105th Congress, 1st Session – – – – – – – – – – – – House Document 105–164

NAVIGATION PROJECT FOR CAPE FEAR-NORTHEAST RIVERS, NORTH CAROLINA

COMMUNICATION

FROM

THE ACTING ASSISTANT SECRETARY (CIVIL WORKS), THE DEPARTMENT OF THE ARMY

TRANSMITTING

A REPORT ON THE AUTHORIZED DEEP-DRAFT NAVIGATION PROJECT FOR THE CAPE FEAR-NORTHEAST (CAPE FEAR) RIVERS, NORTH CAROLINA, PURSUANT TO PUB. L. 104–303, SEC. 101(a)(22)

NOVEMBER 4, 1997.—Referred to the Committee on Transportation and Infrastructure and ordered to be printed

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U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON : 1998

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DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
CIVIL WORKS
108 ARMY PENTAGON
WASHINGTON DC 20310-0108

REPLY TO
ATTENTION OF

31 OCT 1997

Honorable Newt Gingrich
Speaker of the House
of Representatives
Washington, D.C. 20515

Dear Mr. Speaker:

Section 101(a)(22) of the Water Resources Development Act of 1996, authorized a deep-draft navigation project for the Cape Fear-Northeast (Cape Fear) Rivers, North Carolina. The Secretary of the Army supports the authorization and plans to implement the project through the normal budget process.

The authorized project is described in the report of the Chief of Engineers dated September 9, 1996, which includes other pertinent reports and comments. These reports are in final response to a resolution adopted by the House Committee on Public Works and Transportation on September 8, 1988.

The views of the State of North Carolina, the Departments of the Interior and Health and Human Services, and the Environmental Protection Agency, are set forth in the enclosed communications.

The authorized project maximizes net national economic development benefits consistent with environmental quality. The project consists of deepening the existing navigation channels from the Atlantic Ocean to the Port of Wilmington from a depth of 38 feet below mean low water(MLW) to a depth of 42 feet below MLW, with an additional 2 feet of depth across the ocean bar; deepening the existing 25-foot deep channel in the Northeast Cape Fear River from about 750 feet upstream of Hilton Railroad Bridge to the turning basin near the upstream limits of the project to a depth of 34 feet below MLW, along with widening the channel from about 200 to about 250 feet; extending the length of the anchorage basin opposite the principal terminals at Wilmington from about 1,200 feet to about 1,500 feet; and widening the turning basin at the upstream end of the

Federal project from about 700 feet to about 800 feet. Fish and wildlife mitigation involves the restoration of about 27 acres of upland sites to mitigate for the loss of approximately 13.4 acres of existing marsh and shallow water habitats.

Based on October 1995 prices, the estimated total first cost of the authorized project is about $225,435,000, of which about $134,878,000 would be Federal and about $90,557,000 would be non-Federal. All costs associated with the removal of electric cables and other obstructions in navigable waters of the United States and for which the facility owners do not have a compensable real estate property interest, currently estimated at $3,000,000, are to be paid by the facility owner and are not included in the projects first cost.

The Office of Management and Budget advises that there is no objection to the submission of the report to the Congress. A copy of its letter is enclosed in the report.

Sincerely,

John H. Zirschky
Acting Assistant Secretary of the Army
(Civil Works)

Enclosure

COMMENTS OF THE OFFICE OF MANAGEMENT AND BUDGET

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

1997

The Honorable John H. Zirschky
Acting Assistant Secretary of the
Army for Civil Works
Pentagon - Room 2E570
Washington, D.C. 20310-0108

Dear Dr. Zirschky:

As required by Executive Order 12322, we have completed our review of former Assistant Secretary Lancaster's recommendation for the report of the Cape Fear - Northeast Cape Fear Rivers, Wilmington, North Carolina.

The recommendation for this project in his letter of October 31, 1996, is consistent with the policies and program of the President. The Office of Management and Budget does not object to submission of this report to Congress.

