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LETTER TRANSMITTING CHANGES TO FINAL RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION WORK PLAN ZONE J CNC CHARLESTON SC
11/21/1996
NAVFAC SOUTHERN

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**DEPARTMENT OF THE NAVY**

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
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5090/11
Code 1877
21 November 1996

Mr. G. Randall Thompson
Director, Division of Hazardous and Infectious Waste Management
Bureau of Solid and Hazardous Waste Management
South Carolina Department of Health and Environmental Control
2600 Bull Street
Columbia, SC 29201

Subj: ZONE J RCRA FACILITY INVESTIGATION WORKPLAN

Dear Mr. Thompson,

The purpose of this letter is to submit changes to the Zone J Final RCRA Facility Investigation Workplan for Naval Base Charleston. The Workplan is submitted to fulfill the requirements of condition IV.B.2 of the RCRA Part B permit issued to the Navy by the South Carolina Department of Health and Environmental Control and U.S. Environmental Protection Agency.

Comments made by the Department and the EPA on the initial submittal have been addressed and included in this submittal. The Response to Comments which is also included was reviewed with Department and EPA representatives in order to ensure the comments were adequately addressed. We request that the Department and the EPA review the page changes to the workplan and responses to comments. Please provide comment or approval as appropriate. If you should have any questions, please contact Brian Stockmaster or Matthew Hunt at (803) 820-7481 and (803) 820-5525 respectively.

Sincerely,

M. A. Hunt

M. A. HUNT
Environmental Engineer
Installation Restoration III

Encl: Zone J Final RFI Workplan, dated 20 November 1996
Copy to:
SCDHEC (Bergstrand, Tapia), USEPA (3) (Brittain)
CSO Naval Base Charleston (Camp), SPORTENVDETCHASN (Dearhart)

**RESPONSES TO NOVEMBER 4, 1996 SCDHEC COMMENTS ON THE SEPTEMBER 10, 1996 DRAFT OF THE RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION WORK PLAN FOR ZONE J**

With regards to the requested summary of 1991 analytical data obtained during a pre-dredge sediment sampling event, unfortunately it seems that no such data exist. The Charleston Division of the U.S. Army Corps of Engineers (the sponsoring agency) was contacted on several occasions to acquire these results and this rumored data is not in their files. The Navy regrets any confusion this may have caused.

The analytical results of the small scale sampling event in 1992 are also unavailable at this time. These samples, while helpful in a historic aspect, will likely not provide sufficient data to revise the proposed sampling effort in the Cooper River. It is expected that the proposed Zone L storm sewer outfall samples and the documents acquired to date (including the 1989 biota study and the 1994 - 1995 sediment sample results) will be adequate to portray possible potential origins and routes of contaminants entering the Cooper River.

# RESPONSES TO NOVEMBER 4, 1996 USEPA COMMENTS ON THE SEPTEMBER 10, 1996 DRAFT OF THE RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION WORK PLAN FOR ZONE J

## GENERAL COMMENTS

1. Response to USEPA Comments, Response 10. It says in part that:

> The Navy reiterates that some RCRA Permit requirements are not readily applicable to Zone J.
>
> EPA disagrees with this response and expects full compliance with the RCRA Permit.

**RESPONSE** **The Navy will comply with the requirements of the RCRA Permit.**

2. Response to USEPA Comments, Comment 10. While portions of the Zone J RFI Work Plan have been revised to take into consideration this former EPA comment, some sections have not been revised thus continuing to allude to the Zone J RFI effort as being primarily an ecological risk assessment for the entire Naval Base. These sections require revision. Some examples are cited below.

**RESPONSE** **Those portions of the work plan which over-emphasize the ecological aspects of the Zone J RFI will be reviewed and revised as needed.**

## SPECIFIC COMMENTS

1. Page 1-1, Section 1.0. The statement is made that:

> The scope of this work plan also includes the complete assessment of ecological risk posed by terrestrial sites determined to be potentially hazardous through other zone-specific investigations.

See General Comment 2 above. This should be revised to state clearly that each zone-specific investigation will be complete within itself including all necessary ecological risk assessment.

**RESPONSE** **This statement has been deleted.**

2. Page 1-8, Section 1.2. The statements are made that:

> The Zone J RFI will also ensure that each zone-specific AOC/SWMU investigation includes a complete and formal ecological risk assessment (ERA) following the strategies presented in Section 3, Volume III of the *Final Comprehensive RFI Work Plan*. Preliminary assessments of specific AECs may be conducted as part of a zone-specific investigation and, if necessary, completed during the Zone J RFI.

See General Comment 2 and Specific Comment 1 above.

**RESPONSE** **This statement has been deleted.**

3. Page 1-11, Section 1.2. The statement is made that:

> Not meeting the RCRA definition of a "facility" and lacking the conditions typically found at terrestrial sites, the water bodies will be assessed through the evaluation of the potential receptor(s) and/or transport pathways rather than the potential contaminant source(s).

a. Conversely, EPA is interested in the potential contaminant source(s), the transport pathways, and the impact of that contamination on potential receptor(s), in that order.

b. In the other zone-specific RFI Work Plans, a number of specific sites have been identified where wastes were discharged directly into Zone J. To a limited extent, these sites will be investigated in conjunction with those other Zone investigations. Further, a number of sites have been identified where surface water and/or groundwater might discharge wastes directly into the water bodies. If necessary, EPA is prepared to designate every one of these sites as a SWMU, to require the development of a RCRA Facility Assessment (RFA), and to require a RFI for each site. However, if we can accomplish the same result without this extra time and expense, EPA favors conducting these investigations in conjunction with the Zone J RFI. For each of these sites, EPA wants to know the same information as for a land-based site. Specifically:

   1) What is the horizontal and vertical extent of contamination?

   2) What is the nature and concentration of the contamination?

   3) What is the fate and transport of the contamination?

   4) What is the risk to human health as a result of the contamination?

5) What is the risk to the environment as a result of the contamination?

As with the land-based sites, grid samples and background samples are required. EPA expects the same for the Zone J investigation.

c. See General Comments 1 and 2, and Specific Comment 1 above.

**RESPONSE** **Sections 1.2 and 1.4 of the work plan have been revised to more clearly present the specific coordination between the open water investigations proposed in Zone J and other zone-specific investigations (especially Zones L, E, and A) which address inland contaminant sources and pathways potentially impacting Zone J water bodies and associated receptors.**

4. Pages 1-11 - 12, Section 1.2. The statements are made that:

To support the fast-track objectives, the submittal of each zone-specific RFI Report will not be suspended until the basewide risk assessment is completed. Instead, each RFI report will present, at a minimum, a summary of preliminary risk assessment findings.

See General Comment 2 and Specific Comment 1 above.

**RESPONSE** **This statement has been deleted.**

5. Page 4-51, Section 4.2.5. The statements are made that:

The previous Zone H and Zone I samples were not specifically designed to assess ecological risk. They have, however, provided valuable information for the Zone J Phase II contaminant assessment of AEC V-1.

See General Comment 2 and Specific Comment 1 above.

**RESPONSE** **This statement has been deleted.**

6. Page 4-53, Section 4.2.5. The statements are made that:

The previous Zone H samples were not specifically designed to assess ecological risk to AEC V-2. They do, however, provide valuable information for the Zone J Phase II contaminant assessment.

See General Comment 2 and Specific Comment 1 above.

**RESPONSE** **This statement has been deleted.**

7. Page 4.84, Section 4.2.5. The statements are made that:

> Furthermore, it has been reported that the USACOE is considering acquiring Clouter Island for continued use as a land-based dredge spoil area. Until this possible transfer is substantiated, no action by the Navy is anticipated.

Regardless of the future owner and future use of Clouter Island, EPA expects the Navy to complete the RFI at Clouter Island as planned.

**RESPONSE** **This statement has been deleted.**

## ADDITIONAL REVISIONS TO ZONE J WORK PLAN

Subsequent to the October 30, 1996 scoping meeting held at the USEPA offices in Atlanta, GA and attended by SOUTHDIV, USEPA, and SCDHEC representatives and consensus made there, certain ecological aspects of the Zone J RFI Work Plan required editorial revisions which were not identified by these comments. These changes and those specified in the most recent agency comments are highlighted for easy identification.

With regards to Ecological Risk Assessments, Sections 1, 3, and 4 of the Zone J RFI Work Plan have been revised to reflect the shift in responsibility of ERA completion to each zone-specific RFIs. This may include the Phase II Contaminant Assessment and, if necessary, Phase III Problem Formulation/Conceptual Model. Certain tentative sampling locations at NAVBASE areas of ecological concern (AECs) presented in this and previous drafts of the Zone J RFI Work Plan may be deemed unnecessary if, during zone-specific RFIs, potential risk to the AEC is negligible.

## 1.0 INTRODUCTION

As part of the U.S. Navy Comprehensive Long-term Environmental Action Navy program, the following Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Work Plan has been prepared to address potential impacts from base activities to the water bodies and wetlands surrounding Naval Base Charleston (NAVBASE) in Charleston, South Carolina. Ecological and human health risks to Zone J receptors from NAVBASE contaminants will also be assessed during this RFI. In addition to the assessment of the water bodies, site information has already been gathered as part of the Zone J preliminary evaluation of natural habitats associated with terrestrial sites associated with other zone-specific RFIs. These basewide habitat evaluations provide each RFI with descriptions and potential receptor summaries to enhance respective investigations. This work plan is also intended to be used in conjunction with the *Comprehensive RFI Work Plan* prepared for NAVBASE.

As an initial phase of the Zone J RFI, all undisturbed or undeveloped areas at NAVBASE which may require further assessment were identified. These areas were characterized through a review of pertinent documents and a basewide ecological field survey conducted by EnSafe/Allen & Hoshall (E/A&H) from October 1994 to February 1995. Because of the size of the area to be surveyed, eight ecological study areas (ESAs) were created. NAVBASE proper was separated into five contiguous ESAs, each categorized based on similar land type and usage; the remaining three ESAs were assigned to the water bodies and noncontiguous property (Clouter Island; see Figure 1-1).

**Ecological Study Areas**

| | | |
|---|---|---|
| ESA I | — | Defense Reutilization and Marketing Office (DRMO)/Warehouse Area |
| ESA II | — | Noisette Creek/Golf Course/Officer Housing |
| ESA III | — | Northern Industrial Area |
| ESA IV | — | Southern Industrial Area |
| ESA V | — | Southern End of Base |
| ESA VI | — | Cooper River |
| ESA VII | — | Shipyard Creek |
| ESA VIII | — | Clouter Island Areas of Concern |

The basewide ecological survey was also intended to provide data which partially satisfied the habitat evaluation objectives of subsequent zone-specific Phase I Preliminary Site Assessments (PSA) as described in the *Final Comprehensive Baseline Risk Assessment Work Plan* (E/A&H 1994). A complete PSA was also performed at specific areas within each ESA determined to be of ecological significance (obvious wetlands, woodlands, etc.). Ecological data obtained from the basewide survey and Phase I PSA have been incorporated into the proposed investigative strategies presented in Section 3 and were used for the selection of tentative sampling locations proposed in each zone-specific investigation. The specific areas of ecological concern (AECs) observed during each ESA survey are highlighted in Figure 1-2 (Sheets 1 and 2). The boundary of each RFI investigative zone (Zones A through K) is represented by a bold, dashed line.

## 1.1 Environmental Setting

### Physiography

NAVBASE is in the lower South Carolina Coastal Plain Physiographic Province, on the Cooper River side of the Charleston Peninsula formed by the confluence of the Cooper and Ashley rivers. Topography in the area is typical of the South Carolina lower coastal plain, having low-relief plains broken only by the meandering courses of sluggish streams and rivers which flow toward the coast past occasional marine terrace escarpments.

The water bodies included in the Zone J RFI are a portion of the Cooper River (ESA VI), which forms the eastern border of NAVBASE; Noisette Creek, a small tributary to the Cooper River in the northern portion of the base (ESA II); and Shipyard Creek (ESA VII), a drainage creek southwest of NAVBASE. Also included are the woodlands and wetland habitats surrounding the Zone K areas of concern on the southwest shoreline of Clouter Island (ESA VIII).

Figure 1-1 Ecological Study Area Location Map

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Figure 1-2 Areas of Ecological Concern (Sheets 1 and 2)

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### Geologic and Hydrogeologic Information

The local and regional geologic/hydrogeologic characteristics are described in Volume II, Sections 1.2 through 1.5 of the *Comprehensive RFI Work Plan*. The geology of the Charleston area is typical of the southern Atlantic Coastal Plain. Of particular relevance is the anthropogenic origin of soil throughout the base. NAVBASE, like most of the Charleston peninsula bordering the Ashley, Cooper, and Wando rivers, was originally low-lying marsh. By 1901, when the Navy took over the property, most of the northern half of the present property had been filled. The southern end of the base has since been filled with a wide variety of materials, with the majority of the filling activity taking place during World War II. Most of these filled areas have since been developed for other uses. Figure 1-3 indicates the extent of modern fill activities.

Shallow groundwater beneath NAVBASE flows north-northeast into the Cooper River and south-southeast into Shipyard Creek due to the gently sloping topography away from the center of NAVBASE. The water table is within 3 to 7 feet of the ground surface. The shallow groundwater table slowly but continually discharges to the Cooper River and Shipyard Creek and, to a lesser extent, to Noisette Creek.

### Climatology

The climate of NAVBASE is described in Volume II, Section 1.6 of the *Comprehensive RFI Work Plan*.

## 1.2 Investigative Rationale

The investigative rationale for the Zone J RFI has been developed to meet objectives consistent with the overall investigative strategy for NAVBASE Charleston as presented in Volume I of the *Comprehensive RFI Work Plan*, which emphasizes the "fast-track cleanup" program. The foremost objective is to assess the impact of past and present NAVBASE activities upon the surrounding water bodies by the defining the nature and extent of constituents of potential

concern (COPCs) attributable to NAVBASE and differentiating them from constituents associated with possible off site sources. The nature and extent of contamination is defined herein as the horizontal and vertical area in which concentrations of COPCs in the investigated media are above either PRGs or background concentrations, whichever is appropriate. For those contaminants linked to NAVBASE sources, the data collected will also be used to evaluate fate and transport, human health, and ecological risks associated with them. Ultimately the data collected during the RFI may be used in support of a corrective measures study (CMS) if the findings of the RFI indicate a CMS is needed.

The Zone J RFI Work Plan was scoped based on available data compiled from a number of sources including other Zone specific RFIs either recently completed or presently underway at NAVBASE. As a result, the site specific sampling strategies outlined in Section 3.0 were designed to be as complete as possible based on the best available information at this time. If the initially proposed sampling efforts at an AEC do not achieve the objectives of the RFI, the respective investigation will continue until sufficient data are obtained to achieve the stated goals of the RFI.

The Zone J RFI will implement a phased approach to data collection that will ultimately be used to determine if cause-effect relationships exist between contaminant concentrations at AOCs/SWMUs and the observed impacts to potential receptors in the NAVBASE water bodies. The few AOCs specific to Zone J are offshore in the Cooper River — AOCs 500, 501, and 502 (underwater unexploded ordnance [UXO] sites) and AOCs 691 and 692 (the Cooper River waterfront itself). The UXO sites will be investigated by Explosive Ordnance Division subcontractor. The waterfront sites will be incorporated into the overall Cooper River assessment. It is important to note that with the exception of the sites listed above, the progress of the Zone J investigation will largely depend on the availability of AOC/SWMU specific contaminant information obtained during related zone investigations such as the Zone L assessment of the numerous outfalls along the naval base's shoreline. The assessment of the

Figure 1-3 Fill Activity Map

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Cooper River and Shipyard Creek will coordinate closely with the other zone specific RFIs (especially the more industrialized Zones L, E, and A) which are also investigating the inland portions and outfalls of many of these pathways. If, during an inland zone's preliminary sampling of a selected outfall or other pathway, it is determined that a contaminant source and pathway exists, Zone J will address the associated fate and transport, nature and extent, and risks to human health and the environment. The collaborative approach proposed for the Zone J investigation is outlined in Section 2. To determine whether additional sampling not specified in this work plan is needed, data collected under this plan will be evaluated regarding potential human health and ecological impacts expressed as preliminary remedial goals (PRGs) and technical requirements for a CMS. For some chemicals, additional information regarding background concentrations will be required, necessitating onsite and offsite data collection. Background, migration pathways, human and ecological receptors, and PRGs are discussed in Section 1, Volume III of the *Final Comprehensive RFI Work Plan*. Sampling will continue until the extent of any contamination associated or potentially associated with past and present NAVBASE Area of Concern/Solid Waste Management Unit (AOC/SWMU) operations is determined. Background concentrations for inorganics will be determined using the "2X rule." Using this rule, background will be regarded as concentrations less than or equal to the mean concentration of the designated background sampling locations multiplied by two. While this simple rule is considered adequate for screening purposes, anticipated complexities will require a more refined calculation of background concentrations for remedial decision-making.

The proposed schedule for conducting the Zone J investigation is included in the *Corrective Action Management Plan* prepared for the NAVBASE RFI. Due to its comprehensive nature and need to incorporate all relevant information into the RFI report, the Zone J RFI must parallel other zone investigations. Scheduling of activities during the Zone J investigation will be closely coordinated with U.S. Environmental Protection Agency (USEPA) Region IV, the South Carolina Department of Health and Environmental Control (SCDHEC), and natural resource trustees.

