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BASEWIDE ECOLOGICAL ASSESSMENT REPORT NAS CECIL FIELD FL

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ABB ENVIRONMENTAL

BASEWIDE ECOLOGICAL ASSESSMENT REPORT

NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

UNIT IDENTIFICATION CODE: N60200
CONTRACT NO. N62467-89-D-0317/090

MARCH 1996

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
NORTH CHARLESTON, SOUTH CAROLINA
29419-9010

NAS CECIL FIELD
JACKSONVILLE, FL

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NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

Unit Identification Code: N60200

Contract No. N62467-89-D-0317/090

Prepared by:

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March 1996

UNITED STATES NAVY
NAVAL FACILITIES ENGINEERING COMMAND

CERTIFICATION OF TECHNICAL
DATA CONFORMITY (MAY 1987)

The Contractor, ABB Environmental Services, Inc., hereby certifies that, to the best of its knowledge and belief, the technical data delivered herewith under Contract No. N62467-89-D-0317/090 are complete and accurate and comply with all requirements of this contract.

DATE: March 13, 1996

NAME AND TITLE OF CERTIFYING OFFICIAL: Rao V.R. Angara
Task Order Manager

NAME AND TITLE OF CERTIFYING OFFICIAL: Anita Pease
Project Technical Lead

(DFAR 252.227-7036)

FOREWORD

The Department of the Navy developed the Installation Restoration (IR) program to locate, identify, and remediate environmental contamination from the past disposal of hazardous materials at Navy and Marine Corps installations. The Navy IR program follows the Department of Defense Environmental Restoration program mandated by the Superfund Amendments and Reauthorization Act of 1986 to address waste sites that may pose a threat to human health or the environment.

The IR program consists of Preliminary Assessment and Site Inspection, Remedial Investigation and Feasibility Study (RI/FS), and Remedial Design and Remedial Action at sites where disposal of chemicals allegedly occurred. The Preliminary Assessment and Site Inspection identifies the presence of pollutants. The RI/FS analyzes the nature and extent of contamination and determines the optimum remedial solution. The Remedial Design and Remedial Action complete the implementation of the solution.

Previous investigations have determined that Naval Air Station (NAS) Cecil Field has 18 waste sites that may pose a threat to human health or the environment. Therefore, an RI/FS will be performed to address the extent, magnitude, and impact of possible contamination at these waste sites.

This Basewide Ecological Assessment Report (BEAR) evaluates potential adverse ecological effects associated with exposures to contamination from all operable units and potential sources of contamination (PSCs). The BEAR contains information on the ecological setting of NAS Cecil Field, the general methodology for ecological risk assessments (ERAs) for individual sites, summaries of the ERA results for each of the sites, and an evaluation of risks for watersheds associated with all sites.

Questions regarding the report should be addressed to the Commanding Officer, Code OOB, P.O. Box 111, NAS Cecil Field, Jacksonville, Florida 32215-0111.

EXECUTIVE SUMMARY

This Basewide Ecological Assessment Report (BEAR) assesses potential ecological risks for aquatic and terrestrial receptors resulting from the release of contaminants from the Installation Restoration program hazardous waste sites and potential sources of contamination (PSCs).

The purpose of the BEAR is to provide a summary of all ecological studies conducted at NAS Cecil Field. The primary objectives of the BEAR are to:

- describe the ecological setting of NAS Cecil Field,
- describe the methodology used to complete individual ecological risk assessments (ERAs) for each of the hazardous waste sites,
- synopsize the ERA results for each site, and
- assess the total ecological risks for watersheds at NAS Cecil Field represented by multiple sites and PSCs.

In addition, the BEAR presents the results of the ERA for Lake Fretwell and Rowell Creek upstream of Lake Fretwell.

Ecological Risks at Lake Fretwell. Potential risks for ecological receptors were evaluated for ecological chemicals of potential concern in surface water and sediment of Lake Fretwell and Rowell Creek upstream of Lake Fretwell.

Lethal effects are predicted for the avian representative wildlife species (i.e., the kingfisher and great blue heron), based on exposures associated with the ingestion of copper in contaminated fish from Lake Fretwell. Sublethal effects (adverse effects to growth and reproduction) are also predicted for the raccoon, kingfisher, and great blue heron. The primary contributor to sublethal effects for the raccoon is Aroclor-1260 associated with the ingestion of contaminated fish in Lake Fretwell. For the two avian representative wildlife species, sublethal risks are associated with ingestion of mercury in contaminated fish from Lake Fretwell.

Lethal effects are not expected for representative wildlife species at Rowell Creek upstream of Lake Fretwell; however, sublethal effects are predicted for the raccoon. Exposures to Aroclor-1260 in contaminated fish tissue from Rowell Creek are the primary contributor to predicted risks for the raccoon.

Based on the weight-of-evidence approach for each of the sampling locations (toxicity testing results, benthic community, and chemical analysis), risks may be present for certain macroinvertebrate receptors at four of the eight sampling stations in Lake Fretwell and one of the sampling stations in Rowell Creek upstream of Lake Fretwell. It is possible that the toxicological results are correlated with exposure to a mixture of contamination in the sediment and other factors that influence the bioavailability of sediment toxicants.

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GLOSSARY

ABB-ES	ABB Environmental Services, Inc.
AIMD	Aircraft Intermediate Maintenance Department
AQUIRE	Aquatic Information Retrieval
ASTM	American Society for Testing and Materials
AVORD	aviation ordnance
AWQC	ambient water quality criteria
BAF	bioaccumulation factor
BCF	bioconcentration factor
BEAR	Basewide Ecological Assessment Report
BRA	baseline risk assessment
CAR	contamination assessment report
CDM	Camp, Dresser, and McKee
C-NOEC	chronic no observed effect concentation
CRDL	contract-required detection limit
CRQL	contract-required quantitation limits
CZR	CZR Incorporated
DCB	dichlorobenzene
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethene
DDT	dichlorodiphenyltrichloroethane
DO	dissolved oxygen
°C	degrees Celsius
EA	Engineering, Science, and Technology
ECC	ecological contaminant of concern
ECPC	ecological chemicals of potential concern
ECT	Environmental Consulting Technology, Inc.
EPT	ephemeroptera-plecoptera-trichoptera
ER-L	effects range-low
ERA	ecological risk assessment
ER-M	effects range-median
ESE	Environmental Science and Engineering, Inc.
FCREPA	Florida Committee on Rare and Endangered Plants and Animals
FDA	Florida Department of Agriculture
FDEP	Florida Department of Environmental Protection
FGFWFC	Florida Game and Fresh Water Fish Commission
FNAI	Florida Natural Areas Inventory
FS	feasibility study
ft/sec	feet per second
HI	hazard index
HQ	hazard quotient
IR	installation restoration
IRA	initial remedial action
IROD	Interim Record of Decision

kg	kilogram
LD_{50}	low dose where 50 percent of animals die
LEL	lower explosive limit
LOEC	lowest observed effect concentration
MATC	maximum acceptable toxicant concentration
mg/ℓ	milligrams per liter
mg/kg	milligrams per kilogram
μg/kg	micrograms per kilogram
μg/ℓ	micrograms per liter
m^2	square meter
μmho/cm	micromhos per centimeter
NAS	Naval Air Station
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
NWI	National Wetlands Inventory
OME	Ontario Minister of the Environment
OU	operable unit
PAH	polynuclear aromatic hydrocarbons
PDE	potential dietary exposure
PEL	permissible exposure limit
PRGs	preliminary remedial goals PDEpotential dietary exposure
PSC	potential source of contamination
RA	remedial action
RBP	rapid bioassessment protocols
RI	remedial investigation
ROD	Record of Decision
RTVs	reference toxicity values
SFF	site foraging frequency
SMP	site management plan
SQAG	Sediment Quality in Florida Coastal Waters
SQGs	sediment quality guidelines
SSC	species of special concern
SVOC	semivolatile organic compound
TBV	toxicity benchmark values
TCE	trichloroethene
TCL	target compound list
TEL	threshold effects level
TPH	total petroleum hydrocarbons
TRPH	total recoverable petroleum hydrocarbons

GLOSSARY (Continued)

UCL	upper confidence limit
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
UST	underground storage tank
VOC	volatile organic compound
WET	Wetland Evaluaiton Technique

CHAPTER 1.0

1.0 INTRODUCTION

1.1 PURPOSE. The Basewide Ecological Assessment Report (BEAR) for Naval Air Station (NAS) Cecil Field assesses the potential ecological risks for aquatic and terrestrial receptors resulting from the release of contaminants from the Installation Restoration (IR) program waste sites and potential sources of contamination (PSCs) (ABB Environmental Services, Inc. [ABB-ES], 1993). The operable units (OUs) and PSCs at NAS Cecil are described in the Site Management Plan (SMP) (ABB-ES, 1993). OUs are used to define investigative sets of sites at NAS Cecil Field based on the types of waste disposed of and the suspected contaminants of concern. Figure 1-1 shows the general location of NAS Cecil Field. Figure 1-2 shows the location of each of the OUs and PSCs at NAS Cecil Field.

Currently, 18 sites are included in the IR program. Twelve of these sites are organized into the following eight OUs:

- OU 1 — Site 1 Old Landfill
  Site 2 Recent Landfill

- OU 2 — Site 5 Oil Disposal Area
  Site 17 Oil and Sludge Disposal Pit Southwest

- OU 3 — Site 7 Old Firefighting Training Area
  Site 8 Boresite Range, Hazardous Waste Storage Area, and Firefighting Training

- OU 4 — Site 10 Rubble Disposal Area

- OU 5 — Site 14 Blue 5 Ordnance Disposal Area
  Site 15 Blue 10 Ordnance Disposal Area

- OU 6 — Site 11 Golf Course Pesticide Disposal Area

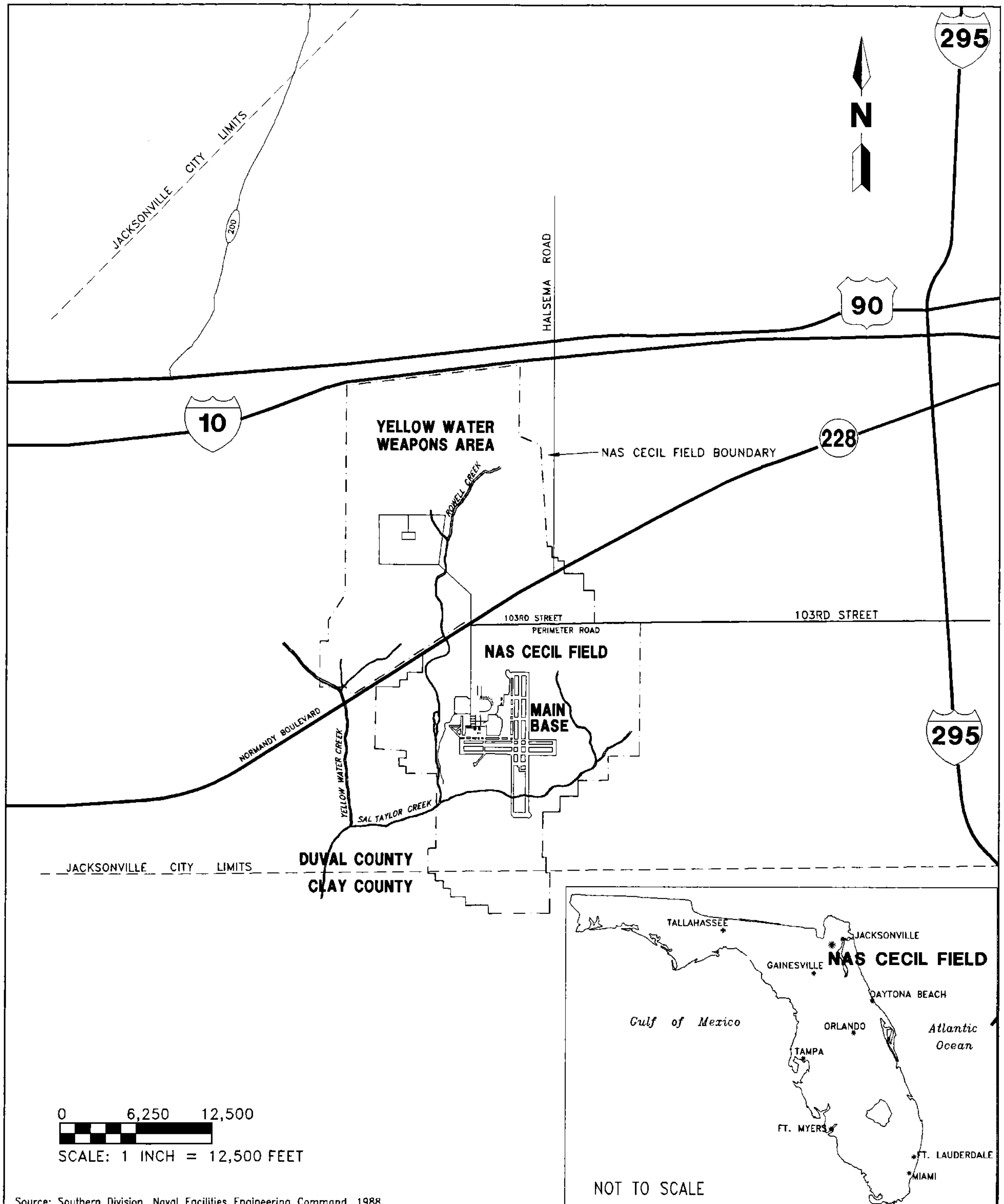
- OU 7 — Site 16 Aircraft Intermediate Maintenance Department (AIMD) Seepage Pit

- OU 8 — Site 3 Oil and Sludge Disposal Pit

Sites where the potential for contamination is present, but little or no confirmatory data are available, are classified as PSCs. These areas require initial confirmation and characterization sampling prior to determining whether further investigation is necessary. The remaining six sites include the following PSCs:

- PSC 4 — Grease Pits
- PSC 6 — Lake Fretwell Rubble Disposal Area
- PSC 9 — Recent Grease Pits
- PSC 12 — Public Works Disposal Area
- PSC 18 — Ammunition Disposal Area
- PSC 19 — Rowell Creek Rubble Disposal Area

This report will address the following four primary objectives:



Source: Southern Division, Naval Facilities Engineering Command, 1988

FIGURE 1-1
GENERAL LOCATION MAP

BASEWIDE ECOLOCICAL ASSESSMENT REPORT

NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

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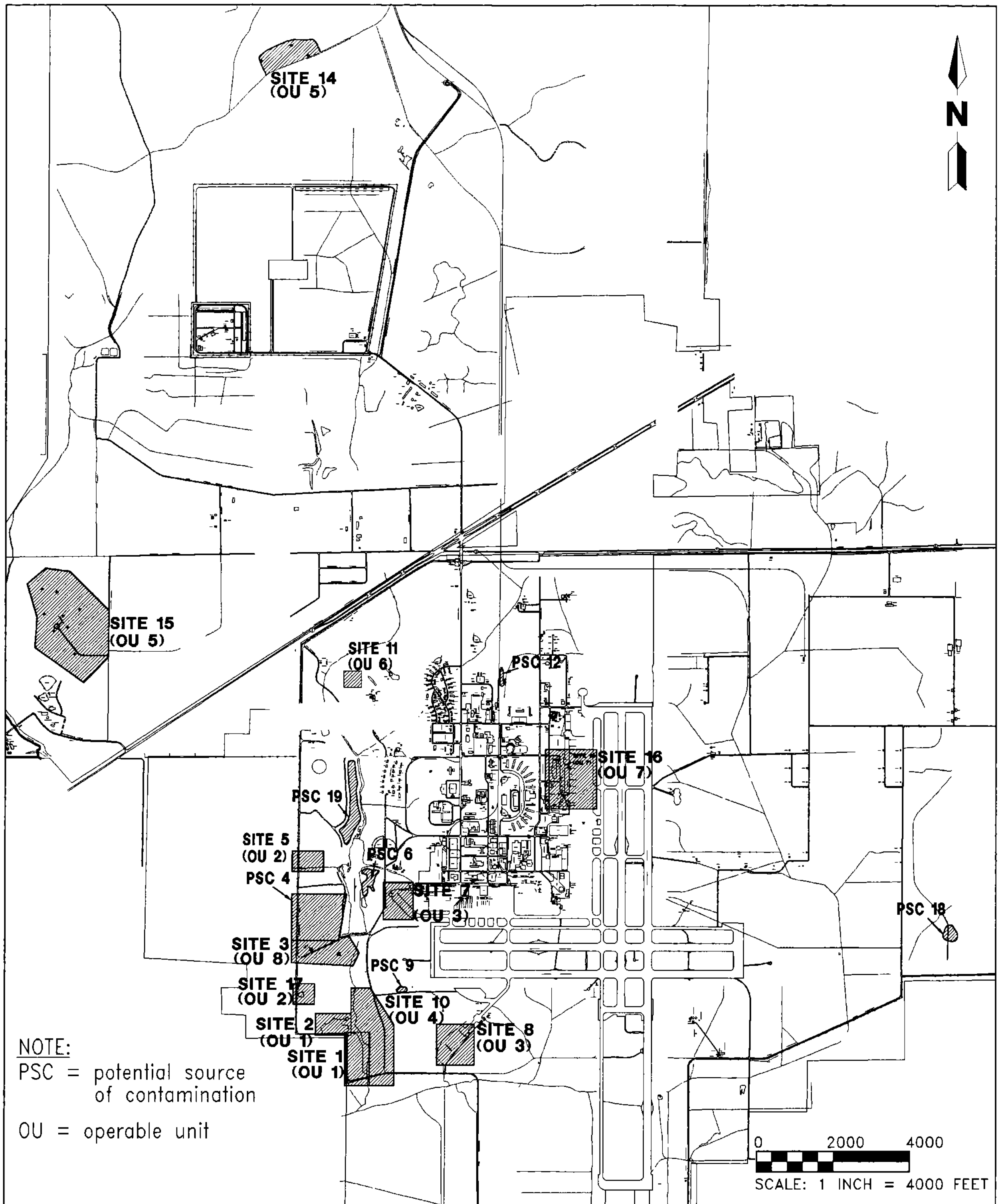

FIGURE 1-2
LOCATION OF OPERABLE UNITS (OUs) AND POTENTIAL SOURCES OF CONTAMINATION (PSCs) AT NAS CECIL FIELD

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SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

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- description of the ecological setting of NAS Cecil Field,
- description of the methodology used to complete individual ecological risk assessments (ERAs) for each of the OUs,
- synopsis of the ERA results for each OU, and
- assessment of the total ecological risks represented by multiple OUs and PSCs at NAS Cecil Field.

The assessment of total risk is based on the results of the respective ERAs completed for each of the OUs as part of the remedial investigation (RI) and feasibility study (FS) process. Additional analyses of the total risk represented by the release of contamination from multiple OUs and PSCs is included in Chapter 8.0. The analysis of overall risk will pertain to the aquatic environments at NAS Cecil Field.

1.2 SCOPE. The BEAR is a "living" document that will be updated at least once a year as long as new ERAs are completed for OUs at NAS Cecil Field. Based on the results of the ERA for each OU, portions of the BEAR will be updated and reissued.

The BEAR will be organized into the following sections:

- Chapter 1: Introduction
- Chapter 2: Ecological setting of aquatic and upland wildlife habitats; wetlands, including rare, endangered, and threatened species
- Chapter 3: Description of ERA methodology
- Chapter 4: Summary of the ecological contaminants of concern
- Chapter 5: Summary of biological sampling including toxicity testing, aquatic and terrestrial studies, wetland studies, and chemical analyses of plant and animal tissue
- Chapter 6: Summary of the results of the ERAs for each of the OUs
- Chapter 7: ERA for Lake Fretwell
- Chapter 8: Analysis of potential ecological risks in the NAS Cecil Field watersheds resulting from all sites and summary of recommendations

CHAPTER 2.0

2.0 ECOLOGICAL SETTING

The ecological setting at each of the OUs and PSCs at NAS Cecil Field is described below. Aquatic habitats (Section 2.1), upland habitats (Section 2.2), and wetlands (Section 2.3) are described in separate subsections and for each of the OUs and PSCs in Section 2.4. Rare, endangered, and threatened species that may be present at NAS Cecil Field are described in Section 2.5.

2.1 AQUATIC HABITATS. Numerous creeks and streams ranging in width from 3 to 15 feet, with lengths totalling approximately 8 miles, are present at the NAS Cecil Field property, providing habitat for aquatic wildlife. Plate 1 shows the aquatic habitats and surface drainage features present at NAS Cecil Field. Streams at the facility include Yellow Water Creek, Sal Taylor Creek, and Rowell Creek, as well as smaller tributaries. Of these, the largest is Yellow Water Creek, which flows through the southwest corner of the Yellow Water Weapons Annex.

Several small ponds and four lakes are scattered throughout the base. The four lakes are Lake Newman, Lake Fretwell, Lake Wright, and Yellow Water (located in the personnel support area of the station). Lake Newman and Lake Fretwell are both manmade lakes that are part of the Rowell Creek drainage system. The largest of the lakes is Lake Fretwell, which is approximately 8 acres in size. It is stocked with bass for sport fishing and has been developed into a recreational complex.

Generally, the eastern and southern portions of the station drain to Sal Taylor Creek. The northern and western portions of the base drain to Lake Newman, Lake Fretwell, or Rowell Creek, which discharges to Sal Taylor Creek in the south-central portion of the facility. Sal Taylor Creek drains westward to Yellow Water Creek, which drains south to the St. Johns River via Black Creek.

A list of resident aquatic species at NAS Cecil Field is presented in Appendix A, Ecological Receptor Species at NAS Cecil Field. This list is based on those aquatic species collected from the aquatic habitats as well as species that are suspected to be resident but were not collected and identified. Appendix A also includes lists of mammals, birds, reptiles, amphibians, benthic macroinvertebrates, and plants associated with aquatic habitats.

2.2 UPLAND WILDLIFE HABITATS. Habitat provided for terrestrial wildlife species at each of the OUs and PSCs at NAS Cecil Field is described in Section 2.4. The term "upland" refers to land not considered to be a jurisdictional wetland by the State of Florida. In general, upland habitat is described for the facility based on a review of information gathered from biological sampling events (EA Engineering, Science, and Technology [EA], 1994a; 1994b) and previous reports (Camp, Dresser, and Mckee [CDM], 1994). The system for description and classification of upland habitats is based on the Florida Natural Areas Inventory (FNAI) and Department of Natural Resources, 1990. The locations of upland habitats at NAS Cecil Field are shown on Plate 1.

2.3 WETLANDS. The locations of wetlands at NAS Cecil Field are shown on Plate 1. This map was generated based on information available from previous reports (Envirodyne Engineers, 1985), a previous wetland study (CDM, 1994), and National Wetlands Inventory (NWI) maps. Information on wetlands specific to OUs and PSCs is included as part of Section 2.4.

2.4 SITE-SPECIFIC INFORMATION. The ecological setting of each of the OUs and PSCs at NAS Cecil Field is summarized in this section. The vegetative cover, terrestrial and aquatic habitats, ecological receptors, and types and locations of wetlands are discussed for each OU and PSC.

Habitats present at NAS Cecil Field consist of both wetland and upland communities. Wetlands are identified according to soil type, hydrology, and plant life sustained in the area. Upland areas are drier than wetlands and are generally present at a higher elevation. Plate 1 shows the upland and wetland habitats present at NAS Cecil Field. Sections 5.3 and 5.4 contain more information on the upland and wetland communities present at the facility.

Wetlands are described according to both their U.S. Fish and Wildlife Services (USFWS) classification (Cowardin and others, 1979) and their FNAI counterpart. It is important to note that the FNAI classification system describes undisturbed areas. Because many of the OUs and PSCs have been altered due to past disposal practices and other human activities, the FNAI classifications used may not completely describe all vegetative cover types at each of the OUs and PSCs.

2.4.1 Operable Units Information is available on the ecological setting of all of the OUs identified at NAS Cecil Field.

Two extensive surveys to support ecological assessments at NAS Cecil Field were completed in 1993. An extensive wetlands survey was completed for OUs 1, 2, 7, and 8 (CDM, 1994). Wetlands were identified and delineated, and terrestrial habitats were mapped during this survey. The objectives and results of the wetlands survey are discussed in detail in Section 5.4 of this report. Table 2-1 lists all the types, indicator species, and approximate sizes of wetlands associated with OUs and PSCs at NAS Cecil Field. Plate 1 shows the habitat types, vegetative cover, and the types and extent of wetlands and watersheds across the facility. Site-specific observations made during this study are discussed in the following subsections where appropriate.

Additionally, a comprehensive aquatic biological study was completed for NAS Cecil Field in 1993 (EA, 1994a). Biological sampling was conducted at stations within several watersheds at NAS Cecil Field, including Rowell Creek, Sal Taylor Creek, Yellow Water Creek, Lake Fretwell, and tributaries to these water bodies. Both reference locations and locations where OU and PSC activities may have impacted aquatic habitat were sampled. The objectives and results of the biological study are discussed in detail in Section 5.2 of this report. Plate 1 shows the locations of watersheds (i.e., aquatic habitats) where studies were conducted, and Plate 2 shows the sampling locations for surface water and sediment. Locations where samples were collected during this biological study are marked with sample identifiers including the characters "BIO." Site-specific observations made during this study are discussed in the following subsections where appropriate.

Table 2-1
Summary of Wetland Classes of Study Areas

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Study Area	Wetland Class	Indicator Species (common name)	Approximate Acreage
OU 1, Site 1	Palustrine Scrub/Shrub Broad-Leaved Deciduous	Red maple, sweetgum, wax myrtle, royal fern, gallberry, and cinnamon fern.	1.5
	Palustrine Forested Broad-Leaved Deciduous	Laurel oak, water ash, red maple, and bald cypress.	3
	Palustrine Emergent Persistent	Arrowheads, rushes, sedges, and black willow.	1.5
OU 1, Site 2	Palustrine Emergent Persistent	Rushes, sedges, royal fern, cattails, and hatpins.	0.5
	Palustrine Forested Broad-Leaved Deciduous	Sweetgum, swampbay, red maple, red bay, slash pine, and cinnamon fern.	3.5
OU 2, Site 5	Palustrine Forested Broad-Leaved Deciduous	Water ash, red maple, bald cypress, aider, sweetbay, and cinnamon fern.	[1].3
	Palustrine Emergent Persistent	Arrowheads, rushes, sedges, water lily, and black willow.	1.8
OU 2, Site 17	Palustrine Forested Broad-Leaved Deciduous	Sweetgum, swampbay, red maple, red bay, slash pine, and cinnamon fern.	[1] 1.1
OU 5, Site 14	Palustrine Scrub-Shrub Marsh	NI	NI
OU 5, Site 15	Floodplain Swamp	NI	NI
OU 7, Site 16	Palustrine Forested Broad-Leaved Deciduous	Red maple, laurel oak, water ash, bald cypress, sweetgum, slash pine, loblolly pine, sweetbay, cinnamon fern, and wax myrtle.	NA
	Palustrine Forested Needle-Leaved Evergreen	Pond pine in association with dense stands of broad-leaved evergreen and deciduous shrubs.	NA
	Palustrine Forested Broad-Leaved Evergreen	Sweet bay, red bay, and loblolly bay.	NA
	Palustrine Emergent Persistent	Cattails, bulrushes, saw grass, sedges, reed, manna grasses, slough grass, whitetop, dock, water willow, and smartweeds.	NA
	Palustrine Scrub and Shrub Evergreen	Fettergush, young or stunted black spruce, pond pine, coastal sweetbells, gallberry, black titi.	NA
	Palustrine Forested Broad-Leaved Deciduous and Needle-Leaved Evergreen	Red maple, pond pine, combination of typical vegetation of broad-leaved deciduous and needle-leaved evergreen.	NA
	Palustrine Forested Deciduous	Red maple, bald cypress, typical vegetation of broad-leaved deciduous in addition to pond cypress.	NA
OU 8, Site 3	Palustrine Forested Broad-Leaved Deciduous	Red maple, sweet gum, swamp bay, sweet bay, wax myrtle, loblolly bay, and cinnamon fern.	[2]6.2
	Palustrine Scrub-Shrub Broad-Leaved Deciduous	Sweet bay, swamp bay, red bay, loblolly bay, wax myrtle, muscadine grape, gallberry, meadow beauty, and netted chain fern.	[2]6.2
	Palustrine Emergent Persistent	Black willow, myrtle oak, climbing hempweed, scarlet pimpernel, rushes, and dotted smartweed.	0.5

See notes at end of table.

Table 2-1 (Continued)
Summary of Wetland Classes of Study Areas

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Study Area	Wetland Class	Indicator Species (common name)	Approximate Acreage
PSC 4	Palustrine Scrub-Shrub Marsh	Southern bayberry, red maple, gallberry, titi, red bay, tupelo, oaks, sweetbay magnolia, tall gallberry holly, and myrtle-leaf holly.	NI

Source: Camp, Dresser, and Mckee, 1993 and 1994; ABB-ES, 1995.

[1] Represents approximate site acreage where environmental sampling occurred. Adjacent wetland acreage is more extensive.
[2] Combined acreage for palustrine forested broad-leaved deciduous and palustrine scrub-shrub broad-leaved deciduous.

Notes: OU = operable unit.
NI = not identified; wetlands have not been delineated at this site or PSC.
NA = not applicable; wetlands were not directly located at the site or PSC.
PSC = potential source of contamination.

Ecological field investigations including habitat mapping of OUs 3, 4, 5, and 6 were completed in September 1995. The goal of the field investigations was to gather qualitative information on the ecological setting of these areas. Currently, the results of these field investigations are the only data available about habitats and receptors at these OUs. The results of these investigations are summarized in Paragraphs 2.4.1.3 through 2.4.1.6.

2.4.1.1 **Operable Unit 1** OU 1 consists of two sites: Site 1, the Old Landfill; and Site 2, the Recent Landfill. The two sites are adjacent to one another. Figures 2-1 and 2-2 show the upland and wetland habitats present at Sites 1 and 2, respectively.

<u>Terrestrial Habitats and Receptors</u>. A cypress dome, dominated by mature bald cypress trees and associated mature hardwood species, is present in the wetlands area that covers the eastern portion of Site 1. The western portion of the site is an upland community consisting of a planted pine forest.

The upland plant community covering Site 2 consists primarily of grasses, a dense shrub and herb layer, and scattered slash pines (*Pinus elliotii*). The area north of Site 2 consists of a planted pine forest. An upland mixed forest borders Site 2 to the west. Wetlands were identified to the east of Site 2.

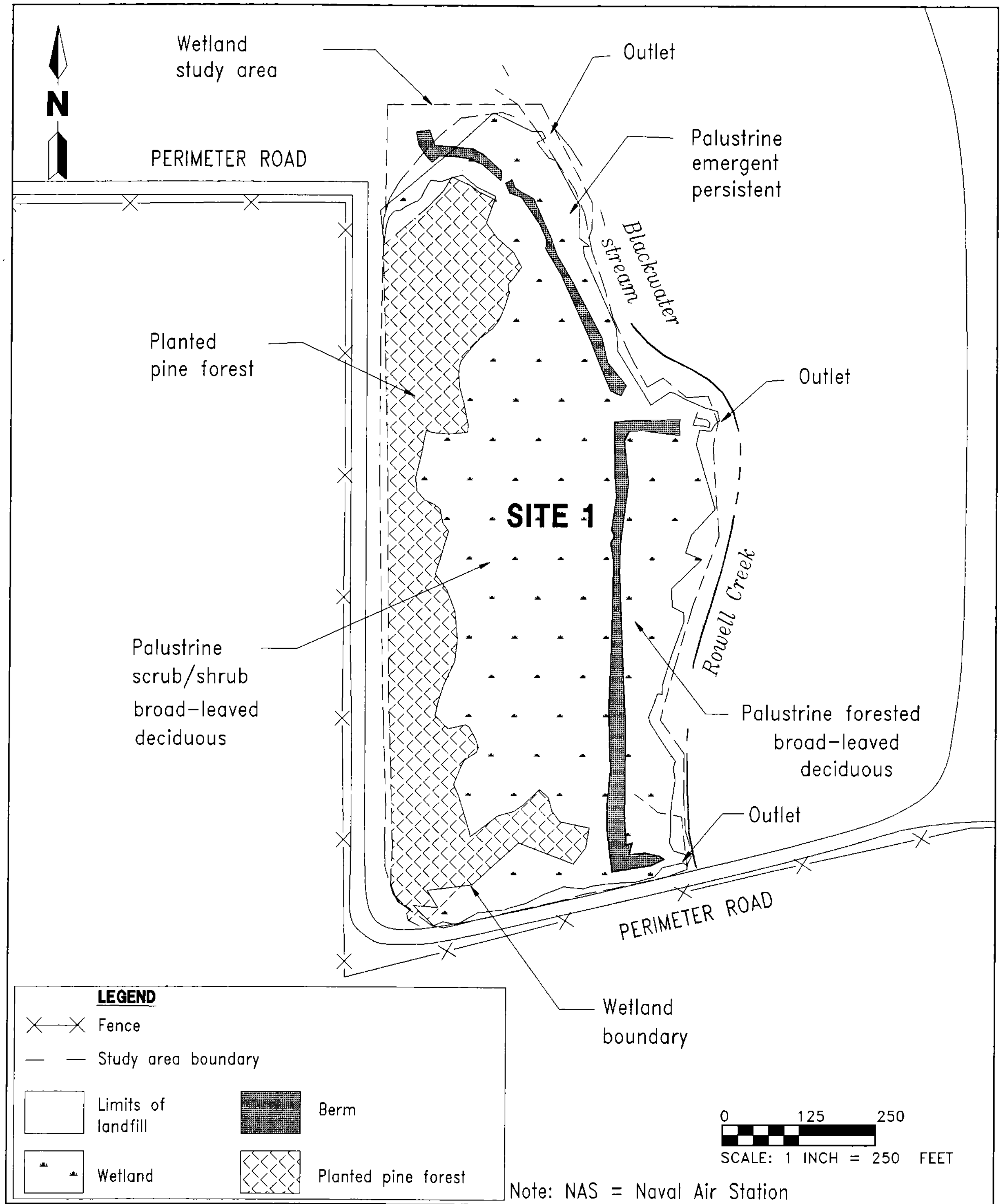
The vegetative community at Site 2 provides limited habitat for terrestrial wildlife. However, Site 1 and the wetland to the east of Site 2 have vegetative communities that are capable of supporting an abundance of wildlife (ABB-ES, 1994a). Numerous wildlife species representing all trophic levels have been observed in this area.

Potential terrestrial receptors at OU 1 include wildlife, plants, and invertebrates. Terrestrial wildlife that have been directly observed at OU 1 include both lower trophic level organisms (e.g., insects, rodents, and armadillo [*Dasypus novemcinctus*]), and higher trophic-level predators such as barred owl (*Strix varia*), screech owl (*Otus asio*), sharp-shinned hawk (*Accipter striatus*), pygmy rattlesnake (*Sistrus miliarus barbouri*), water moccasin (*Agkistrodon pisciverous conanti*), and other snakes (ABB-ES, 1994a). Other terrestrial flora and fauna potentially residing at OU 1 are listed in Appendix A.

<u>Aquatic Habitats and Receptors</u>. Aquatic habitats at OU 1 were characterized as part of a facilitywide field survey completed in July 1993 (EA, 1994a). An earlier aquatic sampling event was completed in this area in 1991 (Evironmental Consulting and Technology, Inc. [ECT], 1992). The results of the 1991 study were used to help design the 1993 sampling program and are discussed briefly below.

The 1991 sampling program consisted of quantitative collection of macroinvertebrates and qualitative collection of fish from six stations on Rowell Creek. Similar to the earlier study, the 1993 sampling program consisted of quantitative collection of macroinvertebrates and qualitative collection of fish at four locations and a reference station in the vicinity of OU 1. Results of both of these studies are discussed in detail in Section 5.2.

A list of the benthic macroinvertebrates collected in the vicinity of OU 1 during the study is presented in Appendix A-7. Additionally, eight fish species from six families were identified in Rowell Creek adjacent to OU 1 in 1993. The fish collected were primarily juvenile or small species of fish.



Note: NAS = Naval Air Station

FIGURE 2-1
WETLAND AND UPLAND HABITATS PRESENT AT SITE 1

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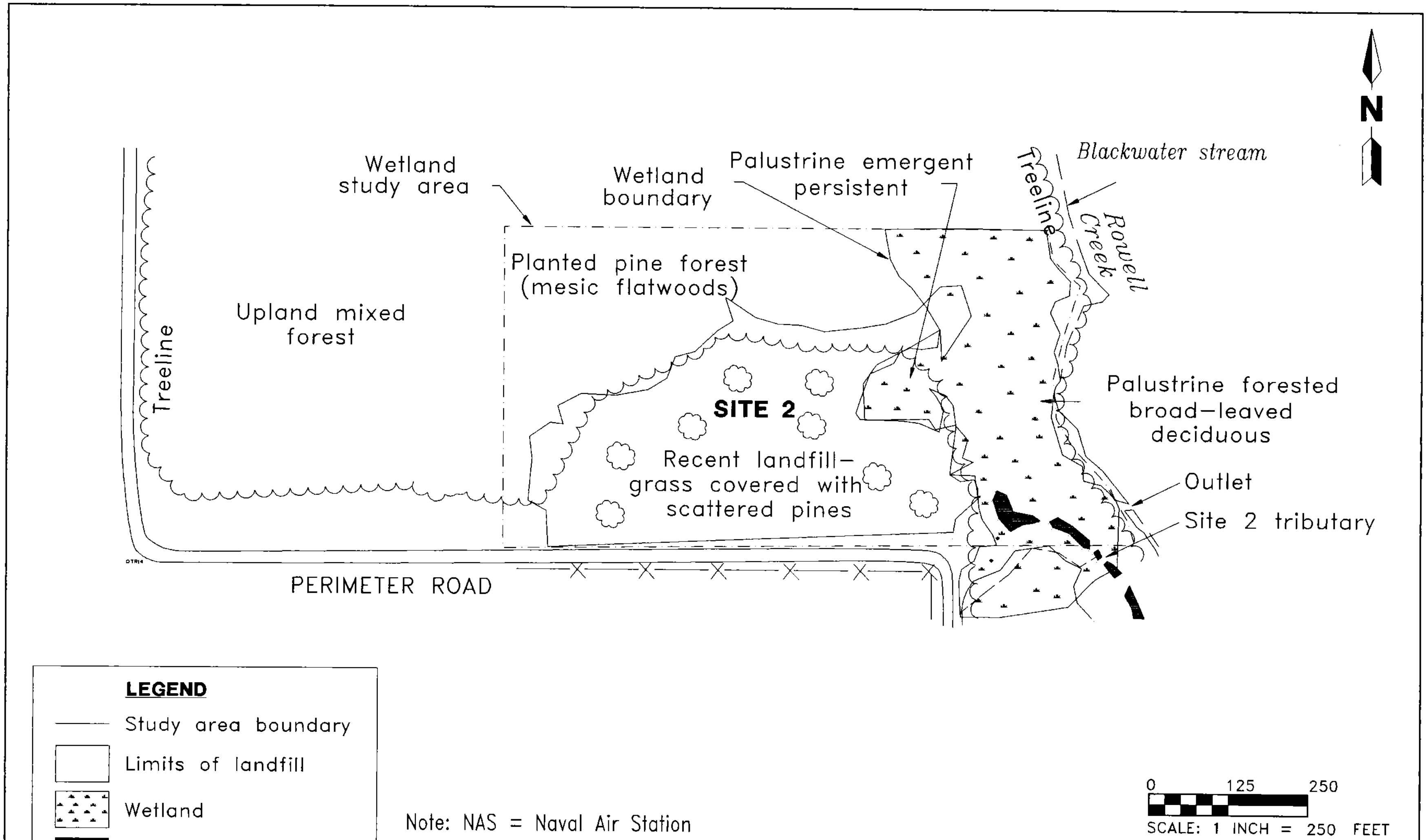

Note: NAS = Naval Air Station

FIGURE 2-2
WETLAND AND UPLAND HABITATS PRESENT AT SITE 2

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Substrate at most of the sampling stations in the areas adjacent to OU 1 consisted of sand; two sampling stations located in the Site 2 tributary had leaf mat substrate. Water temperatures and pH were within normal ranges. The dissolved oxygen content varied from a low of 0.5 milligrams per liter (mg/ℓ) to 5.6 mg/ℓ. Water clarity ranged from clear to slightly tannic, with the exception of water from the Site 2 tributary, which was classified as turbid with an orange-rust color appearance and flocculent material. The water surface in this tributary has an iridescent appearance that breaks apart.

Potential aquatic receptors at OU 1 include invertebrates, plants, algae, amphibians, and fish. These receptors are present in Rowell Creek and in the Site 2 tributary. Other aquatic species identified at OU 1 during field sampling events are listed in Appendix A.

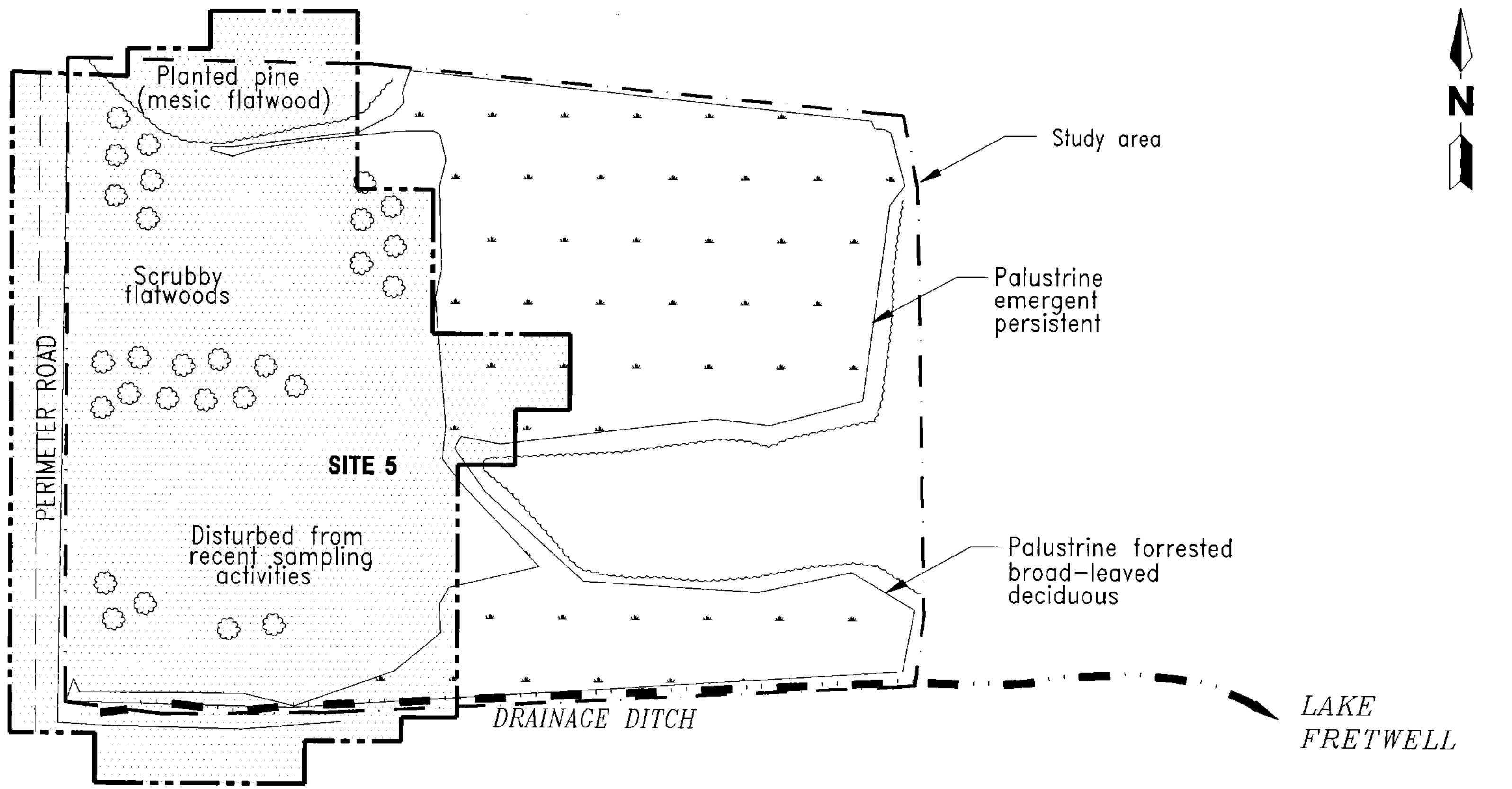
Wetlands. Three classes of wetlands were identified at OU 1. Of these, all three classes were found on the eastern portion of Site 1 (palustrine forested broad-leaved deciduous, palustrine emergent persistent, and palustrine scrub and shrub broad-leaved deciduous), and two classes were identified to the east of Site 2 (palustrine forested broad-leaved deciduous and palustrine emergent persistent). Table 2-1 lists the types, indicator species, and sizes of these wetlands, and Figures 2-1 and 2-2 show the location and types of wetlands identified at Sites 1 and 2, respectively (CDM, 1994). The results of the wetlands survey are discussed in more detail in Section 5.4.

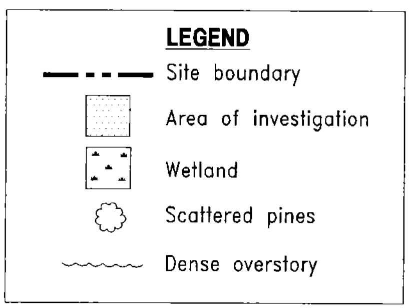
2.4.1.2 **Operable Unit 2** OU 2 consists of two sites: Site 5, the Oil Disposal Area Northwest; and Site 17, the Oil and Sludge Disposal Area Southwest. Site 5 is located approximately 3,000 feet north of Site 17. Figures 2-3 and 2-4 show the upland and wetland habitats present at Sites 5 and 17, respectively.

Terrestrial Habitats and Receptors. The plant communities at Sites 5 and 17 are similar, with disturbed upland cover types on the western portions of the sites and wetlands located on and to the east of the sites. The upland communities covering Site 5 include scrubby flatwoods, planted pines, and disturbed upland regions. Two types of wetlands are located to the east and south of the site. A drainage ditch, which bounds Site 5 on the south, carries surface water eastward toward Lake Fretwell, located approximately 1,000 feet from the site. An upland community consisting of a planted pine forest is located to the north and west of Site 5.

The western portion of Site 17 is an upland community. It is a grass-covered area with scattered young slash pines and a dense shrub and herb layer. A wetland area has been identified on the eastern portion of the site, and a planted pine forest surrounds the site.

The invertebrate biomass within the uplands at both Sites 5 and 17 probably serves as a forage base for a limited number of wildlife species, including amphibians, reptiles, birds, and mammals. Up to 20 or 30 species of reptiles and amphibians can be supported in an upland habitat (Ashton and Ashton, 1988; 1989; 1991). Several small mammal trails were observed in the interior and around the perimeter of the uplands at Site 5. These trails may be from several types of species, including the eastern cottontail rabbit (*Sylvilagus floridanus*), the hispid cotton rat (*Sigmodon hispidus*), the cotton mouse (*Peromyscus gossypinus*), the armadillo, the red fox (*Vulpes vulpes*), the gray fox (*Urocyon cinereoargenteus*), and while-tailed deer (*Odocoileus virginianus*).





Note: NAS = Naval Air Station

FIGURE 2-3
WETLAND AND UPLAND HABITATS PRESENT AT SITE 5

BASEWIDE ECOLOGICAL ASSESSMENT REPORT

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

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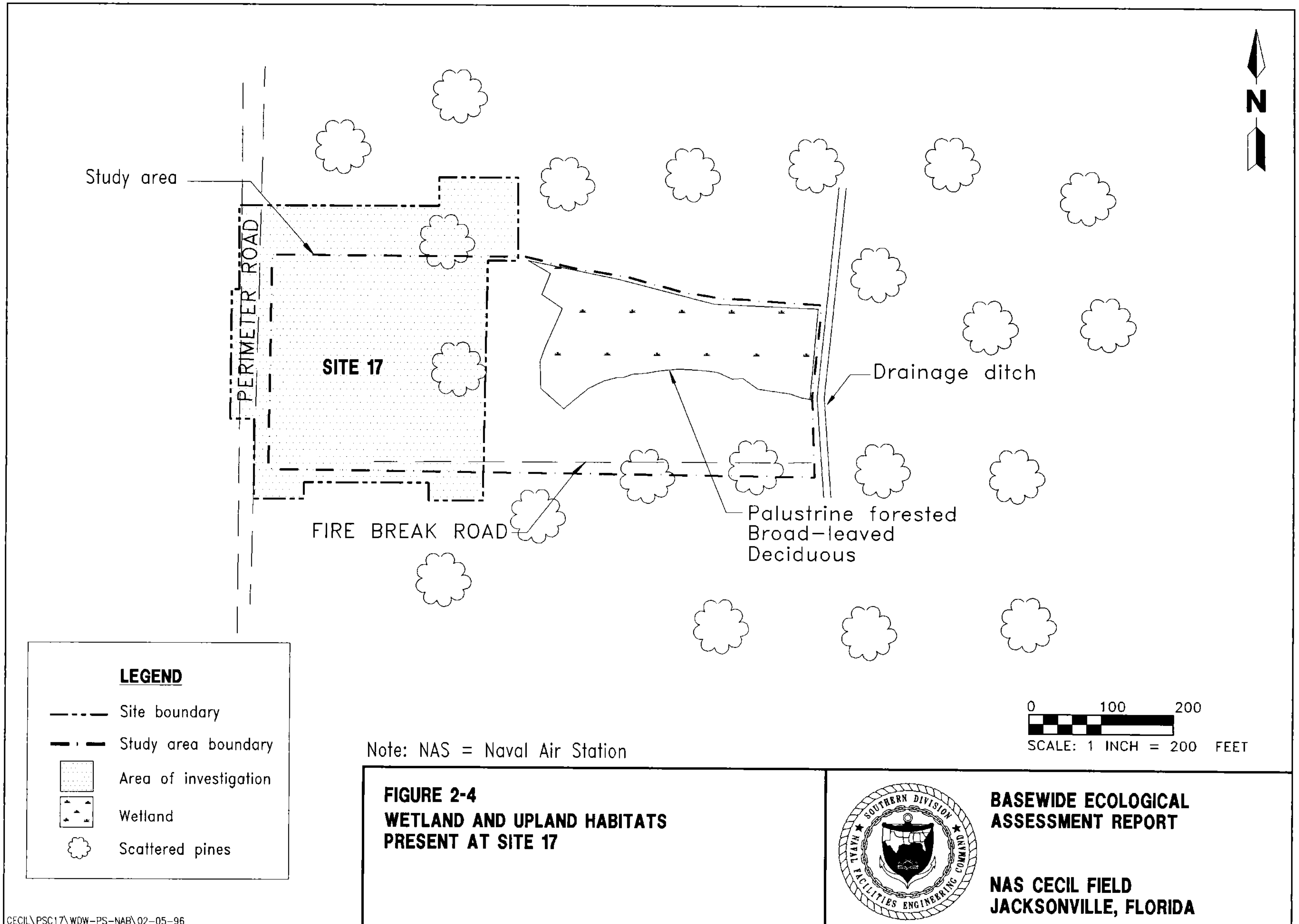

Note: NAS = Naval Air Station

FIGURE 2-4
WETLAND AND UPLAND HABITATS PRESENT AT SITE 17

BASEWIDE ECOLOGICAL ASSESSMENT REPORT

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

Sites 5 and 17 also provide habitat for avifauna. Birds that have been directly observed at OU 2 include: brown thrasher (*Toxostoma rufum*), bobwhite quail, mockingbird (*Mimus polyglottus*), common grackle (*Quiscalus quiscula*), fish crow (*Corvus ossigfragus*), killdeer (*Charadrius voviferus*), northern cardinal (*Cardinalis cardinalis*), blue jay (*Cyanocitta cristata*), mourning dove (*Zenaida macroura*), rufous-bellied woodpecker (*Centrus carolinus*), pine warbler (*Dendroica pinus*), ruby-crowned kinglet (*Regulus calendula*), solitary vireo (*Vireo solitarius*), and black and white warbler (*Mniotilta varia*).

Potential terrestrial receptors at OU 1 include wildlife, plants, and invertebrates. Other terrestrial flora and fauna potentially residing at OU 1 are listed in Appendix A.

Aquatic Habitats and Receptors. Aquatic habitats at the Site 5 drainage ditch were characterized as part of a facilitywide field survey completed in July 1993 (EA, 1994a). This survey also included sampling of aquatic macroinvertebrate communities in Rowell Creek and Lake Fretwell. Four sampling stations were located in the Site 5 drainage ditch. Aquatic sampling was not completed at Site 17 because there is no aquatic habitat in this area.

The goals and results of the 1993 study are discussed in Section 5.2. The sampling program consisted of quantitative collection of macroinvertebrates at four locations and a reference station. Fish were not collected in the Site 5 drainage ditch.

A list of the benthic macroinvertebrates collected in the vicinity of Site 5 during the study is shown in Appendix A-7. Substrate at most of the sampling stations consisted of 50 to 80 percent leaf pack; one sampling station had slightly more mud, muck, or silt than the other four locations. Water temperatures and pH were within normal ranges. The dissolved oxygen content varied from 0.4 mg/ℓ to 3.4 mg/ℓ, all below the Florida water quality standard of $\geq$ 5 mg/ℓ. Water was clear at all stations evaluated.

Potential aquatic receptors at Site 5 include invertebrates, plants, algae, and amphibians. These receptors are present in the drainage ditch. Aquatic species identified at Site 5 are listed in Appendix A.

Wetlands. Two classes of wetlands were identified at OU 2. Of these, both wetland classes were found on and to the east of Site 5 (palustrine forested broad-leaved deciduous and palustrine emergent persistent, respectively), and one class was identified at Site 17 (palustrine forested broad-leaved deciduous). Table 2-1 lists the types, indicator species, and sizes of these wetlands. Figures 2-3 and 2-4 show the location and types of wetlands identified adjacent to Sites 5 and 17, respectively (CDM, 1994). The results of the wetlands survey are discussed in further detail in Section 5.4.

2.4.1.3 **Operable Unit 3** OU 3 consists of two sites: Site 7, the Old Fire-Fighter Training Area; and Site 8, the Firefighter Training Area/Boresite Range/Hazardous Waste Storage Area. Both sites are located near the flightline area. Habitat mapping of these sites was completed in 1995. Figures 2-5 and 2-6 provide an overview of the habitats at Site 7 and Site 8, respectively.

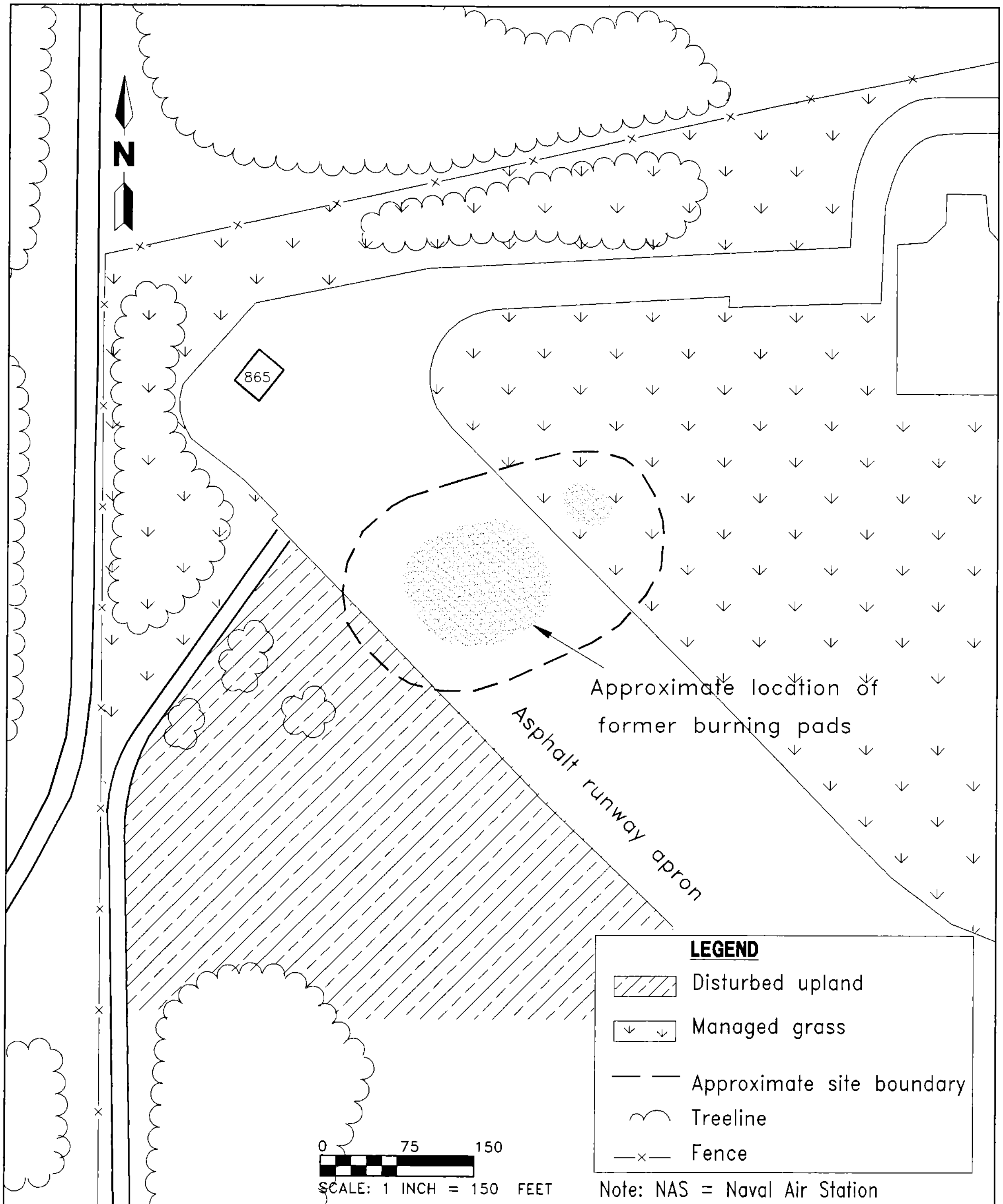

FIGURE 2-5
UPLAND HABITATS PRESENT AT SITE 7

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BASEWIDE ECOLOGICAL ASSESSMENT REPORT

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

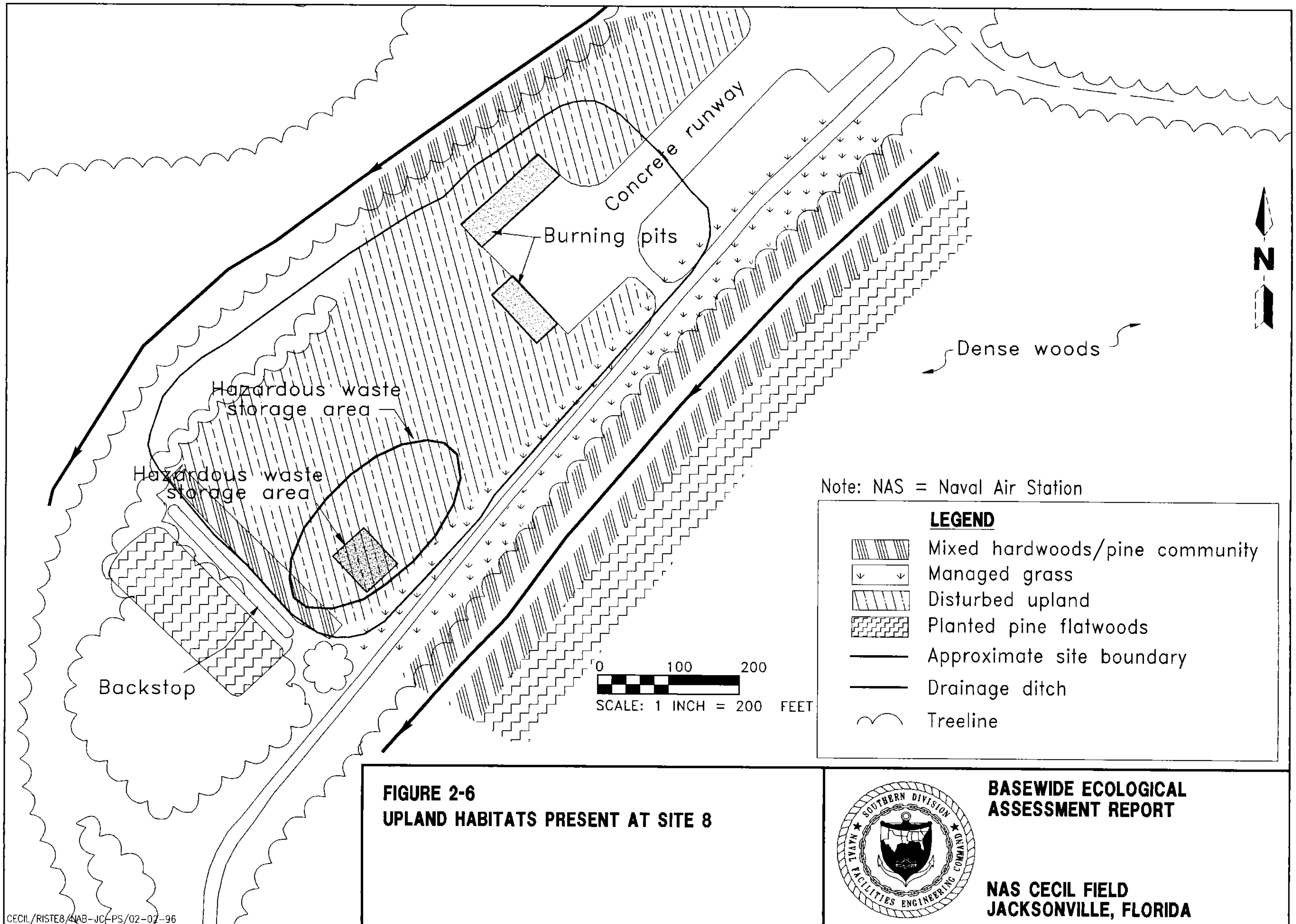

FIGURE 2-6
UPLAND HABITATS PRESENT AT SITE 8

BASEWIDE ECOLOGICAL ASSESSMENT REPORT

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

Terrestrial Habitats and Receptors. Ecological communities identified at Site 7 include mowed grass (4 to 6 inches in height) and disturbed uplands. Plant species observed at the site included grasses, yellow aster (*Aster* sp.), yellow fleabane, grasses (*Echinochloa* sp.), crabgrass (*Digitaria* or *Eleusine* sp.), bitterweed (*Helenium amarum*), blackberry (*Rubus* sp.), verbena, fleabane (*Erigeron* sp.), bullbriar greenbriar (*Smilax bona-nox*), buchnera (*Buchnera* sp.), ragweed (*Ambrosia* sp.), laramide, bracken fern (*Pteridium aquilinum*), winged sumac (*Rhus copallina*), dog fennel (*Eupatorium capillifolium*), cherry, and occasional live oak (*Quercus virginiana*) and slash pine.

Several ecological communities were found at Site 8, including mowed grass, disturbed upland, manmade drainage ditches, planted pine flatwoods, and a mixed pine and hardwood community. The site is surrounded by forested areas. Tree and shrub species observed at Site 8 include bay (*Magnolia* sp.), longleaf pine (*Pinus australis*), red cedar (*Juniperis virginiana*), live oak, loblolly pine (*Pinus taeda*), laurel oak, red maple, willow, black cherry, saw palmetto (*Serenoa repens*), water oak, southern bayberry (*Myrica cerifera*), sweetgum, and holly (*Myrica inodora*). Herbivorous and graminoid species found at Site 8 include crabgrass, yellow-eyed grass (*Xyris* sp.), fleabane, snapdragon, dog fennel, spanish needles (*Bidens pilosa*), panic grass (*Panicum vergatum*), sedges (*Carex* sp.), goldenrod (*Solidago fistulosa*), acacia (*Acacia* sp.), blackberry, cinnamon fern (*Osmunda cinnamomea*), bracken fern, bullbriar greenbriar, Virginia creeper (*Parthenocissus quinquefolia*), thistle (*Cirsium* sp.), verbena, tall grasses, yellow aster, agalinis (*Agalinis fasciculata*), bedstraw (*Galium* sp.), sumac, loblolly bay (*Gordona lasianthus*), and netted chain fern (*Woodwardia areolata*).

Potential receptor species at OU 3 include terrestrial plants, birds, mammals, and reptiles. Few signs of mammals were found at the site, though birds and reptiles were observed. Other terrestrial flora and fauna potentially residing at OU 3 are listed in Appendix A.

Aquatic Habitats and Receptors. A manmade drainage ditch was observed at Site 8. The ditch contained stagnant to slow-moving water, often with tannin staining. This ditch may provide minimum suitable habitat for aquatic macroinvertebrates.

Wetlands. Wetlands were not identified at OU 3.

2.4.1.4 Operable Unit 4 OU 4 consists of Site 10, the Rubble Disposal Area. It extends due north from Perimeter Road along the eastern edge of Rowell Creek, south of Lake Fretwell. Habitat mapping at OU 4 was completed in 1995. Figure 2-7 provides an overview of the habitats present at Site 10.

Terrestrial Habitats and Receptors. The following communities were identified at OU 4, roughly from east to west: disturbed upland, mixed hardwood and pine community, upland mixed forest (with a transitional hardwood and floodplain forest area grading down into the blackwater stream), floodplain swamp, and blackwater stream. Tree and shrub species found at Site 10 include sweetgum, Carolina cherry (*Pinus carolina*), southern bayberry, red cedar, water oak (and various other oak species), saw palmetto, bay, live oak, blueberry (*Vaccinium* sp.), cypress, sweetbay magnolia, red maple, and false willow. Herbaceous and graminoid plant species found at Site 10 include bullbriar greenbriar, bracken fern, wild poinsettia (*Poinsettia heterophylla*), dog fennel, yellow aster, dry

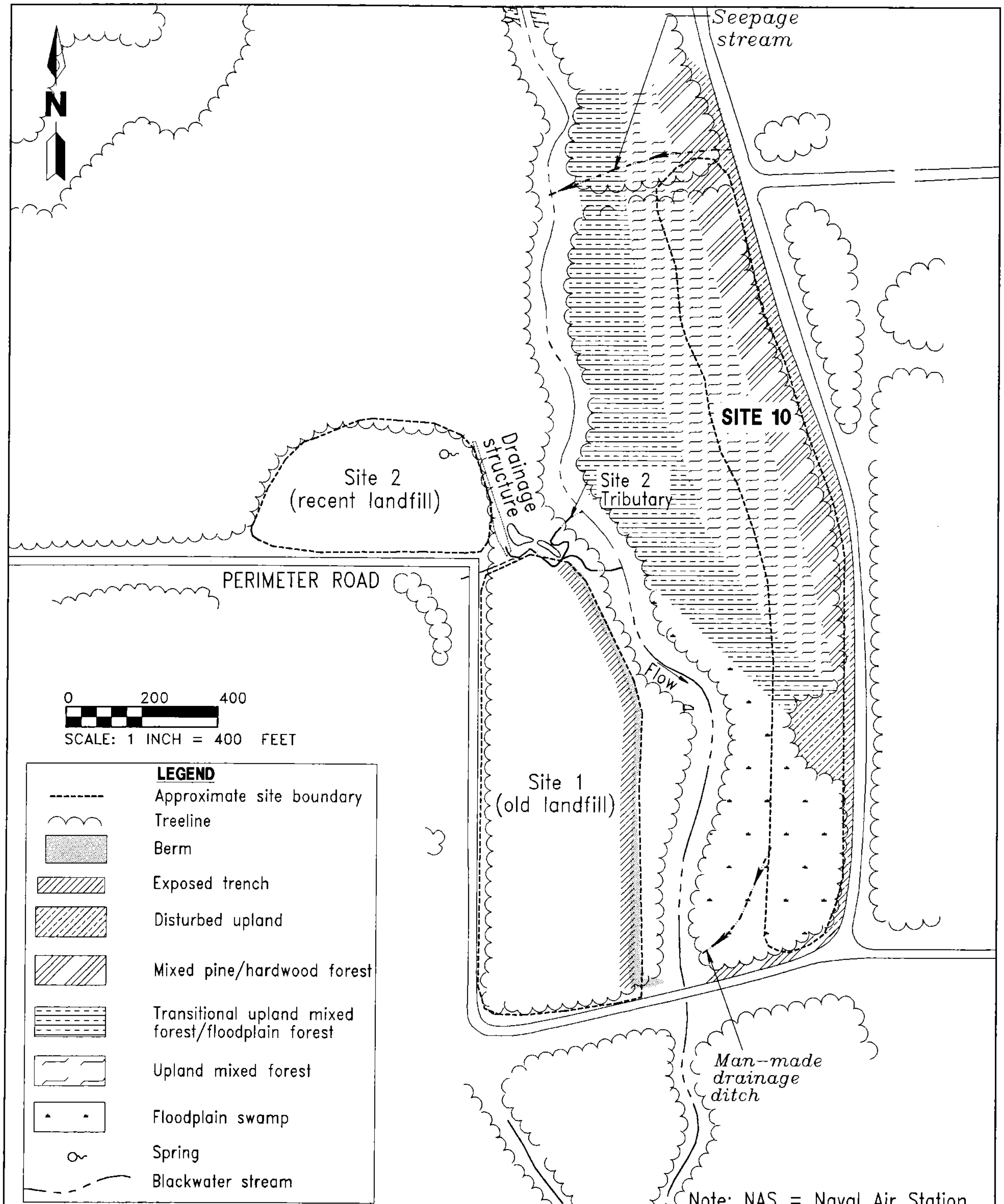

FIGURE 2-7
UPLAND HABITATS PRESENT AT SITE 10

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BASEWIDE ECOLOGICAL ASSESSMENT REPORT

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

grass, fleabane, coralberry (*Symphoricarpos orbiculatus*), sea myrtle (*Baccharis halmifolia*), grasses (*Endogronan* sp.), goldenrod, Virginia creeper, peppervine (*Ampelopsis arborea*), thistle, morning glory (*Ipomoea* sp.), muscadine grape (*Vitis rotundifolia*), evening primrose (*Oenothera* sp.), crabgrass, rudbeckia, trumpet creeper (*Campsis radicans*), holly, flat-topped white aster (*Aster umbellatus*), beauty berry (*Callicarpa americana*), panic grass, poison ivy (*Toxicodendron radicans*), blazing star (*Liatris tenufolia* and other species), climbing fern (*Ligodium* sp.), bamboo, grape fern (*Botrychium* sp.), sundew (*Drosera intermedia*), red aster, cattails (*Typha* sp.), climbing hempweed (*Mikania scandens*), clubmoss (*Lycopodium* sp.), meadow beauty (*Rhexhia virginica*), violet (*Viola* sp.), persimmon (*Diospyros virginiana*), cardinal flower (*Lobelia cardinalis*), maiden-hair fern (*Adiantum pedatum*), pokeweed, horsetail, cinnamon fern, royal fern (*Osmunda regalis*), pickerelweed (*Pontederia cordata*), buckwheat, wild poinsettia, and lobelia (*Lobelia* sp.).

Potential receptor species at OU 4 include terrestrial plants, birds, mammals, and reptiles. Few signs of mammals were found at the site, though birds and reptiles were observed. Other terrestrial flora and fauna potentially residing at OU 4 are listed in Appendix A.

<u>Aquatic Habitats and Receptors</u>. A seepage stream was found along the northern terminus of the site, and a manmade drainage ditch was found in the southern portion of the site. The ditch contained stagnant to slow-moving water, often with tannin staining. This ditch may provide minimum suitable habitat for aquatic macroinvertebrates.

<u>Wetlands</u>. Wetlands were not identified at OU 4.

2.4.1.5 **Operable Unit 5** OU 5 consists of two sites: Site 14, the Blue 5 Ordnance Disposal Area; and Site 15, the Blue 10 Ordnance Disposal Area. They are both located in the Yellow Water Weapons Area portion of NAS Cecil Field. Habitat mapping at these sites was completed in 1995. Figures 2-8 and 2-9 show the habitats present at Sites 14 and 15, respectively.

<u>Terrestrial Habitats and Receptors</u>. Several ecological communities were observed at Site 14, including disturbed uplands, manmade drainage ditches, mesic and wet planted pine flatwoods, wet meadow, scrub and shrub marsh with depression-emergent marsh characteristics, and carnivorous plants.

Tree and shrub species observed at Site 14 include myrtle-leaved holly (and other hollies), slash pine, southern bayberry, water hemlock (*Cicuta* sp.), and tall gallberry holly (*Ilex coriacea*). Herbaceous and graminoid plant species observed at Site 14 include twig rush (*Cladium* sp.), sedges (*Carex* sp. and *Cyperus* sp.), hatpins (*Eriocaulon* sp.), yellow-topped aster, blazing star, sand blackberry (*Rubus cuneifolius*), St. Johnswort (*Hypericum* sp.), grasses, yellow-eyed grass, common dodder (*Cuscuta* sp.), white bracted sedge (*Dichromena latifolia*), meadow beauties, rattlebox (*Sesbania* sp.), ragweed, acacia, dog fennel, redroot (*Lachnanthes caroliniana*), sedge (*Scirpus* sp.), foxtail clubmoss (*Lycopodium alopeuroides*), bugleweed (*Lycopus* sp.), seedbox (*Ludwigia alternifolia*), rabbit tobacco (*Gnaphalium obtusifolium*), twig rush, sea myrtle, muscadine grape, hatpins, agalinis, hooded pitcher plant (*Sarracenia minor*), bog buttons (*Lachnocaulon* sp.), asters, sundew, horned bladderwort (*Utricularia cornuta*), purple bladderwort (*Utricularia purpurea*), and tickseed (*Coreopsis gladiata*).

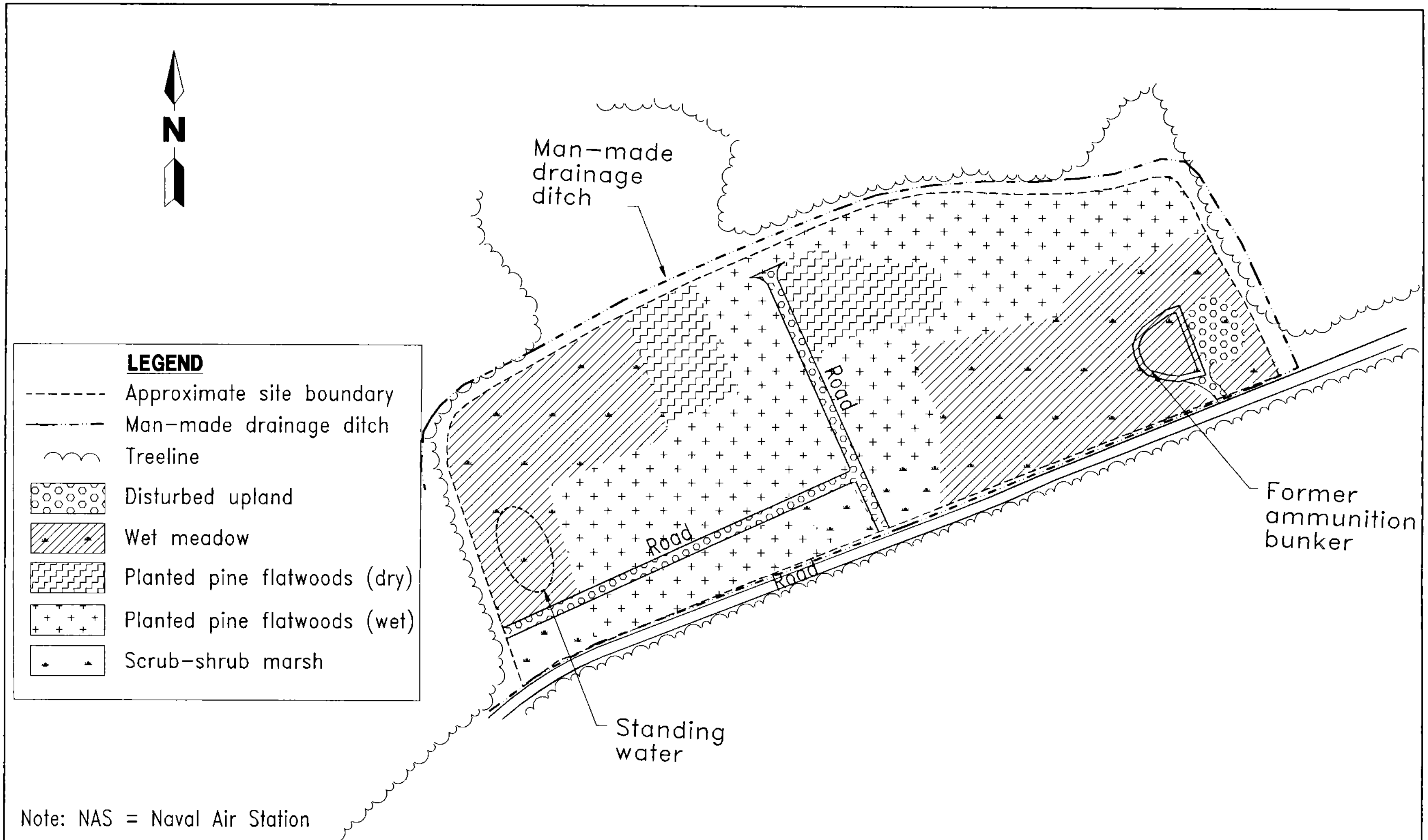

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FIGURE 2-8
UPLAND HABITATS PRESENT AT SITE 14

BASEWIDE ECOLOGICAL ASSESSMENT REPORT

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

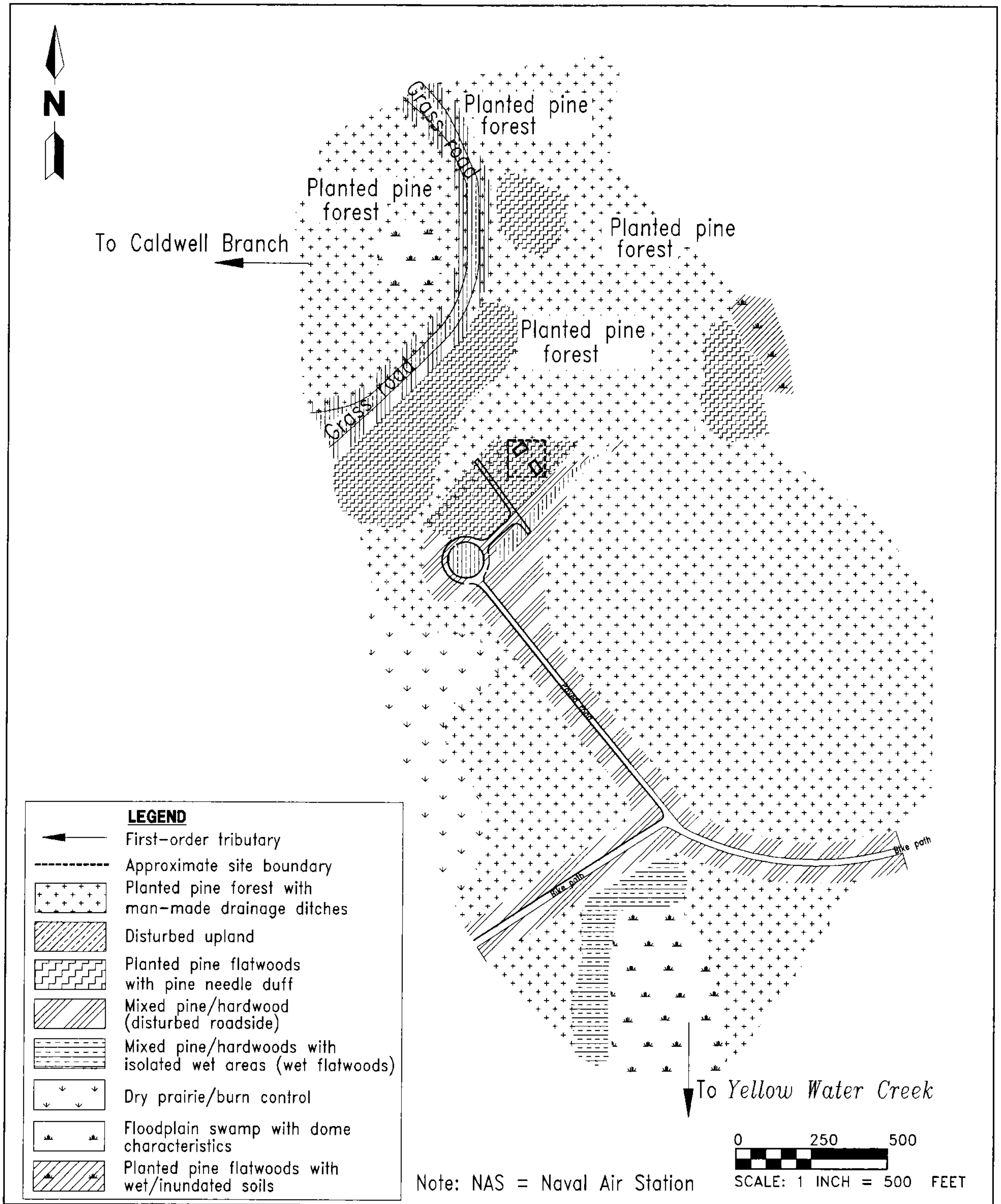

FIGURE 2-9
UPLAND HABITATS PRESENT AT SITE 15

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BASEWIDE ECOLOGICAL ASSESSMENT REPORT

NAS CECIL FIELD JACKSONVILLE, FLORIDA

Several ecological communities were also observed at Site 15, including disturbed uplands, mesic and wet planted pine flatwoods (ranging from a dense, shrubby understory dominated by hollies to no understory dominated by pine needle duff), mesic and wet mixed pine and hardwoods, manmade drainage ditches, first-order tributaries with tannin staining, pine flatwoods with dry prairie characteristics, and floodplain swamps with dome swamp characteristics. Most of the roadside canopy was a disturbed mixed pine and hardwood community.

The majority of the site, composed of pine flatwoods, was dominated by slash pines. Other tree and shrub species observed at Site 15 include sweetgum, southern bayberry, hollies, red maple, saw palmetto, live oak, water oak, occasional longleaf pine, black willow, gallberry (*Ilex glabra*), bald cypress (*Taxodium distichum*), laurel oak, turkey oak (*Quercus laevis*), scrub oak (*Quercus ilicifolia*), sweetbay magnolia, cedar, and titi (*Cyrilla racemiflora*). Herbaceous and graminoid species observed at Site 15 included bullbriar greenbriar, muscadine grape, graminoids, Virginia creeper, poison ivy, clubmoss, yellow-eyed grass, iris (*Iris* sp.), various ferns, blackberry, ragweed, fleabane, morning glory, thistle, cinnamon fern, sedges (*Carex* sp.), sphagnum moss (*Sphagnum* sp.), royal fern, netted chain fern, Spanish moss (*Tillandsia usneoides*), mullein (*Verbascum thapsus*), pitcher plants, dog fennel, water pennywort (*Hydrocotyle americana*), bracken fern, acacia, lichens, mimosa, yellow pea, verbena, blue sage (*Salvia azurea*), and beauty berry.

Potential receptor species at OU 5 include terrestrial plants, birds, mammals, and reptiles. Signs of wild boar (*Sus scrofa*) were evident at Site 14. Birds and reptiles were observed at both sites. Other terrestrial flora and fauna potentially residing at OU 5 are listed in Appendix A.

<u>Aquatic Habitats and Receptors</u>. Manmade drainage ditches were found at both Sites 14 and 15, and a first-order tributary was observed at Site 15. The ditches may provide minimum suitable habitat for aquatic macroinvertebrates. Though the tributary does not provide adequate habitat for most species of fish, it is possible that some aquatic macroinvertebrate, amphibian, and reptile species inhabit the tributary. The blackwater stream adjacent to Site 15 is a perennial, intermittent seasonal stream that may provide adequate habitat for a variety of aquatic and semiaquatic vertebrates and macroinvertebrates.

<u>Wetlands</u>. A wet meadow habitat was found at Site 14. This area was characterized as a disturbed wetland. A palustrine scrub-shrub marsh was also observed at Site 14. The floodplain swamps observed at Site 15 were in the vicinity of Yellow Water and Caldwell Creeks.

2.4.1.6 Operable Unit 6 OU 6 consists of Site 11, the Pesticide Disposal Area. It is located in the middle of NAS Cecil Field's golf course. Habitat mapping at this site was completed in 1995. Figure 2-10 provides an overview of the habitats at this site.

<u>Terrestrial Habitats and Receptors</u>. The ecological communities found at OU 6 include a mixed hardwood community (with dry swamp characteristics), a mixed pine and hardwood community, planted pine flatwoods, and mowed grass (the fairways). The mixed pine and hardwood and planted pine flatwoods communities have a fairly open understory with ground litter dominated by pine needle duff.