Sincerely,

Kathleen Peroff
Deputy Associate Director
Energy and Science Division

COMMENTS OF THE STATE OF NORTH CAROLINA

North Carolina Department of Cultural Resources

James B. Hunt Jr., Governor
Betty Ray McCain, Secretary

Division of Archives and History
Jeffrey J. Crow, Director

August 14, 1996

AUG 1996
RECEIVED
SECRETARY'S OFFICE
DOA

Lt. Col. Terry R. Youngbluth
District Engineer
U.S. Army Corps of Engineers
Wilmington District
P.O. Box 1890
Wilmington, NC 28402-1890

Re: DEIS/Feasibility report, Cape Fear-Northeast Cape Fear Rivers Study, New Hanover County, 96-E-0000-0533, 97-E-0000-0015, ER 97-7113

Dear Lt. Col. Youngbluth:

Thank you for the opportunity to review the final environmental impact statement for the above project.

We concur with the recommendations made on page 56 of the EIS that "a magnetometer survey will be conducted of those ranges [Lower Swash, Battery Island, Southport, Baldhead-Caswell, Smith Island] and any targets located during the survey will be investigated and evaluated during Preconstruction Engineering and Design Studies."

The above comments are made pursuant to Section 106 of the National Historic Preservation Act and the Advisory Council on Historic Preservation's Regulations for Compliance with Section 106 codified at 36 CFR Part 800.

Thank you for your cooperation and consideration. If you have questions concerning the above comment, please contact Renee Gledhill-Earley, environmental review coordinator, at 919/733-4763.

Sincerely,

David Brook

David Brook
Deputy State Historic Preservation Officer

DB:slw

cc: Stephen B. Benton, Division of Coastal Management
State Clearinghouse
David B. Sanford Jr., Army Corps of Engineers, Washington, D.C.

State of North Carolina
Department of Environment,
Health and Natural Resources
Legislative & Intergovernmental Affairs

James B. Hunt, Jr., Governor
Jonathan B. Howes, Secretary
Richard E. Rogers, Jr., Acting Director

DEHNR

MEMORANDUM

TO: Chrys Baggett
State Clearinghouse

FROM: Melba McGee
Project Review Coordinator

RE: 97-0015 Final Feasibility Report and EIS on Improvement of Navigation - Cape Fear/NE Cape Fear Comprehensive Study, New Hanover County

DATE: August 16, 1996

The Department of Environment, Health, and Natural Resources has reviewed the proposed project. We concur with the findings of this document provided careful consideration be given to the concerns made by the N.C. Wildlife Resources Commission and the Division of Water Quality. I encourage the applicant to continue coordinating with our commenting agencies throughout the final planning stages of this project. This will help avoid unnecessary delays during the permit review process.

Thank you for the opportunity to respond.

attachments

State of North Carolina
Department of Environment,
Health and Natural Resources
Division of Water Quality

James B. Hunt, Jr., Governor
Jonathan B. Howes, Secretary
A. Preston Howard, Jr., P.E., Director

DEHNR

AUG 1996
RECEIVED
SECRETARY'S OFFICE
DOA

August 12, 1996

MEMORANDUM

To: Melba McGee

Through: John Dorney

From: Greg Price

Subject: Final Feasibility Report and EIS on Improvement of Navigation - Cape Fear/NE Cape Fear Comprehensive Study
New Hanover County
EHNR #97-0015

The subject document has been reviewed by this office. The Division of Water Quality (DWQ) is responsible for the issuance of the Section 401 Water Quality Certification for activities which impact waters of the state including wetlands. The following comments are offered in response to the FEIS.

1. In regards to the rock blasting issue, the Corps must comply to condition #3 of the 401 certification (WQC #2971) issued for the Wilmington Harbor Channel Widening project on February 9, 1995. Condition #3 states that written DEM approval for blasting is required after consultation with other state and federal agencies. Any fish or other aquatic organisms killed during blasting must be replaced at a cost to be determined by these agencies.

2. The DWQ concurs with the proposed mitigation plan which includes the use of Island #13 or #14 for restoration combined with prevention of degradation (POD) at Tonys and Lagoon Creeks.

3. If post monitoring indicates a community shift from swamp forest to brackish marsh, mitigation for swamp forest loss may be required.