As the Comprehensive RFI requires, an RFI/Baseline Risk Assessment (BRA) report will be generated at the conclusion of each zone investigation. Final RFI and Final BRA reports will address NAVBASE as a single entity once all zone investigations are completed.

## 1.3 Human Health Assessment

Each upland zone is responsible for addressing human health issues specific to AOCs and SWMUs within that zone. Likewise, Zone J RFI will address human health issues, which are primarily related to the open water bodies (i.e., exposure to affected surface water, sediment, and biota). Risks to human health associated with these media, summarized in Section 2.1 of this plan, will be assessed as outlined in Section 2 of the *Comprehensive Baseline Risk Assessment* (E/A&H 1994).

## 1.4 Other Relevant Investigations

Because the Zone J RFI is part of a larger investigative strategy, results from other investigations may influence the scope of the proposed work for Zone J since some pathways identified for investigation in Volume III of the *Comprehensive RFI Work Plan* are relevant to Zone J, but are being investigated initially in other zones. Table 1-1 lists a general summary of sites being investigated in other zones which may be potential sources of contamination for the Zone J water bodies. Subsequent sections of this *Zone J RFI Work Plan* outline the data collection process for the RFI of the water bodies and also identifies those aspects of other zone-specific investigations of inland sites (i.e., outfall samples) which may expand the scope of the Zone J RFI. The investigations of other nearshore zones are expected to provide particularly valuable information regarding potential sources and related impacts to the Zone J water bodies. For example, results of the grid based sediment sampling conducted as part of Zone J will be compared to results of sediment sampling conducted at the mouths of the drydocks as part of Zone E. If the preliminary samples collected for Zone E indicate the presence of constituents that are readily discernable from constituents in the Zone J Cooper River grid locations the data will serve as an indicator that the drydocks are a likely source of contaminants to the Cooper

River. Additional sampling may also be required to delineate the nature and extent of contamination released from the drydocks. If the NAVBASE project team determines additional sampling is required in the Cooper River, it will be completed under the scope of Zone J. Dredge spoil materials will also be characterized as part of several zone investigations to establish a baseline data set representative of dredge materials across all historic dredge disposal areas at NAVBASE (Figure 1-3). Offsite investigation to determine reference areas will be conducted as part of the both the Comprehensive and Zone J RFI. In summary, results from other zone-specific RFIs will be necessary to fully understand the significance of the results of the proposed Zone J investigation.

**Table 1-1**
**Other Relevant Investigations**

| Zone J Water Body | Potentially Impacted by | Potential Outfalls and Other Contaminant Pathways to Water Body |
|---|---|---|
| **Cooper River** | Zone A | Storm sewer outfalls, runoff from golf course, groundwater, runoff from SWMU 2. |
| | Zone B | Storm sewer outfalls, runoff from golf course, groundwater. |
| | Zone E | Discharge from Drydocks, Storm sewer/Industrial wastewater Outfalls, Runoff from SWMU 54. |
| | Zone G | Storm sewer outfalls. |
| | Zone I | Dewatering outfall from Dredge Material Area, Storm sewer outfalls. |
| | Zone K | Dewatering outfall from Clouter Island Dredge Material Area, Coastal and offshore AOCs. |
| | Zone L | Sanitary and Storm Sewer Outfalls. |
| **Shipyard Creek** | Zone G | Storm sewer outfalls. |
| | Zone H | Runoff from SWMU 9 to headwaters of Shipyard Creek, groundwater. |
| | Zone I | Dewatering outfall from Dredge Material Area, Storm sewer outfalls. |
| **Noisette Creek** | Zone A | Storm sewer outfalls, runoff from golf course, groundwater. |
| | Zone B | Storm sewer outfalls, runoff from golf course, groundwater. |
| | Zone C | Runoff from the former coal pile. |

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## 3.0 AEC-SPECIFIC INVESTIGATIVE APPROACH

The ecological assessments of specific AECs have been divided into three phases as described in the *Final Comprehensive Baseline Risk Assessment Work Plan for Naval Base Charleston* (E/A&H 1994). Each phase is intended to yield specific environmental data about the AECs through source, pathway, and receptor identification. The first phase has been conducted for all identified AECs as part of the Zone J work plan development and ongoing RFIs in the remaining zones. At the time of preparation of this document, the Phase II portion of the assessments were completed for Zones A, B, C, H, and I. A brief description of what is entailed in each phase of the assessment is included below.

Phase I consists of a Preliminary Site Assessment (PSA) of each AEC to determine general site information and, if necessary, to develop a sampling strategy for Phase II of the investigation, which will involve assessing contamination at each AEC through chemical sampling. Problem formulation and model development will occur in Phase III to assess risk to potential receptors. Information from all phases, as appropriate, will be incorporated into a risk calculation to measure or estimate current and future effects. Figure 3-1 charts the framework for the BRA process.

Phase II Contamination Assessment sampling strategies of AECs will be guided by Phase I PSA data and by the analytical data from relevant AOC/SWMU investigations, whenever possible. Before AEC-specific Phase I investigations can be properly executed, a broad investigative approach (i.e., ESA designations, basewide habitat evaluations) was necessary to identify undeveloped and/or undisturbed portions of NAVBASE. This approach is summarized below.

To obtain basic ecological information for NAVBASE, each ESA was evaluated by reviewing pertinent ecological data such as those presented in the *Final Environmental Impact Statement for Disposal and Reuse of the Charleston Naval Base* (FEIS; E&E 1995). Ecological checklists for habitat types and potential receptors at NAVBASE were also completed for each terrestrial

ESA during the basewide habitat survey and are presented in Appendix A. In addition to the open water bodies, these areas of ecological concern (see Figure 1-2) will be the focus of Phases II and III the RFI process and will be guided by other relevant zone investigations and AEC-specific details obtained from Phase I, including habitat types, location of outfalls, and potential receptors.

The aquatic ESAs were evaluated through field observations and a review of existing and available information from previous assessments. Except for the Charleston Harbor Study, these studies included data from only a few isolated sampling and monitoring stations within the Cooper River and Shipyard Creek. Results from these studies are summarized in Section 4.

Phase II Contaminant Assessment sampling locations are designed to determine if an identified AEC is potentially impacted by an upgradient AOC/SWMU. If the resulting analytical data are sufficient to reasonably and quantitatively determine an AEC is impacted, the Phase II investigation will be complete. The locations presented in this plan are considered tentative and, if appropriate, may be implemented in the relevant zone-specific investigation.

## 3.1 Phase I — Preliminary Site Assessment

The PSA of each AEC was completed in April 1995 to provide preliminary descriptions of the undeveloped and undisturbed areas at NAVBASE and allow zone-specific investigations to incorporate this information. Each PSA began with a thorough review of all relevant site data, including information obtained from the ESA surveys and checklists, previous investigations, topographic maps, aerial photographs, and any other information pertinent for baseline assessment of impacts to the biological resources within the area. Data were reviewed as made available from RFIs throughout NAVBASE.

Figure 3-1 Environmental Risk Assessment Flowchart

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Specific habitat descriptions for each AEC were determined to supplement the data obtained during the ESA habitat evaluations, along with a cursory evaluation of potential biological receptors typically found in such habitats. A biological inventory was performed at each AEC to obtain information on confirmed and/or suspected biological receptors, including flora and fauna. The PSA noted outfall locations and other potential contaminant migration and exposure routes to the AEC. These and other physical AEC data were used to select tentative, non-site-specific sampling locations. These data were recorded on AEC-specific checklists presented in Appendix B.

Numerous recent basewide studies, interviews, and regional ecological assessments at NAVBASE are compiled in the FEIS (E&E 1995), which summarizes ecological data and includes land use, terrestrial and aquatic environments, threatened and endangered species, wetland areas, floodplains, and environmental aspects such as storage tanks, outfalls, and adjacent properties. To reduce the duplication of effort, the FEIS was a primary reference for the initial ESA site visits.

**Habitat Evaluation**

After relevant data were reviewed, habitats were evaluated to assess current conditions of each AEC. Ecologists experienced in assessment procedures and familiar with the flora and fauna of the Charleston area visited each AEC. For terrestrial areas and free-standing wetlands, the ecologists evaluated habitat, identified common plant communities and sensitive resources, and assessed the probability of threatened or endangered species within the AEC. This evaluation also involved field determinations for wetland presence, critical and unique habitats, and any other special habitat that might be indicated (see Section 4.1). Data obtained from a prior review of state and federal documents such as National Wetland Inventory Maps, National Forest List, South Carolina State Parks List, and South Carolina Critical Habitats were used to enhance the field effort.

During the PSA for the open-water ESAs (ESAs VI and VII) and all potentially impacted riparian wetlands, the habitat was evaluated primarily through the review of existing habitat data and a site visit via motor boat or canoe. Contamination effects at each AEC were visually assessed. Anomalous features such as stressed or absent vegetation, unusual odors, colors, or stains were also recorded on the appropriate checklist.

**Biological Inventory**

Information on the suspected biological receptors at NAVBASE reviewed during the basewide habitat evaluation and PSAs is summarized in Section 4.1. These biological data were obtained from regional, state, and federal agency information such as Natural Areas Inventory, Threatened and Endangered Species List, and other applicable studies for NAVBASE. State and federal agency personnel have also been interviewed for current status of suspected biological receptors. From this information and field observations, a list of potential biological receptors at each AEC has been produced.

Because there is no standard method for conducting the PSA, the ecologists used the general biological survey methods outlined in Section 8.3 of *Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference* (USEPA/600/3-89/013). Specific approaches varied based on habitat type, size, and diversity.

**Migration Routes**

Obvious contaminant migration routes from AOCs/SWMUs to nearby AECs were identified whenever possible to determine if ecological components may be at risk. Pathway identification will be further addressed in the zone-specific RFIs. Topographic features for each contaminated site were reviewed, along with identifying other physical conduits such as channels, drainage ditches, catch basins, and streams. In some instances, groundwater may constitute the primary migration pathway for contaminant exposure to natural resources remote from a site. Much of this information was obtained through review of documents, U.S. Geological Survey (USGS)

topographic maps, site visits, and the hydrogeological portion of the completed RFI zone investigations.

**Exposure Routes**

Based on information derived from the PSA and migration route determination, exposure route scenarios will be developed whenever possible to indicate potential contamination pathways to suspected biological receptors. These exposure scenarios are working hypotheses that provide a starting point for developing the subsequent problem formulation phase.

**Phase I Conclusions**

After Phase I PSA data such as the identification of nearby AOC/SWMUs, outfalls, wetlands, and general environmental conditions were compiled and evaluated, a tentative Phase II sampling strategy was developed. Phase I data are presented in Section 4.2 along with a summary risk determination and maps indicating the locations of habitats, plant communities, and previous sampling locations at relevant AOCs/SWMUs.

For AECs which were sufficiently characterized during previous zone-specific RFI investigations, this risk prediction is a subjective analysis designed as a "go-stop" mechanism for the subsequent Phase II sampling. However, at AECs without adequate analytical data, final Phase II recommendations will be based on both the PSA and risk assessments conducted during the zone-specific RFIs.

**Phase I Sampling Strategy**

For terrestrial sites such as woodlands and open fields, soil sampling locations will be determined based on observed migration and exposure routes. Sampling locations at aquatic sites will be directed at areas where contaminants are determined most likely to accumulate. These will be based on surface features, drainage patterns, and, if necessary, the distribution of fine-grained sediment and/or organic content. If, at a later point in the investigation, it is

determined that additional areas need to be addressed, based on either groundwater flow or other factors, these areas will also be sampled.

## 3.2 Phase II — Contaminant Assessment

A Phase II Contaminant Assessment will be required only at AECs which are shown to be impacted or potentially impacted from an AOC or SWMU and where human or ecological receptors exist or are indicated. Phase II sampling locations at the NAVBASE AECs will be determined from relevant AOC/SWMU investigations and the results of the Phase I investigation. All Phase II soil, sediment, groundwater, and surface water sampling will be conducted in accordance with protocols outlined in the *Comprehensive Sampling and Analysis Plan* for NAVBASE. In soil, surface (0 to 1 foot below ground surface [bgs]) concentrations will be used for risk evaluations. Physical soil parameters (pH, porosity, grain size, organic content, etc.) that may alter contaminant bioavailability will be measured in conjunction with chemical analyses. Sampling densities will be based on location-specific information and data needs. Section 5, Sampling Procedures, presents general sampling concerns for each phase.

### Phase II Sampling Procedure

All sampling will adhere to the NAVBASE Charleston *Comprehensive RFI Work Plan.* The nature of any proposed ecological sampling may, however, require more effective methods than those described in the *Comprehensive Sampling and Analysis Plan* (CSAP) or other zone work plans. Any necessary biota sampling, for example, will require special collection equipment and techniques. Also, three offshore UXO sites will require special procedures, as stated below. The most appropriate procedures, once selected, will be submitted for approval and included as a technical memorandum and/or a modification to the *Comprehensive RFI Work Plan.*

***Soil/Sediment Samples*** — Terrestrial samples and samples in water shallower than wading depth will be collected using a stainless-steel hand auger. Sediment samples from deeper locations will be collected using a Ponar grab sampler or similar device.

***Grid Samples*** — For the open water sites, grid sampling will be conducted. The distances between grid and transect lines will vary depending on the size of the area to be sampled and the degree of precision desired. For grid sampling in larger wetlands, each established grid node will be assigned a coordinate number. If an adequate grid has not been established for sampling a particular area, one will be created.

**Proposed Analytical Parameters**

All surface water, sediment and soil samples collected in Zone J AECs will be analyzed using the following USEPA, SW-846, Third Edition method parameters:

| | |
|---|---|
| VOCs | USEPA 8240 |
| SVOCs | USEPA 8270 |
| Pesticides/PCBs | USEPA 8080 |
| Cyanide | USEPA 9010 |
| Metals | USEPA 6010, 7060 (As), 7412 (Pb), 7470 (Hg), 7740 (Se), and 7841 (Tl) |

Sediment and soil samples also will be analyzed for Total Organic Carbon (TOC; USEPA 415.1, 415.2) and organotins (laboratory standard operating procedure).

A portion of the samples will be duplicated and analyzed for Appendix IX parameters, such as hexavalent chromium, dioxins, herbicides, organophosphate pesticides, and more comprehensive lists of VOCs and SVOCs. Any deviations from the above listed parameters will be discussed and justified in the appropriate AEC sampling plan.

In aqueous environments, biased surface water and sediment samples will be collected in areas suspected to exhibit significant contaminant concentrations. These areas will be identified using sediment distribution and dredging maps provided by the U.S. Army Corps of Engineers (USACOE) or other data developed during Phase I. Sediment samples will be collected to at least 6 inches below the substrate surface. Suspected and confirmed source locations, along with

suspected risk to biological receptors in the area, will be used to determine whether to sample these media. Sampling methods will follow protocols suggested in USEPA's *Sampling Protocols for Collecting Surface Waters, Bed Sediments, Bivalves, and Fish for Priority Pollution Analysis* (Versar, Inc., 1981) and USEPA's *Ecological Assessment of Hazardous Waste Site: A Field and Laboratory Reference Document* (EPA/600/3-89/013). As with soil, physicochemical data on water and sediment will be obtained for use in bioavailability predictions. For water, data will include temperature, salinity, alkalinity, dissolved oxygen, pH, conductivity, nutrients, total suspended solids, biochemical oxygen demand, turbidity, and chemical oxygen demand. For sediments, data will include pH, Eh, TOC, CEC, grain size, and density. Once suitable reference locations are identified, background concentrations will be obtained and supplemented with literature information whenever possible.

After baseline data have been collected on contaminants, the general characteristics of the stressor chemicals will be studied to provide specific data on intensity, chemical alteration, duration, and secondary effects. Any site-specific information on soil and water chemistry obtained from the zone-specific RFIs will also aid in assessing the potential effects of the stressor.

**Preliminary Risk Characterization**

After completing the contamination assessment at each AEC, a Preliminary Risk Characterization (PRC) will be formulated. This characterization will assimilate data obtained during the Phase I PSA and Phase II Contaminant Assessment to predict effects to critical biological receptors, based on conservative contamination estimates. These predictions-of-effects will be based on comparison of observed contaminant values to regulatory guidance or TBC values. TBC values include USEPA Ambient Water Quality Criteria, USEPA Region IV Sediment and Surface Water Screening Values, and Risk-Based Concentrations (RBCs) in addition to referenced effects concentrations of the toxicological characteristics for suspected contaminants. To help determine the overall risk to potential human and ecological receptors, the contaminant concentrations

determined from other zone-specific AOC/SWMU investigations will also be assessed. If an AOC/SWMU-specific investigation indicates contamination below applicable regulatory screening values, the scope of the subsequent Zone J investigation may be reduced (fewer samples). The effects of physical disruptions (dredging) will also influence the breadth of the investigation. Receptor-specific physiological traits and media transport mechanisms that may alter toxic effects may also be used to formulate effects scenarios. Because effects to receptors may have already occurred at NAVBASE, a more in-depth analysis of historical biological data may be required to verify predictions. For instance, sediment-borne contaminants may have, over time, already altered fishery resources in the Cooper River. If, after careful consideration, such a cause-effect relationship appears to exist, historical biological data (recreational catch statistics, etc.) may aid in verifying this prediction.

After completing the PRC, a decision will be made on the need for further ecological work. Such decisions will be critical in the ERA process and, therefore, the PSA and PRC components are considered extremely important elements.