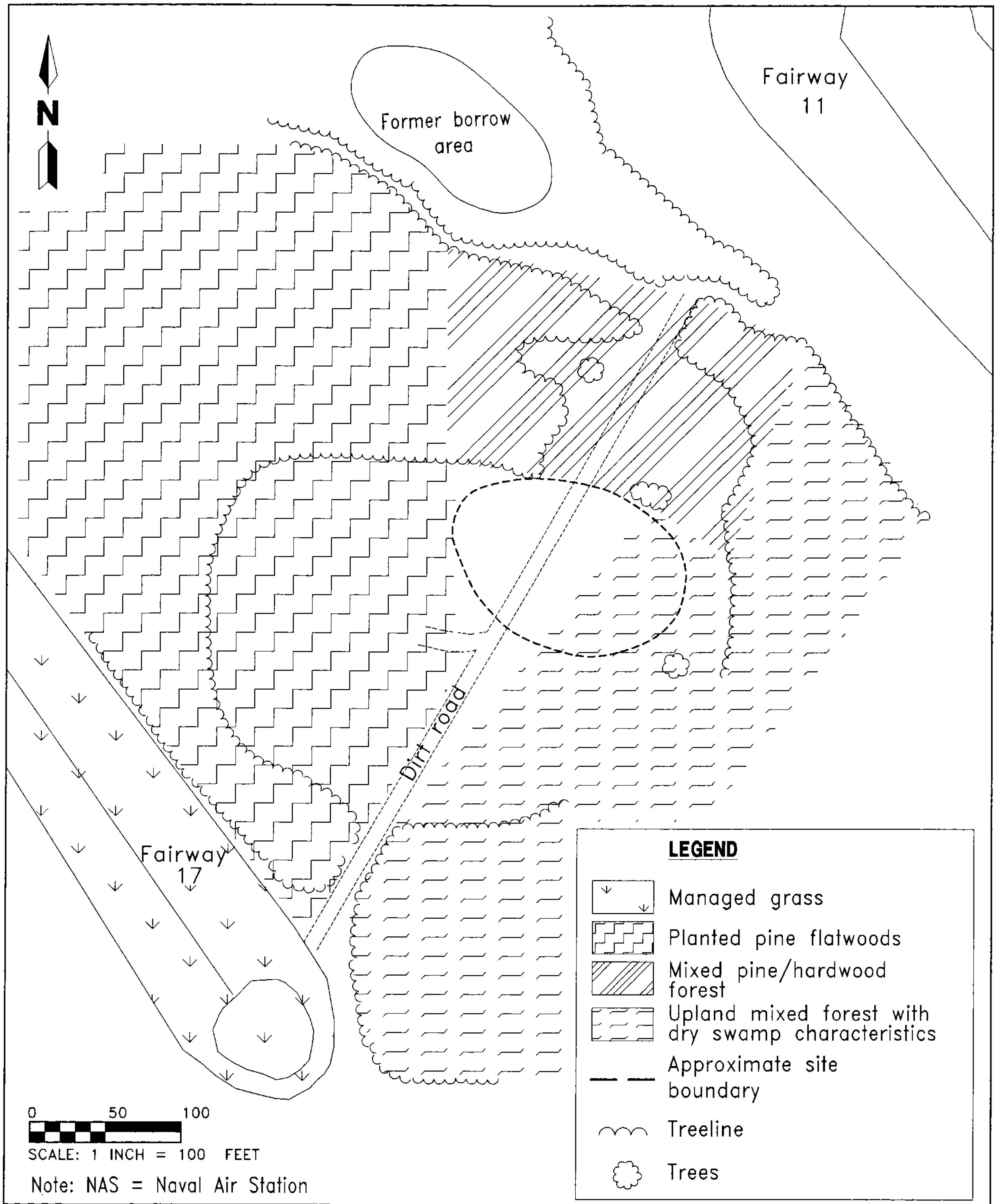

FIGURE 2-10
UPLAND HABITATS PRESENT AT SITE 11

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BASEWIDE ECOLOGICAL ASSESSMENT REPORT

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

Tree and shrub species observed at Site 11 include sweetgum, saw palmetto, longleaf pine (*Pinus palustris*), live oak, cherry, water oak, red maple, bald cypress (dead trunks), fetterbush (*Lyonia lucida*), bay, southern bayberry, laurel leaf oak (*Quercus laurifolia*), and sweetbay magnolia. Herbaceous and graminoid species observed at Site 11 include cinnamon fern, goldenrod, greenbriar, muscadine grape, poison ivy, ferns, sedges, Virginia creeper, beauty berry, and blackberry.

Potential receptor species at OU 6 include terrestrial plants, birds, mammals, and reptiles. Few signs of mammals were found at the site, though birds and reptiles were observed. Other terrestrial flora and fauna potentially residing at OU 6 are listed in Appendix A.

<u>Aquatic Habitats and Receptors</u>. Aquatic habitat is not present at OU 6.

<u>Wetlands</u>. Wetlands were not identified at OU 6.

2.4.1.7 **Operable Unit 7** OU 7 consists of Site 16, the AIMD seepage pit area, which is located in an industrial setting near NAS Cecil Field's flightline. Figure 2-11 provides an overview of the site showing the nearest terrestrial and wetland habitats.

<u>Terrestrial Habitats and Receptors</u>. OU 7 is vegetated with approximately 22,000 square feet of mowed grass. No surface soil staining or stressed vegetation, possibly resulting from past activity at the site, was visible during site visits in 1988, 1991, and 1993. The area adjacent to the site is relatively flat and is covered with asphalt and concrete. Because OU 7 is a small grassy area in an industrial setting, surrounded by paved roadways and parking lots, terrestrial receptors are not expected to reside at the site.

<u>Aquatic Habitats and Receptors</u>. OU 7 is located in an industrial area; there are no streams, creeks, or other natural water bodies in the immediate vicinity of the site. However, aquatic habitats located to the east of OU 7 were characterized as part of a facilitywide field survey completed in July 1993 (EA, 1994a). Three sampling stations were located in drainage ditches approximately 500 feet east of the runway. The ditches, which receive stormwater drainage from both the runway areas and the developed areas west of the runway (including OU 7), carry discharge approximately 2,400 feet eastward to Sal Taylor Creek.

The goals and results of the 1993 aquatic study are discussed in Section 5.2. The sampling program consisted of quantitative collection of benthic macroinvertebrates (at the three locations and a reference station, all of which are located in Sal Taylor Creek), and qualitative collection of fish (at only one location and the reference station). The results of this study are discussed in detail in Section 5.2.

A list of the benthic macroinvertebrates collected in the vicinity of Site 16 during the study is shown in Appendix A-7. Two fish species, including the eastern mosquitofish (*Gambusia affinis*) and least killifish (*Heterandria formosa*), were collected from the two sampling stations in the vicinity of the site. The species collected were generally small, with low biomass.

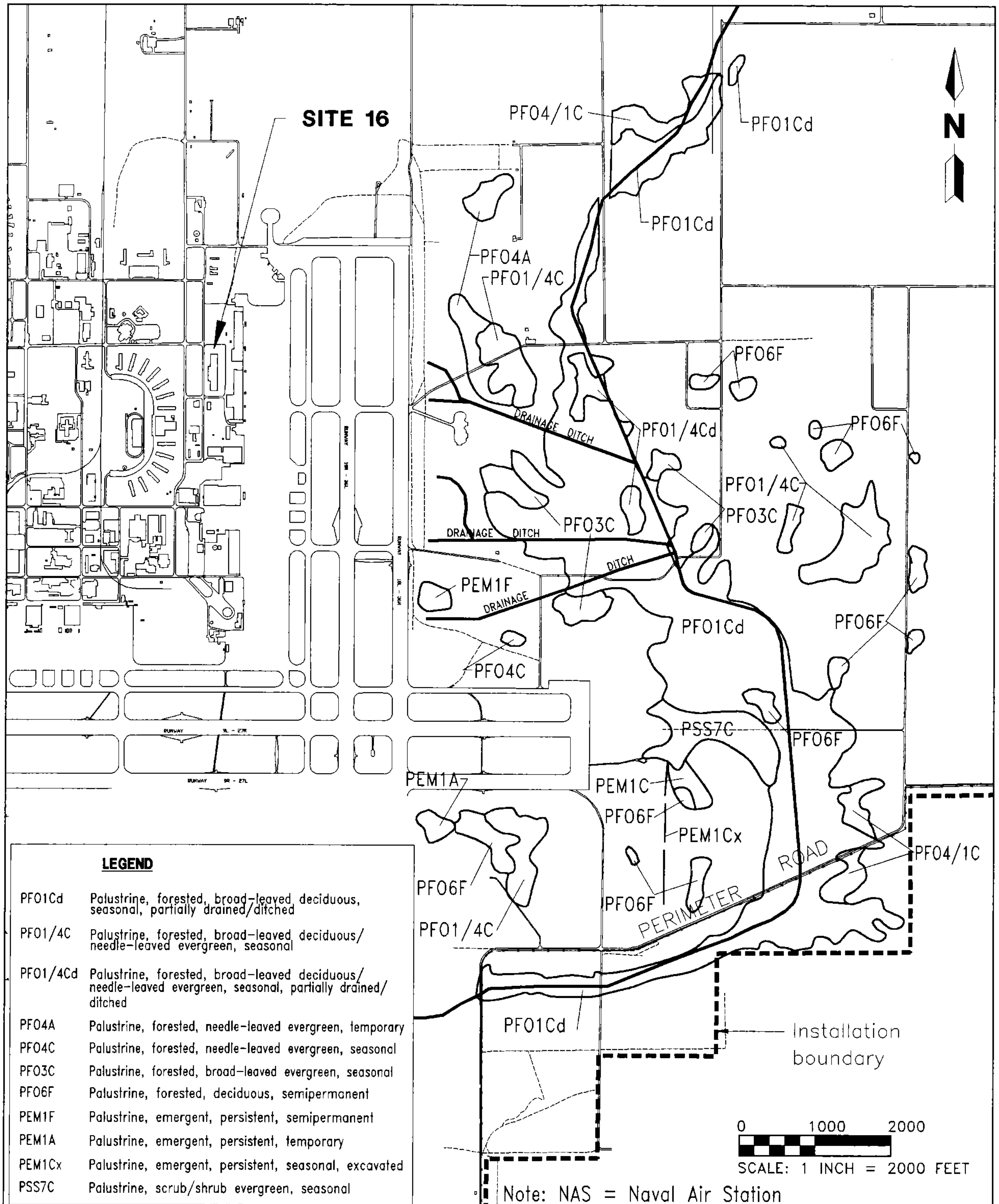

FIGURE 2-11
WETLANDS EAST OF SITE 16

BASEWIDE ECOLOGICAL ASSESSMENT REPORT

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

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Water temperatures and pH were within normal ranges. The dissolved oxygen (DO) content varied from 3.4 mg/ℓ to 4.9 mg/ℓ, all below the Florida water quality standard of ≥ 5 mg/ℓ.

Water was clear at all stations evaluated. A viscous oily sheen was observed on the water surface at one station, and a petroleum sediment odor was evident at this and a second location (see Plate 2 for sampling stations). At least 50 percent aquatic vegetation was observed at the three sampling stations. Aquatic vegetation was not present at the reference station. A leaf pack and mud, muck, or silt substrate was noted only at the reference location.

There is no aquatic habitat in the immediate vicinity of OU 7. However, if contaminants from the site migrated via surface water runoff or groundwater discharge toward the drainage ditches, potential receptors would include invertebrates, plants, algae, and fish. Aquatic species identified in this area are listed in Appendix A.

Wetlands. Wetlands were not identified in the immediate area of OU 7. However, through a review of a national wetland inventory map (USFWS, 1983), seven classes of wetlands were identified approximately 5,000 feet east of the site (Table 2-1). Sal Taylor Creek flows through and directly influences these wetlands. Figure 2-11 shows the locations of these wetlands east of OU 7. The seven classes (Cowardin and others, 1979) identified east of OU 7 are:

- palustrine forested broad-leaved deciduous,
- palustrine forested needle-leaved evergreen,
- palustrine forested broad-leaved evergreen,
- palustrine emergent persistent,
- palustrine scrub and shrub evergreen,
- combination palustrine forested broad-leaved deciduous and needle-leaved evergreen, and
- palustrine forested deciduous (unspecified).

2.4.1.8 Operable Unit 8 OU 8 consists of Site 3, the Oil and Sludge Disposal Area. Figure 2-12 shows the upland and wetland habitats present at Site 3.

Terrestrial Habitats and Receptors. An upland community consisting primarily of disturbed uplands with some characteristics of a dry prairie is located in the western portion of OU 8, both north and south of the Lake Fretwell service road. The area consists of flat, sandy soil with dense ground cover and few to no trees. Vegetation identified in this area includes ragweed, goldenrod, dog fennel, bracken fern, sand blackberry, golden ragweed (*Senecio aureus*), and muscadine grape. Scattered wax myrtle (*Myrica cerifera*) and slash pine are also present.

A small scrubby flatwoods area is present to the north of OU 8. This area is flat and sandy with scattered pine trees, a sparse shrubby understory, and barren sand. Vegetation identified in this area includes longleaf pine, loblolly pine, saw palmetto, myrtle oak (*Quercus myrtifolia*), goldenrod, and sand blackberry.

Similar to OU 2, the invertebrate biomass within the uplands at OU 8 probably serves as a forage base for a limited number of wildlife species, including amphibians, reptiles, birds, and mammals. Up to 20 or 30 species of reptiles and amphibians can be supported in an upland habitat (Ashton and Ashton, 1988; 1989;

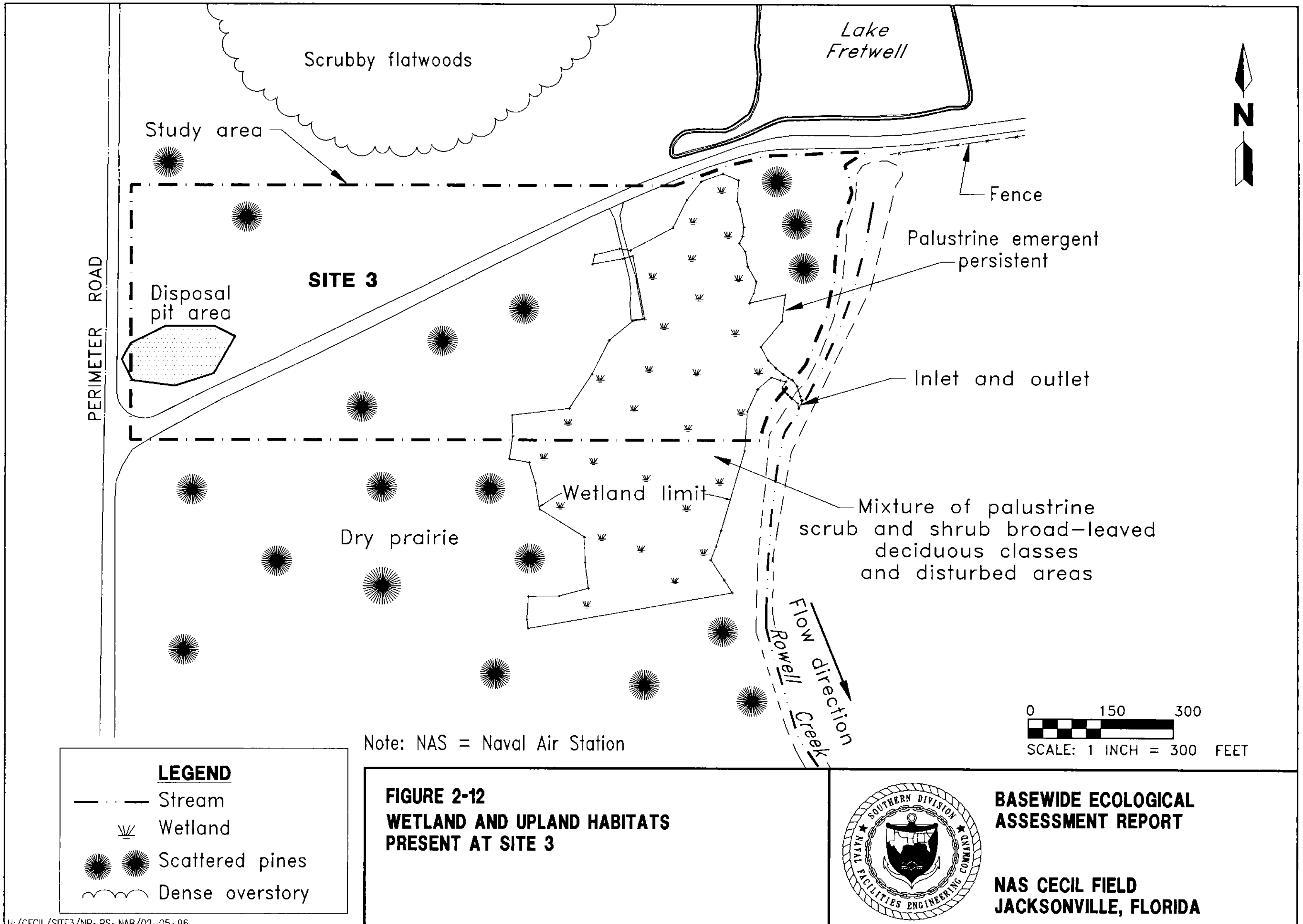

FIGURE 2-12
WETLAND AND UPLAND HABITATS PRESENT AT SITE 3

BASEWIDE ECOLOGICAL ASSESSMENT REPORT

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

1991). The scrubby flatwoods to the north of Site 3 may provide habitat for a diverse array of avifauna, including insectivorous gleaners of pine needles and bark, flycatchers, a seed-eating assemblage, and nocturnal and diurnal aerial predators (Wolfe and others, 1988). The wetlands associated with OU 8 are expected to provide suitable habitat for a diverse congregation of wildlife species, which are potential receptors at the site. Invertebrates that inhabit the floor and arboreal canopy of the region are consumed by a number of amphibian, reptile, bird, and mammal species, which in turn provide food for many secondary and tertiary consumers.

Potential receptors species at OU 8 include terrestrial wildlife, plants, and invertebrates. Species that have been directly observed at OU 8 are listed in previous paragraphs. Other terrestrial flora and fauna potentially inhabiting OU 8 are listed in Appendix A.

Aquatic Habitats and Receptors. Aquatic habitats in Rowell Creek, which borders Site 3 to the east, were characterized as part of a facilitywide field survey completed in July 1993 (EA, 1994a). One sampling station was located in Rowell Creek downgradient of OU 8, approximately 1,200 feet east of where wastes were originally disposed of at the site (Plate 2). The goals and results of the 1993 study are discussed in Section 5.2. The sampling program consisted of quantitative collection of macroinvertebrates at this location; no fish were collected.

A list of the benthic macroinvertebrates collected in the vicinity of Site 3 during the study is shown in Appendix A-7. Substrate at the sampling station was mostly sand (80 percent); no leaf pack, mud, muck, or silt was observed. The water temperature at this station was 27.1 degrees Celsius (°C) and the pH was 6.7. The DO content was 5.2 mg/ℓ, slightly above the Florida standard of ≥ 5 mg/ℓ (Florida Legislature, 1995). The surface water was clear, but a chlorine odor was evident in the surface water and sediment from the sampling station. The odor may be attributable to a sewage outfall located upstream of the sampling station. Treated effluent from NAS Cecil Field's domestic wastewater treatment plant is discharged to Rowell Creek via this outfall.

Potential aquatic receptors at OU 8 include invertebrates, plants, algae, and amphibians. These receptors are present in Rowell Creek. Potential aquatic receptor species identified at OU 8 are listed in Appendix A.

Wetlands. Three classes of wetlands have been identified at OU 8: palustrine forested broad-leaved deciduous, palustrine scrub-shrub broad-leaved deciduous, and palustrine emergent persistent. The types, indicator species, and approximate size of these wetlands are listed in Table 2-1. Figure 2-12 shows the location and types of wetlands identified at OU 8 (CDM, 1994). The results of the wetlands survey are discussed in more detail in Section 5.4.

2.4.2 Other Sites and PSCs Ecological field investigations of the following PSCs were completed in September 1995:

- PSC 4, Historical Grease Pits,
- PSC 6, Lake Fretwell Rubble Disposal Area,
- PSC 9, Recent Grease Pits,
- PSC 12, Public Works Rubble Disposal Area,
- PSC 18, Ammunition Disposal Area, and
- PSC 19, Rowell Creek Rubble Disposal Area.

Ecological field investigations for the above-mentioned PSCs were completed concurrently with the investigations for OUs 3, 4, 5, and 6. The objectives of these investigations are described in Subsection 2.4.1. The following paragraphs present the results of the ecological investigations conducted at the remaining PSCs.

2.4.2.1 **Potential Source of Contamination 4** PSC 4, the Historical Grease Pit Area, extends from the Perimeter Road to the western edge of Lake Fretwell. Figure 2-13 provides an overview of the habitats identified at this PSC.

Terrestrial Habitats and Receptors. Many ecological communities were observed at PSC 4, including disturbed uplands, planted pine flatwoods, mixed pine and hardwoods, carnivorous plants (in a marshy unpaved road), scrub-shrub marsh, palustrine scrub-shrub transitional wetland, floodplain forest, and dry prairie.

The planted pinewood forest was dominated by slash pine; other tree and shrub species observed at PSC 4 include southern bayberry, red maple, gallberry, titi, red bay (*Persea borbonia*), tupelo, oaks, sweetbay magnolia, tall gallberry holly, scrub oak, myrtle-leaf holly (*Ilex myrifolia*), dwarf chinquapin oak (*Quercus prinoides*), Spanish oak (*Q. falcata*), and saw palmetto. Herbaceous and graminoid species observed at PSC 4 include agalinis, acacia, briars (*Smilax* sp.), hooded pitcher plants, round-leaved sundews (*Drosera* sp.), bog buttons, St. Johnswort, indigo (*Baptista* sp.), ragweed, buttonbush (*Cephalanthus occidentalis*), redroot, hatpins, rushes (*Juncus* sp.), sedges, seedbox, netted chain fern, cowbane (*Oxypolis* sp.), smartweed, royal fern, cinnamon fern, meadow beauty, goldenrod, water pennywort, grasses, blackberry, muscadine grape, persimmon, wiregrass (*Aristida stricta*), bracken fern, bullbriar greenbriar, dog fennel, blazing star, and winged sumac.

Potential receptors species at PSC 4 include terrestrial wildlife, plants, and invertebrates. Species that have been directly observed are listed in the previous paragraph. Other terrestrial flora and fauna potentially inhabiting PSC 4 are listed in Appendix A.

Aquatic Habitats and Receptors. Lake Fretwell, which is located along the eastern terminus of the PSC, would classify as an impounded lake that may potentially receive runoff from PSC 4.

Wetlands. A palustrine scrub-shrub marsh was observed at PSC 4.

2.4.2.2 **Potential Source of Contamination 6** PSC 6, the Lake Fretwell Rubble Disposal Area, is located along the eastern shore of Lake Fretwell, due south of the recreation area and southwest of the wastewater treatment plant. Figure 2-14 provides an overview of the habitats identified at this PSC.

Terrestrial Habitats and Receptors. The following ecological communities were found at the site: mowed grass, disturbed upland, planted pine flatwoods, depression-emergent marsh, and a degraded area with rubble.

Tree and shrub species observed at the site include slash pine (in the planted pine flatwoods), sweetgum, red maple, water oak, black cherry, tupelo, sweetbay magnolia, southern bayberry, willow, elderberry (*Sambucus canadensis*), and

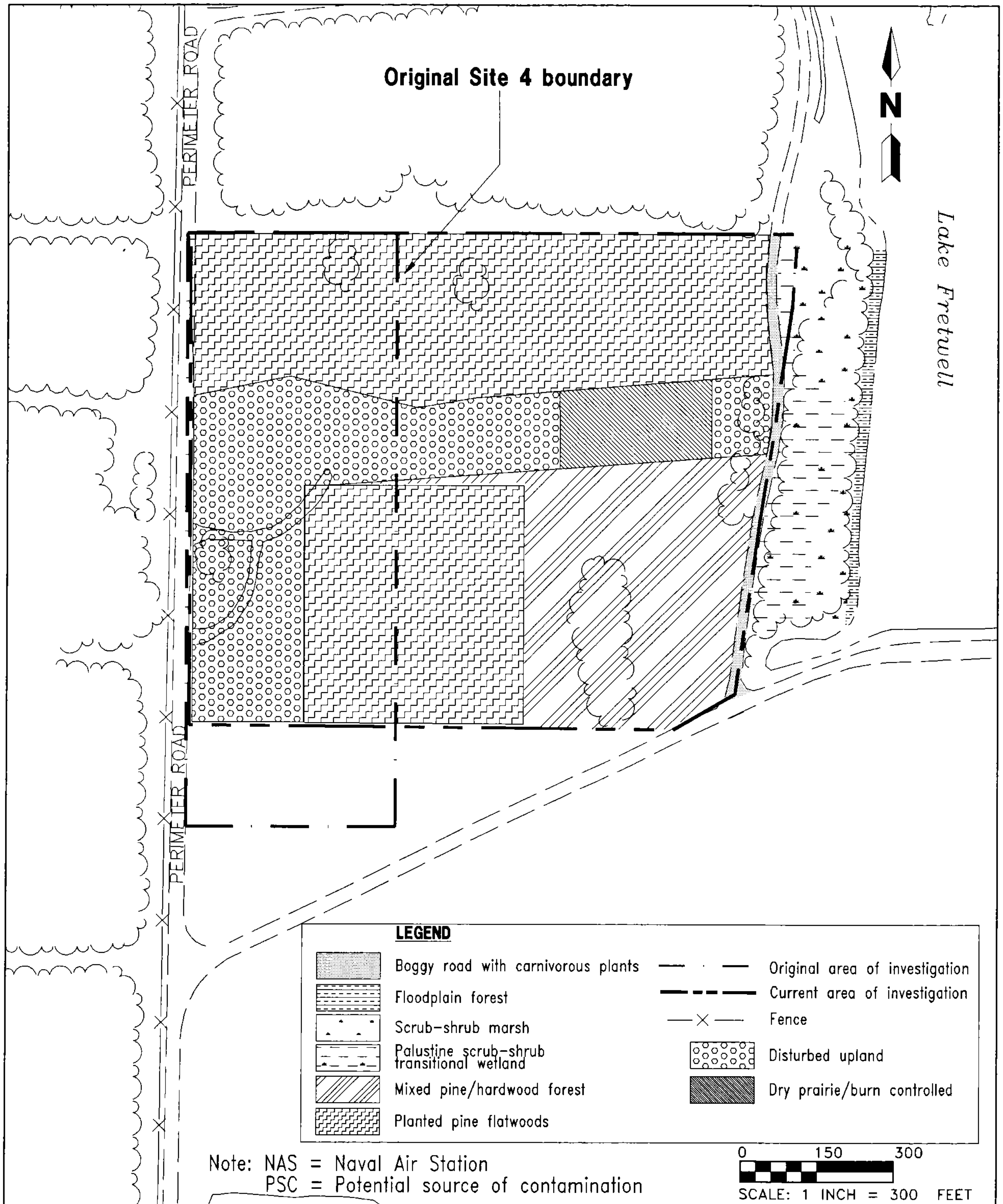

FIGURE 2-13
WETLAND AND UPLAND HABITATS PRESENT AT PSC 4

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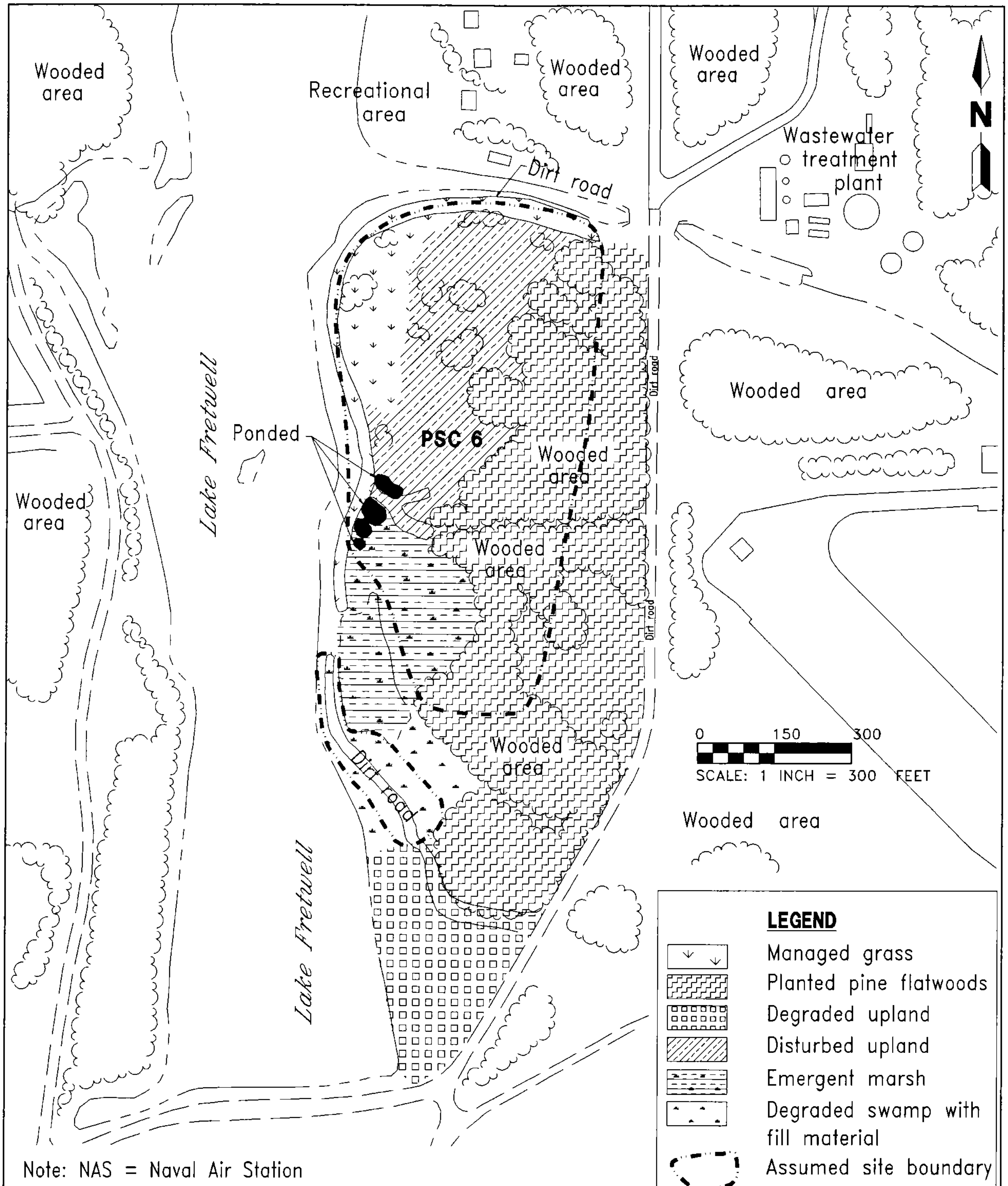
NAS CECIL FIELD JACKSONVILLE, FLORIDA



Note: NAS = Naval Air Station
PSC = Potential source of contamination

FIGURE 2-14
UPLAND HABITATS PRESENT AT PSC 6

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BASEWIDE ECOLOGICAL ASSESSMENT REPORT

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

buttonbush. Some herbaceous and graminoid species observed at PSC 6 include great cane bamboo, muscadine grape, grasses, dog fennel, rattlebox, spanish needles, cattails, and rushes. Concrete debris present at PSC 6 may inhibit both plant growth and secondary or tertiary predation of small mammals.

Potential receptors species at PSC 6 include terrestrial wildlife, plants, and invertebrates. Species that have been directly observed are listed in the previous paragraph. Other terrestrial flora and fauna potentially inhabiting PSC 6 are listed in Appendix A.

Aquatic Habitats and Receptors. A depression-emergent marsh was identified at PSC 6.

Wetlands. Wetlands were not identified at PSC 6.

2.4.2.3 **Potential Source of Contamination 9** PSC 9, the Recent Grease Pits Area, is located south of the flightline area and east of Site 10 along a service road. Figure 2-15 provides an overview of the habitats identified at this PSC.

Terrestrial Habitats and Receptors. A wooded area is located to the south of PSC 9 across the service road, and manmade drainage ditches run along the northern edge of PSC 9. The site itself is primarily an overgrown field or disturbed upland.

Shrubs encountered at PSC 9 include black willow and southern bayberry. Herbaceous and graminoid species observed at PSC 9 include blazing star, yellow aster, dog fennel, hempweed, thistle, seedbox, goldenrod, burrs, cattail, greenbriar, yellow-eyed grass, Spanish needles, fleabane, mimosa, mosses, poison ivy, burr-reeds, meadow beauty, agalinis, rattlebox, cowbane, white-eyed grass, acacia, grasses (*Echinochloa* sp.), water pennywort, sedges (including *Cyperus* sp.), narrow-leaved seedbox, round-leaved sundew, spike rush (*Eleocharis* sp.), and peas (*Cassia* sp.). Gastropod shells were also found at PSC 9.

Potential receptors species at PSC 9 include terrestrial wildlife, plants, and invertebrates. Species that have been directly observed are listed in the previous paragraph. Other terrestrial flora and fauna potentially inhabiting PSC 9 are listed in Appendix A.

Aquatic Habitats and Receptors. A manmade drainage ditch was observed at PSC 9. These ditches may provide minimum suitable habitat for aquatic macroinvertebrates.

Wetlands. Wetlands were not identified at PSC 9.

2.4.2.4 **Potential Source of Contamination 12** PSC 12, the Public Works Rubble Disposal Area, is located near the base recycling area (behind the Public Works Department). Figure 2-16 provides an overview of the habitats identified at this PSC.

Terrestrial Habitats and Receptors. The majority of the site is used for storage and as a parking area. Electrical lines run overhead; therefore, the area is kept clear of large trees. The area covered by PSC 12 is best described as a

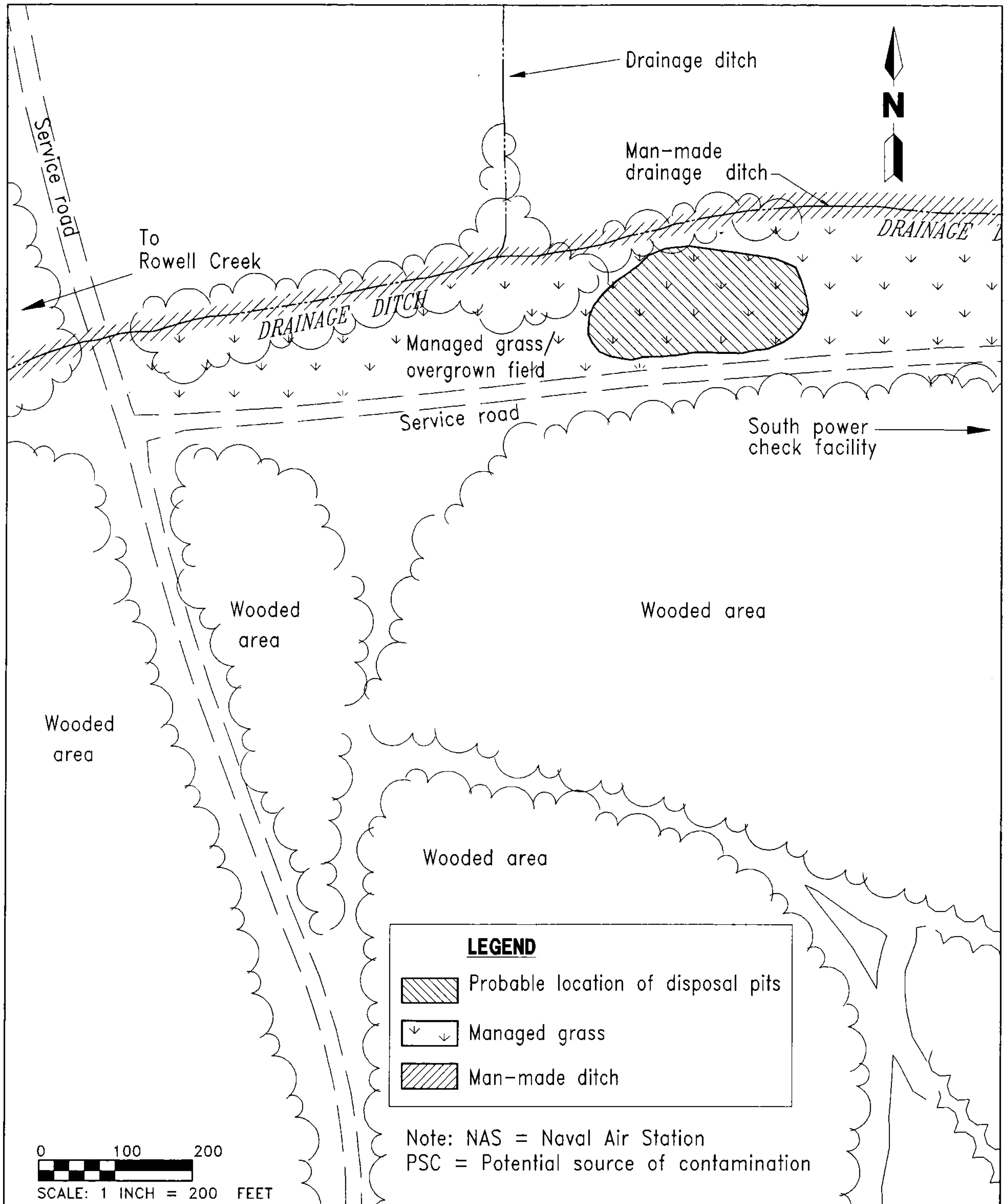

FIGURE 2-15
UPLAND HABITATS PRESENT AT PSC 9

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NAS CECIL FIELD
JACKSONVILLE, FLORIDA

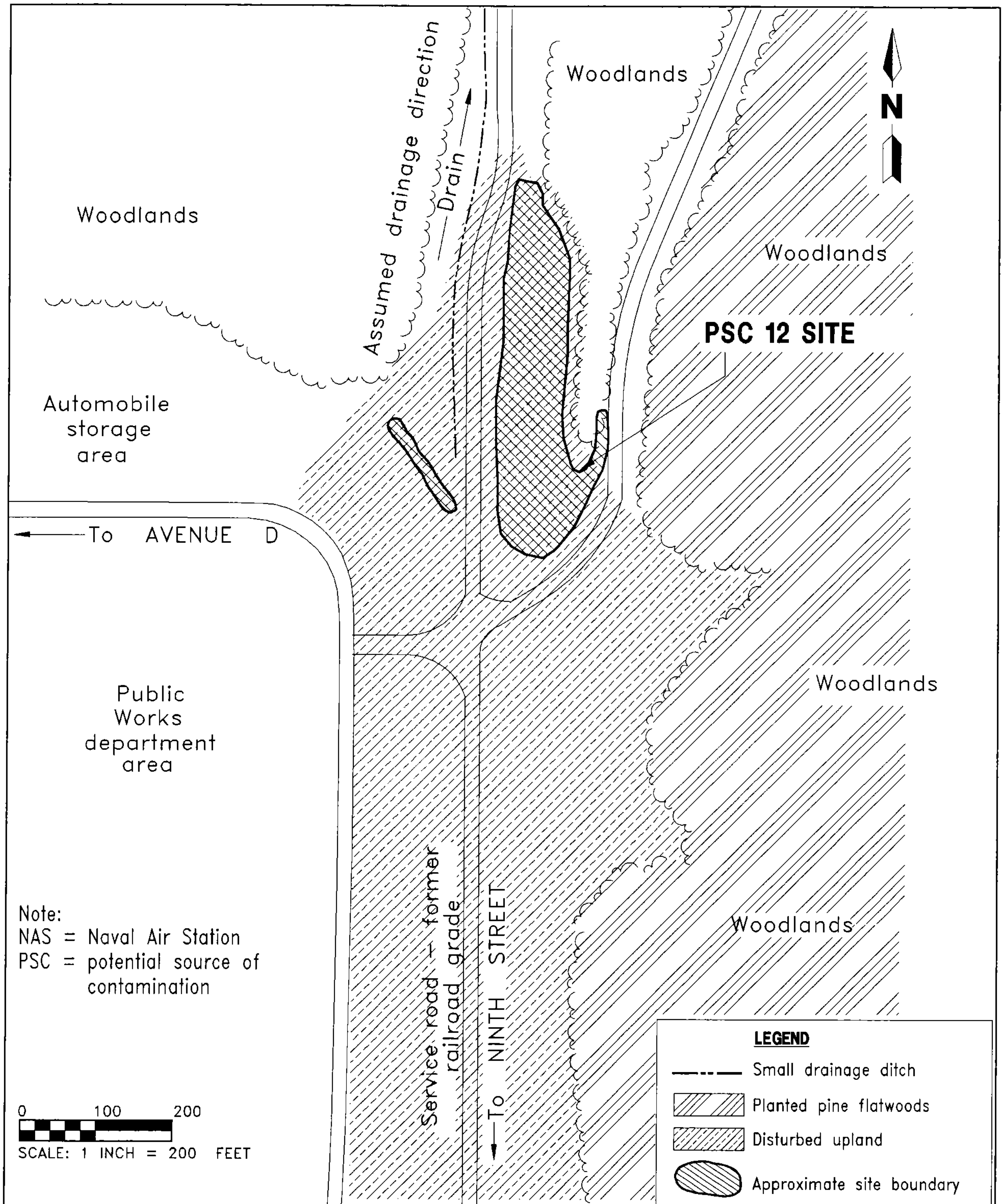

FIGURE 2-16
UPLAND HABITATS PRESENT AT PSC 12

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NAS CECIL FIELD JACKSONVILLE, FLORIDA

disturbed upland community. Behind the site (to the east) are planted pine flatwoods; large piles of fill material and rubble have been deposited in the transition area between the disturbed uplands and the pine flatwoods.

Tree species observed at PSC 12 include longleaf pine, cabbage palm, saw palmetto, slash pines, water oak, gallberry, and live oak. Herbaceous and graminoid species observed at PSC 12 include grasses, fleabane, sedges, Spanish needles, ragweed, acacia, water pennywort, seedbox, Virginia creeper, sea myrtle, rattlebox, dog fennel, verbena, morning glory, goldenrod, muscadine grape, blackberry, and bracken fern.

Potential receptors species at PSC 12 include terrestrial wildlife, plants, and invertebrates. Species that have been directly observed are listed in the previous paragraph. Other terrestrial flora and fauna potentially inhabiting PSC 12 are listed in Appendix A.

<u>Aquatic Habitats and Receptors</u>. Aquatic habitats were not observed at PSC 12.

<u>Wetlands</u>. Wetlands were not identified at PSC 12.

2.4.2.5 Potential Source of Contamination 18 PSC 18, the Ammunition Disposal Area, is located in a forested area in the eastern and central portion of NAS Cecil Field. Figure 2-17 provides an overview of the habitats identified at this PSC.

<u>Terrestrial Habitats and Receptors</u>. The three ecological communities observed at PSC 18 include planted pine flatwoods, floodplain forest, and a floodplain swamp or braided blackwater stream. The habitat at PSC 18 is likely to be of high value to semiterrestrial and aquatic wildlife.

The closed arboreal canopy at the site is dominated by red maple and water oak, with occasional tupelo, ashes, and other oaks. The understory is open, and dominated by saw palmetto. Other shrub and herbaceous species observed at the site include southern bayberry, red bay, bryophytes, anolis, meadow beauty, lyonia, St. Johnswort, blueberry, sweetgum, bald cypress, inkberry, nannyberry (*Viburnum lentago*), winged sumac, netted chain fern, sedges, pickerel weed, muscadine grape, bullbriar greenbriar, panic grass, golden club (*Orontium aquaticum*), cross vine (*Bignonia* sp.), sphagnum moss, redberry greenbriar (*Smilax walteri*), and cinnamon fern.

Potential receptors species at PSC 18 include terrestrial wildlife, plants, and invertebrates. Species that have been directly observed are listed in the previous paragraph. Other terrestrial flora and fauna potentially inhabiting PSC 18 are listed in Appendix A.

<u>Aquatic Habitats and Receptors</u>. The floodplain forest and floodplain swamp or braided blackwater stream habitats are likely of high value to aquatic wildlife.

<u>Wetlands</u>. Wetlands were not identified at PSC 18.

2.4.2.6 Potential Source of Contamination 19 PSC 19, the Rowell Creek Rubble Disposal Area, is located due west of Rowell Creek and south of 6th Street. Figure 2-18 provides an overview of the habitats identified at this PSC.

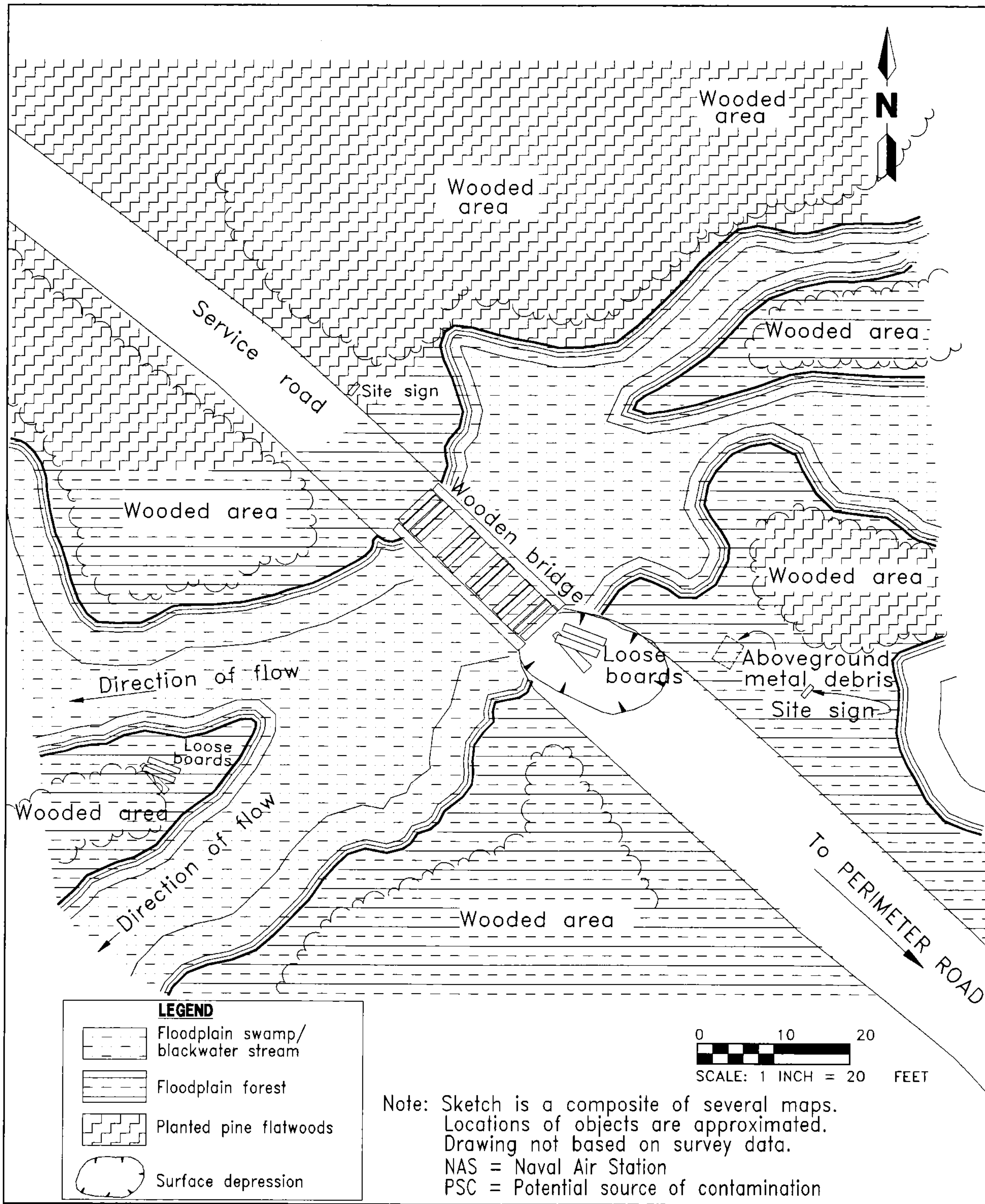

FIGURE 2-17
UPLAND HABITATS PRESENT AT PSC 18

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BASEWIDE ECOLOGICAL ASSESSMENT REPORT

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

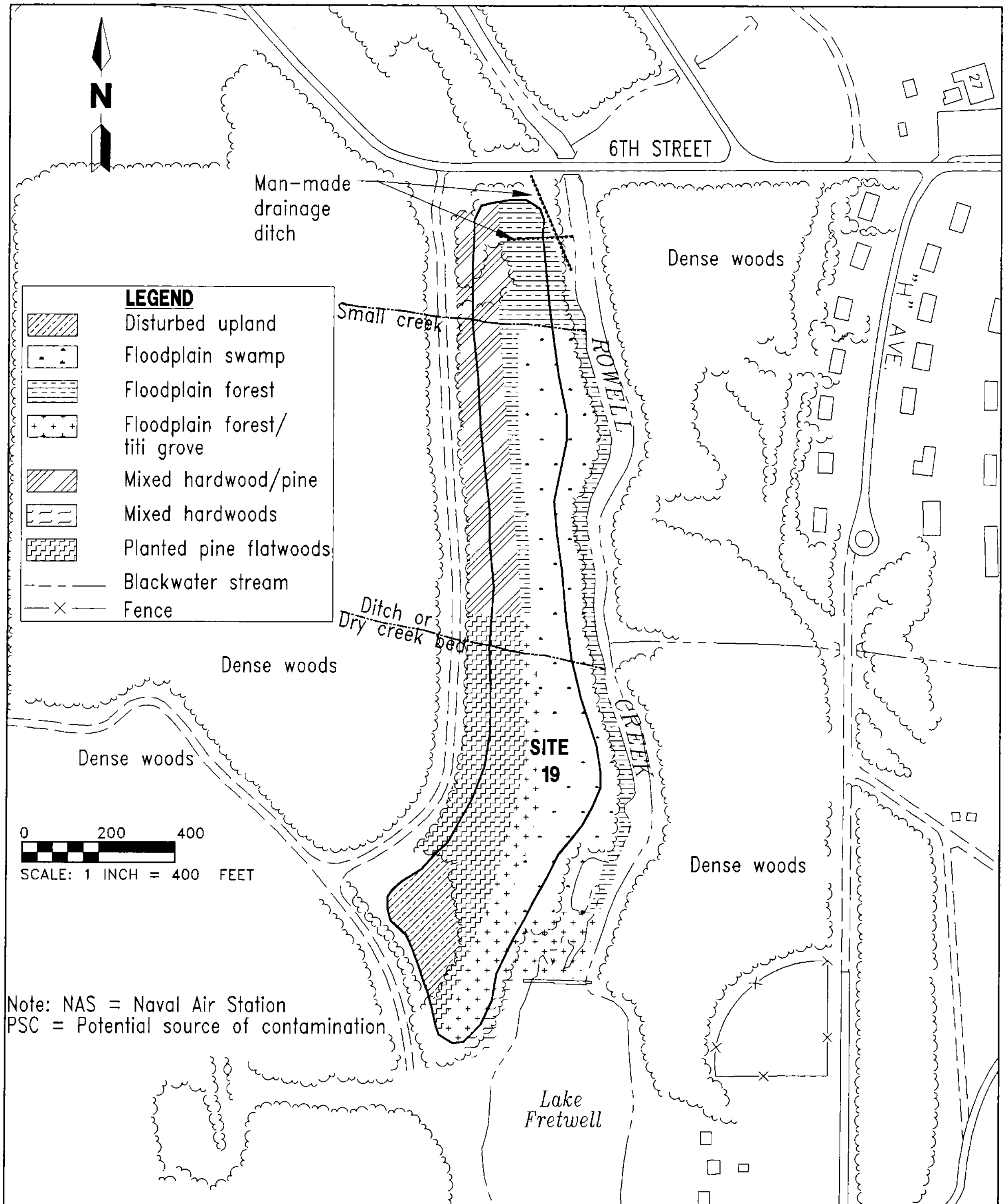

FIGURE 2-18
UPLAND HABITATS PRESENT
AT PSC 19

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BASEWIDE ECOLOGICAL ASSESSMENT REPORT

NAS CECIL FIELD
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Terrestrial Habitats and Receptors. Many ecological communities were identified at PSC 19, including (roughly from the west toward Rowell Creek) disturbed uplands, planted pine flatwoods, mixed pine and hardwoods, upland mixed forest, manmade drainage ditches, floodplain forest (some areas with some titi groves), floodplain swamp, and blackwater stream.

The dominant tree species observed at the site include red maple, slash pine, southern bayberry, black cherry, tupelo, and sweetgum. Other tree and shrub species included southern bayberry, holly, saw palmetto, sourwood (*Oxydendrum* sp.), red bay, sweetbay magnolia, red ash (*Fraxinus pennsylvanica*), ironwood (*Carpinus caroliniana*), hornbeam (*Ostrya* sp.), water oak, swamp honeysuckle (*Rhododendron viscosum*), buttonbush, tall gallberry holly, and titi. Herbaceous and graminoid species observed at PSC 19 include barberry (*Berberis* sp.), black comb fern (*Polypodium plumula*), bullbriar greenbriar, muscadine grape, poison ivy, bamboo, cinnamon fern, lady fern (*Athyrium filix-femina*), netted chain fern, sedges, royal fern, New York fern (*Thelypteris noveboracensis*), golden club, laurel greenbriar (*Smilax laurifolia*), lizard's tail (*Saururus cernuus*), bracken fern, Spanish needles, blackberry, yellow-eyed grass, sphagnum moss, sweetbells (*Leucothoe* sp.), yellow aster, dog fennel, bluestem, Virginia creeper, water pennywort, and morning glory.

Potential receptors species at PSC 19 include terrestrial wildlife, plants, and invertebrates. Species that have been directly observed are listed in the previous paragraph. Other terrestrial flora and fauna potentially inhabiting PSC 19 are listed in Appendix A.

Aquatic Habitats and Receptors. A manmade drainage ditch was observed at PSC 9. These ditches may provide minimum suitable habitat for aquatic macroinvertebrates. The floodplain forest, floodplain swamp, and blackwater stream habitats are likely of high value to aquatic wildlife.

Wetlands. Wetlands were not identified at PSC 19.

2.5 RARE, ENDANGERED, AND THREATENED SPECIES. Certain species that are potentially present at NAS Cecil Field are protected by Federal and/or State laws. The Florida Administrative Code defines protected species as follows: (1) *Endangered species* are those that are so few or depleted in number or so restricted in range or habitat as to be in imminent danger (or may attain such status in the immediate future) of extinction or extirpation;(2) *Threatened species* are those which are acutely vulnerable to environmental alteration or whose range or habitat is declining rapidly, thus leading to, or potentially leading to, rapid population decline. These species are likely to become endangered within the foreseeable future; (3) *Species of special concern* are those in need of special protection, recognition, or consideration because they are inherently vulnerable to habitat alteration, human disturbance, or human exploitation, which in turn may lead to their becoming threatened. The Florida Committee on Rare and Endangered Plants and Animals (FCREPA) also designates the category of rare to those species having a limited geographic distribution, special habitat requirements, or occurrance at the periphery of their range (Envirodyne Engineers, 1985). These status designations are applied to the species in the following sections.

Rare, endangered, and threatened species identified as potentially present at NAS Cecil Field are listed in Table 2-2. The list is based in part on a review of available information in the Initial Assessment Study (Envirodyne Engineers, 1985), a Rare and Endangered Plant Survey Report (Environmental Services and Permitting, Inc., 1990), Technical Memorandum for Supplemental Sampling at OUs 1, 2, and 7 (ABB-ES, 1992), and the Cecil Field Gopher Tortoise Survey and Management Plan (CZR Incorporated [CZR], 1994). Supplemental information was provided through communication with officials at the Florida Game and Fresh Water Fish Commission (FGFWFC) (Wooding, 1994; Wood, 1995) and natural resource officers at NAS Cecil Field (Cochran, 1995) and Southern Division, Naval Facilities Engineering Command (Burst, 1995).

2.5.1 **Fauna** Animal species protected under Federal or State statutes that are known or expected to occur at NAS Cecil Field include the following:

The Florida gopher frog (*Rana capito*) is considered threatened by FCREPA (FNAI, 1994), is listed as a species of special concern by FGFWFC, and is currently under review by USFWS (Wood, 1994). It inhabits dry, well-drained soils of sandhill communities, pine flatwoods, and sand pine scrub. It commonly utilizes the burrow of the gopher tortoise (*Gopherus polyphemus*), which is a confirmed resident of NAS Cecil Field. The Florida gopher frog is a reported resident of Duval County (FNAI, 1994), and suitable habitat exists at NAS Cecil Field, especially at or near Sites 1, 2, 3, 4, and 5.

The American alligator (*Alligator mississippiensis*), reclassified from endangered to threatened status within the State of Florida and a State-listed species of special concern (Wood, 1994), is a confirmed resident of Lake Fretwell, which is located near Sites 3, 4, 5 and 6. Typical food of the alligator includes fish, birds, and reptiles. Nesting begins in late spring, with the female constructing a mound nest of vegetation near a body of water.

The eastern indigo snake (*Drymarchon corais couperi*) is listed as threatened by both the USFWS and FGFWFC (Wood, 1994). It is tolerant of a wide variety of habitats: pine flatwood, moist tropical hammocks, and, more typically, sandhill habitats (Moler, 1992). This snake is known to utilize the burrow of the gopher tortoise for shelter. It is a confirmed resident at Cecil Field, and may be exposed to contaminants at or near Sites 1, 2, 3, 4, 5, and 17.

The gopher tortoise (*Gopherus polyphemus*), a State species of special concern (SSC) and a Federal-candidate species (Wood, 1994), is a confirmed resident at NAS Cecil Field. This tortoise constructs its burrows in dry, sandy soil afforded by sand pine, longleaf pine, and live oak hammock communities. It is omnivorous, although adults usually graze on grasses and herbs. The gopher tortoise is particularly important because its burrow provides refuge to a number of other species, such as the gopher frog and indigo snake (Moler, 1992). This reptile has been observed by ABB-ES ecologists within 1,000 feet of Site 5. A number of gopher tortoise burrows were observed on the NAS property, some in association with Sites 1 and 4 (Envirodyne Engineers, 1985). A survey of gopher tortoises conducted at NAS Cecil Field (CZR, 1994) indicates that approximately 1,300 gopher tortoises inhabit NAS Cecil Field (density = 0.43 gopher tortoises/acre), and approximately 12 inhabit the Yellow Water Weapons complex (density = 0.05 gopher tortoises/acre). The biotic communities inhabited by the gopher

Table 2-2
Rare, Endangered, and Threatened Flora and Fauna at or in the Vicinity of NAS Cecil Field

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Common Name	FGFWFC[1]	USFWS[2]	FDA[3]	Comments
Florida gopher frog (*Rana capito*)	SSC	C2		Possible resident at NAS Cecil Field (Envirodyne Engineers, 1985).
American alligator (*Alligator mississippiensis*)	SSC	T(S/A)		Confirmed resident in Lake Fretwell (Envirodyne Engineers, 1985).
Eastern indigo snake (*Drymarchon corais couperi*)	T	T		Possible resident at NAS Cecil Field (Envirodyne Engineers, 1985). Its presence has not been confirmed (Cochran, 1995).
Gopher tortoise (*Gopherus polyphemus*)	SSC	C2		Confirmed resident at NAS Cecil Field; observed in association with Sites 2, 4, and 5; a possible resident at Site 1 (Envirodyne Engineers, 1985; ABB-ES, 1994a; ABB-ES, 1994b). Also observed in several areas of NAS Cecil Field and the Yellow Water Weapons Annex by CZR (1994).
Wood stork (*Mycteria americana*)	E	E		Confirmed migrant; observed feeding at Lake Fretwell (Cochran, 1995). Suitable habitat for feeding may be present in additional shallow water areas at NAS Cecil Field (Envirodyne Engineers, 1985).
Southeastern kestrel (*Falco sparverius paulus*)	T	C2		Either this, or the closely related subspecies, F. sparverius, has been observed in the Yellow Water Weapons Annex by ABB-ES biologists and others (Cochran, 1995).
Bald eagle (*Haliaeetus leucocephalus*)	T	T		Confirmed migrant (Envirodyne Engineers, 1985).
Bachman's sparrow (*Aimophila aestivalis*)		C2		Observed in Yellow Water Weapons Annex (CZR, 1994).
Loggerhead shrike (*Lanius lucovicianus*)		C2		Observed at Yellow Water Weapons Annex near the weapons compound by ABB-ES biologist, and near runways at the facility (Cochran, 1995).
Sherman's fox squirrel (*Sciurus niger shermani*)	SSC	C2		Possible resident near Site 18 (ABB-ES biologist), and confirmed at NAS Cecil Field (Cochran, 1995).

See notes at end of table.

Table 2-2 (Continued)
Rare, Endangered, and Threatened Flora and Fauna at or in the Vicinity of NAS Cecil Field

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Common Name	FGFWFC[1]	USFWS[2]	FDA[3]	Comments
Florida black bear (*Ursus americanus floridanus*)	T	C2		Evidence of black bears reported in outlying areas in 1982 (Envirodyne Engineers, 1985).
Florida mouse (*Podomys floridanus*)	SSC	C2		Known from Clay County, may range into habitats (sand pine scrub and longleaf pine-turkey oak communities) present at NAS Cecil. Not known to be a resident at NAS Cecil Field (Envirodyne Engineers, 1985; Cochran, 1995).
Hooded pitcher plant (*Sarracenia minor*)			T	Observed in wetlands associated with Sites 3 and 17 (ABB-ES), and Sites 4 and 5 (CDM, 1994).
Spoon-leaved sundew (*Drosera intermedia*)			T	Observed at one location at Yellow Water Weapons Annex in drainage ditch (Environmental Services & Permitting [ESP], 1990).
Cinnamon fern (*Osmunda cinnamomea*)			CE	Observed at Site 1 (ABB-ES ecologist), 2, 3, 4, 5 and 17 (CDM, 1994 and the Yellow Water Weapons Annex (CZR, 1994).
Royal fern (*Osmunda regalis*)			CE	Observed at Site 1 (ABB-ES ecologist), 2, 4, 5 and 17 (CDM, 1994) and the Yellow Water Weapons Annex (CZR, 1994).
Southern shield fern (*Thelypteris kunthii*)			T	Not observed at NAS Cecil Field, but appropriate habitat exists at Sites 11 and 18.
Comb fern (*Polypodium plumula*)			T	Not observed at NAS Cecil Field, but appropriate habitat exists within mesophytic hardwood communities.
Bartram's ixia (*Salpingostylis coelestina*)			E	Confirmed by Navy personnel in the southwest quadrant of NAS Cecil Field (Burst, 1995; Cochran, 1995).
Variable-leaf crown beard (*Verbesina heterophylla*)		C2		Observed at one location at NAS Cecil Field in sandhill habitat (ESP, 1990).
Netted chain fern (*Woodwardia areolata*)			T	Observed at Sites 3 and 5 (CDM, 1994), 1 and 17 (ABB-ES ecologist).
Grass pink (*Calopogon tuberosus*)			T	Observed at Site 17 by ABB-ES ecologist.

See notes at end of table.

Table 2-2 (Continued)
Rare, Endangered, and Threatened Flora and Fauna at or in the Vicinity of NAS Cecil Field

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Common Name	FGFWFC[1]	USFWS[2]	FDA[3]	Comments
Ladies' tresses (*Spiranthes vernalis*)			T	Confirmed at NAS Cecil Field (Cochran, 1995).
Rose pogonia (*Pogonia ophioglossoides*)			T	Confirmed at NAS Cecil Field (Cochran, 1995).
Foxtail clubmoss (*Lycopodium alopeuroides*)			T	Observed at Site 4 (CDM, 1994) and OU 2 (ABB-ES ecologist).
Wild azalea (*Rhododendron canescens*)			CE	Observed at NAS Cecil Field (CZR, 1994).
Swamp honeysuckle (*Rhododendron viscosum*)			T	Observed at NAS Cecil Field (CZR, 1994).
Dahoon holly (*Ilex cassine*)			CE	Observed at NAS Cecil Field (CZR, 1994).
American holly (*Ilex opaca*)			CE	Observed at NAS Cecil Field (CZR, 1994).
Dwarf palmetto (*Sabal minor*)			T	Observed in disturbed upland areas of OU 1 and OU 2 (ABB-ES ecologists).

[1] Florida Game and Fresh Water Fish Commission (FGFWFC) (list published in Sections 39-27.003-005, Florida Administrative Code) (Wood, 1994).
[2] U.S. Fish and Wildlife Service (USFWS) (list published in List of Endangered and Threatened Wildlife and Plants, 50 CFR 17.11-12) (Wood, 1994).
[3] Florida Department of Agriculture (FDA) and Consumer Services (list is statutorily designated by the Preservation of Native Flora of Florida Act (581.185-187, Florida Statutes) (Wood, 1994).

Notes: SSC = species of special concern.
C2 = a candidate for Federal listing with some evidence of vulnerability, but for which not enough information exists to justify listing.
NAS = Naval Air Station.
T(S/A) = threatened due to similarity of appearance.
T = threatened.
E = endangered.
CE = commercially exploited.

tortoise included pine flatwoods, longleaf pine or turkey oak hills, shrub and brushland, and altered or ruderal land. Additional information on the gopher tortoise survey is included in Subsection 5.3.3.

The wood stork *(Mycteria americana)* is known to breed in Florida and southeastern Georgia; it is a confirmed migrant at NAS Cecil Field, where it has been observed feeding at Lake Fretwell (Cochran, 1995). Drainage or alteration of feeding habitats have led to its listing as endangered by USFWS, FGFWFC (Wood, 1994), and FCREPA (Kale, 1978). Adults seek shallow freshwater marshes, flooded pastures, or ditches that may have sufficient concentrations of fish to accommodate their inefficient method of groping for food (Kale, 1978). Additional suitable habitat for feeding may be present at NAS Cecil Field in shallow water areas such as the wetlands on or near Sites 1, 2, 3, 4, 5, and 17.

The southeastern kestrel (*Falco sparverius paulus*) is considered threatened by both FGFWFC (Wood, 1994) and FCREPA (Kale, 1978, as cited in Envirodyne Engineers, 1985), and is under review by the USFWS. It occurs in open pine forests or clearings with available perches. Either this species or the unlisted eastern American kestrel, *F. sparverius sparverius*, occurs at NAS Cecil Field; a positive identification to subspecies has not been made at present (Cochran, 1995). Kestrels may feed in planted pine areas at or near Sites 1, 2, 3, 4, and 5, and have been observed in the Yellow Water Weapons area by ABB-ES biologists.

The bald eagle (*Haliaeetus leucocephalus*) has been downgraded from endangered to threatened by the USFWS (Wood, 1994; 1995); it is also listed as threatened by FGFWFC (Wood, 1994). It was once considered widespread in Florida, but its numbers have diminished considerably since the 1940s. It is presently increasing in number within the state (Wood, 1995). The bald eagle is generally associated with lakes, rivers, and shallow coastal areas, particularly during nesting season, and has been reported in Duval County (FNAI, 1994). Since nesting occurs near the St. Johns River, the bald eagle may occasionally stray over NAS Cecil Field.

Bachman's sparrow (*Aimophila aestivalis*) is a candidate for Federal listing (C2), with some evidence of vulnerability, but for which not enough information exists to justify listing. It occurs in dry open pine or oak woods with scattered understory and in overgrown fields (Bull and Farrand, 1977). This species has been observed in the Yellow Water Weapons area (CZM, 1994).

Sherman's fox squirrel *(Sciurus niger shermani)* is listed as a species of special concern by FGFWFC and a candidate for listing by USFWS (Wood, 1994). Diminishing habitat of this species is the primary reason it is listed. Preferred habitats are those communities offered by sandhill association (longleaf pine and turkey oak) and ectonal situations in flatwoods. Typically, this squirrel depends upon pine seeds and acorns for food (Humphrey, 1992). Presence in Duval County of small, scattered populations of this species is confirmed (Wooding, 1990). A fox of this or the closely related and also protected subspecies, *S. sciurus avicennia*, was observed at NAS Cecil Field by an ABB-ES biologist; it was seen in the pine woods along the eastern portion of Perimeter Road. Sherman's fox squirrel may range into appropriate habitat at other locations, including Sites 1, 2, 4, and 5.

The Florida black bear (*Ursus americanus floridanus*) is under consideration for listing by USFWS and considered threatened by both FGFWFC (Wood, 1994) and

FCREPA. It is currently found only in large tracts of property which offer heavy vegetation as refuge (Humphrey, 1992). Evidence of black bears was reported in 1982 from the outlying portions of the property (Envirodyne Engineers, 1985).

The Florida mouse (*Podomys floridanus*) is limited in range to a patchy distribution in peninsular Florida, and has a very narrow habitat range within sand pine scrub and longleaf pine-turkey oak communities. It is listed as threatened by FGFWFC (Wood, 1994) and FCREPA (Humphrey, 1992) and is found in Clay County (Envirodyne Engineers, 1985). Although it is not listed in the inventory database for Duval County (FNAI, 1994), the Florida mouse may potentially range into appropriate habitats at NAS Cecil Field.

2.5.2 Flora None of the 44 endangered or 10 threatened plant species listed by USFWS and known to occur in Florida (Wood, 1994) are believed to occur at NAS Cecil Field (Envirodyne Engineers, 1985; CDM, 1994). Those plant species that are listed by the Florida Department of Agriculture (FDA) as threatened or commercially exploited and that were observed or may potentially occur at NAS Cecil Field include the following:

The **hooded pitcher plant** was observed at several sites at NAS Cecil Field. ABB-ES biologists and ecologists observed this plant in the wetland associated with Site 3 and in the eastern portion of Site 17. CDM (1994) observed the pitcher plant near Site 1 in the Rowell Creek floodplain, as well as at Sites 4 and 5. This species occurs in bogs, wet savannahs, and open pinelands throughout central and northern Florida, and may be present in wetlands at additional sites at NAS Cecil Field.

The **spoon-leaved sundew** occurs in moist places associated with thin pinelands or open areas (Duncan and Foote, 1975). It was observed in the Yellow Water Weapons area (ESP, 1990), and this or a related species was reported near Site 4. Additional sites at NAS Cecil Field offer appropriate habitat for this species.

The **cinnamon fern** has been observed at Site 1 and in the bottomland forest associated with Site 2, as well as at Sites 3, 4, 5, and 17 (CDM, 1994). It was also observed in the Yellow Water Weapons area by CZR (1994). It is commonly found in wet woods and swamps throughout Florida (Wunderlin, 1982). This fern is listed by the FDA because it is commercially exploited in Florida (Wood, 1994).

The **royal fern** is also commercially exploited in Florida (Wood, 1994). It occurs commonly in wetlands of Florida (Wunderlin, 1982) and has been observed at NAS Cecil Field at Sites 1 (ABB-ES, 1994a), 2 (in the emergent persistent wetland), 4, 5, and 17 (CDM, 1994).

The **southern shield fern** (*Thelypteris kunthii*) is listed as threatened by the FDA (Wood, 1994). It is commonly found in rocky woods and cypress swamps in Florida (Wunderlin, 1982) and may be present at NAS Cecil Field.

The **comb fern** is also listed as threatened by the FDA (Wood, 1994). Although it has not been observed at NAS Cecil Field, appropriate habitat is present. It is an epiphytic form frequently found in hammocks throughout Florida (Wunderlin, 1982).

Bartram's ixia (*Salpingostylis coelestina*) is unique in that it is exclusive to a small area in northeastern Florida. Its habitat is wet, grassy, flatwoods associated with slash or longleaf pines and wiregrass and wet prairie; it is a confirmed species in Duval County (FNAI, 1994). Due to its very limited range, Bartram's ixia is listed as endangered by FDA (Wood, 1994) and as threatened by FCREPA (Ward, 1978, as cited in Envirodyne Engineers, 1985). This species was reported at NAS Cecil Field in the 1990 study (ESP, 1990), and its presence was later confirmed by Navy personnel (Burst, 1995; Cochran, 1995).

The **variable-leaf crown beard** (*Verbesina heterophylla*) is a terrestrial plant that occurs in sandhill and mesic flatwoods (FNAI, 1994). It was observed at one location at NAS Cecil Field in a sandhill habitat (ESP, 1990), but proximity to other study sites was not reported. Appropriate habitat exists at Sites 2, 3, 4, 5, and 17.

The **netted chain fern** was observed in wetlands at NAS Cecil Field at Sites 2, 3, and 5 (CDM, 1994) and at Sites 5 and 17 (by an ABB-ES ecologist). It was also observed at the Yellow Water Weapons complex (CZR, 1994), and is commonly found in swamps and wet woods in Florida (Wunderlin, 1982). The netted chain fern is another commercially exploited species in Florida.

The **grass pink** (*Calopogon tuberosus*), a member of the orchid family and listed as threatened by FDA (Wood, 1994), was observed in the eastern part of Site 17 by ABB-ES ecologists. This species occurs in moist soil of pine woodlands and marshes (Wunderlin, 1982), and could potentially occur in wetlands associated with additional sites at NAS Cecil Field.

Ladies' tresses (*Spiranthes* sp.), also members of the orchid family, include several species that are listed as threatened by FDA (Wood, 1994). Hank Cochran (1995) indicated that a member of this genus has been confirmed at NAS Cecil Field (species name was not provided). This slender, grasslike genus is found in wet, grassy areas throughout Florida (Taylor, 1992).

The **rose pogonia** (*Pogonia ophioglossoides*) is listed as threatened by FDA (Wood, 1994) and is present at NAS Cecil Field (Cochran, 1995). Also a member of the orchid family, this fragrant, pink or rose-pink flowering plant is found in wet pine flatwoods and marshes in central and northern Florida (Taylor, 1992).

Foxtail clubmoss is listed as threatened by the FDA (Wood, 1994). It is a wetland species found in wet pinelands and along the edges of swamps. It has been observed at Site 4 (CDM, 1994) and OU 2 by ABB-ES ecologists.

The **wild azalea** (*Rhododendron canescens*) is listed as a commercially exploited species by FDA (Wood, 1994). This member of the Ericaceae family is found in wet to well-drained woodlands and along streams of central and northern Florida (Taylor, 1992). It was observed at NAS Cecil Field by CZR (1994).

The **swamp honeysuckle** is listed by FDA as threatened (Wood, 1994). This species occurs in wet woods and swamps, and flowers from spring to early fall (Taylor, 1992). The wild azalea has been observed at NAS Cecil Field (CZR, 1994).

The **dahoon holly** (*Ilex cassine*) is a commercially exploited species in Florida (Wood, 1994). It is found in flatwood depressions and along margins of swamps and ponds (Wunderlin, 1982), and has been observed at NAS Cecil Field (CZR, 1994).

The **American holly** (*Ilex opaca*) is also a commercially exploited species in Florida (Wood, 1994). This species is an occasional inhabitant of mesic woods (Wunderlin, 1982) and has been observed at NAS Cecil Field (CZR, 1994).

The **dwarf palmetto** (*Sabal minor*) is listed as threatened by the FDA (Woods, 1994). It occurs frequently in moist to wet woods (Wunderlin, 1982) and has been reported in disturbed upland areas of OU 1 and OU 2 at NAS Cecil Field.

CHAPTER 3.0

3.0 ECOLOGICAL RISK ASSESSMENT METHODOLOGY

ERAs evaluate actual and potential adverse effects to ecological receptors associated with exposure to contamination from a hazardous waste site. The ERAs for each of the OUs at NAS Cecil Field were completed in accordance with current guidance materials for ERAs at Superfund sites including the following:

- *Risk Assessment Guidance for Superfund Environmental Manual* (United States Environmental Protection Agency [USEPA], 1989a),
- *Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference* (USEPA, 1989b),
- *Ecological Assessment of Superfund Sites: An Overview* (USEPA, 1991a), and
- *Framework for Ecological Risk Assessment* (USEPA, 1992a).

Recent risk assessment guidance including the USEPA "Eco Update" bulletins (USEPA 1991b, 1992b, 1992c) and recent publications (e.g., Maughan, 1993; Suter, 1993) were also consulted.

The assessment approach integrates both field and predictive methodologies to assess risks. The decisions regarding overall risk to ecological receptors are based on the weight-of-evidence from the results of all components of the assessment methodology (i.e., an approach that integrates results of physical, biological, toxicological, and modeling studies to draw risk-based conclusions). The weight-of-evidence components were designed to provide measures of risks for different ecological receptors, exposure pathways, and potential adverse effects.

The sections below the five components of an ERA including problem formulation, exposure assessment, ecological effects assessment, risk characterization, and uncertainty analyses.

3.1 PROBLEM FORMULATION. Problem formulation is the initial step of the ERA process. Problem formulation is composed of identification of receptors, identification of exposure pathways for those receptors, and the assessment and measurement endpoints selected for the ERAs.

3.1.1 Identification of Receptors Potential ecological receptors include both aquatic and terrestrial plants and animals. Aquatic receptors include invertebrates, plants, algae, amphibians, and fish. Terrestrial wildlife receptors include mammals, bird, reptiles, invertebrates, and amphibians. Aquatic and terrestrial species identified during the biological field investigations are used to identify plants and aquatic and terrestrial receptors. Terrestrial and wetland flora and fauna and aquatic species potentially using NAS Cecil Field are identified in Appendix A.

3.1.2 Identification of Exposure Pathways Exposure pathways are identified for four groups of ecological receptors (terrestrial and wetlands wildlife, terrestrial plants, terrestrial invertebrates, and aquatic receptors). The exposure pathway includes a source of contamination, potentially contaminated media (surface soil, food, groundwater, surface water, or sediment), and an exposure route. A conceptual model of the exposure pathways from source to ecological receptors is developed for each OU or group of sites within an OU.

Not all potential routes of exposure are presented in the contaminant pathway model. The model represents only those pathways that are evaluated in the ERA. This limitation is necessary to focus the risk evaluation on the pathways for which: (1) contaminant exposures are the highest and most likely to occur and (2) there are adequate data pertaining to the receptors, contaminant exposures, and toxicity for completion of risk analyses.

Terrestrial and Wetland Wildlife. The exposure routes evaluated for wildlife represent those pathways that are believed to contribute the highest potential contaminant exposures. These exposures include ingestion of soil, sediment, surface water, and food items that are contaminated as a result of accumulation of constituents from site media. An assumption is made that fur, feathers, or chitinous exoskeleton limit the transfer of contamination across the dermis; therefore, exposures related to dermal contact are not evaluated as part of the ERA. Exposures related to inhalation are also not evaluated because this pathway is generally considered an insignificant route of exposure except in unusual circumstances, such as following a spill or release.

Potential contaminant exposures for reptiles and amphibians exist at NAS Cecil Field, but are not evaluated due to a lack of availability of data relating contaminant exposures to adverse responses for reptiles and amphibians.

Terrestrial Plants and Invertebrates. Terrestrial plants and soil invertebrates may be exposed to contamination in surface soil by direct contact with and ingestion of the soil. Terrestrial plants may also be exposed to contamination in groundwater where the roots reach a zone of saturation. Because of difficulties estimating contaminant exposures for terrestrial plants from groundwater, the groundwater exposure pathway is generally not selected for evaluation.

Aquatic Receptors. Exposure pathways evaluated for aquatic receptors at NAS Cecil Field (including invertebrates, plants, amphibians, and fish) include direct contact with surface water, sediment, and groundwater (as it discharges to the surface water). Aquatic life may also be exposed to contamination in sediment as a result of ingestion of the sediment. This pathway is not chosen for evaluation because information on the amount of sediment ingested by aquatic organisms and associated toxicity is generally not available.

3.1.3 Identification of Endpoints The endpoints selected for the ERAs are identified and listed at the beginning of the ERA process. Examples of endpoints used in ERAs for NAS Cecil Field are provided in Table 3-1. Measurements of actual toxicity and adverse effects are completed when possible to decrease uncertainties and to measure the adverse effects associated with the actual mixture of contaminants present in environmental media (soil, surface water, sediment, and groundwater). The measurement and assessment endpoints for aquatic receptors, terrestrial and wetland wildlife, and terrestrial plants and invertebrates are discussed separately. 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.

Table 3-1
Possible Endpoints for Ecological Assessment

Basewide Ecological Assessment Report
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Medium	Receptor	Assessment Endpoint	Measurement Endpoint
Surface Water	Aquatic life (invertebrates, fish, plants, and amphibians).	Survival and maintenance of benthic macroinvertebrate community structure and function.	Direct measurement of macroinvertebrate community structure and function.
		Survival and maintenance of fish and macroinvertebrate populations.	Contaminant concentrations in surface water and shallow groundwater associated with adverse effects to growth, reproduction, or survival of aquatic organisms.
			Toxicity testing of shallow groundwater.
Sediment	Aquatic life (invertebrates, fish, plants, and amphibians).	Survival and maintenance of benthic macroinvertebrate community structure and function.	Field sampling and measurement of macroinvertebrate community structure and function.
		Survival and maintenance of fish, macroinvertebrate, and aquatic plant populations.	Toxicity testing of sediment.
			Contaminant concentrations in sediment associated with adverse effects to growth, reproduction, or survival of aquatic organisms.
Surface Water, Sediment, and Surface Soil	Terrestrial and wetland wildlife.	Survival of wildlife populations and communities.	Oral contaminant exposure concentrations representing adverse effects to growth, reproduction, or survival of mammalian or avian laboratory test populations.
Surface Soil	Terrestrial invertebrates.	Survival of terrestrial invertebrate communities.	Survival of earthworms exposed to surface soil samples in laboratory toxicity tests.
Surface Soil	Terrestrial plants.	Survival, reproduction, and growth of plant communities.	Germination of lettuce seeds exposed to surface soil samples in laboratory toxicity tests.

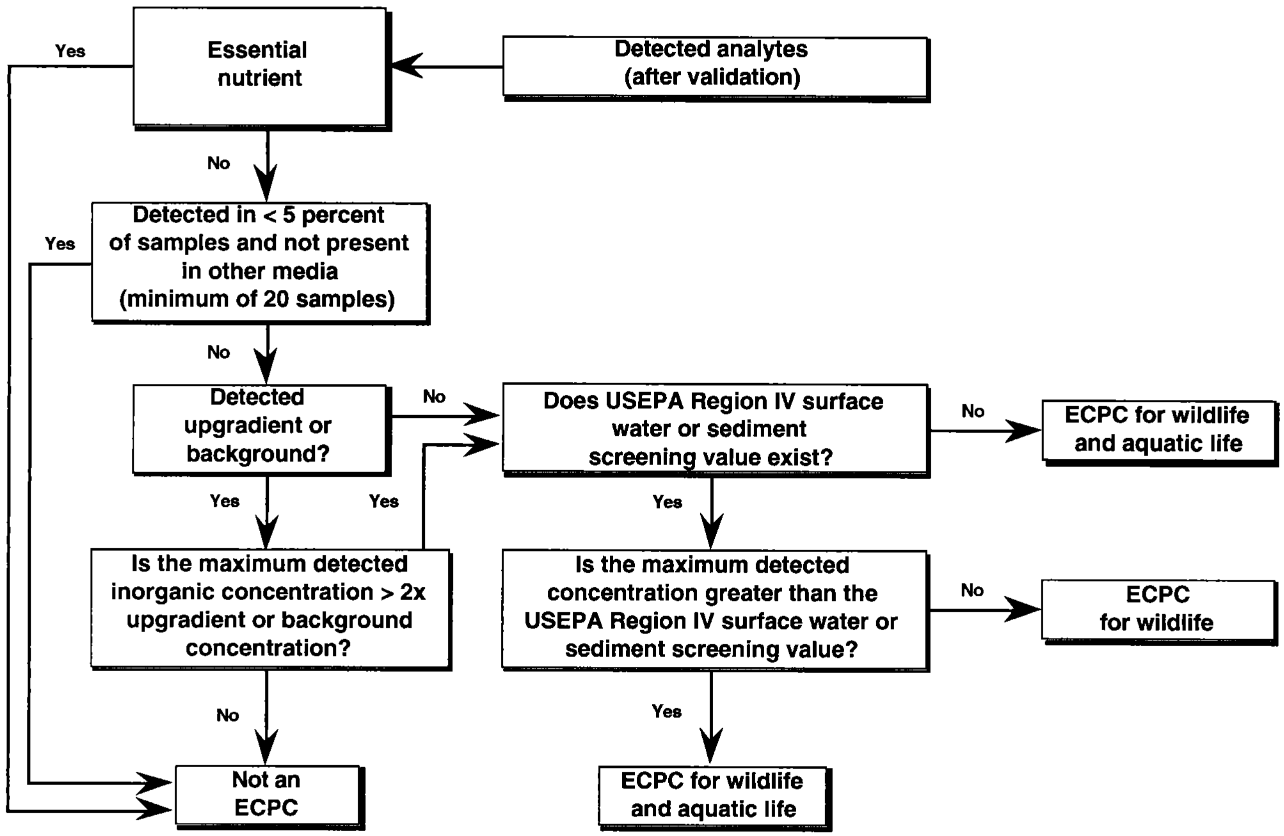
Terrestrial and Wetland Wildlife. The assessment endpoint for terrestrial and wetland wildlife is the maintenance of wildlife populations and communities within the habitats present at the NAS Cecil Field OUs. A description of these habitats is presented in Chapter 2.0. Because no long-term wildlife population data are available at NAS Cecil Field, a direct measurement of this assessment endpoint is not possible. The literature-derived results of laboratory toxicity studies that relate the dose of a contaminant in an oral exposure with an adverse response to growth, reproduction, or survival of a test population (avian or mammalian species) are used as a measure of the assessment endpoint.

Terrestrial Plants and Invertebrates. The assessment endpoint for terrestrial plants and soil invertebrates is the survival, growth, and reproduction of terrestrial invertebrates and plant communities. When toxicity testing data are available, this endpoint is measured through toxicity testing of earthworm (*Eisenia foetida*) and lettuce (*Lactuca sativa*) seed with surface soil samples from the hazardous waste sites. This laboratory toxicity testing provides a direct measure of the toxicity of the mixture of chemicals in soil to a terrestrial invertebrate and plant species. It is assumed that the responses of these test species are adequate indicators for other terrestrial invertebrates and plants occurring at NAS Cecil Field. In cases where toxicity testing of the surface soil was not completed, literature values on contaminant concentrations in surface soil that are associated with survival and growth of terrestrial invertebrates and plants are used as the measurement endpoint.

Aquatic Receptors. Where information on the benthic macroinvertebrate community is available, the assessment endpoint for aquatic receptors is the survival and maintenance of a well-balanced benthic macroinvertebrate community structure and function. This endpoint was measured based on the results of semiquantitative benthic macroinvertebrate sampling described in Section 5.2 and toxicity testing of the sediment described in Section 5.1. Survival and maintenance of fish and aquatic plant populations is a second assessment endpoint for aquatic life. The survival and maintenance of fish, plant, and invertebrate populations is estimated based on literature-reported concentrations of a contaminant in water or sediment in a laboratory or field toxicity test that is associated with adverse effects on reproduction, growth, or survival of a test population. Toxicity testing of groundwater is also used as a measurement endpoint to evaluate the survival and maintenance of fish populations at NAS Cecil Field.