The applicant is reminded that endorsement of an EIS by DWQ would not preclude the denial of a 401 Certification upon application if wetland impacts have not been avoided and minimized to the maximum extent practicable. Questions regarding the 401 Certification should be directed to Greg Price (733-1786) in DWQ's Environmental Sciences Branch.

cc: Michelle Suverkrubbe
Jim Gregson, Wilmington DWQ Regional Office

North Carolina Wildlife Resources Commission

512 N. Salisbury Street, Raleigh, North Carolina 27611, 919-733-3391
Charles R. Fullwood, Executive Director

AUG 1993

MEMORANDUM

TO: Melba McGee
Office of Legislative & Intergovernmental Affairs

FROM: Bennett Wynne
Habitat Conservation Program

DATE: August 2, 1996

SUBJECT: US Army Corps of Engineers (Corps) Final Feasibility Report and Environmental Impact Statement on Improvement of Navigation; Cape Fear-Northeast Cape Fear Rivers Comprehensive Study, Project Number: 97-0015, New Hanover County, North Carolina.

The Wildlife Resources Commission has completed a review of the project and associated impacts on wildlife and fishery resources. Our comments are provided in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et. seq.).

Many of the concerns we raised during our March 21, 1996 review of the draft are adequately addressed in the final version of this document. We still have some comments, however.

Spill Potential - Larger vessels carrying bigger loads increase the potential severity of a hazardous material spill should an accident occur. We consider this a legitimate fish and wildlife resource concern. So far as we can tell, neither the Coast Guard nor insurance companies have been contacted to determine whether existing resources are adequate to contain, treat, and clean up a bigger spill. This should be investigated and included in the Final document.

Blasting - We understand that pre- and post-blast plans will be cooperatively developed by the review and regulatory agencies over the next 2 years. We continue to emphasize that the post-blast plan should include a quantitative assessment of species and sizes injured or killed.

Salinity Intrusion - In our May 15, 1996 memo providing supplemental comments to the Corps (copy attached), we recommended refinements to the groundwater model and variables to be included in the surface water monitoring program. We also recommended mitigation for possible conversion of wooded wetlands to salt marsh. The recommendations in this memo should be incorporated into these ongoing efforts.

Provided our comments are addressed, we will find the project consistent with our *Policies and Guidelines for Conservation of Wetlands and Aquatic Habitats*. Thank you for the opportunity to comment. If you need to discuss these comments or need additional assistance, please call me at (919) 522-9736.

cc: William Wescott, Coastal HabCon Coordinator
s:\boatfish\habcon\coast\d2 (wlhrb3.doc)

North Carolina Wildlife Resources Commission

512 N. Salisbury Street, Raleigh, North Carolina 27604-1188, 919-733-3391
Charles R. Fullwood, Executive Director

MEMORANDUM

To: C.E. Shuford, Jr., P.E., Acting Chief
Engineering and Planning Division, USACOE

From: Franklin T. McBride, Manager Franklin T McBride
Habitat Conservation Program

Date: May 15, 1996

Subject: Supplemental comments regarding the April 18, 1996 interagency meeting at the District Office in Wilmington.

Preliminary results of the groundwater model and additional results of the surface water saltwater intrusion model, both associated with deepening and widening the Wilmington harbor channel, were presented at the April 18 meeting. An alternative mitigation site for primary nursery area, which will be lost to dredging, was also described. The following are our comments regarding each of these project components follows.

Preliminary groundwater model results: NC Division of Water Resources and the Corps of Engineers (Corps) presented preliminary results indicating that salt water intrusion into the region's groundwater aquifers will not be significant. However, presenters emphasized that the model is a regional model and does not have the resolution to predict actual responses at specific locations. Therefore, our concerns for freshwater mussel and Greenfield rams-horn snail populations in Town Creek remain unchanged. Town Creek is a unique aquatic system having greater than average groundwater inflow, limestone substrates, and neutral pH. **We recommend that subsequent model refinements include expanded test wells and monitoring along the Town Creek watershed. Also, final model results should include projections 10-20 years into the future to account for increased pumping of groundwater associated with additional regional development.**

Additional results of the surface water saltwater intrusion model: Model calculations run under normal flows confirmed the results of the earlier run under low flow conditions predicting that channel deepening to 44 feet would decrease river salinity. Even if this does prove to be true, greater tidal amplitude (2 inch higher high tides) will send water containing some salt farther into mature wooded wetlands. We fully expect some conversion of bottomland swamp to salt marsh. Values of each habitat type to fish and wildlife resources may not be equal. Wildlife species favoring wooded wetlands such as black bear, wood duck, and American woodcock would be adversely affected by the habitat shift. The Corps has committed to a monitoring program for the project. **We recommend that the monitoring program be conducted for a minimum of 5 years, preferably 10 years, to include the following variables:**

1. area estimates of herbaceous vegetation and woody vegetation in wetlands;

2. tree mortality in wetlands;

3. salinity of surficial aquifer; and

4. salinity of river at surface and bottom.