### 3.3 Phase III — Problem Formulation/Conceptual Model

The problem formulation stage is the most critical element of the ERA process. In this stage, data collected during the PSA and PRC will be analyzed to determine if assessment endpoints can be identified. Assessment endpoints, which are the environmental components to be protected at each AEC, will be chosen based on the PRC. Ecological endpoints typically include changes to local fish populations, ecosystem alterations, or other ecological effects. Assessment endpoints for human health include excess cancer incidence and other toxic effects possibly caused by contaminants proven to be associated at NAVBASE. Hypotheses will be critically reviewed to determine if studies or data produced can support risk-management decisions.

In conjunction with problem formulation, a conceptual model will be developed to select measurement endpoints that can be used to quantitatively express the effects of the contaminant

hazard. These measurement endpoints will include environmental characteristics directly related to the assessment endpoint chosen. Toxicity tests, community indices, or tissue burden studies may be selected as measurement endpoints (see Appendices C, D, and E of the *Comprehensive Baseline Risk Assessment Work Plan,* [E/A&H 1994] for descriptions of these measurement endpoints). The model will include the methods (sampling plan) needed to collect the information necessary to test the model and address uncertainty issues. At this stage, a decision will again be made on whether assessment endpoints are appropriate and whether the ERA process should continue. Appropriate agency consultation during this problem development and modeling phase will ensure that selected objectives are applicable and relevant.

**Site Assessment**

After formulating a reasonable conceptual model, a site will be assessed to determine the practicality of testing the hypothesis. Phase II data collected on contaminant distributions and biological receptor availability will be used to propose sampling methods for the conceptual model. The overall feasibility of obtaining necessary model components will be the site assessment's goal. A decision will be made as to the model's applicability based on field observations.

**Site Investigation**

The site investigation will involve all remaining field sampling, in-situ monitoring, and measurable endpoint data collection. All work will follow the conceptual model design to test the formulated hypothesis.

**Risk Characterization**

After completing the site investigation, all data will be interpreted to determine the cumulative risk to receptors based on contamination found. Both quantitative and qualitative information derived during the AEC investigation will be used to determine a weight-of-evidence conclusion.

Important issues that will be addressed include the assessment of exposure versus the observed or predicted environmental effects and their type, extent, and severity. Risks and uncertainties will also be summarized and their apparent significance interpreted.

**Reference Area Identification**

An essential part of the ERA will be identifying probable reference areas. These reference areas will be as geographically close to the site as possible, with similar habitat, topography, geology, and hydrology. Selected reference areas will have no apparent impacts from known site source contamination, based on survey and historical information.

Identifying suitable reference areas near the NAVBASE AECs has historically been a challenge due to the heavily industrialized surroundings. Although this condition has delayed the selection of appropriate Zone J reference areas, it is suspected that suitable reference areas may be found in the wetland and open water habitats of the Ashley or Wando rivers.

**Wetland Procedures**

If a wetland requires delineation for remedial or other purposes, the boundaries will be determined using methods described in the USACOE 1987 *Wetland Delineation Manual* (also refer to Appendix A of the *Comprehensive Baseline Risk Assessment Work Plan*).

**UXO Procedures (AOCs 500, 501, and 502)**

Due to the special nature of these sites, an Explosive Ordnance Disposal (EOD) subcontractor will be selected to conduct these investigations. Upon selection, the EOD subcontractor will be tasked to prepare an addendum to the work plan describing the specific techniques that will be used to locate the ordnance. Sediment and surface water samples will be collected at these sites after the ordnance is located and safely removed or detonated in place. At that time, samples shall be collected relative to the site of the ordnance recovery/detonation and analyzed for

constituents associated with the specific type of weapon. If the ordnance cannot be located, confirmation sampling covering a broader, more general area may still be warranted.

# 4.0 EVALUATION OF NAVBASE HABITATS

## 4.1 Overview of Ecological Components

The Charleston Naval Base consists of approximately 1,575 acres of moderately to heavily developed coastline with 614 buildings totaling 7,965,505 square feet. Features on the base include: approximately 2.3 million square feet of industrial space; 1.8 million square feet of warehouse space; 2.2 million square feet of administrative space; 86 residences; 19 residential barracks; 152 marina slips; 23 piers; five drydocks; and recreational facilities (FEIS 1995). The majority of NAVBASE is characterized as disturbed material (USGS 1993), consisting primarily of dredged fill material and material used in the upkeep of NAVBASE's gravel, asphalt, and concrete parking areas, buildings, laydown yards, and improved roads.

To reduce duplication of effort, the general ecological information presented in this section was supplemented primarily from the Environmental Impact Statement (Pre-Final) and verified in the field during E/A&H's ESA habitat evaluations whenever possible.

***Vegetation*** — The extensive development and anthropogenic disturbances that have occurred at NAVBASE have greatly influenced the naturally occurring vegetation, most evident in the limited diversity. Some areas, such as the shipyard, contain very little vegetation of any sort. Only the southern portion of NAVBASE is dominated by native vegetation, much of which is associated with Shipyard Creek and the dredge disposal area. The ESA/AEC descriptions further detail vegetation observed in each area.

***Terrestrial Wildlife*** — The various types of habitat present at NAVBASE, including residential, woodland, and adjacent coastal areas, support diverse mammalian, herpetilian, and avian wildlife populations. With the relative isolation of portions of NAVBASE and the abundant coastal habitat, the greatest diversity of wildlife is found in avian fauna.

Because of the relatively isolated nature of NAVBASE (i.e., extensive development to the west and the Cooper River to the east), the mammals onsite are predominantly smaller species. The largest verified mammals include the raccoon (*Procyon lotor*) and opossum (*Didelphis virginiana*), although white-tailed deer (*Odocoileus virginianus*) and the gray fox (*Urocyon cinereoargenteus*) may be present onsite. Gray and fox squirrels (*Sciurus carolinensis* and *S. niger*), eastern cottontail and marsh rabbits (*Silvilagus floridanus* and *S. palustris*), golden mouse (*Ochrotomys nuttalli*), and other small rodent species may also be present.

Various reptiles and amphibians are also expected to occur onsite. Species may include the northern diamondback terrapin (*Malaclemy terrapin terrapin*), green anole (*Anolis carolinensis*), broad-headed skink (*Eumeces laticeps*), eastern garter snake (*Thamnophis sirtalis*), and southern leopard frog (*Rana utricularia*).

Numerous avian species use NAVBASE and surrounding areas, including species commonly occurring in developed areas, in open field and edge communities, and along coastal areas. Extensive coastal habitat near the site is available for use by a multitude of transient avian species in addition to the resident species. Species typical of developed/residential areas include the American robin (*Turdus migratorius*), northern cardinal (*Cardinalis cardinalis*), purple finch (*Carpadacus purpureus*), fish crow (*Corvus ossifragus*), European starling (*Sturnus vulgaris*), and a variety of gulls (*Larus* spp.). Open fields and edge communities will generally support higher concentrations and diversity of species, including Carolina chickadee (*Parus carolinensis*), northern junco (*Junco hyemalis*), eastern kingbird (*Tyrannus tyrannus*), eastern meadowlark (*Sturnella magna*), mockingbird (*Mimis polyglottis*), cedar waxwing (*Bombycilla cedrorum*), and barn swallow (*Hirundo rustica*). Because of minimal woodland habitat, few interior forest avian species are expected to inhabit NAVBASE, except during seasonal migrations. Raptors including the red-tailed hawk (*Buteo jamaicensis*) and the American kestrel (*Falco sparverius*) may also use the area. Coastal tidal cordgrass wetlands are typically used by the clapper rail

(*Rallus longirostris*), boat-tailed grackle (*Quiscalus major*), and the red-winged blackbird (*Agelaius phoeniceus*). Tidal mudflats are used by a multitude of wading birds including the larger egrets, herons, and bitterns (Family *Ardeadae*) and the smaller plovers (*Chardrius* spp.), curlews (*Numenius* spp.), and sandpipers (*Tringa* spp. and *Calidris* spp.). The open water of the Cooper River is used by a variety of gulls and terns (*Sterna* spp.), as well as pelicans (*Pelecanus occidentalis*) and osprey (*Pandion halietus*).

***Aquatic Wildlife*** — As part of the Charleston Harbor Estuary, the Cooper, Ashley, and Wando rivers make up the basis of an ecologically complex system which supports a wide variety of estuarine aquatic fauna with more than 570 macroinvertebrate and finfish species (FEIS 1995). The estuary provides seasonal and year-round habitat for both adult and juveniles of many species of fish, crustaceans, and shellfish, many of which are commercially and recreationally important. The estuary's wetlands, marshes, and tidal creeks are important nursery areas for the recruitment of most of the important fisheries.

The biological diversity within the Cooper River is relatively lower than that of the Ashley or Wando rivers, probably a reflection of the higher concentration of industrial and commercial port facilities on the river. However, the river still supports many important species. Commercial fishery resources in the Cooper River near the shipyard consist of some crabbing for blue crab (*Callinectus sapidus*) and a seasonal elver (young American eels, *Anguilla rostrata*) fishery (FEIS 1995). Recreational fishing near NAVBASE occurs in the Cooper River, as well as the smaller tidal Noisette and Shipyard creeks. Typical finfish include sheephead (*Archosargus probatocephalus*), flounder (*Paralichthys* spp.), mullet (*Mugil* spp.), drum (*Stellifer* spp.), Atlantic croaker (*Micropogon undulatus*), spotted hake (*Urophycis requis*), weakfish (*Cynoscion regalis*), spot (*Leiostomus xanthurus*), blueback herring (*Alosa aestivalis*), white catfish (*Ictalurus catus*), silver perch (*Bairdiella chrysura*), and spotted seatrout (*Cynoscion nebulosus*). In addition, white shrimp (*Penaeus setiferus*) and red drum (*Sciaenops ocellatus*)

are also sought by recreational fishermen. Identified shellfish beds of oysters (*Crassostrea virginica*), and various clams and mussels can be found within each of the two tidal creeks. Of ecological importance near NAVBASE are large numbers of bay anchovy (*Anchoa mitchelli*), Atlantic menhaden (*Brevooritia tyrannus*), and grass shrimp (*Palamonetes* spp.), which are the major forage base for many higher trophic level species.

The intertidal zones, between the open waters of the Cooper River and its tributaries, and the uplands of NAVBASE, are host to numerous organisms including fiddler crabs (*Uca* spp.), mud crabs (*Eurytium* spp.), periwinkle (*Littorina* spp.), mud snails (*Nassarius* spp.), and a multitude of immature insects, oligochaetes, and annelid worms (FEIS 1995). These organisms play an important role in the intertidal ecosystem as detritus-algal feeders.

***Threatened and Endangered Species*** — Several state-designated species of concern currently or historically have occurred on NAVBASE. Both federally and state-listed species are listed in Table 4-1.

Two buildings at NAVBASE (Buildings 224 and 657) are known to provide rooftop nesting sites for the least tern (*Sterna antillerum*), listed as state-threatened species. Typically, this species uses beach areas above the reach of ordinary high tide. However, due to the increased development pressures on their natural habitats, the terns have resorted to using rooftops with white crushed rock or pea gravel substrates. The use of these rooftop colonies likely fluctuates from year to year. Approximately 23 pairs were documented at NAVBASE in a 1994 nest count.

Wading-bird colonies have been established in the larger wooded tracts of land on the southern end of the base near Shipyard Creek. Typical species include white ibis (*Eudocimus albus*), little

**Table 4-1**
**Federally and State-Listed Threatened, Endangered, and Candidate Species That Occur or Potentially Occur on the Charleston Naval Base**

| Species | | | Status | |
|---|---|---|---|---|
| Common Name | Scientific Name | Residence Status | USF&WS | SCDNR |
| **Plants** | | | | |
| Sea-Beach Amaranth (pigweed) | *Amaranthus pumilus* | UR | SR | NC |
| Canby's Dropwort | *Oxypolis canbyi* | UR | E | E |
| Cypress Knee Sedge | *Carex decomposita* | UR | SR | — |
| Sea Purslane | *Trianthema portulacasfrum* | CR | — | SC |
| Whisk Fern | *Psilotum nudum* | UR | — | SL |
| Climbing Fern | *Lygodium palmatum* | UR | — | SL |
| Piedmont Flatsedge | *Cyperus tetragonus* | PR | — | SL |
| Baldwin Nutrush | *Scleria baldwinii* | UR | — | SL |
| Nodding Pogonia | *Triphora trianthophora* | UR | — | SL |
| Savannah Milkweed | *Asclepias pedicellata* | UR | — | RC |
| Sweet Pinesap | *Monotropsis odorata* | UR | — | RC |
| Climbing Fetter-Bush | *Pieris phillyreifolia* | UR | — | SL |
| Pondberry | *Lindera melissifolia* | UR | E | E |
| Chaff-Seed | *Schwalbea americana* | UR | SR | NC |
| Incised Groovebur | *Agrimonia incisa* | UR | C2 | NC |
| Venus Flytrap | *Dionaea muscipula* | UR | — | RC |
| **Mammals** | | | | |
| West Indian Manatee | *Trichechus manatus* | PM | E | E |
| Bull's Island Deer | *Odocoileus virginianus* | UR | — | C2 |
| Black Bear | *Ursus americanus* | UM | — | SC |

**Table 4-1**
**Federally and State-Listed Threatened, Endangered, and Candidate Species That Occur or Potentially Occur on the Charleston Naval Base**

| Species | | | Status | |
|---|---|---|---|---|
| Common Name | Scientific Name | Residence Status | USF&WS | SCDNR |
| **Birds** | | | | |
| Brown Pelican | *Pelicanus occidentalis* | LM | — | SC |
| Least Tern | *Sterna antillerum* | CR | — | T |
| American Swallow-tailed Kite | *Elanoides forficatus forficatus* | PM | SR | E |
| Arctic Peregrine Falcon | *Falco peregrinus tundrius* | PM | T | T |
| Bald Eagle | *Haliaeetus leucocephalus* | LM | E | E |
| Bachman's Warbler | *Vermivora bachmanii* | UR | E | E |
| Wood Stork | *Mycteria americana* | LM | E | E |
| Red-cockaded Woodpecker | *Picoides borealis* | UR | E | E |
| Osprey | *Pandion haliaetus* | CR | — | SC |
| Piping Plover | *Charadrius melodus* | PM | T | T |
| Bachman's Sparrow | *Aimophila aestivalis* | UR | SR | SR |
| Black Rail | *Lateralus jamaicensis* | PR | CR | C2 |
| Loggerhead Shrike | *Lanius ludovicianus* | CR | — | C2 |
| **Fish** | | | | |
| Shortnose Sturgeon | *Acipenser brevirostrum* | LM | E | E |
| **Reptiles and Amphibians** | | | | |
| American Alligator | *Alligator mississippiensis* | PR | T/SA | T/SA |
| Eastern Tiger Salamander | *Ambystoma tigrinum tigrinum* | UR | C2 | SC |
| Broad-striped Dwarf Siren | *Pseudobranchus striatus* | PR | — | SC |
| Kemp's Ridley Sea Turtle | *Lepidochelys kempii* | PM | E | E |
| Leatherback Sea Turtle | *Dermochelys coriacea* | PM | E | T |
| Green Sea Turtle | *Chelonia mydas* | PM | T | E |

**Table 4-1**
**Federally and State-Listed Threatened, Endangered, and Candidate Species That Occur or Potentially Occur on the Charleston Naval Base**

| Species | | | Status | |
|---|---|---|---|---|
| Common Name | Scientific Name | Residence Status | USF&WS | SCDNR |
| **Reptiles and Amphibians (cont'd)** | | | | |
| Loggerhead Sea Turtle | *Caretta caretta* | PM | T | T |
| Island Glass Lizard | *Ophisaurus compressus* | UR | SR | SR |
| Gopher Frog | *Rana areolata capito* | PR | — | C2 |
| Flatwoods Salamander | *Ambystoma cingulatum* | UR | C2 | SC |
| **Communities** | | | | |
| Least Tern Breeding Colony | | CR | — | SC |
| Wading Bird Breeding Colony | | CR | — | SC |

*Key:*

| | | |
|---|---|---|
| CR | = | Confirmed Resident |
| SR | = | Status Review |
| R | = | Likely Resident |
| E | = | Endangered |
| PR | = | Possible Resident |
| T | = | Threatened |
| UR | = | nlikely Resident |
| SL | = | State Listed |
| CM | = | Confirmed Migrant or Occasional Visitor |
| RC | = | Of Concern, Regional |
| LM | = | Likely Migrant or Occasional Visitor |
| NC | = | Of Concern, National |
| PM | = | Possible Migrant or Occasional Visitor |
| C2 | = | Candidate Sp. for Fed. Listing, Cat. 2 |
| UM | = | Unlikely Migrant or Occasional Visitor |
| T/SA | = | Threatened due to Similarity of Appearance |
| SC | = | Of Concern, State |
| USF&WS | = | U.S. Fish and Wildlife Service |
| SCDNR | = | South Carolina Department of Natural Resources |

blue herons (*Florida caruea*), Louisiana herons (*Hydranassa tricolor*), snowy egrets (*Egretta thula*), cattle egrets (*Bulbulcus ibis*), and black-crowned night herons (*Nycticorax nycticorax*).

Wading-bird rookeries typically are in isolated areas with significant numbers of mature trees and snags that are 10 to 20 feet above the ground. Although the wooded areas used by the colony provide only marginal habitat, the use of the colony before, and its attempted resettlement after, Hurricane Hugo indicates the availability of suitable habitats in the Cooper River region may be limited.