3.2 SELECTION OF ECOLOGICAL CHEMICALS OF POTENTIAL CONCERN. Ecological chemicals of potential concern (ECPCs) represent the analytes detected in media (surface soil, surface water, sediment, or groundwater) that are considered in the ERA. The ECPCs are assumed to be associated with waste disposal practices at the sites and could present a risk for ecological receptors. The process for selection of ECPCs is depicted on Figure 3-1. Surface water and sediment ECPCs are selected separately for wildlife and aquatic receptors because available ECPC screening tools distinguish between these two groups of receptors.

Pursuant to USEPA (1989a; 1989b) national guidance, analytical data for each site at NAS Cecil Field are evaluated to determine their validity for use in the risk assessment. Analytes are not selected as ECPCs if the site concentrations are within 5 to 10 times the concentrations in associated trip blanks or method blanks. In addition, analytes in surface soil, surface water, sediment, and groundwater are not selected as ECPCs if the analyte was detected in 5 percent



Notes:

USEPA = U.S. Environmental Protection Agency

ECPC = Ecological chemical of potential concern

> = Greater than

< = Less than

x = Times

FIGURE 3-1
ECOLOGICAL CHEMICAL OF POTENTIAL CONCERN SELECTION PROCESS

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or fewer of the samples analyzed and were not selected as ECPCs in any other media. In accordance with USEPA Region IV guidance (USEPA, 1991c), if the maximum detected concentration of an inorganic analyte is less than two times the average inorganic concentration detected in the respective upgradient (surface water, sediment, or groundwater) of background samples (surface soil), then the analyte is not selected as an ECPC.

All analytes in surface soil, surface water, and sediment retained as ECPCs after the first two steps are selected as ECPCs for terrestrial or wetlands wildlife. ECPCs for aquatic receptors for groundwater, surface water, and sediment are selected based on an additional step, in accordance with USEPA Region IV guidance (USEPA, 1991c; 1992d). Analytes detected in the sediment are selected as ECPCs if the maximum detected concentration exceeds the sediment quality screening value or is two times higher than the concentration in the upgradient reference station (inorganics only). The sediment quality screening value is derived from the lower of the threshold effects level (TEL) from the Florida Sediment Quality Assessment guidelines (MacDonald, 1994) or the effects range low (ER-L) sediment values (Long 1993). Analytes in surface water and groundwater are retained as ECPCs for aquatic receptors if the maximum detected concentration exceeds the USEPA Region IV screening concentration (USEPA, 1992d), exceeds the average concentration times two in the upgradient reference station (inorganics only), or a screening value is not available.

Calcium, magnesium, potassium, and sodium are excluded as ECPCs for all media as they are considered to be essential nutrients and are only toxic at extremely elevated concentrations. Evidence suggests that there is little potential for toxic effects resulting from overexposure to these essential nutrients. The highly controlled physiological regulatory mechanisms of these inorganics suggest that there is little, if any, potential for bioaccumulation, and available toxicity data demonstrate that high dietary intake of these nutrients as well tolerated (National Academy of Sciences, 1977; National Research Council [NRC], 1984; 1982).

All ECPCs selected for the ERA are summarized in tables that include:

- the frequency of detection,
- range of contract-required quantitation limits (CRQLs) and contract-required detection limits (CRDLs),
- range of detected concentrations,
- average detected concentration,
- average of all concentrations (only for analytes selected as ECPCs from 10 or more samples),
- 95th percentile upper confidence limit (UCL) (only for analytes selected as ECPCs from 10 or more samples),
- USEPA Region IV screening criteria (surface water and sediment only), and
- twice the average background or upgradient concentration for each of the inorganic analytes.

3.3 EXPOSURE ASSESSMENT. Exposure assessment is the process of estimating or measuring the amount of an ECPC in environmental media (surface soil, surface water, sediment, food items, or groundwater) to which an ecological receptor may be exposed via respective exposure routes. The following paragraphs discuss how contaminant exposures are, in general, estimated or measured for aquatic receptors, wildlife, terrestrial plants, and terrestrial soil invertebrates.

3.3.1 Aquatic Receptors Exposure concentrations for aquatic receptors are the amounts of the ECPCs measured in analytical samples of surface water and sediment at the respective sampling locations. Sediment samples collected for toxicity testing represent exposure of laboratory-grown test organisms to the actual mixture of contaminants in the system, and represent a means for measurement of bioavailability and adverse responses to sediment contamination.

3.3.2 Terrestrial and Wetlands Wildlife Routes of contamination for wildlife for which exposure concentrations are measured or estimated are decided on a site-specific basis. Exposure routes usually include direct or indirect ingestion of soil, surface water, or sediment, and ingestion of contaminated food. Concentrations of the ECPCs measured in surface soil samples are used to estimate contaminant exposures for wildlife receptors. Typically, maximum and average concentrations are used to approximate worst-case and average contaminant exposures.

The actual amount of an ECPC taken in by a wildlife species as a result of indirect or direct ingestion of water, soil, or sediment is dependant on a number of factors. To consider these factors, certain species are selected as representative wildlife species for evaluation in a food chain model. The representative wildlife species include mammalian and avian species representing the range of trophic levels and body sizes present at the site. Table 3-2 summarizes how contaminant exposure concentrations are determined for ECPCs in surface soil, sediment, and surface water for the representative wildlife species evaluated in the food web model.

A total Potential Dietary Exposure (PDE) is estimated for each representative wildlife species for each ECPC in all media according to the equations in Table 3-2. The PDE is calculated based on the estimated concentrations of the ECPCs in food items that the species would consume; the amount of soil, surface water, or sediment that it would ingest; the relative amount of different food items in its diet; body weight; and food and water ingestion rate. If measurements of concentrations of contaminants in prey items have been collected, these values are used in place of the estimated values.

Prey items for wildlife species in the food web exposure models include invertebrates and plants. Concentrations of ECPCs in invertebrates and plant tissue are estimated using bioaccumulation factors (BAFs). BAFs in invertebrates and plants are defined as the ratio of the ECPC concentration in plant or invertebrate tissue to the ECPC concentration in surface soil. The BAFs reported for avian and mammalian receptors are defined as the reported ratios of ECPC concentrations in the tissues of these receptors to the concentrations of ECPCs in their food items. BAFs are either back-calculated based on site-specific measurements or extrapolated from literature values or regression equations in the scientific literature. If literature values are not available, then BAFs may be estimated using best professional judgement.

Table 3-2
Model for Estimation of Chemical Exposures for Representative Wildlife Species

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Estimation of Contaminant Exposures Related to Surface Soil

Description:	Estimates the amount (dose) of a contaminant ingested and accumulated by a species via incidental ingestion of contaminated surface soil and ingestion of contaminated food items.
Soil Contaminant Concentration:	Maximum: The maximum detected concentration of the ecological chemicals of potential concern (ECPCs) when the number of samples is $\leq$ 9, and the lesser of the maximum detected concentration or the 95th percent upper confidence limit (UCL) when the number of samples is $\geq$ 10. Average: Average of detected concentrations. If the average is greater than the maximum exposure point concentration (EPC), the maximum EPC was selected.
Concentration of a Contaminant in a Food Item (T_N):	$$\underset{(mg/kg)}{\text{Food Contaminant Concentration}} = BAF \times \underset{(mg/kg)}{\text{Soil Contaminant or Prey Item Concentration}}$$ 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.
Potential Dietary Exposure (PDE):	$$PDE = \frac{[P_1 \times T_1 + P_2 \times T_2 + \ldots + P_N \times T_N + \text{soil exposure}] \times IR_{Diet} \times SFF}{BW}$$ 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), IR_{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 onsite).
Soil Exposure:	$$\underset{(mg/kg)}{\text{Soil Exposure}} = (\%\ \text{of Diet as Soil}) \times \underset{(mg/kg)}{\text{Soil Contaminant Concentration}}$$

See notes at end of table.

Table 3-2 (Continued)
Model for Estimation of Chemical Exposures for Representative Wildlife Species

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Estimation of Contaminant Exposures Related to Surface Water and Sediment

Description: Estimates the amount of a contaminant ingested and accumulated by a species resulting from ingestion of surface water, incidental ingestion of sediment, and ingestion of contaminated aquatic food items.

Contaminant Concentration: Same as described above for soil.

Contaminant Concentration in Aquatic Prey Tissue (mg/kg):

$$\begin{array}{c}\textit{Aquatic Prey}\\ \textit{Contaminant}\\ \textit{Concentration}\\ (mg/kg)\end{array} = \left[BAF \times \begin{array}{c}\textit{Sediment Contaminant}\\ \textit{Concentration}\\ (mg/kg)\end{array}\right] + \left[BCF \times \begin{array}{c}\textit{Surface Water}\\ \textit{Contaminant}\\ \textit{Concentration}\\ (mg/\ell)\end{array}\right]$$

where

BCF = bioconcentration factor (mg/kg of contaminant in food item per mg/ℓ of contaminant in water). Only BCFs greater than 300 were considered as per USEPA, 1989g.

BAF = bioaccumulation factor (see note above).

Sediment Exposure:

$$\begin{array}{c}\textit{Sediment}\\ \textit{Contaminant}\\ \textit{Exposure}\\ (mg/day)\end{array} = \begin{array}{c}\textit{\% of Diet}\\ \textit{as}\\ \textit{Sediment}\end{array} \times \begin{array}{c}IR_{diet}\\ (kg/day)\end{array} \times \begin{array}{c}\textit{Sediment Contaminant}\\ \textit{Concentration}\\ (mg/kg)\end{array}$$

Surface Water Exposure:

$$\begin{array}{c}\textit{Surface Water}\\ \textit{Contaminant}\\ \textit{Exposure}\\ (mg/day)\end{array} = \begin{array}{c}\textit{Surface Water}\\ \textit{Contaminant}\\ \textit{Concentration}\\ (mg/\ell)\end{array} \times \begin{array}{c}\textit{Water Ingestion}\\ \textit{Rate}\\ (\ell/day)\end{array}$$

Aquatic Prey Exposure:

$$\begin{array}{c}\textit{Aquatic Prey}\\ \textit{Exposure}\\ (mg/day)\end{array} = \begin{array}{c}\textit{\% Diet}\\ \textit{as}\\ \textit{Aquatic Prey}\end{array} \times \begin{array}{c}IR_{diet}\\ (kg/day)\end{array} \times \begin{array}{c}\textit{Aquatic Prey}\\ \textit{Contaminant}\\ \textit{Concentration}\\ (mg/kg)\end{array}$$

where

IR_{diet} = food ingestion rate of receptor (kg of food per day).

Total Exposure Related to Surface Water and Sediment:

$$\begin{array}{c}\textit{Potential}\\ \textit{Dietary}\\ \textit{Exposure}\\ (mg/kg)\end{array} = \frac{\begin{array}{c}\textit{Aquatic Prey}\\ \textit{Exposure}\\ (mg/kg)\end{array} + \begin{array}{c}\textit{Surface Water}\\ \textit{Exposure}\\ (mg/kg)\end{array} + \begin{array}{c}\textit{Sediment}\\ \textit{Exposure}\\ (mg/kg)\end{array}}{BW}$$

where BW = body weight (kg) of receptor.

Notes:
≤ = less than or equal to.
≥ = greater than or equal to.
mg/kg = milligrams per kilogram.
mg/kgbw-day = milligrams per kilogram body weight per day.
kg = kilogram.
% = percent.
mg/ℓ = milligrams per liter.
kg/day = kilogram per day.
ℓ/day = liter per day.

The site foraging frequency (SFF) allows for consideration of the frequency of feeding in the site area by estimating the acreage of the site relative to the receptor's feeding range and by considering the fraction of the year the receptor would be exposed to site-related chemicals. By definition, the SFF cannot exceed one.

For each representative wildlife species, the estimated percentage of soil in the overall diet is multiplied by the concentration of each ECPC in the soil and the food ingestion rate (Kilogram [kg] per day) to determine the soil exposure concentration. Incidental soil ingestion associated with foraging activities is based on a study by Beyer and others (1991), the USEPA Exposure Factors Handbook (USEPA, 1993), or is conservatively assumed to represent 5 percent of the total dietary intake.

3.4 ECOLOGICAL EFFECTS ASSESSMENT. The ecological effects assessment describes the potential adverse effects to ecological receptors associated with the identified ECPCs and reflects the type of assessment endpoints selected. The general methods used for identifying and characterizing ecological effects for ECPCs in surface soil, surface water, sediment, and groundwater are described in the following paragraphs.

3.4.1 Surface Soil The measures of adverse ecological effects for terrestrial wildlife, terrestrial plants, and soil invertebrates are discussed separately. Potential adverse ecological effects for wildlife are estimated for each ECPC based on available literature information. Reference toxicity values (RTVs) are determined for each ECPC for avian and mammalian receptors. The RTV relates the dose of a respective ECPC in an oral exposure with an adverse effect. For each ECPC identified and each representative wildlife species selected, two RTVs are identified. A lethal RTV represents the threshold for lethal effects and is based on an oral LD_{50} (oral dose lethal to 50 percent of a test population). The lethal RTV is one-fifth of the lowest reported LD_{50} for the most closely related test species. One-fifth of an oral LD_{50} value is considered to be protective of lethal effects for 99.9 percent of individuals in a test population (USEPA, 1986). An assumption is made that the value represented by one-fifth of an oral LD_{50} would be protective of 99.9 percent of the individuals within the terrestrial wildlife populations and represents a level of acceptable risk.

A sublethal RTV is also identified that represents a threshold dose for sublethal effects. Sublethal effects are defined as those that impair or prevent reproduction or growth.

The RTVs are assumed to be a measure of the assessment endpoints for protection of the survival, growth, and reproduction of terrestrial wildlife populations. RTVs are derived separately for avian and mammalian species.

If neither lethal nor sublethal toxicity information is available for an ECPC, it is not possible to identify RTVs, and risks associated with the predicted exposure for the respective ECPC are not quantitatively evaluated.

The toxicity of ECPCs in surface soil is either measured by use of soil laboratory toxicity tests or evaluated based on literature information. Soil toxicity testing is available for some sites and includes a 14-day survival toxicity test with earthworms (*Eisenia foetida*) and a seed germination toxicity test with lettuce seed (*Lactuca sativa*) (Green and others, 1989). Bioaccumulation of contaminants in earthworms was determined for some sites by measuring the concentrations of contaminants in worm tissue following completion of the soil toxicity testing.

In absence of toxicity testing, literature information is consulted to evaluate the toxicity of ECPCs in soil to invertebrates and plants. Concentrations of ECPCs in soil reported to be toxic to invertebrates and plants are compared with site concentrations to evaluate risks.

3.4.2 Surface Water and Sediment Lethal and sublethal RTVs are identified for each ECPC in sediment and surface water for the representative wildlife species, as previously described. Potential adverse ecological effects associated with ECPCs for aquatic receptors are evaluated by the use of toxicity testing. When toxicity testing is unavailable, adverse effects associated with ECPCs in surface water are also evaluated by comparing the ECPC concentrations in surface water and sediment samples with available standards and reported toxicity benchmark values (TBVs).

If toxicity testing data are available, toxicity benchmarks for each of the ECPCs in surface water and sediment are identified. State of Florida Surface Water Quality Standards (Florida Legislature, 1995) and Federal Ambient Water Quality Criteria (AWQC) (USEPA, 1991d) are considered. Additional aquatic toxicity information for ECPCs is obtained from searches of the USEPA Aquatic Information Retrieval (AQUIRE) database. Sediment toxicity benchmarks selected for comparison to detected sediment concentrations include National Oceanic and Atmospheric (NOAA) ER-L and Effects Range-Median (ER-M) sediment guidelines (Long and others, 1993 and 1995), USEPA Sediment Quality Guidelines (SQG) based on equilibrium partitioning (USEPA, 1988), and State of Florida sediment quality guidelines (MacDonald, 1994).

3.4.3 Groundwater Potential adverse effects associated with ECPCs in groundwater are available in the form of laboratory aquatic toxicity testing results for individual ECPCs. The toxicity of groundwater to aquatic receptors was also evaluated through chronic toxicity testing with the water flea (*Ceriodaphnia dubia*) and fathead minnow (*Pimephales promelas*) for one of the sites. Aquatic toxicity information for the ECPCs is obtained from searches of the USEPA AQUIRE database. Additional toxicity benchmarks include the State of Florida Surface Water Quality Standards (Florida Legislature, 1995) and USEPA AWQC (USEPA, 1991d). Groundwater is only evaluated where transport of contamination to a nearby surface water body is reasonably expected to occur.

3.5 RISK CHARACTERIZATION. The following paragraphs describe how risks are characterized for ecological receptors. Potential adverse ecological effects are characterized separately for terrestrial and wetlands wildlife, terrestrial plants, and soil invertebrates resulting from exposure to ECPCs in surface soil, surface water, sediment, and groundwater. Risks may be characterized for aquatic receptors for exposures resulting from ECPCs in surface water, sediment, and groundwater.

3.5.1 Surface Soil Risks for the representative wildlife species associated with ingestion and bioaccumulation of ECPCs in surface soil and prey items are quantitatively evaluated using hazard quotients (HQs), which are calculated for each ECPC by dividing the estimated PDE concentration by the toxicological benchmark (RTV). Hazard indices (HIs) are determined for each receptor by summing the HQs for all ECPCs. When the estimated PDE is less than the RTV (i.e., the HQ < 1), it is assumed that chemical exposures would not be associated with adverse effects to receptors (i.e., inhibited growth, reproduction, and survival of the individual organism) and that no risks to wildlife populations are assumed. When the HQ or HI is greater than 1, an evaluation of the HQs comprising the HI is completed. The number of affected individuals in a population presumably increases with increasing HQ or HI values; therefore, the likelihood of population-level effects occurring is generally expected to increase with higher HQ or HI values.

Risks for terrestrial plants and soil invertebrates are characterized based on the responses of the test population observed in the toxicity testing. If adverse effects are observed in either of the toxicity tests, simple linear regressions are completed to determine if a correlation(s) exists between the concentration of an analyte and the adverse response measured in the bioassay. Further qualitative consideration and discussion of the weight-of-evidence is also completed to characterize risk to these receptors.

<u>3.5.2 Surface Water and Sediment</u> Risks associated with exposures to ECPCs in surface water and sediment are characterized separately for aquatic receptors and wildlife. Risks for aquatic receptors are characterized for each sampling location based on a weight-of-evidence evaluation of the following factors:

- presence or absence of analytes in surface water and sediment samples;
- concentrations of analytes measured in surface water and sediment samples;
- responses of test species in the sediment laboratory toxicity tests;
- measurements of the aquatic macroinvertebrate community structure and function;
- comparison of concentrations of ECPCs in unfiltered surface water to reported toxicity of the ECPC in laboratory tests (AQUIRE information), Federal AWQC [USEPA, 1991d], and State of Florida Surface Water Quality Standards (Florida Legislature, 1995);
- comparison of concentrations of ECPCs in sediment relative to NOAA ER-L and ER-M sediment guidelines (Long and others, 1993 and 1995), USEPA sediment quality guidelines based on equilibrium partitioning (USEPA, 1988), Florida sediment screening guidelines (MacDonald, 1994), and Ontario Minister of the Environment (OME) Lower Effects Level (LEL) provincial sediment quality guidelines (Persaud and others, 1989); and
- physical and chemical factors in the aquatic environment (other than chemical contamination).

If there are negative test results in the toxicity testing, simple linear regressions are completed to determine if a correlation exists between the concentration of an analyte in sediment samples and the adverse response in the toxicity test.

Risks for the representative wildlife species associated with ingestion of surface water, potentially contaminated aquatic life, and sediment are quantitatively evaluated using HQs, which are calculated for each ECPC by dividing the estimated contaminant exposure concentration by the RTV. HIs are determined for each representative wildlife species by summing the HQs for all ECPCs. When the estimated exposure concentration of an individual ECPC is less than the respective RTV (i.e., the HQ < 1), the contaminant exposure is assumed to fall below the range considered to be associated with adverse effects for growth, reproduction, and survival (of the individual organism) and no risks to the wildlife populations are assumed. When the ratio is greater than 1 (i.e., HQ or HI > 1), a discussion of the ecological significance is included and risk is assumed. When HIs are greater than 1, an evaluation of the HQs comprising the HI is completed.

3.5.3 Groundwater Risks for aquatic life associated with exposures to ECPCs in unfiltered groundwater as it discharges to surface water are evaluated. Predicted concentrations of the ECPCs in surface water are compared to toxicity information from AQUIRE and promulgated State and Federal standards. When exposure concentrations exceed the toxic concentrations or standards, the magnitude and probability of risks are characterized. If available, toxicity testing results of groundwater samples are used to characterize risks.

3.6 UNCERTAINTY ANALYSES. The objective of the uncertainty analysis is to discuss the assumptions of the ERA process that may influence the risk assessment results and conclusions. General uncertainties inherent in the risk assessment process are included in Table 3-3. Specific uncertainties associated with the assessment of risks at specific sites are discussed in Chapter 6.0.

Table 3-3
Potential Sources of Uncertainty in Ecological Risk Assessment

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Potential source	Direction of Effect	Justification
Uncertainties Associated with ECPC Selection Process		
Degradation of chemicals not considered	Overestimate	Risk estimates are based on recent chemical concentrations. Concentrations will tend to decrease over time from degradation and the formation of daughter products.
No evaluation of TIC data	Underestimate	Risk was not calculated for potential exposure to these compounds.
Screening of sediment ECPCs	Underestimate	Several of the USEPA Region IV sediment screening values are based on laboratory CRQLs, not sediment toxicity data. Because some ECPCs may have been screened out of the risk assessment because their concentrations are less than the sediment screening value, this may result in an underestimate of risk.
Uncertainties Associated with Exposure Assessment		
Food chain assumed to occur at site	Unknown	Occurrence of the food chain used in the models at the sites is unknown.
Food chain model exposure parameter assumptions	Unknown	Some exposure parameters are from the literature and some are estimated. Efforts were made to select exposure parameters representative of a variety of species or feeding guilds, so that exposure estimates would be representative of more than a single species.
Uncertain occurrence of receptors at sites	Unknown	Actual occurrence at the sites by receptors considered in the food chain models is uncertain.
Assumption that receptor species will spend equal time at all habitats within home range	Unknown	Organisms will spend varying amounts of time in different habitats, thus affecting their overall exposures.
Extrapolation from test species to representative wildlife species	Unknown	Species differ with respect to absorption, metabolism, distribution, and excretion of chemicals. The magnitude and direction of the difference will vary with each chemical.
Consumption of contaminated prey	Unknown	Toxicity to prey receptors may result in sickness or mortality. Fewer prey items would be available for predators. Predators may stop foraging in areas with reduced prey populations, or discriminate against, or conversely select contaminated prey.
Limited evaluation of dermal or inhalation exposure pathways	Underestimate	The dermal and inhalation exposure pathways are generally considered insignificant due to protective fur, feathers, chitinous exoskeleton, and the low concentration of chemicals under natural atmospheric conditions. However, under certain conditions, these exposure pathways may occur.

See notes at end of table.

Table 3-3 (Continued)
Potential Sources of Uncertainty in Ecological Risk Assessment

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Potential source	Direction of Effect	Justification
Maximum exposure scenarios	Overestimate	It is unlikely any receptor would be exposed concurrently to maximum concentrations of all ECPCs.
Missing BAF or RTV values	Underestimate	BAFs and RTVs were not available in the literature for many compounds and receptor classes (i.e., small birds); therefore, these gaps result in an underestimate of the total risk represented by the summary HI.
BAF estimation	Unknown	As many literature values were not available for some species and analytes, alternate BAFs were derived using other assumptions or regressions . There is additional uncertainty related to the averaging of log K_{ow} values for certain classes of semivolatile organic compounds prior to calculating BAFs using the Travis and Arms (1988) regression equations, resulting in an overestimate of risk for some compounds and an underestimate of risk for other compounds.
Continuous uptake and bioaccumulation of ECPCs by soil biota	Unknown	Tissue and organ responses to ECPC uptake were represented by a linear function, which is an oversimplification of a more complex system (i.e., trophic states and lipid concentrations may affect bioaccumulation).
Bioaccumulation of ECPCs in leafy portions of plants	Overestimate	Ryan and others (1988) state that compounds with log K_{ow} values >5 are unavailable to plants due to soil sorption. Compounds with log K_{ow} values >5 will be taken into the roots of plants, but are not easily transported into the leafy parts of plants (Briggs and others, 1982; 1983). The surface soil and ingestion exposure model overestimates ECPC exposure via plant ingestion to those receptors that only eat the leafy portions of plants.
Use of unfiltered surface water samples	Overestimate	Measurement of ECPC concentrations in unfiltered samples includes both dissolved and particulate fractions. The dissolved fraction is considered to be the biologically available component.
Relative uptake of inorganics by different plant species	Unknown	Estimated plant BAFs for certain inorganics were based on BAF data for leafy produce grown in sewage sludge. Variability in type of plant and substrate may make the chosen BAF values an overestimate or underestimate of actual uptake.

See notes at end of table.

Table 3-3 (Continued)
Potential Sources of Uncertainty in Ecological Risk Assessment

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
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Potential source	Direction of Effect	Justification
Uncertainties Associated with Effects		
Lack of toxicity information for reptile species	Unknown	Information is not available on the toxicity of chemicals to reptilian species resulting from dietary or oral exposures. It is assumed that if mammals and birds are protected then reptiles should be protected also; therefore, reptiles were not evaluated in the risk assessment. However, reptiles may not be protected if they are more sensitive than mammals or birds.
Use of measurement endpoints	Overestimate	Although an attempt was made to have measurement endpoints reflect assessment endpoints, limited available ecotoxicological literature resulted in the selection of certain measurement endpoints that may overestimate assessment endpoints.
Lack of toxicity information for mammals or birds	Underestimate	Reference toxicity values for certain compounds and receptor groups were not available thereby underestimating the risk predicted by the summary HI.
Uncertainties Associated with Risk Characterization		
Risk evaluated for individual terrestrial receptors only	Overestimate	Effects on individual terrestrial organisms may occur with little population or community level effects. However, as the number of affected individuals increases, the likelihood of population-level effects increases.
Effect of decreased prey item populations on predatory receptors	Unknown	Adverse population effects to prey items may reduce the foraging population for predatory receptors, but may not necessarily adversely impact the population of predatory species.
Multiple conservative assumptions	Overestimate	Cumulative impact of multiple conservative assumptions yields high risk to ecological receptors, and may result in risk at background concentrations or the prediction of risks when there is no potential for adverse effects.
Summation of effects (HIs)	Unknown	The assumption that effects are additive ignores potential synergistic or antagonistic effects. It assumes similarity in mechanism of action, which is not the case for many substances. Compounds may induce toxic effects in different organs or systems.

Notes: ECPC = ecological chemical of potential concern.
TIC = tentatively identified compounds.
USEPA = U.S. Environmental Protection Agency.
CRQLs = contract required quantitation limits.
BAF = bioaccumulation factor.
RTVs = reference toxicity values.
HI = hazard index.
K_{ow} = octanol-water partition coefficient

CHAPTER 4.0

4.0 SUMMARY OF ECOLOGICAL CONTAMINANTS OF CONCERN

Ecological Contaminants of Concern (ECCs) are the analytes associated with an ecological risk. The individual risk assessments for each OU identify the ECPCs for each of the media, based on the methodology described in Section 3.2. ECCs are then determined based on the results of the risk characterization, as described in Section 3.5. The ECCs identified for each of the OUs for surface soil, groundwater, surface water, and sediment are summarized in the following subsections. Additional information on the selection of ECPCs may be found in each of the site-specific baseline risk assessment reports (ABB-ES, 1994a; ABB-ES, 1995a; ABB-ES, 1995b).

4.1 SURFACE SOIL. Surface soil exposure pathways are identified for three groups of ecological receptors (terrestrial wildlife, terrestrial plants and soil invertebrates). The exposure pathway includes a source of contamination (surface soil), and an exposure route. For wildlife, exposure routes evaluated include ingestion of soil, sediment, and food items that are contaminated as a result of accumulation of constituents from site media. Terrestrial plants and soil invertebrates may be exposed to contamination in surface soil by direct contact with and ingestion of the soil.

Table 4-1 summarizes the ECCs selected in surface soil for each OU and PSC. Discussion of the findings for each OU is provided below.

4.1.1 OU 1, Site 1 Surface soil samples collected and analyzed to evaluate potential risk to ecological receptors at Site 1 include CEF-1-SS1 through CEF-1-SS16 (Plate 4).

Thirty-one of the 35 analytes detected in surface soil exceeded background screening values and were selected as ECPCs for Site 1. Potential adverse effects to wildlife as a result of exposure to the ECPCs in surface soil at Site 1 were not identified via the food web model. Further, the results of the toxicity testing in the earthworm (*Eisenia [E.] foetida*) and lettuce seeds (*Lactuca [L.] sativa*), measuring adverse effects on growth, reproduction, and survival, indicate that the contamination present in surface soil at Site 1 does not represent an unacceptable risk for terrestrial plants or soil invertebrates. Based on these data, no surface soil ECCs were identified for Site 1.

4.1.2 OU 1, Site 2 Plate 4 shows the locations of surface soil samples collected at Site 2. Surface soil samples collected and analyzed to evaluate potential risks to ecological receptors at Site 2 include CEF-2-SS1 through CEF-2-SS6, and CEF-2-SS10.

Twenty analytes were selected as ECPCs for surface soil at Site 2. Potential adverse effects to wildlife as a result of exposure to the ECPCs in surface soil at Site 2 were not identified through the food web model. Toxicity tests in Site 2 surface soil revealed no adverse effects to *E. foetida* or *L. sativa* growth, reproduction, and survival. Therefore, no surface soil ECCs were identified for Site 2.

Table 4-1
Summary of Ecological Contaminants of Concern for Surface Soil

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Contaminant of Potential Concern	OU 1		OU 2		OU 3[1]		OU 4[1]	OU 5[1]		OU 6[1]	OU 7	OU 8
	Site 1	Site 2	Site 5	Site 17	Site 7	Site 8	Site 10	Site 14	Site 15	Site 11	Site 16	Site 3
Aroclor 1260			X									
TRPH			X									

[1] The ERA for this OU has not been completed to date.

Notes: OU = operable unit.
X = denotes ecological contaminant of concern (i.e., analyte associated with ecological risk).
TRPH = total recoverable petroleum hydrocarbons.
ERA = ecological risk assessment.

Sampling locations:
OU 1, Site 1: CEF-1-SS1 through CEF-1-SS16.
OU 1, Site 2: CEF-2-SS1 through CEF-2-SS8, and CEF-2-SS10.
OU 2, Site 5: CF5SS1 through CF5SS31, including CF5SS10D, CF5SS20D, CF5SS30D, and CF5SS31D.
OU 2, Site 17: CF17SS1 through CF17SS14, including CF17SS3D and CF17SS12D.
OU 3, Site 7: Not completed to date.
OU 3, Site 8: Not completed to date.
OU 4, Site 10: Not completed to date.
OU 5, Site 14: Not completed to date.
OU 5, Site 15: Not completed to date.
OU 6, Site 11: Not completed to date.
OU 7, Site 16: Not applicable.
OU 8, Site 3: Disposal area - CF3-SS-1 through CF3-SS10 (and its duplicate), and CF3-SS-14 through CF3-SS-23 (including a duplicate at CF3-SS-20).
Helicopter crash site - CF3-SS-11 through CF3-SS-13, and CF3-SS-24 (and its duplicate).

4.1.3 OU 2, Site 5 Plate 4 depicts the locations of Site 5 surface soil samples. Surface soil samples collected and evaluated for potential risk to ecological receptors at Site 5 include CEF-2-SS1 through CEF 2-SS31.

ECPCs selected for Site 5 surface soil include 5 volatile organic compounds (VOCs), 21 semivolatile organic compounds (SVOCs) (primarily polycyclic aromatic hydrocarbons [PAHs], and phthalates), 6 pesticides, and Aroclor-1260. Eleven of the 19 detected inorganic analytes were retained as ECPCs. In addition, total recoverable petroleum hydrocarbon (TRPH) was measured in all 31 surface soil samples from Site 5 at concentrations ranging from 12 milligrams per kilogram (mg/kg) (CF5-SS-7) to 28,000 mg/kg (CF5-SS-4). Food web model analysis identified no potential risks for wildlife exposed to Site 5 surface soil. However, further analyses of data suggest that elevated concentrations of TPH and Aroclor-1260 at Station CF5-SS-4 have the potential to impact the plant and invertebrate communities at Site 5. These two analytes are identified as ECCs for Site 5 surface soil (Table 4-1).

4.1.4 OU 2, Site 17 Plate 4 depicts the locations of Site 17 surface soil samples. Surface soil samples collected to evaluate potential risks to ecological receptors at Site 17 include CF17SS1 through CF17SS14.

All nine organic analytes detected in Site 17 surface soil were retained as ECPCs, including four VOCs, four SVOCs, and 4,4'-dichlorodiphenyldichloroethene (DDE). Three of the 11 inorganic analytes detected in Site 17 surface soil were retained as ECPCs. In addition, TRPH was detected in nine of the 14 surface soil samples from Site 17 at concentrations ranging from less than 10 mg/kg (the detection limit) to 210 mg/kg (CF17-SS-8).

Food web model analysis suggests that no adverse effects to growth, reproduction, or survival are likely for terrestrial wildlife resulting from exposures to the ECPCs in surface soil at Site 17. Analyses of earthworm and lettuce seed toxicity test results did not reveal adverse effects related to Site 17 surface soil. A slight inhibition of lettuce seed germination at sampling stations CF17SS8 and CF17SS9 was not associated with concentrations of ECPCs in surface soil (as determined by regression analyses). It is possible that this effect is due to a non-measured physical, biological, or chemical factor (i.e., ECPC exposure is likely not responsible for the observed effect). No ECCs were identified for Site 17 surface soil.

4.1.5 OUs 3, 4, 5, and 6 Evaluation of surface soil exposures to ecological receptors has not been completed to date.

4.1.6 OU 7, Site 16 Surface soil was not evaluated as an exposure pathway for Site 16 because the small grassy area adjacent to the site is located in an industrial setting, surrounded by paved roads and parking lots. Terrestrial receptors are not expected to reside at the site.

4.1.7 OU 8, Site 3 Two surface soil data sets were evaluated in the OU 8 ERA (Plate 4). The first data set included the 20 samples (CF3-SS-1 through CF3-SS-10), and CF3-SS-14 through CF3-SS-23) collected from the grassy OU 8 disposal area. The second data set includes four surface soil samples (CF3-SS-11 through CF3-SS-13 and CF3-SS-24) collected from the forested area in the vicinity of the helicopter crash site.

Four VOCs, 13 SVOCs, 5 pesticides, Aroclor-1254, and 9 of the inorganic analytes were retained as ECPCs to evaluate risks to ecological receptors from exposure to surface soil in the OU 8 disposal area. Three VOCs, 5 pesticides, and 1 of the 12 inorganic analytes detected in the four surface soil samples from the helicopter crash area were retained as ECPCs for evaluation in the OU 8 Baseline Risk Assessment (ABB-ES, 1995b).

The results of the food web modeling suggest that wildlife receptors are not likely to be at risk from exposure to OU 8 surface soil.

Earthworm survival in toxicity tests was not adversely affected following exposure to OU 8 soil, suggesting that soil invertebrates are not at risk at Site 3. Reliability of results from lettuce seed germination is questionable based on the high variability between sample replicates and the relatively low germination observed in the reference soil location. Regression analyses indicate that reduced lettuce seed germination is poorly correlated with concentrations of the selected ECPCs in surface soil. It is likely that factors other than these chemicals are responsible for the reduced lettuce seed germination rates at CF3-SS-17 and CF3-SS-20. This suggests that plants may not be at risk from exposure to surface soil at the site (i.e., no lethal toxicity is associated with exposure to ECPCs in Site 3 surface soil). Therefore, no surface soil ECCs were identified for OU 8, Site 3 (Table 4-1).

4.2 GROUNDWATER. Groundwater exposure pathways are identified for three groups of ecological receptors (terrestrial and wetland wildlife, terrestrial plants, and aquatic receptors). The exposure pathway includes a source of contamination, potentially contaminated media (groundwater discharging to the surface), and an exposure route. Potential exposures of terrestrial wildlife to groundwater may occur via ingestion of surface water that has received groundwater discharge. The indirect exposure of wildlife to groundwater was not evaluated because this route is not believed to contribute a high potential contaminant exposure.

Terrestrial plants may also be exposed to contamination in groundwater where roots reach a zone of saturation. This groundwater exposure pathway was not selected for evaluation because of difficulties estimating contaminant exposures for terrestrial plants from groundwater.

Exposure pathways evaluated for aquatic receptors (including invertebrates, plants, amphibians, algae, and fish) include direct contact with groundwater as it discharges to surface water. This exposure pathway is the focus of groundwater exposure for NAS Cecil Field ecological receptors.

Table 4-2 summarizes the ECCs selected for each site. Discussion of the findings for each site is provided below.

4.2.1 OU 1, Sites 1 and 2 Plate 3-A presents the locations of monitoring wells for Sites 1 and 2. Due to the close proximity of Sites 1 and 2 and the fact that groundwater from both sites discharges to Rowell Creek, groundwater is evaluated for both sites (OU 1) as a single unit. Groundwater sampling stations evaluated for the presence of analytes associated with risk attributable to OU 1, Sites 1 and 2, include CF1MW1S, CF1MW4, CF1MW5S, CF1MW6S, CF1MW8I, CF1MW9S, CF1MW10S, CF1MW12I, CF1MW13S, CF1MW14I, CF1MW15S, CF1MW16I, CF1MW17I, CF1MW18S, CF2MW1S, CF2MW4S, CF2MWS, CF2MW6S, CF2MW7I, CF2MW8I, and CF2MW11S.

Table 4-2
Summary of Ecological Contaminants of Concern for Groundwater

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Contaminant of Potential Concern	OU 1		OU 2		OU 3[1]		OU 4[1]	OU 5[1]		OU 6[1]	OU 7	OU 8
	Site 1	Site 2	Site 5	Site 17[2]	Site 7	Site 8	Site 10	Site 14	Site 15	Site 11	Site 16	Site 3
VOCs/SVOCs												
1,2-Dichlorobenzene												[7] X
1,3-Dichlorobenzene												[7] X
1,4-Dichlorobenzene												[7] X
bis(2-Ethylhexyl)phthalate			[3] X								[4,6] X	[7] X
Pesticides/PCBs												
Aroclor 1248												[7] X
alpha-Chlordane			[5] X									
Inorganics												
Aluminum			[3] X								[3] X	[7] X
Beryllium			[3] X									
Chromium			[3] X									[7] X
Copper			[3] X									[7] X
Iron			[3] X								[6] X	[7] X
Lead			[3] X									
Mercury			[3] X									
Zinc			[3] X								[6] X	

See notes at end of table.

Table 4-2 (Continued)
Summary of Ecological Contaminants of Concern for Groundwater

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
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[1] The ecological risk assessment for this OU has not been completed to date.
[2] Groundwater was not evaluated at Site 17.
[3] Analyte exceeded screening values in undiluted, unfiltered water only. This exposure scenario is believed unlikely for Naval Air Station Cecil Field ecological receptors because contaminants are bound to suspended solids and not bioavailable to aquatic receptors.
[4] Bis(2-Ethylhexyl)phthalate exceeded screening values in undiluted, unfiltered water only. This analyte is a known laboratory contaminant, and its actual association with the site is uncertain.
[5] Alpha-Chlordane was detected in only 1 of 30 monitoring wells at Site 5.
[6] Concentrations of bis(2-ethylhexyl)phthalate, iron, and zinc originate in the intermediate aquifer and flow upward to the surficial aquifer; therefore, these analytes are not believed to be associated with contamination at Site 16.
[7] The site-specific dilution factor (as diluted groundwater discharges to Rowell Creek) is an order of magnitude higher than the measured dilution in the toxicity test required to reduce groundwater toxicity to test organisms; therefore, risks for aquatic receptors are not likely when diluted groundwater discharges to Rowell Creek.

Notes: OU = operable unit.
VOC = volatile organic compound.
SVOC = semivolatile organic compound.
X = analyte is associated with an ecological risk.
PCBs = polychlorinated biphenyls.

Sampling Stations:
OU 1, Sites 1 and 2: CF1MW1S, CF1MW4. CF1MW5S, CF1MW6S, CF1MW8I, CF1MW9S, CF1MW10S, CF1MW12I, CF1MW13S, CF1MW14I, CF1MW15S, CF1MW16I, CF1MW17I, CF1MW18S, CF2MW1S, CF2MW4S, CF2MW5S, CF2MW6S, CF2MW7I, CF2MW8I, CF2MW11S.
OU 2, Site 5: 1991 data - CEF-5-3, CEF-5-4, CEF-5-5, CEF-5-6, CEF-5-7. 1993 data - CF5MW3S, CF5MW4S, CF5MW5S, CF5MW6S, CF58S, CF59I, CF10S, CF511I, CF512D, CF5MW16S, CF5MW17I, CF5MW18D, CF5MW19S,(including CF5MW19SD), CF5MW20S, CF5MW21I, CF5MW22D, CF5MW23-S, CF524S, CF525I, CF526D, CF527S, CF5MW28D (including CF5MW28DD), CF5MW29S (including CF5MW29SD), and CF5MW30S.
OU 2, Site 17: Not applicable.
OU 3, Site 7: Not completed to date.
OU 3, Site 8: Not completed to date.
OU 4, Site 10: Not completed to date.
OU 5, Site 14: Not completed to date.
OU 5, Site 15: Not completed to date.
OU 6, Site 11: Not completed to date.
OU 7, Site 16: 16MW10S, 16MW12I, 16MW17S, 16MW18D, 16MW19S, 16MW21S, 16MW22I, 16MW23D, 16MW24S, 16MW25D, 16MW27I, 16MW28D, 16MW32S, 16MW33D, 16MW38S, 16MW39I, 16MW40D, 16MW5S, 16MW7S, and 16MW9D, including duplicates at 16MW10, 16MW21S, 16MW28D, and 16MW40D.
OU 8, Site 3: CF3MW3S, CF3MW4S, CF3MW6S, CF3MW7D, CF3MW7S, CF3MW13S, MF3MW14I, MF3MW15D, MF3MW8S, MF3MW19D, CF3MW28S, CF3MW29D, CF3MW31S, and CF3MW32D.

Eleven ECPCs were selected for unfiltered groundwater at OU 1 including one VOC, two SVOCs, and eight inorganics. Comparison of ECPCs with aquatic toxicity benchmark values indicates analytes present in the OU 1 groundwater are not likely to pose a risk to aquatic receptors. No ECCs were identified in the groundwater at Sites 1 and 2.

4.2.2 OU 2, Site 5 Data from 30 monitoring wells were used to evaluate groundwater potentially contributing to surface water contamination in the Site 5 drainage ditch and wetland (Table 4-2). Plate 3-A depicts the locations of these monitoring wells. The data set included primarily 1993 data, although analytical chemistry data from five 1991 monitoring well locations (CEF-5-3, CEF-5-4, CEF-5-5, CEF-5-6, and CEF-5-7S) were also evaluated. Wells screened at shallow, intermediate, and deep intervals were all included in the summary of groundwater data; groundwater from any of these three intervals could conceivably discharge to the Site 5 wetland or drainage ditch.

ECPCs identified in unfiltered, undiluted groundwater from Site 5 samples included 6 VOCs, 6 SVOCs, 1 pesticide (alpha-chlordane), and 14 inorganic analytes. Of the organic ECPCs in groundwater, only the concentrations of bis(2-ethylhexyl)phthalate and alpha-chlordane slightly exceeded available screening values and are considered ECCs for Site 5 groundwater (Table 4-2). However, alpha-Chlordane was only detected in 1 of 30 groundwater monitoring wells at Site 5. Further, given the uncertainties associated with phthalates as laboratory contaminants and the low frequency of detection for alpha-Chlordane, it is unlikely that future groundwater discharges of organic analytes are likely to pose substantial ecological risks from surface water exposure in the Site 5 wetland.

Of the 14 inorganic ECPCs in Site 5 groundwater, predicted average and maximum concentrations of eight analytes detected in unfiltered, undiluted groundwater were in excess of aquatic toxicity benchmarks and are identified as ECCs for Site 5 groundwater. When a dilution factor is applied, two of these ECCs are eliminated (copper and zinc). Concentrations of all eight analytes may be associated with suspended solids in groundwater and, therefore, not bioavailable at these levels. Further, the use of unfiltered, undiluted groundwater to evaluate potential risk to aquatic receptors via surface water exposure is an extremely conservative approach and may not be reflective of actual site conditions.

4.2.3 OU 2, Site 17 Groundwater was not identified as an exposure pathway for Site 17 ecological receptors and was, therefore, not evaluated.

4.2.4 OUs 3, 4, 5, and 6 Evaluation of groundwater exposures to ecological receptors has not been completed to date.

4.2.5 OU 7, Site 16 Data from 21 monitoring wells (Plate 3-A) located within the identified plume (CEF-16-10S, CEF-16-12I, CEF-16-17S, CEF-16-18D, CEF-16-19S, CEF-16-20D, CEF-16-21S, CEF-16-22I, CEF-16-23D, CEF-16-24S, CEF-16-25D, CEF-16-27I, CEF-16-28D, CEF-16-32S, CEF-16-33D, CEF-16-38S, CEF-16-39I, CEF-16-40D, CEF-16-5S, CEF-16-7S, and CEF-16-9D) at OU 7 were used to evaluate groundwater potentially contributing to surface water contamination in the Site 16 drainage ditches and the adjacent wetlands. Reference analyte concentrations for groundwater were gathered from a cluster of four monitoring wells (CEF-16-13S, CEF-16-14D, CEF-16-15S, and CEF-16-16D) upgradient of Site 16. Wells screened in the shallow, intermediate, and deep intervals of the surficial aquifer were included in the summary of groundwater data, because groundwater from any of these three intervals could conceivably discharge to the Site 16 drainage ditches or wetlands.

Risks were evaluated for two potential pathways of future migration of Site 16 groundwater contamination to surface water. These two pathways include future discharge of groundwater contaminants to Sal Taylor Creek and to the nearby emergent wetlands. Exposure concentrations of groundwater ECPCs discharging to Sal Taylor Creek were predicted based on a dilution factor, while no dilution was applied to concentrations of groundwater ECPCs discharging to the wetlands. Fourteen ECPCs were identified in Site 16 groundwater samples. Five VOCs, one SVOC, and eight inorganics were selected as ECPCs.

Comparison of organic ECPCs to aquatic toxicity benchmarks suggested that these analytes are not likely to adversely affect aquatic receptors at Site 16. Of the eight inorganic ECPCs in Site 16 groundwater, predicted maximum concentrations of aluminum, iron, and zinc in the wetlands exceeded surface water toxicity benchmarks. However, concentrations of iron and zinc appear to originate in the intermediate aquifer and flow upward to the surficial aquifer; therefore, these detections are not believed to be associated with contamination from Site 16. In addition, aluminum as measured in unfiltered groundwater does not represent the fraction of the metal that is dissolved and biologically available and toxic to aquatic organisms.

<u>4.2.6 OU 8, Site 3</u> Data collected in 1994 from 14 monitoring wells were used to evaluate groundwater conditions potentially contributing to surface water contamination in Rowell Creek adjacent to OU 8. All wells screened at shallow, intermediate, and deep intervals from the upper aquifer were included in the summary of groundwater data; groundwater from any of these intervals could conceivably discharge to Rowell Creek. Sample locations include: CF3-MW-3S, CF3-MW-4S, CF3-MW-6S, CF3-MW-7D, CF3-MW-7S, CF3-MW-13S, MF3-MW-14I, MF3-MW-15D, MF3-MW-18S, MF3-MW-19D, CF3-MW-28S, CF3-MW-29D, CF3-MW-31S, and CF3-MW-32D (Plate 3-A).

Twenty-five ECPCs were identified in OU 8 unfiltered undiluted groundwater. ECPCs included seven VOCs, nine SVOCs, Aroclor 1248, and eight inorganic analytes.

The maximum and average undiluted and unfiltered concentrations of 1,2-, 1,3-, and 1,4-dichlorobenzene; bis(2-ethylhexyl)phthalate; Aroclor-1248; aluminum; chromium; copper; and iron all exceed their respective aquatic toxicity benchmarks. These analytes were identified as groundwater ECCs for OU 8 (Table 4-2). Results of toxicity testing of samples from two monitoring wells (CF3-MW-17S and CF3-MW-28S) of test species, fathead minnow (*P. promelas)* and the water flea, (*C. dubia*) showed reduced growth and mortality in the fathead minnow, and reduced survival and reproduction in the water flea. Up to a 20-fold dilution in the toxicity test was required to reduce OU 8 groundwater toxicity. Seven analytes (1,1-dichloroethane, dichlorobenzene, aluminum, chromium, copper, iron, and lead) detected in groundwater exceeded aquatic toxicity benchmarks and may have contributed to the adverse effects observed to *C. dubia* and *P. promelas* in the toxicity tests. The range of reproductive, growth, and mortality effects concentrations for daphnids and fathead minnows from the USEPA AQUIRE database suggest that the three dichlorobenzene isomers (1,2-, 1,3-, and 1,4-dichlorobenzene) are likely to be primary groundwater risk contributors in the toxicity tests, although additive and synergistic effects from other toxicants are also possible. However, a 20-fold dilution reduced OU 8 groundwater toxicity in these toxicity tests. The anticipated site-specific dilution factor (133-fold) is an order of magnitude greater than the measured 20-fold laboratory dilution. Aquatic organisms are not likely to be at risk from acute or chronic exposures to dichlorobenzene in OU 8 groundwater when the diluted groundwater discharges to Rowell Creek.

<u>4.3 SURFACE WATER AND SEDIMENT</u>. Surface water and sediment exposure pathways are identified for two groups of ecological receptors (terrestrial and wetland wildlife and aquatic receptors). The exposure pathway includes a source of contamination, potentially contaminated media (surface water and sediment), and an exposure route.

The exposure routes evaluated for terrestrial and wetland wildlife include ingestion of surface water and incidental ingestion of sediment. Potential contaminant exposures for reptiles and amphibians exist, but are not evaluated due to lack of availability of data relating contaminant exposures to adverse responses for reptiles and amphibians.

Exposure routes evaluated for aquatic receptors include direct contact with surface water and sediment. Aquatic life may also be exposed to contamination in sediment as the result of ingestion of the sediment. This pathway was not chosen for evaluation because information on the amount of sediment ingested by aquatic organisms and associated toxicity is generally not available.

Table 4-3 summarizes the ECCs selected for each OU and PSC. Discussion of the findings for each of the OUs is provided below.

<u>4.3.1 OU 1, Site 1</u> Plate 2 depicts the locations of OU 1 surface water and sediment samples. The following surface water and sediment sampling stations were evaluated for the presence of analytes associated with risk attributable to OU 1, Site 1: RC-SW/SD-6 through RC-SW/SD-8, RC-SW/SD-8A, RC-SW/SD-9, and RC-SW/SD-10.

Three analytes (acetone, aluminum, and barium) exceeded background values and were identified as surface water ECPCs for both aquatic receptors and terrestrial wildlife. Four analytes (acetone, aluminum, barium, and chromium) were selected as ECPCs for terrestrial wildlife only. Two analytes (acetone and methylene chloride) were selected as sediment ECPCs for both aquatic life and terrestrial wildlife. Three analytes (barium, cadmium, and nickel) were selected as ECPCs only for terrestrial wildlife.

Potential adverse effects to reproduction, growth, or survival were not identified for the representative wildlife species from exposure to the ECPCs in surface water at Site 1. A comparison of Site 1 ECPC surface water concentrations to benchmark toxicity values, along with results of field studies and the benthic macroinvertebrate study, supports the general conclusion that runoff from Site 1 does not represent a risk for aquatic receptors at Rowell Creek. No surface water ECCs were identified for OU 1, Site 1.

Table 4-3
Summary of Ecological Contaminants of Concern for Surface Water and Sediment

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Contaminant of Potential Concern	OU 1		OU 2		OU 3[1]		OU 4[1]	OU 5[1]		OU 6[1]	OU 7	OU 8
	Site 1	Site 2	Site 5	Site 17	Site 7	Site 8	Site 10	Site 14	Site 15	Site 11	Site 16	Site 3
VOCs/SVOCs												
Fluorene			SD									
2-Methylnaphthalene			SD									
Naphthalene			SD									
bis(2-Ethylhexyl)phthalate				[2] SD								
Pesticides/PCBs												
4,4-DDD			SD									
4,4-DDE			SD									
4,4-DDT			SD									[4] SD
Aroclor 1254												[4] SD
Aroclor 1260			SD									
Inorganics												
Aluminum		[3] SW SD	[3] SW									[3] SW
Cadmium											[3] SW	
Copper											[3] SW	
Cyanide		SD										
Iron		[3] SW SD	[3] SW								[3] SW	
Lead		[3] SW	[3] SW								[3] SW	
Mercury		SD										
Selenium		SD										
Silver		SD										[3] SW
Vanadium		SD										
Zinc				SD							[3] SW	[3] SW
TRPH			SD								SD	

See notes at end of table.

Table 4-3 (Continued)
Summary of Ecological Contaminants of Concern for Surface Water and Sediment

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
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[1] The ecological risk assessment for this OU has not been completed to date.
[2] Analyte is a known laboratory contaminant, it was identified only in one sample, and it is questionable whether the compound is site-related.
[3] Analyte was detected in unfiltered surface water; evaluation of unfiltered surface water may overestimate risk from this analyte.
[4] Aroclor-1254 and 4,4-DDT were not detected in OU 8 groundwater, indicating that their presence is not due to OU 8, but rather another upgradient source.

Notes: OU = operable unit.
VOC = volatile organic compound.
SVOC = semivolatile organic compound.
SD = sediment.
PCBs = polychlorinated biphenyls.
DDD = dichlorodiphenyldichloroethane.
DDE = dichlorodiphenyldichloroethene.
DDT = dichlorodiphenyltrichloroethane.
SW = surface water.
TRPH = Total recoverable petroleum hydrocarbon.

Sampling locations:
OU 1, Site 1: Surface water - RC-SW-6 through RC-SW-8, RC-SW-8A, RC-SW-9, and RC-SW-10; Sediment - RC-SD-6 through RC-SD-8, RC-SD-8A, RC-SD-9, and RC-SD-10.
OU 1, Site 2: Surface water - 2-SW-1 through 2-SW-3; Sediment - 2-SD-1 through 2-SD-3.
OU 2, Site 5: Drainage Ditch Surface water - 5-SW1 through 5-SW4; Drainage Ditch Sediment - 5-SD-1 through 5-SD-4; Wetland Surface Water - 5-SW-6 and 5-SW-7; Wetland Sediment - 5-SD-6 and 5-SD-7.
OU 2, Site 17: Surface water - CF-17-SW1 and CF-17SW1D (duplicate); Sediment - CEF-17-SD1 (6/94), CEF-17-SD1D (6/94 duplicate), and CEF-17-SD1 (re-sample 2/95), CEF17-SD1D (2/95 duplicate) and CEF-17-SD2 (6/94).
OU 3, Site 7: Not completed to date.
OU 3, Site 8: Not completed to date.
OU 4, Site 10: Not completed to date.
OU 5, Site 14: Not completed to date.
OU 5, Site 15: Not completed to date.
OU 6, Site 11: Not completed to date.
OU 7, Site 16: Surface water - STC-SW-1, STC-SW-3, STC-SW-4; Sediment - STC-SD-1, STC-SD-3, STC-SD-4.
OU 8, Site 3: Surface water - CF3SW1, CF3SW1 (duplicate), RCSW3; Sediment - CF3SD1, CF3SD1 (duplicate), RCSD3.

Results of the food web model indicate that no potential adverse effects to reproduction, growth, or survival for the representative wildlife species are anticipated from exposure to the ECPCs in sediment at Site 1. The results of the field studies and sediment toxicity testing do not show impairment of the benthic macroinvertebrate community or toxicity of sediment at Rowell Creek sampling locations RC-Bio-8, RC-Bio-8A, RC-Bio-9, and RC-Bio-10, that are adjacent to Site 1 and downstream of Site 2. No sediment ECCs were identified for OU 1, Site 1.

4.3.2 OU 1, Site 2 Surface water and sediment sampling stations evaluated for the presence of analytes associated with risk attributable to Site 2 include 2-SW/SD-1 through 2-SW/SD3 (Plate 2).

Six of the analytes detected in Site 2 surface water were selected as ECPCs for both aquatic life and terrestrial wildlife (aluminum, barium, cyanide, iron, lead, and manganese). Three of the analytes were selected as ECPCs for terrestrial wildlife only (1,4 dichlorobenzene, chlorobenzene, and nickel).

Results of the food web model identified possible risks associated with iron in sediment for small mammals that may forage in the stream. Observed impairment of the benthic macroinvertebrate community at Site 2 was attributed to exposures to aluminum, lead, and iron in surface water, and aluminum, cyanide, mercury, selenium, silver, iron and vanadium in sediment. These nine analytes were identified as ECCs for surface water and/or sediment (Table 4-3). The adverse biological responses may, however, be associated with an orange flocculent material that blankets the bottom substrate of the tributary and the water column. This material may be causing physical impairment of the benthic community and toxicity of the test organisms.

4.3.3 OU 2, Site 5 The following surface water and sediment sampling stations were evaluated for the presence of analytes associated with risk attributable to the Site 5, drainage ditch: 5-SWSD-1 through 5-SW/SD-4 (Plate 2). Those samples evaluated for the Site 5 wetland include 5-SW/SD-6 and 5-SW/SD-7 (Plate 2).

Six of the analytes in surface water were selected as ECPCs for both aquatic life and terrestrial wildlife (aluminum, barium, cyanide, iron, lead, and manganese). Three of the analytes were selected as ECPCs for terrestrial wildlife only (1,4 dichlorobenzene, chlorobenzene, and nickel). Potential risks were not identified for wildlife exposed to Site 5 surface water in the drainage ditch or wetland. The benthic macroinvertebrate data revealed that one drainage ditch station (5-SW4) and the upstream reference station fell below the expected condition, given the quality of the habitat present. It could not be concluded that contamination in surface water from Site 5 was contributing to the decreased condition observed at the downstream sampling station. Aluminum, iron, and lead concentrations in surface water in the drainage ditch, wetland, and reference samples exceeded aquatic toxicity benchmark values and may be associated with the benthic community impact. However, since these analytes are present in reference samples as well as site samples, it cannot be concluded that effects are site-related. Further, the detected concentrations of inorganic analytes in unfiltered surface water may not be bioavailable to aquatic receptors due to the presence of suspended solids in unfiltered samples. However, these ECCs were conditionally identified for Site 5 surface water.

In Site 5 sediment, 22 of the 23 detected analytes exceeded background screening values and were selected as ECPCs. Fourteen analytes were selected as ECPCs for both aquatic and terrestrial wildlife. Eight analytes were selected as ECPCs for terrestrial wildlife only. Potential risks were not identified for wildlife exposed to Site 5 sediment in the drainage ditch or wetland. Evaluation of sediment toxicity testing data suggests that certain aquatic organisms are impacted by exposure to Aroclor-1260, dichlorodiphenyltrichloroethane ($DDT_{R)}$, TRPH in Site 5 sediment. Fluorene, 2-methylnaphthalene and naphthalene also exceed sediment toxicity benchmark values. These analytes were identified as ECCs for Site 5 sediment (Table 4-3).

4.3.4 OU 2, Site 17 Representative surface water samples could not be collected from the Site 17 wetland during June, 1994, sampling event. Surface water was evaluated for Site 17 based on results of a resampling effort in February 1995. Reanalyses of sediment samples for Site 17 were conducted, combining data from both sampling events. Surface water samples for Site 17 include CF-17-SW1 and its duplicate (CF-17-SW1D); sediment samples include CEF-17-SD1 and its duplicate (collected in June 1994), CEF-17-SD1 and its duplicate (resample 2/95), and CEF-17-SD2 (6/96) (see Plate 2).

No organic analytes were detected in the Site 17 surface water samples. None of the nine detected inorganic analytes were retained as ECPCs. No ECCs were identified for Site 17 surface water.

Two VOCs (2-butanone and toluene) and 5 SVOCs were detected and retained as sediment ECPCs for aquatic and wildlife receptors. One pesticide (4,4'-DDE), eight inorganic analytes and TRPH were also selected as sediment ECPCs. Risks to terrestrial and wetland wildlife were not identified through food web model analyses. Detected concentrations of bis(2-Ethylhexyl)phthalate and zinc in sediment exceeded available sediment screening values for protection of aquatic receptors; therefore, these analytes were identified as ECCs for Site 17 sediment (Table 4-3). Bis(2-ethylhexyl)phthalate is a known laboratory contaminant and was identified in only one sample; it is unlikely that this analyte is site-related.

4.3.5 OUs 3, 4, 5, and 6 Evaluation of surface water and sediment exposures to ecological receptors has not been completed to date.

4.3.6 OU 7, Site 16 Unfiltered surface water and sediment was sampled at three locations in the drainage ditches (STC-SW/SD-1, STC-SW/SD-3, and STC-SW/SD-4) and one reference location northeast of Site 16 in Sal Taylor Creek (STC-SW/SD-R1) (Plate 2).

Fifteen analytes were detected in the surface water samples. Of the 15 detected analytes, two VOCs and five inorganics were identified as ECPCs for both aquatic life and terrestrial wildlife. One VOC and one inorganic were selected as ECPCs for terrestrial wildlife only.

Risks to wildlife exposed to Site 16 surface water were not identified through food web model analyses. Comparison of the concentrations of the ECPCs detected in surface water samples from the drainage ditches with available toxicity benchmarks indicated maximum concentrations of cadmium, copper, iron, lead, and zinc exceeded the aquatic toxicity benchmarks. The concentration of lead measured in water samples from the reference location in Sal Taylor Creek also exceeded available benchmarks. These inorganic analytes were identified as ECCs for Site 16 surface water (Table 4-3). However, it is believed that the presence of these metals in the surface water of the drainage ditches is not site-related. The ditches receive stormwater drainage from the runway area and much of the developed area west of the runways. Additionally, evaluation of unfiltered water may overestimate risk to receptors as it may not be representative of the bioavailability of inorganic analytes.

Twenty analytes were detected in the sediment samples. Three VOCs, 1 SVOC, and 10 inorganics were identified as ECPCs for both terrestrial wildlife and aquatic receptors. Three inorganics were selected as ECPCs for terrestrial wildlife only. TRPH was also detected in the Site 16 drainage ditch sediment and was identified as an ECPC.

No risks were identified through food web model analyses for wildlife exposed to Site 16 sediment. There were no apparent trends in the status of the benthic macroinvertebrate community in the drainage ditches and reference station in Sal Taylor Creek as compared to the reference data. It couldn't be concluded from these data that contaminants in the sediment were contributing to the poor condition observed in the drainage ditches. However, based on the results of the laboratory sediment bioassays, impacts to the survival and reproduction of certain invertebrate receptors may be occurring in the drainage ditches. Associations between toxicity to invertebrate receptors may be attributable to elevated concentrations of TRPH in sediment at STC-SD-1 and STC-SD-3; therefore, TRPH is identified as an ECC at Site 16 (Table 4-3).

4.3.7 OU 8, Site 3 Surface water and sediment sampling stations are depicted on Plate 2. In June, 1993, one unfiltered surface water sample (RC-SW-3) was collected in Rowell Creek approximately in the center of the OU 8 plume discharge location. Two additional unfiltered surface water samples were collected in November 1994 from Rowell Creek above and below RC-SW-3 (CF3-SW-1 and CF3-SW-2, respectively) (Figure 3-1). All three surface water samples were collected downgradient of the Navy wastewater treatment plant. Surface water from sampling station CF3-SW-2 was collected to represent upgradient conditions unimpacted by the OU 8 groundwater plume, whereas surface water from CF3-SW-1 was collected to represent conditions within and downgradient from plume discharge.

Of the fourteen analytes detected in surface water from the upstream reference station, Endosulfan I was the only analyte detected in the upstream sample that was not present in either of the downstream locations. Of the four analytes identified as ECPCs in the mid-plume location adjacent to OU 8 (station RC-SW-3), chloroform was selected as a wildlife ECPC only. In the downstream sample (CF3-SW-1), eight analytes were retained as ECPCs, five of which were selected only as wildlife ECPCs.

Results of the food web modeling indicate no lethal or sublethal adverse effects to wildlife from exposure to surface water. Analysis of the benthic macroinvertebrate habitat quality parameter data suggests that habitat quality conditions at RC-BIO-3 represent a poor environment for many types of aquatic organisms. Differences in habitat structure may be sufficient to explain the decreased biological condition; however, the NAS Cecil Field sewage treatment plant discharge impact could not be eliminated as a causative agent. Aluminum and zinc concentrations in surface water exceeded benchmark toxicity values and were identified as possible ECCs. However, these concentrations were measured in unfiltered water, which may overestimate actual exposures associated with inorganic analytes and subsequent risks to OU 8 aquatic receptors.

In June 1993, one sediment sample (RC-SD-3) was collected in Rowell Creek approximately in the center of the OU 8 plume discharge location. Two additional sediment samples were collected in November 1994 from Rowell Creek above and below RC-SD-3 (CF3-SD-2 and CF3-SD-1, respectively) (Plate 2). Sediment from sampling station CF3-SD-2 was collected to represent upgradient conditions unimpacted by the OU 8 groundwater plume, whereas sediment from CF3-SD-1 was collected to represent conditions within and downgradient from the plume.

At RC-SD-3, 2-butanone, 2 phthalate esters, Aroclor-1254, 4,4'-DDE, and 4 of the 10 detected inorganic analytes were identified as ECPCs. Four ECPCs (4,4'-DDE, copper, lead, and zinc) were selected only as wildlife ECPCs . In the downgradient sample (CF3-SD-1), three analytes were identified as ECPCs: 2-butanone, 4,4'-DDT, and endrin ketone. None of the seven detected inorganic analytes were selected as ECPCs.

Results of the food web modeling indicate no lethal or sublethal adverse effects to wildlife from exposure to sediment. Aroclor-1254 and 4,4'-DDT concentrations at RC-SD-3 exceeded sediment toxicity benchmarks for the protection of aquatic receptors; therefore, these two analytes were identified as ECCs. However, neither of these analytes were detected in OU 8 groundwater, indicating that the presence of Aroclor-1254 and 4,4-DDT does not appear to be due to OU 8, but to another upgradient source. It is unlikely that aquatic receptors are currently at risk from exposure to the low levels of Aroclor 1254 or 4,4'-DDT detected in OU 8 sediment.

CHAPTER 5.0

5.0 SUMMARY OF BIOLOGICAL SAMPLING

Several biological studies have been completed at NAS Cecil Field to support site-specific ERAs. The results of each of these studies are discussed in this chapter. Studies completed include toxicity testing (Section 5.1), aquatic studies (Section 5.2), terrestrial studies (Section 5.3), wetlands identification, mapping and delineation (Section 5.4) and laboratory analyses of plant and animal tissue (Section 5.5).

5.1 TOXICITY TESTING.

Toxicity testing of surface soil, sediment, and groundwater has been completed as part of ERAs for several sites at NAS Cecil Field. Table 5-1 lists the OUs and other areas where toxicity tests have been completed, along with the media tested, number of samples collected, test organisms used, and test types. Locations where samples of sediment, groundwater, and surface soil were collected for toxicity testing are shown on Plates 2, 3, and 4, respectively (sample identifiers contain the characters "TOX"). Samples were collected concurrently for chemical analysis and toxicity testing. The results of the chemical analyses for the media, then, can be used to establish contaminant exposure concentrations and provide the means for interpreting biological responses in the toxicity tests.

Methods used to perform surface soil toxicity testing for earthworms (*Eisenia foetida*) and lettuce seeds (*Lactuca sativa*) generally meet the standard procedures described in the protocol for short-term toxicity screening of hazardous waste site soil (Green and others, 1989). Methods used for sediment toxicity testing using the water flea (*Ceriodaphnia dubia*) are based on Method 1002.0 prescribed by USEPA (1989). Methods used for sediment toxicity testing using the amphipod (*Hyallela [H.] azteca*) and midge larvae (*Chironomus [C.] tentans*) meet the standard procedures described in the American Society for Testing and Materials (ASTM) guidelines for conducting sediment toxicity tests with freshwater invertebrates (ASTM, 1991). Reports containing summaries of toxicity testing results are outlined in Appendix C; references include: Springborn Laboratories, 1994; Environmental Science and Engineering (ESE), 1995a; ESE, 1995b; and Inchcape Testing Services/Aquatec Laboratories, 1995a.

5.1.1 Operable Units

The results of toxicity testing for each of the OUs at NAS Cecil Field are discussed below.

Numerical results from toxicity testing of surface soil at OUs 1, 2, and 8 and OU 5 are summarized in Tables 5-2 and 5-3, respectively. Tables 5-4 and 5-5 present the numerical results of sediment toxicity testing from OUs 1, 2, and 7 and Lake Fretwell/Rowell Creek upstream of Lake Fretwell, respectively. The groundwater toxicity testing results are presented in Table 5-6. Summaries of the toxicity testing results for surface soil, sediment, and groundwater are presented in Tables 5-7, 5-8, and 5-9, respectively.

5.1.1.1 Operable Unit 1

Surface soil and sediment toxicity testing was completed for both Sites 1 and 2 at OU 1 (Springborn Laboratories, 1994). Samples were collected in 1993. Numerical results of surface soil and sediment toxicity testing are shown in Tables 5-2 and 5-4, respectively. Analysis and interpretation of the test results for surface soil and sediment bioassays are shown in Tables 5-7 and 5-8, respectively, and are discussed below.

Table 5-1
Summary of Toxicity Tests Completed at NAS Cecil Field

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Operable Unit	Site	Medium	No. Samples	Test Organism	Test Type
OU 1	Site 1	Soil	15	a) *Eisenia foetida* b) *Lactuca sativa*	a) 14-day survival test b) 5-day germination test
		Sediment	5	a) *Hyallela azteca* b) *Ceriodaphnia dubia*	a) 14-day survival test b) 7-day survival and reproduction test
	Site 2	Soil	10	a) *Eisenia foetida* b) *Lactuca sativa*	a) 14-day survival test b) 5-day germination test
		Sediment	2	a) *Hyallela azteca* b) *Ceriodaphnia dubia*	a) 14-day survival test b) 7-day survival and reproduction test
OU 2	Site 5	Soil	15	a) *Eisenia foetida* b) *Lactuca sativa*	a) 14-day survival test b) 5-day germination test
		Sediment	5	a) *Hyallela azteca* b) *Ceriodaphnia dubia*	a) 14-day survival test b) 7-day survival and reproduction test
	Site 17	Soil	7	a) *Eisenia foetida* b) *Lactuca sativa*	a) 14-day survival test b) 5-day germination test
OU 5	Site 15	Soil	6	a) *Eisenia foetida* b) *Lactuca sativa*	a) Whole and dilution-series 30-day surviv-al and growth test b) 5-day germination test
OU 7	Site 16	Sediment	3	a) *Hyallela azteca* b) *Ceriodaphnia dubia*	a) 14-day survival test b) 7-day survival and reproduction test
OU 8	Site 3	Soil	9	a) *Eisenia foetida* b) *Lactuca sativa*	a) 28-day survival test b) 5-day germination test
		Groundwater	2	a) *Ceriodaphnia dubia* b) *Pimephales promelas*	a) Dilution-series chronic toxicity test b) Dilution-series chronic toxicity test
Lake Fretwell	NA	Sediment	11	a) *Hyallela azteca* b) *Chironomus tentans*	a) 14-day survival and growth test b) 14-day survival and growth test
Reference Locations[1]	NA	Sediment	4	a) *Hyallela azteca* b) *Ceriodaphnia dubia* c) *Chironomus tentans*	a) 14-day survival test b) 7-day survival and reproduction test c) 14-day survival test

[1] Reference samples were collected from Yellow Water Creek (YWC-SD/TOX-R1 and YWC-SD/TOX-20), Sal Taylor Creek (STC-SD/TOX-R1), and Rowell Creek (RC-SD/TOX-R1) (Plate 2).

Notes: NAS = Naval Air Station.
OU = operable unit.
NA = not applicable.

Table 5-2
Results of Surface Soil Toxicity Testing for OUs 1, 2, and 8

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Operable Unit/Site Sample Location	Earthworm (*Eisenia foetida*)		Lettuce Seed (*Lactuca sativa*)
	Mortality (%)	Weight change (%)	Germination (%)
OU 1, Site 1			
BSS01 (Test 1)	2.5	-1.9	[1]8.3
BSS01 (Test 2)	7.5	-1.4	[1]0.0
1SS01	0	15	90
1SS02	[2]15	6.2	9.7
1SS03	2.5	3.3	93
1SS04	2.5	7.6	78
1SS05	0	2.3	91
1SS06	5	5.3	[1]83
1SS07	0	6.3	96
1SS08	0	9.8	98
1SS09	0	9.1	88
1SS10	7.5	-3.0	89
1SS11	2.5	2.5	89
1SS12	0	0.88	86
1SS13	0	3.2	99
1SS14	2.5	3.3	96
1SS15	2.5	6.8	91
OU 1, Site 2			
2SS01	2.5	-14	88
2SS02	2.5	-6.5	99
2SS03	2.5	-5.6	97
2SS04	10	13.5	[1]87
2SS05	0	2.6	97
2SS06	7.5	-1.2	97
2SS07	0	4.1	93
2SS08	0	-2.4	98
2SS09	17.5	5.8	96
2SS10	2.5	-4.6	95
OU 2, Site 5			
CF5SS2	0	-6.21	88
CF5SS4	[1]100	NA	[1]22
CF5SS6	0	1.98	92
CF5SS8	0	-6.77	89
CF5SS9	0	10.83	90
CF5SS13	0	-1.58	[3]79
CF5SS14	2.5	6.25	91
CF5SS15	0	-3.31	92
CF5SS19	0	-5.67	83
CF5SS20	0	0.57	94
CF5SS21	2.5	8.13	93

See notes at end of table.

Table 5-2 (Continued)
Results of Surface Soil Toxicity Testing for OUs 1, 2, and 8

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Operable Unit/Site	Earthworm (*Eisenia foetida*)		Lettuce Seed (*Lactuca sativa*)
Sample Location	Mortality (%)	Weight change (%)	Germination (%)
CF5SS23	0	-1.77	84
CF5SS24	0	3.46	92
CF5SS26	0	3.85	91
CF5SS31	0	11.05	83
OU 2, Site 17			
CF17SS3	0	11.67	87
CF17SS6	0	2.79	93
CF17SS8	2.5	30.9	[1]59
CF17SS9	0	0.77	[1]69
CF17SS10	0	5.96	94
CF17SS11	2.5	28.1	88
CF17SS12	0	-4.19	93
OU 8, Site 3			
CEF3SS1[4]	0	NM	50
CEF3SS4	0.02	NM	65
CEF3SS9	0.02	NM	68
CEF3SS12	0	NM	78
CEF3SS15	0	NM	56
CEF3SS17	0	NM	[5]22
CEF3SS20	0.02	NM	[6]19
CEF3SS22	0	NM	24
CEF3SS24	0	NM	93
Control[7]	0	NM	95

[1] Statistically different from the control sample.
[2] Statistically different from control. However, this difference is not considered to be biologically significant because several of the earthworms were missing from this test vessel at test termination and the observed mortality cannot be attributed to exposure to the soil sample. Missing earthworms were recovered alive in the waterbath.
[3] Statistically different from control. However, this difference is not considered to be biologically significant because the observed mortality is only slightly higher than control levels.
[4] Reference soil sample.
[5] Significantly different from the reference location ($p = 0.05$).
[6] Significantly different from the reference location ($p < 0.1$).
[7] Control was artificial soil: 10 percent peat; 20 percent Kaolinite clay; and 70 percent silica sand.

Notes: Sample locations are shown on Plate 4.
OU = operable unit.
% = percent.
NM = not measured.
< = less than.

Table 5-3
Results of Surface Soil Toxicity Testing for OU 5

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Sample Location	Earthworm (*Eisenia foetida*)			Lettuce Seed (*Lactuca sativa*)
	14-day Survival (%)	30-day Survival (%)	30-day Mean Growth (g)	Germination (%)
Control	100	100	0.25	94
CF15SS6	[1]33	[1]0	NC	95
CF15SS7	100	100	0.334	92
CF15SS18	100	100	0.270	98
CF15SS26	[1]20	[1]0	NC	97
CF15SS46	[1]17	[1]0	NC	93
CF15SS48	100	100	0.356	94
6.25% CF15SS15	87	30	0.071	89
12.5% CF15SS15	93	70	-0.053	93
25% CF15SS15	100	100	-0.031	96
50% CF15SS15	100	10	-0.293	97
100% CF15SS15	[1]17	[1]0	NC	98
6.25% CF15SS20	100	60	0.375	95
12.5% CF15SS20	100	17	0.188	98
25% CF15SS20	100	97	0.167	93
50% CF15SS20	100	97	0.258	88
100% CF15SS20	100	97	0.133	56

[1] Statistically different from control sample.

Notes: Sample locations are shown on Plate 4.
OU = operable unit.
% = percent.
g = gram(s).
NC = not calculable.

Table 5-4
Results of Sediment Toxicity Testing for OUs 1, 2, and 7

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Operable Unit/Site	Waterflea (*Ceriodaphnia dubia*)		Amphipod (*Hyallela azteca*)
Sample Location	Survival (%)	Reproduction (offspring per adult)	Survival (%)
OU 1, Site 1			
RC-Tox-6	90	[1]14	98
RC-Tox-7	[1]30	[2]5	99
RC-Tox-8	100	27	99
RC-Tox-8A	100	22	98
RC-Tox-9	100	17	96
OU 1, Site 2			
2-Tox-2	[1]70	[1]11	[2]83
2-Tox-3	90	17	94
OU 2, Site 5			
5-Tox-1	80	[1]12	[1,2]24
5-Tox-2	100	17	100
5-Tox-3	80	[1]9	[1,2]36
5-Tox-4	[2]60	[1]8	[2]71
5-Tox-5	100	[1]11	90
OU 7, Site 16			
STC-Tox-1	90	15	[2]0
STC-Tox-3	[1]50	[1]7	[2]20
STC-Tox-R1	100	15	99

[1] Considered to be substantially different than reference or laboratory control (i.e., biologically significant).
[2] Statistically different as compared to the reference control.

Notes: Sample locations are shown on Plate 2.
OU = operable unit.
% = percent.

Table 5-5
Results of Sediment Toxicity Testing for Lake Fretwell and Rowell Creek Upstream of Lake Fretwell

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Sample Location	Amphipod (*Hyallela azteca*)			Midge larvae (*Chironomus tentans*)	
	Survival (%)	Growth (weight in mg/organism)	Growth (length in mm)	Survival (%)	Growth (weight in g/organism)
Control 1[1]	100	0.28	3.3	85	1.06
LF-SD/TOX-11	0[3,4]	NA	NA	82	1.74
LF-SD/TOX-12	0[3,4]	NA	NA	80	1.47
LF-SD/TOX-13	100	0.29	3.4	65[3]	1.72
LF-SD/TOX-14	93[3]	0.29	3.4	62[3]	1.91
LF-SD/TOX-15	100	0.39	3.6	63[3]	1.37
LF-SD/TOX-16	98	0.42	3.6	77	1.87
LF-SD/TOX-17	100	0.37	3.5	67	0.88
YWC-SD/TOX-20	95[3]	0.32	3.4	75	1.05
Control 2[2]	88	0.4	3.4	75	1.45
LF-SD/TOX-9	94	0.46	3.7	42[3,4]	1.5
LF-SD/TOX-10	99	0.47	3.7	87	1.47
RC-SD/TOX-18	98	0.41	3.5	18[3,4]	1.17
GC-SD/TOX-19	88	0.43	3.6	75	1.24

1 Laboratory control for sediment samples LF-SD/TOX-11 through LF-SD/TOX-17 and YWC-SD/TOX-20.
2 Laboratory control for sediment samples LF-SD/TOX-9, LF-SD/TOX-10, RC-SD/TOX-18, and GC-SD/TOX-19.
3 Significantly different from the laboratory control sediment.
4 Significantly different from the reference sediment (YWC-SD/TOX-20).

Notes: Sample locations are shown on Figure 7-2.
% = percent.
mg = milligram.
mm = millimeter.
g = gram.

Table 5-6
Results of Groundwater Toxicity Testing

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Sample Location / Percent Sample	Water flea (*Ceriodaphnia dubia*)		Fathead Minnow (*Pimephales promelas*)	
	Survival (%)	Reproduction (offspring per adult)	Survival (%)	Dry Weight (mg) per minnow
CEF3MW13S				
5	100	27.2	77	0.37
10	90	27.2	92	0.34
20	100	25.7	93	0.35
50	100	[1]22.1	95	0.29
100	100	26.2	78	[1]0.26
Control	100	30.9	93	0.33
[2]C-NOEC = 100	**[2]MATC = NC**	**[2]LOEC > 100**	**[2]C-NOEC=50 [2]MATC=71**	**[2]LOEC = 100**
CEF3MW28S				
5	100	[1]25.0	90	0.36
10	[1]60	14.4	90	0.38
20	[1]60	10.6	93	0.35
50	[1]40	4.2	88	0.36
100	90	[1]4.7	[1]12	0.36
Control	100	30.2	97	0.38
[2]C-NOEC <= 5	**[2]MATC = NC**	**[2]LOEC = 5**	**[2]C-NOEC=100 [2]MATC=71**	**[2]LOEC = 100**

[1] Statistically different relative to control ($p < 0.05$).
[2] All chronic no observed effect concentration (C-NOEC), maximum acceptable toxicant concentration (MATC), and lowest observed effects concentration (LOEC) values presented as a percent of the groundwater sample.

Notes: Sample locations are shown on Plate 3-A.
% = percent.
> = greater than.
< = less than.

Table 5-7
Summary of Toxicity Testing Results for Surface Soil

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Operable Unit	Site or PSC	Test Organism	Test Type	Test Result
OU 1	Site 1	a) *Eisenia foetida* b) *Lactuca sativa*	a) 14-day survival test b) 5-day germination test	Soil was not toxic to either test organism.
	Site 2	a) *Eisenia foetida* b) *Lactuca sativa*	a) 14-day survival test b) 5-day germination test	Soil was not toxic to either test organism.
OU 2	Site 5	a) *Eisenia foetida* b) *Lactuca sativa*	a) 14-day survival test b) 5-day germination test	Soil was not toxic to either test organism at all sampling locations except for CF5SS4. At this location, there was 100 percent mortality of both earthworms (*E. foetida*) and lettuce seeds (*L. sativa*). Concentrations of TPH and PCBs in soil were found to be positively correlated with lettuce seed toxicity. Therefore, TPH and PCBs at surface soil sampling location CF5SS4 may be adversely affecting the terrestrial plant and invertebrate community in the area.
	Site 17	a) *Eisenia foetida* b) *Lactuca sativa*	a) 14-day survival test b) 5-day germination test	Soil samples collected from Site 17 were not toxic to earthworms. Germination of lettuce seeds was slightly inhibited at CF17SS8 and CF17SS9. However, no correlation of ECPC concentrations and germination of lettuce seeds was observed. It is believed that a non-measured physical, biological, or chemical factor is responsible for the observed slight reduction in lettuce seed germination in soil samples, rather than contaminants present in the soil.
OU 5	Site 15	a) *Eisenia foetida* b) *Lactuca sativa*	a) 30-day survival test b) 5-day germination test	Survival of earthworms was significantly lower than controls at sampling locations CF15SS6, CF15SS26, CF15SS46, and the 100 percent sample of CF15SS15. Growth of earthworms was also inhibited when exposed to soil from CF15SS15. Effects to earthworms may be related to concentrations of lead in soil. Germination of lettuce seeds was generally not affected by exposure to test soils, with the exception of the 100 percent sample of CF15SS20. Concentrations of PAHs may be related to the observed lowered germination rate in this sample. These interpretations are preliminary because the ERA for OU 5 has not been completed.
OU 8	Site 3	a) *Eisenia foetida* b) *Lactuca sativa*	a) 30-day survival test b) 5-day germination test	Soil samples were not toxic to earthworms. Statistically significant differences in lettuce seed germination rates were observed between soil samples from Site 3 and the control sample. The reliability of these results is suspect because duplicate samples did not show the same germination rates as their respective original samples, and because low germination was observed in the control sample. Linear regression analysis showed little correlation between seed germination rates and concentrations of analytes in surface soil.

Notes: PSC = potential source of contamination.
OU = operable unit.
TPH = total petroleum hydrocarbons.
PCB = polychlorinated biphenyls.
ECPC = exposure point concentration.
PAH = polynuclear aromatic hydrocarbons.
ERA = ecological risk assessment.

Table 5-8
Summary of Toxicity Testing Results for Sediment

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Operable Unit	Site or PSC	Test Organism	Test Type	Test Result
OU 1	Site 1	a) *Hyallela azteca* b) *Ceriodaphnia dubia*	a) 14-day survival test b) 7-day survival and reproduction test	Sediment was not toxic to either test organism at four sampling locations. At one location, RC-Tox-7, percent survival and reproduction were reduced. At another location, RC-Tox-6, reproduction was reduced. These effects are believed to be related to discharge from Site 2.
	Site 2	a) *Hyallela azteca* b) *Ceriodaphnia dubia*	a) 14-day survival test b) 7-day survival and reproduction test	Both survival and reproduction were significantly decreased for the water flea (*C. dubia*) when exposed to sample 2-Tox-2 from the Site 2 tributary, as compared to a control sample. Survival of amphipods (*H. azteca*) was also significantly less than controls when exposed to this sample. Concentrations of iron in sediment were found to be positively correlated with mortality of amphipods during toxicity tests. The presence of other inorganics in the tributary could also be associated with sediment toxicity. Adverse physical conditions (i.e., orange flocculent material) present in the Site 2 tributary may be more responsible for sediment toxicity than the presence of metals in sediment.
OU 2	Site 5	a) *Hyallela azteca* b) *Ceriodaphnia dubia*	a) 14-day survival test b) 7-day survival and reproduction test	Sediment collected from three of the four stations in the Site 5 drainage ditch were toxic to one or both of the test organisms. Impacts to survival of certain invertebrate receptors may be occurring in the Site 5 drainage ditch. This suggests that the mixture of contaminants in the sediment may be toxic to aquatic life. Statistical analyses showed that TPH, Aroclor-1260, and total DDT concentrations were positively correlated with sediment toxicity.
OU 7	Site 16	a) *Hyallela azteca* b) *Ceriodaphnia dubia*	a) 14-day survival test b) 7-day survival and reproduction test	Sediment collected from STC-Tox-1 and STC-Tox-3 was toxic to one or both of the test organisms. Reproduction in the water flea was also reduced at sampling station STC-Tox-3. Toxicity may be attributable to elevated concentrations of TPH in sediment; however, it is believed that TPH is not related to disposal activities at Site 16.
NA	Lake Fretwell and Rowell Creek Upstream of Lake Fretwell	a) *Hyallela azteca* b) *Chironomus tentans*	a) 14-day survival test b) 14-day survival test	Mortality of 100 percent was observed in the amphipod (*H. azteca*) at the Lake Fretwell sampling stations LF-SD/TOX-11 and LF-SD/TOX-12. Additionally, 58 percent mortality was observed in the midge larvae (*C. tentans*) test at sampling station LF-SD/TOX-9. Impacts to survival of certain invertebrate receptors may be occurring in the southern portion of Lake Fretwell. In Rowell Creek upstream of Lake Fretwell, sediment from RC-SD/TOX-18 was toxic to the midge larvae. Linear regressions revealed no positive association between the concentration of detected ECPCs in sediment and adverse responses observed in the sediment toxicity tests.