If the area of wooded wetlands has been diminished by conversion to salt marsh at the end of the monitoring period, we further recommend that wooded wetland loss be mitigated at a 2:1 ratio. The low ratio (for wooded wetland mitigation) acknowledges the value of salt marsh, while still providing replacement of an increasingly threatened habitat type.

Alternative mitigation site: It is our understanding the new, alternative mitigation site involves preservation of some 835 acres of functioning primary nursery, swamp forest, and upland longleaf pine habitats upstream of Wilmington as opposed to the original plan of restoring 27 acres of previously filled primary nursery habitat downriver of the city. The alternative site appears to be of high value to fish and wildlife resources and at risk of being clearcut (swamp forest) and/or developed (upland longleaf pine). We routinely favor restoration over preservation for projects requiring mitigation because no net loss of wetlands occurs. However, due to the apparent value and vulnerability of the alternative site, we are willing to consider a combination of restoration and preservation for this project.

Thank you very much for the additional opportunity to comment. If you have any questions regarding these comments, please call Bennett Wynne at (919) 522-9736.

cc: Bennett Wynne
William Wescott
s-drive

State of North Carolina
Department of Environment,
Health and Natural Resources
Division of Coastal Management

James B. Hunt, Jr., Governor
Jonathan B. Howes, Secretary
Roger N. Schecter, Director

DEHNR

MEMORANDUM

TO: Melba McGee, NC Division of Policy and Development
FROM: Steve Benton, NC Division of Coastal Management

SUBJECT: Review of SCH # 97- 0015 **DATE:** 7/15/96

AUG 1996

✓ **A Copy of All Comments Received by the SCH is Requested** ___ **Reviewer Comments Attached**

Review Comments:

✓ This document is being reviewed for consistency with the NC Coastal Management Program pursuant to federal law and/or NC Executive Order 15. Agency comments received by SCH are needed to develop the State's consistency position.
Project Review Number (if different from above) CD96-20.
A Consistency position will be developed based on our review on or before 8/22/96.

___ A Consistency Determination document ___ is, or ___ may be required for this project. Applicant should contact Steve Benton or Caroline Bellis in Raleigh, phone # (919) 733-2293, for information on the proper document format and applicable state guidelines and local land use plan policies.

___ Proposal is in draft form, a consistency response is inappropriate. A Consistency Determination should be included in the final document.

___ A Consistency Determination document (pursuant to federal law and/or NC Executive Order 15) is not required.
___ A consistency response has already been issued.
Project No. ______________. Date issued ______________.
___ Proposal involves < 20 Acres or a structure < 60,000 Sq. Feet and no AEC's or Land Use Plan problems.
___ Proposal is not in the Coastal Area and will have no significant impacts on any land or water use or natural resource of the Coastal Area.

___ A CAMA Permit ___ is, or ___ may be required for all or part of this project proposal. Applicant should contact ______________ in ______________, phone # ______________, for information.

___ A CAMA Permit ___ has already been issued, or ___ is currently being reviewed under separate circulation.
Permit No. ______________. Date issued ______________.

___ Other (see attached).

State of North Carolina Consistency Position:

___ The proposal is consistent with the NC Coastal Management Program provided that all conditions are adhered to and that all state authorization and/or permit requirements are met prior to implementation of the project.

___ The proposal is inconsistent with the NC Coastal Management Program.

___ Other (see attached)

COMMENTS OF THE DEPARTMENT OF THE INTERIOR

United States Department of the Interior

OFFICE OF THE SECRETARY
Washington. D.C. 20240

AUG 26 1996

ER 96/450

Mr,. David B. Sanford, Jr.
Chief, Policy Review and Analysis Division
Policy Review Branch
ATTN: CECW-AR (SA)
7701 Telegraph Road
Alexandria, Virginia 22315-3861

Dear Mr. Sanford:

The Department of the Interior has completed its review of the proposed Chief of Engineers report and Final Environmental Impact Statement for the Cape Fear - Northeast Cape Fear Rivers Comprehensive Study Wilmington, New Hanover, and Brunswick Counties, North Carolina.