The brown pelican (*Pelicanus occidentalis*), a state-listed species of concern, is recorded as using the Charleston Harbor estuary in the NAVBASE vicinity (E&E 1994). This species is likely only a visitor to the area, using the Cooper River and adjacent tidal creeks to forage. The species typically nests on small coastal islands and little potential nesting habitat is available on NAVBASE.

Also a state-listed species of concern and confirmed resident at NAVBASE, the osprey (*Pandion haliaetus*) often attempts to nest on cranes and ship masts. The adjacent waterways to NAVBASE provide excellent forage habitat for the osprey.

Sea purslane (*Trianthema portulacasfrum*), a plant classified as a South Carolina species of concern, is typically found along stream and irrigation ditches, and in sandy shores, flats, and banks. This rare vascular plant has been found on the dredge disposal area at the southern end of the base (Porcher 1993). Since this species is not listed as endangered or threatened, this plant has no legal protection in South Carolina.

## 4.2 NAVBASE ESA and AEC Habitat Descriptions

To obtain preliminary information for NAVBASE areas, identify the undeveloped and ecologically sensitive areas within Zone J and other zones, and determine the scope of proposed

RFI efforts, a basewide habitat evaluation was conducted by E/A&H between October 1994 and February 1995. NAVBASE properties and associated water bodies were divided into eight ESAs based on primary land usage and type and extent of development. Each ESA was surveyed by qualified environmental scientists to identify all potential AECs. Ecological checklists were first completed for each ESA and followed by an AEC-specific checklist. These lists are presented in Appendices A and B.

Several studies have been performed on and in the vicinity of NAVBASE by various agencies and environmental contractors including the USEPA, South Carolina Department of Natural Resources (SCDNR), National Oceanic and Atmospheric Agency (NOAA), USACOE, South Carolina Sea Grant Consortium, as well as several local universities. The topics of study include sediment/water quality and benthic diversity of the Cooper River and Shipyard Creek, and potential contamination in the DRMO area. Several studies have been conducted at NAVBASE proper, including a survey for rare and endangered species. Information obtained from the review of these studies was incorporated into the preliminary assessments and will be considered during subsequent stages of the each zone-specific RFI.

### 4.2.1 ESA I — Warehouse/DRMO Area

The predominant industrial features in ESA I are the DRMO and Fleet Industrial Supply Center (FISC), consisting of approximately 25 one-story linear warehouses and open storage areas. A small, isolated palustrine scrub-shrub wetland in a grassy area northwest of Building 1648 is the only AEC in this area potentially impacted from site activities (AEC I-1/Subzone A-1; Figure 4-1). Vegetation is thickest in the center of the 1-acre wetland and several small ornamental trees were planted on its western perimeter. This seasonally flooded wetland likely receives surface water runoff from the surrounding areas and, according to early NAVBASE storm drainage maps, may also receive discharge from a storm water drainage system. Piping and catch basins of this underground storm water system once ran beneath and on the north and east sides of the wetland area and ultimately lead through the DRMO area to the Cooper River

(National Pollutant Discharge Elimination System [NPDES] Outfall 3). The integrity of this drainage system and its influence on the AEC I-1 wetland is uncertain.

Two undeveloped areas also associated with ESA I are either of minimal ecological significance or located off Navy property and therefore were not classified as Zone J AECs. An approximately 4-acre grassy field with several trees is west of Avenue D. The only natural features in this maintained field are several mature oak trees (*Quercus* spp.). Crossing the western edge of this open area are several north-south railways which the RCRA Facility Assessment (RFA) has identified as part of AOC 504. Also present in the central portion of this area are SWMU 42, a former asphalt plant, and AOC 505, a cross-tie storage area. These sites will be investigated during the Zone L and A RFIs.

The offsite ecological feature, west of the field in ESA I, is a large estuarine intertidal emergent wetland which receives drainage from portions of North Charleston and high tide waters from the Cooper River via Noisette Creek. Two elevated pipelines cross the wetland and, upon reaching the NAVBASE property line, go below ground. According to base utility maps, the southernmost pipeline is a potable water main (Noisette Creek Connection) supplying water to the northern portion of NAVBASE. The northernmost pipeline is broken in several places and appears to be abandoned.

Eight identified storm water outfalls along the eastern shoreline of ESA I discharge directly to the Cooper River. The northernmost outfall is from an open ditch and culvert drainage system which conveys storm water eastward along the northern property line between a large, offsite aboveground storage tank (AST) farm and the DRMO open storage area. Three SWMUs are near this drainage system: SMWU 39, a petroleum/oil/lubricant drum storage area in the northwest corner of the ESA, and SWMUs 1 and 38, both DRMO open storage areas. Also in ESA I is SWMU 40, the DRMO Storage Shed, approximately 500 feet east of AEC I-1 and SWMU 2, the Scrap Bins, approximately 600 feet north. A portion of the NAVBASE railroad

Figure 4-1 DRMO Wetland (AEC I-1)

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system (AOC 504) also runs through the study area, west of AEC I-1 and parallel to Avenue B North. Four secondary railways branch eastward from the main railway, running north of Building 1605, south of the scrap yard, along Third Street North and out to Pier A. These AOC/SWMUs are included in the Zone A and Zone L RFIs. The fringe wetlands and outfalls along the Cooper River will be addressed in both Zone A and Zone J.

**Previous Investigations**

Several site investigations have been conducted in ESA I. In March 1988, Environmental and Safety Designs, Inc. (EnSafe) prepared the *Report of Field Activities; Closure of Interim Status Hazardous Waste Facilities, Naval Shipyard, Charleston, South Carolina*, in which preclosure activities of the DRMO Storage Shed (SWMU 40) are summarized. The *Final Contamination and Exposure Assessment for Lead Contamination within the DRMO* (ESE 1986) found lead contamination in soil at SWMU 2 ranging from less than 1.3 to 371,000 milligrams per kilogram (mg/kg). The highest lead concentrations were in the area of the former battery storage bin, approximately 400 feet north of AEC I-1. Lead-in-soil concentrations exceeding 1,000 mg/kg were identified in an approximately 6-acre area, distinguishing lead as the primary contaminant of concern in ESA I. A 1993 investigation of SWMU 2, the scrap yard in the same area, indicates a less extensive area of lead contamination (E/A&H, 1993). A soil sample collected at the location previously exhibiting the highest lead concentration in ESE's 1986 investigation contained only 34 mg/kg lead at 0 to 1 foot bgs. The sampling locations with relative lead concentrations are presented in Figure 4-2.

As part of the Zone A RFI, three soil and three sediment samples were collected in AEC I-1 to assess risk to the wetland area from contaminants associated with SWMU 2. Since lead was previously identified as the primary contaminants of concern, these samples were analyzed for only Appendix IX metals. Two sediment samples were also collected in the nearshore environment of the Cooper River near NPDES Outfalls 2 and 3. The analytical results of these

Zone A samples, presented in the Draft *Zone A RFI Report*, will be considered during the assessment for both of these ecologically sensitive areas.

**Phase I Conclusions**

The AEC I-1 wetland is adjacent to two open storage areas to the north and east which currently store miscellaneous items including airplane tires, motor vehicles, metal shelving, cabinets, and lockers. A large warehouse (Building 1648) immediately to the south discharges storm water toward the wetland. The grassy field west of the wetland is also periodically flooded during heavy rains. The storm water system indicated on NAVBASE maps was not observed in or around the wetland, signifying that the catch basins have been either removed or filled. Two low areas are in the north and east corners, but no drains were evident. No other obvious outfalls or discharge points to the wetland were present, making surface water runoff and groundwater the most likely migration route to and from this wetland.

During the PSA, standing water approximately 1.5 to 2 feet deep in the central portion of the wetland was slightly turbid. Sediments in the deeper areas of standing water were dark brown with a moderate overlayer of detritus. A sheen was observed on the water surface in the shallower areas. Based on the dampness of surficial soil, hydric conditions are likely present several yards beyond its vegetated perimeter. Typical palustrine scrub-shrub wetland vegetation was present, with black willow (*Salix nigra*) and tallowtrees (*Sapium sebiferum*) dominant. A large willow (greater than 18 inches diameter) in the center of the wetland had been partially uprooted and is still showing new growth. The thick understory consisted of wax myrtle (*Myrica cerifera*), common elderberry (*Sambucus canadensis*), and cattail (*Typha latifolia*) with both tall grass and broad-leaf herbaceous plants covering most of the ground. Submergent and emergent vegetation was also present in the deeper waters.

Avifauna were abundant in the small isolated wetland, with red-wing black bird, boat-tailed grackle, and starling foraging throughout. A nesting mourning dove (*Zengida macroura*) was

Figure 4-2 Lead Contamination in the DRMO Area

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observed in the low branches of a willow tree on the southern perimeter. Appropriate habitat indicates that small mammals may also be present, although no tracks were observed. Small minnow-size fish were also observed in the areas of ponded water. During the Zone A sampling efforts at AEC I-1, there was no standing water, prohibiting the collection of surface water samples.

**Sampling Plan**

Previous Zone A sampling locations are presented in Figures 4-1 and 4-2. These soil/sediment samples will help characterize the COPCs within the wetland. Based on review of preliminary data, biological receptors at AEC I-1/Subzone A-1 may be potentially impacted due to lead contamination in the DRMO area (SWMU 2). Conclusions of this sampling event will be presented in the Zone A RFI Report.

### 4.2.2 ESA II — Golf Course/Noisette Creek/Officer Housing

Primary land uses in ESA II are recreational and residential with an 18-hole golf course occupying the northern half and officer housing occupying the southern half. Noisette Creek, a small, tidally influenced tributary, flows eastward through the golf course to the Cooper River and has been identified as AEC II-1 (Figure 4-3). Noisette Creek, along with a small pond and several acres of wetlands, is the only identified AEC within ESA II. According to base drainage maps, the creek receives surface and storm water runoff from the golf course as well as off-base properties upstream.

According to the National Wetland Inventory and FEIS, Noisette Creek is associated with several wetland types: estuarine subtidal, estuarine intertidal, and palustrine forested. The subtidal wetlands consist of the open-water, nonvegetated portion of Noisette Creek that does not become exposed at low tide. This wetland type has been classified as having unconsolidated bottom substrate (FEIS 1995). The intertidal wetland consists of the frequently flooded marshes and mud flats on the margins of Noisette Creek. The near-shore areas within these wetlands are

characterized by dense stands of halophytic vegetation including smooth cordgrass (*Spartina alterniflora*) with patches of saltmeadow cordgrass (*Spartina patens*) and black needlerush (*Juncus roemerianus*).

An area at the mouth of Noisette Creek has been identified as a palustrine forested wetland. This area abuts frequently flooded Spartina marsh and is dominated by willow and oak. Estuarine influence in this tidal drainage is indicated by the high number of periwinkle and snail shells on the ground. Little herbaceous vegetation is present, indicating extended inundation; a defined drainage channel also is present. Information regarding physical attributes, such as mean depth, was not determined during the preliminary ESA survey.

A small golf course pond is approximately 300 feet south of Noisette Creek, near the fairway to the sixth hole. According to base storm drainage maps, this pond receives runoff from various golf course drains near the pond (the farthest being less than 600 feet south). Any overflow from the pond flows through an underground pipe into Noisette Creek.

Officer's housing occupies the remaining southern portion of the ESA. The homes are surrounded with well-maintained lawns landscaped with both native and exotic trees and shrubs. Typical tree species include a wide variety of oaks (*Quercus* spp.) with many of the mature trees draped with Spanish moss (*Tillandsia usneoides*). Other species include pines (*Pinus* spp.), maples (*Acer* spp.), and magnolias (*Magnolia* spp.). Planted shrubs include privet (*Ligustrum* spp.), and laurels and azaleas (both *Rhododendron* spp.). As a residential area with limited ecological significance, this area was not designated as an AEC.

Eight identified storm water outfalls are along Noisette Creek's half-mile run through naval property. The first NAVBASE outfalls that discharge into the creek drain the Coal Storage Area (SWMU 44/Zone C) and are in the extreme northern portion of ESA III.

Figure 4-3 Noisette Creek (AEC II-1)

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The only facility within ESA II which was designated by the RFA as a potential source of contaminants is AOC 507 (Zone B), an oil storage house west of Building 220, approximately 400 feet south of Noisette Creek. According to storm drainage maps, a storm sewer line runs near AOC 507 and discharges into Noisette Creek. The distance between any storm water drainage basins and the AOC has not been determined; therefore, the potential of the sewer line as a contaminant migration pathway to Noisette Creek is uncertain. Two sites (AOC 505 and SWMU 42) in nearby ESA I that may also impact AEC II-1 via surface water runoff or groundwater discharge will be addressed in the Zone A RFI.

**Previous Investigations**

The Zone C RFI has investigated SWMU 44 and, through recent surface water and sediment sampling along the drainage ways near the site and at outfalls 100/101, has obtained preliminary risk assessment data for potential impacts to Noisette Creek from SWMU 44. These data, once evaluated, will be incorporated into Zone J's assessment of Noisette Creek. Analysis of SWMU 44 surficial soil samples indicated elevated concentrations of arsenic and aluminum. Surface water samples collected above and below the outfalls contained only low-level concentrations of metals.

Noisette Creek was included in a study by the Marine Resources Research Institute (MRRI) entitled *Year One Demonstration Project Studies Conducted in the Carolinian Province* (Final Report, September 1995). Water quality parameters, sediment characteristics, sediment contaminants, sediment toxicity tests, benthic communities, and nektonic (free-swimming) assemblages were evaluated from 84 sites from Virginia to Florida. One location in Noisette Creek (CP94NOI) was selected as a supplemental station and sampled during the summer of the pilot year, 1994. Due to the large scale of the figure presented in the MRRI report, the sampling location on Figure 4-3 is approximate.

Although comprehensive sampling was not conducted at the supplemental stations, sediment samples were collected for contaminant analyses, characterization, and toxicity testing. Unfortunately, sediment results from Noisette Creek were not presented in the MRRI's report, perhaps because the creek was a new site and results may not have been available. However, results from bioaccumulation studies on oysters and clams deployed in the creek were given. Adverse effects on oyster and clam growth rates were observed. Clams also experienced a high mortality (60%), which was attributed in part to the low salinity in Noisette Creek. MRRI concluded that conditions in Noisette Creek were possibly toxic based on Microtox and seed clam toxicity tests.

### AEC II-1 Phase I Conclusions

AEC II-1 includes approximately 10 acres of open water, wetland, and riparian habitat, all associated with Noisette Creek. The natural habitats of the AEC are accurately described above. Anthropogenic features of the 0.5 mile of the tidal creek on NAVBASE include the outfalls along the bank and the portion of the southern shoreline near the creek's mouth which has been reinforced with riprap, concrete debris, and a seawall to control erosion. Two bridges are upstream at the western property line, one for railcars, another for motor vehicles. A small footbridge provides access across the creek's central portion.

Vegetation in the riparian zone along both banks is dominated by southern hackberry trees, wax myrtle with smaller populations of live oak (*Quercus virginiana*), privet (*Ligustrum sp.*), eastern red cedar (*Juniperus silicicola*), yaupon (*Ilex vomitoria*), saw palmetto (*Serenoa repens*), mulberry (*Morus sp.*), chokecherry (*Prunus virginiana*), french tamarisk (*Tamarix gallica*), and black willow trees. The wetland vegetation is typical of estuarine emergent habitats with smooth cordgrass, black needlerush, and cattail. Bird species observed during the PSA include barn swallow, white egret, red-wing blackbird, osprey, and pied-billed grebe (*Podilymbus podiceps*). Raccoon tracks were also observed along the muddy shoreline. Pilings beneath bridges accommodated numerous clusters of oyster shells.

Noisette Creek is heavily influenced by the tides, with several undercut areas along the bank where tidal flow has accelerated erosion. The banks are on average 3 to 6 feet above the water, depending on the tide. High tides occasionally combine with heavy rains and cause the tidal creek to spill over banks and flood portions of the surrounding golf course. A sump and pump have been dedicated to a low-lying area on the course immediately south of the creek because of such events. The brackish water in the creek was turbid and the bottom only visible at the mouth and then only at low tide. Visible substrate within the creek consists of marl, gravel, and muck with smaller areas of detritus and debris.

**Sampling Plan**

AEC II-1 is considered to be potentially impacted due to the proximity of Noisette Creek to the golf course (a suspected source of herbicide and pesticide runoff), the presence of numerous storm water outfalls, and runoff from SWMUs 42 and 44, and AOC 507. These suspect activities, along with MRRI's findings, prompt the RFI process to proceed to Phase II Contamination Assessment.

Tentative sampling locations for the complete assessment of Noisette Creek (AEC II-1) are presented in Figure 4-3. Six surface water/sediment samples are proposed to characterize the COPCs within the full run of Noisette Creek and the associated wetlands. These sampling locations are designed to complement the AOC/SWMU sampling plans for the Zone A, B, and C RFIs.

### 4.2.3 ESA III — Northern Industrialized Area

Including both the naval shipyard and controlled industrial area, ESA III contains the most industrialized areas on base and, as such, has only three AECs.