Notes: PSC = potential source of contamination.
OU = operable unit.
TPH = total petroleum hydrocarbons.
DDT = dichlorodiphenyltrinitrotoluene.
NA = not applicable.
ECPC = ecological contaminant of potential concern.

Table 5-9
Summary of Toxicity Test Results for Groundwater

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Operable Unit	Site or PSC	Test Organism	Test Type	Test Result
OU 8	Site 3	a) *Ceriodaphnia dubia* b) *Pimephales promelas*	a) Dilution-series chronic test b) Dilution-series chronic test	Exposure to undiluted groundwater resulted in reduced growth and mortality in the fathead minnow, and reduced survival and reproduction in the water flea. Three dichlorobenzene isomers appear to be the primary risk contributors for groundwater at Site 3. When groundwater was diluted approximately 20-fold during testing, little toxicity was observed; this dilution is an order of magnitude less than the 133-fold dilution expected when groundwater discharges to Rowell Creek.

Note: OU = operable unit.

Site 1 Surface Soil. Fifteen surface soil samples were collected for toxicity testing from Site 1 (1SS01 through 1SS15; Plate 4). The toxicity testing results of surface soil collected from Site 1 are tabulated in Table 5-2 and summarized in Table 5-7. Soil samples collected from Site 1 were not toxic to *E. foetida*. The earthworms exposed to the samples produced cocoons in several test chambers and generally gained more weight than the earthworms in the control sample, indicating good health. In general, soil collected from Site 1 was not toxic to *L. sativa*, with the exception of one of the background samples, BSS01. Although germination was statistically different in two samples (BSS01 and 1SS06) compared to the respective control samples, only sample (BSS01) substantially affected germination. The germination in the remaining samples exceeded 80 percent; therefore, it is believed that germination of *L. sativa* was not affected by exposure to surface soil from Site 1.

Site 1 Sediment. Five sediment samples were collected from Rowell Creek adjacent to Site 1 for toxicity testing (RC-Tox-6, RC-Tox-7, RC-Tox-8, RC-Tox-8A, and RC-Tox-9; Plate 2). The toxicity testing results of sediment collected from Site 1 are tabulated in Table 5-4 and summarized in Table 5-8. The elutriate samples from the sediment collected from Rowell Creek at Site 1 were not toxic to *C. dubia* except at location RC-Tox-6 (reproduction results) and location RC-Tox-7 (percent survival and reproduction). There is no widely accepted method to determine statistical significance of these test results. However, results less than 80 percent survival and fewer than 15 offspring are generally considered to be significant (Springborn Laboratories, 1994). None of the sediment samples collected at Site 1 from Rowell Creek were toxic to *H. azteca*.

Site 2 Surface Soil. Ten surface soil samples were collected for toxicity testing from Site 2 (2SS01 through 2SS10; Plate 4). The toxicity testing results of surface soil collected from Site 2 are tabulated in Table 5-2 and summarized in Table 5-7. None of the soil samples collected from Site 2 were toxic to *E. foetida*. The earthworms exposed to the samples produced cocoons in several test chambers and generally gained more weight than the earthworms in the control sample, indicating good health. In general, soil collected from Site 2 was not toxic to *L. sativa*, with the exception of one of the background samples, BSS01. Although germination was statistically different in two samples (BSS01 and 2SS04) compared to the respective control samples, only sample (BSS01) substantially affected germination. The germination in the remaining samples exceeded 80 percent; therefore, it is believed that germination of *L. sativa* was not affected by exposure to surface soil from Site 2.

Site 2 Sediment. Two sediment samples were collected from the tributary adjacent to Site 2 for toxicity testing (2-Tox-2 and 2-Tox-3; Plate 2). The toxicity testing results of sediment collected from Site 2 are tabulated in Table 5-4 and summarized in Table 5-8. There is no widely accepted method to determine statistical significance of toxicity test results for *C. dubia*; however, results less than 80 percent survival and fewer than 15 offspring are generally considered to be significant (Springborn Laboratories, 1994). Based on this method, the sediment sample at location 2-Tox-2 adversely affected both survival and reproduction of *C. dubia*, as compared to both the reference and the laboratory control. Also, survival of *H. azteca* was significantly less than controls in sediment sample 2-Tox-2.

5.1.1.2 **Operable Unit 2** Both surface soil and sediment samples were collected for toxicity testing at Site 5. Only surface soil samples were collected for toxicity testing at Site 17; there is no water body directly associated with Site 17 from which sediment could be collected. Soil and sediment samples were collected in 1993 (Springborn Laboratories, 1994). Numerical results of surface soil and sediment toxicity testing are shown in Tables 5-2 and 5-4, respectively. Analysis and interpretation of the test results for surface soil and sediment from OU 2 are shown in Tables 5-7 and 5-8, respectively.

Site 5 Surface Soil. Fifteen surface soil samples were collected for toxicity testing from Site 5 (CF5SS2, CF5SS4, CF5SS6, CF5SS8, CF5SS9, CF5SS13, CF5SS14, CF5SS15, CF5SS19, CF5SS20, CF5SS21, CF5SS23, CF5SS24, CF5SS26, CF5SS31; Plate 4). The toxicity testing results of surface soil collected from Site 2 are tabulated in Table 5-2 and summarized in Table 5-7. With the exception of sample CF5SS4, soil samples were not toxic to *E. foetida*. At CF5SS4, 100 percent mortality was observed in the earthworm. *E. foetida* exposed to all other Site 5 soil samples produced cocoons in several test chambers and generally gained more weight than those in the control soil, indicating good health.

In general, the soil collected from Site 5 did not inhibit germination of *L. sativa*, with the exception of sample CF5SS4, where germination was statistically different from the control sample at 22 percent. In addition, germination of *L. sativa* following exposure to one background soil sample (BSS01) was statistically different compared to its respective control sample. Despite the statistical significance for this sample, its germination rate was relatively high (79 percent), and all remaining Site 5 soil samples exhibited over 79 percent germination. It is concluded, then, that germination of *L. sativa* was not adversely affected by exposure to surface soil samples at Site 5, with the exception of CF5SS4.

Site 5 Sediment. Five sediment samples were collected from a drainage ditch at Site 5 for toxicity testing (5-Tox-1 through 5-Tox-5; Plate 2). The toxicity testing results of sediment collected from Site 5 are tabulated in Table 5-4 and summarized in Table 5-8. Mortality of *H. azteca* in three samples (5-Tox-1, 5-Tox-3, and 5-Tox-4) was statistically significant as compared to controls, with values of 76 percent, 64 percent, and 29 percent, respectively. The results for the *C. dubia* tests are difficult to compare statistically to the control results. In general, test results are considered to be significant if there is less than 80 percent survival and fewer than 15 offspring per adult (Springborn Laboratories, 1994). Using this interpretation of the results, mortality was significant in *C. dubia* for station 5-Tox-4 at 40 percent. A reduced number of offspring compared to the upstream reference sample (12) was observed at stations 5-Tox-3 and 5-Tox-4 at 9 and 8, respectively. Reproduction was also suppressed in the upstream reference at 12 versus the threshold of 15.

Site 17 Surface Soil. Seven surface soil samples were collected for toxicity testing from Site 17 (CF17SS3, CF17SS6, CF17SS8, CF17SS9, CF17SS10, CF17SS11, CF17SS12; Plate 4) for sampling locations. The toxicity testing results of surface soil collected from Site 17 are tabulated in Table 5-2 and summarized in Table 5-7. The soil samples collected from Site 17 were not toxic to *E. foetida*. The earthworms exposed to the soil produced cocoons in several test chambers and generally gained more weight than those in the control soil, indicating good health. The soil samples collected also did not adversely affect germination of *L. sativa*, except at one of the background sampling locations (BSS01) and at locations CF17SS8 and CF17SS9 (at 59 percent and 69 percent, respectively).

5.1.1.3 **Operable Unit 3** Toxicity testing has not been completed for media at OU 3.

5.1.1.4 **Operable Unit 4** Toxicity testing has not been completed for media at OU 4.

5.1.1.5 **Operable Unit 5** Surface soil toxicity tests at OU 5, Site 15 were completed in 1995 (ESE, 1995a). Toxicity tests were not completed for Site 14. Numerical results for these tests are tabulated in Table 5-3.

Site 15 Surface Soil. Six surface soil samples were collected from Site 15 for whole-soil toxicity testing, including a reference sample (CF15SS6, CF15SS7, CF15SS18, CF15SS26, CF15SS46, and reference sample CF15SS48; Plate 4). Two samples were also collected for definitive (dilution-series) toxicity testing from locations CF15SS15 and CF15SS20. The toxicity testing results of surface soil collected from Site 15 are tabulated in Table 5-3 and summarized in Table 5-7.

For the whole-soil tests, survival of *E. foetida* was significantly different from controls and the reference sample at locations CF15SS6, CF15SS26, and CF15SS46. At the end of the 30-day test period, *E. foetida* exposed to soil at these locations experienced 100 percent mortality. For the dilution-series tests with CF15SS15, some earthworm mortalities were observed in the lowest two concentrations of soil (6.25 percent and 12.5 percent) that were not duplicated during replicate testing; therefore, these results are not considered to be significant. For the 100 percent sample of CF15SS15, 100 percent mortality of *E. foetida* was observed after 30 days of exposure. There was weight loss in the *E. foetida* exposed to all concentrations of the dilution-series test for this sample. The 30-day LC_{50} for this sample was determined to be 30.7 percent of the soil. For the dilution-series tests with CF15SS20, no LC_{50} could be calculated because *E. foetida* survival for the 100 percent sample was 97 percent, and all organisms exposed gained weight during the testing period.

With the exception of the 100 percent sample of CF15SS20, there were no significant differences in germination of *L. sativa* between test soils and the control or reference soils. At this one location, germination of *L. sativa* was 56 percent.

5.1.1.6 **Operable Unit 6** Toxicity testing has not been completed for media at OU 6.

5.1.1.7 **Operable Unit 7** Sediment samples were collected in the drainage ditches east of Sal Taylor Creek and downgradient of OU 7, Site 16, for toxicity testing (Springborn Laboratories, 1994). Samples were collected in 1993. Numerical results of sediment toxicity tests are tabulated in Table 5-4 and summarized in Table 5-8.

Site 16 Sediment. Two sediment samples were collected from the drainage ditches east of Sal Taylor Creek, located downgradient of Site 16, for toxicity testing (STC-Tox-1 and STC-Tox-3; Plate 2). The reference location STC-Tox-R1 was collected in Sal Taylor Creek upstream of Site 16. The toxicity testing results of sediment collected downgradient of Site 16 are tabulated in Table 5-4 and summarized in Table 5-8. Significant mortality of *H. azteca* (100 percent and 80 percent) was observed at stations STC-Tox-1 and STC-Tox-3, respectively. The results for the *C. dubia* tests are difficult to compare statistically to the control results. Ten replicates of the sediment elutriate are exposed to one *C. dubia* per replicate; therefore, percent survival is reported as a pass or fail result (i.e., either 0 or 100 percent survival). In general, test results are considered to be significant if there is less than 80 percent survival and fewer than 15 offspring per adult (Springborn Laboratories, 1994). Using this interpretation of the results, mortality was significant in *C. dubia* for station STC-Tox-3 (50 percent); a reduced number of offspring (seven as compared to 15) was also observed at this station.

5.1.1.8 **Operable Unit 8** Surface soil and groundwater samples were collected for toxicity testing from OU 8, Site 3 (Inchcape Testing Services/Aquatec Laboratories, 1995a). Samples were collected in 1994. Numerical results of surface soil and groundwater toxicity tests are shown in Tables 5-2 and 5-6, respectively. Analysis and interpretation of the test results for surface soil and groundwater are shown in Tables 5-7 and 5-9, respectively.

Site 3 Surface Soil. Nine surface soil samples were collected for toxicity testing from Site 3 (CEF3SS1, CEF3SS4, CEF3SS9, CEF3SS12, CEF3SS15, CEF3SS17, CEF3SS20, CEF3SS22, and CEF3SS24; Plate 4). The toxicity testing results of surface soil collected from Site 3 are tabulated in Table 5-2 and summarized in Table 5-7. Soil collected from Site 3 was not toxic to *E. foetida*. Survival was similar to the control and reference soil, ranging from 98 to 100 percent for the 28-day exposure. Germination of *L. sativa* was 95 percent in the control soil sample, but only 50 percent in the reference soil sample CEF3SS1. Seed germination in samples CEF3SS17 and CEF3SS20 was significantly different from the reference soil sample. Interpretation of the germination test results is difficult for two reasons. First, the germination seen in the reference soil sample is relatively low, making comparisons to it somewhat questionable. Second, there was a high degree of variability in three replicate tests completed as part of the study. Sample CEF3SS22 showed low germination (24 percent) that was not statistically significant, probably because of high replicate variability.

Site 3 Groundwater. Groundwater samples were collected from two monitoring wells at Site 3 and submitted for toxicity testing (CEF3MW13S and CEF3MW28S; Plate 3). The toxicity testing results of groundwater collected from Site 3 are tabulated in Table 5-6 and summarized in Table 5-9. Chronic toxicity was observed in *P. promelas* exposed to groundwater from both CEF3MW13S and CEF3MW28S. The chronic no observed effect concentration (C-NOEC) in both samples was 50 percent, and the maximum acceptable toxicant concentration (MATC) in both samples was 71 percent. Chronic toxicity was not reported for *C. dubia* at CEF3MW13S. A statistically significant adverse reproductive response was noted in the 50 percent groundwater sample from this location; however, the 100 percent groundwater sample showed no adverse response; thus, the 50 percent response is considered an anomaly. Chronic toxicity was observed in both test species at CEF3MW28S, with *C. dubia* exhibiting a higher degree of sensitivity than P. *promelas*. The C-NOEC for C. dubia was less than 5 percent of the groundwater sample from this location, and the lowest observed effect concentration (LOEC) was 5 percent. Some uncertainty is associated with the *C. dubia* test results: while no significant mortality was observed in the 100 percent, undiluted groundwater sample, 60 percent mortality was observed in the 50 percent dilution sample. Overall, up to a 20-fold dilution (5 percent sample) was necessary to remove adverse effects in one or both of the test organisms.

5.1.2 Other Sites and PSCs Toxicity testing of sediment was completed for Lake Fretwell and Rowell Creek upstream of Lake Fretwell in 1995 (ESE, 1995b). The toxicity testing results of sediment collected from Lake Fretwell and Rowell Creek upstream of the lake are tabulated in Table 5-5 and summarized in Table 5-8. Toxicity tests have not been completed for any other sites or PSCs at NAS Cecil Field.

5.1.2.1 **Lake Fretwell Sediment** Eight sediment samples from Lake Fretwell (LF-SD/Tox-9 through LF-SD/Tox-16), three samples from Rowell Creek upstream of Lake Fretwell (LF-SD/Tox-17, RC-SD/Tox-18, and GC-SD/Tox-19), and one sample from a reference location in Yellow Water Creek (YWC-SD/Tox-20) were submitted for 14-day survival toxicity tests using amphipods (*H. azteca*) and midge larvae (*C. tentans*). Plate 2 shows these sampling locations. The toxicity testing results of sediment collected from these areas are tabulated in Table 5-5 and summarized in Table 5-8.

Survival of *H. azteca* in the reference (YWC-SD/TOX-20), was significantly different ($p \leq 0.05$) from the laboratory control sediment. Survival of *H. azteca* in samples from stations LF-SD/TOX-11 and LF-SD/TOX-12 were significantly different from the reference sediment. Growth, reported as weight and length, of *H. azteca* in the sediment from all sample stations was not significantly different from the laboratory control and reference sample. Growth of *H. azteca* in sediment from stations LF-SD/TOX-11 and LF-SD/TOX-12 could not be determined due to 100 percent mortality.

Survival of *C. tentans* exposed to sediment from stations LF-SD/TOX-9, LF-SD/TOX-13, LF-SD/TOX-14, LF-SD/TOX-15, and RC-SD/TOX-18 were significantly different from the laboratory control sediment. Survival of *C. tentans* exposed to sediment from stations LF-SD/TOX-9 and RC-SD/TOX-18 were significantly different from the reference sediment. Growth of *C. tentans* exposed to the sediment samples was not significantly different from the control or reference sediments. Complete information on the sediment toxicity testing from Lake Fretwell and Rowell Creek upstream of Lake Fretwell is presented in Appendix D-5.

5.2 AQUATIC STUDIES. Aquatic studies conducted at NAS Cecil Field include examination and sampling of aquatic resources and habitats. Aquatic resources include fish, invertebrates, and aquatic plants. The timing and scope of the aquatic studies completed at NAS Cecil Field are reported in Appendix C.

A semi-quantitative macroinvertebrate survey was conducted at NAS Cecil Field in June and July 1993 (EA, 1994a). An earlier aquatic sampling event was completed in 1991 (ECT, 1992). The 1991 sampling event included sampling of aquatic macroinvertebrate and fish communities at six locations in Rowell Creek. This 1991 study was completed to identify ecological receptors in Rowell Creek and to characterize the status of macroinvertebrate populations. The results of this study were used, in part, to design the aquatic sampling program that was completed in 1993.

The 1993 sampling event included sampling of aquatic macroinvertebrate communities at locations throughout Rowell Creek and Lake Fretwell. Macroinvertebrate sampling at NAS Cecil Field was completed during a low flow period, which is considered to be a period of high stress (FDEP, 1992). Detailed discussions of the field and laboratory methodology for collection and analyses of the macroinvertebrate data are provided in appendices of the baseline risk assessments (BRAs) for each OU. The sampling plan generally included:

- collection of parameters describing aquatic habitat,
- collection of macroinvertebrates by use of dip net sweeps,
- collection of macroinvertebrates by use of Hester-Dendy artificial substrates, and
- collection of macroinvertebrates by use of three replicate petite ponar dredge samples.

At each station location sampled, an aquatic habitat parameter characterization was performed. Physical/chemical parameters included surrounding land use, local watershed information, canopy cover, width, depth, velocity, sediment/substrate characteristics, weather conditions, and water quality measurements (including temperature, dissolved oxygen, pH and conductivity). Metrics used in the characterization of the benthic macroinvertebrate study are presented in Table 5-10.

At stations that were wadable, benthic macroinvertebrates were collected by use of a D-frame dip net. Qualitative samples were collected by conducting net sweeps from multiple habitats at each station. Net sweeps were distributed in the different habitat types (i.e., snags, leaf packs, aquatic vegetation, undercut banks, etc.).

Hester-Dendy artificial substrates were used in addition to dip-net sampling in wadable habitats. Three replicate Hester-Dendy samplers were placed at each station approximately 4 weeks prior to collection of the dip-net samples. The metrics used to describe the structure and function of the benthic macroinvertebrate community as sampled by Hester-Dendy samplers are described in Table 5-10.

At all stations three replicate samples were collected with a petite Ponar grab sampler to investigate the macroinvertebrate community associated with sediment. The metrics used to describe the structure and function of the benthic macroinvertebrate community as sampled by the ponar dredge are also presented in Table 5-10. The taxa identified from the ponar samples are indicative of the infaunal (within as opposed to on top of benthic deposits) benthic community with some epifaunal components represented. Station-to-station differences in the benthic macroinvertebrate community may be due to variations in substrate composition and/or man-induced alterations on the population. Because no State of Florida regional reference exists for this gear type, all comparisons were made to the reference stations for each site and PSC.

To minimize disturbance to samples and habitat before each sample type was collected, the order of collection was Hester-Dendy, Ponar, and dip net, working upstream from the previous sample collection where possible.

Fish were collected by use of either a 10- or 25-foot seine net at each station sampled. The sampling was qualitative in approach, as dictated by habitat restrictions.

Table 5-10
Benthic Macroinvertebrate Community Metrics

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Metric	Description
Total taxa (number of invertebrate taxa)	Defines species richness. Richness generally increases with increasing water quality, habitat diversity, and/or habitat suitability (U.S. Environmental Protection Agency [USEPA], 1990).
Number of individuals per square meter	Classifies invertebrate density (USEPA, 1990)
Dominant taxon	Measures redundancy. A high level of redundancy (i.e., dominance of the fauna by a single taxon) is equated with the dominance of a pollution tolerant organism and a lowered diversity (Plafkin and others, 1989).
Percent dominant taxon	Calculated as the ratio of the taxonomic group with the most individuals (dominant) to the total number of organisms. Percent dominance should remain low to reflect a healthy biotic condition (Plafkin and others, 1989).
Florida index	Commonly used index for Florida streams that focuses on the tolerance of specific populations indigenous to the state. This index does not use the entire macroinvertebrate assemblage, and is heavily weighted to the arthropods (e.g., insects with horny segmented external covering and jointed limbs). The Florida index increases in value as the condition of the water quality increases (Florida Department of Environmental Regulation [FDER, currently known as Florida Department of Environmental Protection, FDEP], 1990).
Shannon-Weaver index	Measures indices of community structure and function. The Shannon-Weaver value may range from 0 to 3.3 log N, where N = the total number of individuals. This index is often insensitive to subtle changes in community structure unless the environment has been grossly modified; however, it is often used to calculate other indices (USEPA, 1990).
Percent diptera	Increases in the presence of stress (USEPA, 1990).
Percent chironomid	Represent pollution tolerant benthic taxa (USEPA, 1990).
Percent ephemeroptera-plecoptera-trichoptera (EPT)	Consists of the most pollution sensitive benthic taxa. Good biotic condition is reflected in communities having a fairly even distribution among EPT and chironomids (USEPA, 1990).
Percent collector-filtered	Reflects the riffle/run community food base and provides insight into the nature of potential disturbance factors. Predominance of a feeding type may indicate an unbalanced community responding to an overabundance of a particular food source. Filtering collectors are sensitive to toxicants bound to fine particulate organic material and may decrease in abundance when exposed to sources of such bound toxicants (USEPA, 1990).
Percent shredders	Shredders are sensitive to riparian (bank to bank) zone impacts and are particularly good indicators of toxic effects when the toxicants are readily adsorbed to course particulate organic matter (USEPA, 1990).
Percent calcium dependent	Measures the number of crustacean and mollusc individuals. These taxa are calcium-dependent and are generally most diverse in alkaline-fed streams. Stress such as habitat degradation or chemical contamination may eliminate certain taxa represented in this metric (FDER, 1990).
Hisenhoff biotic index (HBI)	Developed to summarize overall pollution tolerance of the benthic arthropod community. Similar in concept to the Florida index, but incorporates abundance and a slightly different weighing factor for tolerance. Tolerance values are assigned ranging from 0 to 10 (10 signifying the most tolerant). The 0-10 scale was modified to include non-arthropod species. The HBI index decreases in value with increasing water resource integrity. Although it may be applicable for other types of pollutants, use of the HBI in detecting non-organic pollution effects has not been thoroughly evaluated (FDEP, 1990; USEPA, 1990).

Aquatic habitat quality and biological condition scores were calculated for the sampling stations based on data collected from the above field survey efforts. The sampling and analyses of the benthic communities, and aquatic habitat assessment generally follows USEPA rapid bioassessment protocols (RBP), a cumulative metric technique developed by USEPA (1989c), modified by Barbour and others (1992) and further adapted by FDEP (FDEP, 1992). This process involves the use of a series of metrics or community attributes, each of which is designed to evaluate a component of benthic community structure or function (Table 5-10). The State of Florida regional reference station (Five Mile Creek) was used as a standard of comparison.

The biological and habitat scores obtained by the above methods were divided by the reference score for a percent comparability value. Regression analyses were performed and the stations were plotted. Sampling station locations (which are denoted by the "-Bio-" qualifier) are presented on Plate 2. The figures that present the relationship between habitat quality and biological condition are presented in the OU-specific discussions.

Sampling station plots that fall within the 95 percent confidence interval lines indicate a predictable condition of the biological community in response to habitat quality. This relationship can be expected only in the absence of poor water quality; that is, poor water quality would prevent the biological community from reaching its potential even though appropriate habitat conditions exist. Sites that fall in the lower right-hand area indicate the depression of biological condition in habitat which has the capacity to support a healthy community. This is usually an indication of toxic conditions resulting from poor water quality. Artificial (and, usually temporary) elevation of biological condition because of organic enrichment would put sites in the upper left-hand area of these graphs.

Study results are summarized in the following sections according to OUs and other PSCs. Findings from additional sampling efforts at stations not considered as part of an OU are presented in Subsection 5.2.2.

<u>5.2.1 **Operable Units**</u> Aquatic studies have been completed at OUs 1, 2, 7 and 8. Results of these studies serve as measurement endpoints for assessing the survival and maintenance of aquatic communities and populations within the surface water and sediment at specific study sites. Findings from these studies are summarized below.

5.2.1.1 **Operable Unit 1** The initial aquatic sampling event of OU 1 was completed in 1991 (ECT, 1992). The 1991 sampling event included sampling of aquatic macroinvertebrate and fish communities at six locations in Rowell Creek. One sampling station was located in Rowell Creek adjacent to Site 1 and one station was located downstream of OU 1. Results of this sampling event were used for planning the 1993 sampling event. Aquatic habitats at Sites 1 and 2 were characterized as part of a field survey completed in July 1993 (EA, 1994a). Six aquatic sampling stations were located in Rowell Creek adjacent to Site 1 and downstream of Site 2 (RC-Bio-6, RC-Bio-7, RC-Bio-8A, RC-Bio-8, RC-Bio-9, and RC-Bio-10). Two sampling stations were located in the Site 2 tributary (2-Bio-2 and 2-Bio-3). Two reference locations in Rowell Creek (RC-Bio-4 and RC-Bio-5) were selected for comparative analysis. The OU 1 biological sampling stations are presented on Plate 2.

The 1993 aquatic sampling effort was focused on collection of information on the status of macroinvertebrate community structure and function that would be directly comparable to the results of chemical analyses of surface water and sediment and sediment toxicity testing, and included quantitative collection of macroinvertebrates and qualitative collection of fish. The study area for Sites 1 and 2 consisted of Rowell Creek adjacent to Site 1 and a tributary at Site 2. Appendix C summarizes the objectives of the study. Sampling methods and a description of the metrics used for this study are presented in Section 5.2 and Table 5-10, respectively.

A summary of the water quality measurements and surface water results for total hardness, nitrate and nitrite, total nitrogen, and total phosphorus are summarized in Table 5-11. With the exception of 2-Bio-1, water depth was 1 meter or less at all stations. Water temperatures ranged from 23.0 to 26.1 degrees °C and pH ranged from 6.2 to 7.2, which are within normal ranges. The dissolved oxygen values ranged from a very low value of 0.5 mg/ℓ at 2-Bio-1 to a high of 5.6 mg/ℓ at RC-Bio-4. Conductivity was highest at RC-Bio-9 (402 micromhos per centimeter [μmhos/cm]). Compared to the locations upstream of Sites 1 and 2, including RC-Bio-4 and RC-Bio-5 (269 and 279 μmhos/cm, respectively), conductivity was generally higher at the Rowell Creek locations adjacent to Site 1 (261 to 402 μmhos/cm) and lower at Site 2 (184 to 206 μmhos/cm). All measurements of conductivity fall within the normal range according to State of Florida surface water quality standards (Florida Legislature, 1995).

Water clarity is classified as clear at all stations except RC-Bio-4, RC-Bio-5, 2-Bio-2, and 2-Bio-3. Stations RC-Bio-4 and RC-Bio-5 have a water clarity that is classified as slightly tannic. Both locations at Site 2 are turbid and have an orange-rust color appearance. The water column contains an orange-rust colored flocculent material. The material could represent precipitated metals including aluminum and iron, as well as microbial mass. The surface water at Site 2 also has an iridescent appearance that breaks apart. Periphyton occurs at most stations, but was absent at stations 2-Bio-2 and 2-Bio-3.

Table 5-12 contains the results of the habitat assessment scores for each of the sampling stations at OU 1, including the State of Florida regional reference, Five Mile Creek. Habitat quality at one of the reference stations, RC-Bio-5 (score of 64), is comparable to the downstream Rowell Creek stations (RC-Bio-6 to RC-Bio-10 ranging from 58 to 63). Habitat quality is lowest at the stations at Site 2, including 2-Bio-2 with a score of 45 and 2-Bio-3 with a score of 48.

A taxonomic list of the benthic macroinvertebrates collected at OU 1 is presented in Appendix A-7. Identified taxa were collected from the OU 1 sampling stations using a combination of dip net and Ponar samplers. Hester-Dendy samplers were utilized in the Rowell Creek stations.

<u>OU 1 Dip Net Sampling Results</u>. The metrics used to describe the structure and function of the benthic macroinvertebrate community as sampled by dip net are described in Table 5-10. A list of metrics is presented in the OU 1 Baseline Risk Assessment (ABB-ES, 1994a). Total metric scores ranged from lows of 10 at 2-Bio-2 and 12 at 2-Bio-3 to a high of 32 at RC-Bio-8.

The relationship between habitat quality and biological condition at OU 1 sampling stations is shown on Figure 5-1. RC-Bio-5, RC-Bio-6, RC-Bio-8, RC-Bio-9, and RC-Bio-10 lie within the predictable condition of the biological community

Table 5-11
Summary of OU 1 Surface Water Quality Measurements

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Station	Depth (m)[1]	Temperature (°C)[1]	pH[1]	DO (mg/ℓ)[1]	Conductivity (µmhos/cm)[1]	Secchi (m)[1]	Total Hardness (mg/ℓ as $CaCO_3$)[2]	Nitrate plus Nitrite (mg/ℓ)[2]	Total Nitrogen (mg/ℓ)[2]	Total Phosphorus (mg/ℓ)[2]
RC-Bio/SW-4	0.5	25.6	6.2	5.6	269	0.75	85.3	3.28	4.11	0.80
RC-Bio/SW-5	0.4	25.5	6.4	3.8	279	0.4	85.2	4.12	5.19	0.84
RC-Bio/SW-6	0.3	26.1	7.1	3.7	385	0.3	97.3	6.23	7.34	0.65
RC-Bio/SW-7	0.3	25.7	7.0	3.3	376	0.3	96.1	5.42	6.81	0.66
RC-Bio/SW-8	0.3	24.8	7.2	3.6	394	0.3	98.4	5.87	7.11	0.62
RC-Bio/SW-8A	0.2	25.1	7.0	3.1	386	0.2	97.0	5.43	6.68	0.63
RC-Bio/SW-9	1.0	24.7	7.2	4.1	402	1.0	101	6.13	7.4	0.65
RC-Bio/SW-10	0.2	25.3	6.6	4.0	261	0.0	91	0.4	1.39	0.76
2-Bio/SW-1	>1.0	23.0	6.4	0.4	217	0.3	50.3	0.11	0.48	0.01
2-Bio/SW-2	0.5	24.3	6.6	3.2	184	0.5	54.4	0.03	0.82	0.08
2-Bio/SW-3	0.3	25.8	6.6	3.6	206	0.3	55.8	0.37	0.91	0.01

[1] From Appendix P, OU 1 Baseline Risk Assessment (ABB-ES, 1994). Measured in the field by EA Engineering, Science, and Technology, Inc.
[2] From Appendix A, OU 1 Baseline Risk Assessment (ABB-ES, 1994). Measured in the laboratory.

Notes: OU = operable unit.
m = meter.
°C = degrees Celsius.
DO = dissolved oxygen.
mg/ℓ = milligrams per liter.
µmhos/cm = micromhos per centimeter (a measure of electrical conductivity).
$CaCO_3$ = calcium carbonate.
> = greater than.

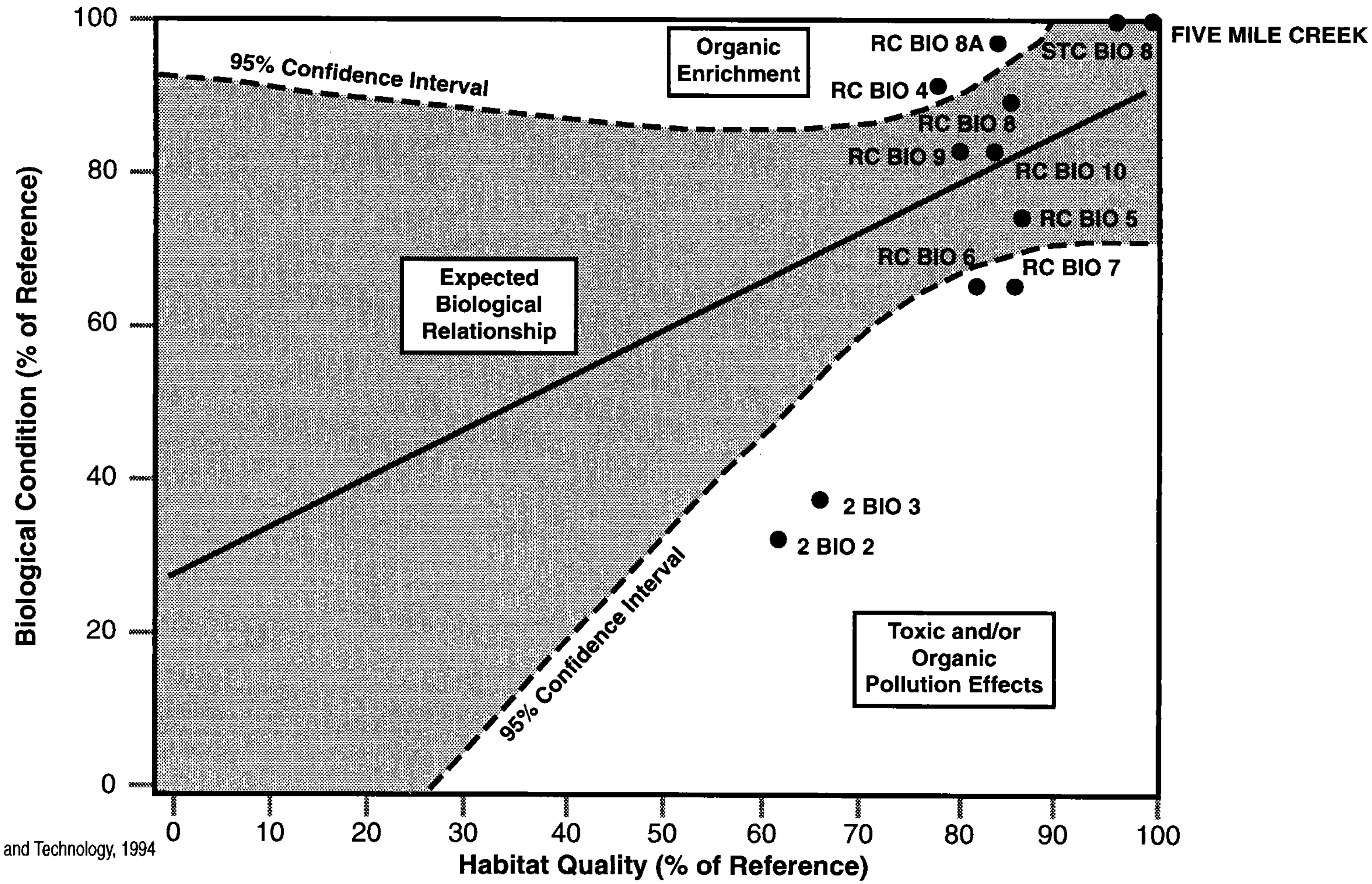
Table 5-12
Habitat Assessment Scores, OU 1

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Station	Bottom Substrate	Water Velocity	Artificial Channel	Bank Stability	Riparian Zone Vegetation	Flow Adjustment	Total Score	Percent Comparison to Reference
RC-Bio-4	18	6	14	5	6	--	49	68.0
RC-Bio-5	23	15	14	5	7	--	64	88.9
RC-Bio-6	14	18	13	5	8	--	58	80.6
RC-Bio-7	14	18	13	8	8	--	61	84.7
RC-Bio-8	20	16	14	6	7	--	63	87.5
RC-Bio-8A	17	16	13	7	8	--	61	84.7
RC-Bio-9	20	15	14	5	8	--	62	86.1
RC-Bio-10	20	20	14	4	5	--	63	87.5
2-Bio-2	15	2	12	7	9	--	45	62.5
2-Bio-3	16	2	12	9	9	--	48	66.7
Five Mile Creek [1]	24	8	15	10	10	5	72	100

[1] Five Mile Creek is the Florida regional reference station considered in this study. Sampling methods and habitat scoring procedures are discussed in Section 5.2.

Notes: OU = operable unit.
-- = not measured.



SOURCE:
EA Engineering, Science, and Technology, 1994

NOTES:
NAS = Naval Air Station
RC = Rowell Creek
BIO = Aquatic biological sampling station
STC = Sal Taylor Creek

KEY:
- - - - = Expected Relationship
——— = Estimated Relationship

FIGURE 5-1
RELATIONSHIP BETWEEN HABITAT QUALITY AND BIOLOGICAL CONDITION, OPERABLE UNIT (OU) 1

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

BASEWIDE ECOLOGICAL ASSESSMENT REPORT

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

8500-19 FIG 5-1 030796MAW

in response to habitat quality. Stations RCGC-Bio-R1, RC-Bio-8A, and RC-Bio-4 exhibited a higher benthic quality than might be expected, perhaps representative of nutrient enrichment, which would artificially sustain a more diverse fauna than dictated by habitat quality. Stations RC-Bio-R1 and RC-Bio-7 fell just below the 95 percent confidence line. Both of these stations had fairly high habitat quality, but appear to be slightly impaired. Stations 2-Bio-2 and 2-Bio-3, when compared to the reference, fall just below the line. These stations could be classified as moderately impaired.

<u>OU 1 Hester-Dendy Substrate Sampler Results</u>. The metrics used to describe the structure and function of the benthic macroinvertebrate community as sampled by the Hester-Dendy substrate sampler are described in Table 5-10. A list of metrics for the Hester-Dendy substrate samplers is presented in the OU 1 Baseline Risk Assessment (ABB-ES, 1994a). Hester-Dendy substrate sampler results are only available for the sampling stations in Rowell Creek and are not available for the Site 2 tributary. The Site 2 tributary sampling stations could not be sampled as the orange-rust colored flocculent material would have engulfed the samplers and prevented colonization. The total number of taxa from stations that could be sampled was lowest at RC-Bio-7 (24). The highest number of taxa was at RC-Bio-5 (41), followed by RC-Bio-9 (39) and RC-Bio-10 (36). The number of individuals was lowest at Five Mile Creek (326/m^2). Compared to the other reference station, RC-Bio-5 (4,881/m^2), all other stations had lower abundance.

The Florida index was lowest at RC-Bio-7 (8). Five Mile Creek (15) scored higher than RC-Bio-6 (9), RC-Bio-8A (10), RC-Bio-8 (13), and RC-Bio-10 (14). Only two Rowell Creek stations, RC-Bio-9 (22) and RC-Bio-5 (16), ranked higher than the regional reference. Differences in levels of taxonomic identification could be responsible for the lower scores at the OU 1 and reference locations. Overall scores, with the exception of the reference stations, were good to very good as classified by the Florida index.

The Shannon-Weaver index values were lowest at RC-Bio-10 (3.274) and highest at Five Mile Creek (4.612) and RC-Bio-6 (3.904). The values at the other stations were fairly high and varied only slightly, ranging from 3.291 at RC-Bio-9 to 3.677 at RC-Bio-7.

The percent of EPT, which consists of the most pollution sensitive benthic taxa (i.e., insect orders *Ephemeroptera* [mayflies], *Plecoptera* [stoneflies], and *Trichoptera* [caddisflies]), was low at RC-Bio-7 (0.0 percent), and Five Mile Creek (5.6 percent). The percent of EPT was lower than the other reference location, RC-Bio-5 (26.8), at the remaining stations, with the exception of RC-Bio-8 (38.9).

The Hilsenhoff Biotic index rates the community on a scale of 1 (high quality) to 10 (low quality). All stations (5.6 to 6.8) had comparable scores to Five Mile Creek (6.4).

Comparing the Rowell Creek Hester-Dendy results to Five Mile Creek, general trends indicate that RC-Bio-7 had metric values that were lower, whereas RC-Bio-9 and RC-Bio-10 had similar or higher values than Five Mile Creek. No conclusive trends existed among metrics for the other stations. The stations in the Site 2 tributary were not sampled.

OU 1 Ponar Sampling Results. The metrics used to describe the structure and function of the benthic macroinvertebrate community as sampled by the ponar dredge are described in Table 5-10. A list of metrics for the ponar dredge gear type is presented in the OU 1 BRA (ABB-ES, 1994a). Total taxa was lowest at 2-Bio-2 (6) and 2-Bio-3 (9) and highest at RC-Bio-8A (33). The upstream reference locations had total taxa of 31 and 21 at RC-Bio-4 and RC-Bio-5, respectively.

The number of individuals was lowest at 2-Bio-3 (287 per square meter [m^2]) and RC-Bio-10 (903/m^2) and highest at RC-Bio-5 (7,826/m^2). Abundance was not very high at the other reference location RC-Bio-4 (2,766/m^2), with three other stations, RC-Bio-8 (1,247/m^2), 2-Bio-2 (1,849/m^2), and RC-Bio-7 (2,136/m^2) having lower numbers and the remaining stations having higher abundance.

The Florida index was low at 2-Bio-2 (1), RC-Bio-5(1), 2-Bio-3 (2), and RC-Bio-7 (2). All other stations were higher than the RC-Bio-5 reference but had low overall scores (range of 4 to 6).

The Shannon-Weaver index was low at 2-Bio-2 (1.574) compared to RC-Bio-4 (3.702) and RC-Bio-5 (2.284). The indices for all other stations were within the values for the reference locations.

The percent of EPT individuals, which comprise the most sensitive taxa, was low at all stations. This is not uncommon when the ponar is used to sample the community. These taxa are more common on cobble and gravel substrate in riffle habitat or on woody debris. The highest value was RC-Bio-10 (3.2 percent), followed by RC-Bio-8A (2.4 percent). All other stations comprised 1 percent or fewer EPT individuals in the community.

The Hilsenhoff biotic index had little variability between stations ranging from 6.9 at RC-Bio-10 to 8.9 at RC-Bio-7. On a scale of 1 to 10, with low values indicative of good community quality, the stations at NAS Cecil Field are all classified as being below average, based on the infaunal benthic community.

OU 1 Fish Sampling Results. Eight fish species from six families were collected from OU 1 and upstream of OU 1, including the coastal shiner, *Notropis petersonis*, tadpole madtom, *Noturus gyrinus*, eastern mosquitofish, *Gambusia holbrooki*, the brook silverside, *Labidesthes sicculus*, redbreast sunfish, *Lepomis auritus*, the bluegill, *Lepomis macrochirus*, largemouth bass, *Micropterus salmoides*, and the blackbanded darter, *Percina nigrofasciata*. Abundance of each species at each collecting station ranged from three to seven. The length and weight ranges for all fish collected are listed in Appendix P of the OU 1 BRA (ABB-ES, 1994a). The fish collected were primarily juvenile or small species of fish (some adults) with consequently low biomass at most stations. Observations indicated the occurrence of blackspot on some specimens of golden shiner from RC-Bio-R1; this is a resting life stage of a fluke found on the skin and fins of fish and is common in many water bodies (EA, 1994a).

Summary of Aquatic Studies Results for OU 1. In summary, 2-Bio-2 and 2-Bio-3 exhibited notable differences in water quality and habitat. The surface water column at these sampling stations contained an orange-rust colored flocculent material that also coated the bottom substrate. Bottom substrate composition was predominantly leaf mats compared to sand at the other locations. The presence of the material contributed to an overall lower habitat quality as compared to the regional reference and other Rowell Creek stations. It is difficult to discern from the ponar data whether the lower metric values at Site 2 are due to habitat differences, external influences, or a combination of the two. However, comparison of the impairment with the distribution of analytes detected in surface water yielded the following observations.

- Impairment of the benthic community was observed at locations with both high (510 $\mu g/\ell$) and low (36.8 $\mu g/\ell$) concentrations of aluminum in surface water.

- Impairment was also observed in the presence and absence of lead and cyanide in surface water.

- The benthic community metrics were not correlated with the concentrations of iron, aluminum, manganese, or barium or any ECPCs in surface water. Linear regressions were not possible for lead or cyanide as these were detected in only one sample.

The benthic community impairment may be a result of clogging of gills, physical impairment of movement and foraging of aquatic receptors, the prevention of light penetration and growth of algal food; a correlation was found between iron concentrations in sediment and responses in the bioassay.

5.2.1.2 **Operable Unit 2** Aquatic habitats at the Site 5 drainage ditch were characterized as part of the semi-quantitative macroinvertebrate survey completed in June and July 1993 (EA, 1994a; EA, 1994b). Sampling stations for Site 5 included 5-Bio-2 through 5-Bio-4, located in the drainage ditch adjacent to and downstream of Site 5, and the upstream reference station, 5-Bio-5 (Plate 2). Results were also compared to the Florida regional reference station, Five Mile Creek. Because aquatic habitat is not located at Site 17, aquatic sampling was not conducted.

The 1993 aquatic sampling effort focused on collection of information regarding the status of macroinvertebrate community structure and function in the Site 5 drainage ditch. Appendix C summarizes the objectives and scope of the study. Sampling methods and a description of the metrics used to characterize the benthic macroinvertebrate community are presented in Section 5.2 and Table 5-10, respectively.

A summary of the physical and chemical characterization scores for each sampling station at OU 2 is included in Appendix I of the OU 2 BRA (ABB-ES, 1995a). Most stations had fairly similar characteristics. All stations were located in forested areas with relatively poor aquatic habitat quality.

The Site 5 surface water quality measurements and values for total hardness, nitrate plus nitrite, total nitrogen, and total phosphorus are summarized in Table 5-13. Water depth was 0.5 m or less at all stations, and no flow or stream velocity was observed. Water temperatures ranged from 23.6 to 26.1 °C and pH ranged from 5.6 to 6.9. The DO values were all less than the Florida Water Quality Standard of $\geq$ 5 mg/ℓ (Florida Legislature, 1995), ranging from a low value of 0.4 mg/ℓ to a high of 3.4 mg/ℓ. The lowest DO concentrations were found at 5-Bio-4 and 5-Bio-5 (the upgradient reference station). Conductivity was highest at 5-Bio-4 (177 μmhos/cm) and was lowest at the upstream, reference

Table 5-13
Summary of OU 2, Site 5 Surface Water Quality Measurements

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Station	Depth (m)[1]	Temperature (°C)[1]	pH[1]	DO (mg/ℓ)[1]	Conductivity (μmhos/cm)[1]	Secchi (m)[1]	Total Hardness (mg/ℓ as $CaCO_3$)[2]	Total Kjeldahl Nitrogen (mg/ℓ)[2]	Nitrate plus Nitrite (mg/ℓ)[2]	Total Nitrogen (mg/ℓ)[2]	Total Phosphorus (mg/ℓ)[2]
5-SW-1[3]	NA	NA	NA	NA	NA	NA	19.2	1.69	0.04	1.73	0.16
5-BIO/SW-2	0.3	26.1	5.6	3.4	99	0.30	17.8	1.86	0.69	2.55	0.17
5-BIO/SW-3	0.2	24.5	6.8	1.0	120	0.20	9.8	1.25	0.03	1.28	0.12
5-BIO/SW-4	0.2	23.6	6.9	0.4	177	0.20	25.8	1.56	ND	1.56	0.23
5-BIO/SW-5	0.5	24.1	6.0	0.8	91	0.50	8.5	0.88	0.02	0.90	0.08
5-SW-6[3]	NA	NA	NA	NA	NA	NA	45.2	1.67	0.14	1.81	0.07
5-SW-7[3]	NA	NA	NA	NA	NA	NA	61.2	2.87	0.33	3.12	0.09
Five Mile Creek[4]	1	23	4.4	5.8	62	0.3	NA	NA	NA	NA	NA

[1] From Appendix I, OU 2 BRA (ABB Environmental Services, Inc. [ABB-ES], 1995). Measured in the field by EA Engineering, Science, and Technology, Inc.
[2] From Appendix A, OU 2 BRA (ABB-ES, 1995). Measured in the laboratory.
[3] Although no macroinvertebrate data were collected at these wetland stations, water quality parameters are included in this table for regional perspective.
[4] Five Mile Creek is the Florida regional reference station considered in this study.

Notes: OU = operable unit.
m = meter.
°C = degrees Celsius.
DO = dissolved oxygen.
mg/ℓ = milligrams per liter.
μmhos/cm = micromhos per centimeter (a measure of electrical conductivity, equal to μohm -1).
$CaCO_3$ = calcium carbonate.
NA = not available.
ND = no data.
BRA = baseline risk assessment.

location (91 μmhos/cm). All measurements of conductivity fall within the normal range according to State of Florida Surface Water Quality Standards (Florida Legislature, 1995).

Water clarity was clear at all stations evaluated and aquatic vegetation was observed only at station 5-Bio-2, with 10 percent aquatic vegetation. Leaf pack was a major component of the substrate at all sampling stations in the Site 5 drainage ditch, ranging from 50 to 80 percent. Station 5-Bio-2 also contained slightly more mud, muck, or silt than other evaluated stations. Periphyton were rarely found at any of the Site 5 drainage ditch stations.

Table 5-14 presents habitat assessment scores for Site 5 derived from this study. Habitat quality at all Site 5 drainage ditch stations is generally poor, due primarily to the lack of flow in the channel, poor bottom substrate, and lack of aquatic macrophytic vegetation. The one upgradient reference station, 5-Bio-5, scored 28 in the habitat assessment scoring. Although this is less than half of the regional reference station (Five Mile Creek, total score = 72), the reference station habitat quality is comparable to the downstream Site 5 drainage ditch stations (5-Bio-2, 5-Bio-3, and 5-Bio-4), which had habitat quality scores ranging from 28 to 37.

A taxonomic list of the benthic macroinvertebrates collected is presented in Appendix A-7. Identified taxa were collected from the drainage ditch stations using a combination of dip net and Ponar samplers. Fish were not collected from OU 2 sampling stations.

<u>OU 2 Dip Net Sampling Results</u>. Methods used in the sampling effort are described above, and metrics used to characterize the benthic macroinvertebrate community are presented in Table 5-10. A list of metrics is also included in the OU 2 Baseline Risk Assessment (ABB-ES, 1995a). Examination and interpretation of the metric scores does not show any trends in the data or pattern of degradation with distance downstream from Site 5. Most of the metric values are similar to those calculated for the upstream reference (5-Bio-5) or the Five Mile Creek reference. Taxa richness is similar across all of the Site 5 stations and is lowest at the upstream location (5-Bio-5). The metric scores for the Hilsenhoff biotic index and Chironomid taxa were similar across the stations and were also similar to those values calculated for the Five Mile Creek regional reference. There is a lower proportion of shredders at locations 5-Bio-5 and 5-Bio-2 than the stations further downstream (5-Bio-3 and 5-Bio-4).

The metric values were assigned bioassessment ranking scores and total metric scores were calculated for each station. Total scores ranged from lows of 8 at 5-Bio-5 (the upgradient reference station) and 14 at 5-Bio-4 to a high of 22 at 5-Bio-2. The low DO levels at 5-Bio-5 may help explain the low total metric score. These scores were compared to the reference locations. The State of Florida regional reference, Five Mile Creek, was selected and used for all station comparisons. An upstream station (5-Bio-5) was used as an upstream reference. The regional reference station, Five Mile Creek, has better habitat quality than the Site 5 sampling stations. Direct comparisons of data from this regional reference with the Site 5 stations should be made carefully in consideration of this factor. It was not possible to find a regional reference station with similar habitat quality. Comparisons with the regional reference were made for the purpose of putting the Site 5 results in perspective with results for other streams in Florida. Emphasis is, however, placed on comparisons between the Site 5 stations and the upstream reference for drawing conclusions concerning potential impacts relative to Site 5.

Table 5-14
Habitat Assessment Scores, Operable Unit 2, Site 5

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Station	Bottom Substrate	Water Velocity	Artificial Channel	Bank Stability	Riparian Zone Vegetation	Flow Adjustment	Total Score	Percent Comparison to Five Mile Creek
5-BIO-2	5	0	12	8	5	--	30	41.7
5-BIO-3	7	0	12	5	4	--	28	38.9
5-BIO-4	15	2	12	3	5	--	37	51.4
5-BIO-5	5	0	12	8	3	--	28	38.9
Five Mile Creek[1]	24	8	15	10	10	5	72	100

[1] Five Mile Creek is the Florida regional reference station considered in this study.

Note: -- = not measured.

The relationship between habitat quality and biological condition among all stations at Site 5 is illustrated as a line graph in Figure 5-2. The only Site 5 drainage ditch station that falls within the predictable condition of the biological community in consideration of habitat quality is Station 5-Bio-3.

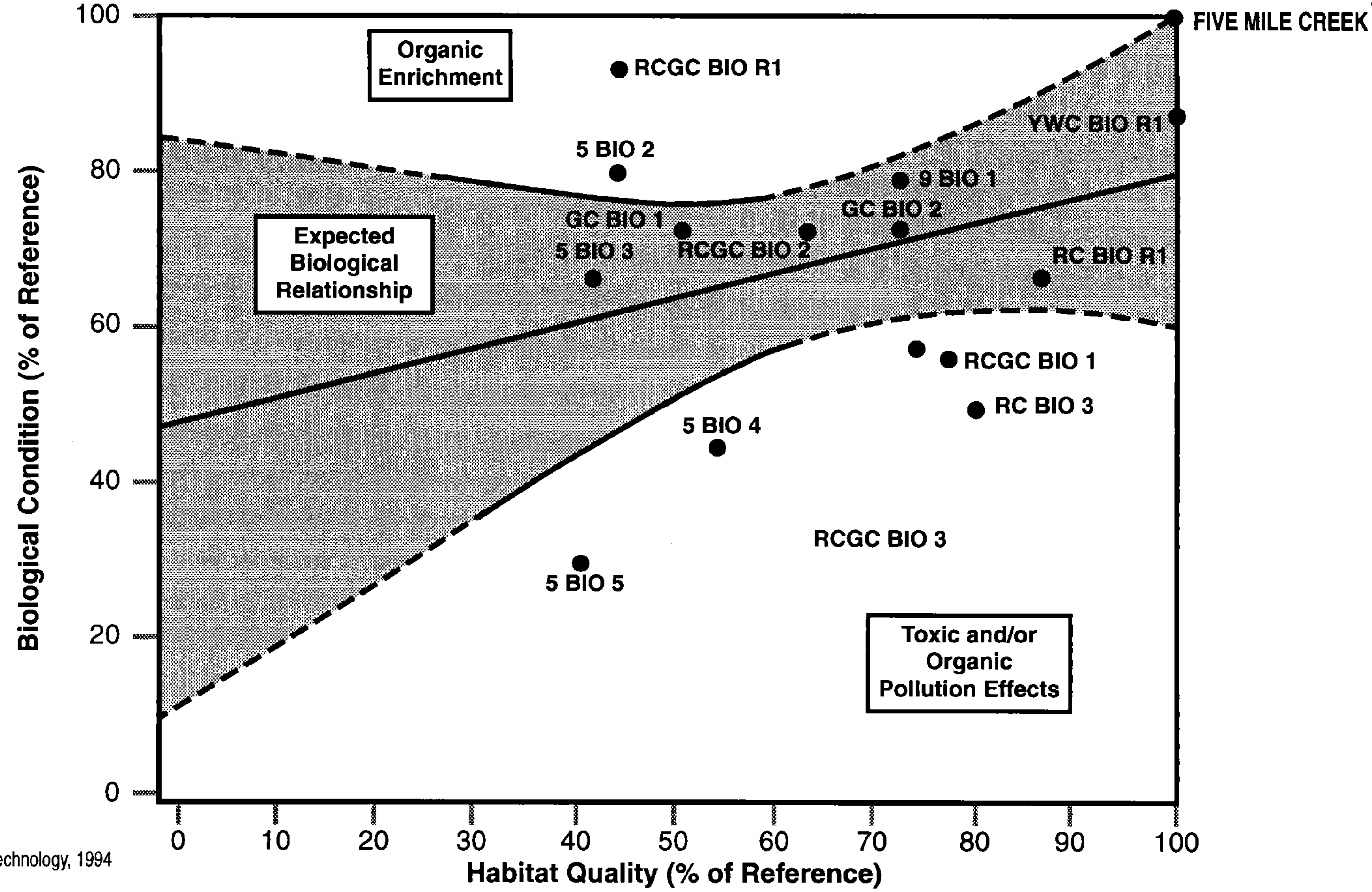
Station 5-Bio-2 exhibited a higher condition of the benthic community than would be expected based on the quality of the habitat present. Stations 5-Bio-4 and 5-Bio-5 fell just below the lower 95 percent confidence interval. The macroinvertebrate community appears to be below the condition expected for the quality of the habitat present.

OU 2 Ponar Sampling Results. Methods used in this sampling effort are described above, and descriptions of metrics are presented in Table 5-10. A complete list of metrics is included in the OU 2 BRA (ABB-ES, 1995a). Because no State of Florida regional reference exists for this gear type, all comparisons were made to the upstream reference station, 5-Bio-5.

Total taxa were low at 5-Bio-5 (5), 5-Bio-4 (10), and 5-Bio-2 (13). The greatest number of total taxa from the Site 5 drainage ditch were found at 5-Bio-3, with 25 taxa represented. Density was lowest at 5-Bio-5 ($143/m^2$). Density was low at station 5-Bio-2 with $702/m^2$, whereas stations 5-Bio-3 and 5-Bio-4 had $1,691/m^2$ and $1,247/m^2$, respectively. The Florida index was lowest at 5-Bio-5 (2) and 5-Bio-4 (2). The other two stations (5-Bio-2 and 5-Bio-3) were somewhat higher at 3 and 5, respectively. Diversity as measured by the Shannon-Weaver index was lowest at 5-Bio-5 (2.246) and 5-Bio-4 (1.973). Density for stations 5-Bio-2 and 5-Bio-3 was slightly higher at 2.807 and 3.116, respectively.

The Hilsenhoff biotic index had little variability between stations ranging from a low of 7.3 at 5-Bio-5 (the upgradient reference station) to 9.4 at 5-Bio-4. Chironomids dominated the benthic community at 5-Bio-2 (75.5 percent) compared to the other Site 5 stations, which ranged from 20.0 percent to 43.2 percent. Percent Chironomid taxa decreased with distance downstream of Site 5 and was lowest at the upstream station (5-Bio-5). Percent dominant taxon at Stations 5-Bio-2 and 5-Bio-3 were similar and comparable to the upstream reference. The metric value was higher at Station 5-Bio-4 at 60.9 percent.

Summary of Aquatic Studies Results for OU 2. A review of the macroinvertebrate habitat quality parameter data suggests that habitat quality conditions throughout this OU 2 drainage ditch, including the upstream reference station, represent a poor environment for many types of aquatic organisms. The generally poor habitat quality observed at the upstream reference station limits the interpretation of the benthic results. Taxa identified within the Site 5 drainage ditch indicate a stressed environment. Comparison of the metrics between the Site 5 sampling stations indicates no clear trends in data with the exception of percent Chironomid taxa. Percent Chironomid taxa decreases with distance downstream of Site 5 and is lowest at the upstream station (5-Bio-5). A benthic community dominated by Chironomid taxa is characteristic of a stressed benthic community. Based on the metrics calculated for the dip net samples, the benthic communities at Stations 5-Bio-04 and 5-Bio-5 are below their respective expected condition relative to the quality of habitat present. Station 5-Bio-03 is within the expected condition given that the habitat quality and the condition of the benthic community at Station 5-Bio-02 is above the expected condition.



SOURCE:
EA Engineering, Science, and Technology, 1994

NOTES:
NAS = Naval Air Station
YWC = Yellow Water Creek
RC = Rowell Creek
BIO = Aquatic biological sampling station
GC = Golf course

KEY:
- - - - = Expected Relationship
——— = Estimated Relationship

FIGURE 5-2
RELATIONSHIP BETWEEN HABITAT QUALITY AND BIOLOGICAL CONDITION, OPERABLE UNITS (OUs) 2 AND 6

BASEWIDE ECOLOGICAL ASSESSMENT REPORT

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

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It could not be concluded that contamination in surface water or sediment from Site 5 was contributing to the decreased condition observed at the downstream sampling station. The only trend in community structure was a decrease in the percent of the taxa as Chironomids with distance downstream of the site.

5.2.1.3 **Operable Unit 3** Aquatic habitats near Site 8 were characterized as part of the facilitywide field survey completed in June and July 1993 (EA, 1994a; EA, 1994b), and focused on the status of macroinvertebrate community structure and function and fish species at Site 8. Appendix C summarizes the objectives and scope of this study. Sampling methods and a description of the metrics used for this study are presented above in Section 5.2 and Table 5-10, respectively. Site 7 at OU 3 does not include aquatic habitats. Sampling stations for Site 8 included 8-Bio-1 (Plate 2), located in a tributary adjacent to and northwest of Site 8, and 8-Bio-2, located downstream of 8-Bio-1. Both stations were located in forested areas. Petroleum sediment odor was present at 8-Bio-2 and sediment had a moderately oily texture. Sand was the major substrate type (60 percent), with detritus constituting most of the remainder (35 percent). Surface water had odor, and no oily sheen was noted. Habitat quality was generally low at 8-Bio-2.

The Site 8 surface water quality measurements are presented in Table 5-15. Water depth was 0.2 m at both stations, and no flow or stream velocity was observed. Water temperatures ranged from 26 to 26.6 °C and pH ranged from 6.3 to 6.4. The DO values were all less than the Florida Water Quality Standard of ≥5 mg/ℓ (Florida Legislature, 1995), ranging from a 2.8 mg/ℓ (at 8-Bio-2) to 5.3 mg/ℓ (at 8-Bio-1). Conductivity was 7.6 μmhos/cm at 8-Bio-8, and 6.7 μmhos/cm at 8-Bio-2. All measurements of conductivity fall within the normal range according to State of Florida Surface Water Quality Standards (Florida Legislature, 1995).

Water clarity was turbid at 8-Bio-1, but clear at 8-Bio-2. No aquatic vegetation was observed at 8-Bio-2, but aquatic macropohytes were common at 8-Bio-1. Table 5-16 presents habitat assessment scores for Site 8. Habitat quality at the Site 8 sampling stations is generally poor, due primarily to the lack of flow in the channel, poor bottom substrate, and lack of aquatic vegetation. The habitat assessment score for 8-Bio-2 was higher overall (34) than for 8-Bio-1 (29). Neither of the Site 8 habitat assessment scores was greater than half that of the regional reference station (Five Mile Creek, total score = 72).

A taxonomic list of the benthic macroinvertebrates collected is presented in Appendix A-7. Identified taxa were collected from the stations using a combination of dip net and Ponar samplers. Although fish are commonly observed at the Site 8 stations, none were collected at the Site 8 stations. Fish collected in Rowell Creek during the 1993 sampling event are listed in Appendix A-2.

<u>OU 3 Dip Net Sampling Results</u>. Methods used in the sampling effort are described above and metrics applied to analysis are presented in Section 5.2 and Table 5-10, respectively. A complete description of metrics for the dip net gear type is included in the EA's report (EA, 1994b). The overall trend for Site 8 stations is low, as compared to the two reference stations, with 8-Bio-2 showing the most difference. Taxa richness is less at the Site 8 stations than the State regional reference station (Five Mile Creek); 8-Bio-2 showed the lowest taxa richness (8). The metric scores for the Hilsenhoff biotic index and Chironomid taxa were similar across the stations and were also similar to those values

Table 5-15
Summary of OU 3, Site 8 Surface Water Quality Measurements

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Station	Depth (m)[1]	Temperature (°C)[1]	pH[1]	DO (mg/ℓ)[1]	Conductivity (μmhos/cm)[1]	Secchi (m)[1]	Total Hardness (mg/ℓ as $CaCO_3$)[2]	Nitrate plus Nitrite (mg/ℓ)[2]	Total Nitrogen (mg/ℓ)[2]	Total Phosphorus (mg/ℓ)[2]
8-Bio-1	0.2	26.6	6.3	5.3	67	0.20	NA	NA	NA	NA
8-Bio-2	0.2	26.0	6.4	7.8	76	0.20	NA	NA	NA	NA

[1] From EA Engineering, Science, and Technology Addendum (EA 1994b). Measured in the field.
[2] Measured in the laboratory.

Notes: OU = operable unit.
m = meter.
°C = degrees Celsius.
DO = dissolved oxygen.
mg/ℓ = milligrams per liter.
μmhos/cm = micromhos per centimeter (a measure of electrical conductivity).
$CaCO_3$ = calcium carbonate.
NA = not available; will be provided when field work is completed.

Table 5-16
Habitat Assessment Scores, OU 3, Site 8

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Station	Bottom Substrate	Water Velocity	Artificial Channel	Bank Stability	Riparian Zone Vegetation	Flow Adjustment	Total Score	Percent Comparison to Reference
8-Bio-1	3	1	13	9	4	--	29	43.3
8-Bio-2	5	1	13	9	6	--	34	50.7
Five Mile Creek[1]	24	8	15	10	10	5	72	100

[1] Five Mile Creek is the Florida regional reference station considered in this study.

Notes: OU = operable unit.
-- = not measured.

calculated for the Five Mile Creek regional reference. There is a higher proportion of shredders at locations 8-Bio-1 and 8-Bio-2 than at either of the reference stations. No filterer-collectors were identified for either of these stations.

The metric values were assigned bioassessment ranking scores and total metric scores were calculated for each station. Total scores ranged from lows of 12 and 18 at 8-Bio-1 and 8-Bio-2, respectively, to 28 at Five Mile Creek. The low DO levels provide an explanation for the low total metric score at the Site 8 stations. Direct comparisons of data from the regional reference with the Site 8 stations should be made carefully in consideration of this factor. It was not possible to find a regional reference station with similar habitat quality. Comparisons with the regional reference were made for the purpose of putting the Site 8 results in perspective with results for other streams in Florida.

The relationship between habitat quality and biological condition among Site 8 stations is illustrated as a line graph on Figure 5-3. Station 8-Bio-1 falls within the predictable condition of the biological community in consideration of habitat quality, while 8-Bio-2 fell just below the lower 95 percent confidence interval, indicating a slight depression of biological condition.

OU 3 Ponar Sampling Results. Methods used in this sampling effort are described in Section 5.2, and descriptions of metrics are presented in Table 5-10. A complete description of metrics is included in EA's report (EA, 1994b). No State of Florida regional reference exists for this gear type.

Total taxa were lower at 8-Bio-2 (n = 8) compared to 8-Bio-1 (n = 13). Density was comparable at both Site 8 stations (about $400/m^2$]. The Florida index was 3 at 8-Bio-1 and 1 at 8-Bio-2. Diversity as measured by the Shannon-Weaver index was lower at 8-Bio-2 (2.394), compared to 8-Bio-1 (3.386).

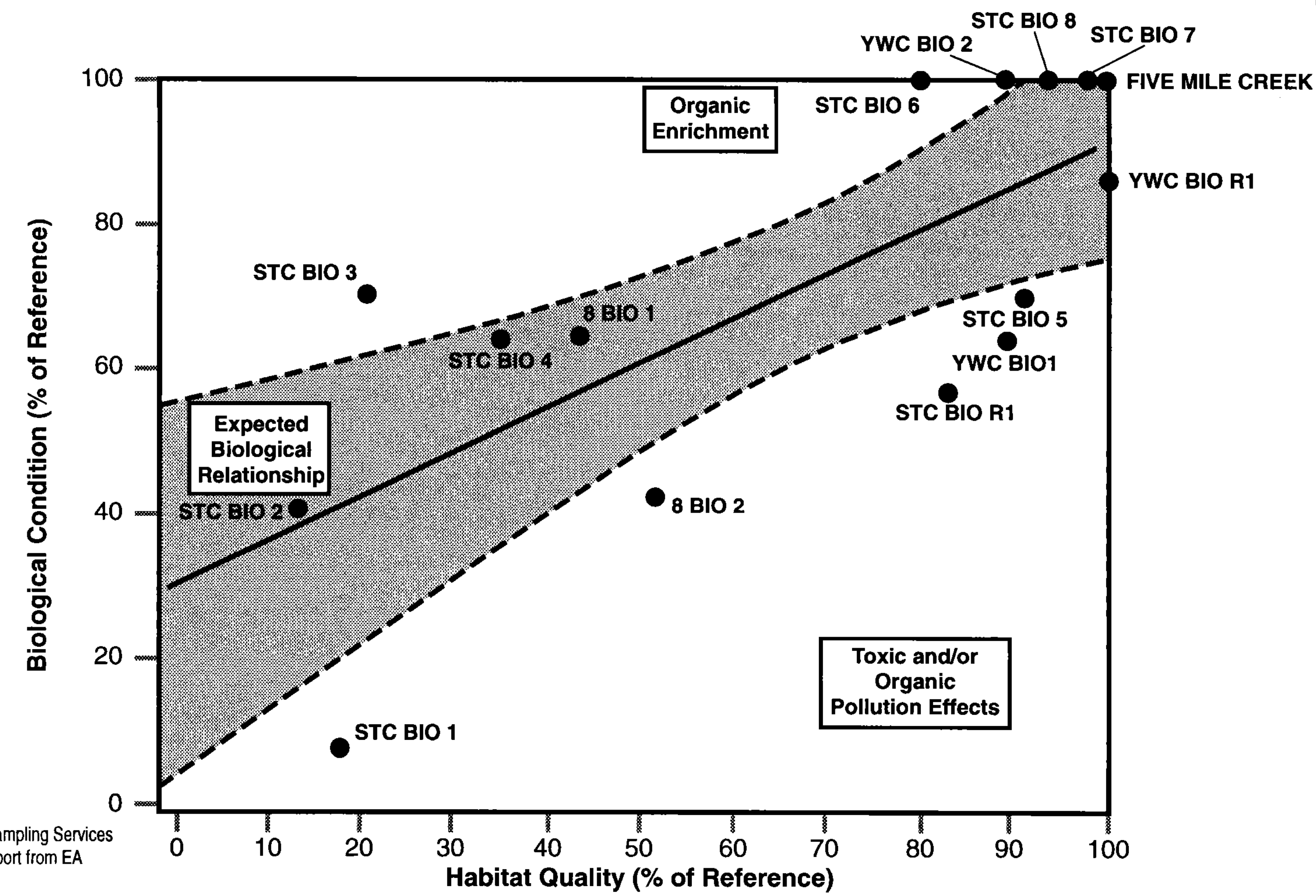
The Hilsenhoff biotic index had little variability between stations ranging from a low of 7.0 at 8-Bio-1, to the 8-Bio-2 value of 9.1. Chironomids and Diptera dominated the benthic communities at the two Site 8 sampling stations (between 37 and 47 percent for each group at each station).

Summary of Aquatic Studies Results for OU 3. A review of the macroinvertebrate habitat quality parameter data suggests that habitat quality conditions at the downstream station represent a poor environment for many types of aquatic organisms. Comparison of the metrics between the Site 8 sampling stations indicates no clear trends in data, although there are some indicators of increased stress at 8-Bio-2. The petroleum sediment odor at 8-Bio-2 may be a factor influencing the community at this location.

5.2.1.4 **Operable Unit 4** Biological sampling was not completed at OU 4, Site 10. Samples collected in Rowell Creek east of Site 10 were analyzed as part of the benthic macroinvertebrate study conducted by EA (1994a) for OU 1.

5.2.1.5 **Operable Unit 5** Due to the lack of aquatic habitat, biological sampling was not completed at OU 5, Sites 14 and 15.

5.2.1.6 **Operable Unit 6** Aquatic habitats near Site 11 were characterized as part of the facilitywide field survey completed in June and July 1993 (EA, 1994a), which focused on the status of the macroinvertebrate community structure



SOURCE:
Addendum to Aquatic Biological Sampling Services Conducted at NAS Cecil Field, Report from EA Engineering, June 1994.

NOTES:
NAS = Naval Air Station
YWC = Yellow Water Creek
BIO = Aquatic biological sampling station
STC = Sal Taylor Creek

KEY:
- - - - = Expected Relationship
——— = Estimated Relationship

FIGURE 5-3
RELATIONSHIP BETWEEN HABITAT QUALITY AND BIOLOGICAL CONDITION, OPERABLE UNITS (OUs) 3 AND 7

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

BASEWIDE ECOLOGICAL ASSESSMENT REPORT

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

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and function and fish species at Site 11. Appendix C summarizes the objectives and scope of this study. Sampling methods and a description of the metrics used for this study are presented above in Section 5.2 and Table 5-10, respectively. Sampling stations for Site 11 include GC-Bio-1, located in a tributary draining the Golf Course and downstream of the pesticide tank rinse area, and GC-Bio-2, located downstream of GC-Bio-1 (Plate 2). The riparian zone of GC-Bio-2 was predominantly forested, as was the upstream reference station for Site 11 (RCGC-Bio-R1). Sand was the major substrate type. Surface water had no odor, and no oily sheen was noted.

The Site 11 surface water quality measurements are summarized in Table 5-17. Water depth was similar at Site 11 stations (0.2 meters at station GC-Bio-1, and 0.5 meters at station GC-Bio-1). Minimal velocity was observed at all Site 11 stations. Water temperatures ranged from 25.1 to 27.5 °C and pH was similar at both stations. The DO value for GC-Bio-1 (4.2 mg/ℓ) was less than the Florida Water Quality Standard of ≥5 mg/ℓ (Florida Legislature, 1995), while that of GC-Bio-2 slightly exceeded the standard value. Conductivity was 144 μmhos/cm at GC-Bio-1, and 186 μmhos/cm at GC-Bio-2. All measurements of conductivity fall within the normal range according to State of Florida Surface Water Quality Standards (Florida Legislature, 1995).

Water clarity was clear at both Site 11 stations. No aquatic vegetation was observed at GC-Bio-2, but aquatic macropohytes and periphyton were abundant at GC-Bio-1.

Table 5-18 presents habitat assessment scores derived for Site 11. Habitat quality at the Site 11 sampling stations is generally poor; habitat assessment scores were lower for both locations as compared to the regional reference station (Five Mile Creek, total score = 72). However, aquatic vegetation was common at station GC-Bio-1. Habitat assessment scores were not provided in the study for RCGC-Bio-R1.

A taxonomic list of the benthic macroinvertebrates collected is presented in Appendix A-7. Identified taxa were collected from the stations using a combination of dip net and Ponar samplers. No fish were observed at GC-Bio 1. One species of fish was collected at GC-Bio-2; twenty-three brook silverside (*Labidesthes sicculus*) were netted, ranging in length from 36 to 56 millimeters, and all weighing less than 0.5 gram. Additional fish species observed at Cecil Field sampling stations are listed in Appendix A-2.

<u>OU 6 Dip Net Sampling Results</u>. Methods used in the sampling effort are described in Section 5.2, and metrics applied to analysis are presented in Table 5-10. A complete discussion of the metrics for the dip net gear type are presented in the EA report (EA, 1994b). The overall trend for OU 6 stations is similar, as compared to the two reference stations. Taxa richness is slightly higher (32) at the State regional reference station (Five Mile Creek), and the other three stations had similar values (24 for each of GC-Bio-1 and GC-Bio-2, and 21 for RCGC-Bio-R1. The metric scores for the Hilsenhoff biotic index, EPT index, and Chironomid taxa were similar across the all four stations. Percent dominant taxa were higher at the two Site 11 stations and RCGC-Bio-R1, as compared to Five Mile Creek values. Similar values were found for the proportion of shredders at the two Site 11 stations and RCGC-Bio-R1, while Five Mile Creek had a higher value. Percent filterer-collectors values for RCGC-Bio-R1 exceeded those for the stations at OU 6.

Table 5-17
Summary of OU 6, Site 11 Surface Water Quality Measurements

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Station	Depth (m)[1]	Temperature (°C)[1]	pH[1]	DO (mg/ℓ)[1]	Conductivity (µmhos/cm)[1]	Secchi (m)[1]	Total Hardness (mg/ℓ as $CaCO_3$)[2]	Nitrate plus Nitrite (mg/ℓ)[2]	Total Nitrogen (mg/ℓ)[2]	Total Phosphorus (mg/ℓ)[2]
GC-Bio-1	0.2	25.1	6.4	4.2	144	0.20	NA	NA	NA	NA
GC-Bio-2	0.5	27.5	7.0	5.6	186	0.90	NA	NA	NA	NA

[1] From EA Engineering, Science, and Technology Addendum, (EA 1994b). Measured in the field.
[2] Measured in the laboratory.

Notes: Surface water quality measurements are not available for the reference station, RCGC-Bio-R1.
OU = operable unit.
m = meter.
°C = degrees Celsius.
DO = dissolved oxygen.
mg/ℓ = milligrams per liter.
µmhos/cm = micromhos per centimeter (a measure of electrical conductivity).
$CaCO_3$ = calcium carbonate.
NA = not available; will be provided when field work is completed.

Table 5-18
Habitat Assessment Scores, OU 6, Site 11

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Station	Bottom Substrate	Water Velocity	Artificial Channel	Bank Stability	Riparian Zone Vegetation	Flow Adjustment	Total Score	Percent Comparison to Five Mile Creek [1]
GC-Bio-1	16	5	3	9	2	--	35	52.2
GC-Bio-2	20	3	12	6	8	--	49	73.1
Five Mile Creek	24	8	15	10	10	5	72	100

[1] Five Mile Creek is the Florida regional reference station considered in this study. Methods for sampling and habitat scoring procedures are discussed in Section 5.2.

Notes: Habitat scores for the reference station, RCGC-Bio-R1, are not available.
OU = operable unit.
-- = not measured.

The metric values were assigned bioassessment ranking scores and total metric scores were calculated for each station. Total scores were equal for both GC-Bio-1 and GC-Bio-2 (20), and were less than the scores of 26 at RCGC-Bio-R1 and 28 at Five Mile Creek. Although scores were slightly higher for Five Mile Creek, direct comparisons of data from the regional reference with the Site 11 stations should be made carefully in consideration of lower DO values at Site 11. It was not possible to find a regional reference station with similar habitat quality. Comparisons with the regional reference were made for the purpose of putting the Site 11 results in perspective with results for other streams in Florida.

The relationship between habitat quality and biological condition among Site 11 stations is illustrated as a line graph on Figure 5-2. Stations GC-Bio-1 and BC-Bio-2 both fall within the predictable condition of the biological community in consideration of habitat quality, while RCGC-Bio-R1 exceeded the 95 percent confidence interval, closely approximating the condition at Five Mile Creek. The two reference stations are believed to be organically enriched, and not comparable in this regard to most NAS Cecil Field stations.

OU 6 Ponar Sampling Results. Methods used in this sampling effort are described in Section 5.2, and descriptions of metrics are presented in Table 5-10. A complete discussion of the metrics for the ponar dredge gear type are presented in the EA report (EA, 1994b). Because no State of Florida regional reference exists for this gear type, all comparisons were made to the upstream reference station, RCGC-Bio-R1.

Total taxa were similar at both Site 11 stations (GC-Bio-1 = 26, GC-Bio-1 = 34); RCGC-Bio-R1 showed a total taxa value of 42, higher than any other station sampled in the watershed at NAS Cecil Field, suggestive of increased water quality or suitability. Density was lowest at GC-Bio-2 (1663/m^2) and increased to 6,034/m^2 at GC-Bio-1. Density at RCGC-Bio-R1 was unusually higher than any other station sampled in the NAS Cecil Field watershed, with a density of 11,624/m^2. The Florida index was highest at RCGC-Bio-R1 (12) of all stations sampled at NAS Cecil Field, as compared to 5 at GC-Bio-1 and 6 at GC-Bio-2. Diversity as measured by the Shannon-Weaver index was highest at GC-Bio-1 (4.151); GC-Bio-2 (3.696) was comparable to RCGC-Bio-R1 (3.627).

The Hilsenhoff biotic index had little variability between stations ranging from a low of 6.8 at GC-Bio-2, to 7.3 at GC-Bio-1 and 7.4 at RCGC-Bio-R1. These data reflect little or no difference in pollution tolerance of the benthic arthropod community at the three sampling stations. Chironomids and dipterids dominated the benthic communities at the two Site 11 sampling stations (39 to 55 percent each) and were lower than RCGC-Bio-R1 (between 62 and 68 percent).

OU 6 Hester-Dendy Sampling Results. Methods used for this sampling technique are presented above in Section 5.2, and the metrics are described in Table 5-10. A complete description of the metrics for this gear type is provided in the EA report (EA, 1994b). The total number of taxa was similar at both Site 11 stations (21 at GC-Bio-1 and 15 at GC-Bio-2); RCGC-Bio-R1 showed 23, and Five Mile Creek showed comparatively higher species richness (30). Percent of the chironomid and dipterid species were similar at both Site 11 stations, but less than both of the reference stations. Percent pollution-sensitive species was high (percent EPT = 12.5 percent) at GC-Bio-1, as compared to 1.4 percent EPT at RCGC-Bio-R1. Calcium dependent species were dominant at GC-Bio-1 (74.3 percent as compared to 10.2 percent at RCGC-Bio-R1), indicative of higher alkalinity at the upstream Site 11 station.

The Florida index was lower at both Site 11 stations (GC-Bio-1 = 4; GC-Bio-2 = 3) and the reference station, RCGC-Bio-R1 (6) than that at Five Mile Creek (15). The Hilsenhoff biotic index values and Shannon-Weaver index obtained in Hester-Dendy samples were similar for all stations at OU 6, including the references stations.

No trends were identified for OU 6 sampling stations by Hester-Dendy sampling efforts. The artificial substrate sampling showed little overall differences among Site 11 stations and RCGC-Bio-R1.

Summary of Aquatic Studies Results for OU 6. A review of the macroinvertebrate habitat quality parameter data suggests that habitat quality conditions at Site 11 stations (GC-Bio-1 and GC-Bio-2) are acceptable. These stations do not appear to be adversely impacted by surface water run-off from the golf course. Station RCGC-Bio-R1 was not representative of most stations sampled at NAS Cecil Field, due to low habitat quality and dense growth of aquatic macrophytes. The unusually high scores for some of the metrics evaluated for this reference station may be due to these unique habitat characteristics.

5.2.1.7 Operable Unit 7 Aquatic habitats near Site 16 were characterized as part of the facility-wide field survey completed in June and July 1993 (EA, 1994a). The study focused on the status of macroinvertebrate community structure and function and fish species in Sal Taylor Creek east of Site 16. Appendix C summarizes the objectives and scope of this study. Methods and a description of the metrics used for this study are presented above in Section 5.2 and Table 5-10, respectively.

Three sampling stations in the drainage ditches and one reference station in Sal Taylor Creek (STC-SW/SD/Bio/Tox-R1) were sampled (Plate 2). Two of the sampling stations (STC-SW/SD/Bio/Tox-1 and STC-SW/SD/Bio/Tox-3) were located in the two ditches east of Site 16 and west of Sal Taylor Creek. The two ditches are adjacent to storm sewers 1 and 2, located approximately 500 feet east of the runway. The drainage ditches extend 500 to 600 feet in length before they merge into one ditch where the third sampling station (STC-SW/SD/Bio-4) was located. The ditches receive stormwater drainage from the runway area and much of the developed area west of the runways (including OU 7). The ditches carry the stormwater approximately 2,400 feet to Sal Taylor Creek.

A summary of the physical and chemical characterization scores for each station sampled is included in Appendix P of the OU 7 BRA. All stations had fairly similar characteristics. However, due to differences in habitat, the reference location in Sal Taylor Creek (STC-Bio-R1) may not be suitable for comparison with drainage ditch parameters. All stations were located in open canopy areas except for the reference location, which was heavily shaded.

The surface water quality measurements for the Sal Taylor Creek and drainage ditch locations including total hardness, nitrate and nitrite, total nitrogen, and total phosphorus are summarized in Table 5-19. Water depth was 1.0 meter or

Table 5-19
Surface Water Quality Measurements Summary for OU 7, Site 16

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Station	Depth (m)[1]	Temperature (°C)[1]	Stream Velocity (m/s)	pH[1]	DO (mg/ℓ)[1]	Conductivity (μmhos/cm)[1]	Secchi (m)[1]	Total Hardness (mg/ℓ as $CaCO_3$)[2]	Total Kjeldahl Nitrogen (mg/ℓ)[2]	Nitrate/ Nitrite (mg/ℓ)[2]	Total Nitrogen (mg/ℓ)[2]	Total Phosphorous (mg/ℓ)[2]
STC-Bio/SW-1	0.5	25.7	0.0	5.8	4.3	92	1.0	21.2	1.62	0	1.62	0.06
STC-Bio/SW-3	0.3	26.5	<0.5	6.2	4.9	146	0.3	40.5	NA	NA	NA	NA
STC-Bio/SW-4	1.0	24.3	<0.5	5.9	3.4	125	1.0	37.9	NA	NA	NA	NA
STC-Bio/SW-R1	0.2	25.1	<0.5	6.3	3.7	169	0.2	87.9	1.09		1.09	0.09
Five Mile Creek[3]	1	23	0.1	4.4	5.8	62	0.3	NA	NA	NA	NA	NA

[1] From Appendix P OU 7 Baseline Risk Assessment (BRA ABB-ES, 1995). BRA Measured in the field by EA Engineering, Science, and Technology, Inc. (EA 1994b).
[2] From Appendix A, OU 7 BRA (ABB-ES 1995b). Measured in the laboratory. Total Kjeldahl nitrogen, nitrate plus nitrite, total nitrogen, and total phosphorous were not measured for STC-Bio/SW-3, STC-Bio-SW-4, and the Five Mile Creek regional reference.
[3] Five Mile Creek is the Florida regional reference station considered in this study.