We have no comments on these documents and do not object to the proposed project.

Sincerely,

Willie R. Taylor

Willie R. Taylor
Director, Office of Environmental Policy and Compliance

COMMENTS OF THE ENVIRONMENTAL PROTECTION AGENCY

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION 4

345 COURTLAND STREET, N.E.
ATLANTA, GEORGIA 30365

Washington Level Review Center
ATTN: CECW-AR (IP)
7701 Telegraph Road
Alexandria, VA 22315-3861

Subject: Final Environmental Impact Statement (EIS) for Cape Fear, Northeast Cape Fear River, New Hanover and Brunswick Counties, NC

Dear Mr. Sanford:

Pursuant to Section 309 of the Clean Air Act and Section 102 (2)(C) of the National Environmental Policy Act, EPA, Region 4 has reviewed the subject document evaluating the consequences of upgrading the navigational capability of the Wilmington Harbor complex.

On the basis of this assessment we were able to determine that the proposed monitoring and mitigation measures are competent to address our original concerns about this proposal. The additional information collected during these on-going studies should determine the trend of long-term project impacts and the significance thereof.

Thank you for the opportunity to comment. If we can be of further assistance, Dr. Gerald Miller (404-347-3555 VM 6853) will serve as initial point of contact.

Sincerely yours,

Heinz Mueller

Heinz J. Mueller, Chief
Environmental Policy Section
Federal Activities Branch

COMMENTS OF THE DEPARTMENT OF HEALTH AND HUMAN SERVICES

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Centers for Disease Control
and Prevention (CDC)
Atlanta GA 30341-3724

July 30, 1996

David B. Sanford, Jr., Chief
Policy Review and Analysis Division
Policy Review Branch
U.S. Army Corps of Engineers
Washington, D.C. 20314-1000

Dear Mr. Sanford:

Thank you for sending a copy of the Final Environmental Impact Statement (FEIS) on Improvement of Navigation, Cape Fear - Northeast Cape Fear Rivers Comprehensive Study, Wilmington, North Carolina. We are responding on behalf of the U.S. Public Health Service.

We believe the FEIS has adequately addressed our potential concerns, and we have no specific comments to offer at this time. The planned mitigation measures should, if adequately implemented, minimize adverse environmental impacts. We noted that the additional modeling efforts presented in this document indicate that saltwater intrusion into the surface or groundwater should not be a problem. However, because of the uncertainties in the model results and predicted increase in tidal range, it is stated that a monitoring plan will be developed. We concur that a monitoring plan should be implemented.

Thank you for adding this address to your mailing list to receive future DEIS's which may indicate potential public health impacts and are developed under the National Environmental Policy Act (NEPA).

Sincerely,

Kenneth W. Holt

Kenneth W. Holt, M.S.E.H.
Special Programs Group (F-29)
National Center for Environmental Health

CAPE FEAR - NORTHEAST RIVERS, NORTH CAROLINA

REPORT OF THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF:

CECW-PE (10-1-7a) 9 Sep 96

SUBJECT: Cape Fear - Northeast (Cape Fear) Rivers, North Carolina

THE SECRETARY OF THE ARMY

1. I submit for transmission to Congress my report on the Cape Fear - Northeast (Cape Fear) Rivers comprehensive navigation study. It is accompanied by the report of the district and division engineers. These reports are in final response to a resolution of the Committee on Public Works and Transportation of the United States House of Representatives adopted 8 September 1988. This resolution directed review of previous reports on the Cape Fear and Northeast Cape Fear Rivers, North Carolina, with a view to determining whether any modifications of the recommendations contained therein are advisable at this time with particular reference to the commercial navigation needs from the Atlantic Ocean to the upper ends of navigation on the Cape Fear River above Wilmington to Fayetteville, North Carolina, and to Kornegays Bridge on the Northeast (Cape Fear) River. Preconstruction engineering and design activities will be continued under this authority.