***AEC III-1/Subzone C-2*** — An approximately 1.5-acre undeveloped palustrine emergent, persistent, semipermanently-flooded wetland (Figure 4-4) is northeast of Avenue F and Kenney

Lane. AOC 512, a former incinerator site in the eastern portion of this AEC, has been investigated as part of the Zone C RFI. Storm drainage maps of this grassy area indicate that AEC III-1 receives storm water discharge from drainage lines and open ditches in the railcar staging area near Building 1079 to the north and from the numerous storm sewer lines to the south (NPDES outfalls 100A and 100B). This wetland also receives storm water from a catch basin in a low-lying area of the lawn 50 feet to the southwest.

***AEC III-2/Subzone C-3*** — Also in ESA III is Facility 910, a storm water detention pond at the northeast corner of McMillan and St. John's avenues (Figure 4-5). The 9,722-square-foot pond is approximately 10 feet below grade with steeply sloped, grass-covered banks. The pond is separated into two basins by a thick cement dike equipped with spillways to control the water level. The pond receives water from a pumping station on McMillan Avenue as well as storm water runoff from St. John's Avenue and Commissary Street. Several perimeter culverts drain directly into the basin. According to base drainage maps, water from this detention system ultimately discharges to the Cooper River.

The man-made detention pond is identified on National Wetland Inventory maps as a semipermanently flooded, palustrine emergent persistent wetland. Cattail is present in both detention basins with patches of various other wetland species, including sedges (*Carex* spp.) and rushes (*Juncus* spp.). Submerged vegetation also was observed in the standing water at the west bank. A small, enclosed transformer station is also immediately outside the northern fenceline of the eastern basin but it exhibited no signs of spills or leakage. The NAVBASE railroad system (AOC 504) runs parallel to the pond and will be addressed during the Zone L RFI.

***AEC III-3/Subzone G-1*** — The third AEC identified in ESA III is the eastern edge of a palustrine emergent wetland extending across the western property line near Building 1794 (Figure 4-6). Drainage maps indicate that water from this wetland ultimately discharges to the

Figure 4-4 Avenue F Wetland (AEC III-1)

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Figure 4-5 Detention Ponds (AEC III-2)

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Figure 4-6 Chicora Marsh (AEC III-3)

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Cooper River at Outfall 37. Approximately 400 feet northeast of this wetland area are SWMUs 3 and 24, a pesticide mixing area at Building 249 and a waste oil reclamation facility in the fuel farm area. These sites and the associated potential pathways to AEC III-3 have been investigated during the Zone G RFI. An offsite suspected source of contamination to this marshy AEC is the Chicora Tank Farm, approximately 0.5 mile west. The tank farm, described below, will be investigated under the Navy's tank closure program.

**Previous Investigations**

***AEC III-1/Subzone C-2*** — The Zone C RFI has collected 12 soil samples within AEC III-1 in response to the presence of a former incinerator (AOC 512). Results of this sampling effort are presented in the *Zone C RFI Report*. Nine of these sample locations were biased to the suspected site of the incinerator and three were Zone C grid-based samples within 300 feet of the AOC. Three of the biased samples were found to contain elevated concentrations of benzo(a)pyrene. This semivolatile compound was detected in numerous surface soil samples from across the base and is suspected to be associated with the prolific use of boiler klinker as a substrate in NAVBASE road construction and fill material. Although the grid-based sub-surface soil sample collected approximately 150 feet south of the AOC exhibited aluminum and mercury concentrations slightly above the respective RBCs, these concentrations were encountered at the second interval beneath an unused asphalt parking lot and are, therefore, not considered risks to ecological receptors at the AEC.

***AEC III-2/Subzone C-3*** — Two additional Zone C grid-based samples were collected near the detention ponds; one at the northwest corner of McMillan and St. John's avenues and one along the fenceline approximately 50 feet west of the transformer vault between Building M-8 and the detention ponds. These were analyzed for metals only and neither soil sampling location indicated any significant contamination.

***AEC III-3/Subzone G-1*** — The Chicora Tank Farm, which has recently been assessed for contaminants (FEIS 1995) may potentially impact AEC III-3. Chicora's six large-capacity fuel USTs are connected to a subsurface drainage system which discharges into a spill containment pond on the northwest portion of the tank farm. All water that enters the pond flows through a drainage ditch into the marshy tidal slough adjacent to the tank farm's northern boundary. The 1995 report concluded that the high concentrations of petroleum constituents (benzene, toluene, ethylbenzene, xylene [BTEX]; PAHs; and total petroleum hydrocarbons [TPH]) were identified in soil and sediment in the spill containment pond. TPH was found at concentrations as high as 1,200 mg/kg.

## Phase I Conclusions

### *AEC III-1/Subzone C-2*

The majority of this area is a low-lying, open field with two deep and narrow drainage ditches. One ditch flows north from Outfall 100B through the center of the field. The area surrounding the outfall (approximately 25% of the field) is regularly flooded, resulting in a community of hydrophytic vegetation and suspected wetland hydrology. A second ditch runs westward from Outfall 100A along the field's northeastern perimeter and receives discharge from a second outfall approximately 150 feet east of 100A. According to the base drainage map, this outfall is associated with both the storm drains in a nearby parking area and the open ditches in the railcar staging area. This outfall has a small catch basin which receives the initial discharge to the ditch in which an unidentified brownish-yellow flocculent layer was floating. Approximately 50 feet west of the basin, two long, narrow cement beams, possible remnants of the incinerator, span the ditch. Another potential impact to the perimeter ditch is from surface water runoff indicated by surface erosion and lack of vegetation between the southern facade of Building 1079 and the ditch. The two ditches in the AEC ultimately converge at its northernmost corner and flow into a large culvert. The culvert passes under the dirt road near Building 1079 to an offsite drainage ditch along St. John's Avenue and, according to base drainage maps, ultimately into Noisette Creek (AEC II-1) 2,300 feet north.

Other than the concrete beams, the only possible evidence of former incinerator activity is a grass-covered mound west of what is thought to be the location of AOC 512 and a small cement ramp west of Outfall 100B, which leads from Avenue F down into the wetland. Both are of unknown origin.

Dominant vegetation within the upland area of AEC III-1 is tall grass with scattered tallowtrees, indicative of disturbed areas. Live oak, possumhaw viburnum (*Viburnum nudum*), and southern hackberry (*Celtis laevigata*) are also present, but in fewer numbers. Scrub-shrub vegetation includes cattail, needlerush, and sedge grasses present in and around the drainage ditches. The pools of standing water in the ditches supports minnow-size fish and amphibians, including large bullfrogs (*Rana catesbeiana*). Loggerhead shrike, mourning doves, starlings, grackle, and red-wing blackbirds were also present.

**Sampling Plan**

**AEC III-1/Subzone C-2** includes or is near two known AOCs (512 and 509) and receives storm water from surface runoff and several outfalls. Although tentative sampling locations presented in Figure 4-4 were designated based on Phase I PSA, subsequent Zone C RFI sampling at and near AEC III-1, however, indicates that ecological risk is not a driver for the Corrective Measures Study and further sampling is not necessary at this AEC.

**AEC III-2/Subzone C-3**, the McMillan Avenue detention pond, is between a residential area to the north, light industrial areas to the south, and a rail yard (part of AOC 504) next to the southern fenceline and is considered an AEC because it supports wetland conditions. According to the base drainage maps and field observations, there are five outfalls into the pond, three in the western basin and two into the eastern basin. These outfalls originate from the adjacent St. John's and McMillan avenues as well as from Commissary Street, 150 feet to the north. A sixth outfall, not indicated on the base drainage map, was observed at the north side of the west basin and also likely receives runoff from Commissary Street. Regular discharge from these

outfalls is indicated by distinct channelization through the thick emergent vegetation in the basins. A main center channel, approximately 10 to 15 feet wide, runs the entire length of both basins, tracking an easterly drainage pattern.

The sloped perimeter of the pond is grassy with patches of scrub-shrub, dominated by black willow. Cattail, arrowhead (*Sagittaria latifolia*), sedge, and cordgrass compose most of the emergent vegetation in the basins. Birds observed during the PSA include mourning dove, boat-tailed grackle, starling, mockingbird, green-backed heron (*Butorides striata*), and several snowy egrets (*Egretta thula*).

**Sampling Plan** — The tentative sampling locations presented in Figure 4-5 were designated based on the Phase I PSA. During Zone C grid-based sampling near this AEC, however, it was determined that no impacts to this detention pond system are anticipated from NAVBASE AOCs or SWMUs. Furthermore, the majority of storm water outfalls associated with the AEC III-2 drainage/detention system originate from offsite roadside storm drains. Unless a potential source of contamination or risk from NAVBASE activities is identified, additional RFI samples are not proposed for this AEC.

**AEC III-3**/Subzone G-1, the Chicora Marsh Wetland, underwent a Phase I PSA and was found to support a small wetland area which surrounded the outfalls and a small, separate, overgrown detention pond. As indicated on base drainage maps, the primary wetland receives discharge from two Navy storm water outfalls — an elevated pipeline approximately 5 feet above the surface of the water, which appeared to be inoperative, and an outfall at water level which was obviously discharging into the wetland. The pipeline to this outfall runs past two waste oil tanks (SWMU 24) and a pesticide mixing area (SWMU 3), both located in Zone G. Therefore impact to this AEC will be assessed during the Zone G RFI.

Two additional drainage ways which run parallel to and east of the Navy fenceline on either side of the outfall also discharge into the wetland, although neither appears on base drainage maps. The drainage way south of the outfall is a deep-cut, open ditch between the Navy fenceline and a small stand of trees on the high eastern bank. The source of discharge immediately north of the outfall is an underground pipe which empties into a small, fenced-in detention pond (approximately 150 by 20 feet). The pipe discharges to the northwest corner of the pond, which retains the water until it overflows into a corrugated metal culvert. The overflow discharges directly into the wetland through the southwest berm. During the site visit, the water level in the pond, although 1 to 2 feet below the level of its banks, was significantly higher than the water in the wetland, indicating an impermeable bottom within the detention pond. The banks of the detention pond appear to be man-made, as evidenced by riprap and concrete debris. Based on systems with similar design features, it is suspected that the detention pond was engineered to reduce the velocity of the pipeline's discharge directly into the wetland.

Dominant vegetation at AEC III-3 includes wax myrtle, black willow, red mulberry, and tallowtrees in both the small wooded portion along the eastern ditch and around the detention pond. The offsite wetland has typical emergent marshland vegetation, primarily cordgrass and needlerush. A large mammal live-trap was set along the eastern fenceline, reportedly part of the basewide effort to control wild dogs. Bird species at the AEC include red-wing blackbird, boat-tailed grackle, and an osprey, which was seen foraging over the large, offsite wetland.

**Sampling Plan** — AEC III-3/Subzone G-1 receives discharge from a drainage line which passes two known SWMUs. Zone G has sampled the environmental media associated with these SWMUs and, once adequate pathway and migration information is obtained, will determine if potential exists for contaminants from either past and present site activities may impact the AEC. The tentative sampling locations presented in Figure 4-6 were designated during the PSA of the AEC. If the RFI of the SWMUs indicates that sampling of the AEC is necessary, these locations may be incorporated into the Zone G RFI.

### 4.2.4 ESA IV — Southern Industrialized Area

Similar to ESA III, the largely developed areas in ESA IV accommodate only a single AEC. An approximately 5-acre open field and palustrine scrub-shrub wetland area is immediately west of Warehouse 224 (AEC IV-1/Subzone G-2; Figure 4-7). Drainage from this area flows via open ditches and culverts to an expansive palustrine emergent/persistent wetland south across Bainbridge Avenue. In addition, two buildings in ESA IV, Warehouse 224 and Building 657, the Enlisted Club, have historically harbored nesting colonies for the state-listed threatened least tern (FEIS 1995). These rooftops were not designated as AECs since the risk to the colonies is not from potential contamination but rather potential loss of an established nesting site from possible renovation or demolition of the buildings. The SCDNR has recommended that the terns not be disturbed and that access to the rooftops be restricted during the nesting season.

The RFA has identified two SWMUs and three AOCs near AEC IV-1: SWMU 10, a hazardous waste storage area at Building 246; SWMU 11, a former caustic pond near Building 1906; AOC 627, the site of an oil spill near Hobson Avenue and Viaduct Road; AOC 633, a transformer substation; and AOC 634, a flammable storage shelter west of Building 224. Each of these sites has been included in the Zone G RFI.

#### AEC IV-1 Phase I Conclusions

AEC IV-1 is an approximately 5-acre area with both a heavily overgrown drainage system to the east and a maintained field with several trees to the west. The eastern ditches form a scrub-shrub wetland which is vegetated along its entire perimeter. An open, marsh area is in the center of the southeastern portion of the wetland, created by the widening of the drainage channel.

Figure 4-7 Building 224 Wetland (AEC IV-1)

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Evidence of a previous spill and potential contaminant migration to the wetland portion of the AEC was observed in the northern drainage ditches which originate near Building 1804 and 451-C. Two oil booms across each of the two ditches were visibly stained, perhaps in response to the reported oil spill at AOC 627. Two cement pits with metal covers are also present in the overgrown margins near the oil booms and are likely to be associated with storm water drainage. On the storm water drainage map for NAVBASE, a sewer line is indicated along the Viaduct Avenue, leading from the road to the northernmost pit. The purpose of the second pit is not certain. Also according the base map, the manhole, present at the terminal point of the northeast ditch, is associated with the drainage of Building 224's eastern parking lot. Concrete and metal debris are also present among the wetland's southwest vegetated perimeter, indicating the likelihood that solid waste has been disposed of within the marsh.

Two unpaved access roads, one from Viaduct Road and one from Forest Sherman Road, lead to a picnic area beneath the trees in the open field. A small drainage ditch in the open field also leads from the vegetated portion of the AEC to a ditch along Bainbridge Avenue. An unidentified outfall, approximately 50 feet upgradient from the roadside ditch, also discharges into the small ditch. Several small depressions or sink holes (approximately 10 inches deep) of unknown origin are in the open field south of the intersection of the small drainage ditch and dirt access road.

Vegetation around the AEC IV-1 wetland consists primarily of wax myrtle and tallowtrees. Also present in the perimeter are southern hackberry, red mulberry, black willow, eastern red cedar, yaupon, and saw palmetto. The marshy area supports cattail and patches of cordgrass. The mature trees (greater than 12 inches diameter at breast height) in the open grassy area are red mulberry and southern hackberry. Bird species observed in the AEC include mockingbird, boat-tailed grackle, starling, mourning dove, osprey, and loggerhead shrike. Several nests were also observed. Reptiles confirmed to be present at the AEC include the eastern glass lizard (*Ophisaurus ventralis*) and the green anole (*Anolis carolinensis*).

**Sampling Plan**

Evidence of past spill(s), solid waste disposal, and several drainage features with uncertain origins were observed during the PSA of AEC IV-1/Subzone G-2. The AEC is also near several known AOC/SWMUs. The potential therefore exists for contaminants from both past and present activities to impact the AEC, prompting the Phase II Contamination Assessment.

As part of the Zone G RFI of this AEC, eight surface water and/or sediment samples were collected for AEC IV-1: three within the ditches leading into the wetland area, one in the center of the marsh area, one at the western drainage ditch where it crosses beneath the dirt access road, and one at the unknown outfall. Two additional samples were collected at each side of the culvert leading from SWMU 11 into the large offsite wetland.

### 4.2.5 ESA V — Southern Open Areas

With less than 10 buildings present, ESA V contains the largest portion of undeveloped land at NAVBASE, including several expansive wetlands. Being a large and contiguous area, ESA V was divided into three smaller AECs. The palustrine forested wetland surrounding the headwaters of Shipyard Creek has been designated as AEC V-1. This area drains a large offsite wetland south of Viaduct and Bainbridge roads (Figure 4-8). The RFA has designated two SMWUs near AEC V-1. SWMU 19, an approximately 1-acre solid waste transfer station, and SWMU 20, an approximately 6-acre field near Building 903 once used as a waste disposal area, are both between Plate Street and Least Tern Lane.

AEC V-2 includes the expansive estuarine intertidal wetland southwest of the athletic fields and the equally large palustrine forested wetland south of Building 655. The palustrine forested wetland is amidst a large wooded tract which constitutes the largest contiguous undeveloped area at NAVBASE (Figure 4-9). A posted wading-bird nesting sanctuary is southeast of the athletic fields in AEC V-2. This protected area was established after the damage caused by Hurricane Hugo in 1989, which demolished most of the mature trees and snags at the former

Figure 4-8 Headwaters of Shipyard Creek (AEC V-1)

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Figure 4-9 West Road Wetland/Woodland (AEC V-2)

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nesting site approximately 1,000 feet to the southeast. The intertidal wetland immediately east of West Road is a salt marsh with irregular topography which allows for areas of nonhydrophytic vegetation. The unimproved West Road separates this wetland from the fringe wetlands of Shipyard Creek, yet culverts beneath the road allow tidal influence to extend inland.

Numerous AOC/SWMU sites are in or near AEC V-2. Most of AEC V-2 and the athletic fields to the east were formerly used as a landfill and have therefore been designated as SWMU 9. Three AOCs also are in the grassy area northeast of the running track (Facility 1847); AOCs 649 through 651 are each former storage areas for various industrial subcontractors. A former satellite accumulation area near Building 810 has been designated as SWMU 121. AOC 648, a transformer vault, is west of Building 673. AOC 654, an abandoned septic tank and drain field, is west of Building 661. AOC 503, a UXO site where two depth bombs were jettisoned in 1943, is north of an unimproved access road between West Road and Building 655. A satellite accumulation area at Building 665 has been designated as SWMU 159. These sites were investigated under the Zone H RFI and their associated risk potentials are presented in the *Zone H RFI Report*.