Notes: OU = operable unit.
m = meter.
°C = degrees Celsius.
m/s = meter per second.
DO = dissolved oxygen.
mg/ℓ = milligrams per liter.
μmhos/cm = micromhos per centimeter (a measure of electrical conductivity, equal to $\mu ohm^{-1}/cm$).
$CaCO_3$ = calcium carbonate.
< = less than.
NA = not available.

less at all stations, water temperatures ranged from 24.3 to 26.5 °C, and pH ranged from 5.8 to 6.3. The DO values were less than the State of Florida surface water quality standard of ≥5 mg/ℓ (Florida Legislature, 1995) at the four Site 16 sampling locations (including the reference station), ranging from a low value of 3.4 mg/ℓ (STC-SW/Bio-4) to a high of 4.9 mg/ℓ (STC-SW/Bio-3). DO measurements at the storm sewer discharge locations (STC-SW/Bio-1 and STC-SW/Bio-3) were higher than the other two sampling stations.

Conductivity was highest at STC-SW/Bio-R1 (169 μmhos/cm) and lowest at STC-SW/Bio-1 (92 μmhos/cm). All measurements of conductivity fall within the normal range according to State of Florida surface water quality standards (Florida Legislature, 1995).

Water was clear at all stations. A viscous oily sheen was observed on the water surface at one station (STC-SW/Bio-1). Petroleum sediment odor was evident at two stations (STC-SD/Bio-1 and STC-SD/Bio-3). Fifty percent aquatic vegetation was observed at two stations (STC-SW/Bio-1 and STC-SW/Bio-4) and 75 percent aquatic vegetation was observed at one station (STC-SW/Bio-3). Aquatic vegetation was not observed at the reference location (STC-SW/Bio-R1). Leaf pack and mud, muck, or silt were observed as substrate components only at the reference station (STC-SW/Bio-R1).

Habitat assessment scores for Site 16 are presented in Table 5-20. Habitat quality at all Site 16 stations is generally poor. The upgradient reference station, STC-Bio-R1, scored 56 in the habitat assessment. Although this is less than the regional reference station at Five Mile Creek (total score of 72), the reference station (STC-Bio-R1) habitat quality is considerably higher than the Site 16 drainage ditch sampling stations (STC-Bio-1, STC-Bio-3, and STC-Bio-4), which had habitat quality scores ranging from 11 to 23. Although the habitats of the Sal Taylor Creek reference station (STC-Bio-R1) and Five Mile Creek regional reference station are comparable, the habitat assessment scores show that both the Sal Taylor Creek reference station and the Five Mile Creek regional reference location are vastly different from the drainage ditch stations and may not be suitable as reference locations for purposes of comparison. In addition, the drainage ditches are artificial, manmade channels, and the reference locations and the drainage ditch sampling locations are substantially different with regard to bottom substrate, water velocity, and vegetation.

A taxonomic list of the benthic macroinvertebrates collected is presented in Appendix A-7. Identified taxa were collected from the drainage ditch and reference station using a combination of dip net, Hester-Dendy, and Ponar samplers.

<u>OU 7 Fish Sampling Results</u>. Fish were collected with a 10-foot seine at sampling station STC-Bio-4 in the deepest section of the drainage ditch and at the reference location STC-Bio-R1. A total of two fish species were collected from the Site 16 fish sampling stations (STC-Bio-4 and STC-Bio-R1). Two eastern mosquitofish (*Gambusia affinis*) were collected at the reference location (STC-Bio-R1). Thirty-six eastern mosquitofish and four least killifish (*Heterandria formosa*) were collected at STC-Bio-4. As indicated by the length and weight data (Appendix P, OU 7 BRA), the fish collected were small species of fish with consequently low biomass. The most notable abnormality was the

Table 5-20
Habitat Assessment Scores, OU 7

Basewide Risk Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Station	Bottom Substrate	Water Velocity	Artificial Channel	Bank Stability	Riparian Zone Vegetation	Flow Adjustment	Total Score	Percent Comparison to Five Mile Creek [1]
STC-Bio-1	5	0	2	2	2	NA	11	16
STC-Bio-3	5	3	2	2	2	NA	14	21
STC-Bio-4	5	5	3	8	2	NA	23	34
STC-Bio-R1	18	10	14	8	6	NA	56	84
Five Mile Creek	24	8	15	10	10	5	72	100

[1] Five Mile Creek is the Florida regional reference station considered in this study. Methods for sampling and habitat scoring procedures are discussed in Section 5.2.

Notes: NA = not applicable.
OU = operable unit.

presence of eroded caudal fins on three specimens (out of 36 specimens) of eastern mosquitofish collected at sampling station STC-Bio-4. No physical abnormalities or deformities were observed on the fish collected from STC-Bio-R1.

OU 7 Dip Net Sampling Results. Methods used in the sampling effort are described in Section 5.2, and metrics applied to the analysis are presented in Table 5-10. A complete description of the metrics for the dip net gear type used in this study is presented in the EA report (EA, 1994b). Examination and interpretation of the metric scores do not show any trends in the data or a pattern of degradation with increased distance from Site 16. Most of the metric values are similar to those calculated for the reference location (STC-Bio-R1), but are quite different from the Five Mile Creek reference. With the exception of STC-Bio-1, which had the lowest score of 7, total taxa or taxa richness is similar across the Site 16 stations, with scores ranging from 14 (STC-Bio-R1) to 20 (STC-Bio-4). Total taxa at the Five Mile Creek station was 32. Invertebrate density at the Site 16 sampling stations varied widely, ranging from $14/m^2$ (STC-Bio-R1) to $420/m^2$ (STC-Bio-1). Density at the Five Mile Creek station was $824/m^2$. Percentage dominant taxon was higher at all Site 16 sampling stations as compared to the Five Mile Creek station. STC-Bio-1 was highest with a score of 64 and STC-Bio-4 was lowest with a score of 20. Percent dominant taxon at the Five Mile Creek station was 11.

The Florida index metric scores were similar for all four Site 16 sampling stations ranging from 2 at STC-Bio-1 to 6 at STC-Bio-3, but were all lower than the Five Mile Creek station, which had a score of 12. Diversity, as measured by the Shannon-Weaver index, was also similar for all Site 16 sampling stations ranging from 1.626 at STC-Bio-1 to 3.282 at STC-Bio-4. The Shannon-Weaver index at the Five Mile Creek station was higher than all Site 16 sampling stations at 4.5.

Percent diptera ranged from a low of 2 at STC-Bio-1 to a high of 87 at STC-Bio-4. The score at the Five Mile Creek station fell within this range at 21. Percent chironomid metric scores were similar to percent diptera scores ranging from 2 at STC-Bio-1 to 86 at STC-Bio-4. The score at the Five Mile Creek station was 20. The percentage of EPT was negligible at all four Site 16 sampling stations compared to 10 percent EPT at Five Mile Creek.

With the exception of station STC-Bio-3 (1 percent), filter-collectors were not identified at any of the Site 16 stations. The percentage of filter-collectors at the Five Mile Creek station was considerably higher at 10. Shredders did not occur at sampling station STC-Bio-1; the highest percentage of shredders occurred at STC-Bio-3 with a score of 37. The Five Mile Creek and Sal Taylor Creek reference stations fell within that range at 16 and 17, respectively. Percent calcium dependent scores, which were zero at STC-Bio-1 and 2 at STC-Bio-3 and STC-Bio-4, were lower than the Florida regional reference (18). STC-Bio-R1, however, had a higher score of 26.

The Hilsenhoff biotic index rates the community on a scale of 1 (low pollution tolerance; high quality) to 10 (high pollution tolerance; low quality). STC-Bio-1 had the lowest quality score at 9.9. The metric scores for the Hilsenhoff biotic index were similar across the other stations (6.2 to 7.7) and were also similar to the Five Mile Creek regional reference (6.9).

The metric values were assigned bioassessment ranking scores, and total metric scores were calculated for each station. Total scores ranged from a low of 2 at STC-Bio-1 to a high of 20 at STC-Bio-3. These scores were compared to both reference locations including the State of Florida regional reference, Five Mile Creek, and the reference station (STC-Bio-R1). The regional reference station, Five Mile Creek has substantially better habitat quality than the Site 16 sampling stations. Comparisons between the reference stations and the drainage ditches were conducted; however, due to differences in habitat and habitat quality, the results of the comparisons are inconclusive. The regional reference data are useful, however, to compare the Site 16 results with results for other streams in Florida.

The relationship between habitat quality and biological condition among all stations at OU 7 is illustrated as a line graph on Figure 5-3. The only Site 16 sampling station that falls within the predictable condition of the biological community in consideration of habitat quality is station STC-Bio-4. Station STC-Bio-3 exhibited a higher condition of the benthic community than would be expected, based on the quality of the habitat present. Station STC-Bio-R1 fell just below the lower 95 percent confidence interval indicating that the community is slightly impaired. Station STC-Bio-1 fell well below the lower 95 percent confidence interval, indicating that the community is impaired. The macroinvertebrate community at STC-Bio-1 appears to be below the condition expected for the quality of the habitat present. However, it is important to note that those results were plotted against the regional reference for a percent comparability value. Had the data been normalized against the Sal Taylor Creek reference station, it is possible that none of the drainage ditch locations would fall below the 95 percent confidence interval.

OU 7 Hester-Dendy Sampling Results. Hester-Dendy samplers were used at stations STC-Bio-1 and STC-Bio-4. Hester-Dendy data were not available for station STC-Bio-R1 because the sampler was exposed as a result of receding water levels. Given that the Hester-Dendy samplers were exposed due to low flow conditions and shallow water depth and that no standard of comparison exists, evaluation of the Hester-Dendy data was not conducted.

OU 7 Ponar Sampling Results. Methods used for this analysis are presented in Section 5.2, and descriptions of metrics are presented in Table 5-10. A complete description of metrics used in the study is provided in the EA report (EA, 1994b). Ponar dredge samples were taken at all Site 16 sampling stations (STC-Bio-1, STC-Bio-3, and STC-Bio-4). Because no State of Florida regional reference exists for this type of sampling equipment, all comparisons were made to reference station STC-Bio-R1.

Total taxa was lowest at STC-Bio-1 with a score of 4. The remaining two ponar dredge sampling stations had similar scores (10 and 17), but were still lower than the reference (STC-Bio-R1), which had a score of 24. Density was lowest at STC-Bio-1 at 143/m^2. Density was similar at stations STC-Bio-4 and STC-Bio-3 with 530 and 731/m^2, respectively. The reference station had the highest density with 2,610/m^2. Percent dominant taxon for the Site 16 ponar dredge sampling stations ranged from 28 at STC-Bio-3 to 70 at STC-Bio-1. Percent dominant taxon for the reference station (STC-Bio-R1) fell within that range at 40.

The Florida index was low for all Site 16 ponar dredge sampling stations with scores ranging from 1 at STC-Bio-1 to 2 at STC-Bio-3 and STC-Bio-4. The reference station did not score much higher with a Florida index of 5. The Shannon-Weaver index was lowest at STC-Bio-1 with a score of 1.357. The remaining two stations had similar scores of 2.645 at STC-Bio-4 to 3.453 at STC-Bio-3. The Shannon-Weaver index at the reference station (STC-Bio-R1) fell within that range with a score of 3.003.

Percent diptera ranged from 10 at STC-Bio-1 to 87 at STC-Bio-4. The reference station (STC-Bio-R1) scored well below this range at 4, indicative of a low stress environment. Chironomids dominated the benthic community at STC-Bio-4 (81 percent) whereas the other Site 16 stations had scores of 10 percent at STC-Bio-1 and 39 percent at STC-Bio-3. Percent chironomid at the reference station (STC-Bio-R1) was low at 4. Percent EPT was zero (0) at all Site 16 ponar dredge sampling stations. At the reference station (STC-Bio-R1), percent EPT was low at 1. The variability in distribution among EPT and chironomids at the drainage ditch sampling locations is indicative of poor biotic condition.

Filter-collectors were not present at the Site 16 ponar dredge stations except for STC-Bio-3, which had a percentage of 8. The percentage of filter-collectors at the reference station (STC-Bio-R1) was comparable to STC-Bio-3 at 7. Percent shredders at all Site 16 sampling stations was low, ranging from 2 at STC-Bio-3 to 11 at STC-Bio-4. The reference station (STC-Bio-R1) fell below that range at 1. Percent calcium dependent scores were also low, ranging from zero at STC-Bio-1 and STC-Bio-4 to 14 at STC-Bio-3. The percent calcium dependent score at the reference station (STC-Bio-R1) was comparable to the highest score at 12.

The Hilsenhoff biotic index was similar at all Site 16 ponar dredge sampling stations, ranging from 8.3 at STC-Bio-4 to 10 at STC-Bio-1 indicating a very pollutant-tolerant community. The reference station (STC-Bio-R1) fell within that range with a score of 8.9, also indicative of a pollutant-tolerant community.

<u>Summary of Aquatic Studies Results for OU 7</u>. A review of the macroinvertebrate habitat quality parameter data suggests that habitat quality conditions throughout the drainage ditches east of Site 16 and the runways and the reference station represent a poor environment for many types of aquatic organisms. Furthermore, as was also the case with Site 5, OU 2, the highly variable conditions associated with ephemeral streams such as the drainage ditches are not representative of aquatic habitat for which available bioassessment protocols were designed to evaluate; only certain types of aquatic taxa are well adapted to exploit these habitats. Comparisons of the metrics between the Site 16 sampling stations indicate no clear trends in data. In addition, the absence of a reference location that is similar in habitat to the manmade drainage ditches limits the interpretation of the benthic results. Based on the metrics calculated for the dip net samples, the benthic communities at stations STC-Bio-1 and STC-Bio-R1 are below their respective expected conditions relative to the quality of habitat present. It is believed that STC-Bio-1 received drainage from OU 7 when it was operating and may be receiving contaminated groundwater infiltrating into the storm sewers. Station STC-Bio-4 is within the expected condition given the habitat quality, and the condition of the benthic community at station STC-Bio-3 is above the expected condition.

It could not be concluded that contamination in surface water or sediment from Site 16 was contributing to the poorer condition observed at Site 16 drainage ditches. Factors possibly influencing the benthic community at STC-Bio-1 include petroleum sediment odor and an oily sheen noted on the surface water.

5.2.1.8 Operable Unit 8 The semi-quantitative macroinvertebrate survey conducted at NAS Cecil Field in June and July 1993 (EA, 1994a; EA, 1994b), included sampling of aquatic macroinvertebrate communities at locations throughout Rowell Creek and Lake Fretwell. Methods and a description of the metrics used for this study are presented in Section 5.2 and Table 5-10, respectively. One sampling location from this sampling event was in Rowell Creek, downgradient from Site 3 (Plate 2). This Rowell Creek station (station RC-Bio-3) is located approximately 1,200 feet east of the disposal area within the area of groundwater plume discharge from Site 3. The plume enters Rowell Creek downstream from the Lake Fretwell dam. Between RC-Bio-3 and Lake Fretwell is a sewage outfall associated with the NAS Cecil Field Navy wastewater treatment plant. The presence of this sewage outfall adds some uncertainty to the evaluation of the macroinvertebrate community at Site 3. Any observed impacts on the macroinvertebrate community at RC-Bio-3 may be attributable to either the sewage treatment plant outfall or the Site 3 groundwater plume.

The surface water quality measurements and measurements of total hardness, nitrate plus nitrite, total nitrogen, and total phosphorus at RC-Bio-3 are summarized in Table 5-21. Water quality data are also provided in Table 5-21 for sampling stations CF3SW1 (located downgradient from RC-Bio-3) and CF3SW2 (located between the sewage treatment outfall and upgradient of RC-Bio-3; Plate 2). Although no macroinvertebrate data were collected at these Rowell Creek stations, water quality parameters were reviewed for regional perspective. Water depth at RC-Bio-3 was 0.2 meter from the riparian zone to instream, and low stream velocity (0.2 cubic feet per second) was observed. Water temperature taken at or near the bottom was 27.1 °C and pH was 6.7. The DO value of 5.2 mg/ℓ was slightly above the Florida water quality standard of ≥5 mg/ℓ (Florida Legislature 1995). Conductivity was 437 μmhos/cm, which is within the normal range according to State of Florida surface water quality standards (Florida Legislature, 1995).

Water clarity was clear; however, an odor of chlorine was prominent in the RC-Bio-3 surface water and sediment. Five percent aquatic vegetation and 10 percent woody debris were observed at RC-Bio-3. Sand was a major (80 percent) component of the substrate. No leaf pack, mud, muck, or silt were apparent in the substrate. Periphyton, fish, or aquatic macrophytes were not found at this station.

Aquatic habitat quality scores were calculated for the Site 3 sampling stations based on data collected during the field survey. The results of the habitat quality scoring, including the State of Florida regional reference, Five Mile Creek, are summarized in Table 5-22. Habitat quality at the station is generally poor, due at least in part to poor bottom substrate and lack of aquatic macrophytic vegetation. The score (54) represented 80.6 percent that of the regional reference station (Five Mile Creek, total score = 72).

A taxonomic list of the benthic macroinvertebrates at NAS Cecil Field is presented in Appendix A-7. Identified taxa were collected using dip nets, a ponar dredge, and Hester-Dendy artificial substrates.

Table 5-21
Summary of OU 8, Site 3 Surface Water Quality Measurements

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Station	Depth[1] (m)	Temperature[1] (°C)	pH [1]	DO[1] (mg/ℓ)	Conductivity[1] (µmhos/cm)	Secchi[1] (m)	Total Hardness[2] (mg/ℓ as $CaCO_3$)	Total Kjeldahl Nitrogen[2] (mg/ℓ)	Nitrate plus Nitrite[2] (mg/ℓ)	Total Nitrogen[2] (mg/ℓ)	Total Phosphorus[2] (mg/ℓ)
CF3SW1 [3,4]	NA	21	6.3	2.7	121	NA	97	NA	NA	NA	0.4
RC-Bio/SW3	0.2	27.1	6.7	5.2	437	0.20	[5]106	NA	[6]5.55	NA	1.30 [7]
CF3SW2 [3]	0.2	24.5	6.8	1.0	120	0.20	110	NA	NA	2	NA
Five Mile Creek [7]	1	23	4.4	5.8	62	0.3	NA	NA	NA	NA	0.5

[1] From Appendix R, OU 8 Basewide Risk Assessment (ABB Environmental Services, Inc. [ABB-ES] 1995c). Measured in the field by EA Engineering, Science, and Technology, Inc. (EA 1994b)
[2] From Appendix D, OU 8 Basewide Risk Assessment (ABB-ES 1995c) Measured in the laboratory.
[3] Although no macroinvertebrate data were collected at these wetland stations, water quality parameters are included in this table for regional perspective.
[4] Values for this station represent an average of duplicate samples collected simultaneously.
[5] Value is for sample collected June 26, 1993.
[6] Value represents an average of samples collected June 26, 1993 and August 18, 1993.
[7] Five Mile Creek is the Florida regional reference station considered in this study.

Notes: OU = operable unit.
m = meter.
°C = degrees Celsius.
DO = dissolved oxygen.
mg/ℓ = milligrams per liter.
µmhos/cm = micromhos per centimeter (a measure of electrical conductivity).
$CaCO_3$ = calcium carbonate.
NA = not available.

Table 5-22
Habitat Assessment Scores, OU 8, Site 3

Basewide Risk Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Station	Bottom Substrate	Water Velocity	Artificial Channel	Bank Stability	Riparian Zone Vegetation	Flow Adjustment	Total Score	Percent Comparison to Five Mile Creek
RC-BIO-3	12	20	12	7	3	--	54	80.6
Five Mile Creek[1]	24	8	15	10	10	5	72	100

[1] Five Mile Creek is the Florida regional reference station considered in this study.

Notes: OU = operable unit.
-- = not measured.

OU 8 Dip Net Sampling Results. Methods used to describe the structure and function of the benthic macroinvertebrate community as sampled by the ponar dredge are described in Section 5.2 and summarized in Table 5-10. A complete description of metrics for the dip net gear type used in this study is provided in the EA report (EA, 1994b). Examination and interpretation of the metric scores show considerable differences between RC-Bio-3 and the Five Mile Creek reference station. Taxa richness, Florida index and EPT index are markedly decreased at RC-Bio-3, but percent dominant taxon and percent shredders are greatly increased at RC-Bio-3. Station RC-Bio-3 scored approximately 50 percent of the regional reference station (Five Mile Creek). The low DO levels and generally poorer habitat quality at RC-Bio-3 may help explain the low total metric score relative to Five Mile Creek. It is unclear whether either the residential sewage treatment plant outfall, the poor habitat quality, or the groundwater plume from Site 3 is responsible for the lower metrics observed in dip net samples from RC-Bio-3.

OU 8 Hester-Dendy Sampling Results. Methods used for this sampling technique are presented in Section 5.2, and the metrics are described in Table 5-10. A complete description of metrics used in this study for this gear type is provided in the EA report (EA, 1994b). The Hester-Dendy substrate sampler results generally support those obtained from dip net samples. The total number of taxa was decreased at RC Bio 3 and consisted primarily (97 percent) of the dominant chironomid species, *Polypedilum illinoense*, a pollution-tolerant taxon. None of the most pollution-sensitive species were detected (as reflected in a 0 percent EPT value).

The Florida index was only slightly lower at RC-Bio-3 (12) than that at Five Mile Creek (15), a less dramatic difference than that found in dip net samples. The Hilsenhoff biotic index values obtained in Hester-Dendy samples were similar for RC-Bio-3 (6.0) and the regional reference station (6.4). As this index may be insensitive to the presence of nonorganic pollutants such as those containing chlorine, the effect of sewage outfall versus contributions from Site 3 effluent cannot be delineated. Percent diptera was 99.5, as also was percent chironomid, as compared to 60.5 percent for both metrics at Five Mile Creek. The percent EPT and percent collector filterers was 0.0 percent, and 98.6 percent shredders were noted.

The relatively large decrease in the Shannon-Weaver index at RC-Bio-3 (0.279) as compared to the regional reference station value (4.612) suggests that the Rowell Creek environment has been modified. However, these data warrant careful consideration, given habitat quality differences between Rowell Creek and Five Mile Creek.

The artificial substrate sampling indicates a poorly developed benthic macroinvertebrate community. However, due to lack of adequate reference data, the source of this impact is not defined. The decreased condition of the benthic macroinvertebrate community may be due to the residential sewage treatment plant outfall or to the influence of the Site 3 groundwater plume, or to the generally poor habitat quality of RC-Bio-3.

OU 8 Ponar Sampling Results. Metrics used to describe the structure and function of the benthic macroinvertebrate community at RC-Bio-3 as sampled by the ponar dredge are described in Table 5-10. A complete description of metrics used in this study is provided in the EA report (EA, 1994b). The dominant taxon (42 percent) was a chironomid species, *Polypedilum illinoense*, a pollution-tolerant taxon. None of the most pollution-sensitive species were detected (as reflected in a 0 percent EPT value). Density of macroinvertebrates was high at RC-Bio-3 ($10,736/m^2$).

Summary of Aquatic Studies Results for OU 8. A review of the macroinvertebrate habitat quality parameter data suggests that habitat quality conditions at RC-Bio-3 represent a poor environment for many types of aquatic organisms. Data from dip net, ponar, and Hester-Dendy studies support this conclusion. Adequate reference data were not available, limiting interpretation of the benthic results. Aquatic habitat conditions at Site 3 are dissimilar from that of the regional reference station. Five Mile Creek is deeper, cooler, more acidic, more oxygenated, and has a lower conductivity than RC-Bio-3. These differences in habitat structure may be sufficient to explain the decreased biological condition at RC-Bio-3. However, the residential sewage treatment plant discharge or the Site 3 groundwater plume may also contribute to the differences in community structure at this sampling location.

5.2.2 Other Sites and PSCs Aquatic studies conducted by EA (1994) included additional locations that were not evaluated in association with OUs. These sampling stations (as shown on Plate 2) include RCGC-Bio-1 (located downstream of the drainage from surface deposits of 5 gallon containers), RCGC-Bio-2 (downstream of drainage from Fairway 7 drum site), RCGC-Bio-3 (the previous Bio-2 location), RC-Bio-1 and RC-Bio-2 (adjacent to Site 19), LF-Bio-1, located at the northern point of Lake Fretwell), RC-Bio-3 (adjacent to Site 3, located below the Lake Fretwell dam and the sewage treatment outfall), LF-Bio-2 (at the Lake Fretwell inlet from the Site 5 tributary), LF-Bio-3 (middle of the lake), LF-Bio-4 (near the lake shore, adjacent to Site 3 and PSC 4), LF-Bio-5 (located behind the Lake Fretwell dam, to the west), LF-Bio-6 (behind the Lake Fretwell dam to the east), LF-Bio-7 (located at the lake inlet, from the west and at the southern point near Site 3), LF-Bio-8 (located north of LF-Bio-6 in Lake Fretwell), 6-Bio-1 (located in the pond on PSC 6), STC-Bio-2 (located in Sal Taylor Creek in the ditch downstream of Site 16, STC-Bio-5 (located upstream of tributary from Site 8), STC-Bio-6 (Sal Taylor Creek, downstream of the tributary from Site 8), STC-Bio-7 (downstream of STC-6), STC-Bio-8 (downstream of confluence with Rowell Creek), 9-Bio-1 (in the tributary downstream of PSC 9), YWC-Bio-1 (in Yellow Water Creek downstream of Site 15, 200 feet upstream of the road near the housing area), and YWC-Bio-2 (200 feet upstream of Normandy Boulevard).

Reference stations utilized for the NAS Cecil Field watershed include RCGC-Bio-R1 (the reference station for location on the golf course), RC-Bio-R1 (Rowell Creek upstream of Normandy Boulevard), STC-Bio-R1 (Sal Taylor Creek in the munitions area upstream of ditches draining Site 16), and YWC-Bio-R1 (Yellow Water Creek upstream of Site 15). The reference station locations are also depicted on Plate 2.

Sampling methods of the aquatic studies are discussed in Section 5.2, and metrics used to evaluate the structure and function of communities within these sampling locations are presented in Table 5-10. Results of these studies are summarized below.

Surface water quality measurements for the additional sites and PSCs and reference stations are presented in Table 5-23.

Table 5-23
Summary of Surface Water Quality Measurements for Additional Sites, PSCs, and Reference Stations

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Station	Depth (m)[1]	Temperature (°C)[1]	pH[1]	DO (mg/ℓ)[1]	Conductivity (μmhos/cm)[1]	Secchi (m)[1]
RCGC-Bio-1	0.2	21.8	5.4	0.9	17.3	1.00
RCGC-Bio-2	1.0	23.4	6.2	1.4	168	1.00
RCGC-Bio-3	0.4	23.2	6.6	2.3	195	0.40
RC-Bio-1	0.5	28.0	7.3	5.7	187	1.50
RC-Bio-2	0.5	27.9	7.8	5.9	187	1.70
RC-Bio-3	0.2	27.1	6.7	5.2	437	0.1
LF-Bio-1	0.2	31.9	7.9	7.6	178	1.30
LF-Bio-2	0.2	31.4	7.7	7.7	179	1.00
LF-Bio-3	0.2	30.1	7.2	6.5	177	1.20
LF-Bio-4	0.2	28.9	6.9	5.6	178	1.50
LF-Bio-5	0.2	29.0	7.6	5.9	180	1.70
LF-Bio-6	0.2	27.8	8.1	5.6	181	1.30
LF-Bio-7	0.2	27.3	6.8	4.0	183	22.20
LF-Bio-8	0.2	30.7	7.4	6.9	169	1.40
6-Bio-1	NA	NA	NA	NA	NA	0.5
STC-Bio-2	0.3	26.5	6.2	7.4	148	0.30
STC-Bio-5	0.2	24.0	6.5	5.0	79	1.2
STC-Bio-6	0.2	25.6	6.7	6.8	143	0.20
STC-Bio-7	0.2	25.6	6.7	6.8	143	0.20
STC-Bio-8	NA	NA	NA	NA	NA	NA
9-Bio-1	0.2	22.4	5.8	4.3	62	0.20
YWC-Bio-1	0.2	25.2	6.4	4.4	99	0.20
YWC-Bio-2	0.2	24.4	6.5	4.4	114	1.00
RCGC-Bio-R1	NA	NA	NA	NA	NA	NA
RC-Bio-R1	NA	NA	NA	NA	NA	NA
STC-Bio-R1	0.2	25.1	6.3	3.7	169	0.20
YWC-Bio-R1	0.2	23.9	6.5	4.1	105	0.20

[1] Measured in the field.

Notes: PSC = potential source of contamination.
m = meter.
°C = degrees Celsius.
DO = dissolved oxygen.
mg/ℓ = milligrams per liter.
μmhos/cm = micromhos per centimeter (a measure of electrical conductivity).
NA = not applicable.

All the additional sampling locations except STC-Bio-2, LF-Bio-1, LF-Bio-2, LF-Bio-5, and LF-Bio-7 are in areas that are 50 percent or more forested. Moderate sediment oils were present only at STC-Bio-2, and a slight amount was detected at 6-Bio-1. Sediment odors were normal at all stations except 9-Bio-1, RCGC-Bio-1 and RCGC-Bio-3, where evidence of anaerobic gases were present, and STC-Bio-2, where petroleum odor was detected. Most stations had substrates composed of at least 50 percent sand; exceptions were 9-Bio-1 and RCGC-Bio-1 (40 percent each), RCGC-Bio-1, RCGC-Bio-2, STC-Bio-R1 and YWC-Bio-2 (45 percent each), STC-Bio-2 (15 percent), STC-Bio-5, LF-Bio-1, LF-Bio-4, LF-Bio-6, LF-Bio-7 and 6-Bio-1 (0 percent each), YWC-Bio-R1 (25 percent) and LF-Bio-2 and LF-Bio-3 (10 percent each).

Surface water was clear at all stations except STC-Bio-5, which was turbid. Sampling stations associated with the golf course, Lake Fretwell and Yellow Water Creek, along with RC-Bio-2, RC-Bio-3, STC-Bio-5, STC-Bio-R1 and 6-Bio-1 showed a tannic coloration. Water odor was normal at all these sampling stations. Water surface oils were present as a sheen only at STC-Bio-2. Periphyton and aquatic macrophytes were rare or absent at all these stations.

Table 5-24 presents habitat assessment scores derived for the additional sites, PSCs, and reference stations. The highest habitat quality score was noted at the reference station, YWC-Bio-R1 (75), also exceeding the regional reference station, Five Mile Creek (67). STC-Bio-5 and STC-Bio-7 had moderately high scores (63 and 66, respectively). The lowest score was noted at STC-Bio-2 (13).

Although the habitat assessment procedure is designed for stream habitat, information that was applicable to the lake stations was tabulated and scores were assigned (Table 5-24). These scores were only comparable to each other and showed some variability. The scores for Lake Fretwell ranged from 26 at LF-Bio-1 to 46 at LF-Bio-7. At the pond station, 6-Bio-1, the score was 52.

A taxonomic list of the benthic macroinvertebrates collected is presented in Appendix A-7. Identified taxa were collected from the stations using a combination of dip net, Ponar and Hester-Dendy samplers. Fish species observed at NAS Cecil Field sampling stations are listed in Appendix A-2.

Dip Net Sampling Results for Additional Sites, PSCs and Reference Stations. Methods used in the sampling effort are described in Section 5.2, and metrics applied to analysis are presented in Table 5-10. Complete descriptions of metrics for the dip net gear type are presented in the EA reports (EA, 1994a; EA, 1994b). Total scores for these stations ranged from a low of 12 at STC-Bio-2 to 40 at STC-Bio-8. Most stations scored slightly less than the Five Mile Creek score of 28. Other reference station scores were 18 (for RC-Bio-R1), 26 for RCGC-Bio-R1, 16 for STC-Bio-R1, and 24 for YWC-Bio-R1.

The relationship between habitat quality and biological condition is illustrated for some of the additional stations on Figures 5-2 and 5-3. Methods used in deriving this relationship are described in Section 5.2. On Figure 5-2, the following stations lie within the predictable conditions of the community: 9-Bio-1, RCGC-Bio-3, and RC-Bio-R1. Station RCGC-Bio-R1 exhibited a higher benthic quality than might have been expected. This may be representative of nutrient enrichment, which will artificially sustain a more diverse fauna in a given habitat quality than expected . Stations RCGC-Bio 1 and RCGC-Bio-2 fell below the 95 percent confidence line and could be classified as slightly impaired.

Table 5-24
Habitat Assessment Scores for Additional Sites, PSCs, and Reference Stations

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Station	Bottom Substrate	Water Velocity	Artificial Channel	Bank Stability	Riparian Zone Vegetation	Flow Adjustment	Total Score	Percent Comparison to Five Mile Creek
RCGC-Bio-1	23	3	14	5	7	NA	52	77.6
RCGC-Bio-2	23	3	14	3	7	NA	50	74.6
RCGC-Bio-3	20	3	14	2	4	NA	43	64.2
RC-Bio-1	20	6	14	7	7	NA	54	80.6
RC-Bio-2	20	6	14	8	7	NA	55	82.1
RC-Bio-3	12	20	12	7	3	NA	54	80.6
LF-Bio-1	4	0	14	6	2	NA	26	--
LF-Bio-2	10	0	14	9	2	NA	35	--
LF-Bio-3	10	0	14	9	4	NA	37	--
LF-Bio-4	10	0	14	9	4	NA	37	--
LF-Bio-5	7	0	14	9	0	NA	30	--
LF-Bio-6	7	0	14	9	0	NA	30	--
LF-Bio-7	18	0	14	8	6	NA	46	--
LF-Bio-8	10	0	14	9	5	NA	28	--
6-Bio-1	24	0	1.4	9	5	NA	52	--
STC-Bio-2	5	2	2	2	2	NA	13	19.4
STC-Bio-5	18	18	14	5	8	NA	63	94
STC-Bio-6	12	16	13	7	6	NA	54	80.6
STC-Bio-7	21	21	13	6	5	NA	66	98.5
STC-Bio-8	NA	NA	NA	NA	NA	NA	NA	NA
9-Bio-1	16	7	13	5	8	NA	49	73.1
YWC-Bio-1	24	7	14	9	8	NA	62	92.5
YWC-Bio-2	25	10	14	6	5	NA	60	89.6
RCGC-Bio-R1	NA	NA	NA	NA	NA	NA	NA	NA
RC-Bio-R1	NA	NA	NA	NA	NA	NA	NA	NA
STC-Bio-R1	18	10	14	8	6	NA	56	83.6
YWC-Bio-R1	24	22	14	8	7	NA	75	100
Five Mile Creek	24	8	15	10	10	5	67	100

[1] Five Mile Creek is the Florida regional reference station considered in this study. Methods for sampling and habitat scoring procedures are reported in Section 5.2.

Notes: PSC = potential source of contamination.
NA = not available.
-- = Comparison not appropriate for Lake Fretwell.

These represent situations where organic pollution or toxicants could be adversely affecting the biological conditions, regardless of the quality of the habitat. However, the very low dissolved oxygen present at these two stations may possibly be adversely influencing the communities.

On Figure 5-3, the following stations lie within the predictable conditions of the community: STC-Bio-2, STC-Bio-7, STC-Bio-8, and YWC-Bio-R1. Stations STC-Bio-6 and YWC-Bio-2 showed a higher than expected benthic quality. Stations STC-Bio-R1, STC-Bio-5, and YWC-Bio-1 were moderately impaired.

Ponar Sampling Results for Additional PSCs and Reference Stations. Methods used in the sampling effort are descried in Section 5.2, and metrics applied to analysis are presented in Table 5-10. Complete descriptions of metrics used in these studies are presented in the EA reports (EA, 1994a; EA, 1994b). Since no State of Florida regional reference data exist for this gear type, all stream station data comparisons were made to the reference stations RC-Bio-R1, RCGC-Bio-R1, STC-Bio-R1 and YWC-Bio-R1. Since no lake reference stations were established as part of this study, the only suitable stations for comparisons were RC-Bio-1 and RC-Bio-2, located just upstream from Lake Fretwell.

The total number of taxa was lowest at LF-Bio-6 (8 taxa), followed by LF-Bio-5 (10). Other stations with a number of taxa that was lower than the reference stations were 9-Bio-1 (17 taxa), STC-Bio-2 (19), LF-Bio-1, LF-Bio-3, LF-Bio-4 (20), and LF-Bio-8 (22). The remaining stations ranged from 23 to 46 taxa each, comparing favorably with reference stations.

The number of individuals was lowest at 6-Bio-1 (831/m^2), compared to 2,480/m^2 and 11,624/m^2 for RC-Bio-R1 and RCGC-Bio-R1, respectively. Density at most other stations was appreciably higher than RC-Bio-R1, but tended to have lower abundance compared to RCGC-Bio-R1 and YWC-Bio-R1 (6,479/m^2).

The Florida index was lowest at YWC-Bio-1 (1). All stations were lower than RCGC-Bio-1 (12), and most were also lower than YWC-Bio-R1 (6); only YWC-Bio-2 (9) and STC-Bio-8 (8) exceeded the latter.

The Shannon-Weaver index was lowest at LF-Bio-4 (1.332). Index values at all other stations were comparable to the reference stations (RC-Bio-R1 (2,844), RCGC-Bio-R1 (3.627), STC-Bio-R1 (3.003), and YWC Rio-R1 (3.531).

The percent EPT individuals was low at all stations as expected because of the substrate type. These taxa are more common on cobble/gravel substrate than on sand or mud. Most stations had 0 percent EPT and the highest percentages were at RC-Bio-R1 (9.8 percent) and LF-Bio-2 (5.5 percent).

The Hilsenhoff Biotic index values were high at most stations, ranging from 6.3 at YWC-Bio-R1 to 9.7 at LF-Bio-4. On a scale of 1-10, with the low values indicative of good quality community, the stations at NAS Cecil Field are all classified as below average, based on the infaunal benthic community.

The trends in metric values indicate that LF-Bio-6 and STC-Bio-4 ranked lower for many of the key metrics compared to the reference stations and other stations studied. Station LF-Bio-6, the deepest station sampled in Lake Fretwell, had very low dissolved oxygen at the bottom, which may have contributed to its low metric values. STC-Bio-4 ranked low in the Hester-Dendy and Ponar samples. The stream stations RC-Bio-R1, STC-Bio-R1, and YWC-Bio-R1 were suitable reference stations with high habitat assessment scores and moderate to high metric values. Station RCGC-Bio-R1 was not representative of most stations sampled, due to low habitat quality and dense growth of aquatic macrophytes, which was not typical of most stations. However, RCGC-Bio-R1 did score unusually high on many metrics, which may have been due to the unique habitat characteristics discussed above.

Hester-Dendy Sampling Results for Additional Sites, PSCs and Reference Stations. Because some samplers were totally exposed or were not set at some stations, Hester-Dendy sampler data are not available at the following stations: RC-Bio-1 and 2, STC-Bio-R1, and LF-Bio-1 through LF-Bio-8.

The total number of taxa was lowest at STC-Bio-2 (7 taxa), much lower than all the others in the comparison. The other stations ranged from 22 taxa (RC-Bio-R1) to 41 (STC-Bio-8). STC-Bio-R1 (36) and Five Mile Creek (30) were next highest.

The number of individuals was lowest at STC-Bio-2 ($313/m^2$) and at Five Mile Creek ($326/m^2$). The remaining stations had similar or higher numbers of individuals. The highest number was observed at RC-Bio-3 ($26,686/m^2$).

The Florida index values were lowest at STC-Bio-1 and 2 (both were 0), followed by RC-Bio-R1 (3). Compared to Five Mile Creek (15), values at all other stations were lower. The next highest value was measured at STC-Bio-8 (14), followed by YWC-Bio-1 (12).

The Shannon-Weaver index values were lowest at STC-Bio-2 (1.419). All other stations had comparable values, ranging from 2.484 at YWC-Bio-1 to 4.612 at Five Mile Creek.

The percent of EPT individuals, which consists of the most pollution-sensitive benthic taxa, was 0.0 at STC-Bio-2 and STC-Bio-4. Percentages at the reference stations, Five Mile Creek (5.6 percent), RC-Bio-R1 (0.8 percent), and RCGC-Bio-R1 (1.4 percent), were also low. The percent of EPT was highest at STC-Bio-8 (34.1 percent), followed by YWC-Bio-R1 (17.5 percent).

The Hilsenhoff biotic index scores ranged from a good quality score of 4.7 at STC-Bio-8 to a low score of 8.7 at RC-Bio-R1. Many of the stations had scores higher than Five Mile Creek (6.4), including reference stations RC-Bio-R1 (8.7) and RCGC-Bio-R1 (7.4).

The trends in the metric values indicate that STC-Bio-2 and 4 consistently ranked lower than the reference stations and all other stations. The reference stations at Five Mile Creek and YWC-Bio-R1 were among the higher ranking stations and were more suitable as reference stations than RC-Bio-R1 or RCGC-Bio-R1, which had similar metric values to the potentially influenced stations.

Summary of Aquatic Studies Results for the Additional Sites/PSCs and Reference Stations. A review of the macroinvertebrate habitat quality parameter data suggests that habitat quality conditions at stations STC-Bio-R1, STC-Bio-5, and YWC-Bio-1 are moderately impaired. All other stations lie within or above the predictable condition. Station-to-station differences may be due to differences in substrate composition, where they exist, in addition to or instead of man-induced alteration of the population. The very low dissolved oxygen present at RCGC-Bio-1 and RCGC-Bio-2 may possibly be adversely impacting these communities.

5.2.3 Other Studies No additional aquatic studies have been completed to date.

5.3 TERRESTRIAL STUDIES. Terrestrial studies include examination or sampling of terrestrial wildlife or habitat at NAS Cecil Field. Terrestrial wildlife includes mammals, birds, reptiles, amphibians, terrestrial invertebrates, and plants. The objectives and scope of terrestrial studies are reported in Appendix C, and ecological receptor species observed or expected to occur at NAS Cecil Field are listed in Appendix A. Study results for each OU and PSC are summarized in the following subsections. Any terrestrial studies not completed for a specific OU are summarized in Subsection 5.3.3. A facilitywide survey of the gopher tortoise (*Gopherus polyphemus*), listed as a species of special concern by the Florida Game and Fresh Water Fish Commission, was conducted by CZR (1994); a summary is presented in Subsection 5.3.3.

5.3.1 Operable Units Terrestrial studies have been completed at OUs 1, 2, 3, 4, 5, 6, 7, and 8. These studies consist of mapping plant cover types, based upon FNAI (1990) classification of natural communities, and direct observations and field signs of terrestrial wildlife. The selection of appropriate representative wildlife species for risk assessments is based upon the species known or expected to occur at each OU, as determined by these field studies.

A summary of upland habitats observed at the OUs and PSCs is presented in Table 5-25, including identification of habitat types found at each OU and PSC. Plate 1 shows the location and extent of upland habitats associated with OUs and PSCs at NAS Cecil Field. Further descriptions of terrestrial communities are provided in the paragraphs below for each OU and PSC.

5.3.1.1 Operable Unit 1 Mapping of vegetative communities was completed for Sites 1 and 2 (CDM, 1994); the objectives and timing of this field effort are described in Appendix C. A description of upland habitats at OU 1 is presented in Table 5-25, and the locations at Sites 1 and 2 are depicted on Figures 2-1 and 2-2 respectively.

OU 1 habitats most closely resemble mesic flatwood and upland mixed forest communities (FNAI, 1990). The western border of Site 1 is an upland community consisting of a planted pine forest. Typical vegetation identified in this area include slash pine (*Pinus elliotti*), longleaf pine (*Pinus palustris*), loblolly pine (*Pinus taeda*), red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), sand blackberry (*Rubus cuneifolius*), blackberry (*Rubus* sp.), and muscadine grape (*Vitis rotundifolia*).

At Site 2, an upland mixed forest with a well-developed, closed-canopy forest of upland hardwoods, dominated by water oak (*Quercus nigra*), myrtle oak (*Q. myrtifolia*), and sweetgum borders the northwestern corner. The trees in this area appear to be older than NAS Cecil Field (50 years), indicating no prior disturbance with the exception of a few monitoring well installations.

Bordering the northern edge of Site 2 is a planted pine forest. Although this is a disturbed area with drainage ditches and a few roads, characteristics of the Mesic Flatwood FNAI classification are evident. The area is relatively flat with poorly drained soil. Vegetation includes longleaf pine, slash pine, loblolly pine, saw palmetto (*Serenoa repens*), bog buttons (*Lachnocaulon anceps*), and gallberry (*Ilex glabra*).

Table 5-25
Description of Upland Habitats

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Classification	Description	Representative Vegetation (common name)	Location
Mesic Flatwood (Includes planted pines)	Open canopy forest of widely spaced pine trees and a dense ground cover of herbs and shrubs; relatively flat; moderately to poorly drained terrain.	Slash pine, longleaf pine, loblolly pine, red maple, sweetgum, sand blackberry, blackberry, muscadine grape, saw palmetto, bog buttons, and gallberry.	OU 1, Sites 1 & 2 OU 2, Site 5 OU 3, Site 8 OU 4, Site 10 OU 5, Site 15 OU 6, Site 11 PSC 4 PSC 19
Upland Mixed Forest	Well developed, closed canopy forest and upland.	Water oak, myrtle oak, and sweetgum.	OU 1, Sites 1 & 2 OU 4, Site 10 OU 6, Site 11
Scrubby Flatwood	Open canopy of widely scattered pine trees, with a sparse shrub understory; relatively flat, areas of open sand, with some characteristics of Mesic Flatwood.	Slash pine, longleaf pine, loblolly pine, muscadine grape, saw palmetto, wax myrtle, blackberry, goldenrod.	OU 2, Site 5
Disturbed Areas	Open, dry areas dominated by forbes, many of which are colonizing areas disturbed by investigative activities.	Water oak, myrtle oak, and sweetgum.	OU 2, Sites 5 & 17 OU 3, Site 7 & 8 OU 4, Site 10 OU 5, Sites 14 & 15 PSC 4 PSC 6 PSC 9 PSC 12 PSC 19
Dry Prairie	Flat, sandy soil with little to no trees and dense ground cover.	Ragweed, goldenrod, dog fennel, bracken fern, wax myrtle, sand blackberry, golden ragweed and muscadine grape.	OU 8, Site 3 OU 5, Site 15 PSC 4
Maintained Fields	Grassy areas that are maintained by mowing.	Grasses, mixed herbaceous vegetation.	OU 7, Site 16 OU 3, Sites 7 & 8 OU 5, Site 11 PSC 6

Sources: Camp, Dresser, and Mckee, 1993; ABB Environmental Services, Inc. Ecological Trip Reports

Notes: OU = operable unit.
PSC = potential source of contamination.

The vegetative community of Site 2 provides limited habitat for terrestrial wildlife, in contrast to Site 1. Ecological diversity at Site 1, based upon direct observation of individuals and signs of lower trophic level organisms, includes insects, rodents, and armadillo (*Dasypus novemcinctus*), as well as higher trophic level predators, including sharp-shinned hawk (*Accipiter striatus*), pygmy rattlesnake (*Sistrurus miliarus barbouri*), and other snakes.

5.3.1.2 **Operable Unit 2** Mapping of vegetative communities was completed for Sites 5 and 17 (CDM, 1994 and ABB-ES ecologists); the scope and objectives of this field effort are described in Appendix C. A description of upland habitats at OU 2 is presented in Table 5-25, and the locations at Sites 5 and 17 are depicted on Figures 2-3 and 2-4, respectively.

Terrestrial parts of Site 5 include scrubby flatwoods, planted pine (mesic flatwoods), and disturbed upland regions (Plate 1). These uplands are dominated by various pine species, including longleaf pine, slash pine, and loblolly pine. Occasional water oak and red maple are found in the southern and eastern parts of the site. The shrubby understory at Site 5 varies from sparse to dense and includes shrubs such as saw palmetto, wax myrtle (*Myrica cerifera*), Carolina cherry (*Prunus caroliniana*), and fetterbush (*Lyonia* sp.). Dense vines cover much of the shrub layer; plants in this layer include catbriar (*Smilax bona-nox*), muscadine grape, bramble (*Rubus* sp.), and Virginia creeper (*Parthenocissus virginiana*). Open areas in the drier parts of the site are dominated by forbes, many of which are colonizing areas disturbed by investigative activities at the site. Herbaceous vegetation observed at Site 5 includes bracken fern (*Pteridium aquilinum*), cinnamon fern (*Osmunda cinnamomea*), sand blackberry, dog fennel (*Eupatorium capitatum*), St. Johnswort (*Hypericum* sp.), fleabane (*Erigeron* sp.), evening primrose (*Oenothera* sp.), broom sedge (*Andropogon virginiana*), rush (*Juncus marginatus*), and grasses, including a *Paspalum* species.

At Site 17, the western part is upland, with palustrine, forested, broad-leaved deciduous wetland occurring to the east of the site (Plate 1). The vegetative community covering Site 17 (the former disposal area) consists of upland plant communities. A grass-covered area with scattered young slash pine trees and a dense shrub and herb layer covers this region. Woody vegetation in the Site 17 uplands includes slash pine loblolly pine, myrtle oak, red maple muscadine grape, bay, and blackberry. This plant community is disturbed and does not fall within any FNAI natural community type. Herbaceous species observed in the disturbed Site 17 uplands include plantain, Virginia creeper, rushes, and dog fennel.

Bordering Site 17 is a planted pine forest. Although this is a disturbed area with drainage ditches and fire roads, characteristics of the mesic flatwood FNAI classification are evident. The area is relatively flat with poorly drained soil. Vegetation includes longleaf pine, slash pine, loblolly pine, saw palmetto, bog buttons, and gallberry.

It is likely that the invertebrate biomass at the uplands at both OU 2 sites serves as a forage base for a limited number of wildlife species, including amphibians, reptiles, birds, and mammals. Upland habitats likely support several reptile and amphibian species, including 20 to 30 species of reptiles and amphibians (Ashton and Ashton, 1988; 1989; 1991). Species of mole salamander (*Ambystoma* spp.) spend at least part of the year in pine woodlands, and a number of other salamanders, frogs (including members of the genera *Hyla*, *Rana*, and

Pseudacris), and toads (*Bufo* spp.) may also occur in this habitat. Several lizard species and colubrid snakes may also be found in disturbed pine forest communities (Ashton and Ashton, 1988).

Several small mammal trails were observed in the interior and around the perimeter of Site 5 uplands. Some of these trails may be the work of the eastern cottontail rabbit (*Sylvilagus floridanus*). Other mammals that may occur in this habitat include the hispid cotton rat (*Sigmodon hispidus*) and cotton mouse (*Peromyscus gossypinus*), as well as the armadillo (*Dasypus novemcinctus*). Predatory mammals such as the red fox (*Vulpes vulpes*) and gray fox (*Urocyon cinereoargenteus*) may feed on small mammals at these sites, and white-tailed deer (*Odocoileus virginianus*) may forage in these areas.

Depending upon the vegetative association, southeastern pine forests provide habitat for a diverse array of avifauna, including insectivorous gleaners of pine needles and bark, flycatchers, a seed-eating assemblage, and nocturnal and diurnal aerial predators (Wolfe and others, 1988). Birds of prey such as the black vulture (*Coragyps atratus*), turkey vulture (*Cathartes aura*), red-tailed hawk (*Buteo jamaicensis*), and red-shouldered hawk (*B. lineatus*) search for prey items in the more open regions, and granivorous birds such as the mourning dove (*Zenaida macroura*) and northern bob-white (*Colinus virginianus*) are likely to occur in the upland communities at Sites 5 and 17.

Birds observed at the two sites include the brown thrasher (*Toxostoma rufum*), bobwhite quail, mockingbird (*Mimus polyglottus*), common grackle (*Quiscalus quiscula*), fish crow (*Corvus ossifragus*), killdeer (*Charadrius voviferus*), northern cardinal (*Cardinalis cardinalis*), blue jay (*Cyanocitta cristata*), mourning dove, rufous-sided towhee (*Pipilo erythrophthalmus*), common flicker (*Colaptes auratus*), red-bellied woodpecker (*Centurus carolinus*), pine warbler (*Dendroica pinus*), ruby-crowned kinglet (*Regulus calendula*), solitary vireo (*Vireo solitarius*), and black and white warbler (*Mniotilta varia*).

5.3.1.3 **Operable Unit 3** OU 3 consists of Sites 7 and 8. Site-specific descriptions are provided below. A description of upland habitats at OU 3 is provided in Table 5-25, and the locations of Sites 7 and 8 are depicted on Figures 2-5 and 2-6, respectively.

Site 7, the old Firefighting Training Area, is located near the flightline area. The only ecological communities observed at Site 7 were mowed grass (to a height of 4 to 6 inches) and disturbed uplands. These latter areas are best characterized as degraded old fields, overgrown fields, and weedy parking lots/storage. Plant species observed at the site include grasses, yellow aster, yellow fleabane, grasses, crabgrass (*Digitaria or Eleusine* sp.), bitterweed (*Helenium amarum*), blackberry, verbena, fleabane, bullbriar greenbriar, buchnera (*Buchnera* sp.), ragweed (*Ambrosia artemisiifolia*), laramide, bracken fern, winged sumac (*Rhus copallina*), dog fennel, cherry, and occasional live oak and slash pine.

In mowed grass areas, there may be a limited assemblage of terrestrial invertebrates and birds found in these managed grassy areas, however, the occurrence of ecological receptors foraging in these areas is expected to be minimal. The limited cover present in mowed and disturbed uplands, and proximity of these sites to roads generally precludes their use by large predatory animals; however, small rodents or birds may be found foraging at the site. Appendix A contains a list of species that may occur at mowed grass and disturbed upland areas.

Site 8, the Firefighter Training Area, Boresite Test Range, and Hazardous Waste Storage Area, is located south of the flightline area near the Perimeter Road. Several ecological communities were found at Site 8, including mowed grass, disturbed upland, planted pine flatwoods, and a mixed pine and hardwood community. The site is surrounded by forested areas.

Disturbed upland areas are dominated by graminoids and other herbaceous plants, with a sparse shrubby understory, and no arboreal canopy. These areas are best characterized as degraded old fields, overgrown fields, weedy parking lots/storage areas, and unpaved roads.

The FNAI (1990) habitat classifications were designed to characterize pristine areas and, due to active management of these flatwoods, do not correspond well with this cover type. However, particular features of the planted pine flatwoods exhibit similar characteristics defined by the FNAI as upland pine forest (which grades into upland mixed forest), mesic flatwoods, and wet flatwoods. The pine flatwoods are characterized by rolling hills composed of sandy soils with variable amounts of clay (thus retaining soil moisture).

The mixed pine and hardwood community at Site 8 is a transitional community composed of the same plant species found in the planted pine and upland mixed forest communities. The mixed pine and hardwood communities were scattered in and bordering the stand of planted pines (e.g., along roadsides), and were primarily dry.

Tree and shrub species observed at Site 8 include bay, longleaf pine, red cedar (*Juniperus virginiana*), live oak, loblolly pine, laurel oak, red maple, willow (*Salix* sp.), black cherry (*Prunus serotina*), saw palmetto, water oak, southern bayberry (*Myrica cerifera)*, sweetgum, and holly (*Myrica inodora*). Herbivorous and graminoid species found at Site 8 include crabgrass, yellow-eyed grass, fleabane, snapdragon, dog fennel, Spanish needles (*Bidens pilosa*), panic grass (*Panicum vergatum*), sedges, goldenrod (*Solidago* sp.), acacia (*Acacia* sp.), sedges, blackberry, cinnamon fern, bracken fern, bullbriar greenbriar, Virginia creeper, thistle (*Cirsium* sp.), verbena, tall grasses, yellow aster, agalinis (*Agalinis fasciculata*), bedstraw (*Galium* sp.), sumac, loblolly bay (*Gordonia lasianthus*), and netted chain fern (*Woodwardia areolata*).

In mowed grass areas, there may be a limited assemblage of terrestrial invertebrates and birds found in these managed grassy areas, however, the occurrence of ecological receptors foraging in these areas is expected to be minimal. The limited cover present in mowed and disturbed uplands, and proximity of these sites to roads generally precludes their use by large predatory animals; however, small rodents or birds may be found foraging at the site. Appendix A contains a list of species that may occur within ecological communities identified at Site 8.

5.3.1.4 Operable Unit 4 OU 4 consists of Site 10, the Rubble Disposal Area shown on Figure 2-7. It extends due north from the Perimeter Road along the eastern edge of Rowell Creek (south of Lake Fretwell). The following upland communities were identified at Site 10, roughly from east to west: disturbed upland, mixed hardwood/pine community, and upland mixed forest. A description of upland habitats at OU 4 is provided in Table 5-25.

Disturbed upland areas are dominated by graminoids and other herbaceous plants, with a sparse shrubby understory, and no arboreal canopy. These areas are best characterized as degraded old fields, overgrown fields, weedy parking lots/storage areas, and unpaved roads.

The mixed pine and hardwood community at Site 10 is a transitional community composed of the same plant species found in upland mixed forest communities. The mixed pine and hardwood forests bordered the along and the upland mixed forest.

The upland mixed forest observed at Site 10 is a well-developed community characterized as having a closed arboreal canopy and sandy-clay soils with organic or sometimes calcareous components. The rolling topography usually contributes to water runoff, however the soils and leaf litter conserve soil moisture (FNAI, 1990). This community is likely preceded by an upland pine community.

Tree and shrub species found at Site 10 include sweetgum, Carolina cherry, southern bayberry, gallberry (*Ilex glabra*) and other hollies, red cedar, water oak, Spanish oak, live oak, saw palmetto, bay, blueberry, dahoon holly, cypress, sweetbay magnolia, red maple, and false willow. Herbaceous and graminoid plant species found at Site 10 include bullbriar greenbriar, bracken fern, wild poinsettia (*Poinsettia heterophylla*), dog fennel, yellow aster, dry grass, fleabane, coralberry (*Symphoricarpos orbiculatus*), sea myrtle (*Baccharis halmifolia*), grasses, goldenrod, Virginia creeper, peppervine (*Ampelopsis arborea*), thistle, morning glory (*Ipomoea* sp.), muscadine grape, evening primrose (*Oenothera* sp.), crabgrass, rudbeckia, trumpet creeper (*Campsis radicans*), holly, flat-topped white aster, beauty berry (*Callicarpa americana*), panic grass, persimmon (*Diospyros virginiana*), meadow beauty (*Rhexia virginica*), grass, poison ivy (*Toxicodendron radicans*), blazing star (*Liatris tenuifolia* and other species), climbing fern (*Ligodium* sp.), bamboo, grape fern (*Botrychium* sp.), red aster, climbing hempweed (*Mikania scandens*), clubmoss (*Lycopodium* sp.), meadow beauty (*Rhexia virginica*), violet (*Viola* sp.), yellow-eyed grass, rushes, pea (*Cassia* sp.), vervain, maiden-hair fern (*Adiantum pedatum*), pokeweed, cinnamon fern, royal fern (*Osmunda regalis*), pickerelweed (*Pontederia cordata*), buckwheat, wild pointsettia, and lobelia.

5.3.1.5 Operable Unit 5 OU 5 consists of Sites 14 and 15. Site-specific descriptions are provided below. The locations of Sites 14 and 15 are depicted on Figures 2-8 and 2-9, respectively. A description of upland habitats at OU 5 is provided in Table 5-25.

Site 14, the Blue 5 Ordnance Disposal Area, is located in the Yellow Water Weapons Area. The terrestrial community identified at this site is disturbed upland. Disturbed upland areas are dominated by graminoids and other herbaceous plants, with a sparse shrubby understory, and no arboreal canopy. These areas are best described as degraded old fields, overgrown fields, weedy parking lots/storage areas, and unpaved roads. The limited cover and proximity of these sites to roads generally precludes their use by large predatory animals; however, small rodents or birds may be found foraging at the site.

Tree and shrub species observed at Site 14 include myrtle-leafed holly (and other hollies, slash pine, southern bayberry, water hemlock (*Cicuta* sp.), and tall gallberry holly (*Ilex glabra*). Herbaceous and graminoid plant species observed at Site 14 include twig rush, sedges, hatpins, yellow-topped aster, blazing star, sand blackberry, St. Johnswort, grasses, yellow-eyed grass, common dodder (*Cuscuta* sp.), white bracted sedge (*Dichromena latifolia*), meadow beauties, rattlebox (*Sesbania* sp.), ragweed (*Ambrosia artemisiifolia*), acacia, dog fennel, redroot, foxtail clubmoss (*Lycopodium alopecuroides*), bugleweed (*Lycopus* sp.), seedbox (*Ludwigia alternifolia*), rabbit tobacco (*Gnaphalium obtusifolium*), twig rush, sea myrtle, muscadine grape, hatpins, agalinis, hooded pitcher plant (*Saracenia minor*), bog buttons, asters, sundew (*Drosera* sp.), horned bladderwort (*Utricularia cornuta*), purple bladderwort (*U. purpurea*), and tickseed (*Coreopsis gladiata*).

Site 15, the Blue 10 Ordnance Disposal Area, is located in the western portion of the Yellow Water Weapons Compound. Upland ecological communities observed at Site 15 include disturbed uplands, mesic planted pine flatwoods (ranging from a dense, shrubby understory to no understory dominated by pine needle duff), mesic mixed pine and hardwoods and pine flatwoods with dry prairie characteristics. Most of the roadside canopy was a disturbed mixed pine and hardwood community. Dry prairie habitats occur in flat, moderately to poorly drained terrain and are controlled by periodic burns, thus limiting pine introduction into the community.

Some features of the planted pine flatwoods exhibit similar characteristics defined by the FNAI as upland pine forest (which grades into upland mixed forest), mesic flatwoods, and wet flatwoods. The pine flatwoods are characterized by rolling hills composed of sandy soils with variable amounts of clay (thus retaining soil moisture).

The majority of the site, composed of planted pine flatwoods, was dominated by slash pines. Other tree and shrub species observed at Site 15 include sweetgum, southern bayberry, hollies, red maple, saw palmetto, bay, live oak, water oak, occasional longleaf pine, gallberry, laurel oak, turkey oak, scrub oak, sweetbay magnolia, and cedar. Herbaceous and graminoid species observed at Site 15 included bullbriar greenbriar, muscadine grape, graminoids, Virginia creeper, poison ivy, white sabatia (*Sabatia brevifolia*), bamboo, yellow star grass, morning glory, beauty berry, ragweed, yellow-eyed grass, various ferns, blackberry,, mullein (*Verbascum thapsus*), blue curls (*Trichostema dichotomum*), ragweed, fleabane, morning glory, thistle, cinnamon fern, sedges, sphagnum moss (*Sphagnum* sp.), royal fern, netted chain fern, Spanish moss, dog fennel, bracken fern, acacia, lichens, mimosa, yellow pea, verbena, blue sage (*Salvia azurea*), and beauty berry.

5.3.1.6 Operable Unit 6 OU 6, which consists of Site 11, the Pesticide Disposal Area, is located in the middle of the NAS Cecil Field Golf Course (between fairways 17 and 11). Figure 2-10 shows the habitats present at Site 11. The ecological communities found at this site include a mixed hardwood community (with dry swamp characteristics), a mixed pine and hardwood community, planted pine flatwoods, and mowed grass (the fairways). The mixed pine and hardwood and planted pine flatwoods communities have a fairly open understory with ground litter dominated by pine needle duff. A description of upland habitats at OU 6 is presented in Table 5-25.

Some features of the planted pine flatwoods exhibit similar characteristics defined by the FNAI as upland pine forest (which grades into upland mixed forest), mesic flatwoods, and wet flatwoods. The pine flatwoods are characterized by rolling hills composed of sandy soils with variable amounts of clay (thus retaining soil moisture).

The mixed pine and hardwood community, a transitional community, is composed of the same plant species found in the planted pine and upland mixed forest communities. The mixed pine and hardwood forests were scattered in or bordering the stands of planted pine plantations (e.g., along roadsides), and were primarily dry.

In the maintained areas (roadsides and fairways) there may be a limited assemblage of terrestrial invertebrates and birds found in these managed grassy areas, however, the occurrence of ecological receptors foraging in these areas is expected to be minimal.

Tree and shrub species observed at Site 11 include sweetgum, saw palmetto, longleaf pine, live oak, cherry, water oak, red maple, baldcypress (*Taxodium distichum*) (dead trunks), fetterbush, bay, southern bayberry, laurel leaf oak, and sweetbay magnolia. Herbaceous and graminoid species observed at Site 11 include cinnamon fern, goldenrod, greenbriar, muscadine grape, poison ivy, ferns, sedges, Virginia creeper, beauty berry, and blackberry.

5.3.1.7 Operable Unit 7 OU 7 consists of Site 16, the AIMD Seepage Pit and adjacent area. Figure 2-11 shows the location of Site 16. Site 16 is vegetated with approximately 22,000 square feet of mowed grass. Surface soil staining and stressed vegetation from waste activities were not visible during site visits in 1988, 1991, and 1993. The general area adjacent to Site 16 is relatively flat and is covered with asphalt and concrete. Because Site 16 is a small area of mowed grass surrounded by paved roadways and parking and storage lots in an industrialized area, terrestrial receptors are not expected to reside at this site. In the mowed grass areas, there may be a limited assemblage of terrestrial invertebrates and birds found in these managed grassy areas; however, the occurrence of ecological receptors foraging in these areas is expected to be minimal.

5.3.1.8 Operable Unit 8 Terrestrial areas of Site 3 consist of scrubby flatwoods and disturbed, grassy uplands (Figure 2-12). A description of these habitats is presented in Table 5-25. An upland community consisting primarily of disturbed uplands with some characteristics of a dry prairie occurs in the western part of Site 3, both to the north and south of the Lake Fretwell service road. The Site 3 disposal areas are located in this part of the site. This area consists of flat, sandy soil with dense ground cover, and little to no trees. Typical vegetation identified here includes ragweed, goldenrod, dog fennel, bracken fern, sand blackberry, golden ragweed, and muscadine grape. Scattered wax myrtle and slash pine are also present.

A small part of the northern end of the study area most closely resembles the FNAI (1990) scrubby flatwoods cover type. The area is flat and sandy with scattered pine trees, a sparse shrubby understory, and barren sand. Typical vegetation identified in this area includes longleaf pine, loblolly pine, saw palmetto, myrtle oak, goldenrod, and sand blackberry.

It is likely that the invertebrate biomass at the Site 3 uplands serves as a forage base for a limited number of wildlife species, including amphibians, reptiles, birds, and mammals. Upland habitats likely support several reptilian and amphibian species, including 20 to 30 species of reptiles and amphibians (Ashton and Ashton, 1988; 1989; 1991). Species of mole salamander spend at least part of the year in pine woodlands (such as the scrubby flatwoods at Site 3), and a number of other salamanders, frogs and toads may also occur in this habitat. Several lizard species and colubrid snakes may also be found in disturbed pine forest communities (Ashton and Ashton, 1988).

Depending upon the vegetative association, southeastern pine forests provide habitat for a diverse array of avifauna, including insectivorous gleaners of pine needles and bark, flycatchers, a seed-eating assemblage, and nocturnal and diurnal aerial predators (Wolfe and others, 1988). The scrubby flatwoods along the northern boundary of Site 3 are expected to host such an assemblage, and the edge of this wooded area allows for additional diversity of species. Birds of prey such as the black vulture, turkey vulture, red-tailed hawk, and red-shouldered hawk search for prey items in the more open regions, and granivorous birds such as the mourning dove and northern bobwhite are likely to occur in this upland community.

Mammals that may occur in scrubby flatwoods include the rabbit, the hispid cotton rat, and the cotton mouse, as well as the armadillo. Predatory mammals such as the red fox and gray fox may feed on small mammals at these sites, and white-tailed deer may forage here.

Disturbed grassy uplands typically host reptiles such as the box turtle (*Terrapene carolina*), six-lined racerunner (*Cnemidophorus sexlineatus*), black racer (*Coluber constrictor*), and coachwhip (*Masticophus flagellum*). Birds likely to forage here include the turkey vulture, bobwhite, and meadowlark. The least shrew (*Cryptotis parva*), cotton rat, harvest mouse (*Reithrodontomys humulis*), spotted skunk (*Spilogale putorius*), and bobcat (*Lynx rufus*) are among mammals typically found in this habitat (FNAI, 1990).

5.3.2 Other Sites and PSCs Upland habitats have also been characterized for additional PSCs that are not associated with OUs. Descriptions of these are presented below.

5.3.2.1 PSC 4 PSC 4, the Historical Grease Pits shown on Figure 2-13, extends from the Perimeter Road to the western edge of Lake Fretwell. Upland communities identified by ABB-ES biologists include disturbed uplands, planted pine flatwoods and mixed pine and hardwoods and dry prairies. A description of these habitats is provided in Table 5-25.

Disturbed upland areas are dominated by graminoids and other herbaceous plants, with a sparse shrubby understory, and no arboreal canopy. These areas are best characterized as degraded old fields, overgrown fields, weedy parking lots/storage areas, and unpaved roads. The limited cover and proximity of these sites to roads generally precludes their use by large predatory animals; however, small rodents or birds may be found foraging at the site.

Some features of the planted pine flatwoods exhibit similar characteristics defined by the FNAI as upland pine forest (which grades into upland mixed forest), mesic flatwoods, and wet flatwoods. The pine flatwoods are characterized by rolling hills composed of sandy soils with variable amounts of clay (thus retaining soil moisture).

The mixed pine and hardwood community, a transitional community, is composed of the same plant species found in the planted pine. The mixed pine and hardwood forests were found scattered in or bordering stands of planted pines (e.g., along roadsides).

Dry prairie habitats occur in flat, moderately to poorly drained terrain and are controlled by periodic burns, thus limiting pine introduction into the community.

The planted pine flatwoods are dominated by slash pine; other tree and shrub species observed at PSC 4 include southern bayberry, red maple, gallberry, redbay, oaks, sweetbay magnolia, scrub oak, myrtle-leaf holly, dwarf chinquapin oak (*Quercus prinoides*), Spanish oak, and saw palmetto. Herbaceous and graminoid species observed at PSC 4 include agalinis, acacia, greenbriars, indigo (*Baptista* sp.), ragweed, buttonbush, redroot, rushes, seedbox, netted chain fern, cowbane, royal fern, cinnamon fern, meadow beauty, goldenrod, grasses, blackberry, muscadine grape, persimmon, wiregrass, bracken fern, bullbriar greenbriar, dog fennel, blazing star, and winged sumac.

5.3.2.2 **PSC 6** PSC 6, the Lake Fretwell Rubble Disposal Area shown on Figure 2-14, is located along the eastern shore of Lake Fretwell, due south of the recreation area, and southwest of the wastewater treatment plant. The following upland ecological communities, as described in Table 5-25, were found at the site: mowed grass, disturbed upland, planted pine flatwoods. The degraded area with concrete rubble has very little exposed ground.

Disturbed upland areas or overgrown fields are dominated by graminoids and other herbaceous plants, with a sparse shrubby understory, and no arboreal canopy. The limited cover and proximity of these sites to roads generally precludes their use by large predatory animals; however, small rodents or birds may be found foraging at the site.

Some features of the planted pine flatwoods exhibit similar characteristics defined by the FNAI as upland pine forest (which grades into upland mixed forest), mesic flatwoods, and wet flatwoods. The pine flatwoods are characterized by rolling hills composed of sandy soils with variable amounts of clay (thus retaining soil moisture).

Tree and shrub species observed at the site during the September, 1995 field visit by ABB-ES biologists include slash pine (in the planted pine flatwoods), sweetgum, red maple, water oak, black cherry, sweetbay magnolia, southern bayberry, elderberry, and buttonbush. Herbaceous and graminoid species observed at PSC 6 include great cane bamboo, muscadine grape, grasses, dog fennel, rattlebox, and Spanish needles.

In the mowed grass areas, there may be a limited assemblage of terrestrial invertebrates and birds found in these managed grassy areas, however, the occurrence of ecological receptors foraging in these areas is expected to be minimal. Appendix A contains a list of receptors potentially occurring in disturbed upland, planted pine flatwoods and maintained grass areas.

5.3.2.3 **PSC 9** PSC 9, the Recent Grease Pits shown on Figure 2-15, is located south of the flightline area and east of PSC 10 along a service road. A wooded area is south of PSC 9 across the service road. The site itself is primarily an overgrown field, or disturbed upland (Table 5-25).

Disturbed upland areas are dominated by graminoids and other herbaceous plants, with a sparse shrubby understory, and no arboreal canopy. These areas are characterized as degraded old fields, overgrown fields, weedy parking lots/storage areas, and unpaved roads. The limited cover and proximity of these sites to roads generally precludes their use by large predatory animals; however, small rodents or birds may be found foraging at the site.

Shrubs encountered at PSC 9 include black willow and southern bayberry. Herbaceous and graminoid species observed at PSC 9 include blazing star, yellow aster, dog fennel, hempweed, thistle, seedbox, goldenrod, greenbriar, yellow-eyed grass, Spanish needles, fleabane, mimosa, mosses, poison ivy, burr-reeds, meadow beauty, agalinis, rattlebox, cowbane, white-eyed grass, acacia, grasses, sedges, narrow-leaved seedbox, round-leaved sundew, and peas. Gastropod shells were also found by ABB-ES biologists at PSC 9.

5.3.2.4 **PSC 12** PSC 12, the Public Works Rubble Disposal Area shown on Figure 2-16, is located near the base recycling area behind the Public Works Department. The majority of the site is used for storage and as a parking area; electrical lines run overhead, therefore, the area is kept clear of large trees. Disturbed upland community describes the area covered by PSC 12 (Table 5-25). Behind the site (to the east) are planted pine flatwoods; large piles of fill material and rubble have been deposited in the transition area between the disturbed uplands and the pine flatwoods.

Disturbed upland areas are dominated by graminoids and other herbaceous plants, with a sparse shrubby understory, and no arboreal canopy. These areas are characterized as degraded old fields, overgrown fields, weedy parking lots/storage areas, and unpaved roads. The limited cover and proximity of these sites to roads generally precludes their use by large predatory animals; however, small rodents or birds may be found foraging at the site.

Some features of the planted pine flatwoods exhibit similar characteristics defined by the FNAI as upland pine forest (which grades into upland mixed forest), mesic flatwoods, and wet flatwoods. The pine flatwoods are characterized by rolling hills composed of sandy soils with variable amounts of clay, which retains soil moisture.

Tree species observed at PSC 12 include longleaf pine, cabbage palm, saw palmetto, slash pines, water oak, gallberry, and live oak. Herbaceous and graminoid species observed at PSC 12 include grasses, fleabane, sedges, Spanish needles, ragweed, acacia, seedbox, Virginia creeper, sea myrtle, rattlebox, dog fennel, verbena, morning glory, goldenrod, muscadine grape, blackberry, and bracken fern.

5.3.2.5 **PSC 18** PSC 18, the Ammunition Disposal Area shown on Figure 2-17, is located in a forested area in the eastern and central portion of NAS Cecil Field. The upland community observed at PSC 18 is planted pine flatwoods (Table 5-25).

Some features of the planted pine flatwoods exhibit similar characteristics defined by the FNAI as upland pine forest (which grades into upland mixed forest), mesic flatwoods, and wet flatwoods. The pine flatwoods are characterized by rolling hills composed of sandy soils with variable amounts of clay, which retains soil moisture.

The closed arboreal canopy at the site is dominated by red maple and water oak, with occasional tupelo, ashes, and other oaks. The understory was open, and dominated by saw palmetto. Other shrub and herbaceous species observed at the site include southern bayberry, redbay, bryophytes, anolis, meadow beauty, lyonia, St. Johnswort, blueberry, sweetgum, inkberry, nannyberry (*Viburnum lentago*), winged sumac, netted chain fern, muscadine grape, bullbriar greenbriar, panic grass, golden club (*Orontium aquaticum*), cross vine (*Bignonia* sp.), redberry greenbriar, and cinnamon fern.

5.3.2.6 PSC 19 PSC 19, the Rowell Creek Rubble Disposal Area shown on Figure 2-18, is located due west of Rowell Creek and south of 6th Street. Upland communities identified by ABB-ES biologists during the September 1995 field visit, include (roughly from the west towards Rowell Creek) disturbed uplands, planted pine flatwoods, mixed pine and hardwoods and upland mixed forest (Table 5-25).

Disturbed upland areas are dominated by graminoids and other herbaceous plants, with a sparse shrubby understory, and no arboreal canopy. Degraded old fields, overgrown fields, weedy parking lots/storage areas, and unpaved roads characterize this type of area. The limited cover and proximity of these sites to roads generally precludes their use by large predatory animals; however, small rodents or birds may be found foraging at the site.

Some features of the planted pine flatwoods exhibit similar characteristics defined by the FNAI as upland pine forest (which grades into upland mixed forest), mesic flatwoods, and wet flatwoods. The pine flatwoods are characterized by rolling hills composed of sandy soils with variable amounts of clay (thus retaining soil moisture).

The mixed pine and hardwood community, a transitional community, is composed of the same plant species found in the planted pine and upland mixed forest communities. The mixed pine and hardwood forests were scattered in and bordering stands of planted pine plantations (e.g., along roadsides).

Upland mixed forests are well-developed communities characterized as having a closed arboreal canopy and sandy-clay soils with organic or sometimes calcareous components. The rolling topography usually contributes to water runoff, however the soils and leaf litter conserve soil moisture (FNAI, 1990). This community is likely preceded by an upland pine community.

The dominant tree species observed at the site include red maple, slash pine, southern bayberry, black cherry, and sweetgum. Other tree and shrub species included holly, saw palmetto, sourwood, redbay, sweetbay magnolia, red ash (*Fraxinus pennsylvanica*), ironwood (*Carpinus caroliniana*), and hornbeam (*Ostrya* sp.). Herbaceous and graminoid species observed at PSC 19 include barberry, black comb fern, bullbriar greenbriar, muscadine grape, poison ivy, bamboo, cinnamon fern, lady fern (*Athyrium filix-femina*), netted chain fern, sedges, royal fern, New York fern (*Thelypteris noveboracensis*), golden club, laurel greenbriar, lizard's tail, bracken fern, Spanish needles, blackberry, yellow-eyed grass, sweetbells (*Leucothoe* sp.), yellow aster, dog fennel, bluestem (*Andropogon viscosum*), Virginia creeper, and morning glory.

<u>5.3.3 Other Studies</u> A facilitywide survey of the gopher tortoise (*Gopherus polyphemus*), which is listed as a species of special concern by the Florida Game

and Fresh Water Fish Commission, was conducted (CZR, 1994) to identify suitable habitat, estimate population numbers, develop management guidelines, determine potential mitigation sites, and determine the existence of other endangered, threatened or special concern species within the survey areas. The estimated number of gopher tortoises at NAS Cecil Field (90 percent confidence limit) totaled 1319 ± 167, with an estimated additional 12 ± 25 animals scattered throughout the Yellow Water Complex (see Section 2.5 and Table 2-2). Total estimated habitat acreage was 3,075 acres at NAS Cecil Field, and an additional 245 acres in the Yellow Water Weapons area. Suitable habitat for the gopher tortoise includes the pine flatwoods, longleaf pine/turkey oak hills, shrub and brushland, and altered and ruderal land. No other protected species were observed at NAS Cecil Field or the Yellow Water Complex during this study (CZR, 1994).

5.4 WETLAND STUDIES. Wetland studies include examination and sampling of wetlands at NAS Cecil Field. The objectives and scope of wetland studies are reported in Appendix C. Appendix A-1 includes a list of wetland plant species observed at NAS Cecil Field. Study results are summarized in the following subsection according to OU and PSC. A description of wetland habitats at the OUs and PSCs is presented in Table 5-26. Wetland habitats identified at OUs and PSCs that were not comparable to the classifications systems of Cowardin and others (1979) or FNAI (1990) are presented in site-specific text descriptions. Wetland studies not yet completed for a specific OU or PSC are summarized in Subsection 5.4.3.

5.4.1 Operable Units Wetland assessments have been conducted at OUs 1, 2, 7 and 8 (Table 5-26). Wetlands were delineated according to current State of Florida (FDER, 1990) and Federal guidelines (Environmental Laboratory, 1987a). Based on a review of regulations and discussions with the FDEP representatives, it was determined that the U.S. Army Corps of Engineers delineation technique would satisfy the State of Florida guidelines. Wetland communities were described according to their USFWS classification (Cowardin and others, 1979) and FNAI counterpart. It should be noted, however, that the FNAI wetland classification system describes undisturbed vegetative communities. In addition, there is considerable overlap between communities identified according to the FNAI. Wetlands were also evaluated for their value and ability to perform certain wetland functions (CDM, 1994). The functional assessment was completed using a computer model called the Wetland Evaluation Technique (WET) to identify and evaluate remedial alternatives for each OU. The results of the WET analyses are presented in the Wetlands Assessment Report (CDM, 1994).

Wetlands were also characterized at OUs 3, 4, 5, and 6 by ABB-ES ecologists and were described according to the USFWS classification (Cowardin and others, 1979) and FNAI (1990), where possible. These are summarized in Table 5-26 and locations are depicted on Plate 1. Descriptions are provided below for each OU.

5.4.1.1 Operable Unit 1 Table 5-26 presents the USFWS and corresponding FNAI wetland classifications at OU 1, Sites 1 and 2 (respectively) along with a description of the wetland characteristics and observed vegetation. Plate 1 and Figures 2-1 and 2-2 depict the locations of wetlands at Sites 1 and 2, respectively. The wetland and upland habitats at both Sites 1 and 2 have been significantly altered in the past due to a variety of manmade disturbances, including construction, modifications, or grading.

Table 5-26
Wetland Classification System Characteristics

Basewide Ecological Assessment
Naval Air Station Cecil Field
Jacksonville, Florida

USFWS Classification[1]	Corresponding FNAI Classification[2]	Description	Representative Vegetation (common name)	Location
Palustrine Forested Broad-Leaved Deciduous	Floodplain Swamp	Occurs on flooded soil along stream channels.	Red maple, laurel oak, water ash, and bald cypress.	OU 1, Site 1 & 2 OU 2, Site 5 OU 5, Site 15 PSC 4 PSC 18 PSC 19
Palustrine Forested Broad-Leaved Deciduous	Bottomland Forest	Closed canopy forest occurring on low-lying flatlands that border streams with distinct banks.	Red maple, sweet-gum, slash pine, lob-lolly pine, sweetbay, cinnamon fern, and wax myrtle.	
Palustrine Forested Broad-Leaved Deciduous	Hydric Hammock	Well-developed hardwood and cabbage palm forest with variable understory; low, flat, wet sandy areas.	Cabbage palm, dia-mond-leaf oak, red cedar, red maple, swamp bay, sweet-bay, water oak.	OU 2, Site 17 PSC 4
Palustrine Scrub/Shrub Broad-Leaved Deciduous	Wet Flatwoods	Relatively open canopy; flat, poorly drained ter-rain.	Loblolly pine, slash pine, longleaf pine, sweetbay, sedges, wax myrtle, and gall-berry.	OU 1, Site 1
Palustrine Scrub/Shrub Broad-Leaved Deciduous	Seepage Slope	Usually saturated but rarely inundated.	Loblolly pine, slash pine, longleaf pine, titi, wax myrtle, and gallberry.	
Palustrine Emergent Persistent	Floodplain Marsh	Usually flooded with flow-ing water.	Arrowheads, bog but-tons, rushes, sedges, dotted smartweed, black willow, sweet-bay, royal fern, hat pins, and cattail.	OU 1, Site 1 & 2 OU 2, Site 5 PSC 6
Riverine	Seepage Stream	Perennial or intermittent seasonal water courses originating from shallow ground waters that have percolated through deep, sandy, upland soils.	Few aquatic flora; filamentous green algae, tape grass and pondweed.	OU 4, Site 10
No Comparable Classification	Wet Prairie (Wet Meadow)	Treeless with sparse to dense ground cover on low, relatively flat, poorly drained terrain.	Southern bayberry, hollies, herbaceous species and graminoids	OU 5, Site 14

Source: Camp, Dresser, and Mckee, 1993.
[1] Cowardin and others, 1979.
[2] Florida Natural Areas Inventory (FNAI), 1990.

Notes: USFWS = U.S. Fish and Wildlife Service.
OU = operable unit.
PSC = potential source of contamination.

Approximately three-fourths of Site 1 is classified as wetland. The remaining one-fourth of the study area consists of planted pines along the western edge. A cypress dome with mature bald cypress trees and associated mature hardwood species exists at Site 1. The area adjacent to Rowell Creek on the eastern side of the berm (Palustrine Forested Broad-Leaved Deciduous [Cowardin and others, 1979] or Floodplain Swamp [FNAI, 1990], is prone to intermittent flooding by Rowell Creek. Wetlands on the western side of the berm (Palustrine Scrub and Shrub Broad-Leaved Deciduous [Cowardin and others, 1979] or Wet Flatwoods and Seepage Slope [FNAI, 1990]), contain soil of heterogeneous moisture, and are located on the former landfill. Runoff from this area migrates downslope eastward toward Rowell Creek. The northern part of this system (Palustrine Emergent Persistent Wetland [Cowardin and others, 1979]) is fed from a nearby artesian groundwater spring located to the northeast of Site 2. This area remains saturated due to the presence of groundwater discharge and surface runoff. Characteristic flora of this area include arrowheads (*Sagittaria latifolia*), sedges, and black willow.

To the east of Site 2, wetlands fall within two USFWS classes including Palustrine Forested Broad-Leaved Deciduous and Palustrine Emergent Persistent (Cowardin and others, 1979). The Palustrine Forested area corresponds to two FNAI wetland classes including the Floodplain Swamp and Bottomland Forest. The Bottomland Forest borders Rowell Creek where the banks are distinct, such that water rarely overflows the stream channel to inundate the forest. The water table is usually high in these areas. Floodplain Swamp areas are also located along Rowell Creek in low-lying areas where floodwater collects.