2. The reporting officers recommend the following improvements to Wilmington Harbor:

a. Deepening the channels from the Atlantic Ocean to Wilmington from 38 feet to 42 feet, with 2 feet additional depth across the ocean bar;

b. Deepening the existing 25-foot channel in the Northeast Cape Fear River from 750 feet upstream of Hilton Railroad Bridge to the turning basin near the upstream limits of the project to 34 feet, along with widening the channel from 200 to 250 feet;

c. Extending the anchorage basin opposite the principal terminals at Wilmington from 1,200 feet to 1,500 feet; and

d. Widening the turning basin at the upstream end of the Federal project from 700 feet to 800 feet.

e. Dredged material from project construction will be placed in an ocean dredged material disposal site and a confined harbor channel upland site. An additional confined harbor channel upland site will be used for disposal of project maintenance dredged material.

The total length of the channel deepening is approximately 38 miles and will alleviate the channel depth constraints which now require that the larger vessels be loaded to less than capacity to enter and leave the port. Mitigation features involve restoration of 27 acres of upland sites to mitigate for the loss of approximately 13.4 acres of existing marsh and shallow water habitat. The recommended plan is the national economic development plan.

3. The Administration is in the process of developing a new cost sharing policy for dredged material disposal facilities associated with Federal navigation projects. This proposal would allow the cost of diking and other improvements necessary for proper disposal of dredged material to be considered a general navigation feature and cost-shared accordingly. The operation, maintenance, repair, replacement and rehabilitation (OMRR&R) of the disposal facility would be 100 percent Federal, except for disposal facilities for projects in excess of 45 feet where the non-Federal sponsor would share 50 percent of the incremental OMRR&R costs. This proposal is currently being considered by Congress as part of the 1996 water resources development bill.

4. Project costs are allocated to the commercial navigation project purpose. The following project costs and cost sharing differ from the reporting officer's recommendation and are consistent with the Administration's new cost sharing policy. At October 1995 prices, the estimated total first cost of the recommended plan is $225,435,000, of which $135,341,000 would be Federal and $90,094,000 would be non-Federal. The non-Federal portion includes an additional payment of 10 percent of the construction of the general navigation features (GNF), with interest, less credit for the value of lands, easements and rights-of-way (LER). Total project costs include $206,841,000 for general navigation features, $120,000 for aids to navigation, $311,000 for LER, and $18,163,000 for non-Federal associated costs for berthing area modifications. All costs associated with removal of electric cables and other obstructions in navigable waters of the United States and for which the facility owners do not have compensable real estate property interests, currently estimated at $3,000,000, are to be paid by the facility owners and are not included in the project first cost. Average annual benefits and costs, based on a discount rate of 7.625 percent and a 50-year period of analysis, are estimated at $24,663,000 and $19,799,000, respectively, including $569,000 for OMRR&R. The ratio of benefits to costs is 1.2 to 1.

5. Washington level review indicates that the proposed plan is technically sound, economically justified, and environmentally acceptable. The proposed project complies with applicable U.S. Army Corps of Engineers planning procedures and regulations. Also, the views of interested parties, including Federal, State, and local agencies have been considered.

6. Accordingly, I recommend implementation of the proposed project generally in accordance with the reporting officers recommended plan, and subject to cost sharing that is consistent with Administration policy. My recommendation is also subject to the non-Federal sponsor agreeing to

comply with applicable Federal laws and policies, including the following requirements:

· Provide, operate, maintain, repair, replace, and rehabilitate, at its own expense, the local service facilities in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;

· Provide all lands, easements, and rights-of-way, and perform or ensure the performance of all relocations determined by the Federal Government to be necessary for the construction, operation, maintenance, repair, replacement, and rehabilitation of the general navigation features;

· Accomplish all removals determined necessary by the Federal Government other than those removals specifically assigned to the Federal Government;

· Provide, during the period of construction, a cash contribution equal to 25 percent of the total cost of construction of the general navigation features for costs attributable to dredging to a depth in excess of 20 feet but not in excess of 45 feet;