The remainder of ESA V (AEC V-3; Figure 4-10) primarily consists of a designated dredge materials area (DMA), which received dredged sediments from both the Cooper River and Shipyard Creek. This approximately 75-acre area is surrounded by a 15- to 20-foot dike with two spillways positioned along the south and west perimeter to allow sediment dewatering. The northeastern portion of the DMA has been cross-diked and completely filled, making this area the highest topographic elevation at NAVBASE. Upland habitats on this filled area east of the DMA include tall grasses, scrub-shrub, and, in the areas which have been long since undisturbed, stands of small trees. Deer tracks (*Odocoileus virginianus*) were present along the dike-top road and a deer carcass was seen in the fringe wetland along the NAVBASE shore near the mouth of Shipyard Creek.

Eight AOCs and four SWMUs are within AEC V-3. Buildings 1887 and 1888 and the surrounding open areas are associated with former firing ranges and have been designated as AOCs 669, 670, and 684. AOC 685 is a former smoke drum at the corner of Juneau and Partridge avenues. AOCs 686, 687, and 688 are ammunition storage facilities on the east side of Juneau Avenue. The parking lot at the southern tip of the base has been designated as AOC 689 for past landfill activities. AOC 690 includes portions of roadways at the southern end of the base which are suspected sites of unauthorized dumping. SWMU 12 is a former fire fighter training area between the DMA and West Road. SWMU 14, an approximately 5-acre grassy field 100 feet east of Building 677, is an abandoned subsurface chemical disposal area. SWMU 15 is a former incinerator south of Building 1843 and SWMU 16 is the grass-covered roof of Bunker X-55 where paint was reportedly stored. These sites have been investigated during the Zones H and I RFIs, and their risk potentials will be presented in the appropriate RFI report.

**Previous Investigations**

ESA V includes portions of both RFI Zones H and I, the first zones designated for field investigations. Fieldwork has been completed for both zones and analytical data have been collected from all AOC/SWMU sites. Preliminary review of these data has identified several COPCs which may impact the AECs within ESA V. Analytical data from sediment samples collected from the headwaters of Shipyard Creek and the intertidal wetland between West Road and the athletic field (AECs V-1 and V-2) are incorporated into the Zone H risk assessment and presented in the Zone H RFI Report. Contaminant concentrations in the sediment samples exceeded the effect and/or screening values set by the USEPA Region IV *Waste Management Division Sediment Screen Values for Hazardous Waste*. These values are presented in Table 4-2. Zone H sediment sample locations are shown on Figures 4-8, 4-9, and 4-10.

Figure 4-10 Dredged Materials Area and Surroundings (AEC V-3)

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**Table 4-2**
**Maximum Concentrations Detected in Sediments**
**in ESA V/Zone H**

| Parameter | AEC V-1 | AEC V-2 | Effects Level/Sceening Value[a] |
|---|---|---|---|
| **Inorganics (mg/kg)** | | | |
| Antimony | 2.7 | 6.9 | 2/12 |
| Arsenic | 15.6 | 19.6 | 7.24 |
| Cadmium | 0.64 | 1.7 | 0.676/1.0 |
| Chromium | 291 | 59.7 | 52.3 |
| Copper | 228 | 53.7 | 18.7 |
| Lead | 107 | 92.2 | 30.2 |
| Mercury | 0.69 | 0.26 | 0.13 |
| Nickel | 37.3 | 24.6 | 15.9 |
| Zinc | 387 | 147 | 124 |
| **Organics (μg/kg)** | | | |
| Acenaphthene | — | 230 | 6.71/330 |
| Chlordane | — | 17 | 0.5/1.7 |
| DDT | 140 | 29 | 1.58/3.3 |
| Fluoranthene | 9,500 | 120 | 113/330 |
| Phenanthrene | — | 150 | 86.7/330 |
| Pyrene | 6,400 | 110 | 153/330 |

*Notes:*
a = USEPA Region IV (1995b) Draft Sediment Screening Values (SSVs).
mg/kg = milligrams per kilogram
μg/kg = micrograms per kilogram

Surface water samples were also collected at four of the sampling locations in Zone H (009W0001 and 009W0004 in AEC V-1, and 009W0012 and 009W0015 in AEC V-2). Analysis of these water samples also indicated elevated concentrations of metals. These data, presented

in the *Zone H RFI Report*, will be carefully considered during the investigation of Zone J water bodies.

**Phase I Conclusions**

***AEC V-1***

The headwater region of Shipyard Creek is designated AEC V-1 for its riparian, wetland, and open field habitats. This area is bounded on the north and east by Bainbridge Avenue and on the west by an open storage facility used by Public Works Department. A Santee-Cooper transformer station and SWMU 19, a solid waste transfer station, are along Least Tern Lane to the south. SWMU 20, the open field once used as a disposal area, is in the center of the AEC. A culvert which drains surface water runoff from areas east of Bainbridge Avenue runs west beneath the road and into AEC V-1, creating a forested/scrub-shrub wetland. This wetland extends approximately 1,500 feet southeast along the low-lying area between Bainbridge Avenue and the now overgrown Plate Street. Concrete and asphalt debris were in the roadside portions of the wetland. The northern portion of AEC V-1 west of Plate Street receives discharge from another watershed area of Shipyard Creek. A culvert in the western portion of the AEC runs from the expansive offsite palustrine emergent wetland, beneath the access road to the public works storage yard and into AEC V-1. The two smaller watersheds converge immediately north of Building 903 to form a larger creek which meanders southward until going off the base near Building 1838. In this headwater portion, the creek banks are high and steep. Surface water runoff is readily apparent at several deeply eroded locations on the west side of the bank south of Building 1838.

Vegetation in the riparian areas of AEC V-1 includes southern hackberry, wax myrtle, black willow, popcorn, red mulberry, and eastern red cedar with honeysuckle (*Lonerica japonica*) and pepper-vine (*Ampelopsis arborea*) in the understory. Wetland portions of the AEC support populations of cattail, needlerush, and cordgrass. The shallows of these headwaters also have

communities of small fish, fiddler crabs, and sand crabs and are therefore popular feeding areas for heron, egrets, and kingfishers (*Megaceryle alcyon*).

**Sampling Plan** — As indicated by the sampling locations presented in Figure 4-8, E/A&H has already conducted extensive sampling in AEC V-1 as part of the Zone H RFI. As discussed above, one surface water and three sediment samples were collected during the RFI of SWMU 9 (see Figure 4-8) and numerous soil samples have been collected throughout SWMUs 19, 20, and 121.

The tentative sampling locations presented in the figure were designated by the PSA of this AEC. Based on the analytical results and risk calculations of the relevant Zone H samples, however, significant risk to representative receptor species in AEC V-1 was not indicated. The Zone G RFI of AEC IV-1/Subzone G-2 will provide additional information regarding the assessment of AEC V-1. Therefore, no additional samples are proposed.

*AEC V-2*

As described above, this undeveloped central portion of ESA V has several different types of habitat, including an intertidal wetland, a forested wetland, and an upland forest. The intertidal wetland, once an antennae field, receives regular tidal inundation via a culvert and, during exceptionally high tides, flooding over West Road. Distinct channelization is present along the inland side of West Road, aiding the drainage of receding tidal waters. The wetland is bounded on the north and northeast by a slightly elevated band of deciduous forest. The southeastern portion of AEC V-2 supports a second, more expansive upland forest which abuts several parking lots and buildings to the northeast and a clearing which marks the AEC's southern perimeter. The woods between Holland Street and West Road have a slightly lower topography, allowing standing water and hydrophytic vegetation throughout. Debris and litter were present in varying degrees at most areas of AEC V-2, especially around the athletic fields and parking

areas. Stains were also observed in a small ditch west of Building 665 and in a catch basin north of Building 665, both near SMWU 159.

The diverse habitats in this AEC host various types of vegetation. Typical estuarine vegetation such as cattail, cordgrass, and needlerush is present in the central portions of the intertidal wetland and wax myrtle, french tamarisk, and black willow are common along the wetland's fringe. The forested portions of the AEC are dominated by several overstory species such as tallowtrees, southern hackberry, and mulberry, with loblolly pine (*Pinus taeda*), tree-of-heaven (*Ailanthus altissima*), and eastern red cedar tree present in fewer numbers. Common understory species are privet, possumhaw viburnum, saw palmetto, honeysuckle, and Virginia creeper (*Parthenocissus quinquefolia*).

These habitats host a wide variety of wildlife and offer a large area of suitable nesting and foraging habitats. Passerine birds include cardinal, cedar waxwing, loggerhead shrike, brown thrasher (*Toxostoma rufrum*), mockingbird, and mourning dove. Red-tailed hawk, killdeer (*Charadrius vociferus*), egrets, and heron were also observed. Nest boxes had been mounted on the fenceposts along the north end of West Road but were in poor condition and unoccupied. Fiddler crabs are abundant in the mud flat areas in the intertidal wetland and regularly flooded creek banks. Numerous small fish were in the ditch near the culvert leading from Shipyard Creek to the intertidal wetland. Numerous raccoon tracks were also present throughout.

**Sampling Plan** — AEC V-2 is also included in Zone H and, as a result, has undergone a significant degree of contaminant assessment. Within the intertidal wetland, one surface water and nine sediment samples have been collected. Other sediment and surface water samples were collected in the forested wetland immediately east of Building 661 (see Table 4-2 for a summary of analytical results). Numerous soil samples have also been collected in association with AOCs 503, 649, 650, 651, and 654 and SWMUs 9, 121, and 159 and along West Road (refer

to Figure 4-9). Based on the adequate spatial distribution of previous sampling locations and low risk potentials in this area determined by the Zone H RFI, no additional sampling in proposed.

***AEC V-3***

AEC V-3 is the largest area of ecological concern at NAVBASE, with balanced coverage by both woodland and wetland habitat with several areas with open field. Dominating the center of the AEC is the DMA which, due to the periodic flooding and dewatering associated with dredging activities, is continually repopulated by early successional, opportunistic plant species. During the April 1995 PSA, most of the vegetation within the DMA was either dormant or dead likely due to previous inundation. Bordering the diked area to the north, east, and west is a narrow to medium band of deciduous woodlands. Woodlands are also present at the southernmost tip of the peninsula. The area between the woodlands contains both a tidal palustrine forested and intertidal wetlands, similar to those within AEC V-2.

A long, narrow open field runs west of and parallel to the northern end of Juneau Avenue. This field is transected by several ditches, overgrown with cattail, which drain runoff from the northern filled portion of the DMA to the Cooper River. The open field extends southward, behind Buildings X-44 and X-55 where it widens into an abandoned athletic field and obstacle course. The inland side of Juneau Avenue then becomes lined with the woods surrounding the diked area and continues south to the estuarine wetland. Northwest of the DMA is a maintained 3-acre lawn (SWMU 14) which NAVBASE personnel occasionally use for recreational activities.

Two unimproved roads lead to the filled portion of the DMA. One, still in use, is west off of Juneau Avenue near AOC 685 and provides access over the filled area to the dike-top road. A second dirt road had been created from C.B. Lane near the tennis courts (Building 1790), but has since been barricaded with a large fallen tree and is becoming overgrown. Access to the

southern portion of the dike-top road can also be made via West Road through a clearing at the southwestern spillway.

Woodland vegetation at AEC V-3 is similar to that found in the nearby AECs, with a thick overstory of southern hackberry, mulberry, and tallowtrees with a few chokecherry, black willow, and cedar trees scattered throughout. The understory is dominated by wax myrtle, possumhaw viburnum, and saplings of the dominant trees. Although once found in this disturbed area during past ecological investigations, sea purslane, a state species of concern, was not observed during the PSA for AEC V-3. Numerous fallen trees and snags are present throughout the AEC, likely a result of past storms. The estuarine wetland between the DMA and West Road is dominated by cattail, needlerush, and cordgrass, with a fringe of french tamarisk, hackberry, and wax myrtle.

Varied wildlife is present in AEC V-3, especially within the DMA. Waterfowl species were observed in and around the drainage ways, including teal (*Anas sp.*), mallard (*Anas platyrhynchos*), sanderling (*Calidris alba*), black-crowned night heron (*Nycticorax nycticorax*), green-backed heron, and snowy egret, likely feeding on the abundant insect larvae and small fish present in the shallow waters and channelways. Osprey, loggerhead shrike, cedar waxwing, boat-tailed grackle, mockingbird, robin, and starlings were seen in the wooded portions of the AEC. Tracks of deer and raccoon were also present in the muddy shoreline and along the dike-top road.

**Sampling Plan** — AEC V-3 is entirely within Zones H and I. The widespread distribution of Zone H and I sites covers an area from AOC 685 at the northern end of Juneau Avenue to AOC 690, the southernmost peninsular roadways. Samples have also been collected from within the DMA and in the western grassy field once used as a subsurface chemical disposal area (SWMU 14). These previous sampling locations provide both significant coverage and characterization of environmental impact to AEC V-3. The results of these pertinent

investigations will be presented in the appropriate RFI reports and carefully considered during the assessment of the Zone J water bodies. Based on the adequate spatial distribution of previous Zone H and I sampling locations and resulting risk determinations, no additional sampling is proposed for AEC V-3.

### 4.2.6 ESA VI — Cooper River and Associated Wetlands

The Cooper River flows south past NAVBASE and ultimately empties into the Charleston Harbor. The tidal saltwaters in the Cooper River (SCDHEC Class SB) are considered suitable for secondary contact recreation (boating), crabbing, fishing, (except harvesting clams, mussels, or oysters for market purposes or human consumption), and the survival and propagation of a balanced indigenous aquatic community of marine flora and fauna (FEIS 1995).

Bordering the less industrialized northern and southern portions of NAVBASE (ESAs I, II, and V/Zones A, B, and I) are several areas of fringe wetland and salt marsh. These sensitive wetland areas, some of which are quite expansive, are remnants of the past marshland which once occupied the entire NAVBASE peninsula. Instead of a quay wall, riprap has been used to control erosion along the nonindustrialized portions of the NAVBASE shoreline and is interspersed with a variety of solid waste, primarily concrete construction debris.

The primary ecological risk from NAVBASE to the Cooper River is the discharge of storm water (refer to Figure 1-2) and past discharges of industrial wastewater. Discharge of contaminated groundwater is also a potential contributing risk factor and will be assessed through interpretation of analytical data from samples collected from the numerous nearshore groundwater monitoring wells and perimeter well pairs.

The multiple permitted storm water discharges into the Cooper River fall under NPDES jurisdiction and are permitted to convey only storm water runoff offsite from various facilities onsite and designates limits to only TOC, temperature, oil, and grease. Approximately 80% of

storm water at NAVBASE discharges directly into the Cooper River. The remaining storm water is conveyed to Noisette or Shipyard creeks.

Most of the industrial discharges originating on NAVBASE were redirected to a municipal wastewater treatment plant in the early 1970s. These discharges to the treatment plant have also been properly permitted and have limits on pH, biochemical oxygen demand, total organic carbon, total suspended solids, and nitrate. Of primary ecological concern is discharge from the heavily industrialized Charleston Naval Shipyard (CNSY), which has replaced most of the base's natural river shoreline. At the CNSY, ship building and maintenance activities have been conducted on the Cooper River since the early 1900s. As a result of such long-term industrial activities, numerous AOCs and SWMUs are present at the CNSY. Such nearshore and land-based AOCs/SWMUs will be assessed during the appropriate zone-specific investigation, primarily Zone E, and any applicable data generated from such investigations will be incorporated in the work planned for the Zone J assessment of the Cooper River.

Although the potential exists for several industrial sources to discharge wastewater into the Cooper River, no studies conducted at NAVBASE have confirmed this possibility. Due to the antiquity of the sewer system, however, the possibility does exist (FEIS 1995). Nonidentified industrial sources may also be diverted into the storm water system, rather than being discharged to wastewater treatment facilities. The NAVBASE sewer system, including the outfalls into the Cooper River, will be investigated in the Zone L RFI.

According to NAVBASE drainage maps, 13 identified storm water outfalls discharge into the fringe wetlands along the Cooper River shoreline north of the shipyard and 18 outfalls discharge into wetlands along the southern shoreline (see Figure 1-2). Other permitted outfalls to the Cooper River include the drainage ditch from the dewatering spillway within the DMA and surface water runoff from the marina parking area. Most runoff from this area is directed to

a small bermed catch basin in the southeast corner of the lot where the water is collected and then drained directly into the Cooper River and surrounding wetland.

Also significant to the assessment of the Cooper River are the continuing dredging activities. The USACOE maintains a navigational channel approximately 42 feet deep and 600 feet wide along the Cooper River to allow large naval ships, submarines, and commercial vessels to navigate along the Cooper River. In addition, the sediments around most of the 26 Navy docks on NAVBASE were routinely dredged to maintain a depth of 30 to 35 feet, although with the recent closure of the base, this practice reportedly has been discontinued.

According to USACOE, periodic dredging of the Cooper River's main channel started at the southern boundary of the CNSY and continued north past the northern shipyard boundary. The dredged material was reportedly discharged onto Clouter Island. In 1994, the USACOE collected 11 predredging sediment elutriate samples from the Cooper River and compared the total modified elutriate results to 1987 USEPA Water Quality Criteria (WQC) for Chemicals of Concern in Marine Waters. Sample concentrations from the four locations near NAVBASE (CH-7, CH-8, CH-9, and CH-10) were reported to be either below acute concentrations or were not detected. However, the laboratory's detection limit for several metals (copper, nickel, and silver), pesticides, (chlordane, endosulfan, and toxaphene), and the PAH fluoranthene were above the WQC, therefore some exceedances of these criteria may not have been detected.