The Palustrine Emergent Persistent area is inundated by water from a groundwater seep. The seep drains overland approximately 80 feet and is diverted into a manmade channel where it empties into an Emergent Persistent wetland area prior to entering Rowell Creek. This area is inundated throughout much of the year.

OU 1 wetlands support an abundance of wildlife. Ecological diversity in these areas was confirmed through the observation and signs of numerous wildlife species, including the barred owl (*Strix varia*), screech owl (*Otus asio*), sharp-shinned hawk (*Accipiter velox*), pygmy rattlesnake, water moccasin (*Agkistrodon piscivorus conanti*), and other snakes.

5.4.1.2 **Operable Unit 2** Table 5-26 presents the USFWS and corresponding FNAI wetland classifications at OU 2, Sites 5 and 17 (respectively) along with a description of the wetland characteristics and observed vegetation. Plate 1 and Figures 2-3 and 2-4 depict the locations of wetlands at Sites 5 and 17, respectively.

The wetland identified at Site 5 falls under two USFWS classes: Palustrine Forested Broad-leaved Deciduous and Palustrine Emergent Persistent (Cowardin and others, 1979). The Palustrine Forested Wetland to the east of the site is associated with the Rowell Creek and Lake Fretwell floodplain. This area is classified as Palustrine Forested Broad-leaved deciduous (Cowardin and others, 1979) or Floodplain Swamp (FNAI, 1990). This section of Site 5 is prone to intermittent flooding by Rowell Creek. The dominant tree in this region is red maple, with occasional sweet bay and bald cypress. The shrub understory is open and includes alder (*Alnus serrulata*), titi (*Cyrilla racemiflora*), wax myrtle, gallberry, fetterbush, and swamp bay. Herbaceous species noted in this region include cinnamon fern, royal fern, netted chain fern, and poison ivy.

A small region of persistent, palustrine, emergent vegetation occurs between upland parts of Site 5 and the Rowell Creek and Lake Fretwell Floodplain Swamp. This community is located in the northeastern region of the study area. This open region includes royal fern, fragrant water lily (*Nymphea odorata*), bog buttons, spatterdock (*Nuphar luteum*), and St. Johnswort. This open area is surrounded by the Site 5 uplands to the west, forested floodplain to the east and north, and the Site 5 drainage ditch to the south.

The drainage ditch leading from Site 5 to Lake Fretwell is characterized by flooded soil along parts of the drainage ditch channel. The approximately 12- to 15-foot-wide drainage ditch is relatively linear, with banks sloping from 2:1 to 3:1. Parts of the drainage ditch channel are dominated by lizard's tail, rushes, and sedges. The banks of the drainage ditch are densely vegetated with shrubby cover, including alder, elderberry, false willow, wax myrtle, and black willow.

At Site 17, the wetland identified to the east (Plate 1 and Figure 2-4) falls within two USFWS cover classes (Cowardin and others, 1979) (Palustrine Forested Broad-leaved Deciduous and Palustrine Emergent Persistent). This forested area includes a well-developed hardwood community, with a dense shrubby and herbaceous understory. Dominant woody vegetation in this region includes red maple, swamp bay, sweet bay, sweet gum, gallberry, and wax myrtle. Herbaceous and lianoid species noted in this wetland region include sphagnum moss, royal fern, colic root, cinnamon fern, yellow jessamine (*Gelsemium sempervirens*), poison ivy, green briar, and Virginia creeper. Several stands of hooded pitcher plant and a species of grass pink (*Calopogon tuberosus*) were also observed in this wetland. These species are both designated as threatened species according to the FGFWFC (1993).

The Rowell Creek floodplain and its associated wetlands are expected to provide suitable habitat for a diverse assemblage of wildlife species. A rich diversity of invertebrates inhabits the floor and arboreal canopy of floodplain forests in the region. These invertebrates are consumed by a number of amphibian, reptile, bird, and mammal species, which in turn provide food for many secondary and tertiary consumers.

Signs of raccoon (*Procyon lotor*) and white-tailed deer were encountered in the floodplain swamp, which likely provides habitat for a number of insectivorous, herbivorous, and carnivorous mammals, as well as a diverse assemblage of reptiles and amphibians. Reptiles typically occurring in such floodplains included the water moccasin, as well as several snake and turtle species. Amphibian species likely occurring in such areas include oak toads (*Bufo quercicus*) and southern leopard frog (*Rana sphenocephala*). Various species of mole salamander, treefrog (*Hyla* spp.), and grass frog (*Pseudacris* spp.) may also occur in wetland habitats at either site.

Birds commonly observed at palustrine forests include swamp sparrow, Carolina wren (*Thryothorus ludovicianus*), northern cardinal, and common yellowthroat (*Geothlypis trichas*). Open water regions in the floodplain may provide habitat for mallards (*Anas platyrhynchos*), wood ducks (*Aix sponsa*), and a number of wading birds including great blue herons (*Ardea herodias*). Beaver, raccoon, otter (*Lutra canadensis*), and opossum (*Didelphis virginiana*) are also known to occur in forested wetlands at NAS Cecil Field. The short-tailed shrew, an insectivorous small mammal, is known to occur in wetland forests in Florida (O'Neil and Mettee, 1982).

5.4.1.3 Operable Unit 3 Site 7 does not include wetland habitats. Site 8 includes some manmade ditches (Plate 1 and Figure 2-6) of 2 to 5 feet in width, with undeveloped banks (i.e., the banks are gently sloping), shallow and grass-lined, and containing stagnant to slow-moving water (often with tannin staining). It is possible that these ditches provide minimal suitable habitat for aquatic macroinvertebrates.

5.4.1.4 Operable Unit 4 The eastern portion of OU 4, Site 10 consists of wetlands including a transitional hardwood/floodplain forest area grading down into the blackwater stream, floodplain swamp, and blackwater stream (Table 5-26). A seepage stream was found along the northern terminus of the site, and a manmade drainage ditch was found in the southern portion of the site (Plate 1 and Figure 2-7).

Typically, floodplain forest communities are dominated by hardwoods and occur on the dry soils of the upper reaches of a floodplain (i.e., on levees, impoundments, river terraces); floodplain forests are usually inundated for a portion of the growing season (FNAI, 1990).

Seepage streams are described by the FNAI (1990) as clear, narrow, and shallow perennial or intermittent seasonal streams fed primarily by shallow groundwater that percolates through sandy soils. The surrounding forest habitat typically is dominated by hardwoods which block most of the sunlight (resulting in a lack of aquatic flora). The stream observed at Site 10 was sandy-bottomed, channelized, clear, and had a flow velocity of approximately 1 ft/sec. The banks of the stream were approximately 12 feet across (from the tops of the slopes), unvegetated, and were overhanging providing good habitat for semi-aquatic mammals and reptiles.

Plants observed in the wetlands at the site include sundew, cattails, rushes, water pennywort (*Hydrocotyle americana*), cardinal flower (*Lobelia cardinalis*), and horsetails.

5.4.1.5 Operable Unit 5 Site 14, the Blue 5 Ordnance Disposal Area shown on Plate 1 and Figure 2-8, is located in the Yellow Water Weapons Area. Wetland communities found at this site include manmade drainage ditches, wet planted pine flatwoods, wet meadow, and scrub-shrub marsh with depression/emergent marsh characteristics (Table 5-26).

The wet meadow area was characterized as a disturbed wetland with occasional slash pines, poorly drained soils, overgrown bushes, and weedy edges. The dominant shrubs observed in the wet meadows at Site 14 include various southern bayberry and hollies. Hooded pitcher plant, diodia (*Diodia virginiana*), bog buttons, asters, rabbit tobacco, dog fennel, purple bladderwort, tickseed, Maryland meadow beauty climbing hempweed, sundew, agalinis, blazing star, bugleweed, horned bladderwort, grasses, sedges, asters, seedbox, yellow-top, foxtail clubmoss, and ragweed were found in the wetland at Site 14. Some features of the planted pine flatwoods exhibit similar characteristics defined by the FNAI as upland pine forest (which grades into upland mixed forest), mesic flatwoods, and wet flatwoods. The pine flatwoods are characterized by rolling hills composed of sandy soils with variable amounts of clay (thus retaining soil moisture).

The scrub-shrub marsh is characterized by poorly drained, saturated soils and was dominated by sedges, rushes, and hydrophytes with scattered shrubs and saplings. Various plant species observed in the shrub and sapling layers include sourwood, titi, red maple, fetterbush, redbay, tupelo, and slash pine. Herbaceous plant species observed in this community include hatpins, seedbox, netted chain fern, cowbane, knotweed, St. Johnswort, and royal fern.

Site 15, the Blue 10 Ordnance Disposal Area shown on Plate 1 and Figure 2-9, is located in the western portion of the Yellow Water Weapons Compound. Wetland communities observed at the site include wet planted pine flatwoods with a dense, shrubby understory dominated by hollies, wet mixed pine/hardwoods, manmade drainage ditches, first-order tributaries with tannin staining, and floodplain swamps with dome swamp characteristics (Table 5-26).

Some features of the wet planted pine flatwoods exhibit similar characteristics defined by the FNAI as upland pine forest. The wet pine flatwoods are characterized by rolling lowland composed of sandy soils with variable amounts of clay (thus retaining soil moisture).

The wet mixed pine/hardwood community, a transitional community is composed of the same plant species found in the planted pine and upland mixed forest communities (previously mentioned). This transitional community borders the stands of planted pine plantations (e.g., along roadsides), and was, at this site, a wet area.

The manmade drainage ditches are best described as 2 to 5 feet in width, with undeveloped banks (i.e., the banks are gently sloping), shallow and grass-lined, and containing stagnant to slow-moving water (often with tannin staining). It is possible that these ditches provide minimal suitable habitat for aquatic macroinvertebrates.

First order tributaries to the Yellow Water Creek and Caldwell Creek were encountered at Site 15 (Plate 1 and Figure 2-9). These tributaries are approximately 10 feet wide, with gently sloping banks, tannin stained water, and low flow velocity (<1 feet per second [ft/sec]). Although these ditches do not provide adequate habitat for most species of fish, it is possible that some aquatic macroinvertebrate, amphibian, and reptile species may inhabit these ditches.

Floodplain swamps are typically found along stream channels and low spots within stream or river floodplains. The soils are often a variable mix of sands, alluvial material, and organic material. Floodplain swamps are characterized by buttressed, hydrophytic trees (e.g., cypress) with a sparse understory and ground cover (FNAI, 1990).

The floodplain swamps observed at Site 15 are in the vicinity of black water creeks (Yellow Water Creek and Caldwell Creek), however, there is no obvious topographical transition into a creek floodplain. Instead, the swamps appear to be depressional, inundated areas surrounded by mesic pine uplands. These depression swamps have vegetation consistent with both a floodplain swamp community and a dome swamp community (FNAI, 1990). Therefore, the swamps at Site

15 may best be characterized as floodplain swamps with some dome swamp characteristics.

Tree and shrub species observed at Site 15 include sweetgum, southern bayberry, hollies, red maple, saw palmetto, bay, live oak, water oak, occasional longleaf pine, black willow, gallberry, baldcypress, laurel oak, turkey oak, scrub oak, sweetbay magnolia, cedar, and titi. Herbaceous and graminoid species include graminoids, reindeer moss, marsh pink, clubmoss, iris, various ferns, sedges, sphagnum moss, royal fern, netted chain fern, Spanish moss, pitcher plants, and water pennywort.

5.4.1.6 **Operable Unit 6** OU 6, which consists of Site 11, does not include wetland habitats.

5.4.1.7 **Operable Unit 7** Although wetlands were not identified in the immediate area of Site 16 (CDM, 1994), wetlands are located to the east of Site 16, as shown on Plate 1 and Figure 2-11. Sal Taylor Creek, which is located approximately 5,000 feet east of OU 7, flows through and directly influences these wetlands. According to the USFWS national wetland inventory map, the wetlands east of Site 16 fall under the following seven general USFWS classes (Cowardin and others, 1979): Palustrine Forested Broad-leaved Deciduous, Palustrine Forested Needle-leaved Evergreen, Palustrine Forested Broad-leaved Evergreen, Palustrine Emergent Persistent, Palustrine Scrub and Shrub Evergreen, combination Palustrine Forested Broad-leaved Deciduous and Needle-leaved Evergreen, and Palustrine Forested Deciduous (unspecified). The distribution of these wetland classes at Site 16 are depicted on Plate 1. Table 5-26 presents the USFWS wetland classifications for the wetlands east of Site 16, a brief description of the wetland characteristics, a list of the dominant plant species expected in each wetland cover type, and a summary list of representative vegetation expected in each wetland cover type.

5.4.1.8 **Operable Unit 8** Table 5-26 contains the USFWS and corresponding FNAI wetland classifications for the OU 8 study area, along with a brief description of the wetland characteristics, and a summary list of representative vegetation in each wetland cover type. The locations of each wetland type are presented on Plate 1 and Figure 2-12.

Site 3 wetlands are best described as a mixture of Palustrine Forested and Scrub-Shrub Broad-Leaved Deciduous classes, with some Palustrine Emergent Persistent mixed in the northerly part of the wetland. The mixed forested and scrub-shrub communities most clearly resemble the FNAI classifications of Bottomland Forest, Wet Prairie, and Baygall.

The Bottomland Forest is characterized by a low-lying, closed canopy hardwood forest. Dominant trees are red maple, sweetgum, and various pines. The shrubby understory includes wax myrtle and loblolly bay. Herbaceous vegetation in this habitat includes cinnamon ferns and netted chain fern. Communities in the Wet Prairie part of Site 3 consist of sparse, dense ground cover of grasses and herbs. Dominant species include hatpins, panic grass, St. Johnswort, and meadow beauty, with some scattered wax myrtle. The baygall community, also a part of this area, is typically found in flat areas or on slopes where high lowland water tables help maintain soil moisture. Typical plants in this community include sweetbay, swamp bay, red bay, loblolly bay, gallberry, muscadine grape, netted chain fern, and cinnamon fern.

The Palustrine Emergent Persistent area, which is mixed into the northeastern part of the wetlands at Site 3, most closely approximates the FNAI Floodplain Marsh classification. It is dominated by emergent grasses, herbs, and shrubs. Typical species include sedges, bulrush, climbing hempweed, scarlet pimpernel (*Anagallis arvensis*), and dotted smartweed (*Polygonum punctatum*), along with scattered black willow and myrtle oak.

The Rowell Creek floodplain and its associated wetlands are expected to provide suitable habitat for a diverse assemblage of wildlife species. A rich diversity of invertebrates inhabits the floor and arboreal canopy of floodplain forests in the region. These invertebrates are consumed by a number of amphibian, reptile, bird, and mammal species, which in turn provide food for many secondary and tertiary consumers.

The floodplain swamp likely provides habitat for a number of insectivorous, herbivorous, and carnivorous mammals, as well as a diverse assemblage of reptiles and amphibians. Reptiles typically occurring in such floodplains include the water moccasin as well as several snake and turtle species. Amphibian species likely to occur in such areas include oak toads and southern leopard frog. Various species of mole salamander, treefrog, and grass frog may also occur in wetland habitats at Site 3.

Birds commonly observed in palustrine forests include swamp sparrow, Carolina wren, northern cardinal, and common yellowthroat. Beaver, raccoon, otter, and opossum are also known to occur in forested wetlands at NAS Cecil Field. The short-tailed shrew, an insectivorous small mammal, is known to occur in wetland forests in Florida (O'Neil and Mettee, 1982).

5.4.2 Other Sites and PSCs Wetlands were also characterized at PSCs that are not considered a part of OUs. These characterizations were completed by ABB-ES ecologists and descriptions were based upon the USFWS classification (Cowardin and others, 1979) and FNAI (1990), where possible. Findings are summarized in Table 5-26 and locations of the wetlands are depicted on Plate 1. Descriptions are provided below for each PSC.

5.4.2.1 **PSC 4** PSC 4, the Historical Grease Pits shown on Plate 1 and Figure 2-13 extends from the Perimeter Road to the western edge of Lake Fretwell. Wetland communities identified by ABB-ES ecologists include a marshy unpaved road containing carnivorous plants, scrub-shrub marsh, palustrine scrub-shrub transitional wetland, and floodplain forest. Lake Fretwell, along the eastern terminus of the site, would classify as an impounded lake that may potentially receive runoff from PSC 4. Table 5-26 presents the USFWS wetland classifications for the wetlands east of PSC 4, a brief description of the wetland characteristics, a list of the dominant plant species expected in each wetland cover type, and a summary list of representative vegetation expected in each wetland cover type.

The scrub-shrub marsh is characterized by poorly drained, saturated soils and at PSC 4 was dominated by sedges, rushes, and hydrophytes with scattered shrubs and saplings. Various plant species observed in the shrub and sapling layers included sourwood, titi, red maple, fetterbush, redbay, tupelo, and slash pine. Herbaceous plant species observed in this community included hatpins, seedbox, netted chain fern, cowbane, knotweed, St. Johnswort, and royal fern.

The palustrine scrub-shrub transitional wetland is characterized by a sapling and thick scrub-shrub layer of sweetflag (*Acorus* sp.) with moist to wet, poorly drained soils and no arboreal canopy. Saplings and shrubs observed in this community include titi, southern bayberry, sweet-bay magnolia, red bay, holly, slash pine, red maple, and oaks. Herbaceous species observed include redroot, royal fern, cinnamon fern, netted chain fern, St. Johnswort, sedges, meadow beauty, goldenrod, and water pennywort.

Typically, floodplain forest communities are dominated by hardwoods and occur on the dry soils of the upper reaches of a floodplain (i.e., on levees, impoundments, river terraces); floodplain forests are usually inundated for a portion of the growing season (FNAI, 1990).

Tree and shrub species observed at PSC 4 wetlands include southern bayberry, gallberry, titi, redbay, tupelo, oaks, sweetbay magnolia, and myrtle-leaf holly. Herbaceous and graminoid species observed at PSC 4 include sweetflag, hooded pitcher plants, round-leaved sundews, bog buttons, St. Johnswort, buttonbush, redroot, hatpins, rushes, sedges, netted chain fern, smartweed, St. Johnswort, royal fern, cinnamon fern, water pennywort, and grasses.

5.4.2.2 **PSC 6** PSC 6, the Lake Fretwell Rubble Disposal Area shown on Plate 1 and Figure 2-14, is located along the eastern shore of Lake Fretwell, due south of the recreation area, and southwest of the wastewater treatment plant. The wetland community found at the site is a depression/emergent marsh (Table 5-26).

The depression/emergent marsh is composed primarily of hydrophytic emergent vegetation. The dominant species observed at the PSC 6 marsh were cattails; other herbaceous and graminoid species observed included rushes, St. Johnswort, yellow-eyed grass, common dodder, twig rush, sedges, and white bracted sedge. Sporadic shrubs and saplings observed in and around the perimeter of the marsh include elderberry, buttonbush, slash pines, water oak, tupelo, sweetbay magnolia, southern bayberry, and willow.

5.4.2.3 **PSC 9** PSC 9, the Recent Grease Pits shown on Plate 1 and Figure 2-15, is located south of the flightline area and east of PSC 10 along a service road. Manmade drainage ditches run along the northern edge of PSC 9. Cattail, water pennywort, sedges, round-leaved sundew, and spike rush were observed.

5.4.2.4 **PSC 12** PSC 12, the Public Works Rubble Disposal Area shown on Plate 1 and Figure 2-16, is located near the base recycling area behind the Public Works Department. Wetland communities are not present at PSC 12.

5.4.2.5 **PSC 18** PSC 18, the Ammunition Disposal Area shown on Plate 1 and Figure 2-17, is located in a forested area in the eastern and central portion of NAS Cecil Field. The wetland communities observed at PSC 18 include floodplain forest and a floodplain swamp and braided blackwater stream (Table 5-26). The habitat at PSC 18 is likely to be of high value to semi-terrestrial and aquatic wildlife.

Typically, floodplain forest communities are dominated by hardwoods and occur on the dry soils of the upper reaches of a floodplain (i.e., on levees, impoundments, river terraces); floodplain forests are usually inundated for a portion of the growing season (FNAI, 1990).

A floodplain swamp community is typically found along stream channels and low spots within stream or river floodplains. The soils are often a variable mix of sands, alluvial material, and organic material. Floodplain swamps are characterized by buttressed, hydrophytic trees (e.g., cypress) with a sparse understory and ground cover (FNAI, 1990).

The canopy at PSC 18 is dominated by water oak, with occasional tupelo, ashes, and other oaks. The understory is open. Other shrub and herbaceous species observed at the site include southern bayberry, redbay, bryophytes, anolis, meadow beauty, lyonia, St. Johnswort, baldcypress, inkberry, nannyberry, winged sumac, netted chain fern, sedges, pickerel weed, sphagnum moss, and cinnamon fern.

5.4.2.6 **PSC 19** PSC 19, the Rowell Creek Rubble Disposal Area shown on Plate 1 and Figure 2-18, is located due west of Rowell Creek and south of 6th Street. Wetland communities identified by ABB-ES ecologists during the September 1995 field visit include (roughly from the west towards Rowell Creek) manmade drainage ditches, floodplain forest (some areas with some titi groves, floodplain swamp, and blackwater stream [Table 5-26]).

Typically, floodplain forest communities are dominated by hardwoods and occur on the dry soils of the upper reaches of a floodplain (i.e., on levees, impoundments, river terraces); floodplain forests are usually inundated for a portion of the growing season (FNAI, 1990).

A floodplain swamp community is typically found along stream channels and low spots within stream or river floodplains. The soils are often a variable mix of sands, alluvial material, and organic material. Floodplain swamps are characterized by buttressed, hydrophytic trees (e.g., cypress) with a sparse understory and ground cover (FNAI, 1990).

The dominant tree species observed at the site include red maple, slash pine, southern bayberry, black cherry, tupelo, and sweetgum. Other tree and shrub species included southern bayberry, holly, sourwood, redbay, sweetbay magnolia, hornbeam, water oak, swamp honeysuckle, buttonbush, and titi. Herbaceous and graminoid species observed at PSC 19 include lady fern, netted chain fern, sedges, royal fern, New York fern, sphagnum moss and water pennywort.

5.4.3 Other Studies No additional studies have been completed to date.

5.5 CHEMICAL ANALYSES OF PLANT OR ANIMAL TISSUE. Analyses of plant and animal tissue have been performed to provide site-specific information necessary for OU or PSC-specific ERAs. Currently, plant tissue from NAS Cecil Field has not been analyzed for chemical content.

Two types of animal tissue studies have been completed: earthworm analysis and fish tissue analysis. Earthworms were analyzed as part of surface soil toxicity testing, and fish tissue were analyzed as part of a fish sampling program at Lake Fretwell and Rowell Creek. The results of each of these studies are discussed separately. The following subsections provide summaries of the chemical analyses of earthworm and/or fish tissue for each site. Summary tables of the contaminants of concern in earthworm and/or fish tissue are provided for each site.

5.5.1 Earthworm Tissue Analyses As part of surface soil toxicity testing, tissue from earthworms (*Eisenia foetida*) has been analyzed at OUs 2 and 8. A summary of these studies is presented below.

5.5.1.1 **Analyses for OU 2** *E. foetida* exposed to surface soil from OU 2 during toxicity tests were subsequently analyzed for content of pesticides, PCBs, and inorganic analytes. Site-specific BAFs for these chemicals were derived based upon known soil content of these chemicals. The derived BAFs were utilized in food web models to estimate exposure of terrestrial wildlife to specific analytes in terrestrial invertebrates. Table 5-27 presents a summary of earthworm BAF values for surface soil ECPCs at OU 2. Tissue data are not available for TPH.

5.5.1.2 **Analyses for OU 8** Tissue studies similar to those conducted for OU 2 with earthworms were completed for OU 8. For the purpose of estimating BAFs, *E. foetida* exposed to OU 8 surface soil during toxicity tests were analyzed for inorganic analyte content. The lack of organic analytes in the surface soil samples selected for the bioaccumulation study, coupled with limited sample size and resultant high detection limits, precluded analyses of organics in earthworm tissue.

The site-specific BAF values derived from these studies are presented in Appendix T of the OU 8 BRA (ABB-ES, 1995b), and are summarized in Table 5-28. The BAFs were utilized in food web models to estimate exposure of terrestrial wildlife to concentrations of surface soil ECPCs in terrestrial invertebrates.

5.5.2 Fish Tissue Analyses A fish sampling program was completed at NAS Cecil Field in April 1995 (Inchcape/Aquatec, 1995b; Quanterra, 1995). The locations of fish samples collected from Lake Fretwell and Rowell Creek upstream of Lake Fretwell are depicted on Figure 5-4. Analyses of contaminant concentrations in fish tissue were conducted to reduce uncertainty in the exposure estimation and risk characterization process for human and ecological receptors. The objectives of the fish sampling program were as follows:

- to collect whole fish and fish fillet tissue samples from Lake Fretwell, upper Rowell Creek, and a reference area;
- to analyze tissue samples for metals, pesticides, and PCBs; and
- based on analytical results, to determine the extent of contamination in fish tissue above background conditions in order to provide a basis for determining if contaminants in fish tissue pose a risk to human health and the environment.

For the purposes of the ERA, data from whole fish tissue samples are used to measure the extent of contamination to which ecological receptors (including fish, reptiles, birds, and mammals) may be exposed. Whole body samples for each of the three feeding guilds selected (primary and secondary consumer, omnivorous bottom feeder, and tertiary consumer) were collected. The target species for each of the trophic levels/feeding guilds are as follows:

Table 5-27
Summary of Earthworm BAFs for OU 2[1]

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Chemical	SITE 5						SITE 17		
	CF5SS13 BAF	CF5SS15 BAF	CF5SS19 BAF	CF5SS20 BAF	CF5SS26 BAF	Site 5 BAF[2]	CF17SS8 BAF	CF17SS10 BAF	Site 17 BAF[2]
Organics									
4,4-DDD	NC	NC	NC	NC	3.03	3.03	NC	NC	NC
4,4-DDE	NC	42.6	28.7	3.63	0.925	19.0	NC	NC	NC
4,4-DDT	NC	NC	NC	NC	1.23	1.23	NC	NC	NC
Aroclor-1260	3.32	NC	NC	3.30	NC	3.31	NC	NC	NC
Inorganics									
Barium	0.125	0.0873	0.118	0.215	0.131	0.135	NC	NC	NC
Beryllium	NC	NC	NC	0.148	0.040	0.0941	NC	NC	NC
Cadmium	1.28	1.24	0.444	NC	2.0	1.24	NC	NC	NC
Cobalt	1.57	0.385	0.300	0.296	0.200	0.550	NC	NC	NC
Copper	0.600	0.840	0.800	0.339	0.840	0.684	NC	NC	NC
Lead	0.101	0.085	0.127	0.0658	0.103	0.0965	0.266	0.0919	0.179
Manganese	1.53	0.114	0.179	0.155	0.141	0.424	0.176	0.188	0.182
Nickel	NC	0.0335	NC	0.325	NC	0.179	NC	NC	NC
Zinc	10.4	0.313	2.20	0.287	0.733	2.78	NC	NC	NC

[1] BAFs are presented for only the analytes selected as ecological chemicals of potential concern in surface soil samples from OU 2. Analytes detected in earthworms that were not detected in surface soil are assumed to be non-site-related.
[2] Site-specific BAFs are equal to the arithmetic average of all sample location-specific BAFs.

Notes: BAF = bioaccumulation factor.
OU = operable unit.
DDD = dichlorodiphenyldichloroethane.
NC = BAF was not calculated for this chemical at this location.
DDE = dichlorodiphenyldichloroethene.
DDT = dichlorodiphenyltrichloroethane.

Table 5-28
Summary of Earthworm BAFs for OU 8[1]

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Chemical	Sample Location BAFs			Site 3 BAF[2]
	CF3SS9 BAF	CF3SS17 BAF	CF3SS24 BAF	
Inorganics				
Barium	0.0361	0.102	0.0988	0.0790
Cadmium	0.357	2.97	NC	1.66
Copper	0.119	0.209	0.396	0.241
Lead	0.0189	0.0385	0.0254	0.0276
Manganese	0.213	0.263	0.290	0.255
Mercury	0.113	NC	NC	0.113
Silver	0.133	0.758	NC	0.446
Zinc	0.521	0.806	9.73	3.69

[1] BAFs are presented for only the analytes selected as ecological chemicals of potential concern in surface soil samples from OU 8. Analytes detected in earthworms that were not detected in surface soil are assumed to be non-site-related.
[2] Site-specific BAFs are equal to the arithmetic average of all sample location-specific BAFs.

Notes: BAF = bioaccumulation factor.
OU = operable unit.
NC = BAF was not calculated for this chemical at this location.

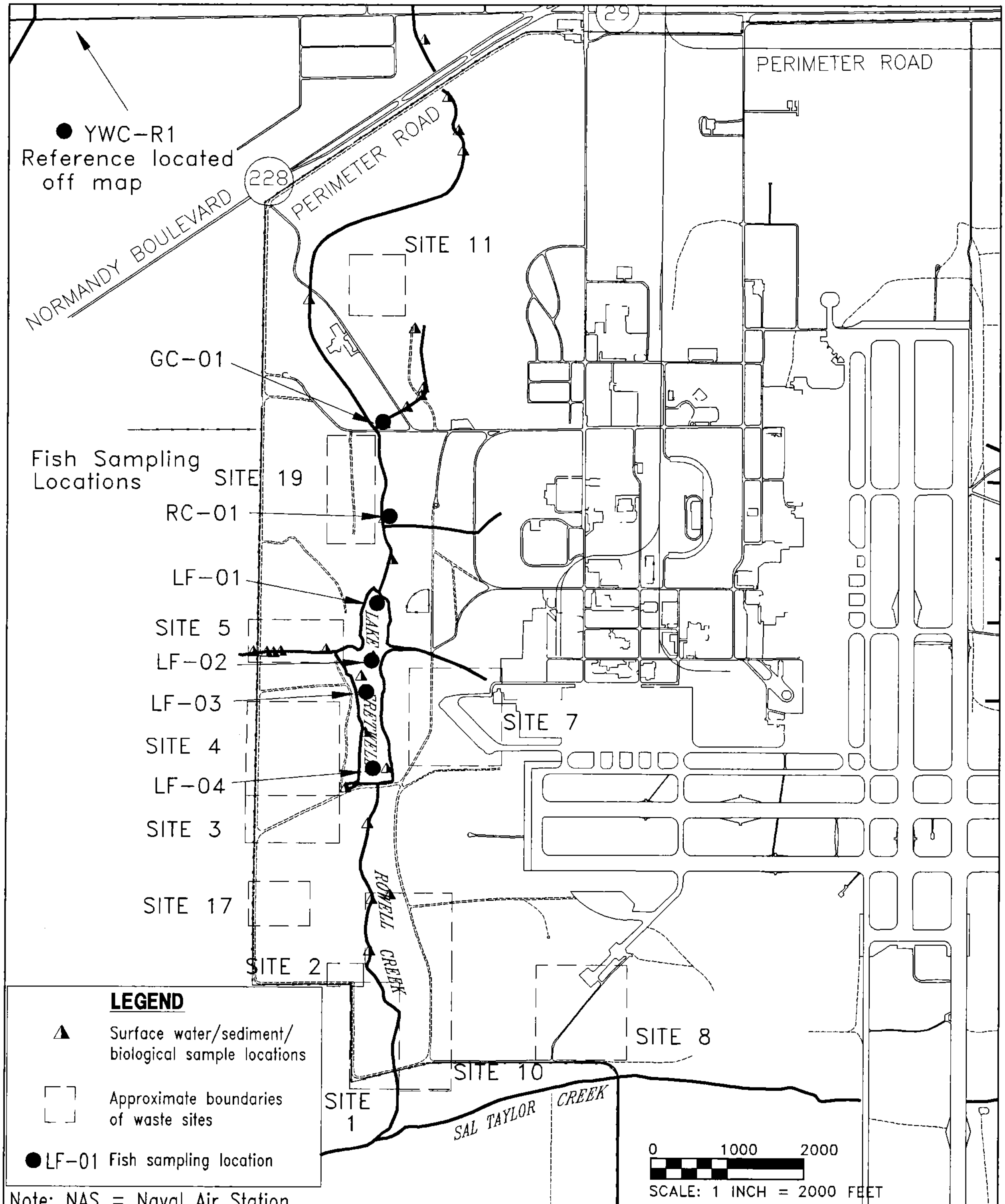


FIGURE 5-4
LOCATIONS OF FISH SAMPLES FROM LAKE FRETWELL AND ROWELL CREEK UPSTREAM OF LAKE FRETWELL

CECIL/STCRK/CCK-PS-NAB/02-05-96

BASEWIDE ECOLOGICAL ASSESSMENT REPORT

NAS CECIL FIELD JACKSONVILLE, FLORIDA

- Golden shiner (*Notemingonus crysoleucas*). This species is used to represent a primary/secondary consumer that feeds on planktonic crustaceans, algae, and aquatic insects. Golden shiners are typically found in relatively clear, weedy lakes and ponds, and may serve as an important prey item for the larger consumers in Lake Fretwell.

- Lake chubsucker (*Erimyzon sucetta*). This species is used to represent an omnivorous bottom feeder.

- Largemouth bass (*Micropterus salmoides*). This species is chosen to represent a tertiary consumer of recreational importance in Lake Fretwell. Largemouth bass live in weedy lakes, where they feed on invertebrates, frogs, and other fish.

Fish sampling and analysis was performed according to the technical approach described in the Fish Sampling Plan (ABB-ES, 1995c). Fish sampling locations are shown on Figure 5-1. Whole fish were collected from two locations in Rowell Creek upstream of Lake Fretwell (GC01 and RC01), one reference station in Yellow Water Creek (YWC-R1), and four locations in Lake Fretwell (LF01 to LF04). Duplicate samples were collected at locations LF01 and LF03. Samples collected at each of the sampling locations, including duplicates, were evaluated as independent samples.

The results of fish sampling and chemical analyses for the golden shiner, the lake chubsucker, and the largemouth bass are presented in Tables 5-29, 5-30, and 5-31, respectively. For the golden shiner, six pesticides, Aroclor-1260, and 14 inorganics were detected at one or more sampling locations; for the lake chubsucker, nine pesticides, Aroclor-1260, and 14 inorganics were detected; and for the largemouth bass, five pesticides, Aroclor-1260, and 13 inorganics were detected.

The chemicals 4,4-DDE and Aroclor-1260 were the most widely distributed organic contaminants in fish in the sampling area. Both chemicals were detected in golden shiner tissue at four sampling locations; in lake chubsucker tissue, 4,4-DDE was detected at six locations and Aroclor-1260 at four locations; and in largemouth bass tissue, 4,4-DDE was detected at six locations and Aroclor-1260 at five locations. Concentrations of 4,4-DDE in the different species collected included the following: golden shiner tissue, 1.3 to 12 μg/kg; lake chubsucker tissue, 2 to 5.1 μg/kg; and largemouth bass tissue, 4.4 to 24 μg/kg. Concentrations of Aroclor-1260 in the different species collected included the following: golden shiner tissue, 49 to 550 μg/kg; lake chubsucker tissue, 73 to 240 to μg/kg; and largemouth bass tissue, 140 to 640 μg/kg. Overall, concentrations of 4,4-DDE and Aroclor-1260 were highest in the largemouth bass.

Other pesticides detected in fish include 4,4-DDD, dieldrin, endosulfan I, methoxychlor, alpha-chlordane, and gamma-chlordane. The largest of these detections was a result of 45 μg/kg of methoxychlor at location LF03DUP in the lake chubsucker. Most of the other detections are less than 10 μg/kg. Lake chubsucker tissue had more detections of pesticides than the other fish species; however, this may be the result of duplicate sampling for this species (all samples were evaluated separately).

Table 5-29
Results of Chemical Analyses of Golden Shiner Whole Fish

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Chemical	Lake Fretwell				Rowell Creek Upstream of Lake Fretwell		Reference Location
	LF01	LF02	LF03	LF04	RC01	GC01	YWCR1
Organics (μg/kg)							
4,4-DDD	ND	ND	ND	ND	ND	NA	NA
4,4-DDE	ND	12	1.3 J	1.3 J	2.5 J	NA	NA
4,4-DDT	ND	ND	ND	ND	ND	NA	NA
Aroclor-1260	ND	550	49 J	52 J	56 J	NA	NA
Dieldrin	13	ND	ND	ND	ND	NA	NA
Endosulfan I	7.3	ND	ND	ND	ND	NA	NA
Endosulfan II	ND	ND	ND	ND	ND	NA	NA
Heptachlor	ND	ND	ND	ND	ND	NA	NA
Methoxychlor	ND	38 J	ND	ND	ND	NA	NA
alpha-Chlordane	ND	ND	.83 J	ND	1.3 J	NA	NA
gamma-Chlordane	ND	2.5 J	ND	ND	ND	NA	NA
Inorganics (mg/kg)							
Aluminum	269	240	129	270	ND	NA	NA
Arsenic	ND	ND	ND	ND	ND	NA	NA
Barium	13.1	14.9	18.8	28.3	26.9	NA	NA
Calcium	15,600 J	32,200 J	17,500 J	50,700 J	50,700 J	NA	NA
Chromium	1.9	ND	ND	ND	ND	NA	NA
Copper	20.7	23.1	17.1	20.5	10.5	NA	NA
Iron	286	283	409 J	341	93.9 J	NA	NA
Lead	ND	ND	2.9	ND	ND	NA	NA
Magnesium	1,120	1,140	1,080	2,150	1,630	NA	NA
Manganese	ND	ND	14.4	15.9	8.2	NA	NA
Mercury	.41 J	ND	ND	ND	.5 J	NA	NA
Nickel	ND	ND	ND	ND	ND	NA	NA
Potassium	11,600	10,000	12,000 J	17,300	11,900 J	NA	NA
Selenium	3.4	ND	ND	ND	ND	NA	NA
Sodium	4,330 J	4,560 J	4,710 J	2,060 J	4,430 J	NA	NA
Zinc	113 J	143 J	122 J	164 J	190 J	NA	NA
% Lipids	0.37	0.43	0.20	0.13	0.20	NA	NA

Notes: μg/kg = micrograms per kilogram.
DDD = dichlorodiphenyldichloroethane.
ND = not detected.
NA = no data are available at this location for this species.
DDE = dichlorodiphenyldichloroethene.
J = Estimated value.
DDT = dichlorodiphenyltrichloroethane.
mg/kg = milligrams per kilogram.
% = percent.

Table 5-30
Results of Chemical Analyses of Lake Chubsucker Whole Fish

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Chemical	Lake Fretwell						Rowell Creek Upstream of Lake Fretwell		Reference Location
	LF01	LF01DUP	LF02	LF03	LF03DUP	LF04	RC01	GC01	YWCR1
Organics (μg/kg)									
4,4-DDD	4.8 J	ND	ND	ND	ND	ND	ND	5.4 J	ND
4,4-DDE	ND	2 J	5.1 J	4.2 J	2.6 J	2.9 J	3.4 J	ND	ND
4,4-DDT	ND	ND	ND	ND	ND	ND	ND	ND	17.00 J
Aroclor-1260	ND	ND	240	ND	160	87 J	73 J	ND	ND
Dieldrin	ND	1.1 J	ND	ND	ND	ND	1.7 J	ND	2.1 J
Endosulfan I	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan II	ND	ND	ND	ND	ND	ND	ND	ND	.89 J
Heptachlor	ND	ND	ND	ND	ND	ND	ND	ND	2 J
Methoxychlor	ND	ND	ND	ND	45 J	3.6 J	ND	ND	33 J
alpha-Chlordane	2.3 J	.89 J	ND	2.2 J	1.4 J	ND	2.1 J	ND	ND
gamma-Chlordane	ND	.53 J	.69 J	ND	ND	ND	.94 J	.90 J	ND
Inorganics (mg/kg)									
Aluminum	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	2.9	2.7 J	ND	2.8 J	ND	3.3 J	ND	ND	ND
Barium	23.5	11.1	4.5	13.5 J	9.3 J	8.9	11.3	16.9	22.2
Calcium	95,500 J	47,000 J	14,200 J	64,100 J	44,900 J	36,600 J	64,600 J	69,400 J	45,700 J
Chromium	2	ND	ND	1.70	2.3	3.5	1.9	ND	ND
Copper	ND	5.5	ND	3.3	3.6	ND	2.8	ND	3.4
Iron	241	193 J	ND	132 J	217 J	301	161 J	401	250 J
Lead	ND	2.5	ND	ND	ND	ND	ND	ND	1.7 J
Magnesium	3,040	1,660	1,090	2,150 J	1,950	1,610	1,730	2,180	1,680
Manganese	21.9	10.9	ND	17.8	17.4	12.7	11.7	12.3	16.7
Mercury	ND	ND	ND	ND	ND	ND	ND	ND	.66 J
Nickel	ND	ND	ND	ND	ND	3.3	ND	ND	ND
Potassium	13,900	12,000 J	10,900	10,600 J	12,800 J	12,800	10,800 J	11,800	11,500 J
Selenium	4.2	ND	ND	ND	ND	ND	ND	ND	ND
Sodium	5,190 J	4,520 J	4,260 J	4,560 J	5,140 J	4,130 J	4,470 J	5,150 J	4,550 J
Zinc	143 J	98.4 J	81.1 J	121 J	116 J	95.8 J	94 J	103 J	116 J
% Lipids	0.27	0.10	0.20	0.37	0.17	0.23	0.33	0.43	0.57

Notes: μg/kg = micrograms per kilogram.
DDD = dichlorodiphenyldichloroethane.
J = estimated value.
ND = not detected.
DDE = dichlorodiphenyldichloroethene.
DDT = dichlorodiphenyltrichloroethane.
mg/kg = milligrams per kilogram.
% = percent.

Table 5-31
Results of Chemical Analyses of Largemouth Bass Whole Fish

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Chemical	Lake Fretwell				Rowell Creek Upstream of Lake Fretwell		Reference Location
	LF01	LF02	LF03	LF04	RC01	GC01	YWCR1
Organics (µg/kg)							
4,4-DDD	24	ND	ND	ND	ND	37	NA
4,4-DDE	24	11 J	6.3 J	4.4 J	11 J	30	NA
4,4-DDT	ND	ND	ND	ND	ND	ND	NA
Aroclor-1260	640	530	220	150	250	ND	NA
Dieldrin	ND	ND	ND	ND	ND	ND	NA
Endosulfan I	ND	ND	ND	ND	ND	11	NA
Endosulfan II	ND	ND	ND	ND	ND	ND	NA
Heptachlor	ND	ND	ND	ND	ND	ND	NA
Methoxychlor	ND	ND	ND	ND	ND	ND	NA
alpha-Chlordane	15	ND	ND	ND	3.4 J	ND	NA
gamma-Chlordane	4.2 J	ND	ND	ND	.39 J	3 J	NA
Inorganics (mg/kg)							
Aluminum	ND	ND	ND	ND	ND	ND	NA
Arsenic	3 J	ND	ND	2.7 J	ND	2.1 J	NA
Barium	2.8	2.9	1.6	2.3	1	1.1	NA
Calcium	61,600 J	29,800 J	16,200 J	33,100 J	13,300 J	13,100 J	NA
Chromium	1.4	ND	ND	2.3 J	ND	ND	NA
Copper	ND	ND	7.9	ND	2.8	ND	NA
Iron	76.1	158	94.2 J	86.5	48.4 J	62.5	NA
Lead	ND	ND	ND	ND	ND	ND	NA
Magnesium	1,690	1,490	1,070	1,330	999	778	NA
Manganese	ND	11.1	1.6	ND	ND	ND	NA
Mercury	1.3 J	1.2 J	1.1 J	1.3 J	1.3 J	1.5 J	NA
Nickel	ND	ND	ND	ND	ND	ND	NA
Potassium	8,290	13,200	10,700 J	10,700	10,300 J	8,460	NA
Selenium	3	4 J	3.4 J	ND	ND	2.7 J	NA
Sodium	4,720 J	5,140 J	4,280 J	4,350 J	4,000 J	3,230 J	NA
Zinc	57.2 J	95.5 J	59.3 J	60.2 J	41.8 J	36.2 J	NA
% Lipids	1.9	0.27	0.23	0.10	0.50	2.60	NA

Notes: µg/kg = micrograms per kilogram.
DDD = dichlorodiphenyldichloroethane.
ND = not detected.
NA = no data are available at this location for this species.
DDE = dichlorodiphenyldichloroethene.
J = Estimated value.
DDT = dichlorodiphenyltrichloroethane.
mg/kg = milligrams per kilogram.
% = percent.

Five pesticides were detected in lake chubsucker tissue collected from the upstream reference station, indicating that detections of pesticides may not be site-related, but rather the result of widespread pesticide application at and around NAS Cecil Field.

Several inorganics were detected in all three test species at every sampling location, including essential nutrients such as calcium, magnesium, potassium, and sodium. Other, less common inorganics were also detected. Aluminum, chromium, lead, mercury, and selenium were detected in golden shiner tissue; lead, nickel, and selenium were detected in lake chubsucker tissue; and chromium, copper, and manganese were detected in largemouth bass tissue. Although most of these inorganics were detected at low levels at only one or two sampling locations for each species, two chemicals were more abundant: Aluminum was detected in golden shiner tissue at four sampling locations, and chromium was detected in lake chubsucker tissue at five sampling locations.

Lipid-normalized analytical results for hydrophobic organic analytes and mercury detected in the golden shiner, the lake chubsucker, and the largemouth bass are presented in Tables 5-32, 5-33, and 5-34, respectively. The fish tissue data were lipid normalized to evaluate differences between trophic levels or differences between the lake and stream environment that are not explicable in terms of the lipid content of these animals. Lipid normalization is performed by dividing the concentration of a chemical detected in a fish by the percent lipid content of the fish. This adjustment is done because it is assumed that lipophilic compounds accumulate in fish in proportion to tissue lipid content; therefore, contaminant concentrations should vary directly with fish lipid content assuming equivalent exposures. Pesticides and Aroclor-1260 are known to be lipophilic. However, inorganic compounds generally are not lipophilic, and conclusions about lipid-normalized fish tissue concentrations for inorganics may be inaccurate (Hebert and Keenleyside, 1995). Therefore, discussions about lipid-normalized data are limited to results of detections of pesticides and Aroclor-1260.

The lipid content of the three different species of fish tissue sampled at NAS Cecil Field was as follows: golden shiner tissue, 0.13 to 0.43 percent; for lake chubsucker tissue, 0.10 to 0.43 percent; and for largemouth bass tissue, 0.10 to 2.60 percent. All the species are of similar low lipid content, with the largemouth bass having a slightly higher lipid content overall. When adjusted for tissue lipid content, the concentrations of pesticides and Aroclor-1260 in the fish rise by several orders of magnitude. The lipid-normalized concentrations for pesticides and PCBs among the species are generally within the same orders of magnitude, as they were for the unadjusted data. Overall, evaluation of the lipid-adjusted organic data does not lead to any discernable trend for any particular chemical or species, other than those already discussed for the non-adjusted data.

Based on these results, it appears that fish in Lake Fretwell and Rowell Creek are bioaccumulating 4,4-DDE, Aroclor-1260, and some metals. Golden shiner tissue appears to be bioaccumulating aluminum relative to other species, where aluminum was not detected. Similarly, lake chubsucker tissue appears to be bioaccumulating chromium more readily than other species. Largemouth bass tissue generally had a higher lipid content than the other two test species. In addition, tissue from largemouth bass collected at sampling station LF-01

Table 5-32
Results of Chemical Analyses of Golden Shiner Whole Fish Adjusted for Percent Lipids

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Chemical	Lake Fretwell				Rowell Creek Upstream of Lake Fretwell		Reference Location
	LF01	LF02	LF03	LF04	RC01	GC01	YWCR1
Organics (μg/kg)							
4,4-DDE	ND	2,791	650	1,000	1,250	NA	NA
Aroclor-1260	ND	127,907	24,500	40,000	28,000	NA	NA
Dieldrin	3,514	ND	ND	ND	ND	NA	NA
Endosulfan I	1,973	ND	ND	ND	ND	NA	NA
Methoxychlor	ND	8,837	ND	ND	ND	NA	NA
alpha-Chlordane	ND	ND	415	ND	650	NA	NA
gamma-Chlordane	ND	581	ND	ND	ND	NA	NA
Inorganics (mg/kg)							
Mercury	111	ND	ND	ND	250	NA	NA

Notes: μg/kg = micrograms per kilogram.
DDE = dichlorodiphenyldichloroethene.
ND = not detected.
NA = no data are available at this location for this species.
mg/kg = milligram per kilogram.

Table 5-33
Results of Chemical Analyses of Lake Chubsucker Whole Fish
Adjusted for Percent Lipids

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Chemical	Lake Fretwell						Rowell Creek Upstream of Lake Fretwell		Reference Station
	LF01	LF01DUP	LF02	LF03	LF03DUP	LF04	RC01	GC01	YWCR1
Organics (µg/kg)									
4,4-DDD	1,778	ND	ND	ND	ND	ND	ND	1,256	ND
4,4-DDE	ND	2,000	2,550	1,135	1,530	1,261	1,030	ND	ND
4,4-DDT	ND	ND	ND	ND	ND	ND	ND	ND	2,982
Aroclor-1260	ND	ND	120,000	ND	94,118	37,826	22,121	ND	ND
Dieldrin	ND	1,100	ND	ND	ND	ND	515	ND	368
Endosulfan II	ND	ND	ND	ND	ND	ND	ND	ND	156
Heptachlor	ND	ND	ND	ND	ND	ND	ND	ND	351
Methoxychlor	ND	ND	ND	ND	26,471	1,565	ND	ND	5,789
alpha-Chlordane	852	890	ND	595	824	ND	636	ND	ND
gamma-Chlordane	ND	530	345	ND	ND	ND	285	209	ND
Inorganics (mg/kg)									
Mercury	ND	ND	ND	ND	ND	ND	ND	ND	116

Notes: µg/kg = micrograms per kilogram.
DDD = dichlorodiphenyldichloroethane.
ND = not detected.
DDE = dichlorodiphenyldichloroethene.
DDT = dichlorodiphenyltrichloroethane.
mg/kg = milligram per kilogram.

Table 5-34
Results of Chemical Analyses of Largemouth Bass Whole Fish Adjusted for Percent Lipids

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Analyte	Lake Fretwell				Rowell Creek Upstream of Lake Fretwell		Reference Location
	LF01	LF02	LF03	LF04	RC01	GC01	YWCR1
Organics (μg/kg)							
4,4-DDD	1,263	ND	ND	ND	ND	1,423	NA
4,4-DDE	1,263	4,074	2,739	4,400	2,200	1,154	NA
Aroclor-1260	33,684	196,296	95,652	150,000	50,000	ND	NA
Endosulfan I	ND	ND	ND	ND	ND	423	NA
alpha-Chlordane	789	ND	ND	ND	680	ND	NA
gamma-Chlordane	221	ND	ND	ND	78	115	NA
Inorganics (mg/kg)							
Mercury	68	444	478	1,300	260	58	NA

Notes: μg/kg = micrograms per kilogram.
DDD = dichlorodiphenyldichloroethane.
ND = not detected.
NA = not applicable.
DDE = dichlorodiphenyldichloroethene.
mg/kg = milligram per kilogram.

contained the highest detected concentrations of 4,4-DDD, 4,4-DDE, Aroclor-1260, and alpha- and gamma-chlordane. Detected concentrations of mercury (ranging from 1.1 to 1.5 mg/kg) were also highest in whole fish tissue from largemouth bass.

Some of the OUs and PSCs at NAS Cecil Field may be responsible for the presence of these chemicals in this watershed system; however, due to the close proximity of several sources, it is difficult to ascertain point sources of contaminants to this area. It is believed that the former widespread use of pesticides at NAS Cecil Field contributes to the presence of pesticides, including 4,4-DDE, in the Rowell Creek watershed. Also, a once-common method to suppress dust on dirt roads (such as those found in several areas at NAS Cecil Field) was to spray them with waste oils. Transformer oil, a common waste oil, once contained PCBs to act as a dielectric. Though this practice for dust suppression was discontinued several years ago (probably in the 1960s or 1970s) at NAS Cecil Field, oils contaminated with PCBs could be a source of Aroclor-1260 to the Lake Fretwell watershed.

CHAPTER 6.0

6.0 ECOLOGICAL RISK ASSESSMENT RESULTS

The results and conclusions of each of the ERAs for the OUs and PSCs at NAS Cecil Field are summarized in this chapter. The results are presented in the order of each OU and PSC.

6.1 OPERABLE UNITS. Currently, the ERAs for OUs 1, 2, 7, and 8 have been completed. ERAs have not yet been completed for OUs 3, 4, 5, and 6. A summary of the ERA results for OUs at NAS Cecil Field is presented in Table 6-1.

6.1.1 **Operable Unit 1** The ERA for OU 1 was completed in December 1994 (ABB-ES, 1994a). Results and conclusions of the ERA are discussed for OU 1 by site and by medium of concern.

6.1.1.1 **Surface Soil at Site 1** A total of 34 analytes were detected in surface soil at Site 1. Of these, 31 were retained as ECPCs, including one VOC, 14 SVOCs, five pesticides, three PCB congeners, and eight inorganics. The ECPC selection process is discussed in Chapter 3.0.

Receptors that may potentially be exposed to Site 1 surface soil include terrestrial wildlife, terrestrial plants, and soil invertebrates. Six representative wildlife species were selected for Site 1. A model was used to predict contaminant exposures for each representative species selected, based on its position in the food chain. Risks to terrestrial plants and soil invertebrates were assessed based on surface soil toxicity testing completed for OU 1. The selection of species and models used to predict exposure are discussed in detail in Chapter 3.0; results of toxicity testing are discussed in detail in Section 5.1.

Risks to Terrestrial Wildlife. The lethal and sublethal HIs and HQs calculated using the food web model for each representative species were all less than 1, indicating no potential adverse effects to wildlife resulting from exposure to ECPCs in surface soil at Site 1.

Risks to Terrestrial Plants and Soil Invertebrates. Soil samples collected for toxicity tests at Site 1 were not toxic to either earthworms or lettuce seeds. Based on the results of these tests, which measure growth, reproduction, and survival of test organisms, it is assumed that the contamination present in surface soil at Site 1 does not present an unacceptable risk to terrestrial plants or soil invertebrates.

6.1.1.2 **Surface Water at Site 1** Surface water samples collected adjacent to Site 1 are downgradient of groundwater discharge from Site 2. A total of eight analytes were detected in these surface water samples at Site 1. Of these analytes, three were retained as ECPCs, including one VOC and two inorganics. The ECPC selection process is discussed in Chapter 3.0.

Receptors that may potentially be exposed to Site 1 surface water include aquatic receptors and terrestrial wildlife. Risks for aquatic receptors resulting from exposure to ECPCs in surface water were characterized based on both field measurements of the structure and function of the benthic macroinvertebrate communities; and on comparison of exposure concentrations of ECPCs in surface

Table 6-1
Summary of ERA Results for Operable Units

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Operable Unit	Site	Date ERA Completed	Media			
			Surface Soil	Surface Water	Sediment	Groundwater
OU 1	Site 1	December 1994	No risk.	No risk.	Adverse biological conditions were measured at sampling stations RC-Bio-6 and RC-Bio-7, downstream of the confluence between the Site 2 tributary and Rowell Creek. Conditions observed may be attributable to Site 2 tributary.	No risk.
OU 1	Site 2	December 1994	No risk.	No risk.	Adverse biological conditions were measured within the Site 2 tributary. Toxicity tests showed adverse effects to survival and reproduction of test species at stations 2-Tox-2 and 2-Tox-3; effects are believed to be related to iron concentrations in sediment. An orange-red flocculent material is present in the tributary, and it is believed that its presence may be responsible for the adverse conditions observed. Iron concentrations in sediment may reflect the amount of flocculent material present.	No risk.
OU 2	Site 5	May 1995	No risk to terrestrial wildlife. Toxicity tests showed 100% mortality of test species for sample CF5-Tox-4; effects are believed to be related to concentrations of TPH and PCBs in soil. Therefore, these chemicals may be adversely affecting terrestrial plants and soil invertebrates in the area of this sample.	No risk.	Toxicity tests showed adverse effects to survival of test species for three samples in the drainage ditch: 5-Tox-1, 5-Tox-3, and 5-Tox-4. Effects appear to be related to concentrations of TPH, Aroclor-1260, and total DDT. Therefore, these contaminants may be adversely affecting aquatic life in the drainage ditch.	No risk.
OU 2	Site 17	May 1995	No risk to terrestrial wildlife or soil invertebrates. Toxicity tests showed that lettuce seed germination was inhibited at sampling locations CF-17-SS8 and CF-17-SS9, but no correlation between effects and contaminant concentrations was observed. It is therefore believed that exposure to soil poses little risk to terrestrial plants.	No risk.	No risk.	NM

See notes at end of table.

Table 6-1 (Continued)
Summary of ERA Results for Operable Units

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Operable Unit	Site	Date ERA Completed	Media			
			Surface Soil	Surface Water	Sediment	Groundwater
OU 3	NA	NC	NA	NA	NA	NA
OU 4	NA	NC	NA	NA	NA	NA
OU 5	NA	NC	NA	NA	NA	NA
OU 6	NA	NC	NA	NA	NA	NA
OU 7	Site 16	March 1995[1]	NM	No risk.	Toxicity tests showed adverse effects to survival and reproduction of test species. Effects may be related to TPH in sediment samples, but TPH is not believed to be site-related.	No risk.
OU 8	Site 3	April 1995[1]	No risk to terrestrial wildlife or soil invertebrates. Toxicity tests showed that lettuce seed germination rates were lower soil samples CEF3SS17 and CEF3SS20 than in control samples. However, test results could not be replicated and low germination rates were observed in the control sample. Terrestrial plants are not believed to be at risk from exposure to soil.	No risk.	No risk.	Toxicity tests showed that exposure to undiluted, unfiltered groundwater from wells CF3-MW-13S and CF3-MW-28S resulted in adverse effects to growth, mortality, survival, and reproduction of test species. Three dichlorobenzene isomers appear to be the primary risk contributors. However, when groundwater is diluted, little toxicity was observed. It is therefore believed that groundwater discharging to Rowell Creek poses little risk to aquatic receptors.

[1] Draft ERA published on this date.

Notes: ERA = ecological risk assessment.
OU = operable unit.
TOX = otal organic halogens.
% = percent.
TPH = total petroleum hydrocarbons.
PCB = polychlorinated biphenyl.
DDT = dichlorodiphenyltrichloroethene.
NM = not a medium of concern.
NA = not applicable.
NC = not completed.

water samples with representative toxicity benchmarks or standards. Results of biological sampling are discussed in detail in Section 5.2. For terrestrial wildlife, four representative wildlife species were selected for Site 1. A model was used to predict contaminant exposures for each representative species selected, based on its position in the food chain. The selection of species and models used to predict exposure are discussed in detail in Chapter 3.0.

Risks to Aquatic Receptors. The lowest reported adverse effects concentrations for acetone and barium, two analytes retained as ECPCs, are orders of magnitude higher than their measured concentrations in Site 1 surface water samples. Based on this observation, it is assumed that neither of these analytes contributes to risks for aquatic receptors at Site 1.

Concentrations of aluminum in surface water ranged from 91.5 to 601 $\mu g/\ell$; these exceed the Federal Chronic AWQC value of 87 $\mu g/\ell$ for aluminum. However, the ERA for OU 1 concluded that aluminum in surface water is not contributing to risk to receptors in the area and is not attributable to runoff from Site 1. The highest concentration of aluminum measured in surface water at Site 1 is less than concentrations reported to cause lethal or sublethal effects to fish, invertebrates, aquatic plants, and algae. Also, biological sampling results indicate that the benthic macroinvertebrate community is not impaired at six of the surface water sampling locations near Site 1, and no link could be established between concentrations of aluminum in surface water and the measured impairment at two stations. Finally, statistical comparison of the surface water concentrations upstream and downstream of Site 1 does not show a significant increase in aluminum downstream; therefore, its presence is not likely to be related to Site 1.

Risks to Terrestrial Wildlife. The lethal and sublethal HIs and HQs calculated for each representative species were all less than 1, indicating no potential adverse effects to wildlife resulting from exposure to ECPCs in surface water at Site 1.

6.1.1.3 Sediment at Site 1 Sediment samples collected adjacent to Site 1 are downgradient of groundwater discharge from Site 2. Sediment samples were collected from the same location as surface water samples. A total of 13 analytes were detected in sediment samples at Site 1. Of these, three were retained as ECPCs for both aquatic and terrestrial receptors, including acetone, barium, and methylene chloride. Two chemicals were retained as ECPCs for aquatic receptors only (cadmium and nickel). The ECPC selection process is discussed in Chapter 3.0.

Receptors that may potentially be exposed to Site 1 sediment include aquatic receptors and terrestrial wildlife. Risks for aquatic receptors resulting from exposure to ECPCs in sediment were characterized based on results of both sediment toxicity tests and quantitative benthic macroinvertebrate sampling. Results of biological sampling are discussed in detail in Chapter 5.0. For terrestrial wildlife, four representative wildlife species were selected for Site 1. A model was used to predict contaminant exposures for each representative species selected, based on its position in the food chain. The selection of species and models used to predict exposure are discussed in detail in Chapter 3.0.

Risks to Aquatic Receptors. Overall, the results of the field studies and sediment toxicity tests indicate that there is no impairment of the macroinvertebrate community, or toxicity of sediment samples to water fleas or amphipods, for four of the six sampling locations adjacent to Site 1. This evidence suggests that any contamination released from Site 1 is not resulting in unacceptable risks at these locations.

Adverse biological conditions were measured at two locations in Rowell Creek, RC-Bio-6 and RC-Bio-7, immediately downstream of the Site 2 tributary. Comparison of the biological responses at these two locations with the distribution of analytes in sediment yielded the following observations:

- There was no statistical difference between concentrations of barium measured at locations where adverse biological responses were observed versus locations where a healthy macroinvertebrate community was observed.

- Two ECPCs for sediments, acetone and methylene chloride, could not be linked to observations of adverse biological responses.

- Cadmium and nickel were detected in only one sediment sample immediately downstream of the Site 2 tributary and were also detected in the Site 2 tributary. Concentrations of these analytes were below their respective USEPA Region IV sediment screening values.

Based on these observations, there appears to be no obvious chemical or visual contamination of sediment that can be associated with the adverse biological responses at the two locations. There are, however, indications that the discharge of the tributary at Site 2 could be associated with the adverse responses seen at Site 1. This discharge was noted during the field investigation at OU 1; it was observed as a trail of orange flocculent material draining into Rowell Creek at two defined points of entry. The presence of the flocculent material, which is discussed further in this section, is believed to be due to aluminum, iron, other metal-precipitated hydroxides, and salts, and microbial growth.

If the discharge of the Site 2 tributary is adversely influencing the macroinvertebrate community at Site 1, the reach of the stream at risk is limited to a stretch approximately 700 feet long (measured from the southernmost confluence of the Site 2 tributary with Rowell Creek to the next downstream sampling location). No impairment of the macroinvertebrate community was observed beyond this point.

Risks to Terrestrial Wildlife. The lethal and sublethal HIs and HQs calculated for each representative species were all less than 1, indicating no potential adverse effects to wildlife resulting from exposure to ECPCs in sediment at Site 1.

6.1.1.4 Groundwater at Sites 1 and 2 Due to the close proximity of Sites 1 and 2 and the fact that the groundwater from both sites discharges to Rowell Creek, groundwater is evaluated for OU 1 as a whole.

Surficial groundwater from Sites 1 and 2 flows toward Rowell Creek and is discharged to the wetlands associated with the sites. Therefore, aquatic receptors may be exposed to contaminated groundwater. Nine analytes detected in filtered groundwater samples were retained as ECPCs, including one VOC, two SVOCs, and six inorganics.

Predicted exposure concentrations of ECPCs for aquatic receptors were estimated based on the dilution of groundwater as it enters Rowell Creek. A dilution factor of 0.03 for groundwater contaminants entering Rowell Creek was calculated as part of a modelling effort.

Using the estimating approach described in the preceding paragraph, the predicted average and maximum concentrations of all the ECPCs except vanadium and aluminum fall either below their State or Federal water quality standards, or below the lowest reported concentrations associated with an adverse effect to fish, invertebrates, mollusks, or algae reported in the USEPA AQUIRE database. Thus, most of the ECPCs are not considered to pose a risk for aquatic receptors. It was not possible to evaluate the risks associated with vanadium in surface water because no toxicity information is available on vanadium in water, and there are no Federal or State standards for this analyte.

The predicted average and maximum concentrations of aluminum are both greater than the Federal chronic AWQC of 87 $\mu g/\ell$. Aluminum in Rowell Creek is discussed in greater detail in Paragraph 6.1.1.2. The predicted average concentration of 179 $\mu g/\ell$ falls below the reported range of toxicity for aluminum. Overall, the weight of evidence suggests that discharge of groundwater from Sites 1 and 2 is not contributing to aluminum contamination in Rowell Creek in the vicinity of OU 1.

6.1.1.5 Surface Soil at Site 2 A total of 27 analytes were detected in surface soil samples collected from Site 2. Of these, 20 were retained as ECPCs, including 11 SVOCs, 3 pesticides, 1 PCB congener, and 5 inorganics. The ECPC selection process is discussed in Chapter 3.0.

Receptors that may potentially be exposed to Site 2 surface soil include terrestrial wildlife, terrestrial plants, and soil invertebrates. Six representative wildlife species were selected for Site 2. A model was used to predict contaminant exposures for each representative species selected, based on its position in the food chain. Risks to terrestrial plants and soil invertebrates were assessed based on surface soil toxicity testing completed for OU 1. The selection of species and models used to predict exposure are discussed in detail in Chapter 3.0; results of toxicity testing are discussed in detail in Section 5.1.

<u>Risks to Terrestrial Wildlife</u>. The lethal and sublethal HIs and HQs calculated using the food web model for each representative species were all less than 1, indicating no potential adverse effects to wildlife resulting from exposure to ECPCs in surface soil at Site 2.

<u>Risks to Terrestrial Plants and Soil Invertebrates</u>. Soil samples collected for toxicity tests at Site 2 were not toxic to either earthworms or lettuce seeds. Based on the results of these tests, which measure growth, reproduction, and survival of test organisms, it is assumed that the contamination present in surface soil at Site 2 does not present an unacceptable risk to terrestrial plants or soil invertebrates.

6.1.1.6 Surface Water at Site 2 Surface water samples were collected from both the Site 2 drainage structure and the Site 2 tributary to Rowell Creek. A total of 10 analytes were detected in these surface water samples. Of these, six inorganics were retained as ECPCs for both aquatic receptors and terrestrial wildlife, and two VOCs were retained as ECPCs for terrestrial wildlife only. The ECPC selection process is discussed in Chapter 3.0.

Receptors that may potentially be exposed to Site 2 surface water include aquatic receptors and terrestrial wildlife. Risks for aquatic receptors resulting from exposure to ECPCs in surface water were characterized based on both field measurements of the structure and function of the benthic macroinvertebrate communities, and on comparison of exposure concentrations of ECPCs in surface water samples with representative toxicity benchmarks or standards. Results of biological sampling are discussed in detail in Chapter 5.0. For terrestrial wildlife, four representative wildlife species were selected for Site 2. A model was used to predict contaminant exposures for each representative species selected, based on its position in the food chain. The selection of species and models used to predict exposure are discussed in detail in Chapter 3.0.

Risks to Aquatic Receptors. Concentrations of aluminum, barium, cyanide, lead, and manganese fell below those reported from laboratory toxicity testing to be associated with either lethal or sublethal effects to fish, invertebrates, plants, or algae; therefore, risks are not expected to be associated with exposure to these chemicals.

Iron concentrations detected in the Site 2 tributary are within those concentrations reported to be lethal to fish and to have sublethal effects to both fish and aquatic invertebrates. Therefore, exposure to iron present in the Site 2 tributary could cause mortality in fish, invertebrates, or algae.

The results of biological studies indicate that the benthic macroinvertebrate community is impaired in the area of the Site 2 tributary. However, impairment of the benthic community could not be statistically associated with the detection of any of the ECPCs in surface water, including iron, in the Site 2 tributary. The risks for benthic macroinvertebrates are discussed further in Paragraph 6.1.1.7 with the ERA results for sediment.

Risks to Terrestrial Wildlife. Risks to terrestrial wildlife due to exposure to ECPCs in surface water are discussed in the next section as part of the ERA results for exposure to sediment.

6.1.1.7 Sediment at Site 2 Sediment samples were collected at the same locations as surface water samples from both the Site 2 drainage structure and the Site 2 tributary to Rowell Creek. A total of 22 analytes were detected in these sediment samples. Of these, 13 were retained as ECPCs for both aquatic receptors and terrestrial wildlife (including four VOCs, one SVOC, and eight inorganics), and eight analytes were retained as ECPCs for terrestrial wildlife only (including three SVOCs and five inorganics). The ECPC selection process is discussed in Chapter 3.0.

Receptors that may potentially be exposed to Site 2 sediment include aquatic receptors and terrestrial wildlife. Risks for aquatic receptors resulting from exposure to ECPCs in sediment were characterized based on results of both sediment toxicity tests and quantitative benthic macroinvertebrate sampling.

Results of biological sampling are discussed in detail in Chapter 5.0. For terrestrial wildlife, four representative wildlife species were selected for Site 2. A model was used to predict contaminant exposures for each representative species selected, based on its position in the food chain. The selection of species and models used to predict exposure are discussed in detail in Chapter 3.0.

Risks to Aquatic Receptors. Results of both field studies and sediment toxicity tests indicate impairment of the benthic macroinvertebrate community and toxicity of sediments at sampling locations within the Site 2 tributary.

Both survival and reproduction were significantly decreased for water fleas when exposed to sample 2-Tox-2 from the Site 2 tributary, as compared to a control sample (see Plate 2 for sampling locations). Survival of amphipods was also significantly less than controls when exposed to this sample. The two stations 2-Tox-2 and 2-Tox-3 in the tributary are classified as moderately impaired, representing a situation where organic pollution or toxicants could be adversely affecting the biological conditions regardless of habitat quality, which was fairly low at Site 2.

The following conclusions were reached regarding risks to aquatic receptors attributable to exposure to ECPCs in sediments:

- None of the four VOCs retained as ECPCs for sediment was found to be correlated with the impairment of the macroinvertebrate community at Site 2.
- The only metal with which a biological response (e.g., toxicity test result or benthic community metrics) could be positively correlated was iron concentrations in sediments versus mortality of amphipods. As iron concentrations increased, the toxicity of sediments from Site 2 increased. Iron concentrations in the sediment and surface water samples could reflect the amount of iron oxide (orange flocculent material) in the respective samples.
- The presence of several inorganics (cyanide, mercury, selenium, silver, chromium, and vanadium) in the tributary may be associated with the impairment of the benthic community and the observed toxicity of the sediments.
- The adverse physical conditions associated with the flocculent material in the Site 2 tributary may be more responsible for benthic community impairment and sediment toxicity than the presence of metals in sediment. This material clogs fish gills and can physically impair the movement and foraging of aquatic receptors. The blanketing effect of the material prevents light penetration and growth of biomass (algae) for receptors, and covers the available spaces in the bottom substrate where macroinvertebrates live.

Risks to Terrestrial Wildlife. The results of calculations of HQs and HIs show that the HIs for one of the representative species, the eastern cottontail, are above the target of 1 for exposures based on the average detected concentrations of ECPCs (HI=1.8) and the maximum detected concentrations of ECPCs (HI=4.3). The primary contributor to the HIs are the HQs for iron. If exposures of iron associated with sediment ingestion are dropped from the lethal HI calculation, the HIs for both average and maximum exposure fall well below 1.

If exposures related to ingestion of sediments are removed from the calculations of lethal and sublethal HIs, the HIs all fall below 1. This indicates that exposures to ECPCs in sediment is the primary contributor to predicted risks, with iron being the primary risk driver. ECPCs in surface water are not an important contributor to risks to terrestrial wildlife; therefore, risks were not predicted for wildlife ingesting surface water at Site 2.

6.1.2 Operable Unit 2 The ERA for OU 2 was completed in May 1995 (ABB-ES, 1995a). Results and conclusions of the ERA are discussed for OU 2 by site and by medium of concern.

One surface water sample and two sediment samples were collected from the wetland area of Site 17 in June 1994 (see Plate 2 for sampling locations). The data from the surface water sample were found to be questionable by the data validator, so resampling of surface water and sediment at one location was completed in February 1995 to reduce the uncertainties associated with evaluation of these media. Thus, the ERA was based on data from one surface water sample and three sediment samples.

In addition, groundwater at Site 17 was not a medium of concern for the ERA because it is not believed to discharge to the surface at this site.

6.1.2.1 Surface Soil at Site 5 A total of 53 analytes were detected in surface soil samples collected from Site 5. Of these, 44 were retained as ECPCs, including 5 VOCs, 21 SVOCs, 6 pesticides, 1 PCB congener, and 11 inorganics. The ECPC selection process is discussed in Chapter 3.0.

Receptors that may potentially be exposed to Site 5 surface soil include terrestrial wildlife, terrestrial plants, and soil invertebrates. Six representative wildlife species were selected for Site 5. A model was used to predict contaminant exposures for each representative species selected, based on its position in the food chain. Risks to terrestrial plants and soil invertebrates were assessed based on surface soil toxicity testing completed for OU 2. The selection of species and models used to predict exposure are discussed in detail in Chapter 3.0; results of toxicity testing are discussed in detail in Chapter 5.0.

Risks to Terrestrial Wildlife. The lethal and sublethal HIs and HQs calculated for each representative species are all below 1, indicating no potential adverse effects to reproduction, growth, or survival for species exposed to ECPCs in surface soil at Site 5.

Risks to Terrestrial Plants and Soil Invertebrates. Except at one sampling location, surface soil collected for toxicity testing was not toxic to either earthworms or lettuce seeds. At one location, CF5-Tox-4, there was 100 percent mortality of both earthworms and lettuce seeds (see Plate 4 for sampling locations). Linear regression showed that concentrations of TPH and PCBs in this sample were positively correlated with lettuce seed toxicity; as concentrations rose, soil was more toxic to the seeds. These results indicate that TPH and PCBs at CF5-Tox-4 may be adversely affecting the terrestrial plant and invertebrate community in the area.

6.1.2.2 **Surface Water at Site 5** There are two surface water systems present at Site 5. Surface water is present within a drainage ditch adjacent to the site, and a wetlands area also contains surface water. Evaluation of risks were performed separately for these two areas.

A total of 14 analytes were detected in surface water within the Site 5 drainage ditch. Of these, eight were retained as ECPCs for both aquatic receptors and terrestrial wildlife (including two VOCs and six inorganics), and two were retained as ECPCs for terrestrial wildlife only (including one VOC and one inorganic). Nine inorganics were detected in surface water at the Site 5 wetland. Of these, only manganese was retained as an ECPC for both aquatic receptors and terrestrial wildlife. The ECPC selection process is discussed in Chapter 3.0.

Receptors that may potentially be exposed to Site 5 surface water include aquatic receptors and terrestrial wildlife. Risks for aquatic receptors resulting from exposure to ECPCs in surface water were characterized based on both field measurements of the structure and function of the benthic macroinvertebrate communities and on comparison of exposure concentrations of ECPCs in surface water samples with representative toxicity benchmarks or standards. The results of biological sampling are discussed in detail in Section 5.2. For terrestrial wildlife, four representative wildlife species were selected for Site 5. A model was used to predict contaminant exposures for each representative species selected, based on its position in the food chain. The selection of species and models used to predict exposure are discussed in detail in Chapter 3.0.

<u>Risks to Aquatic Receptors</u>. Concentrations of aluminum in both of the surface water systems at Site 5 exceeded surface water criteria and guidelines; however, aluminum in an upstream sample collected near Site 5 also exceeded criteria. Concentrations of iron and lead in both the drainage ditch and the upstream sample exceeded surface water criteria.

No trends are apparent in the status of the benthic macroinvertebrate community in the Site 5 drainage ditch adjacent to and downstream of Site 5. It could not be concluded that contamination in surface water from Site 5 was contributing to the decreased condition observed at the downstream sampling station. Risks to aquatic receptors are discussed more fully with the sediment results in Paragraph 6.1.2.3.

<u>Risks to Terrestrial Wildlife</u>. For both surface water systems at Site 5, the lethal and sublethal HIs and HQs calculated for each representative species were all below 1, indicating no potential adverse effects to reproduction, growth, or survival for species exposed to ECPCs in surface water at Site 5.

6.1.2.3 **Sediment at Site 5** ECPCs for sediment were selected separately for the drainage ditch area and the wetland area of Site 5. The ECPC selection process is discussed in Chapter 3.0.

A total of 27 analytes were detected in sediment samples from the Site 5 drainage ditch. Of these, 22 were retained as ECPCs for both aquatic receptors and terrestrial wildlife (including 6 VOCs, 5 SVOCs, 3 pesticides, 1 PCB congener, and 7 inorganics), and 3 were retained as ECPCs for terrestrial wildlife only (including 1 SVOC and 2 inorganics).

A total of 16 analytes were detected in sediment samples from the Site 5 wetland. Of these, 10 were retained as ECPCs for both aquatic receptors and terrestrial wildlife (including 1 VOC and 9 inorganics), and 3 were retained as ECPCs for terrestrial wildlife only (all inorganics).

Receptors that may potentially be exposed to Site 5 sediment include aquatic receptors and terrestrial wildlife. Risks for aquatic receptors resulting from exposure to ECPCs in sediment were characterized based on results of both sediment toxicity tests and quantitative benthic macroinvertebrate sampling. Results of biological sampling are discussed in detail in Section 5.2. For terrestrial wildlife, four representative wildlife species were selected for Site 5. A model was used to predict contaminant exposures for each representative species selected, based on its position in the food chain. The selection of species and models used to predict exposure are discussed in detail in Chapter 3.0.

Risks to Aquatic Receptors. As discussed earlier for Site 5 surface water, there are no apparent trends in the status of the macroinvertebrate community in the Site 5 drainage ditch. It could not be concluded that sediment contamination was contributing to the decreased condition observed in the downstream sampling stations. A review of the habitat quality suggests that conditions at the drainage ditch are poor for many types of aquatic organisms, especially those not adaptable to the variable conditions associated with ephemeral streams such as this ditch.

Sediment collected from 5-Tox-4 was toxic to waterfleas, and sediment collected from locations 5-Tox-1, 5-Tox-3, and 5-Tox-4 was toxic to amphipods. Based on the results of these laboratory sediment bioassays, impacts to survival of certain invertebrate receptors may be occurring in the Site 5 drainage ditch. This suggests that the mixture of contaminants in the sediment may be toxic to aquatic life.

To determine which contaminants measured in the drainage ditch sediment may be causative agents for the observed toxicity, linear regressions were completed for selected analytes. This comparison yielded the following results:

- Because VOCs are generally only toxic to aquatic receptors at elevated concentrations, it is unlikely that VOCs are substantially responsible for test impacts as they were detected at low concentrations in the drainage ditch.

- PAHs detected in sediment are suspected to be laboratory contaminants and not site-related; it is unlikely that they are responsible for the observed sediment toxicity.

- Based on statistical analyses, review of sediment screening values, and distribution of the analytes within the Site 5 drainage ditch, it is unlikely that inorganics are substantial contributors to observed sediment toxicity.

- Although total DDT concentrations (DDT_R, the sum of concentrations of 4,4-DDD, 4,4-DDE, and 4,4-DDT) were positively correlated with sediment toxicity, it is unlikely that DDT_R is the primary contributor to observed laboratory mortality at the Site 5 drainage ditch locations.

Concentrations of DDT_R were within the range of contamination tolerated by a majority of evaluated freshwater organisms in the Great Lakes (Persaud and others, 1992).

- Statistical analyses showed that both TPH and Aroclor-1260 concentrations were positively correlated with sediment toxicity. This suggests that, in addition to DDT_R, TPH and Aroclor-1260 may be contributing to observed mortality in test organisms in the laboratory toxicity tests. TPH is known to adversely affect aquatic organisms (Alexander, 1982; Mahaney, 1994; McGrath and Alexander, 1979).

Risks to Terrestrial Wildlife. The lethal and sublethal HIs and HQs calculated for each representative species were all below 1, indicating no potential adverse effects to reproduction, growth, or survival for species exposed to ECPCs in sediment at Site 5 in either the drainage ditch or the wetlands area.

6.1.2.4 **Groundwater at Site 5** Data from 30 monitoring wells sampled at Site 5 were used to evaluate groundwater conditions potentially contributing to surface water contamination in the Site 5 drainage ditch and wetland areas.

Detections of analytes in unfiltered groundwater were used to select ECPCs. This is a very conservative approach because unfiltered groundwater data represent concentrations in both the dissolved and the particulate fractions of groundwater. Particulates in the groundwater are not bioavailable to aquatic receptors and are not likely to be discharged to surface water. A total of 44 analytes were detected in unfiltered groundwater samples. Of these, 37 were retained as ECPCs for aquatic receptors, including 8 VOCs, 9 SVOCs, 3 pesticides, and 17 inorganics. The ECPC selection process is discussed in Chapter 3.0.

Predicted exposure concentrations of ECPCs for aquatic receptors were estimated based on the dilution of groundwater as it enters the Site 5 drainage ditch and wetland area. A dilution factor of 0.062 for unfiltered groundwater contaminants was calculated as part of a modelling effort. Discharge of undiluted groundwater was also evaluated, representing a very conservative approach toward estimating risks due to groundwater exposure.

Risks to Aquatic Receptors. Comparison of the average and maximum exposure concentrations of ECPCs with available criteria and toxicity benchmarks indicated that no risks to aquatic receptors would result from exposure to ECPCs in diluted groundwater. Although risks for aquatic receptors would theoretically be increased with exposure to eight inorganic ECPCs at concentrations detected in undiluted, unfiltered groundwater, this exposure scenario is deemed highly unlikely. Furthermore, any analytes present in unfiltered groundwater in the particulate fraction would not be bioavailable to aquatic receptors, and thus would not represent an exposure risk.

6.1.2.5 **Surface Soil at Site 17** A total of 20 analytes were detected in surface soil from Site 17. Of these, 12 were retained as ECPCs, including 4 VOCs, 4 SVOCs, 1 pesticide, and 3 inorganics. The ECPC selection process is discussed in Chapter 3.0.

Receptors that may potentially be exposed to Site 17 surface soil include terrestrial wildlife, terrestrial plants, and soil invertebrates. Six representative wildlife species were selected for Site 17. A model was used to predict contaminant exposures for each representative species selected, based on its position in the food chain. Risks to terrestrial plants and soil invertebrates were assessed based on surface soil toxicity testing completed for OU 2. The selection of species and models used to predict exposure are discussed in detail in Chapter 3.0; results of toxicity testing are discussed in detail in Section 5.1.

Risks to Terrestrial Wildlife. The lethal and sublethal HIs and HQs calculated for each representative species were all below 1, indicating no potential adverse effects to reproduction, growth, or survival for species exposed to ECPCs in surface soil at Site 5.

Risks to Terrestrial Plants and Soil Invertebrates. Soil samples collected from Site 17 were not toxic to earthworms. Two soil samples, CS-17-SS8 and CS-17-SS9, were toxic to lettuce seeds, but the background sample BSS01 was also toxic to them (see Plate 4 for sampling locations). Germination of lettuce seeds was also slightly inhibited at these two surface soil sampling stations. However, no correlation of ECPC concentrations in surface soil and germination of lettuce seeds was observed. Both of these samples with lower germination of lettuce seeds contained few contaminants. It is possible that a nonmeasured physical, biological, or chemical factor is responsible for the observed slight reduction in lettuce seed germination. Overall, it is believed that contamination present in Site 17 surface soil does not present an unacceptable risk for terrestrial plants or soil invertebrates.

6.1.2.6 **Surface Water at Site 17** A total of nine inorganics were detected in the surface water sample collected at Site 17. None were retained as ECPCs, and no risk to either aquatic receptors or terrestrial wildlife due to exposure to contaminants in Site 17 surface water is expected.

6.1.2.7 **Sediment at Site 17** Three sediment samples were collected from the wetlands downgradient of Site 17. A total of 24 analytes were detected in sediment samples. Of these, 14 were retained as ECPCs for both aquatic receptors and terrestrial wildlife, including 2 VOCs, 5 SVOCs, and 7 inorganics. Six analytes were retained as ECPCs for terrestrial wildlife only, including one pesticide and five inorganics, and one inorganic was retained as an ECPC for aquatic receptors only. The ECPC selection process is discussed in Chapter 3.0.

Contaminant exposures via direct contact with sediment were evaluated by comparing exposure concentrations with available sediment quality guidelines. No sediment toxicity tests were completed for samples collected at Site 17. Although the use of guidelines to estimate risks involves some uncertainty, this approach provides a conservative screening tool in the absence of site-specific toxicity test data. For terrestrial wildlife, five representative wildlife species were selected for Site 5. A model was used to predict contaminant exposures for each representative species selected, based on its position in the food chain. The selection of species and models used to predict exposure are discussed in detail in Chapter 3.0.

Risks to Aquatic Receptors. Based on a comparison of exposure concentrations of ECPCs to sediment quality guidelines, risks are not anticipated for aquatic receptors in the Site 17 wetland. Concentrations of zinc and bis(2-ethylhexyl)phthalate slightly exceeded benchmarks but were below reported effects concentrations reported for aquatic receptors. For the 11 ECPCs in which sediment screening values were not available, aluminum, barium, and selenium exceeded reported effects levels. The effects level for aluminum is based on effects to larval trout, which are known to be among the most sensitive ecological receptors. Also, the magnitude of exceedances for barium and selenium is low, suggesting that adverse effects due to exposures to these chemicals is minimal or unlikely.

Overall, risks are not anticipated for aquatic receptors associated with exposure to ECPCs in wetland sediment at Site 17.

Risks to Terrestrial Wildlife. The lethal and sublethal HIs and HQs calculated for each representative species were all below 1, indicating no potential adverse effects to reproduction, growth, or survival for species exposed to ECPCs in sediment in the wetlands at Site 17.