· Repay with interest, over a period not to exceed 30 years following completion of the period of construction of the project, an additional 0 to 10 percent of the total cost of construction of general navigation features depending upon the amount of credit given for the value of lands, easements, rights-of-way, and relocations provided by the non-Federal sponsor for the general navigation features. If the amount of credit exceeds 10 percent of the total cost of construction of the general navigation features, the non-Federal sponsor shall not be required to make any contribution under this paragraph, nor shall it be entitled to any refund for the value of lands, easements, rights-of-way, and relocations in excess of 10 percent of the total cost of construction of the general navigation features;

· Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the general navigation features for the purpose of inspection, and, if necessary, for the purpose of operating, maintaining, repairing, replacing, and rehabilitating the general navigation features;

· Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, replacement, and rehabilitation of the project, any betterments, and the local service facilities, except for damages due to the fault or negligence of the United States or its contractors;

· Keep, and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, and other evidence is required, to the extent and in such detail as will properly reflect total cost of construction of the general navigation features, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and local governments at 32 CFR Section 33.20;

· Perform, or cause to be performed, any investigations for hazardous substances as are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the construction, operation, maintenance, repair, replacement, or rehabilitation of the general navigation features. However, for lands that the Government determines to be subject to the navigation servitude, only the Government shall perform such investigation unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;

· Assume complete financial responsibility, as between the Federal Government and the non-Federal sponsor, for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the construction, operation, maintenance, repair, replacement, and rehabilitation of the general navigation features;

· To the maximum extent practicable, perform its obligations in a manner that will not cause liability to arise under CERCLA;

· Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way, required for construction, operation, maintenance, repair, replacement, and rehabilitation of the general navigation features, and inform all affected persons of applicable benefits, policies, and procedures in connection with said act;

· Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and

Activities Assisted or Conducted by the Department of the Army"; and

· Provide a cash contribution equal to 25 percent of the total historic preservation mitigation and data recovery costs attributable to commercial navigation that are in excess of 1 percent of the total amount authorized to be appropriated for commercial navigation.

7. The recommendation contained herein reflects the information available at this time and current departmental policies governing formulation of individual projects. It does not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program nor the perspective of higher review levels within the executive branch. Consequently, the recommendation may be modified before it is transmitted to the Congress as a proposal for authorization and implementation funding. However, prior to transmittal to the Congress, the sponsor, the State of North Carolina; the North Carolina State Ports Authority; interested Federal agencies; and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

PAT M. STEVENS IV
Major General, USA
Acting Chief of Engineers

REPORT OF THE DISTRICT ENGINEER

SYLLABUS

This feasibility report was prepared in final response to a resolution adopted 8 September 1988 by the United States House of Representatives. The authorizing resolution directs that the existing Federal project for Wilmington Harbor be reviewed and improvements considered.

The District Engineer recommends the following improvements to Wilmington Harbor:

- Deepening the channels from the Atlantic Ocean to Wilmington from 38 feet to 42 feet, with 2 feet additional depth across the ocean bar.

- Deepening the 25-foot channel in the upriver portion of the harbor to 34 feet, along with widening the channel from the existing width of 200 feet to 250 feet.

- Enlarging two anchorage/turning basins.

The total length of the channel deepening is approximately 38 miles. Alternatives evaluated included lesser and greater channel depths. In addition, deepening of other portions of Wilmington Harbor was evaluated, and found to be economically infeasible.

The Recommended Plan of Improvement will alleviate the channel depth constraints which now require that the larger vessels be loaded to less than capacity to enter and leave the port.

Economic benefits for the Recommended Plan of Improvement consist of vessel operating cost savings for oceangoing vessels. With expected annual benefits estimated at $24,663,000 and average annual costs estimated at $19,799,000, the project benefit-cost ratio is 1.2 to 1. Project first costs are currently estimated at $228,435,000.

The fully funded first cost for the project, adjusted for inflation based on Office of Management and Budget guidelines and the expected project construction schedule, is currently estimated at $272,000,000. Project first costs will be shared between the Federal Government and the non-Federal sponsor. The State of North Carolina is the non-Federal sponsor for the Recommended Plan. The Federal share of the fully funded project first cost is currently estimated at $163,337,000. The non-Federal share of the fully funded project first cost is currently estimated at $108,663,000.