In 1995, 17 predredging sediment samples were collected from the Charleston Harbor by the USACOE. The draft results from the three 1995 samples (CH-2, CH-3, and CH-4) near NAVBASE are presented in Table 4-3 and on Figure 4-11.

The last dredging events around the piers and docks of the Naval Shipyard were conducted from December 1993 to December 1994 by private dredging companies for the Navy. According to

NAVBASE Public Works, all dredged materials were discharged onto Clouter Island and no analytical samples were collected.

Preliminary evaluation of Cooper River dredging activities indicates that mapping of sediment TOC and grain size may not accurately define those areas where NAVBASE contaminants may have historically accumulated and would be of limited use in scoping and sampling activities. Considering the dredging and natural redistribution of sediments along the main channel of the Cooper River and near the shipyard piers, physical substrate information obtained would be obsolete upon any redredging or passage of a significant period of time. This information would then be of limited use as a decision-making tool during a CMS or remedial action. Instead, TOC and grain size analyses will be included with the analytical suite of parameters proposed for each sampling location to better assess the potential impacts to the water body.

**Table 4-3**
**Cooper River**
**USACOE Pre-dredge Sediment Sampling**
**Draft Results, 1995**

| Parameter | Sampling Locations CH-2 | CH-3 | CH-4 | Achieved Detection Limit | Sediment Screening Value[a] |
|---|---|---|---|---|---|
| **Inorganics (mg/kg — dry)** | | | | | |
| Arsenic | **7.4** | **15** | **19.9** | 0.59 | 7.24 |
| Beryllium | 0.919J | 1.25 | 2.67 | 2.53 | NA |
| Cadmium | 0.072 | 0.54 | 0.22 | 0.01 | 1 |
| Chromium | 44.6 | **61.5** | **103** | 2.35 | 52.3 |
| Copper | 6.88 | 14.8 | **33.6** | 4.85 | 18.7 |
| Mercury | 0.014 | 0.050 | **0.180** | 0.012 | 0.13 |
| Silver | 0.127 J | 0.26 U | 0.125 J | 0.26 | 2 |
| Total Cyanide | 0.08 U | 0.16 | 3.40 | 0.062 to 0.15 | NA |
| N-Ammonia | 160.0 | 97.0 | 540.0 | 0.14 to 0.30 | NA |
| Sulfide | 0.39 U | 200.00 | 1100.00 | 0.34 to 8.9 | NA |

**Table 4-3**
**Cooper River**
**USACOE Pre-dredge Sediment Sampling**
**Draft Results, 1995**

| Parameter | Sampling Locations CH-2 | CH-3 | CH-4 | Achieved Detection Limit | Sediment Screening Value[a] |
|---|---|---|---|---|---|
| Total Organic Carbon | NA | NA | 0.036 | 0.0002 | NA |
| **Organics (µg/kg — dry)** | | | | | |
| Naphthalene | 6.03 B | 22.10 B | 28.90 | 2.36 | 330 |
| Acenaphthylene | 2.59 B | 8.05 B | 20.10 | 2.13 | 330 |
| Acenaphthene | 2.13 U | 14.10 | 23.20 | 1.41 | 330 |
| Fluorene | 4.23 U | 16.30 | 23.10 | 3.06 | 330 |
| Phenanthrene | 5.0 U | 36.30 | 68.00 | 4.27 | 330 |
| Anthracene | 6.08 | 27.50 | 40.20 | 4.56 | 330 |
| Fluoranthene | 7.01 B | 166.00 | **331.00** | 1.67 | 330 |
| Pyrene | 4.34 | 316.00 | 251.00 | 1.49 | 330 |
| Benzo(a)anthracene | 4.27 | 80.90 | 146.00 | 0.91 | 330 |
| Chrysene | 0.93 U | 77.20 | 154.00 | 1.37 | 330 |
| Benzo(b)fluoranthene | 4.76 | 79.70 | 140.00 | 1.60 | 330 |
| Benzo(k)fluoranthene | 2.97 U | 26.90 | 51.50 | 2.32 | 330 |
| Benzo(a)pyrene | 2.31 U | 48.40 | 80.90 | 2.08 | 330 |
| Indeno(1,2,3-cd)perylene | 2.85 B | 33.50 | 61.80 | 1.16 | 330 |
| Dibenzo(a,h)anthracene | 1.34 U | 10.90 | 16.00 | 1.24 | 330 |
| Benzo(g,h,i)perylene | 7.40 | 3.10 | 41.40 | 1.16 | 330 |
| Total LMW PAHs | 8.62 | 124.35 | 203.50 | — | 330 |
| Total HMW PAHs | 26.33 | **880.9** | **1284.9** | — | 655 |
| Total PAHs | 34.95 | 1005.25 | 1488.40 | — | 1684 |
| Dieldrin | 0.21 U | 1.36 | 0.30 U | 0.396 | 3.3 |
| 4,4'-DDD | 0.26 U | **4.11** | 0.38 U | 0.500 | 3.3 |

**Table 4-3**
**Cooper River**
**USACOE Pre-dredge Sediment Sampling**
**Draft Results, 1995**

| Parameter | Sampling Locations CH-2 | CH-3 | CH-4 | Achieved Detection Limit | Sediment Screening Value[a] |
|---|---|---|---|---|---|
| **Organics (ug/kg — dry) cont'd.** | | | | | |
| 4,4'-DDT | 0.74 U | 1.82 | 1.06 U | 1.41 | 3.3 |
| Tributyltin | 0.84 B | 2.31 B | 1.01 B | 0.48 | NA |
| Dibutyltin | 0.56 U | 26.0 | 0.90 | 0.56 | NA |
| Monobutyltin | 1.82 U | 8.55 | 7.84 | 1.82 | NA |

*Notes:*
a = Sediment Screening Value, Region 4 Waste Management Division, Nov. 1995
**bold** = denotes concentration exceeding Sediment Screening Value
U = Not detected at or above detection limit.
B = Analyte detected in sample is < 5 times blank value.
NA = Value Not Available
— = Not Applicable
LMW = Low Molecular Weight
HMW = High Molecular Weight
µg/kg = micrograms per kilogram

## Offshore AOCs

As part of the Zone J investigation of the Cooper River, the following offshore AOCs will also be assessed: AOC 500, UXO between Piers S and T; AOC 501, a UXO site off the southern end of base; and AOC 502, a third UXO site near Pier G (refer to Figure 1-2). Section 3.3 addresses the investigatory approach proposed for these Zone J UXO sites.

The two remaining open-water AOCs in Zone J (AOC 691, the waterfront, and AOC 692, free oil from areas along the Cooper River) will be addressed during the overall assessment of the Cooper River. Both site specific and grid-based soil and groundwater sampling proposed in the nearshore RFI zones will also contribute valuable source/contaminant data for the Zone J RFI of the Cooper River.

Figure 4-11 Cooper River Grid Samples

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## Previous Investigations

Most of the Cooper River studies which involve the assessment of hydrology and water and sediment quality have encompassed the entire Charleston Harbor System or the even larger Carolinian Province with limited focus on the water bodies near NAVBASE. Information is therefore limited primarily to the few isolated stations near NAVBASE and to that which can be assimilated from overall system conditions. The following section summarizes the data obtained from several such studies.

### *A Physical and Ecological Characterization of the Charleston Harbor Estuarine System*

This 1990 study, commonly known as the Charleston Harbor Study (CHS), is a review of numerous pertinent studies and a collection of long-term trend data. This report was submitted to the South Carolina Coastal Council to characterize hydrographic conditions and selected biological communities in the estuarine portions of the Cooper, Wando, and Ashley rivers, and the Charleston Harbor basin following a rediversion project in the upper portion of the watershed. The report included data related to risk determination such as water quality, sediment distribution, benthic macroinfaunal communities, finfish/invertebrate communities, and contaminant concentrations and distributions.

***Sediments*** — During the long-term study, sediments observed at Station CR01, in the center of the Cooper River by ESA V (see Figure 4-11), had the highest percentage of fine material found within the targeted river areas, although it fluctuated substantially throughout the study. CR01 sediments were made up primarily of silt and clay but percentages change erratically from one sampling effort to the next.

In the intensive short-term study, a wide diversity of sediment types was observed in the Cooper River next to NAVBASE. No specific trend in sediment particle size was obvious from the data. It was noted that in regions where hydrographic energy was obstructed by piers and docking facilities, such as the Navy Base, Naval Shipyard, and industrial centers, the greatest

concentrations of fine-grained materials were found. Sediments near the Naval complex were described as unconsolidated material. However, sand dominated sediments along the east bank of the Cooper River across from the Naval Shipyard.

***Benthic Macrofaunal Communities*** — The long-term seasonal investigation of benthic macrofaunal communities within the Cooper River indicated that, relative to other stations, species diversity and richness were highest at CR01. It was concluded that salinity is the most important determinant of benthic community structure, with sediment type playing a secondary, more site-specific role.

The short-term, spatially intensive study of benthic macrofauna did not indicate any clear relationships between abundance or distribution of benthic organisms and the various human activities in the study area. However, a high abundance of species known to be pollution-tolerant or opportunistic organisms at some sites may have been a result of anthropogenic effects. No specific discussion for the area near NAVBASE was provided but generally the Cooper River had lower diversity values than nearby rivers (Wando and Ashley). It was suggested that these lower diversity values may be a reflection of the greater number of industrial and port facilities along the Cooper River.

***Finfish and Invertebrate Communities*** — A general summary of the impacts of the rediversion project on finfish and invertebrate species is presented in the CHS. Information on distribution is limited primarily to river systems with a summary describing the changes in abundance and biomass for pre- and post-diversion periods. The information provided, as it relates to activities or impacts from NAVBASE, is at best qualitative for the purpose of risk determination. It does provide detailed information on potential receptor species within the study area and thus will be used accordingly.

Information on larval fish and invertebrates is similar to that for larger individuals except that fewer stations were sampled. Specifically, no stations were within the Cooper River and therefore information concerning larval distributions within that portion of the river near the naval complex can only be extrapolated using correlative water quality information.

***Contaminants*** — During the two-year study, both metals and organics were measured in sediment and tissue (several species). During the intensive study, only sediment metals were measured. Due to the transient nature of most of the selected tissue species (except oysters) and the fact that the Naval complex is not necessarily the sole contributor of contaminants in the area, correlation between existing tissue information has been given limited consideration in this overview.

In the sample station near the Naval complex (CR01), the only metal constituents detected in sediment during the two-year study were mercury (22.4 $\mu$g/kg), chromium (36.5 mg/kg) and copper (19.4 mg/kg). According to the report, no organics were found at CR01 during the two-year study.

During the intensive study, chromium and copper were detected at all the Cooper River stations. Chromium concentrations varied, but in general, lower values were observed in the center of the channel with higher concentrations found toward the banks. Copper concentrations in the Cooper River were lower than both stations in Shipyard Creek, which exceeded 20 mg/kg.

Five estuarine species were collected from CR01 for contaminants analyses: blue crabs, white shrimp, spot, southern flounder (*Paralichthys lethostigma*) and American oyster (*Crassostrea virginica*). Table 4-4 presents the sediment and tissue contaminant concentrations detected during both the 1987 and 1988 sampling events.

***Final EIS — Charleston Naval Base***

Information on terrestrial and aquatic environments occurring on or near NAVBASE were assessed in a recent environmental impact statement (E&E 1995). General descriptions of vegetation and wildlife species found across the base were presented. In addition, information on threatened and endangered species in the vicinity of the base was also discussed.

***Habitats*** — Intertidal wetlands are found on the margins of the Cooper River and Shipyard and Noisette creeks. Habitat types such as mud flats, Spartina marshes, and cattail marshes are found, especially at the southern end of the base. Palustrine forested wetlands were identified along Shipyard and Noisette creeks. Most of the areas were identified as having some estuarine influence. Less pervasive wetland habitats found on the base include palustrine scrub-shrub and palustrine emergent wetlands.

***Fauna*** — Avian fauna were considered the most prevalent wildlife type present basewide, and smaller mammal species such as raccoon, opossum, and rabbit most likely to occur in undeveloped portions of the base. A variety of reptiles, amphibians, passerine bird species, and smaller raptors typical of the southeastern U.S. occur across the base. Avian species associated with aquatic environments (shorebirds) are plentiful.

Threatened and endangered species (see Table 4-1) potentially found in the area include the least tern, which have used building rooftops for colonization. Wading bird colonies, including species such as herons and egrets, have been found in isolated areas of the base.

Special status marine species likely to occur in local waters include the loggerhead turtle, Kemp's Ridley sea turtle, West Indian manatee, and the shortnose sturgeon.

**Table 4-4**
**Sediment and Tissue Concentrations from Station CR01**
**Two-Year Study — 1987 and 1988**

| Parameter | Sediment (1987/1988) | Tissue (1987/1988) | | | | |
|---|---|---|---|---|---|---|
| | | Spot | Flounder | Crab | Shrimp | Oyster |
| **Inorganics (mg/kg)** | | | | | | |
| Cadmium | — | — | — /ND | — | — | 2.51/— |
| Chromium | 11.2/36.5 | — | — | — | — | — |
| Copper | — /19.4 | 18.6/— | 18.9/— | 81.2/44.5 | 78.3/64.5 | 179.9/197.3 |
| Mercury (μg/kg) | 13.1/22.4 | — /5.0 | — | 16.6/9.8 | — | — |
| **Organics (μg/kg)** | | | | | | |
| Benzoic Acid | ND | — | — | — /LE | — | — /382 |
| Chloroform | ND | — /63.9 | — /28.1 | — /LE | — | — |
| Hexachlorobutadiene | ND | — | — | 293/LE | — | NSC/— |
| PCBs | ND | 129/— | ND/60 | — /LE | 28/— | NSC/— |
| Toluene | ND | — /20 | — | — /LE | — /22.7 | — |

*Notes:*
— = No results reported
ND = Not Detected
NSC = No Sample Collected
LE = Laboratory Error due to instrument failure, insufficient sample to repeat

### *Personal Communications*

On November 4, 1994, Dr. Thomas D. Mathews of MRRI was contacted concerning specific portions of the CHS with which he was involved. Dr. Mathews indicated that, to his knowledge, the contaminant information provided by the CHS was likely the most current and comprehensive data sets for that portion of the Cooper River near the Naval Base. He stated that the USACOE probably had some data concerning local dredge activities but he has found these data difficult to obtain. The presence and concentrations of organotins in sediments in that reach of the river were also discussed. Dr. Mathews' opinion was that organotin concentrations in the harbor area were most likely not injurious to biota. His opinion was based on information he had obtained from specific NOAA studies.

### AEC VI Phase I Conclusions

As the largest and most complex open water site in Zone J, the PSA of the Cooper River was conducted primarily through review of documented studies. Adequate data regarding the numerous potential contaminant sources and migration pathways from NAVBASE to the Cooper River, biological receptors, and the identification of a suitable reference area have not yet been obtained.

### Sampling Plan

Forty-five sediment and 16 surface water samples are tentatively proposed for the Cooper River and its associated wetlands (AEC VI) and their locations are presented in Figure 4-11. The rationale for the contamination assessment of the Cooper River is to conduct a tiered grid sampling pattern. The grid axes are set on a north-south bearing and variable densities of samples may be collected at select grid nodes. To address offshore AOCs 691 and 692 (the NAVBASE waterfront and free oil areas) and to provide a higher concentration of grid samples close to the NAVBASE shoreline, grid nodes are established on 500-foot centers. To reduce the total number of samples without limiting overall coverage, fewer samples are proposed along the dredged center of the river, where potential contaminants from NAVBASE are less likely to remain, and even fewer along the far shore near Clouter Island. The sampling grid will extend upriver to a point beyond the influence of the tidal wedge, which may transport constituents from NAVBASE upriver during high tide. Several samples are also proposed downriver of NAVBASE to assess the reasonable extent of contamination entering the Charleston Harbor. Due to the temporal and spatial variability of the tidally influenced and mobile surface waters, several sampling events may be necessary.

It is anticipated that the Phase II Contamination Assessment of the Cooper River will be conducted after all relative zone investigations, particularly the Zone L RFI of the NAVBASE sewer systems, have provided sufficient data to guide a more effective selection of focused sampling location within the Cooper River. As sampling is conducted within the RFI zones at

both waterfront sites and perimeter well pairs, more information regarding offsite contaminant migration via surface water, groundwater, and other pathways will be available.

### 4.2.7 ESA VII — Shipyard Creek and Associated Wetlands

A drainage creek to the lower Cooper River, Shipyard Creek is partially included in the southwestern property boundary of NAVBASE and receives the westerly runoff from the central and southern portions of the base (Figure 4-12). The downstream portion of Shipyard Creek is considered a navigable water body, maintained to an USACOE-authorized depth of 30 feet below mean low water level to give large ships access to service piers of a ship maintenance facility on the southwestern shore. Shipyard Creek is dredged approximately once a year according to the USACOE and the last known dredging event took place in 1994. All USACOE dredge spoils were reportedly discharged onto Daniel Island, a designated upland DMA (non-Navy property).