6.1.3 Operable Unit 3 The ERA has not yet been completed for OU 3.

6.1.4 Operable Unit 4 The ERA has not yet been completed for OU 4.

6.1.5 Operable Unit 5 The ERA has not yet been completed for OU 5.

6.1.6 Operable Unit 6 The ERA has not yet been completed for OU 6.

6.1.7 Operable Unit 7 The ERA for OU 7 was completed in January 1996. Results and conclusions of the ERA will be discussed for OU 7, Site 16, by medium of concern. Surface soil is not a medium of concern at Site 16 because the area is covered with pavement and mowed grass, and it is unlikely that the site serves as a habitat for terrestrial wildlife.

6.1.7.1 Surface Water at Site 16 Surface water was collected from three locations in the drainage ditches near Site 16, and at one reference location. A total of 15 analytes were detected in surface water samples. Of these, seven were retained as ECPCs for both aquatic receptors and terrestrial wildlife (including two VOCs and five inorganics), and two were retained as ECPCs for terrestrial wildlife only (including one VOC and one inorganic compound). The ECPC selection process is discussed in Chapter 3.0.

Receptors that may potentially be exposed to surface water near Site 16 include aquatic receptors and terrestrial wildlife. Risks for aquatic receptors resulting from exposure to ECPCs in surface water were characterized based on both field measurements of the structure and function of the benthic macroinvertebrate communities and on comparison of exposure concentrations of ECPCs in surface water samples with representative toxicity benchmarks or standards. Results of biological sampling are discussed in detail in Chapter 5.0. For terrestrial wildlife, four representative wildlife species were selected for Site 16. A model was used to predict contaminant exposures for each representative species selected, based on its position in the food chain. The selection of species and models used to predict exposure are discussed in detail in Chapter 3.0.

Risks to Aquatic Receptors. There are no apparent trends in the status of the benthic macroinvertebrate community in the Site 16 drainage ditches. Conditions at two sampling stations, STC-Bio-1 and the reference station STC-Bio-R1, were poorer than expected given the habitat quality (see Plate 2 for sampling locations); however, it could not be concluded that contamination in surface water from Site 16 was contributing to this condition.

Maximum concentrations of cadmium, copper, iron, lead, and zinc exceeded aquatic toxicity benchmarks. However, it is believed that the presence of these metals is not site-related because the drainage ditches near Site 16 receive stormwater drainage from the runway area and much of the developed area west of the runways.

The risk characterization for aquatic receptors for both surface water and sediment contamination is summarized in Paragraph 6.1.7.2.

Risks to Terrestrial Wildlife. The lethal and sublethal HIs and HQs calculated for each representative species were all below 1, indicating no potential adverse effects to reproduction, growth, or survival for species exposed to ECPCs in surface water in the drainage ditches at Site 16.

6.1.7.2 Sediment at Site 16 Sediment samples were collected from the same locations as surface water samples. A total of 20 analytes were detected in sediment samples. Of these, 14 were retained as ECPCs for both aquatic receptors and terrestrial wildlife (including 3 VOCs, 1 SVOC, and 10 inorganics), and 3 were retained as ECPCs for terrestrial wildlife only (3 inorganics). The ECPC selection process is discussed in Chapter 3.0.

Receptors that may potentially be exposed to Site 16 sediment include aquatic receptors and terrestrial wildlife. Risks for aquatic receptors resulting from exposure to ECPCs in sediment were characterized based on results of both sediment toxicity tests and quantitative benthic macroinvertebrate sampling. Results of biological sampling are discussed in detail in Section 5.2. For terrestrial wildlife, four representative wildlife species were selected for Site 16. A model was used to predict contaminant exposures for each representative species selected, based on its position in the food chain. The selection of species and models used to predict exposure are discussed in detail in Chapter 3.0.

Risks to Aquatic Receptors. There are no apparent trends in the status of the benthic macroinvertebrate community in the Site 16 drainage ditches. Conditions at two sampling stations, including the reference station, were poorer than expected given the habitat quality; however, it could not be concluded that contamination in sediment from Site 16 was contributing to this condition. A review of the habitat quality suggests that conditions at the drainage ditch are poor for many types of aquatic organisms, especially those not adaptable to the variable conditions associated with ephemeral streams such as this ditch. Factors possibly influencing the benthic community at one location include a petroleum sediment odor and an oily sheen on the surface water noted in the area.

Sediment collected from locations STC-Tox-1 and STC-Tox-3 were toxic to amphipods; sediment collected from location STC-Tox-3 was toxic to water fleas (see Plate 2 for sampling locations). Reproduction in the water flea was also reduced during tests with sediment sample STC-Tox-3. Based on these results, impacts to the survival and reproduction of certain invertebrate receptors may be occurring at these locations in the drainage ditches.

Toxicity may be attributable to elevated concentrations of TPH in sediment at locations STC-Tox-1 and STC-Tox-3. Elevated concentrations of TPH are known to adversely affect aquatic organisms (Alexander, 1982; Mahaney, 1994). It is believed, however, that the presence of TPH in sediment is not site-related because the ditches receive stormwater drainage from the runway area and much of the developed area west of the runways.

Overall, risks may be present to certain macroinvertebrate receptors at two of the three drainage ditch sampling stations. For station STC-Tox-1, risks are based on mortality of amphipods in sediment toxicity testing; for station STC-Tox-3, risks are based on the toxicity of sediments to both amphipods and the water flea. These risks may be associated with the presence of TPH in sediments, which is not believed to be site-related. Finally, analysis of the benthic community metrics relative to contaminant concentrations on surface water and sediment are inconclusive.

Risks to Terrestrial Wildlife. The lethal and sublethal HIs and HQs calculated for each representative species were all below 1, indicating no potential adverse effects to reproduction, growth, or survival for species exposed to ECPCs in sediment in the drainage ditches at Site 16.

6.1.7.3 Groundwater at Site 16 Data from 21 monitoring wells sampled at Site 16 were used to evaluate groundwater conditions potentially contributing to surface water contamination in the Site 16 drainage ditches and the adjacent wetlands.

Detections of analytes in unfiltered groundwater were used to select ECPCs. This is a very conservative approach because unfiltered groundwater data represent concentrations in both the dissolved and the particulate fractions of groundwater. Particulates in the groundwater are not bioavailable to aquatic receptors and are not likely to be discharged to surface water. A total of 33 analytes were detected in unfiltered groundwater samples. Of these, 14 were retained as ECPCs for aquatic receptors, including 5 VOCs, 1 SVOC, and 8 inorganics. The ECPC selection process is discussed in Chapter 3.0.

Risks were evaluated for two potential pathways of future migration of groundwater contamination to surface water. These two paths include discharge of groundwater contaminants to Sal Taylor Creek and to the nearby emergent wetlands. Exposure concentrations of groundwater discharging to Sal Taylor Creek were predicted based in a dilution factor of 900; no dilution was applied to concentrations of groundwater ECPCs discharging to the wetlands. Maximum and average exposure concentrations were compared to aquatic toxicity benchmarks and available surface water quality standards.

Risks to Aquatic Receptors. Risks to aquatic receptors from exposure to groundwater in Sal Taylor Creek surface water are not expected, based on a dilution factor of 900 as groundwater enters the creek. The exposure concentrations of all groundwater ECPCs in Sal Taylor Creek are less than their respective lowest aquatic toxicity benchmarks.

Of the ECPCs in Site 16 groundwater, predicted maximum concentrations in the wetlands of four analytes (bis(2-ethylhexyl)phthalate, aluminum, iron, and zinc) exceed surface water toxicity benchmarks. It is possible, but unlikely, that aquatic receptors would encounter this worst-case condition in the wetlands. Concentrations of bis(2-ethylhexyl)phthalate, iron, and zinc appear to originate in the intermediate aquifer at Site 16 (which was found to be free of site-related contaminants) and flow upward to the surficial aquifer; it is therefore believed that these detections are not associated with contamination from Site 16. In addition, the toxicity of aluminum is pH-dependent; the pH of surface water is typically higher than that of groundwater. When aluminum in groundwater is discharged to surface water, the higher pH causes aluminum to move from the dissolved phase to the particulate phase, which decreases its bioavailability to aquatic receptors. Measured concentrations of aluminum encompass both the dissolved and particulate phases, which overestimates the concentrations to which receptors would be exposed.

<u>6.1.8 Operable Unit 8</u> The draft ERA for OU 8 was completed in April 1995 (ABB-ES, 1995b). Results and conclusions of the ERA will be discussed for OU 8, Site 3, by medium of concern.

6.1.8.1 Surface Soil at Site 3 ECPCs were selected separately for two areas at Site 3: the grassy area near the disposal pit and the forested area near the helicopter crash site. The ECPC selection process is discussed in Chapter 3.0.

A total of 47 analytes were detected in surface soil near the disposal pit area at Site 3. Of these, 32 were retained as ECPCs, including 4 VOCs, 13 SVOCs, 5 pesticides, 1 PCB congener, and 9 inorganics. TPH was detected in four soil samples in this area. A total of 20 analytes were detected in surface soil near the helicopter crash site at Site 3. Of these, 9 were retained as ECPCs, including 3 VOCs, 5 pesticides, and 1 inorganic. TPH was detected in three soil samples in this area.

Receptors that may potentially be exposed to Site 3 surface soil include terrestrial wildlife, terrestrial plants, and soil invertebrates. Five representative wildlife species were selected for the disposal area at Site 3, and six representative wildlife species were selected for the helicopter crash site at Site 3. A model was used to predict contaminant exposures for each representative species selected, based on its position in the food chain. Risks to terrestrial plants and soil invertebrates were assessed based on surface soil toxicity testing completed for OU 8. The selection of species and models used to predict exposure are discussed in detail in Chapter 3.0; results of toxicity testing are discussed in detail in Section 5.1.

<u>Risks to Terrestrial Wildlife</u>. The lethal and sublethal HIs and HQs calculated using the food web model for each representative species at both the disposal area and the helicopter crash site were all less than 1, indicating no potential adverse effects to wildlife resulting from exposure to ECPCs in surface soil at Site 3.

<u>Risks to Terrestrial Plants and Invertebrates</u>. Soil samples collected for toxicity tests at Site 3 were not toxic to earthworms. Based on the results of this test, which measure growth, reproduction, and survival of test organisms, it is assumed that the contamination present in surface soil at Site 3 does not present an unacceptable risk to soil invertebrates.

Statistically significant differences in lettuce seed germination rates were observed between surface soil samples CEF3SS17 and CEF3SS20 and the control sample (see Plate 4 for sampling locations). The reliability of these results, however, is suspect because duplicate samples did not show the same germination rates as their respective original samples, and because low germination was observed in the control sample. Linear regression analysis showed little correlation between seed germination rates and concentrations of analytes in soil. Overall, it is believed that terrestrial plants are probably not at risk from exposure to surface soil at Site 3.

6.1.8.2 Surface Water at Site 3 ECPCs were selected separately for two surface water samples collected in Rowell Creek adjacent to Site 3. One sample, CF3-SW-2, was collected to represent upgradient conditions not impacted by the groundwater plume at Site 3, and the second sample, CF3-SW-1, was collected to represent conditions within and downgradient of plume discharge (see Plate 2 for sampling locations). Both samples were collected downgradient of an outfall from NAS Cecil Field's domestic wastewater treatment plant and are likely impacted by this treated effluent.

A total of 10 analytes were detected in the upgradient surface water sample CF3-SW-2. Of these, three were retained as ECPCs for both aquatic receptors and terrestrial wildlife (including one VOC and two inorganics) and one VOC was retained as an ECPC for terrestrial wildlife only. A total of 16 analytes were detected in the downgradient surface water sample CF3-SW-1. Of these, three were retained as ECPCs for both aquatic receptors and terrestrial wildlife (including two VOCs and one inorganic) and five were retained as ECPCs for terrestrial wildlife only (including two VOCs and three inorganics). The ECPC selection process is discussed in Chapter 3.0.

Receptors that may potentially be exposed to Site 3 surface water include aquatic receptors and terrestrial wildlife. Risks for aquatic receptors resulting from exposure to ECPCs in surface water were characterized based on both field measurements of the structure and function of the benthic macroinvertebrate communities and on comparison of exposure concentrations of ECPCs in surface water samples with representative toxicity benchmarks or standards. Results of biological sampling are discussed in detail in Section 5.2. For terrestrial wildlife, five representative wildlife species were selected for Site 3. A model was used to predict contaminant exposures for each representative species selected, based on its position in the food chain. The selection of species and models used to predict exposure are discussed in detail in Chapter 3.0.

Risks to Aquatic Receptors. A review of the habitat quality parameter data collected during testing suggests that habitat conditions at Rowell Creek near Site 3 represent a poor environment for many types of aquatic organisms. Differences in habitat structure between the Rowell Creek area and the reference station may explain the decreased biological condition observed in samples collected adjacent to Site 3. The NAS Cecil Field domestic wastewater treatment plant may also contribute to differences in the community structure in this area.

Surface water concentrations of two analytes, aluminum and silver, exceed aquatic benchmark values. However, the cold-water species that is the most sensitive to exposure to these two chemicals does not occur in Rowell Creek, a warm-water system. Furthermore, the evaluation of unfiltered surface water may overestimate the risk associated with exposure to inorganics, which may be sorbed to particulates and would therefore be less bioavailable than the dissolved fraction. It is unlikely that the levels of aluminum or silver in surface water pose a risk to aquatic receptors at Site 3.

Risks to Terrestrial Wildlife. The lethal and sublethal HIs and HQs calculated using the food web model for each representative species at both sampling locations at Rowell Creek were all less than 1, indicating no potential adverse effects to wildlife resulting from exposure to ECPCs in surface water at Site 3.

6.1.8.3 Sediment at Site 3 Sediment samples were collected from the same locations as surface water samples at Site 3. Similar to surface water, ECPCs were selected separately for the two sediment samples collected in Rowell Creek.

A total of 15 analytes were detected in the upgradient sediment sample CF3-SD-2. Of these, five were retained as ECPCs for both aquatic and terrestrial receptors (including one VOC, two SVOCs, and one PCB congener) and four were retained as ECPCs for terrestrial wildlife only (including one pesticide and three inorganics). A total of 10 analytes were detected in the downgradient sediment sample CF3-SD-1. Of these, two were retained as ECPCs for both aquatic and terrestrial receptors (including one VOC and one pesticide), and one pesticide was retained as an ECPC for terrestrial wildlife only. The ECPC selection process is discussed in Chapter 3.0.

Receptors that may potentially be exposed to Site 3 sediment include aquatic receptors and terrestrial wildlife. Risks for aquatic receptors resulting from exposure to ECPCs in sediment were characterized based on results of quantitative benthic macroinvertebrate sampling. Results of biological sampling are discussed in detail in Chpater 5.0. For terrestrial wildlife, four representative wildlife species were selected for Site 3. A model was used to predict contaminant exposures for each representative species selected, based on its position in the food chain. The selection of species and models used to predict exposure are discussed in detail in Chapter 3.0.

Risks to Aquatic Receptors. Sediment concentrations of two analytes, Aroclor-1254 and 4,4-DDT, exceeded sediment RTVs. Neither of these compounds was detected in groundwater at Site 3, indicating that their presence does not appear to be site-related. Both analytes were detected at low levels, and both are less than their respective draft EPA SQGs. It is unlikely that aquatic receptors are currently at risk from exposure to the low levels of these two analytes in sediment in the Site 3 area.

Risks to Terrestrial Wildlife. The lethal and sublethal HIs and HQs calculated using the food web model for each representative species at both sampling locations at Rowell Creek were all less than 1, indicating no potential adverse effects to wildlife resulting from exposure to ECPCs in sediment at Site 3.

6.1.8.4 Groundwater at Site 3 Surficial groundwater from Site 3 flows toward and discharges to Rowell Creek. Therefore, aquatic receptors may be exposed to contaminated groundwater. Data from 14 monitoring wells sampled at Site 3 were used to evaluate groundwater conditions potentially contributing to surface water contamination in Rowell Creek adjacent to the site.

Results of groundwater modelling at Site 3 indicated that contaminants would be diluted by a factor of 133 when entering Rowell Creek. However, detections of analytes in unfiltered, filtered, and diluted unfiltered groundwater were used to select ECPCs. Using unfiltered concentrations to determine ECPCs is a very conservative approach because the data represent concentrations in both the dissolved and the particulate fractions of groundwater. Particulates in the groundwater are not bioavailable to aquatic receptors and are not likely to be discharged to Rowell Creek. The ECPC selection process is discussed in Chapter 3.0.

A total of 40 analytes were detected in undiluted, unfiltered groundwater samples. Of these, 25 were retained as ECPCs for aquatic receptors, including 7 VOCs, 9 SVOCs, 1 PCB congener, and 8 inorganics. Selection of ECPCs for undiluted, filtered groundwater was performed for inorganics only. Of the 12 inorganics detected in filtered groundwater, six were retained as ECPCs.

Assuming that groundwater is diluted 133-fold when entering Rowell Creek, 14 of the 25 ECPCs selected for undiluted groundwater are eliminated. The 11 remaining ECPCs for diluted groundwater are composed of 4 VOCs, 5 SVOCs, and 2 inorganics.

Concentrations of ECPCs in groundwater were compared to toxicity benchmarks and promulgated State and Federal standards. Additionally, the toxicity of groundwater at Site 3 was evaluated through dilution-series chronic toxicity testing with the water flea and the fathead minnow using two groundwater samples collected from monitoring wells CF3-MW-13S and CF3-MW-28S (see Plate 3 for sample locations).

Risks to Aquatic Receptors. Concentrations of nine analytes in undiluted, unfiltered groundwater samples exceeded aquatic RTVs. However, these data likely overestimate adverse effects to receptors. Comparison of diluted groundwater with RTVs provides a more realistic estimate of the potential for adverse effects to receptors. Only two analytes, 1,2-dichlorobenzene and aluminum, exceed RTVs if groundwater is assumed to be diluted.

Filtration of groundwater significantly reduced the concentration of aluminum in groundwater samples. It is, therefore, unlikely that future discharges of aluminum will pose a risk to aquatic receptors in Rowell Creek.

Exposure to both undiluted groundwater samples from Site 3 resulted in reduced growth and mortality in the fathead minnow, and reduced survival and reproduction in the water flea. In general, the water flea was more sensitive to Site 3 groundwater than the fathead minnow. Up to a 20-fold dilution was required to reduce the toxicity of groundwater to the test species.

Although several groundwater risk contributors were identified, three dichlorobenzene isomers appear to be the primary risk contributors for Site 3. When groundwater was diluted approximately 20-fold, little toxicity was observed. This dilution is an order of magnitude less than the 133-fold dilution expected when groundwater discharges to Rowell Creek. Analyses of the toxicity testing data, then, support the contention that diluted groundwater discharging to Rowell Creek poses little risk to aquatic receptors in the vicinity of Site 3.

6.2 OTHER SITES AND PSCs. No ERAs have been completed for other sites and PSCs at NAS Cecil Field.

6.3 REMEDIAL ACTIONS AT NAS CECIL FIELD. Remedial actions (RAs) have been planned for some of the OUs at NAS Cecil Field. Interim remedial actions (IRAs) have already been completed at some sites. These RAs and IRAs are discussed in this section. Table 6-2 summarizes the RAs and IRAs planned and/or completed for the OUs at NAS Cecil Field.

6.3.1 Operable Unit 1 The Record of Decision (ROD) for cleanup of OU 1 has been completed (ABB-ES, 1995d), and design of the preferred RA is currently underway.

The RA to be implemented at Sites 1 and 2 involves both control of sources of contamination and reduction of ecological risks that were identified in the Site 2 tributary and in Rowell Creek immediately downgradient of the confluence of the Site 2 tributary and Rowell Creek. The biomonitoring program to be implemented to reduce ecological risks at OU 1 includes the following activities:

- chemical analysis of surface water and sediment,
- identifying bacteria in the drainage structure and the Site 2 tributary,
- sampling of benthic macroinvertebrates, and
- toxicity testing of sediments.

These monitoring activities would occur on Site 2 (i.e., the spring and drainage structure), in the Site 2 tributary, and in Rowell Creek. The purposes of biomonitoring program are to:

- identify the source of the observed impacts on the Site 2 tributary;
- identify bacteria present in the Site 2 tributary;
- assess whether or not chemical, physical, and/or biological conditions improve in the Site 2 tributary over the biomonitoring period; and
- determine whether the Site 2 tributary is affecting Rowell Creek or not.

It is estimated that biomonitoring activities, and analysis of the data they generate, would be completed within the first five years of implementing the RA at OU 1. At that time, a review of the cleanup status of OU 1 would be held. If it is determined that cleanup of the Site 2 tributary and/or a portion of Rowell Creek is necessary, one of the cleanup alternatives evaluated in the OU 1 Feasibility Study (ABB-ES, 1994b) will be selected and implemented.

6.3.2 Operable Unit 2. Two Interim Records of Decision (IRODs) were completed for Sites 5 and 17 (ABB-ES, 1994c; 1994d), and both IRAs are underway. The IRA at Site 5 consists of the following activities:

- excavation and segregation of petroleum-contaminated soil and free-product-saturated soil;
- removal of free product from free-product-saturated soil;
- offsite transportation of soil formerly saturated with free product to a treatment, storage, and disposal facility;
- onsite treatment of petroleum-contaminated soil in a constructed biological treatment area;
- analysis of soil samples collected from the excavated area to verify attainment of cleanup criteria;
- backfill of the excavation and site restoration.

This IRA is being completed to control sources of contamination to groundwater (i.e., petroleum-contaminated soil and free product).

Table 6-2
Summary of Remedial Actions Planned for OUs at NAS Cecil Field

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Operable Unit/Site	Cleanup Status	Description of RA or IRA	Objectives of RA or IRA
OU 1, Sites 1 and 2	ROD signed in 1995. Design of RA is underway.	· Chemical analysis of surface water and sediment. · Identification of bacteria in the drainage structure and the Site 2 tributary. · Sampling of benthic macroinvertebrates. · Toxicity testing of sediments.	· Identify the source of the observed impacts on the Site 2 tributary. · Identify bacteria present in the Site 2 tributary. · Assess whether chemical, physical, and/or biological conditions improve in the Site 2 tributary over the biomonitoring period. · Determine whether the Site 2 tributary is affecting Rowell Creek.
OU 2, Site 5	IROD signed in 1994. IRA was initiated in 1995.	· Excavation and segregation of petroleum-contaminated soil and free-product-saturated soil. · Removal of free product from free-product-saturated soil. · Off-site transportation of soil formerly saturated with free product to a treatment, storage, and disposal facility. · On-site treatment of petroleum-contaminated soil in a constructed biological treatment area. · Analysis of soil samples collected from the excavated area to verify attainment of cleanup criteria. · Backfill of the excavation and site restoration.	· Control sources of contamination to groundwater (i.e., free product and petroleum-contaminated soil).
OU 2, Site 17	IROD signed in 1994. IRA was initiated in 1995.	· Excavation and on-site thermal treatment of petroleum-contaminated soil. · Sampling of treated soil stockpile to verify attainment of cleanup criteria. · Backfill of the excavated area with treated soil and site restoration.	· Control a source of contamination to groundwater (i.e., petroleum-contaminated soil).
OU 2, Sites 5 and 17	ROD signed in 1995. Design of RA is underway.	· Excavation of approximately 300 cubic yards of sediment from the Site 5 drainage ditch to a depth of 2 feet. · Treatment of sediment using the existing on-site biological treatment cell. · Sample and analyze the excavated area to verify attainment of cleanup levels. · Backfill the ditch with clean soil. · Institute temporary land-use restrictions.	· Control sources of contamination to sediment at Site 5. · Reduce ecological risks that were identified in sediment at Site 5.
OU 3, Sites 7 and 8	RI/FS has not yet been initiated.	NA	NA
OU 4, Site 10	RI/FS has not yet been initiated.	NA	NA
OU 5, Sites 14 and 15	RI/FS has not yet been initiated.	NA	NA

See notes at end of table.

Table 6-2 (Continued)
Summary of Remedial Actions Planned for OUs at NAS Cecil Field

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Operable Unit/Site	Cleanup Status	Description of RA or IRA	Objectives of RA or IRA
OU 6, Site 11	IROD signed in 1995. IRA was initiated in 1995.	· Excavation, overpacking, and disposal of full, partially full, and empty pesticide containers. · Excavating and off-site disposal of soil contaminated with pesticides once held by containers.	· Control sources of contamination to groundwater (i.e., contents of full and partially full containers, and pesticide-contaminated soil).
OU 7, Site 16	IROD signed in 1993. IRA completed in May 1994. FS completed in July 1995. Preferred RA has not yet been selected.	· Removal, decontamination, and disposal of a concrete underground storage tank (UST). · Sampling, removal, and disposal of liquids from the UST prior to its removal. · Removal, decontamination, and disposal of several underground structures associated with the UST, including a cinder block seepage pit, a concrete settling basin, and associated pipes. · Excavation and disposal of soil contaminated with TCE.	· Control sources of contamination to groundwater (i.e., UST contents and TCE in soil).
OU 8, Site 3	FS completed in June 1995. Preferred RA has not yet been selected.	NA	NA

Notes: OU = operable unit.
NAS = Naval Air Station.
RA = remedial action.
IRA = interim remedial action.
ROD = record of decision.
IROD = interim record of decision.
RI/FS = remedial investigation and feasibility study.
NA = not applicable.
TCE = trichloroethene.

The IRA at Site 17 consists of the following activities:

- excavation and onsite thermal treatment of petroleum-contaminated soil,
- sampling of treated soil stockpile to verify attainment of cleanup criteria, and
- backfill of the excavated area with treated soil and site restoration.

This IRA is being completed to control sources of contamination to groundwater (i.e., petroleum-contaminated soil).

Additionally, the ROD for overall cleanup of OU 2 has been completed (ABB-ES, 1995e), and design of the preferred RA is underway. The RA to be implemented at Sites 5 and 17 involves both control of sources of contamination and reduction of ecological risks that were identified in sediment at Site 5, and human health risks in groundwater at both sites. Source control was addressed by the two IRAs for the sites. The activities to be implemented to reduce ecological risks at the site include the following:

- excavation of approximately 300 cubic yards of sediment from the Site 5 drainage ditch to a depth of 2 feet,
- treatment of sediment using the existing onsite biological treatment cell,
- sample and analyze the excavated area to verify attainment of cleanup levels,
- backfill the ditch with clean soil, and
- institute temporary land-use restrictions.

The sediment cleanup is expected to take 4 months to complete.

6.3.3 Operable Unit 3 The RI/FS has not been initiated yet at OU 3.

6.3.4 Operable Unit 4 The RI/FS has not been initiated yet at OU 4.

6.3.5 Operable Unit 5 The RI/FS has not been initiated yet at OU 5.

6.3.6 Operable Unit 6 The full RI/FS has not been initiated yet at OU 6, Site 11. However, an IROD was completed for the site (ABB-ES, 1995f), and the IRA is in progress. The IRA consists of the following activities:

- excavating, overpacking, and disposing of full, partially full, and empty pesticide containers; and
- excavating and disposing of soil contaminated with pesticides once held by containers.

This IRA is being completed to control sources of contamination (i.e., contents of full or partially full pesticide containers) at OU 6. It is anticipated that the IRA will be completed by April 1996.

6.3.7 Operable Unit 7 The Feasibility Study for OU 7 was completed in September 1995 (ABB-ES, 1995g). The preferred RA has not yet been selected; however, an IRA at OU 7 was completed in May 1994 (ABB-ES, 1994e). The IRA consisted of the following activities:

- removal, decontamination, and disposal of a concrete underground storage tank (UST);
- sampling, removal, and disposal of liquids from the UST prior to its removal;
- removal, decontamination, and disposal of several underground structures associated with the UST, including a cinder block seepage pit, a concrete settling basin, and associated pipes; and
- excavation and disposal of soil contaminated with trichloroethene (TCE.)

This IRA was completed to control sources of contamination (i.e., UST contents and TCE in soil) to groundwater at OU 7.

6.3.8 Operable Unit 8 The draft Feasibility Study for OU 8 was completed in June 1995 (ABB-ES, 1995h). The preferred RA has not yet been selected.

CHAPTER 7.0

7.0 ECOLOGICAL RISK ASSESSMENT FOR LAKE FRETWELL

The information below describes the results of the ERA for Lake Fretwell and Rowell Creek upstream of Lake Fretwell. The ERA was completed according to the methodology described in Chapter 3.0. The ERA includes selection of ECPCs (Section 7.1), exposure assessment (Section 7.2), ecological effects assessment (Section 7.3), risk characterization (Section 7.4), and uncertainty analyses (Section 7.5).

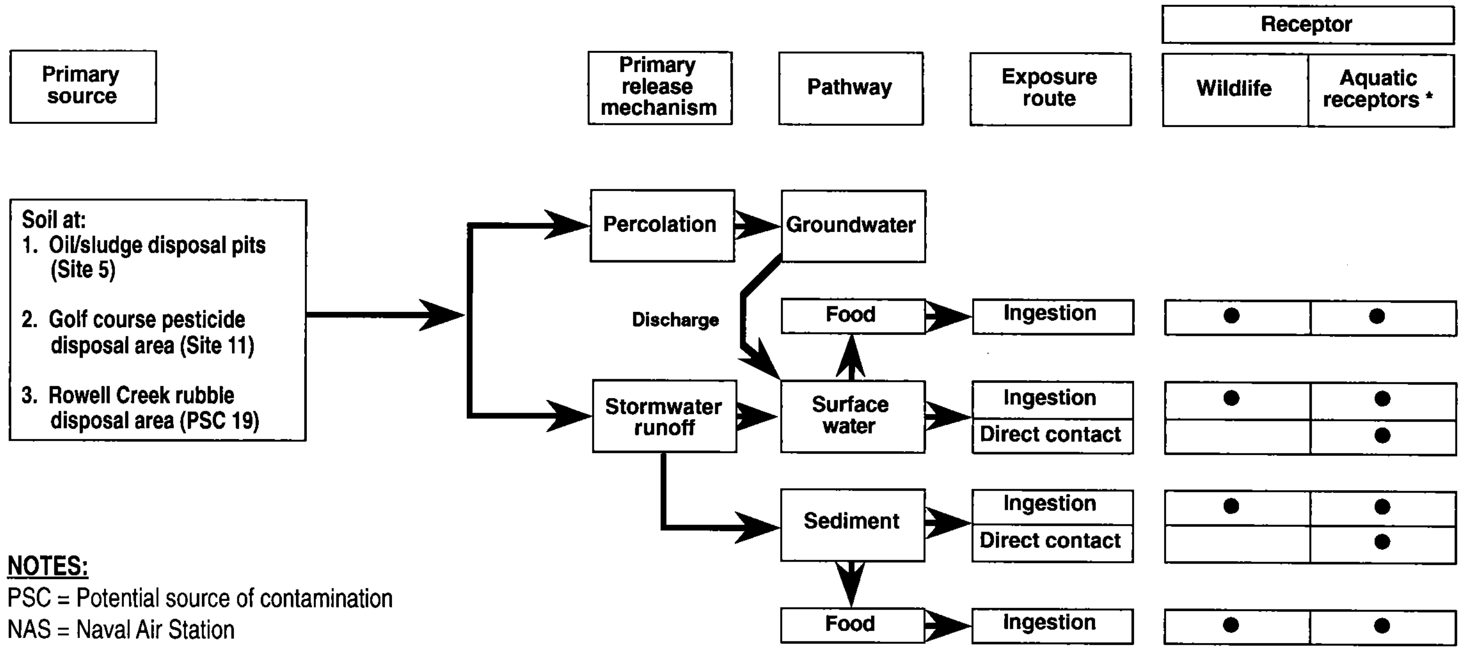
Exposure pathways for ecological receptors evaluated in the assessment are summarized in the Site Conceptual Model (Figure 7-1). Although Lake Fretwell is not designated as an OU at NAS Cecil Field, the lake is surrounded by several sources of potential contamination. Site 11, the Golf Course Pesticide Area, is located to the north of Lake Fretwell; contaminants from the golf course may be transported to Lake Fretwell via Rowell Creek. Site 19, the Rowell Creek Rubble Disposal Area, is also located to the west of Rowell Creek, just north of Lake Fretwell. An extensive palustrine freshwater wetland system associated with Lake Fretwell is located immediately to the east of Site 5, the Oil/Sludge Disposal Pits. A drainage ditch south of Site 5 carries surface water in an easterly direction, through the freshwater wetland, towards Lake Fretwell. The ERA for Lake Fretwell is being completed as part of the BEAR because potential risks for Lake Fretwell ecological receptors were not evaluated as part of the ERA for OU 2, Site 5.

The pathways include exposures to contamination in surface water and sediment. The identified pathways are associated with two areas: Lake Fretwell and Rowell Creek upstream of Lake Fretwell. The surface water and sediment data from both Rowell Creek and Lake Fretwell represents contamination potentially received from both the discharge of groundwater and overland transport from the sites.

Potential exposures to groundwater contamination are not evaluated as part of the ERA for Lake Fretwell and Rowell Creek upstream of Lake Fretwell. It is believed that the surface water samples from Lake Fretwell provide an accurate representation of the contribution of groundwater contamination from the surrounding sites. In addition, exposures from groundwater at Site 5 to aquatic and wetland receptors was evaluated as part of the Baseline Risk Assessment for OU 2 (ABB-ES, 1995a).

7.1 SELECTION OF ECOLOGICAL CHEMICALS OF POTENTIAL CONCERN. Analytes were determined to be an ECPC according to the process described in Section 3.2 and illustrated on Figure 3-1. The results of the selection of ECPCs in surface water and sediment are described in the following sections. ECPCs for aquatic life and terrestrial wildlife were selected separately for both surface water and sediment.

In July of 1993, eight surface water and sediment samples were collected in Lake Fretwell (LF-SW/SD-1 through LF-SW/SD-8; Plate 2) and three surface water and sediment samples were collected in Rowell Creek upstream of Lake Fretwell (RC-SW/SD-1, RC-SW/SD-2, and GC-SW/SD-2). The eight surface water samples from Lake Fretwell and the three samples from Rowell Creek were included in the surface water summaries. Based on detections of PCBs in the 1993 Lake Fretwell sediment data (Appendix B), sediment was resampled for chemical analyses and toxicity



NOTES:
PSC = Potential source of contamination
NAS = Naval Air Station
* Aquatic receptors = Invertebrates, plants, amphibians, and fish

FIGURE 7-1
CONTAMINANT PATHWAY MODEL FOR ECOLOGICAL RECEPTORS, LAKE FRETWELL AND ROWELL CREEK UPSTREAM OF LAKE FRETWELL

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testing and fish tissue was collected in April of 1995. As shown on Figure 7-2, eight sediment samples were collected in Lake Fretwell (LF-SD-9 through LF-SD-16 with a duplicate at LF-SD-9), and three sediment samples were collected in Rowell Creek upstream of Lake Fretwell (LF-SD-17, RC-SD-18, and GC-SD-19) during the April 1995 sampling effort. The 1995 sediment data were summarized to represent the most current exposure conditions in Lake Fretwell and Rowell Creek upstream of Lake Fretwell. The 1993 sediment data are presented in Appendix B. The historical sediment data were qualitatively compared to the 1995 sediment data set. Based on this comparison, detected concentrations of pesticides,PCBs, and inorganics are considerably lower in the 1995 sediment data set. In addition, a number of analytes detected in the 1993 data set (benzo(b)fluoranthene, chrysene, pyrene, 4,4-DDD, 4,4-DDT, Aroclor-1254, and mercury) were not detected in sediment collected in 1995. Analytes detected in the 1995 sediment samples that were not detected in 1993 include endosulfan II, endrin aldehyde, gamma-chlordane, and arsenic.

<u>7.1.1 Surface Water</u> In 1993, surface water was sampled from Lake Fretwell and Rowell Creek upstream of Lake Fretwell. Tables 7-1 and 7-2 provide a summary of the analytical results, screening values, and exposure point concentrations for Lake Fretwell and Rowell Creek upstream of Lake Fretwell, respectively. The summary tables include the USEPA Region IV Freshwater Quality Chronic Screening Values (USEPA, 1995), which were used to screen ECPCs for aquatic receptors. For the analytes selected as ECPCs, maximum and average exposure point concentrations are provided. Calcium, iron, magnesium, potassium, and sodium are excluded from the screening process because they are naturally occurring elements.

7.1.1.1 **Lake Fretwell** Surface water was collected from eight locations (LF-SW-1 through LF-SW-8 with a duplicate at LF-SW-8D) in Lake Fretwell (Plate 2). Of the 16 analytes detected in surface water, 1 volatile (acetone), and 4 inorganics (aluminum, copper, lead, and mercury) were selected as ECPCs for both terrestrial wildlife and aquatic receptors. One volatile (chloroform) and three inorganics (beryllium, nickel, and zinc) were selected as ECPCs for terrestrial wildlife only.

7.1.1.2 **Rowell Creek Upstream of Lake Fretwell** Surface water was collected from three locations (RC-SW-1, RC-SW-2, and GC-SW-2) in Rowell Creek upstream of Lake Fretwell (Plate 2). Of the 13 analytes detected in surface water, 1 volatile (acetone) and 1 inorganic (vanadium) were selected as ECPCs for both terrestrial wildlife and aquatic receptors. One volatile (methylene chloride) and one inorganic (cadmium) were selected as ECPCs for terrestrial wildlife only.

<u>7.1.2 Sediment</u> Sediment was sampled from Lake Fretwell and Rowell Creek upstream of Lake Fretwell. Tables 7-3 and 7-4 provide a summary of the analytical results, the USEPA Region IV Sediment Screening Values (USEPA, 1995), and exposure point concentrations for Lake Fretwell and Rowell Creek upstream of Lake Fretwell, respectively.

7.1.2.1 **Lake Fretwell** Sediment was sampled from eight locations (LF-SD-9 through LF-SD-16 with a duplicate at LF-SD-9D; Figure 7-2) in Lake Fretwell. Table 7-3 provides a summary of the analyses of the sediment samples. Nine of 25 analytes detected in sediment samples were selected as ECPCs for both aquatic life and terrestrial wildlife. The selected analytes include one semivolatile (di-n-butylphthalate), three pesticides (endosulfan II, endrin aldehyde, and

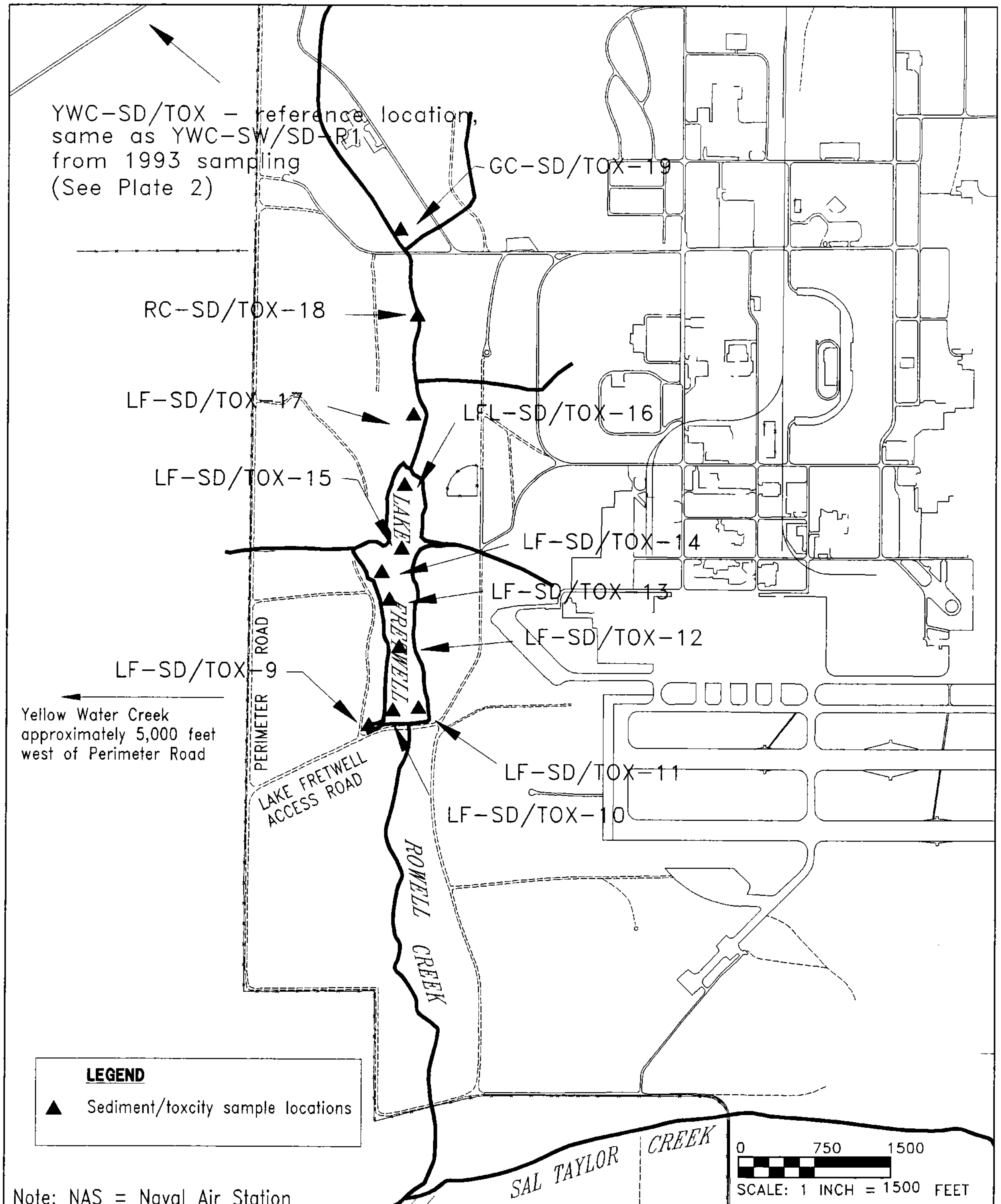

FIGURE 7-2
LOCATIONS OF SEDIMENT AND TOXICOLOGICAL SAMPLING STATIONS AT LAKE FRETWELL AND ROWELL CREEK UPSTREAM OF LAKE FRETWELL

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Table 7-1
Selection of Ecological Chemicals of Potential Concern
Surface Water Associated with Lake Fretwell

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Analyte	Frequency of Detection[1]	Range of Detected Concentrations[2]	Mean of Detected Concentrations[3]	Screening Reference Concentration[4]	Region IV Water Quality Screening Values[5]	Analyte ECPC? (Yes/No)[6]	Wildlife Exposure Concentrations[14]			
							95% UCL[7]	Arithmetic Mean[8]	Exposure Point Concentrations	
									Maximum[9]	Average[10]
Volatile Organics (μg/ℓ)										
Acetone	1/8	7	7	NA	NA	A/W	5.6	5.3	7	7
Chloroform	1/8	[2]3.5	3.5	NA	289	W[12]	5.2	4.8	3.5	3.5
Inorganics (μg/ℓ)										
Aluminum	8/8	84.4 - 751	181	619	87	A/W	369	181	751	181
Barium	8/8	[2]19.75 - 29.6	23.6	59.9	NA	No[11]				
Beryllium	3/8	0.23 - 0.29	0.26	ND	0.53	W[12]	11.8	1.7	0.29	0.26
Calcium	8/8	[2]12,400 - 14,200	13,675	16,980	NA	No[11]				
Copper	6/8	1.7 - [2]7.1	3.5	7.0	6.05	A/W	13.5	5.8	7.1	3.5
Iron	8/8	790 - 1,270	948	4,940	1,000	No[11]				
Lead	2/8	7.7 - 7.8	7.8	6.2	1.17	A/W	18.7	6.8	7.8	7.8
Magnesium	8/8	[2]2,610 - 2,920	2,810	4,127	NA	No[11,13]				
Manganese	4/8	7.6 - 19.1	14.5	24.8	NA	No[11]				
Mercury	5/8	0.08 - 0.5	0.28	ND	0.012	A/W	0.45	0.21	0.5	0.28
Nickel	1/8	13	13	ND	81.2	W[12]	21.1	19.1	13	13
Potassium	6/8	[2]485 - 961	746	1,251	NA	No[11,13]				
Sodium	8/8	6,490 - 7,570	6,883	12,520	NA	No[11,13]				
Zinc	3/8	9.5 - 30.3	21.4	ND	54.5	W[12]	21.5	14.3	30.3	21.4

See notes at end of table.

Table 7-1 (Continued)
Selection of Ecological Chemicals of Potential Concern
Surface Water Associated with Lake Fretwell

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

[1] Frequency of detection is the number of samples in which the analyte was detected divided by the total number of samples analyzed. The following samples were analyzed: LF-SW-1 through LF-SW-8 (with a duplicate at LF-SW-8D).

[2] Is the average of the detected concentration in a sample and its duplicate. For non-detect values, one-half of the Contract Required Quantitation Limit or Contract Required Detection Limit (CRQL/CRDL) is used as a surrogate.

[3] 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.

[4] The screening reference concentration is equal to two times the average background concentration for inorganics and is equal to the average background concentration for organics. Background sample locations include RCGC-SW-R1, RC-SW-R1, and YWC-SW-R1.

[5] U.S. Environmental Protection Agency (USEPA) Region IV, Waste Management Division, Freshwater Water Quality Chronic Screening Values for Hazardous Waste Sites (USEPA, 1995). Values for copper, lead, nickel, and zinc based upon equations using the average hardness for surface water samples from Lake Fretwell of 45.6 $\mu g/\ell$ of $CaCo_3$.

[6] Ecological chemical of potential concern (ECPC) selection process is depicted on Figure 3-1. "A" indicates an ECPC for aquatic receptors. "W" indicates an ECPC for terrestrial receptors.

[7] The 95 percent upper confidence limit (UCL) is calculated on the log-transformed average of all concentrations using the formula provided in the U.S. Environmental Protection Agency Region IV Supplemental Guidance (1991).

[8] The arithmetic mean of all concentrations assigns a value of one-half of the CRQL for organics and Method Detection Limitfor inorganics to all non-detects.

[9] The maximum exposure concentration is equal to the maximum detected concentration.

[10] The average exposure concentration is equal to the mean of detected concentrations.

[11] Maximum detected concentration is less than two times the average background concentration for inorganics.

[12] Maximum analyte concentration is below the Region IV water quality screening value; therefore, the analyte was not considered as an ECPC for aquatic receptors.

[13] Analyte is an essential nutrient and is not present at toxic levels.

[14] Aquatic receptor exposure concentrations are location specific and are equal to the respective concentrations measured in surface water and sediment samples.

Notes: % = percent
$\mu g/\ell$ = micrograms per liter.
NA = not available.
ND = not detected in background samples.

Table 7-2
Selection of Ecological Chemicals of Potential Concern
Surface Water Associated with Rowell Creek Upstream of Lake Fretwell

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection[1]	Range of Detected Concentrations[2]	Mean of Detected Concentrations[3]	Screening Reference Concentration[4]	Region IV Water Quality Screening Values[5]	Analyte ECPC? (Yes/No)[6]	Wildlife Exposure Concentrations[14]			
							95% UCL[7]	Arithmetic Mean[8]	Exposure Point Concentrations	
									Maximum[9]	Average[10]
Volatile Organics (μg/ℓ)										
Acetone	1/3	12	12	NA	NA	A/W	NC	7.3	12	12
Methylene chloride	1/3	1	1	NA	1,930	W[12]	NC	3.7	1	1
Inorganics (μg/ℓ)										
Aluminum	2/3	86.9 - 107	97	619	87	No[11]				
Barium	3/3	23.4 - 25.7	24.7	59.9	NA	No[11]				
Cadmium	1/3	0.26	0.26	ND	0.83	W[12]	NC	1.8	0.26	0.26
Calcium	3/3	13,900 - 14,700	14,333	16,980	NA	No[13]				
Iron	3/3	702 - 996	958	4,940	1,000	No[11,12]				
Lead	1/3	3.4	3.4	6.2	1.93	No[11]				
Magnesium	3/3	2,810 - 2,990	2,907	4,127	NA	No[13]				
Manganese	1/3	7.8	7.8	24.8	NA	No[11]				
Potassium	1/3	866	866	1,251	NA	No[13]				
Sodium	3/3	6,680 - 7,240	6,980	12,520	NA	No[13]				
Vanadium	1/3	3	3	ND	NA	A/W	NC	17.7	3	3

See notes at end of table.

Table 7-2 (Continued)
Selection of Ecological Chemicals of Potential Concern
Surface Water Associated with Rowell Creek Upstream of Lake Fretwell

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

[1] Frequency of detection is the number of samples in which the analyte was detected divided by the total number of samples analyzed. The following samples were analyzed: RC-SW-1, RC-SW-2, and GC-SW-2.

[2] Values where one-half of the Contract Required Quantitation Limit or Contract Required Detection Limit (CRQL/CRDL) is used as a surrogate.

[3] 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.

[4] The screening reference concentration is equal to two times the average background concentration for inorganics and is equal to the average background concentration for organics. Background sample locations include RCGC-SW-R1, RC-SW-R1, and YWC-SW-R1.

[5] U.S. Environmental Protection Agency (USEPA) Region IV, Waste Management Division, Freshwater Water Quality Chronic Screening Values for Hazardous Waste Sites (USEPA, 1995). Values for cadmium and lead based upon equations using the average hardness for surface water samples from Rowell Creek of 67.7 $\mu g/\ell$ of $CaCo_3$

[6] Ecological chemical of potential concern (ECPC) selection process is depicted on Figure 3-1. "A" indicates an ECPC for aquatic receptors. "W" indicates an ECPC for terrestrial receptors.

[7] The 95 percent upper confidence limit (UCL) is calculated on the log-transformed average of all concentrations using the formula provided in the U.S. Environmental Protection Agency Region IV Supplemental Guidance (1991).

[8] The arithmetic mean of all concentrations assigns a value of one-half of the Contract Required Quantitation Limit (CRQL) for organics and Method Detection Limit (MDL) for inorganics to all non-detects.

[9] The maximum exposure concentration is equal to the maximum detected concentration.

[10] The average exposure concentration is equal to the mean of detected concentrations.

[11] Maximum detected concentration is less than two times the average background concentration for inorganics.

[12] Maximum analyte concentration is below the Region IV water quality screening value; therefore, the analyte was not considered as an ECPC for aquatic receptors.

[13] Analyte is an essential nutrient and is not present at toxic levels.

[14] Aquatic receptor exposure concentrations are location specific and are equal to the respective concentrations measured in surface water and sediment samples.

Notes: % = percent.
$\mu g/\ell$ = micrograms per liter.
NA = not available.
NC = not calculated.
ND = not detected in background samples.

Table 7-3
Selection of Ecological Chemicals of Potential Concern
Sediment Associated with Lake Fretwell

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection[1]	Range of Detected Concentrations	Mean of Detected Concentrations[3]	Screening Reference Concentration[4]	Region IV Sediment Quality Screening Values[5]	Analyte ECPC? (Yes/No)[6]	Wildlife Exposure Concentrations[16]			
							95% UCL[7]	Arithmetic Mean[8]	Exposure Point Concentrations	
									Maximum[9]	Average[10]
Semivolatile Organics (µg/kg)										
Di-n-butylphthalate	8/8	[2]17.04 - 380	113	NA	NA	A/W	372	113	380	113
Pesticides/PCBs (µg/kg)										
4,4-DDE	3/8	0.27 - 0.87	0.49	ND	3.3	W[12]	7.6	1.8	0.87	0.49
Aroclor-1260	3/7[11]	3 - 14	7	ND	33	W[12]	508	33.9	14	7
Endosulfan II	1/8	0.12	[2]0.12	ND	NA	A/W	35.5	3.3	0.12	0.12
Endrin aldehyde	1/8	0.31	0.31	ND	NA	A/W	12.4	3.2	0.31	0.31
alpha-Chlordane	3/8	[2]0.19 - 2.4	0.94	ND	1.7	A/W	10.5	1.6	2.4	0.94
gamma-Chlordane	1/8	0.13	0.13	ND	1.7	W[12]	7.2	1.6	0.13	0.13
Inorganics (mg/kg)										
Aluminum	8/8	912 - 10,700	2,923	15,980	NA	No[13]				
Arsenic	1/8	7.7	7.7	ND	7.24	A/W	10.5	9.7	7.7	7.7
Barium	8/8	4.6 - 101	19.8	195.2	NA	No[13]				
Cadmium	2/8	0.46 - 1.4	0.93	ND	1.0	A/W	0.82	0.61	1.4	0.93
Calcium	8/8	523 - 8,300	2,630	5,860	NA	No				
Chromium	8/8	2.9 - [2]18.9	7.6	14.6	52.3	W[12]	15.8	7.6	18.9	7.6
Cobalt	1/8	0.8	0.8	3.4	NA	No[13]				
Copper	8/8	1.4 - 32.7	7.4	50.4	18.7	No[13]				
Cyanide	4/4[15]	0.18 - 0.71	0.34	1.66	NA	No[13]				
Iron	8/8	415 - 4,110	1,162	6,280	NA	No[13,14]				
Lead	8/8	3.4 - 75.8	16.6	47	30.2	A/W	49.9	16.6	75.8	16.6
Magnesium	8/8	55.8 - 2,980	541	1,160	NA	No[14]				
Manganese	8/8	3.1 - 19.7	8.5	17.4	NA	A/W	15.3	8.5	19.7	8.5
Nickel	8/8	1.5 - [2]10	4.1	6.4	15.9	W[12]	8.9	4.1	10	4.1
Potassium	6/8	18.5 - 110	41.9	135	NA	No[13,14]				
Sodium	8/8	196 - 1,060	334	1,154	NA	No[13,14]				
Vanadium	8/8	1.6 - 17.6	5	29.8	NA	No[13]				
Zinc	1/8	132	132	ND	124	A/W	147	18.3	132	132

See notes at end of table.

Table 7-3 (Continued)
Selection of Ecological Chemicals of Potential Concern
Sediment Associated with Lake Fretwell

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
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[1] Frequency of detection is the number of samples in which the analyte was detected divided by the total number of samples analyzed. The following samples were analyzed: LF-SD-9 through LF-SD-16

[2] The average of the detected concentration in a sample and its duplicate. For non-detect values, one-half of the Contract Required Quantitation Limit or Contract Require Detection Limit (CRQL/CRDL) is used as a surrogate.

[3] 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.

[4] The screening reference concentration is equal to two times the average background concentration for inorganics and is equal to the average background concentration for organics. The background sample location is YWC-SD-20.

[5] U.S. Environmental Protection Agency (USEPA) Region IV Waste Management Division Sediment Screening Values for Hazardous Waste Sites (USEPA, 1995).

[6] Ecological chemical of potential concern (ECPC) selection process is depicted on Figure 3-1. "A" indicates an ECPC for aquatic receptors. "W" indicates an ECPC for terrestrial receptors.

[7] The 95 percent upper confidence limit (UCL) is calculated on the log-transformed average of all concentrations using the formula provided in the U.S. Environmental Protection Agency Region IV Supplemental Guidance (1991).

[8] The arithmetic mean of all concentrations assigns a value of one-half of the CRQL for organics and Method Detection Limit for inorganics to all non-detects.

[9] The maximum exposure concentration is equal to the maximum detected concentration.

[10] The average exposure concentration is equal to the mean of detected concentration.

[11] The validated analytical data for Aroclor-1260 was rejected at sampling station LF-SD-10.

[12] Maximum analyte concentration is below the sediment quality screening value; therefore, the analyte was not considered as an ECPC for aquatic receptors.

[13] Maximum detected concentration is less than two times the average background concentration for inorganics.

[14] Analyte is an essential nutrient and is not present at toxic levels.

[15] The validated analytical data for cyanide was rejected at sampling stations LF-SD-10, LF-SD-11, LF-SD-13, and LF-SD-14.

[16] Aquatic receptor exposure concentrations are location specific and are equal to the respective concentrations measured in surface water and sediment samples.

Notes: % = percent.
μg/kg = micrograms per kilogram.
NA = not available.
PCBs = polychlorinated biphenyls.
ND = not detected in the background samples.
DDE = dichlorodiphenyldichloroethene.
mg/kg = milligram per kilogram.

Table 7-4
Selection of Ecological Chemicals of Potential Concern
Sediment Associated with Rowell Creek Upstream of Lake Fretwell

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

Analyte	Frequency of Detection[1]	Range of Detected Concentrations	Mean of Detected Concentrations[3]	Screening Reference Concentration[4]	Region IV Sediment Quality Screening Values[5]	Analyte ECPC? (Yes/No)[6]	Wildlife Exposure Concentrations[16]			
							95% UCL[7]	Arithmetic Mean[8]	Exposure Point Concentrations	
									Maximum[9]	Average[10]
Semivolatile Organics (µg/kg)										
Di-n-butylphthalate	3/3	94 - [2]185	153	NA	NA	A/W	NC	153	185	153
Pesticides/PCBs (µg/kg)										
4,4-DDE	1/2[11]	[2]0.195	0.2	ND	3.3	W[12]	NC	1.3	0.2	0.2
Aroclor-1260	1/2[11]	6.6	6.6	ND	33	W[12]	NC	16.2	6.6	6.6
Dieldrin	1/2[11]	[2]1.53	1.5	ND	3.3	W[12]	NC	0.87	1.5	1.5
alpha-Chlordane	2/2[11]	[2]0.19 - 0.19	0.19	ND	1.7	W[12]	NC	0.19	0.19	0.19
Inorganics (mg/kg)										
Aluminum	3/3	1,720 - [2]2,815	2,292	15,980	NA	No[13]				
Barium	3/3	9.4 - 14.5	12.3	195.2	NA	No[13]				
Calcium	3/3	[2]930.5 - 1,360	1,093	5,860	NA	No[13,14]				
Chromium	3/3	2.6 - [2]5.45	4.4	14.6	52.3	No[12,13]				
Copper	3/3	3.7 - [2]5.5	4.7	50.4	18.7	No[12,13]				
Cyanide	2/2[15]	0.4 - [2]0.41	0.41	1.66	NA	No[13]				
Iron	3/3	631 - 986	795	6,280	NA	No[13]				
Lead	3/3	8.5 - 17	12.6	47	30.2	No[12,13]				
Magnesium	3/3	76.4 - [2]124.35	97.3	1,160	NA	No[13,14]				
Manganese	3/3	3.6 - [2]5.95	4.7	17.4	NA	No[13]				
Nickel	3/3	1.5 - [2]2.5	1.8	6.4	15.9	No[12,13]				
Potassium	1/3	[2]36	36	135	NA	No[13,14]				
Sodium	3/3	[2]260 - 266	264	1,154	NA	No[13,14]				
Vanadium	3/3	3 - [2]5.4	4.4	29.8	NA	No[13]				

See notes at end of table.

Table 7-4 (Continued)
Selection of Ecological Chemicals of Potential Concern
Sediment Associated with Rowell Creek Upstream of Lake Fretwell

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

[1] Frequency of detection is the number of samples in which the analyte was detected divided by the total number of samples analyzed. The following samples were analyzed: LF-SD-17, RC-SD-18 and GC-SD-19.
[2] The average of the detected concentration in a sample and its duplicate. For non-detect values, one-half of the Contract Required Quantitation Limit or Contract Require Detection Limit (CRQL/CRDL) is used as a surrogate.
[3] 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.
[4] The screening reference concentration is equal to two times the average background concentration for inorganics and is equal to the average background concentration for organics. The background sample location is YWC-SD-20.
[5] U.S. Environmental Protection Agency (USEPA) Region IV Waste Management Division Sediment Screening Values for Hazardous Waste Sites (USEPA, 1995).
[6] Ecological chemical of potential concern (ECPC) selection process is depicted on Figure 3-1. "A" indicates an ECPC for aquatic receptors. "W" indicates an ECPC for terrestrial receptors.
[7] The 95 percent upper confidence limit (UCL) is calculated on the log-transformed average of all concentrations using the formula provided in the U.S. Environmental Protection Agency Region IV Supplemental Guidance (1991).
[8] The arithmetic mean of all concentrations assigns a value of one-half of the CRQL for organics and Method Detection Limit for inorganics to all non-detects.
[9] The maximum exposure concentration is equal to the maximum detected concentration.
[10] The average exposure concentration is equal to the mean of detected concentrations.
[11] The validated analytical data was rejected at sampling station GC-SD-19.
[12] Maximum analyte concentration is below the sediment quality screening value; therefore, the analyte was not considered as an ECPC for aquatic receptors.
[13] Maximum detected concentration is less than two times the average background concentration for inorganics.
[14] Analyte is an essential nutrient and is not present at toxic levels.
[15] The validated data for cyanide was rejected at sampling station GC-SD-19.
[16] Aquatic receptor exposure concentrations are location specific and are equal to the respective concentrations measured in surface water and sediment samples.

Notes: % = percent.
μg/kg = micrograms per kilogram.
NA = not available.
NC = not calculated.
PCBs = polychlorinated biphenyls.
DDE = dichlorodiphenyldichloroethene.
ND = not detected in the background samples.
mg/kg = milligram per kilogram.

alpha-chlordane), and five inorganics (arsenic, cadmium, lead, manganese, and zinc). Three pesticides/PCBs (4,4-DDE, Aroclor-1260, and gamma-chlordane) and one inorganic (nickel) were selected as ECPCs for terrestrial wildlife only.

7.1.2.2 **Rowell Creek Upstream of Lake Fretwell** Sediment was sampled from three locations (LF-SD-17, RC-SD-18, and GC-SD-19 with a duplicate at LF-SD-17D; Figure 7-2) in Rowell Creek upstream of Lake Fretwell. Table 7-4 provides a summary of the analyses of the sediment samples. One of 19 analytes detected in sediment samples was selected as an ECPC for both aquatic life and terrestrial wildlife.

The selected analyte is di-n-butylphthalate. Four pesticides/PCBs (4,4-DDE, Aroclor-1260, dieldrin, and alpha-chlordane) were selected as ECPCs for terrestrial wildlife only. No organic analytes were retained as ECPCs for either aquatic receptors or terrestrial wildlife.

7.2 EXPOSURE ASSESSMENT. Exposure assessment is the process of estimating or measuring the amount of an ECPC to which an ecological receptor may be exposed. The following subsections discuss how contaminant exposures were estimated or measured for aquatic receptors and terrestrial wildlife at Lake Fretwell and Rowell Creek upstream of Lake Fretwell. The site conceptual model (Figure 7-1) provides a summary of potential exposure pathways that exist at Lake Fretwell for each group of receptors.

7.2.1 Surface Water Exposure concentrations for ECPCs in surface water are determined for both aquatic receptors and terrestrial wildlife. Exposure pathways for aquatic receptors and terrestrial wildlife were identified in the contaminant pathway model on Figure 7-1. Exposures for terrestrial wildlife to ECPCs in surface water and sediment are evaluated concurrently.

7.2.1.1 **Terrestrial Wildlife** Four species were selected as representative wildlife species for the purpose of evaluating risks associated with exposures to surface water and sediment contamination in Lake Fretwell and Rowell Creek upstream of Lake Fretwell. Life history information used to estimate exposures for each of the representative wildlife species is summarized in Table 7-5. The four representative wildlife species used for exposure modeling include the following:

- Florida water rat (*Neofiber alleni*). This small mammalian omnivore may be exposed to contamination in surface water and sediment as a result of direct ingestion and ingestion of aquatic prey. Aquatic prey (plants and invertebrates) may become contaminated as a result of accumulation of contaminants from the surface water and sediment. The Florida water rat was selected to represent mammalian species that would receive higher doses as a result of their small body size.

- Raccoon (*Procyon lotor*). This species represents an opportunistic omnivorous species that may be exposed to contamination in surface water and sediment both as a result of direct ingestion and ingestion of aquatic prey. Aquatic prey includes plants, invertebrates and fish.

Table 7-5
Exposure Parameters for Representative Wildlife Species

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Representative Wildlife Species	Body Weight (kg)	Reported Diet	Soil and Sediment Ingestion (% of diet)	Assumed Diet for Exposure Assessment (% of diet)	Food Ingestion Rate (kg/day)	Water Intake Rate (ℓ/day)	Home Range (acres)
Florida water rat (*Neofiber alleni*)	0.33 [a]	Primarily aquatic plants and crayfish [b].	<2% sed. [c]	90% Aquatic plants 8% Aquatic organisms	0.027 [d]	0.037 [e]	0.42 [f]
Raccoon (Procyon lotor)	3.99 [g]	Mostly fleshy fruits, nuts acorns, corn; also frogs, crayfish, and insects [b].	7% sed. [c]	93% Aquatic organisms	0.214 [d]	0.344 [e]	385 [h]
Kingfisher (*Ceryle alcyon*)	0.15 [i]	Mostly small fish; some crayfish, frogs, crabs, snakes, and insects [i].	7% sed. [c]	93% Aquatic organisms	0.014 [j]	0.0165 [k]	35 [l]
Great blue heron (*Ardea herodias*)	2.23 [b]	Mostly fish; some amphibians, crustaceans, and birds [b].	<2% sed. [c]	>98% Aquatic organisms	0.401 [m]	0.101 [k]	1.5 [n]

References:
[a] Burt and Grossenheider, 1980.
[b] Wildlife Exposure Factors Handbook, U.S. Environmental Protection Agency (USEPA [1993]).
[c] Sediment ingestion assumed to be 7% for the raccoon and the heron and 2% for the Florida water rat and heron.
[d] Calculated using the mammal equation based on body weight (Wt.) in kg. Food ingestion (kg/day) = 0.0687 x Wt $^{0.822}$. USEPA (1993).
[e] Calculated using the mammal equation based on body (Wt.) in kg. Water ingestion (l/day) = 0.099 x Wt $^{0.90}$. USEPA (1993).
[f] Value for the muskrat was used for the Florida water rat. USEPA (1993).
[g] Median of mean weights for male and female raccoons in Alabama. USEPA (1993).
[h] Average of adult male and female raccoons from May to December. USEPA (1993).
[i] Terres (1991).
[j] Calculated using the bird equation based on body weight (Wt.) in kg. Food ingestion (kg/day) = 0.0582 x Wt $^{0.651}$. USEPA (1993).
[k] Calculated using the bird equation based on body weight (Wt.) in kg. Water ingestion (l/day) = 0.059 x Wt $^{0.67}$. USEPA (1993).
[l] Sayler and Lagler (1949).
[m] As reported estimating from Kushlan's (1978) allometric equation for wading birds, assuming a body weight of 2,230 g. USEPA (1993).
[n] Size of heron feeding territory in summer (USEPA, 1993).

Notes: kg = kilograms.
% = percent.
kg/day = kilograms per day.
ℓ/day = liters per day.
< = lesser than.
g = grams.

- Kingfisher (*Ceryle alcyon*). This species represents a piscivorous avian species that may be exposed to contamination in surface water both as a result of direct ingestion and ingestion of aquatic prey.

- Great blue heron (*Ardea herodias*). This species represents a higher trophic level avian receptor that may be exposed to surface water and sediment contamination from Lake Fretwell. Great blue herons feed primarily on aquatic prey items including fish, frogs, and invertebrates. The great blue heron has been observed at Lake Fretwell and was selected to represent the wading bird guild of ecological receptors (i.e., other herons and egrets).

Contaminant exposures for each of the representative wildlife species related to the surface water and sediment ECPCs are estimated based on the equations in Table 3-2. Exposures evaluated for the representative wildlife species include ingestion of surface water and sediment and ingestion of aquatic life (which may bioconcentrate ECPCs in the surface water or accumulate ECPCs from sediment). Maximum and average exposure concentrations are equal to the respective maximum and mean of the detected concentrations.

PDEs for each of the representative wildlife species for each of the surface water and sediment ECPCs are estimated using a model discussed in Section 3.3. In the model, exposure doses for each ECPC for each representative wildlife species are calculated based on the exposure concentrations in surface water (and sediment) and life history factors for the species. The equations are provided in Table 3-2. Piscivorous exposures are estimated using the maximum analyte concentration detected in any fish species from the corresponding lake or stream sampling stations. In addition, the site-derived fish tissue data were used to estimate exposures to all aquatic prey, including benthic macroinvertebrates. The model for the Lake Fretwell ERA uses the maximum site-specific measurements of pesticide, PCB, and inorganic concentrations in whole fish in place of estimates based on bioconcentration factors (BCFs). The fish data were collected to provide accurate measurements of exposure and to reduce uncertainty in the exposure and risk assessments. The collection and analyses of fish tissue is described in Section 5.5.

The contaminant exposures calculated for each of the representative wildlife species for each of the ECPCs in surface water and sediment are presented in Appendices D-1 and D-2 (for Lake Fretwell and Rowell Creek upstream of Lake Fretwell, respectively).

7.2.1.2 Aquatic Receptors Contaminant exposures related to direct contact with surface water are evaluated for aquatic receptors in Lake Fretwell and Rowell Creek upstream of Lake Fretwell. Exposures are evaluated for each of the geographic sampling locations in Lake Fretwell and Rowell Creek with the exposure concentrations assumed to be equal to the amount of an analyte detected in the surface water sample from the respective location. The concentrations of ECPCs detected in surface water from Lake Fretwell and Rowell Creek upstream of Lake Fretwell are provided in Tables 7-1 and 7-2, respectively.

7.2.2 Sediment Both aquatic receptors and wildlife may be exposed to ECPCs in sediment. Exposure pathways for ECPCs in sediment are depicted on Figure 7-1.

7.2.2.1 **Terrestrial Wildlife** Routes of exposure to contaminated sediment evaluated for each of the representative wildlife species include indirect ingestion of sediment (during foraging activities) and ingestion of contaminated food (aquatic organisms that have accumulated contamination from the surface water and sediment). Site-specific measurements of whole fish were used to measure the contaminant concentrations in aquatic prey. The collection and analysis of fish tissue is described in Section 5.5. Contaminant exposures for each of the representative wildlife species for each of the ECPCs are calculated based on the equations in Table 3-2. The exposure concentrations calculated are reported in Appendices D-1 and D-2 (for Lake Fretwell and Rowell Creek upstream of Lake Fretwell, respectively).

7.2.2.2 **Aquatic Receptors** Contaminant exposures via direct contact were evaluated by the use of sediment toxicity tests. Exposures are evaluated for each of the sampling stations in Lake Fretwell and Rowell Creek upstream of Lake Fretwell with the exposure concentrations assumed to be equal to the amount of an analyte detected in the sediment sample from the respective location.

<u>7.3 **ECOLOGICAL EFFECTS ASSESSMENT**</u>. The ecological effects assessment describes the potential adverse effects associated with the identified ECPCs to ecological receptors.

<u>7.3.1 **Surface Water and Sediment**</u> Potential or adverse ecological effects for ECPCs in surface water and sediment are described in the paragraphs below.

7.3.1.1 **Terrestrial Receptors** The ecological effects assessment for ECPCs in surface water and sediment includes identification of RTVs for avian and mammalian receptors. The RTV relates the dose of a respective ECPC in an oral exposure with an adverse effect. For each ECPC identified and each representative wildlife species selected, lethal and sublethal RTVs are identified. A lethal RTV represents the threshold for lethal effects and is based on oral LD_{50} values (oral dose lethal to 50 percent of a test population). The lethal RTV is one-fifth of the lowest reported LD_{50} for the closest related test species. One-fifth of an oral LD_{50} is considered to be protective of lethal effects for 99.9 percent of individuals in a test population (USEPA, 1986). An assumption is made that the value represented by one-fifth of an oral LD_{50} would be protective of 99.9 percent of the individuals within the terrestrial wildlife populations at Lake Fretwell and Rowell Creek upstream of Lake Fretwell and represents a level of acceptable risk. A sublethal RTV is also identified that represents a threshold dose for effects that impair or prevent reproduction, growth, or survival.

Toxicity data for avian species are limited; in cases where toxicity information is unavailable, RTVs are not identified and risks associated with the predicted exposure for the respective ECPC are not evaluated. The absence of specific data for a taxonomic group does not imply that there is no anticipated toxicological effect associated with contaminant exposure by these receptors.

The RTVs derived for each of the representative wildlife species for each of the ECPCs in surface water and sediment at Lake Fretwell and Rowell Creek upstream of Lake Fretwell are summarized in Appendix D-3. The dose-response information used to derive RTVs is included as Appendix D-4.

7.3.1.2 **Aquatic Receptors** The results of the quantitative sampling and analyses of the benthic macroinvertebrate community at Lake Fretwell (LF-Bio-1 through LF-Bio-8) and Rowell Creek upstream of Lake Fretwell (RC-Bio-1, RC-Bio-2, and GC-Bio-2) are provided in Subsection 5.2.2. The biological sampling locations are depicted on Plate 2. Although the habitat assessment procedure (described in Section 5.2) is designed for stream habitat, information that was applicable to the Lake Fretwell sampling stations was tabulated and scores were assigned (Table 5-24). Due to the lack of a suitable reference station for the Lake Fretwell sampling stations, the Lake Fretwell habitat assessment scores were only comparable to each other. The scores for Lake Fretwell ranged from 26 at LF-Bio-1 to 46 at LF-Bio-7. Habitat assessment scores for sampling stations in Rowell Creek upstream of Lake Fretwell were consistent ranging from 49 at GC-Bio-2 to 55 at RC-Bio-2. For the Rowell Creek sampling stations, the habitat scores were divided by the Five Mile Creek reference station score for a percent comparability value (Table 5-24). These values ranged from 73.1 percent at station GC-Bio-2 to 82.1 percent at RC-Bio-2.

Metrics used to characterize the benthic macroinvertebrate community are described in Table 5-10 and discussed for Lake Fretwell and the upstream stations in Rowell Creek in Subsection 5.2.2. The trends in metric values indicate that station LF-Bio-6 ranked lower for many of the key metrics as compared to the other Lake Fretwell sampling stations. Station, LF-Bio-6, the deepest station sampled in Lake Fretwell, had very low dissolved oxygen at the bottom, which may have contributed to its low metric values. A review of the macroinvertebrate habitat quality parameter data at the other Lake Fretwell and Rowell Creek sampling stations suggests that these stations lie within normal condition.

Table 7-6 summarizes the results (percent survival and growth) from the 14-day toxicity tests with the amphipod, *H. azteca*, and the midge larvae, *C. tentans*. After 14 days of exposure, survival of *H. azteca* in the reference (YWC-SD/TOX-20), was significantly different ($p \leq 0.05$) from the laboratory control sediment; however, this significance is the result of no mortality in the laboratory control. Survival of *H. azteca* in samples from stations LF-SD/TOX-11 and LF-SD/TOX-12 were significantly different from the reference sediment. Growth, reported as weight and length, of *H. azteca* in the sediment from all sample stations was not significantly different from the laboratory control and reference sample. Growth of *H. azteca* in sediment from stations LF-SD/TOX-11 and LF-SD/TOX-12 could not be determined due to 100 percent mortality. Survival of *C. tentans* exposed to sediment from stations LF-SD/TOX-9, LF-SD/TOX-13, LF-SD/TOX-14, LF-SD/TOX-15, and RC-SD/TOX-18 were significantly different from the laboratory control sediment. Survival of *C. tentans* exposed to sediment from stations LF-SD/TOX-9 and RC-SD/TOX-18 were significantly different from the reference sediment. Growth of *C. tentans* exposed to the sediment samples was not significantly different from the control or reference sediments. Complete information on the sediment toxicity testing from Lake Fretwell and Rowell Creek upstream of Lake Fretwell is presented in Appendix D-5.

Ecological effects associated with surface water ECPCs are also estimated based on aquatic toxicity benchmarks. Aquatic toxicity benchmarks include the Florida Surface Water Quality Standards for Class III freshwater (Florida Legislature, 1995) and aquatic toxicity information from the USEPA AQUIRE database (Appendix D-6). Information from the AQUIRE database on the aquatic toxicity of surface water ECPCs to freshwater life is summarized in Table 7-7.

Table 7-6
Results of Sediment Toxicity Testing

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Sample Location	Amphipod (*Hyalella azteca*)			Midge larvae (*Chironomus tentans*)	
	Survival (%)	Growth (weight in mg/organism)	Growth (length in mm)	Survival (%)	Growth (weight in g/organism)
Control 1[1]	100	0.28	3.3	85	1.06
LF-SD/TOX-11	0[3,4,5]	NA	NA	82	1.74
LF-SD/TOX-12	0[3,4,5]	NA	NA	80	1.47
LF-SD/TOX-13	100	0.29	3.4	65[3,5]	1.72
LF-SD/TOX-14	93[3]	0.29	3.4	62[3,5]	1.91
LF-SD/TOX-15	100	0.39	3.6	63[3,5]	1.37
LF-SD/TOX-16	98	0.42	3.6	77	1.87
LF-SD/TOX-17	100	0.37	3.5	67	0.88
YWC-SD/TOX-20	95[3]	0.32	3.4	75	1.05
Control 2[2]	88	0.4	3.4	75	1.45
LF-SD/TOX-9	94	0.46	3.7	42[3,4,5]	1.5
LF-SD/TOX-10	99	0.47	3.7	87	1.47
RC-SD/TOX-18	98	0.41	3.5	18[3,4,5]	1.17
GC-SD/TOX-19	88	0.43	3.6	75	1.24

[1] Laboratory control for sediment samples LF-SD/TOX-11 through LF-SD/TOX-17 and YWC-SD/TOX-20.
[2] Laboratory control for sediment samples LF-SD/TOX-9, LF-SD/TOX-10, RC-SD/TOX-18, and GC-SD/TOX-19.
[3] Significantly different from the laboratory control sediment.
[4] Significantly different from the reference sediment (YWC-SD/TOX-20).
[5] Considered to be substantially different from the reference or control sediment (i.e., biologically significant).

Notes: NA = not available.
% = percent
mg = milligram
mm = millimeter
g = gram

Table 7-7
Toxicity of Surface Water ECPCs to Aquatic Receptors

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Analyte[1]	Fish[2]		Invertebrates[2]		Molluscs[2]		Amphibians[2]		Algae and Aquatic Plants[2]
	Lethal	Sublethal	Lethal	Sublethal	Lethal	Sublethal	Lethal	Sublethal	Sublethal
Volatiles ($\mu g/\ell$)									
Acetone	30/1.0×10^5 - 1.5×10^7	--	62/1×10^4 - 1.5×10^7	14/1.1×10^6 - 6.9×10^6	7/7×10^6 - 4.8×10^7	--	2/2×10^7 - 2.4×10^7	--	9/5.3×10^5 - 1×10^7
Inorganics ($\mu g/\ell$)									
Aluminum[3]	6/3.28×10^3 - 3.5×10^4	--	7/7.4×10^2 - 3.82×10^4	--	2/3.06-$\times 10^4$ - 5.55×10^4	--	--	--	--
Mercury	32/1.5×10^2 - 1×10^5	--	50/4.7 - 3.2×10^4	--	2/5×10^3 - 1×10^4	3/500 - 5.9×10^3	--	--	5/1.2×10^3 - 1.2×10^4
Vanadium	4/128 - 6×10^3	--	--	--	--	--	--	--	--

[1] With the exception of aluminum, copper, and lead, toxicity information for surface water ECPCs was retrieved from AQUIRE. All aquatic toxicity information is included as Appendix D-6. Aquatic toxicity data for aluminum, copper, and lead were gathered from corresponding AWQC documents (U.S. Environmental Protection Agency [USEPA] 1991).
[2] Number of studies/range of concentrations.
[3] Information for aluminum is from USEPA, 1988.

Notes: ECPC = ecological contaminant of potential concern.
$\mu g/\ell$ = micrograms per liter.
-- = not measured.
AQUIRE = Aquatic Information Retrieval.
AWCQ = ambient water quality criteria.

The toxicity of ECPCs in sediment to aquatic receptors is also estimated by comparing maximum and average exposure concentrations of ECPCs in sediment to available sediment toxicity benchmarks. Sediment toxicity benchmarks are the concentrations reported in the literature as a "safe" no-effect concentration, a "threshold" concentration above which adverse effects are observed, and various adverse effects concentrations. Benchmarks are available from *Approach to the Assessment of Sediment Quality in Florida Coastal Waters* (SQAG) (MacDonald and others, 1994) and the updated NOAA database (Long and others, 1995). These benchmarks are listed as part of the risk characterization for sediment in Lake Fretwell and in Rowell Creek upstream of Lake Fretwell, respectively.

7.4 RISK CHARACTERIZATION. Risks are characterized for contamination in surface water and sediment of Lake Fretwell and Rowell Creek upstream of Lake Fretwell for both terrestrial wildlife and aquatic receptors. Risks are characterized based upon the methodology provided in Chapter 3.0. The methodology represents an integrated approach using both field and theoretical methods to provide a measure of actual or potential risks.

7.4.1 Surface Water Potential risks associated with ECPCs in the surface water of Lake Fretwell and Rowell Creek upstream of Lake Fretwell are characterized for both wildlife and aquatic receptors. Risks for terrestrial wildlife are characterized by comparing PDE concentrations for surface water ECPCs with a respective RTV (estimated threshold for toxicity). Risks for aquatic life are characterized based on field measurements and comparison of exposure concentrations of the ECPCs in surface water samples with respective toxicity benchmarks values or standards.

7.4.1.1 Terrestrial Wildlife Risks for representative wildlife species associated with ingestion of surface water, potentially contaminated aquatic life, and sediment are quantitatively evaluated using HQs, which are calculated for each ECPC for lethal and sublethal effects by dividing the estimated contaminant exposure concentration by the lethal and sublethal RTV. Lethal and sublethal HIs are determined for each representative wildlife species by summing the HQs for all ECPCs.

Lake Fretwell. The lethal and sublethal HIs and HQs calculated for each of the representative wildlife species from exposure to Lake Fretwell surface water and sediment ECPCs are provided in Appendix D-1. A summary of the HIs for representative wildlife species in Lake Fretwell is presented in Table 7-8.

Lethal effects are predicted for the kingfisher and great blue heron. The HIs for the kingfisher (1.0) and the great blue Heron (2.1) are above 1 for the exposures based on both the maximum and average detected concentrations of ECPCs. The primary contributor to the lethal HI for the avian representative wildlife species is copper exposures associated with the ingestion of contaminated fish. If copper exposures associated with ingestion of contaminated fish are removed from the food web model, the lethal HIs for the contaminated fish are removed from the food web model, the lethal HIs for the kingfisher and great blue heron are reduced to 0.078 and 0.15, respectively. Lethal risks are not predicted for terrestrial wildlife ingesting surface water and sediment because ingestion of surface water and sediment ECPCs are not important contributors to the HI for avian receptors.

Table 7-8
Summary of Hazard Indices for Representative Wildlife Species Exposed to ECPCs in Surface Water and Sediment from Lake Fretwell

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Receptors[1]	Maximum Exposure/ Lethal RTVs	Average Exposure/ Lethal RTVs	Maximum Exposure/ Sublethal RTVs	Average Exposure/ Sublethal RTVs
Florida water rat	0.019	0.016	0.11	0.073
Raccoon	0.74	0.73	5.3	5.2
Kingfisher	1.0	1.0	2.1	2.0
Great blue heron	2.1	2.1	4.0	3.9

[1] A model of the potential exposures to surface water and sediment at Lake Fretwell for terrestrial wildlife is presented in Appendix D-1.

Notes: ECPC = ecological chemical of potential concern.
RTV = reference toxicity value.

Sublethal effects (adverse effects to growth and reproduction) are predicted for the raccoon, kingfisher, and great blue heron. The HIs for the raccoon (5.3), kingfisher (2.1), and great blue heron (3.9) exceed 1 for exposures based on the maximum detected concentrations of ECPCs. The HIs for these based on the maximum detected concentrations of ECPCs. The HIs for these representative wildlife species also exceed one for exposures based on the average detected concentration of ECPCs. The primary contributor to the sublethal HI for the raccoon is Aroclor-1260 which is associated with ingestion of contaminated fish. For the two avian representative wildlife species, sublethal risks are associated with ingestion of mercury in fish. If mercury exposures associated with ingestion of contaminated fish are removed from the food web model, the sublethal HIs for the kingfisher and great blue heron are reduced to 0.25 and 0.34, respectively. Because ingestion of surface water and sediment ECPCs are not important contributors to the HI for any of the representative wildlife species, risks are not predicted for terrestrial wildlife ingestion surface water or sediment in Lake Fretwell.

Aroclor-1260, copper, and mercury were detected in fish tissue collected from Lake Fretwell. Aroclor-1260, copper, and mercury were detected in largemouth bass at maximum concentrations of 640 μg/kg, and 7.9 mg/kg, and 1.3 mg/kg respectively. Sublethal effects to the representative wildlife species assume ingestion of the maximum concentration of analytes detected in fish tissue from Lake Fretwell. Section 5.5 provides further information on the collection and analysis of fish tissue in Lake Fretwell.

Although surface water samples from Lake Fretwell were collected approximately 2 years earlier (June 1993) than collection of fish tissue (April 1995), aluminum, copper, and mercury were detected in the 1993 surface water samples (Table 7-1). Aroclor-1260 was detected in sediment from Lake Fretwell (which was collected at the same time as the fish tissue) at concentrations ranging from 3 to 14 μg/kg. It is assumed that aquatic life in Lake Fretwell may bioconcentrate ECPCs in surface water (copper and mercury) or accumulate ECPCs from sediment (Aroclor-1260).

<u>Rowell Creek Upstream of Lake Fretwell</u>. The lethal and sublethal HIs and HQs calculated for each of the representative wildlife species from exposure to surface water and sediment ECPCs in Rowell Creek upstream of Lake Fretwell are provided in Appendix D-2. A summary of the HIs for representative wildlife species in Rowell Creek upstream of Lake Fretwell is presented in Table 7-9. Lethal effects are not expected for the representative wildlife species at Rowell Creek resulting from exposure to ECPCs in the surface water or sediment because the lethal HIs and HQs are all less than 1.

Sublethal effects are predicted for the raccoon. The HI for the raccoon is above 1 for exposures based on the maximum and average detected concentrations of the ECPCs (HI = 1.7). The primary contributor to the sublethal HI for the raccoon is Aroclor-1260. The HQ for Aroclor-1260 is 1.67. If Aroclor-1260 exposures associated with ingestion of contaminated fish are removed from the calculation, the sublethal HI for the raccoon falls below 1 at 0.0034. This indicates that exposures to Aroclor-1260 in contaminated fish tissue are the primary contributor to predicted risks for the raccoon. Because ingestion of the surface water and sediment are not important contributors to the HI, risks are not predicted for terrestrial wildlife ingesting surface water or sediment in Rowell Creek upstream of Lake Fretwell.

Table 7-9
Summary of Hazard Indices for Representative Wildlife Species Exposed to ECPCs in Surface Water and Sediment from Rowell Creek Upstream of Lake Fretwell

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Receptors[1]	Maximum and Average Exposure/Lethal RTVs	Maximum and Average Exposure/Sublethal RTVs
Florida water rat	2.3×10^{-5}	0.01
Raccoon	2.2×10^{-4}	1.7
Kingfisher	1.5×10^{-3}	0.038
Great blue heron	2.8×10^{-3}	0.033

[1] A model of the potential exposures to surface water and sediment at Rowell Creek upstream of Lake Fretwell for terrestrial wildlife is presented in Appendix D-2.

Notes: ECPC = ecological chemical of potential concern.
RTV = reference toxicity value.

Aroclor-1260 was detected in both largemouth bass and golden shiner whole fish tissue at concentrations of 0.25 μg/kg and 0.056 μg/kg, respectively. Sublethal effects to the raccoon assume ingestion of the maximum concentration of Aroclor-1260 detected in fish tissue from Rowell Creek upstream of Lake Fretwell. Section 5.5 provides further information on the collection and analysis of fish tissue in Rowell Creek upstream of Lake Fretwell.

Aroclor-1260 was detected in sediment from Rowell Creek upstream of Lake Fretwell at a concentration of 6.6 μg/kg. It is assumed that aquatic life in Rowell Creek upstream of Lake Fretwell may accumulate Aroclor-1260 in sediment.

7.4.1.2 **Aquatic Receptors** Risks for aquatic receptors resulting from exposure to the ECPCs in surface water are characterized based on field measurements of the structure and function of the benthic macroinvertebrate communities. Risks are also characterized based upon comparison of the exposure concentrations of the ECPCs in surface water samples with respective aquatic toxicity benchmarks or standards. Tables 7-10 and 7-11 present the concentrations of the ECPCs detected in respective surface water samples from Lake Fretwell and Rowell Creek upstream of Lake Fretwell. The risk characterization for aquatic receptors for both surface water and sediment contamination in Lake Fretwell and upstream of Lake Fretwell is summarized in Table 7-12. The 1993 surface water and biological samples and 1995 sediment and toxicological samples were collected from the same locations. Corresponding data from the 1993 and 1995 sampling stations are provided as part of the risk characterization for aquatic receptors in Table 7-12.

There are no apparent trends in the status of the benthic macroinvertebrate community in Lake Fretwell and Rowell Creek upstream of Lake Fretwell. Due to the lack of a suitable reference location for the Lake Fretwell sampling stations, the Lake Fretwell habitat assessment scores are comparable only to each other. The macroinvertebrate habitat quality parameter data at the Lake Fretwell and Rowell Creek sampling stations suggest that these stations lie within normal condition.

Lake Fretwell. Table 7-10 provides a comparison of the concentrations of the ECPCs detected in surface water samples from Lake Fretwell with available toxicity benchmarks. Concentrations of aluminum, lead, and mercury exceed the aquatic toxicity benchmarks. The concentrations of aluminum and lead measured in the water samples from the reference locations also exceed available benchmarks.

The AWQC value of 87 μg/ℓ for aluminum may not be appropriate as a screening value because it is based on the protection of brook trout and striped bass. Neither of these sensitive species are present in Lake Fretwell. The final chronic AWQC value of 748 μg/ℓ is a more appropriate screening value for aluminum because this value does not consider the brook trout or striped bass toxicity data. Based on the screening value of 748 μg/ℓ, detected concentrations of aluminum in Lake Fretwell surface water are not likely to present a risk to aquatic receptors.

Detected concentrations of lead and mercury in surface water exceed available benchmarks at sampling stations LF-SW-6 and LF-SW-7. In addition, concentrations of mercury also exceed screening benchmarks at sampling stations LF-SW-3, LF-SW-4, and LF-SW-5. It should be noted, however, that the AWQC value for mercury

Table 7-10
Comparison of Concentrations of ECPCs in Surface Water of Lake Fretwell with Aquatic Toxicity Benchmarks

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Analyte	Range of Detected Reference Concentrations[1]	LFSW1	LFSW2	LFSW3	LFSW4	LFSW5	LFSW6	LFSW7	LFSW8	LFSW8D
Volatile Organic Compounds (µg/ℓ)										
Acetone	10	ND	ND	ND	ND	ND	ND	7 J	ND	ND
Inorganics (µg/ℓ)										
Aluminum	287 - 332	84.9	112	84.4	93.4	87.2	751	94	84.1	192
Copper	1.9 - 5.1	ND	ND	2.5 J	2.5 J	1.7 J	3.9 J	3.4 J	1.7 J	ND
Lead	3.1	ND	ND	ND	ND	ND	7.8	7.7	ND	ND
Mercury	ND	ND	ND	0.08 J	0.14 J	0.5	0.33	0.34	ND	ND

Analyte	AWQC[2]	Florida Surface Water Quality Standard[3] (µg/ℓ)	Lowest Reported Adverse Effect Concentration [4] (µg/ℓ)
Volatile Organic Compounds (µg/ℓ)			
Acetone	NA	NA	10,000
Inorganics (µg/ℓ)			
Aluminum	87	NA	740
Copper	12	6.05	NS
Lead	3.2	1.17	NS
Mercury	0.012	0.012	4.7

[1] The reference locations include RCGC-SW-R1, RC-SW-R1, and YWC-SW-R1.
[2] Federal Ambient Water Quality Criteria (U.S. Environmental Protection Agency [USEPA], 1991).
[3] Chapter 62-302, Florida Administrative Code (January 1995), Surface Water Quality Standards for Class III Freshwater.
[4] From Table 7-7.

Notes: ECPC = ecological chemicals of potential concern.
LFSW = Lake Fretwell surface water.
µg/ℓ = micrograms per liter.
J = estimated value.
AWQC = ambient water quality criteria (guidance established under the Clean Water Act).
ND = not detected.
NA = not available.
NS = not searched.

Table 7-11
Comparison of Concentrations of ECPCs in Surface Water of Rowell Creek Upstream of Lake Fretwell with Aquatic Toxicity Benchmarks

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Analyte	Range of Detected Reference Concentrations[1]	RC-SW-1	RC-SW-2	GC-SW-2	AWQC[2]	Florida Surface Water Quality Standard [3] (µg/ℓ)	Lowest Reported Adverse Effect Concentration[4] (µg/ℓ)
Volatile Organic Compounds (µg/ℓ)							
Acetone	10	12	ND	ND	NA	NA	10,000
Inorganics (µg/ℓ)							
Vanadium	ND	3 J	ND	ND	NA	NA	128

[1] The reference locations include RCGC-SW-R1, RC-SW-R1, and YWC-SW-R1.
[2] Federal Ambient Water Quality Criteria (U.S. Environmental Protection Agency [USEPA] 1991).
[3] Chapter 62-302, Florida Administrative Code (January 1995), Surface Water Quality Standards for Class III Freshwater.
[4] From Table 7-7.

Notes: ECPC = exposure point concentration.
AWQC = Ambient Water Quality Criteria (guidance established under the Clean Water Act).
J = estimated value.
ND = not detected.
NA = not available.
µg/ℓ = micrograms per liter.

Table 7-12
Aquatic Receptor Risk Characterization

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Sampling Locations		Biological Parameters		Contaminants Associated with Risk		Interpretation of Weight-of-Evidence
1993 Surface Water/Biological Sampling Station[1]	1995 Sediment/ Toxicological Sampling Station[2]	Sediment Laboratory Toxicity Testing	Benthic Community Composition	Surface Water[3]	Sediment[4]	
LF-SW/BIO-1	LF-SD/TOX-16	No toxicity	Inconclusive	--	--	No significant risks estimated.
LF-SW/BIO-2	LF-SD/TOX-15	37 percent midge larvae mortality[5]	Inconclusive	--	alpha-Chlordane (TEL)	No significant risks estimated.
LF-SW/BIO-3	LF-SD/TOX-13	35 percent midge larvae mortality[5]	Inconclusive	--	--	No significant risks estimated.
LF-SW/BIO-4	LF-SD/TOX-12	100 percent amphipod mortality[5,6]	Inconclusive	--	--	Risks for aquatic receptors are possible due to sediment toxicity of amphipods.
LF-SW/BIO-5	LF-SD/TOX-11	100 percent amphipod mortality[5,6]	Inconclusive	--	--	Risks for aquatic receptors are possible due to sediment toxicity of amphipods.
LF-SW/BIO-6	LF-SD/TOX-10	No toxicity	Inconclusive	Al and Pb	--	No significant risks estimated.
LF-SW/BIO-7	LF-SD/TOX-9	58 percent midge larvae mortality[5,6]	Inconclusive	Pb	--	Risks for aquatic receptors are possible due to sediment toxicity of midge larvae.
LF-SW/BIO-8	LF-SD/TOX-14	7 percent amphipod mortality[5] and 38 percent midge larvae mortality[5]	Inconclusive	--	Ar (TEL), Cd (TEL, ERL), Pb (TEL, ERL), and Zn (TEL)	Risks for aquatic receptors are possible due to elevated concentrations of Ar, Cd, Pb, and Zn in sediment
RC-SW/BIO-2	LF-SD/TOX-17	No toxicity	Normal condition	--	--	No significant risks estimated.
RC-SW/BIO-1	RC-SD/TOX-18	82 percent midge larvae mortality[5,6]	Normal condition	--	--	Risks for aquatic receptors are possible due to sediment toxicity of midge larvae.
GC-SW/BIO-2	GC-SD/TOX-19	No toxicity	Normal condition	--	--	No significant risks estimated.

See notes at end of table.

Table 7-12 (Continued)
Aquatic Receptor Risk Characterization

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[1] 1993 surface water and biological sampling stations are depicted on Plate 2.
[2] 1995 sediment and toxicological sampling stations are depicted on Figure 7-2.
[3] ECPCs in surface water that exceeded the screening reference concentration and also exceeded benchmarks. Benchmarks for surface water ECPCs are listed in Tables 7-10 and 7-11.
[4] ECPCs in sediment that exceeded at least one benchmark. Benchmarks for sediment ECPCs are listed in Tables 7-13 and 7-14.
[5] Results are statistically significant as compared to the laboratory control.
[6] Results are statistically and biologically significant as compared to the reference location, YWC-SD/TOX-20.

Notes: -- = not measured.
Ar = arsenic.
TEL = threshold effects level from Florida SQAG.
Cd = cadmium.
ERL = effects range low concentration.
Pb = lead.
ECPC = ecological chemical of potential concern.
Zn = zinc.
SQAG = Sediment quality in Florida Coastal Waters.

(0.012 $\mu g/\ell$) is based on a tissue residue level established for the FDA action level; therefore, the value is overly protective of toxicological effects to aquatic life. All detected concentrations of mercury in the surface water of Lake Fretwell are well below the lowest adverse effect concentration reported in the AQUIRE at 4.7 $\mu g/\ell$. Lead was detected in fish tissue collected from Lake Fretwell at a concentration of 2.5 mg/kg in lake chubsucker tissue and 2.9 mg/kg in golden shiner tissue. The presence of lead in surface water of Lake Fretwell may cause a risk to aquatic receptors.

Rowell Creek Upstream of Lake Fretwell. Table 7-11 provides a comparison of the concentrations of the ECPCs detected in surface water samples from Rowell Creek upstream of Lake Fretwell with available toxicity benchmarks. Detected concentrations of acetone and vanadium are well below their respective aquatic toxicity benchmarks; therefore, risks associated with exposure to surface water in Rowell Creek upstream of Lake Fretwell are not predicted for aquatic receptors.

7.4.2 Sediment Potential risks are characterized for contamination in sediment in Lake Fretwell and in Rowell Creek upstream of Lake Fretwell for both terrestrial wildlife and aquatic receptors. The risk characterization methodology is described in Section 3.5.

7.4.2.1 Terrestrial Wildlife The lethal and sublethal HIs and HQs calculated for each of the representative wildlife species for exposures related to both surface water and sediment ECPCs have been discussed in the previous section (paragraph 7.4.1.1).

7.4.2.2 Aquatic Receptors Risks for aquatic receptors associated with ECPCs in sediment at Lake Fretwell and Rowell Creek upstream of Lake Fretwell are characterized for each sampling station based on the approach outlined in Section 3.5. The sediment samples for toxicity testing and chemical analyses were gathered from a split sample of sediment. These samples were collected in April of 1995. Sampling of the macroinvertebrate community and collection of surface water samples for chemical analyses were completed at roughly the same locations in the summer of 1993. Although the results of the benthic macroinvertebrate sampling are not directly comparable with the chemical and toxicity testing analyses (due to variation in the time and location of sample collection), they are discussed in Subsection 5.2.2 and Paragraph 7.3.1.2. The 1993 benthic macroinvertebrate habitat quality parameter data at the Lake Fretwell and Rowell Creek sampling stations suggests that these stations lie within normal condition. Concurrent sampling of the sediment for chemical analyses and toxicity testing allows for comparison of adverse responses in aquatic receptors with measured concentrations of analytes in the sediment samples.

Lake Fretwell. Risks for aquatic receptors in Lake Fretwell associated with ECPCs in sediment are characterized for each sampling station (LF-SD/Tox-9 through LF-SD/TOX-16). Table 7-13 presents the distribution of ECPCs detected in sediment from Lake Fretwell. Nine analytes detected in sediment samples from Lake Fretwell were selected as ECPCs for aquatic life. These ECPCs included one semivolatile, three pesticides, and five inorganics. The ER-L and ER-M sediment values (Long and others, 1995) and the State of Florida SQAGs (MacDonald, 1994) are provided as a point of reference. An evaluation of the weight-of-evidence from the toxicological and chemical data is summarized in Table 7-12 and discussed below.

Table 7-13
Comparison of Lake Fretwell Sediment with Toxicity Benchmarks

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Analyte	LF-SD-9	LF-SD-10	LF-SD-11	LF-SD-12	LF-SD-13	LF-SD-14	LF-SD-15	LF-SD-16
Semivolatile Organic Compounds (µg/kg)								
Di-n-butylphthalate	34 J	60 J	140 J	110 J	83 J	380 J	38 J	73 J
Pesticides/PCBs (µg/kg)								
Endosulfan II	0.23 J	ND	ND	ND	ND	ND	ND	ND
Endrin aldehyde	ND	ND	ND	ND	ND	ND	0.31 J	ND
alpha-Chlordane	0.38 J	ND	0.22 J	ND	ND	ND	2.4 J	ND
Inorganics (mg/kg)								
Arsenic	ND	ND	ND	ND	ND	7.7	ND	ND
Cadmium	ND	ND	ND	ND	ND	1.4	0.46	ND
Lead	6.3	3.4	14.8	4.7	6.4	75.8	11.4	10
Manganese	8.3	4.8	7	13.1	3.1	19.7	5.8	5
Zinc	ND	ND	ND	ND	ND	132	ND	ND

Analyte	Reference Concentrations[1]	NOAA ERL/ERM[2]	State of Florida TEL/PEL[3]
Semivolatile Organic Compounds (µg/kg)			
Di-n-butylphthalate	110 J	NA / NA	NA / NA
Pesticides/PCBs (µg/kg)			
Endosulfan II	ND	NA / NA	NA / NA
Endrin aldehyde	ND	NA / NA	NA / NA
alpha-Chlordane	ND	NA / NA	2.26 / 4.79
Inorganics (mg/kg)			
Arsenic	ND	8.2 / 70	7.24 / 41.6
Cadmium	ND	1.2 / 9.6	0.676 / 4.21
Lead	23.5	46.7 / 218	30.2 / 118
Manganese	8.7	NA / NA	NA / NA
Zinc	ND	150 / 410	124 / 271

See notes at end of table.

Table 7-13
Comparison of Lake Fretwell Sediment with Toxicity Benchmarks

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[1] The reference location is YWC-SD-20 (Plate 2).

[2] National Oceanic and Atmospheric Administration effects range-low (ER-L) and effects range-medium (ER-M) sediment values (Long and others, 1995). ERL (10th percentile) represents a lower threshold value, above which adverse effects on sensitive life stages and/or species have been documented. ER-M (50th percentile) represents a second threshold value, above which adverse effects on most species are frequently or always observed.

[3] Florida Department of Environmental Protection Sediment Quality Assessment Guidelines (MacDonald and others, 1994). Probable effects level (PEL) defines the lower limit of the range of contaminant concentrations associated with adverse biological effects. Threshold effect level (TEL) defines the upper limit of the range of contaminant concentrations not considered to represent significant hazards to aquatic organisms.

Notes: ECPCs for aquatic receptors from Table 7-3.
μg/kg = micrograms per kilogram.
J = estimated value.
PCBs = polychlorinated biphenyls.
ND = not detected.
mg/kg = milligrams per kilogram.
NOAA = National Oceanic and Atmospheric Administration
NA = not available.

Sediment collected from three of the eight sampling stations in Lake Fretwell were toxic to one of the test organisms in the laboratory bioassays as compared to the reference sediment sample collected upstream. Mortality of 100 percent was observed in the amphipod test at sampling stations LF-SD/TOX-11 and LF-SD/TOX-12, which are located at the southeastern and southwestern portions of the lake, respectively. In addition 58 percent mortality was observed in the midge larvae test at sampling station LF-SD/TOX-9, which is located in the southwestern edge of Lake Fretwell. Based on the results of the laboratory sediment bioassays, impacts to survival of certain invertebrate receptors may be occurring in the southern portion of Lake Fretwell.

To determine which contaminants measured in the Lake Fretwell sediment may be possible causative agents for the observed toxicity, simple linear regressions were completed for selected analytes. The regressions compared the observed responses in the bioassays (amphipod and midge larvae mortality) to the concentrations of di-n-butylphthalate, alpha-Chlordane, lead, and manganese in sediment (Appendix D-7). There were several contaminants detected at only one or two stations for which regressions were not possible. The linear regressions reveal no positive association between the concentration of detected ECPCs in sediment and adverse responses observed in the sediment toxicity tests. This suggests that toxicological effects may be associated with simultaneous exposures to multiple contaminants.

A comparison of sediment guidelines with site chemical data (Table 7-13) reveals that alpha-Chlordane, arsenic, cadmium, lead, and zinc exceed available sediment guidelines. Sediment toxicity benchmarks are not available for di-n-butylphthalate, endosulfan II, and endrin aldehyde.

Detected concentrations of di-n-butylphthalate in sediment from Lake Fretwell are not associated with the observed mortality in the sediment toxicity tests. Although di-n-butylphthatlate was detected at all eight sampling stations at concentrations ranging from 34 to 380 μg/kg, this analyte is likely to be a laboratory contaminant rather than a site-related contaminant.

Alpha-Chlordane was detected in three of the eight sediment sampling locations at concentrations ranging from 0.22 μg/kg to 2.4 μg/kg. Detected concentrations of alpha-Chlordane at sampling station LF-SD/TOX-15 (2.4 μg/kg) exceeded the State of Florida TEL. Within this range of concentrations (i.e., between the lower limit TEL and upper limit permissible exposure limit [PEL]), adverse biological effects are possible; however, it is difficult to predict the occurrence, nature, and/or severity of these effects. The results of the sediment toxicity testing from sampling station LF-SD/TOX-15 show 35 percent mortality in the midge larvae as compared to the laboratory control. However, this result is not statistically significant when compared to the reference sediment from NAS Cecil Field.

Although several inorganics are elevated above upgradient concentrations, based on the results of the correlation analysis (Appendix D-7), none of these analytes appears to be a substantial contributor to the observed mortality in the sediment laboratory bioassays. Low correlation coefficients (i.e., R^2 less than 0.1) were observed for all inorganics when regressed against amphipod and midge larvae mortality. Concentrations of these inorganics were all highest at sampling station LF-SD/TOX-14. Detected concentrations of arsenic, cadmium, lead, and zinc at LF-SD/TOX-14 exceed their respective Florida TEL values, and concentrations of cadmium and lead also exceed their respective NOAA ER-Ls at this sampling station. Sediment quality screening values are not available for manganese. The results of the sediment toxicity testing from sampling station LF-SD/TOX-14 show 7 percent mortality in the amphipod test and 38 percent mortality in the midge larvae test as compared to the laboratory control. These results, however, are not statistically significant when compared to the reference sediment from NAS Cecil Field.

Based on the weight-of-evidence for each of the sampling locations (toxicity testing results, benthic community, and chemical analyses), the following statements concerning risks for aquatic life associated with sediment contamination in Lake Fretwell can be made:

- Risks may be present to certain macroinvertebrate receptors at four of the eight sampling stations (LF-SD/TOX-7, LF-SD/TOX-9, LF-SD/TOX-11, and LF-SD/TOX-12). For stations LF-SD/TOX-11 and LF-SD/TOX-12, risks are based on mortality of amphipods in sediment toxicity testing. At sampling station LF-SD/TOX-9, risks are based on mortality of midge larvae in sediment toxicity testing. At sampling station LF-SD/TOX-7, detected concentrations of arsenic, cadmium, lead and zinc exceeded benchmarks and observed toxicity in both test organisms was statistically significant as compared to the laboratory control.

- Based on the results of simple linear regressions (Appendix D-7), the observed mortality in the sediment toxicity tests is not associated with concentrations of individual ECPCs in bulk sediment from Lake Fretwell. Although not evaluated, it is possible that the toxicological results are correlated with exposure to multiple ECPCs and other factors that influence the bioavailability of sediment toxicants.

- Analysis of the benthic community metrics relative to contaminant concentrations in surface water are inconclusive.

<u>Rowell Creek Upstream of Lake Fretwell</u>. Risks for aquatic receptors in Rowell Creek upstream of Lake Fretwell associated with ECPCs in sediment are characterized for each sampling station (LF-SD/Tox-17, RC-SD/TOX-18, and GC-SD/TOX-19). Table 7-14 presents the distribution of ECPCs detected in sediment from Lake Fretwell. Only one analyte (di-n-butylphthalate) detected in sediment samples from Rowell Creek upstream of Lake Fretwell was selected as an ECPC for aquatic life. An evaluation of the weight-of-evidence from the toxicological and chemical data is summarized in Table 7-12 and discussed below.

Sediment collected from one of the three sampling stations in Rowell Creek upstream of Lake Fretwell were toxic to the midge larvae in the laboratory bioassays as compared to the reference sediment sample collected upstream in Yellow Water Creek. Mortality of 82 percent was observed in the midge larvae at sampling station RC-SD/TOX-18. Based on the results of the laboratory sediment bioassays, impacts to survival of certain invertebrate receptors may occurring in portions of Rowell Creek upstream of Lake Fretwell. Linear regressions reveal no positive association between the concentration of detected ECPCs in sediment and adverse responses observed in the sediment toxicity tests. This suggests that the mixture of contamination in sediment may be toxic to aquatic life at sampling station RC-SD/TOX-18.

Table 7-14
Comparison of Rowell Creek (Upstream of Lake Fretwell) Sediment with Toxicity Benchmarks

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Analyte	Reference Concentration[1]	LF-SD-17	LF-SD-17D	RC-SD-18	GC-SD-19	NOAA ERL/ERM[2]	State of Florida TEL/PEL[3]
Semivolatile Organics (µg/kg)							
Di-n-butylphthalate	110 J	200 J	170 J	94 J	180 J	NA / NA	NA / NA

[1] The reference location is YWC-SD-20 (Figure 7-1).
[2] National Oceanic and Atmospheric Administration effects range low (ERL) and effects range-medium (ERM) sediment values (Long and others, 1995). ERL (10th percentile) represents a lower threshold value, above which adverse effects on sensitive life stages and/or species have been documented. ERM (50th percentile) represents a second threshold value, above which adverse effects on most species are frequently or always observed.
[3] Florida Department of Environmental Protection Sediment Quality Assessment Guidelines (MacDonald and others, 1994). Probable effects level (PEL) defines the lower limit of the range of contaminant concentrations associated with adverse biological effects. Threshold effect level (TEL) defines the upper limit of the range of contaminant concentrations not considered to represent significant hazards to aquatic organisms.

Notes: Ecological chemicals of potential concern (ECPCs) for aquatic receptors from Table 7-4.
NOAA = National Oceanic and Atmospheric Administration.
µg/kg = micrograms per kilogram.
J = estimated value.
NA = not available.

Table 7-14 provides a comparison of the ECPC concentrations with sediment benchmarks. Based on this evaluation, risks are not anticipated for aquatic exposures to ECPCs in sediment in Rowell Creek upstream of Lake Fretwell. Benchmarks do not exist for di-n-butylphthalate; however, this analyte is likely the result of laboratory contamination.

In summary, the results of the sediment toxicity testing indicate that aquatic receptors may be at risk at sampling station RC-SD/TOX-18. Observed toxicity may be due to a mixture of contamination in the sediment or other physical disturbances at sampling station RC-SD/TOX-18.

7.5 UNCERTAINTY ANALYSES. A number of uncertainties and assumptions are inherent in the ecological risk assessment process. Table 3-3 summarizes general ERA uncertainties. Specific uncertainties associated with the evaluation of risks associated with contamination at Lake Fretwell and Rowell Creek upstream of Lake Fretwell include the following:

- Due to the presence of several potential sources of contamination surrounding Lake Fretwell and Rowell Creek upstream of Lake Fretwell, it is difficult to attribute predicted risks to a particular site or PSC.

- The surface water and biological samples were collected in June 1993, while the sediment and toxicological samples and fish tissue were collected in April 1995. Although the 1993 surface water and 1995 sediment sampling stations are located in roughly the same vicinity, collection of the samples on different dates increases uncertainty in the data comparison.

- An assumption has been made that organisms evaluated in the laboratory bioassays are representative of organisms in Lake Fretwell and Rowell Creek.

- The lack of information concerning the toxicity of surface water and sediment ECPCs to avian species may result in an underestimation of risks.

- The lack of aquatic toxicity benchmarks for some of the surface water and sediment ECPCs may result in an underestimation of risks for aquatic life.

- The food web model for representative wildlife species assumes ingestion of the maximum concentration of detected analytes in whole fish tissue collected form golden shiner, lake chubsucker, or large-mouth bass. Potential dietary exposures related to ingestion of contaminated aquatic life may be overestimated, depending on the feeding habits of the representative wildlife species.

- The simple linear regression model does not account for the influence of bioavailability (e.g., total organic carbon, sediment grain size) or the potential toxicity of sediment to aquatic life.

- The site-derived fish tissue data were used to estimate exposures to all aquatic prey including benthic macroinvertebrates. Depending on the feeding habits of the representative wildlife species and/or concentrations of ECPCs present in aquatic prey other than fish, this assumption may either overestimate or underestimate potential risks associated with ingestion of contaminated aquatic prey.

CHAPTER 8.0

8.0 ANALYSES OF OVERALL ECOLOGICAL RISKS AND RECOMMENDATIONS

The analyses of overall ecological risks is discussed for the aquatic environments at NAS Cecil Field. Examination of total risks for terrestrial wildlife associated with contamination in surface soil is discussed for each of the OUs in Chapter 6.0. The ERA completed for each OU at NAS Cecil Field includes examination of worst-case exposure conditions where species are assumed to be resident and exposed over a lifetime to contamination in the area of the particular OU or site. Risks for wildlife species exposed to contamination in surface soil from a variety of sites would be expected to result in lower contaminant exposures than the worst-case scenario. Examination of the surface soil ECCs in Chapter 4.0 (Table 4-1) shows that persistent and potentially bioaccumulative contaminants are not identified across several sites that are located in close proximity (i.e., close enough for a species to forage in both areas); therefore a risk evaluation for multiple exposures is not completed. ECCs in surface soils were identified for Site 5 only.

The watersheds at NAS Cecil Field may receive contamination from more than one site or from nonsite related sources such as runoff and overland flow. If so, it becomes important to assess risks associated with multiple exposures. Risks for the watersheds and a discussion of recommendations for further action will be discussed in the following subsections. The assessment of overall ecological risks is based on the ERA results reported in Chapters 6.0 and 7.0, the extent of contamination of the watersheds reported in Chapter 4.0, and the status of the aquatic communities reported in Chapter 5.0. The goals of the risk analyses include:

- identification of contamination in watersheds that has migrated from sites,
- assessment of risks associated with particular contaminants with the intent of identifying the necessity for source controls, and
- identification of any areas with the watershed that are at risk associated with contamination present in the surface water or sediment regardless of the contaminant source.

Potential ecological risks and recommendations for further action will be discussed for Rowell Creek, Lake Fretwell, and tributaries to Rowell Creek in Section 8.1, Sal Taylor Creek in Section 8.2, and Yellow Water Creek in Section 8.3. Table 8-1 summarizes potential ecological risks and recommendations for each of the watersheds.

8.1 ROWELL CREEK. Ecological risks and recommendations for further action for Rowell Creek are subdivided into four segments including Rowell Creek upstream of Lake Fretwell (Subsection 8.1.1), Lake Fretwell (Subsection 8.1.2), Rowell Creek downstream of Lake Fretwell (Subsection 8.1.3), and tributaries to Rowell Creek (8.1.4). Further subdivision of the segments may be necessary as ERAs are completed for additional sites and PSCs.

Table 8-1
Summary of Ecological Risks and Recommendations for NAS Cecil Field Watersheds

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Watershed	Potential Source(s) of Contamination	Ecological Risks	Recommendations
ROWELL CREEK			
1. Rowell Creek Upstream of Lake Fretwell			
Rowell Creek North of 6th St.	None	None	No further action.
Golf Course Tributary	Site 11	ERA not completed; however, potential risks associated with exposures to PCBs and pesticides in sediment may exist for terrestrial wildlife and aquatic receptors.	Further investigation including resampling of sediment in the golf course tributary for chemical analyses and toxicity testing.
Rowell Creek East of PSC 19	Site 11 and PSC 19	Sublethal effects associated with ingestion of Aroclor-1260 in fish tissue are predicted for piscivorous mammals. Risks for certain aquatic macroinvertebrate receptors at RC-18 are based on mortality observed in sediment toxicity tests.	Further sampling at Site 11 to identify sources of potential contamination to Rowell Creek upstream of Lake Fretwell.
2. Lake Fretwell			
Site 5 Drainage Ditch and Wetlands Area	Site 5	Risks for certain aquatic macroinvertebrate receptors at 5-1, 5-3, and 5-4 associated with Aroclor-1260, DDT_R, or TPH in sediment.	Remediation of Site 5 sediment with consideration of source control and confinement of remedial activities to hot spots with subsequent biomonitoring. Alternatives resulting in minimization of impacts to wetlands (i.e., habitat alteration) should be considered.
Lake Fretwell	Site 11, PSC 19, PSC 6, and Site 5	Sublethal effects for all representative wildlife species associated with ingestion of PCBs and metals in fish tissue. Risks for certain aquatic macroinvertebrates at LF-7, LF-9, LF-11, and LF-12 based on mortality observed in sediment toxicity tests.	Further sampling at Site 11 to identify sources of potential contamination to lake and remedial action of Site 5 sediment to reduce influence of site-related contamination via the drainage ditch.

See notes at end of table.

Table 8-1 (Continued)
Summary of Ecological Risks and Recommendations for NAS Cecil Field Watersheds

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Watershed	Potential Source(s) of Contamination	Ecological Risks	Recommendations
3. Rowell Creek Downstream of Lake Fretwell			
Northernmost section	Site 3 and wastewater treatment plant	No risks predicted.	No further action.
Southernmost section	Site 3, wastewater treatment plant, Site 1, Site 2, and PSC 10	Risks for certain aquatic macroinvertebrates based on sediment toxicity and impairment of benthic community at RC-6 and RC-7. Responses may be associated with discharge of tributary draining Site 2 to Rowell Creek.	Proposed biomonitoring activities immediately downgradient of confluence of Site 2 tributary and Rowell Creek.
4. Tributaries to Rowell Creek			
Site 2 Tributary	Site 2	Lethal risks for small mammals associated with ingestion of iron in sediment. Risks for certain aquatic macroinvertebrates based on sediment toxicity and impairment of benthic community. Adverse responses associated with metals in surface water and sediment and orange-red flocculent material present in Site 2 tributary.	Proposed biomonitoring activities for Site 2 tributary.
SAL TAYLOR CREEK			
1. Upstream and East of Flightline	Site 16, North Fuel Farm (1991 JP-5 fuel spill), and flightline	Risks for certain aquatic macroinvertebrates at STC-1 and STC-3 based on mortality observed in sediment toxicity tests. Risks may be associated with TPH in sediment; however the presence of TPH is not related to Site 16. Risks for aquatic receptors in wetlands associated with exposures to bis(2-ethylhexyl)phthalate, aluminum, iron, and zinc in groundwater.	Further sampling of surface water and sediment (including toxicity testing) in the emergent wetlands area to evaluate migration of contaminated groundwater from Site 16.
2. Downstream of Site 8 Tributary	Site 8 and North Fuel Farm (1991 JP-5 fuel spill)	ERA not complete to date.	To be identified upon completion of ERA for OU 3, Site 8.
3. Site 8 Tributary	Site 8	ERA not complete to date.	To be identified upon completion of ERA for OU 3, Site 8.
YELLOW WATER CREEK	Site 15	ERA not complete to date.	To be identified upon completion of ERA for OU 5, Site 15.

Notes: NAS = Naval Air Station.
ERA = ecological risk assessment.
PCBs = polychlorinated biphenyls.
PSC = potential source of contamination.
DDT = dichlorodiphenyltrichloroethane.
TPH = total petroleum hydrocarbons.
OU = operable unit.

8.1.1 Rowell Creek Upstream of Lake Fretwell Rowell Creek upstream of Lake Fretwell is further subdivided into three segments including Rowell Creek north of 6th Street (Paragraph 8.1.1.1), the golf course tributary (Paragraph 8.1.1.2), and Rowell Creek east of PSC 19 (Paragraph 8.1.1.3). Sites potentially contributing to contamination in the surface water and sediment of Rowell Creek upstream of Lake Fretwell include Site 11, the Golf Course Pesticide Disposal Area and PSC 19, the Rowell Creek Rubble Disposal Area (Figure 1-2). The locations of the surface water and sediment samples collected in Rowell Creek upstream of Lake Fretwell are depicted on Plate 2.

8.1.1.1 Rowell Creek North of 6th Street Surface water and sediment samples were collected in Rowell Creek south of Normandy Boulevard and north of 6th Street at sampling stations RCGC-SW/SD/Bio-R1, RCGC-SW/SD/Bio-1, RCGC-SW/SD/Bio-2, and RCGC-SW/SD/Bio-3 (from north to south, respectively). An additional reference location (denoted by the "R1" qualifier) was collected at station RC-SW/SD/BIO-R1 in Rowell Creek north of Normandy Boulevard. The aforementioned sampling stations are located upstream of any known hazardous waste sites or PSCs at NAS Cecil Field; therefore, the results of the chemical and biological sampling are not included in any of the ERAs completed to date. Appendix B contains a list of analytes detected in the surface water and sediment samples, and Subsection 5.2.2 discusses the results of benthic macroinvertebrate studies conducted at these sampling stations. The relationship between habitat quality and biological condition among the sampling stations is illustrated as a line graph (on Figures 5-1, 5-2, and 5-3). Stations RCGC-Bio-3 and RC-Bio-R1 are within the predictable condition of the biological community in response to habitat quality. Station RCGC-Bio-R1 exhibited a higher benthic quality than might have been expected. This may be representative of a situation indicative of nutrient enrichment, which will artificially sustain a more diverse fauna than dictated by habitat quality. Stations RCGC-Bio-1 and RCGC-Bio-2 could be classified as slightly impaired. Factors possibly influencing the communities at the impaired stations include very low DO observed at RCGC-Bio-1 and RCGC-Bio-2.

Recommendations. Because the stretch of Rowell Creek north of 6th Street is upstream of any known hazardous waste sites or PSCs at NAS Cecil Field, no further action is recommended for these sampling locations.

8.1.1.2 Golf Course Tributary Five surface water and sediment samples were collected downstream of Site 11, the Golf Course Pesticide Disposal Area, in the golf course tributary (GC-SW/SD-5, GC-SW/SD-4, GC-SW/SD-3, GC-SW/SD/Bio-1, GC-SW/SD/Bio-2; from north to south, respectively). The ERA for OU 6, Site 11 has not been completed to date; however, in 1995, an IROD and IRA were initiated at Site 11. As described in Subsection 6.3.6, the removal action at Site 11 includes excavation and disposal of pesticide containers and soil contaminated by pesticides. The objectives of the interim removal action are to control sources of contamination to groundwater.

A cursory review of the surface water and sediment data from the golf course tributary (Appendix B) reveals detections of pesticides (including DDE and chlordane) and PCBs (including Aroclor-1254 and Aroclor-1260) in sediment well above the Region IV Sediment Screening Values (USEPA, 1995). Chlordane was also detected in surface water at concentrations two orders of magnitude greater than the Region IV Surface Water Screening Values (USEPA, 1995).

Biological sampling was completed for two of the five golf course tributary sampling locations (GC-Bio-1 and GC-Bio-2) in 1993. The habitat assessment scores for Site 11 sampling stations are listed in Table 5-18 and depicted on Figure 5-2. A review of the macroinvertebrate habitat quality parameter data suggests that habitat quality conditions at stations GC-Bio-1 and GC-Bio-2 are acceptable. Biological samples were not collected at stations GC-3, -4, and -5, which are located further north and in closer proximity to Site 11.

Based on the available information for the golf course tributary, it appears that concentrations of pesticides and PCBs in the sediment may pose a risk for both terrestrial wildlife and aquatic receptors. Although the benthic macroinvertebrate community at two of the five sampling stations is within the predictable condition in response to habitat quality, data for the sampling stations closest to Site 11 are not available. In addition, toxicity testing of sediment was not completed.

<u>Recommendations</u>. Based on surface water and sediment data collected in 1993, concentrations of pesticides and PCBs in sediment may pose a risk for both terrestrial wildlife and aquatic receptors in the golf course tributary and further downstream in Rowell Creek and Lake Fretwell. Further investigation, including resampling of the sediment for chemical analyses and toxicity testing is recommended. Toxicity testing of the sediment is necessary to determine if sediment-associated concentrations of pesticides and PCBs represent significant hazards to aquatic organisms.

8.1.1.3 Rowell Creek East of PSC 19 Two surface water and sediment samples were collected in Rowell Creek east of PSC 19 (RC-SW/SD/Bio-1 and RC-SW/SD-Bio-2; from north to south, respectively; Plate 2) in 1993. In 1995, sediment in Rowell Creek east of PSC 19 was resampled for chemical analyses and toxicity testing at two locations (RC-SD/Tox-18 and LF-SD/Tox-17; north to south in roughly the same location as RC-SD/Bio-1 and RC-SD/Bio-2, respectively; Figure 7-2). Surface water was not recollected in 1995. These two sampling locations are evaluated as part of the Lake Fretwell ERA in Chapter 7.0. Potential sources of contamination include Site 11 to the north and PSC 19 to the east.

Potential risks associated with ECPCs in the surface water and sediment of the two Rowell Creek sampling locations are characterized for both terrestrial wildlife and aquatic receptors in Section 7.4. Sublethal effects associated with ingestion of Aroclor-1260 in fish tissue are predicted for the raccoon. Aroclor-1260 was detected in largemouth bass and golden shiner whole fish tissue collected from Rowell Creek upstream of Lake Fretwell. Due to the presence of elevated concentrations of PCBs in the sediment of the golf course tributary, it is anticipated that the source of detected concentrations of Aroclor-1260 in both fish tissue and the sediment of Rowell Creek is the Golf Course Pesticide Disposal Area at Site 11. PSC 19, the Rowell Creek Rubble Disposal Area, is assumed to be free of contamination (ABB-ES, 1995); therefore, it is unlikely that this area is contributing to contamination in Rowell Creek.

Sediment collected from station RC-SD/Tox-18 was toxic (82 percent mortality) to the midge larvae in toxicity tests; therefore, impacts to the survival of certain invertebrate receptors may be occurring in this portion of Rowell Creek upstream of Lake Fretwell. Linear regressions revealed no association between the concentration of detected ECPCs in sediment and adverse response observed in the sediment toxicity tests, suggesting that the observed toxicity may be due to a mixture of contamination in the sediment or other physical disturbances at station RC-SD/Tox-18. Risks to aquatic receptors associated with exposures to ECPCs in surface water were not identified.

Recommendations. As described in Paragraph 8.1.1.2, resampling of sediment for chemical analyses and toxicity testing in the golf course tributary will provide more information on the potential sources of PCBs in Rowell Creek upstream of Lake Fretwell.

8.1.2 Lake Fretwell Although Lake Fretwell is not designated as an OU at NAS Cecil Field, the lake is surrounded by several sources of potential contamination. Site 11, the Golf Course Pesticide Area, is located to the north of Lake Fretwell; contaminants from the golf course may be transported to Lake Fretwell via Rowell Creek. Site 19, the Rowell Creek Rubble Disposal Area, is also located to the west of Rowell Creek, just north of Lake Fretwell. PSC 6, the Lake Fretwell Rubble Disposal Area, borders Lake Fretwell to the east. A palustrine freshwater wetland system associated with Lake Fretwell is located immediately to the east of Site 5, the Oil/Sludge Disposal Pits. A drainage ditch south of Site 5 carries surface water in an easterly direction, through the freshwater wetland, towards Lake Fretwell. Sites potentially contributing to contamination in the surface water and sediment of Lake Fretwell include Site 11, the Golf Course Pesticide Disposal Area; PSC 19, the Rowell Creek Rubble Disposal Area; PSC 6, the Lake Fretwell Rubble Disposal Area; and Site 5, the Oil Disposal Area (Figure 1-2). The aquatic habitat of Lake Fretwell is subdivided into the Site 5 drainage ditch and wetlands area (Paragraph 8.1.2.1) and Lake Fretwell (Paragraph 8.1.2.2). The locations of the surface water and sediment samples collected in the Site 5 drainage ditch and wetlands area and Lake Fretwell are depicted on Plate 2.

8.1.2.1 Site 5 Drainage Ditch and Wetlands Area Surface water and sediment were evaluated in the Site 5 drainage ditch (5-SW/SD/Bio/Tox-1, 5-SW/SD/Bio/Tox-2, 5-SW/SD/Bio/Tox-4; from west to east, respectively), the wetlands area adjacent to Site 5 (5-SW/SD-6 and 5-SW/SD-7), and an upstream location (5-SW/SD/Bio/Tox-5) west of both Site 5 and Perimeter Road as part of the ERA for OU 2 (Plate 2).

Analyses of the benthic macroinvertebrate sampling results indicate impairment of the benthic community at the Site 5 drainage ditch both upstream and downstream of Site 5. However, evaluation of the sediment toxicity testing data suggest that certain organisms are impacted by exposure to sediment. These data suggest that the responses are associated with contamination emanating from Site 5. Elevated concentrations of Aroclor-1260, DDT_R, or TPH are possibly associated with adverse responses.

Risks were not identified for terrestrial and wetland wildlife resulting from exposures to ECPCs in surface water and sediment at the Site 5 wetland and drainage ditch.

Potential risks for aquatic receptors were evaluated for exposures to ECPCs in groundwater. The concentration of ECPCs in groundwater as they are discharged to the Site 5 wetland were estimated based on a dilution model. The risk characterization did not identify any risks for aquatic receptors associated with ECPCs in diluted groundwater. Although risks for aquatic receptors would theoretically be increased with exposure to inorganic analytes at concentrations detected in undiluted, unfiltered groundwater, such an actual exposure scenario is deemed unlikely.

In summary, contamination in the Site 5 drainage ditch sediment may pose a risk to certain macroinvertebrate receptors. Sediment contamination at sampling stations 5-SD-1, 5-SD-3, and 5-SD-4 appears to have the potential to impact the aquatic invertebrate communities at Site 5. Site 5 sediment contaminants could potentially migrate to Lake Fretwell (for example, as a result of possible resuspension and transport of contaminated sediment during storms). Sediment from these three stations is characterized by elevated concentrations of TPH and Aroclor-1260. In addition, low levels of DDT_R were detected at these sampling stations.

Recommendations. Derivation of an ecological risk-based preliminary remediation goal (PRG) for sediment at the Site 5 drainage ditch involves balancing risks. In addition to the toxicological risks associated with contamination of sediment in the Site 5 drainage ditch, the risks associated with remediation (i.e., habitat destruction risks) should be considered at Site 5. A recent USEPA Science Advisory Board (USEPA, 1990) review of relative ecological risks indicates that environmental protection strategies should prioritize remedial options for the greatest overall risk reduction. USEPA (1990) recommends that the relative risks of remedial strategies be considered, particularly as they relate to natural ecosystem destruction; habitat alteration may result in greater relative risk than environmental contamination.

Remediation of Site 5 sediment could result in ecological impacts associated with habitat alteration. Physical alteration of wetland and aquatic habitat at Site 5 could result in significant habitat alterations, resulting in ecological impacts including:

- destruction of wetland vegetation;
- alteration of wetland hydrology;
- alteration of the ability of Site 5 to perform wetland functions, and including flood water storage, surface water purification, sediment pollution absorption, and sediment load deposition.

Because of the technical difficulties associated with successful wetland restoration and the ecological and financial costs associated with wetland habitat destruction and restoration, alternatives resulting in avoidance of impacts to wetlands should be evaluated at this site. Source control and confinement of activities to parts of the drainage ditch with significant contaminant hot spots should be considered.

If hot spot remediation is the selected alternative at the Site 5 drainage ditch, residual TPH and PCB sediment contamination would remain in the ditch following hot spot remediation. Therefore, a biomonitoring plan should be implemented to monitor any short- and long-term impacts associated with residual contamination in sediment.

If avoidance of wetland alteration is not possible, alternatives resulting in minimization of impacts to the wetland at the site should be considered.

Mitigation should only be selected as the preferred alternative if the avoidance and minimization options have been explored.

8.1.2.2 Lake Fretwell As described in Subsection 8.1.2, several potential sources of contamination exist for Lake Fretwell, the most notable of which include Site 11, the Golf Course Pesticide Disposal Area and Site 5, the Oil Disposal Area. The ERA for Lake Fretwell is presented in Chapter 7.0.

In July 1993, eight surface water and sediment samples were collected in Lake Fretwell (LF-SW/SD/Bio-1 through LF-SW/SD/Bio-8; Plate 2). Based on detections of pesticides and PCBs in the 1993 Lake Fretwell sediment data (Appendix B), sediment was resampled for chemical analyses and toxicity testing and fish tissue was collected in April of 1995. Eight sediment samples were recollected in Lake Fretwell (LF-SD-9 through LF-SD-16; Figure 7-2) during the April 1995 sampling effort.

Sublethal risks were identified for each of the representative wildlife species (Florida water rat, raccoon, kingfisher, and great blue heron) based on ingestion of contaminated fish tissue. The primary contributors to sublethal effects for the representative wildlife species are as follows: aluminum and mercury for the Florida water rat; Aroclor-1260 and mercury for the raccoon; and copper and mercury for the kingfisher and great blue heron. Due to the presence of multiple sites and PSCs surrounding Lake Fretwell, it is difficult to determine the source of these contaminants. It is suspected, however, that the source(s) of Aroclor-1260 may be from either Site 11 or Site 5, where the PCB was found at elevated concentrations in the sediment.

Based on the weight-of-evidence for each of the sampling stations in Lake Fretwell, risks may be present to certain macroinvertebrate receptors at four of the eight sampling locations including LF-SD/Tox-7, LF-SD/Tox-9, LF-SD-Tox-11, and LF-SD/Tox-12. Risks to aquatic receptors are based on the results of the sediment toxicity testing. It is possible that toxicological effects may be associated with simultaneous exposures to multiple contaminants in sediment and other factors that influence the bioavailability of sediment toxicants.

<u>Recommendations</u>. Risks are predicted for terrestrial wildlife and aquatic receptors in Lake Fretwell. Due to the number of sites and PSCs surrounding the lake, it is difficult to identify the source of contamination to the lake. Detected concentrations of PCBs, mercury, and other metals in fish tissue collected from Lake Fretwell may also be the result of multiple sources of potential contamination. It is recommended that further sampling be conducted in the vicinity of Site 11, the Golf Course Pesticide Disposal Area, in order to identify the source of potential contamination to the lake and develop preliminary remediation goals (PRGs), as appropriate. In addition, remedial action at Site 5 may reduce the influx of site-related contaminants in the sediment to Lake Fretwell via the Site 5 drainage ditch.

<u>8.1.3 Rowell Creek Downstream of Lake Fretwell</u> The stretch of Rowell Creek downstream of Lake Fretwell extends approximately 3,500 feet before converging with Sal Taylor Creek to the south. The length of Rowell Creek in the first 1,000 feet directly downstream of Lake Fretwell may receive contamination from Site 3, the Oil and Sludge Disposal Pit. In addition, this portion of Rowell Creek also receives discharge from an upgradient sewage treatment plant. Ecological risks occurring in the northernmost section of Rowell Creek downstream of Lake Fretwell are discussed in Paragraph 8.1.3.1. The remaining 2,500 feet of Rowell Creek north of the confluence of Rowell Creek and Sal Taylor Creek is discussed in Paragraph 8.1.3.2. This portion of Rowell Creek may receive potential contamination from the upstream site (Site 3) and the wastewater treatment plant as well as OU 1 (Sites 1 and 2) to the west and PSC 10 to the east of Rowell Creek.

8.1.3.1 Northernmost Portion of Rowell Creek Downstream of Lake Fretwell Sources of potential contamination to the first 1,000 feet of Rowell Creek directly downstream of Lake Fretwell include Site 3 to the west, discharge from the sewage treatment plant located upstream to the west, and possibly resuspension of sediment from the Lake Fretwell during flooding. In April 1993, surface water and sediment was collected from one location (RC-SW/SD/Bio-3) in Rowell Creek approximately in the center of the Site 3 groundwater plume discharge location. In November 1994, two additional samples were collected north and south of RC-SW/SD/Bio-3 (CF3-SW/SD-1 and CF3-SW/SD-2, respectively). All three samples were collected downgradient of the Navy wastewater treatment plant. The locations of the surface water and sediment sampling stations are shown on Plate 2.

Risks were not identified for terrestrial and wetland wildlife resulting from exposures to ECPCs in surface water and sediment in the first 1,000 feet of Rowell Creek directly downstream of Lake Fretwell.

A review of the habitat quality parameter data collected during testing suggests that habitat conditions at Rowell Creek near Site 3 represent a poor environment for many types of aquatic organisms. Differences in habitat structure between the Rowell Creek area and reference station may explain the decreased biological condition observed in samples collected adjacent to Site 3. The NAS Cecil Field domestic wastewater treatment plant may also contribute to differences in the community structure in this area.

Risks to aquatic receptors were not identified for exposure to surface water and sediment in this portion of Rowell Creek. Although Aroclor-1254 and 4,4-DDT were detected in sediment in the vicinity of Site 3, they were present at low levels, and were not found in Site 3 groundwater. This indicates that transport of these contaminants from Site 3 is not occurring.

Undiluted, unfiltered groundwater at Site 3 may result in risk to aquatic organisms. Although several groundwater risk contributors were identified, three DCB isomers (1,2-DCB, 1,3-DCB, and 1,4-DCB) were found to be the primary risk contributors from Site 3 groundwater. However, when a dilution factor was applied to estimate the dilution of groundwater prior to discharge to Rowell Creek, estimated concentrations of chemicals in groundwater were below available aquatic toxicity benchmarks and criteria. Toxicity testing of groundwater with the water flea and fathead minnow supports the contention that diluted groundwater discharging to Rowell Creek poses little risk to aquatic receptors.

<u>Recommendations</u>. The results of the ERA for Site 3 suggest that ecological receptors are not likely to be at risk from exposure to surface water, sediment, or groundwater (as it discharges to surface water) in the portion of Rowell Creek approximately 1,000 feet downstream of Lake Fretwell; therefore, no further action is recommended for this area.

8.1.3.2 Southernmost Portion of Rowell Creek Downstream of Lake Fretwell The remaining 2,500 feet of Rowell Creek north of the confluence of Rowell Creek and Sal Taylor Creek is discussed below. This portion of Rowell Creek may receive potential contamination from Site 3 and the upstream wastewater treatment plant as well as OU 1 (Sites 1 and 2) to the west and PSC 10 to the east of Rowell Creek.

In 1993, two surface water and sediment samples were collected upstream of OU 1 (RC-SW/SD/Bio-4 and RC-SW/SD/Bio-5) and six samples were collected in Rowell Creek adjacent to OU 1 (RC-SW/SD/Bio/Tox-6, RC-SW/SD/Bio/Tox-7, RC-SW/SD/Bio/Tox-8, RC-SW/SD/Bio/Tox-8A, RC-SW/SD/Bio/Tox-9, and RC-SW/SD/Bio/Tox-10. The locations of the sampling stations are depicted on Plate 2.

Risks were not identified for terrestrial and wetland wildlife resulting from exposures to ECPCs in surface water and sediment in the stretch of Rowell Creek approximately 2,500 feet north of the confluence of Rowell Creek and Sal Taylor Creek.

Sediment toxicity testing and the analyses of the benthic macroinvertebrate sampling results indicate sediment toxicity and impairment of the benthic community at two of the six sampling locations in Rowell Creek (RC-SW/SD/Bio/Tox-6 and RC-SW/SD-Bio/Tox-7). Comparison of the adverse responses with the measurement of ECPCs in surface water and sediment did not reveal any contaminant(s) that could be associated with the responses. There are indications that the responses may be associated with the discharge of the tributary draining Site 2 into Rowell Creek. The two stations with impairment are located immediately downstream of the confluences of the drainage from Site 2. If the tributary is adversely influencing Rowell Creek, the extent of effects is minimal being confined to a maximum reach of stream of approximately 700 feet.

Risks for aquatic receptors associated with ECPCs in groundwater from Sites 1 and 2 were not identified.

<u>Recommendations</u>. The ROD for the cleanup of OU 1 has been completed (ABB-ES, 1995) and the design of the preferred RA is currently underway. The RA involves both control of sources of contamination and reduction of ecological risks identified in Rowell Creek immediately downgradient of the confluence of the Site 2 tributary and Rowell Creek. The proposed biomonitoring activities for Rowell Creek include chemical analysis of surface water and sediment, sampling of benthic macroinvertebrates, and toxicity testing of sediment. The results of the biomonitoring activities will be used to determine whether or not the Site 2 tributary is affecting Rowell Creek and evaluate improvement over time.

<u>8.1.4 Tributaries to Rowell Creek</u> Ecological risks and recommendations for further action are discussed for the Site 2 tributary in Paragraph 8.1.4.1.

8.1.4.1 Site 2 Tributary The Site 2 tributary flows into Rowell Creek from the west just north of sampling station RC-SW/SD/Bio/Tox-6 (Plate 2). Two surface water and sediment samples were collected from the Site 2 tributary (2-SW/SD-Bio-Tox-2 and 2-SW/SD/Bio/Tox-3) and one sample was collected in the Site 2 drainage structure (2-SW/SD/Bio/Tox-1). The locations of the Site 2 sampling locations are depicted on Plate 2.

Lethal effects were identified for small mammals that may forage in the Site 2 tributary. Risks were associated with ingestion of iron in sediment.

Impairment of the benthic macroinvertebrate community and sediment toxicity were observed in the Site 2 tributary. Toxicity of the sediment to one of the two test species was positively correlated (>0.95) to the amount of iron measured in sediment. Exposures of iron for small mammals resulting from incidental ingestion of sediment could potentially result in mortality.

The cause of impairment in the benthic macroinvertebrate community could not be positively determined. The adverse responses observed in toxicity tests could be associated with aluminum, lead, and iron, which exceed acceptable criteria in surface water, or with cyanide, iron, mercury, selenium, silver, vanadium, and cadmium in sediment. The adverse responses could also be the result of physical impairment caused by an orange-red flocculent that is present in the tributary coating the bottom substrate and "blanketing" the water column.

Recommendations. The ROD for the cleanup of the Site 2 tributary has been completed (ABB-ES, 1995) and the design of the preferred RA is currently underway. The RA involves both control of sources of contamination and reduction of ecological risks identified in the Site 2 tributary and in Rowell Creek immediately downgradient of the confluence of the Site 2 tributary and Rowell Creek. The proposed biomonitoring activities for the Site 2 tributary include chemical analysis of surface water and sediment, identification of bacteria in the drainage structure and the Site 2 tributary, sampling of benthic macroinvertebrates, and toxicity testing of sediment. The results of the biomonitoring activities will be used to identify the source of the observed impacts on the Site 2 tributary; identify bacteria present in the Site 2 tributary; assess whether chemical, physical, and/or biological conditions improve in the Site 2 tributary over the biomonitoring period; and determine whether the Site 2 tributary is affecting Rowell Creek.

8.2 SAL TAYLOR CREEK. Ecological risks and recommendations for further action in Sal Taylor Creek are subdivided into four segments including Sal Taylor Creek upstream and east of the flightline (Subsection 8.2.1), Sal Taylor Creek downstream of the Site 8 tributary (Subsection 8.2.2), and the tributaries of Sal Taylor Creek (Subsection 8.2.3).

On February 10, 1991, approximately 900,000 gallons of JP-5 jet fuel overflowed from a tank in the North Fuel Farm Area of NAS Cecil Field. The fuel flowed down the slope on the west side of the tank into a small drainage ditch that discharges into Sal Taylor Creek. A Contamination Assessment Report (CAR) was completed for each of the seven Sal Taylor Creek dam and/or containment sites, which were affected by the 1991 JP-5 fuel spill (CAR reports, ABB-ES, 1992). This work is being conducted under the Tanks Program at NAS Cecil Field. In their 1992 comments to the CAR, FDEP requested that sediment toxicity testing be completed to assess the toxicity of sediment to aquatic receptors in Sal Taylor Creek and document potential current adverse effects of the fuel spill. On October 7, 1994, it was agreed that additional sediment samples would be collected at each of the seven dam and/or containment sites in Sal Taylor Creek. The results of the analytical and toxicity testing data for sediment samples collected from all seven of the dam and/or containment sites will be included in the CAR addenda for the Aviation Ordnance (AVORD)-Dam, North Containment Pond, AVORD-Perimeter Road, Gate 10 Dam, Alpha Dam, Possum Dam, and Gate 14 Dam sites (ABB-ES, 1995).

8.2.1 Upstream and East of the Flightline Four surface water and sediment samples (STC-SW/SD/Bio/Tox-1, STC-SW/SD/Bio/Tox-2, STC-SW/SD/Bio/Tox-3, and STC-SW/SD/Bio-4) were collected in drainage ditches approximately 500 feet east of the runway. Three of the four ditch locations (STC-1, -3 and -4) receive stormwater drainage from both the runway areas and the developed areas west of the runway (including Site 16) and carry discharge approximately 2,400 feet eastward toward Sal Taylor Creek. Sampling station STC-2 receives drainage from the runway, but is not connected to Site 16 via the stormwater drainage system. A reference sample (STC-SW/SD/Bio/Tox-R1) was collected upstream of any known hazardous waste influence in Sal Taylor Creek just south of 103rd St. The locations of the surface water and sediment locations are shown on Plate 2.

Risks were not identified for terrestrial and wetland wildlife resulting from exposures to ECPCs in surface water and sediment in the drainage ditches east of the flightline.

The benthic macroinvertebrate study indicated that the populations of invertebrates in the drainage ditches are generally poorly developed. A review of the habitat quality parameter data, including the reference station, represent a stressful situation for many types of aquatic organisms. The highly variable conditions associated with ephemeral streams such as the drainage ditches are not representative of aquatic habitat for which available bioassessment protocols were designed to evaluate; only certain types of aquatic macroinvertebrates are adapted to live in these habitats. There are no apparent trends in the status of the benthic macroinvertebrate community in the drainage ditches and the reference station in Sal Taylor Creek. It could not be concluded that contaminants in the sediment were contributing to the poorer condition observed in the drainage ditches.

Sediment toxicity testing results indicate that risks may be present for certain types of macroinvertebrate receptors at two of the three sampling stations in the drainage ditches east of the flightline (STC-1 and STC-3). Comparison of the adverse responses with the measurements of ECPCs in surface water and sediment revealed that risks to aquatic receptors may be associated with elevated concentrations of TPH in sediment. Because the ditches receive stormwater drainage from the runway area and much of the developed area west of the runways, it is believed that the presence of TPH in the sediment of the drainage ditches is not related to Site 16.

Potential risks for aquatic receptors were evaluated for exposures to ECPCs in groundwater. The concentration of ECPCs in unfiltered groundwater were estimated as they are discharged to both the wetlands downgradient of surficial groundwater for Site 16 and Sal Taylor Creek. The exposure concentrations of groundwater ECPCs in Sal Taylor Creek were estimated based on concentrations measured in groundwater samples. Migration of groundwater contamination to the wetlands assumed no dilution. The risk characterization did not identify risks for aquatic receptors in Sal Taylor Creek associated with ECPCs in groundwater. However, risks associated with exposures to bis(2-ethylhexyl)phthalate, aluminum, iron, and zinc are possible for aquatic receptors in the wetlands. Concentrations of bis(2-ethylhexyl)phthalate, iron, and zinc appear to originate in the intermediate aquifer and flow upward to the surficial aquifer; therefore, these detections are not believed to be associated with Site 16.

Recommendations. In order to further evaluate the effects of potential groundwater migration from Site 16 to the wetlands area, it is recommended that surface water and sediment samples (including sediment toxicity testing) be collected in the Sal Taylor Creek emergent wetlands area.

8.2.2 Sal Taylor Creek Downstream of the Site 8 Tributary Two surface water and sediment samples were collected in Sal Taylor Creek downstream of the Site 8 tributary and upstream of the Rowell Creek confluence. These sample locations include STC-SW/SD/Bio-6 and STC-SW/SD/Bio-7 (upstream to downstream; Plate 2). One sample was collected upstream of the Site 8 tributary (STC-SW/SD/Bio-5) and one sample was collected in Sal Taylor Creek downstream of the Rowell Creek confluence with Sal Taylor Creek (STC-SW/SD/Bio-8). Potential sources of contamination from Site 8, the Boresite Range, Hazardous Waste Storage Area, and Firefighting Training Area, may impact Sal Taylor Creek in the area of sampling locations STC-6 and STC-7. In addition, the 1991 JP-5 fuel spill represents a source of contamination for this portion of Sal Taylor Creek.

Although an ERA for Site 8 had not been completed to date, a review of the macroinvertebrate habitat quality parameter data suggests that habitat quality conditions at STC-Bio-7 and STC-Bio-8 lie within the predictable condition of the biological community in response to habitat quality. Station STC-Bio-6 exhibited higher benthic quality than expected and station STC-Bio-5, the upstream location, was classified as slightly impaired. These results indicate a healthy benthic macroinvertebrate community in Sal Taylor Creek downstream of Site 8.

The analytical results of the surface water and sediment samples from Sal Taylor Creek are included in Appendix B and will be evaluated upon completion of the ERA for OU 3, Site 8.

Recommendations. Recommendations for further action in Sal Taylor Creek downstream of Site 8 will be identified upon completion of the ERA for OU 3.

8.2.3 Tributaries to Sal Taylor Creek Ecological risks and recommendations for further action are discussed for the Site 8 tributary in Paragraph 8.2.3.1.

8.2.3.1 Site 8 Tributary The Site 8 tributary flows into Sal Taylor Creek just east of sampling station STC-6 (Plate 2). Two surface water and sediment samples were collected in the Site 8 tributary north of the confluence with Sal Taylor Creek (8-SW/SD/Bio-1 and 8-SW/SD/Bio-2 from north to south, respectively; Plate 2). Potential sources of contamination from Site 8, the Boresite Range, Hazardous Waste Storage Area, and Firefighting Training Area, may impact the Site 8 tributary.

Although an ERA for Site 8 has not been completed to date, a review of the macroinvertebrate habitat quality parameter data suggests that habitat quality conditions at the downstream location (8-Bio-2) represent a poor environment for many types of aquatic organisms. Comparison of the metrics between the Site 8 sampling stations indicates no clear trends in the data, although there are some indicators of increased stress at 8-Bio-2. The petroleum sediment odor at 8-Bio-2 may be a factor influencing the community at this location.

The analytical results of the surface water and sediment samples from the Site 8 tributary are included in Appendix B and will be evaluated upon completion of the ERA for OU 3, Site 8.

Recommendations. Recommendations for further action in the Site 8 tributary to Sal Taylor Creek will be identified upon completion of the ERA for OU 3.

8.3 YELLOW WATER CREEK. Yellow Water Creek, which flows through the southwest corner of the Yellow Water Weapons area, is the largest creek at NAS Cecil Field. Two surface water and sediment samples were collected in Yellow Water Creek downstream of the confluence with Caldwell Branch (YWC-SW/SD/Bio-1 and YWC-SW/SD/Bio-2 from north to south, respectively; Plate 2). In addition, one reference sample was collected upstream of Yellow Water Creek in Caldwell Branch (YWC-SW/SD/Bio-R1; Plate 2). Sampling station YWC-1 is located downstream of Site 15, the Blue 10 Ordnance Disposal Area, and 200 feet upstream of the road near the housing area, and station YWC-2 is located 200 feet upstream of Normandy Boulevard. Site 15 represents a potential source of contamination to Yellow Water Creek.

Although an ERA for Site 15 had not been completed to date, a review of the macroinvertebrate habitat quality parameter data suggests that habitat quality conditions at YWC-Bio-1 is moderately impaired. The other stations in Yellow Water Creek lie within or above the predictable condition of the biological community in response to habitat quality.

The analytical results of the surface water and sediment samples from Yellow Water Creek are included in Appendix B and will be evaluated upon completion of the ERA for OU 5, Site 15.

Recommendations. Recommendations for further action in Yellow Water Creek will be identified upon completion of the ERA for OU 5.

REFERENCES

REFERENCES

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APPENDIX A

APPENDIX A

ECOLOGICAL RECEPTOR SPECIES AT NAS CECIL FIELD

Appendix A, Table A-7
MACROINVERTEBRATE TAXA LIST FOR NAS-CECIL FIELD, JUNE 1996

Tricladida
Nemertea
Nematoda
Oligochaeta
- Lumbriculidae
- Enchytraeidae
- Tubificidae
- Tubificidae imm. w
- Tubificidae imm. w/o
- *Limnodrilus hoffmeisteri*
- *Ilyodrilus templetoni*
- *Aulodrius pigueti*
- *Bothrioneurum vejdovskyanum*
- Naididae
- *Slavina appendiculata*
- *Dero*
- *Dero digitata*
- *Dero flabelliger*
- *Dero (Aulophorus)*
- *Dero furcata*
- *Dero (Dero)*
- *Nais*
- *Nais communis*
- *Pristina osborni*
- *Pristina aequiseta*
- *Pristina leidyi*

Hirudinea
- *Helobdella*
- *Helobdella elongata*
- *Helobdella triserialis*
- *Helobdella fusca*
- Glossiphoniidae
- *Placobdella papillifera*
- Hirudinidae
- Erpobdellidae
- *Mooreobdella microstoma*

Gastropoda
- Pleuroceridae
- Hydrobiidae
- Lymnaeidae
- Ancylidae
- Planorbidae
- Physella

Pelecypoda
- *Corbicula fluminea*
- Sphaeriidae
- Unionidae

Arachnoidea
- Acarina

Appendix A, Table A-7 (Continued)
MACROINVERTEBRATE TAXA LIST FOR NAS-CECIL FIELD, JUNE 1996

Malacostraca
- *Asellus*
- Gammaridae
- *Gammarus*
- *Hyalella azteca*
- *Crangonyx*
- *Palaemonetes paludosus*
- Astacidae

Collembola

Ephemeroptera
- *Stenonema*
- *Stenacron*
- Baetidae
- Baetis
- *Callibaetis*
- *Centroptilum*
- Ephemerellidae
- *Caenis*
- *Paraleptophlebia*

Odonata
- Anisoptera
- Aeshnidae
- *Boyeria*
- *Nasiaeschna*
- Gomphidae
- *Dromogomphus*
- *Progomphus*
- Libellulidae
- Corduliidae
- Macromiidae
- Calopterygidae
- *Calopteryx*
- *Hetaerina*
- Coenagrionidae
- *Argia*

Hemiptera
- Belostomatidae
- Corixidae
- Notonectidae

Coleoptera
- *Haliplus*
- *Derovatellus*
- *Laccophilis*
- *Peltodytes*
- Dytiscidae
- *Celina*
- *Gyrinus*
- *Dineutus*
- Hydrophilidae
- *Tropisternus*
- *Berosus*

Appendix A, Table A-7 (Continued)
MACROINVERTEBRATE TAXA LIST FOR NAS-CECIL FIELD, JUNE 1996

- *Helichus*
- *Elmidae*
- *Stenelmis*
- *Dubiraphia*
- *Microcylloepus*
- *Ancyronyx*
- *Ancyronyx variegata*
- Curculionidae

Megaloptera
- Corydalidae
- *Corydalus cornutus*
- *Nigronia serricornis*
- *Sialis*

Trichoptera
- *Chimarra*
- Psychomyiidae
- *Lype diversa*
- *Psychomyia flavida*
- Hydropsychidae
- *Cheumatopsyche*
- *Hydropsyche*
- Hydroptilidae
- *Oxethira*
- Leptoceridae
- *Oecetis*
- *Phylocentropus*
- Polycentropodidae
- *Cyrnellus fraternus*
- *Polycentropus*

Lepidoptera

Diptera
- *Chaoborus*
- *Tipulidae*
- *Tipula*
- *Hexatoma*
- *Bittacomorpha*
- Ceratopogonidae
- Culicidae
- Simuliidae
- Chironomidae
- Orthocladiinae
- Tanypodinae
- *Clinotanypus*
- *Coelotanypus*
- *Procladius*
- *Chironomini*
- *Cricotopus bicinctus*
- *Stenochironomus*
- *Cladotanytarsus*
- Tanytarsini

Appendix A, Table A-7 (Continued)
MACROINVERTEBRATE TAXA LIST FOR NAS-CECIL FIELD, JUNE 1996

Tanytarsus
Tanytarsus Epler F
Chironomus
Cryptochironomus
Polypedilum fallax
Polypedilum convictum
Polypedilum illnoense
Polypedilum scalaenum
Ablabesmyia
Dicrotendipes
Nanocladius
Paralauterborniella
Rheotanytarsus
Parachironomus
Pentaneura
Parametriocnemus
Paratanytarsus
Larsia
Labrundinia
Nilotanypus
Rheocricotopus
Thienemanniella
Tribelos
Cryptotendipes
Paracladopelma
Phaenopsectra
Cladopelma
Stelechomyia
Xylotopus
Thienemannimyia
Cladotanytarsus
Mesosmittia
Harnischia
Natarsia
Glyptotendipes
Tanypus
Microtendipes
Pseudochironomus
Omisus
Endochironomus
Stictochironomus
Zavreliella
Empididae
Hemerodromia
Psychodidae
Stratiomyidae
Tabanidae

APPENDIX B

APPENDIX B

SURFACE WATER AND SEDIMENT ANALYTICAL DATA

APPENDIX C

APPENDIX C

BIOLOGICAL STUDIES AT NAS CECIL FIELD

APPENDIX C

BIOLOGICAL STUDIES AT NAS CECIL FIELD

This appendix lists the references available for each of the biological studies that have been completed at Naval Air Station Cecil Field. The type of study and report content is described below each of the references. Studies are listed in chronological order.

A matrix showing the types of studies completed for the OUs and PSCs at NAS Cecil Field is depicted in Table C-1. A timeline of the biological studies completed at the facility is shown on Figure C-1.

1. Southeastern Environmental Laboratories (SEL), 1991, Lake Fretwell Fish Analysis, Naval Air Station Cecil Field, Jacksonville, Florida, prepared by SEL and NAS Cecil Field Public Works Division, May.

   <u>This document summarizes the results of the 1991 fish sampling effort in Lake Fretwell at NAS Cecil Field. Fish samples were collected by NAS Cecil Field's Public Works Division and shipped to SEL for analysis.</u>

2. Environmental Consulting & Technology, Inc. (ECT), 1992, Final Report on the Aquatic Macroinvertebrate and Fisheries Sampling of Rowell Creek, Naval Air Station Cecil Field, Duval County, Florida, prepared for ABB Environmental Services, Inc. (ABB-ES), December.

   <u>This report summarizes the results of the December 1991 macroinvertebrate and fisheries sampling effort in Rowell Creek at NAS Cecil Field. The objectives of macroinvertebrate and fisheries sampling were to identify and inventory the local fauna, to develop representative species lists for the various water bodies at NAS Cecil Field, and to characterize the diversity of resident populations. Samples were collected from six biological sampling stations at Rowell Creek.</u>

3. CDM Federal Programs, Inc. (CDM), 1993, Wetlands Delineation, Potential Source of Contamination No. 1 Study Area, Naval Air Station Cecil Field, Jacksonville, Florida: prepared for ABB-ES, November.

   <u>This document summarizes the results of the wetlands delineation at OU 1 (Site 1) at NAS Cecil Field. Wetlands were identified in accordance with Federal and State of Florida guidelines.</u>

4. CDM, 1993, Wetlands Delineation, Potential Source of Contamination No. 2 Study Area, Naval Air Station Cecil Field, Jacksonville, Florida: prepared for ABB-ES, November.

   <u>This document summarizes the results of the wetlands delineation at OU 1 (Site 2) at NAS Cecil Field. Wetlands were identified in accordance with Federal and State of Florida guidelines.</u>

TABLE C-1
NAS CECIL FIELD ECOLOGICAL INVESTIGATION MATRIX

Basewide Ecological Assessment Report
Naval Air Station Cecil Field
Jacksonville, Florida

	A	B	C	D	E	F	G	H	I	J	K	L			M	N	O	P	Q	R	S	T
												1	2	3								
Operable Unit 1																						
Site 1	X		X		X	X		X				X	X	X	X	X	X	X	X	X	X	
Site 2	X		X		X	X						X		X	X	X	X	X	X	X	X	
Operable Unit 2																						
Site 5	X	X	X		X	X						X		X	X	X	X	X	X	X	X	IP
Site 17	X	X	X															X	X	X	X	IP
Operable Unit 7																						
Site 16					X	X		X				X	X	X	X	X	X	X	X	X	X	IP
Operable Unit 8																						
Site 3	X	X	X							X	X	X	X	X	X	X	X	X	X	X	X	
Operable Unit 3																						
Site 7																						
Site 8												X		X	X							
Operable Unit 4																						
Site 10																						
Operable Unit 5																						
Site 14																						
Site 15	X		X																			
Operable Unit 6																						
Site 11								X				X	X	X								IP
Lake Fretwell						X	X		X			X	X	X	X	X	X				X	

5. CDM, 1993, Wetlands Delineation, Potential Source of Contamination No. 3 Study Area, Naval Air Station Cecil Field, Jacksonville, Florida: prepared for ABB-ES, November.

This document summarizes the results of the wetlands delineation at OU 8 (Site 3) at NAS Cecil Field. Wetlands were identified in accordance with Federal and State of Florida guidelines.

6. CDM, 1993, Wetlands Delineation, Potential Source of Contamination No. 4 Study Area, Naval Air Station Cecil Field, Jacksonville, Florida: prepared for ABB-ES, November.

This document summarizes the results of the wetlands delineation at OU 2 (Site 4) at NAS Cecil Field. Wetlands were identified in accordance with Federal and State of Florida guidelines.

7. CDM, 1993, Wetlands Delineation, Potential Source of Contamination No. 5 Study Area, Naval Air Station Cecil Field, Jacksonville, Florida: prepared for ABB-ES, November.

This document summarizes the results of the wetlands delineation at OU 2 (Site 5) at NAS Cecil Field. Wetlands were identified in accordance with Federal and State of Florida guidelines.

8. CDM, 1993, Wetlands Delineation, Potential Source of Contamination No. 17 Study Area, Naval Air Station Cecil Field, Jacksonville, Florida: prepared for ABB-ES, November.

This document summarizes the results of the wetlands delineation at OU 2 (Site 17) at NAS Cecil Field. Wetlands were identified in accordance with Federal and State of Florida guidelines.

9. CDM, 1993, Wetland Report, Potential Sources of Contamination Nos. 1, 2, 3, 4, 5, & 17 Study Areas, Naval Air Station Cecil Field, Jacksonville, Florida: prepared for ABB-ES, November.

This report summarizes the results of the wetlands assessment performed for wetlands identified at OUs 1, 2, and 8 (Sites 1, 2, 3, 4, 5, and 17). Wetlands were identified and characterized, and functional assessments of the wetlands are included in the report.

10. CDM, 1993, Terrestrial Habitat Mapping of Potential Sources of Contamination Nos. 1, 2, 3, 4, 5, 16 & 17 Study Areas, Naval Air Station Cecil Field, Jacksonville, Florida: prepared for ABB-ES, November.

This report identifies terrestrial wildlife habitats at OUs 1, 2, 7, and 8 (Sites 1, 2, 3, 4, 5, 16, and 17) at NAS Cecil Field. Habitats are shown on several maps.

11. EA Engineering, Science, and Technology, 1994, Aquatic Biological Sampling Services Conducted at Naval Air Station Cecil Field, Jacksonville, Florida: prepared for ABB-ES, January.

This document summarizes the results of the June 1993 aquatic biological sampling over several streams and lakes at NAS Cecil Field. The objectives of sampling were to characterize aquatic habitats and to collect macroinvertebrates and fish. Biological sampling was conducted at several stations in Rowell Creek, Sal Taylor Creek, Yellow Water Creek, Lake Fretwell, and tributaries to these water bodies. Reference locations as well as locations where OU or PSC activity may have impacted aquatic habitat were sampled. This report focuses on data collected from Rowell Creek, the Rowell Creek golf course reference station, Sal Taylor Creek, and the Site 2 area.

12. CDM, 1994, Wetlands Assessment, Wetland Delineation and Terrestrial Habitat Mapping at Operable Units 1, 2, and 7, Naval Air Station Cecil Field, Jacksonville, Florida: prepared for ABB-ES, April.

    This document summarizes the overall results of an effort in 1993-94 to assess and delineate wetlands and to map terrestrial habitats at OUs 1, 2, 7, and 8 (Sites 1, 2, 3, 4, 5, 16, and 17) at NAS Cecil Field. Wetlands were identified in accordance with Federal and State of Florida guidelines. Wetland plant communities and upland plant communities were described according to classification systems available from the Florida Natural Areas Inventory (FNAI) and the U.S. Fish and Wildlife Service (USFWS). The functional assessments of the wetlands identified at these OUs were completed using a computer model called the Wetland Evaluation Technique (WET). Terrestrial wildlife habitats identified at the OUs are shown on several maps.

13. Springborn Laboratories, 1994, Toxicity Evaluation of the Sediment and Soil from the Cecil Field Naval Air Station in Jacksonville, Florida: SLI report 93-07-4874, prepared for ABB-ES, March.

    This document summarizes the results of the 1993 toxicity testing of sediment and surface soil at OU 2 (Sites 5 and 17) at NAS Cecil Field. Tests completed for sediment samples were short-term chronic toxicity tests with water fleas (C. dubia) and acute toxicity tests with amphipods (H. azteca). Tests completed for soil samples were 14-day subacute toxicity tests with earthworms (E. foetida) and 120-hour germination toxicity tests with lettuce seeds (L. sativa).

14. EA Engineering, Science, and Technology, Inc., 1994, Addendum to Aquatic Biological Sampling Services Conducted at Naval Air Station Cecil Field, Jacksonville, Florida: prepared for ABB-ES, June.

    This document summarizes the results of the June 1993 aquatic biological sampling over several streams and lakes at NAS Cecil Field. The objectives of sampling were to characterize aquatic habitats and to collect macroinvertebrates and fish. Biological sampling was conducted at several stations in Rowell Creek, Sal Taylor Creek, Yellow Water Creek, Lake Fretwell, and tributaries to these water bodies. Reference locations as well as locations where OU or PSC activity may have impacted aquatic habitat were sampled. This report focuses on data collected at the remaining stations that were not discussed at length in EA's January 1994 document.

15. CZR Incorporated, 1994, Cecil Field Gopher Tortoise Survey and Management Plan, Naval Air Station Cecil Field, Jacksonville, Florida, November.

This document presents the results of a gopher tortoise field survey completed at NAS Cecil Field in 1994. Gopher tortoise populations were studied to identify suitable habitat, to estimate population numbers, to determine management areas and develop management recommendations, and to determine the existence of other endangered, threatened, or special concern species at four NAS Cecil Field facilities: Cecil Field, the Yellow Water Weapons Complex, Outlying Landing Field Whitehouse, and Rodman Bomb Target. Potential tortoise habitat was identified and surveyed; burrows were classified and mapped; and flora and fauna observations were recorded in field notes in this report.

16. Inchcape Testing Services/Aquatec Laboratories, 1995, Results of Groundwater and Soil Toxicity Tests Completed on Samples from Cecil Field Naval Air Station, Jacksonville, Florida: prepared for ABB-ES, February.

This document summarizes the results of toxicity testing of 9 surface soil and 2 groundwater samples collected at OU 8 (Site 3) in November 1994. Tests completed for surface soil samples were 5-day lettuce seed (L. sativa) germination tests and 28-day earthworm (E. foetida) survival tests. Tests completed for groundwater samples were chronic toxicity tests for the water flea (C. dubia) and the fathead minnow (P. promelas).

17. Inchcape Testing Services/Aquatec Laboratories, 1995, Fish Collection Forms and Laboratory Bench Sheets, Fish Sampling Program for Lake Fretwell and Upper Rowell Creek, Naval Air Station Cecil Field, Jacksonville, Florida: prepared for ABB-ES, May.

This package summarizes the non-analytical data collected during the April 1995 fish sampling effort at Lake Fretwell and upper Rowell Creek. The overall objective of the fish sampling effort was to determine the concentrations of contaminants present in the tissue of fish that are prey for other wildlife, in order to assess the latter's potential exposure to contaminants present in Lake Fretwell and upper Rowell Creek. The fish collection forms indicate the time, date, sample location, and depths at which fish were collected. The laboratory bench sheets contain the following information: species of fish collected; number of each type of species collected at each location; fish weight; total length of fish; and other remarks such as presence of parasites, lesions, deformities, or other abnormalities that were observed during fish sampling and inspection.

18. Quanterra Laboratories, 1995, Analytical Data from Tissue Samples from Whole Fish and Fish Fillets, Fish Sampling Program for Lake Fretwell and Upper Rowell Creek, Naval Air Station Cecil Field, Jacksonville, Florida: prepared for ABB-ES, May.

This package summarizes the analytical data collected during the April 1995 fish sampling effort at Lake Fretwell and Upper Rowell Creek. Tissues from both whole fish and fish fillets were analyzed for metals, pesticides, and PCBs.

19. Environmental Science and Engineering, 1995, Toxicity Analysis of Sediment Samples from Lake Fretwell, Naval Air Station Cecil Field, Jacksonville, Florida: prepared for ABB-ES, July.

This document summarizes the results of toxicity testing of 13 sediment samples that were collected from Lake Fretwell in April 1995. The tests performed were whole sediment bioassays for 14-day survival and growth of two invertebrate species, amphipods (H. azteca) and (C. tentans).

20. ESE, 1995, Toxicity Analysis of Soil Samples from Site 15, Naval Air Station Cecil Field, Jacksonville, Florida: prepared for ABB-ES, December.

This document summarizes the results of toxicity testing of six soil samples that were collected from Site 15 in July and August 1995. The tests performed were whole soil and definitive (dilution-series) bioassays for 30-day survival and growth of earthworms (E. foetida) and 5-day germination tests with lettuce seeds (L. sativa).

APPENDIX D

APPENDIX D

SUPPORTING ECOLOGICAL INFORMATION FOR LAKE FRETWELL RISK ASSESSMENT

APPENDIX D-1

APPENDIX D-1

SURFACE WATER/SEDIMENT SPREADSHEETS FOR LAKE FRETWELL

APPENDIX D-2

APPENDIX D-2

SURFACE WATER/SEDIMENT SPREADSHEETS FOR ROWELL CREEK UPSTREAM OF LAKE FRETWELL

APPENDIX D-3

APPENDIX D-3

SUMMARY OF RTVs

APPENDIX D-4

APPENDIX D-4

INGESTION TOXICITY INFORMATION

Appendix D-4
Ingestion Toxicity Information for Wildlife Receptors

Basewide Ecological Risk Assessment
Naval Air Station Cecil Field
Jacksonville, Florida

Chemical	Test Species	Test Type	Duration	Effect	Result (mg/kg BW/day)		Reference
					Lethal	Sublethal	
Volatiles							
Acetone	Rat	Oral	NR	LD_{50}	5,800		RTECS, 1994
	Rat	Single Oral Dose		LD_{50}	9,750		Sax, 1984
	Rat	Oral	NR	LOAEL for reproductive effects		273,000	RTECS, 1994
	Mouse	Oral	NR	LD_{50}	3,000		RTECS, 1994
	Rabbit	Oral	NR	LD_{50}	5,340		RTECS, 1994
Bromodichloromethane	Rat	Oral LD_{50}	1 dose	LD_{50}	470		ATSDR, 1988a
	Rat	Oral LD_{50}	1 dose	LD_{50}	943		ATSDR, 1988a
	Mouse	Oral LD_{50}	1 dose	LD_{50}	675		ATSDR, 1988a
	Rat	Oral (acute)	6-10 days of gestation	LOAEL for fetotoxicity		50	ATSDR, 1988a
Chloroform	Dog (Beagle)	Oral (chronic)	7.5 years	Liver cyst formation		12.9	IRIS, 1991
	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		RTECS, 1994
	Rabbit	Oral	NR	Reproductive effects		260	RTECS, 1994
Methylene chloride	Rat	Oral (chronic)	2 years	LOAEL for liver toxicity		52.6	IRIS, 1991
	Rat	Oral LD_{50}	NR	Mortality	1600		RTECS, 1994
	Dog	Oral LD_{50}	NR	Mortality	3000		RTECS, 1994
	Rat	Oral (subchronic)	3 months	NOAEL for mortality, blood chemistry, histopathology		125	USEPA, 1984a
	Rabbit	Single oral dose	1 dose	LD_{50}	1900		Sax, 1984

See notes at end of table.