The NAVBASE shoreline hosts numerous wetlands including estuarine intertidal emergent, estuarine intertidal unconsolidated shore, and estuarine subtidal unconsolidated bottom. A significant wetland community also exists in the intertidal emergent zone along Shipyard Creek. Vegetation in this wetland zone is typical for the area and consists primarily of *Spartina* spp.

Potential impacts to this water body include the upstream and nearshore SWMUs and AOCs in ESA V, particularly SWMUs 9, 12, and 20 and AOCs 689 and 690. The periodic dredging of sediment in this creek likely affects communities of benthic organisms. One of the two dewatering outfalls from the dredge materials area discharge into the emergent wetlands along Shipyard Creek.

Consideration will also be given to potential offsite impacts to Shipyard Creek, which include upstream discharges from a ferrochromium plant operating since the 1940s. The offsite facility

is also undergoing a state-required contamination assessment. A commercial shipyard and tank farm also are on the creek's western shore.

## Previous Investigations

### *EPA Dredged Sediment Assessment*

In August 1988, a final report on an assessment of sediments from five proposed dredge locations in the Charleston Estuary was submitted by USEPA to the USACOE. In this report, titled *Biological and Chemical Assessment of Sediments from Proposed Dredge Sites in Charleston Harbor, 1988,* toxicological effects to marine organisms by sediments from proposed dredge locations were presented. For the purposes of this review, only Site 5 (in Shipyard Creek) data were deemed applicable.

Ten-day tests with whole sediment and 96-hour tests with the suspended particulate phase identified no effects to lugworms, oysters, shrimp, or mysids from sediment from Site 5. No significant effects were noted based on this toxicity information.

Along with the toxicological study, chemical analysis of sediment and a bioaccumulation study were conducted at all locations. Concentration information of selected metals in sediment at Site 5 showed only arsenic (76 mg/kg) and zinc (68 mg/kg) to be at concentrations exceeding USEPA Region IV Sediment Screening Values (SSVs) (7.24 mg/kg and 2.0 mg/kg, respectively). Bioaccumulation information indicated that cadmium, mercury, and zinc concentrations were significantly higher in oysters at Site 5 than at the reference location. Mercury, lead, and chromium in Site 5 shrimp were also significantly higher than reference concentrations. Lugworms bioaccumulated lead in tissue above the detection limit of 0.075 $\mu$g/kg. The mean lead concentration was 1.6 $\mu$g/kg.

Figure 4-12 Shipyard Creek (AEC VII)

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***A Physical and Ecological Characterization of the Charleston Harbor Estuarine System***

During this 1990 study, the highest chromium concentrations were detected in Shipyard Creek sediments (81.18 mg/kg at the uppermost station CR13). Copper concentrations in Shipyard Creek exceeded 20 mg/kg. Both these concentrations exceed those observed in the Cooper River.

***Shipyard River New Work Project***

In May 1992, the USACOE conducted a program to collect and analyze soil samples from six sites at Charleston Naval Station near Shipyard River (Creek). The purpose was to provide documentation on the suitability for disposal of this material. Specific parameters analyzed included metals (including organotins), volatile organics, and dioxins.

Results showed the presence of organotins at all six sampling locations with the lowest concentrations for tributyltin found along the shoreline and within the intertidal area and the highest concentrations in terrestrial soils. Several PAH compounds were identified at stations within the woodlands and dioxins were detected in soil/sediment from both inland and intertidal areas.

***EMAP/NS&T Studies in the Carolinian Province: Indicator Testing and Evaluation in Southeastern Estuaries, May 1995.***

Development studies were conducted during a pilot year program (1993) to evaluate existing Environmental Monitoring and Assessment Program (EMAP) indicators and develop new indicators of environmental quality for southeastern Atlantic estuaries. At 24 stations throughout the Carolinian Province, physicochemical parameters were measured in addition to sediment contamination, laboratory toxicity tests, bioaccumulation, and fish, shellfish, and benthos abundance. A single station was sampled in Shipyard Creek (SPY) and classified the tributary as "degraded" based on bulk sediment contamination exceedances of Long and Morgan's (1990) ER-L (effects range-low) values for several metals (33 mg/kg arsenic, 47.8 mg/kg chromium,

29.58 mg/kg copper, 20.86 mg/kg lead, 318.40 mg/kg manganese, and 72.58 mg/kg zinc) and PAH compounds (2,020 μg/kg benzo[a]pyrene, 744 μg/kg chrysene, 744 μg/kg pyrene, and 672 μg/kg benzo[k]fluoranthene). Also, significant toxicity for sediments from Shipyard Creek was found in both the seed clam toxicity test and Microtox® bioassay. Other toxicity tests with amphipods and mysid shrimp, however, indicated that Shipyard Creek sediments were not toxic to these species.

In bioaccumulation studies on oysters, chromium, zinc, copper, nickel, iron, and manganese tissue concentrations were increased after exposure to Shipyard Creek sediment. Benthic community indices for Shipyard Creek were much lower that those found in reference areas.

***Year One Demonstration Project Studies Conducted in the Carolinian Province by Marine Resource Research Institute: Results and Summaries, September 1995.***

Water quality parameters, sediment characteristics, sediment contaminants, sediment toxicity tests, benthic communities, and nektonic (free-swimming) assemblages were evaluated from 84 sites from Virginia to Florida by MRRI during the summer of 1994. One location in Shipyard Creek (CP94SPY) was selected as a supplemental station and sampled during the pilot year, 1994. Comprehensive sampling was not conducted at the supplemental stations, but sediment samples were collected for contaminant analyses, characterization, and toxicity testing. Also, oysters and clams were deployed to determine bioaccumulation rates. Due to the large scale of the figure presented in the MRRI report, the sampling location on Figure 4-12 is approximate.

Relative to NOAA ER-L values, elevated concentrations of PAHs (total PAHs at 8,195.7 μg/kg dry sediment weight), pesticides (0.12 μg/kg dieldrin, 1.02 μg/kg total chlordane, and 9.30 μg/kg total DDT), and the metals arsenic (10.4 mg/kg) and chromium (1,911 mg/kg) were detected in Shipyard Creek sediments during this sampling program. Based on the classification scheme presented in the document, Shipyard Creek was designated as a degraded site.

Survival data for sediment 10-day solid-phase toxicity test, using the amphipod *Ampelisca abdita*, indicated that Shipyard Creek was not toxic. But when amphipod *A. verrilli* was used, survival was significantly lower than the control. In seed clam toxicity assays, Shipyard Creek was shown to be significantly toxic.

For both clam and oysters, growth was significantly different from control groups. As expected, based on the sediment concentrations bioaccumulation studies showed elevated concentrations of chromium (32.18 mg/kg tissue dry weight) in oysters deployed in Shipyard Creek. Clam concentrations did not reflect the sediment loads.

***The Tidal Creek Project, March 1996 (Interim Report)***

In 1994, the South Carolina Marine Resources Research Institute initiated a study to develop information needed to ensure that tidal creek nursery habitats were adequately protected. Twenty-four tidal creeks were sampled for numerous parameters to determine present environmental and ecological status and thus provide resource agencies with a gauge to measure their respective protection policies and programs. Two locations at Shipyard Creek, one in both the upper and lower reaches, were included in this project. The upper reach was defined as a 300-meter section beginning at the headwaters where the minimum water depth was 1 meter at mean high tide. The lower reach was the next 300 meters, making the total length of study area 600 meters.

In this report, Shipyard Creek was classified as a "developed-industrial" tidal creek system with salinities averaging 16.3 nanograms per kilogram (ng/kg) and dissolved oxygen averaging 60% saturation. Physicochemical attributes in Shipyard Creek were similar to other "developed" creeks studies.

Sediment trace metal concentrations for chromium copper, lead, arsenic, and zinc exceeded NOAA ER-L values in the upper reach of the creek, with arsenic, chromium, lead, and zinc

concentrations higher than ER-L in the lower reach (refer to Table 4-5). Chromium also exceeded the effects range-median (ER-M) value (370 ppm) in both reaches of the creek. Pesticide concentrations in the creek were insignificant and PAH concentrations were not measured.

**Table 4-5**
**Trace Metals in Shipyard Creek Sediments**
**1995 Tidal Creek Project**

| Trace Metal | Upper Reach | Lower Reach | ER-L/ER-M |
|---|---|---|---|
| Arsenic | 12 | 17 | 8.2/70 |
| Chromium | 397 | 419 | 81/370 |
| Copper | 64.6 | 21.9 | 34/270 |
| Lead | 107 | 54.6 | 46.7/218 |
| Zinc | 338 | 197 | 150/410 |

*Notes:*
All units are in mg/kg
ER-L and ER-M values are derived from Long et al. 1995.

Benthic assemblage data did not identify anything unique for Shipyard Creek. Species composition and abundance were similar to the other "developed" creeks studied. Grass shrimp populations in the creek were much lower than in the other four creeks selected for comparison. No relationships for shrimp abundance to contaminant exposure, habitat availability, or water quality regimes were presented.

## AEC VII Phase I Conclusions

AEC VII includes the portion of Shipyard Creek from approximately 300 feet southwest of Building 661 downstream to its confluence with the Cooper River. The PSA of Shipyard Creek was conducted from a small boat which could maneuver both within the main channel and along the shallow and narrow cuts made by various shoreline drainage features through the emergent

vegetation. The bank of the creek along NAVBASE property is almost entirely obscured by the estuarine emergent wetland. A small, exposed portion of the bank near the southern peninsula has been reinforced with wooden shoring, apparently to prevent erosion. In the center of the creek several dozen evenly spaced metal poles extend several feet above the water's surface and likely denote the perimeter of an existing or proposed dredge area. Commercial dredging equipment was also staged on several barges in the center of the creek.

Obvious points of tidal conveyance to and from onshore wetlands and drainageways at NAVBASE were observed at several locations. Fewer such areas were present on the southern shore. The southern wetlands were also less widespread, due to the construction of the shipyard and industrial piers. A survey of this opposing shoreline also indicated a potential source of contamination into the creek. Near the ferrochromium plant, debris piles were at or near the water's edge, including tires, scrap metal, and several rusted drums. Several NPDES permitted discharges are also along this shoreline. It is likely that the surface water runoff associated with the debris piles and the point source discharge from the outfalls impact both the water and sediment quality of Shipyard Creek.

In addition to the cordgrass wetland within the creek, riparian vegetation was present along both shorelines, including southern hackberry, mulberry, wax myrtle, and tallowtrees. Wildlife observed in or near this aquatic AEC include numerous wading birds, including green-backed heron, snowy egret, and great blue heron. Seagulls, brown pelicans, kingfisher, and osprey were also foraging in the open waters. An active osprey nest was on the boom of the dredge crane and a pair of red-tailed hawk was also present. Boat-tailed grackle and red-wing blackbirds were foraging throughout the wetland vegetation. Small fish and turtle were seen in the open water portions and fiddler crab were abundant in the wetland mudflats during low tide.

## Sampling Plan

Twenty sediment and surface water samples are tentantively proposed for Shipyard Creek. These include 12 grid-based samples throughout Shipyard Creek and its associated wetlands (AEC VII). These non-site-specific sampling locations are presented in Figure 4-12. Eight additional offshore sediment samples along the southern portion of the creek were proposed as part of the Zone I investigation of AOC 690, the southern roadsides. As critical samples measuring offsite migration and potential impact to Shipyard Creek, it was considered prudent to postpone the collection of these samples until the Zone J AEC VII investigation.

The rationale for the contamination assessment of Shipyard Creek as a whole is similar to that proposed for the Cooper River; that is, the implementation of a tiered sampling grid. As with AEC VI, the grid axes for the creek are set on a north-south bearing and variable concentrations of samples will be collected at select grid nodes. Grid nodes are established on 100-foot centers to provide a higher concentration of grid samples close to the NAVBASE shoreline. To reduce the total number of Zone J samples without limiting overall AEC coverage, few samples are proposed along the dredged center of the creek, where potential contaminants from NAVBASE are less likely to remain, and even fewer along the far shore. Sediment and surface water samples collected during the previous Zone H investigation will be used to characterize upstream conditions. Several grid samples are also proposed downstream to assess the extent of contamination entering the Cooper River.

The Phase II Contamination Assessment of outfalls into the Shipyard Creek will be conducted after all relative zone investigations have provided sufficient data to guide a more effective selection of AEC VII sampling locations. The only zones that border the creek are Zones H and I, both of which have completed field investigations. As sampling is conducted within these waterfront zones and from the perimeter well pairs, more information will be available regarding offsite contaminant migration via surface water, groundwater, and other pathways.

### 4.2.8 ESA VIII — Clouter Island AOCs

An approximately 1,400-acre portion of Clouter Island (Daniel Island/Clouter Creek Dredge Disposal Area) on the eastern side of the Cooper River directly across from NAVBASE has been reserved by the U.S. Navy for dredge deposition. The expansive and relatively uniform interior of the diked dredged material area is dominated by scrub-shrub vegetation. The Clouter Creek Disposal Area routinely received material from the maintenance dredging around the NAVBASE piers (approximately 1,226,000 cubic yards per year, FEIS 1995), although this practice has reportedly been discontinued. A pair of submerged dredge lines leads from the piers to the island and discharge dredged slurry into the large disposal cells. An onsite pump station facilitates the staging or phasing of dredge deposition by means of alternating discharge pipes placed along the island's western shoreline. Coarse sands, which tend to filter out quickly, are deposited on the west half of the island. Fine clays and silts, which predominate as dredge material from the Cooper River, tend to stay suspended longer and are therefore deposited farther away from the discharge point (to the east side of the island). With few remaining dredge deposition sites near NAVBASE, Clouter Island is considered an important resource and no alternative uses are likely to be proposed.

#### AEC VIII Phase I Conclusions

As a noncontiguous property, Clouter Island is the only ESA in which the scope of the RFI limited to AOC-related habitats; therefore, a PSA of the entire island's ecology was not performed. Thus, the PSA of Clouter Island addressed only the ecological components associated with the three AOCs on the wooded southwestern portion of the island (AEC VIII; see Figure 4-13). These AOCs are all associated with the former Naval Ammunition Depot, (AOC 694/Zone K) and presently consists of one structure (Building 117), several large concrete foundations (from Buildings 102, 103, and 106), and a mound of demolition debris near Building 103, a former magazine. AOC 693, an abandoned Fuse and Primer House (Building 117), is the only structure associated with the former naval ammunition depot that remains intact. AOC 695, the former site of the Building 119 (Electric Locomotive Shed), is

currently 50 feet offshore. Review of a 1939 map of the depot, this building was constructed on top of a railroad trestle which extended out from the shore apparently to allow rail access to supply and munition barges. The 1939 map shows the distance of Buildings 102 and 106 to the shoreline to be approximately 50 feet. The foundations of these buildings are now at the shoreline. The site of AOC 695 being underwater, it is uncertain if any of the structure and its associated wharf and trestle remains or if it was removed.

The ammunition depot's rail system, once servicing the entire complex, is no longer present. A portion of the railbed, however, is still evident as an unimproved shoreline road leading northward from the depot. Heavy earth-moving equipment, likely used for dike repair and maintenance, was parked on this road. Nearby, a second area was also used to stage such equipment as evidenced by two large diesel stains (soil had distinct diesel odor). A dredge line ran along side the unimproved road to the north and the base of the dike. Several truckloads of a dry, gray clay-like material, possibly dredge material from a dredge line maintenance event, have been dumped on and around the foundation of Building 102, the former Shell House, along with several discarded sections of dredge line. This foundation and the foundation of Building 106, the former Fixed Ammo Storehouse approximately 150 feet to the north, are more than 15 feet above the surface of the Cooper River. Erosion from the tides and regular flow of the river have removed a considerable portion of the shoreline between the two structures. Each naval depot site at Clouter Island will be investigated during the Zone K RFI for noncontiguous Navy properties.

Habitats associated with this area are the fringe wetlands along the shore, the scrub-shrub around the foundations of Buildings 102 and 106, and the forested bottomland where Building 117 and the remains of Building 103 are located. Typical marsh vegetation dominates the estuarine emergent wetland, including cordgrass and cattail. Wax myrtle, yaupon, and young mulberry and tallowtrees surround the foundations to the north, with several saw palmettos scattered throughout. The bottomland between the dike and the shoreline is dominated by southern

Figure 4-13 AOCs at Clouter Island (AEC VIII)

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hackberry. Very little undergrowth was present, due primarily to the lack of sunlight penetrating the heavy tree canopy and partially to occasional flooding. The southwestern corner of the dredge disposal area's dike is less than 100 feet north of the depot and rises approximately 25 feet above the forest floor. A cleared trail which parallels a second dredge line leads up the slope from the shore to the top of the dike.

The biota of this AEC is similar to biota of analogous wetland and woodland locations in the area such as Shipyard Creek, and may include nesting habitat for migratory and resident wading and shore birds. Wildlife on the island also includes deer, coyote (*Canis latrans*), and rabbit (*Sylvilagus sp.*), confirmed by the presence of both tracks and scat.

**Sampling Plan**

Sufficient data have not been obtained regarding potential contaminant sources and migration pathways from the AOCs at Clouter Island and a suitable reference area. The presence of the ammunition depot and uncertain closure activities indicate the potential presence of hazardous, ignitable, and/or explosive materials. This condition warrants the RFI of the area to proceed to Phase II Contaminant Assessment, including the potential impacts to the Cooper River. However, no additional Zone J sampling will be conducted until the Zone K RFI of the sites provides the initial AOC-specific contaminant characterization.

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