The principal environmental concerns associated with the Recommended Plan are the possible effects of rock blasting and dredging on aquatic life, including five endangered or threatened species. These species include the shortnose sturgeon, manatee, and three species of sea turtles. Mitigative measures, including pre- and postblast monitoring, protective barriers (air curtains or suspended sheet wall), and seasonal blasting and dredging restrictions have been incorporated into the Recommended Plan to minimize the possibility of adverse impacts on these species.

CAPE FEAR - NORTHEAST CAPE FEAR RIVERS

COMPREHENSIVE STUDY

WILMINGTON, NORTH CAROLINA

**ADDENDUM TO THE
FEASIBILITY REPORT
AND ENVIRONMENTAL IMPACT STATEMENT
ON IMPROVEMENT OF NAVIGATION**

This Addendum contains (1) the Project Cost Allocation at October 1995 price level, (2) the following additional environmental information received since publication of the Final Feasibility Report and Environmental Impact Statement in June 1996:

1. Section 404(B)(1) Evaluation
2. Fish and Wildlife Service Biological Opinion
3. National Marine Fisheries Service Biological Opinion

JULY 1996

Cost Apportionment, Selected Plan of Improvement
Based on WRDA 86 Cost Sharing Policies
(Note: Costs based on MCACES cost estimate, at 1 Oct 95 price levels)
(in $)

ITEM	TOTAL	NON-FEDERAL	FEDERAL
General Navigation Features (75% Federal, 25% Non-Federal)			
Channel Improvements	189,591,000	46,935,000	142,656,000
Plng., Eng., and Design	6,070,000	1,517,000	4,553,000
Construction Management	3,721,000	930,000	2,791,000
Subtotal, General Navigation	199,382,000	49,382,000	150,000,000
Related Costs			
Navigation Aids	120,000	0	120,000
Berthing Areas (Associated Costs)	18,163,000	18,163,000	0
Subtotal, Related Costs	18,283,000	18,163,000	120,000
LERRD			
Disposal Areas	7,459,000	7,459,000	0
Lands	311,000	311,000	0
Subtotal, LERRD	7,770,000	7,770,000	0
Total Federal Project Costs	**225,435,000**	**75,315,000**	**150,120,000**
10% of Gen. Nav. Features (GNF)		19,938,000	
LERRD's Credit		-7,770,000	
Sponsor's Estimated Future Reimbursement		12,168,000	
Adjustment for LERRD			
Ultimate Cost Apportionment	**225,435,000**	**87,483,000**	**137,952,000**
Future Reimbursement		-12,168,000	+12,168,000
Initial Cost Apportionment	**225,435,000**	**75,315,000**	**150,120,000**
Adjustment for non-Federal owner removal costs		3,000,000	
Total Project Costs	**228,435,000**		

Average annual OMRR&R costs of $280,000 are a Federal responsibility.

SECTION 404(B)(1) (PUBLIC LAW 95-217) EVALUATION
CAPE FEAR - NORTHEAST CAPE FEAR RIVERS
COMPREHENSIVE STUDY
WILMINGTON, NORTH CAROLINA

Evaluation of Section 404(b)(1) Guidelines
40 CFR 230

1. Review of Compliance (230.10(a)-(d)) Review of the NEPA Document indicates:	Preliminary 1/		Final 2/	
a. The discharge represents the least environmentally damaging practicable alternative and if in a special aquatic site, the activity associated with the discharge must have direct access or proximity to, or be located in the aquatic ecosystem to fulfill its basic purpose (if no, see section 2 and NEPA document);	YES[ ]	NO[ ]*	YES[X]	NO[ ]
b. The activity does not: 1) violate applicable State water quality standards or effluent standards prohibited under Section 307 of the CWA; 2) jeopardize the existence of federally listed endangered or threatened species or their habitat; and 3) violate requirements of any federally designated marine sanctuary (if no, see section 2b and check responses from resource and water quality certifying agencies);	YES[ ]	NO[ ]*	YES[X]	NO[ ]
c. The activity will not cause or contribute to significant degradation of waters of the U.S. including adverse effects on human health, life stages of organisms dependent on the aquatic ecosystem, ecosystem diversity, productivity and stability, and recreational, aesthetic, and economic values (if no, see section 2);	YES[ ]	NO[ ]*	YES[X]	NO[ ]
d. Appropriate and practicable steps have been taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem (if no, see section 5).	YES[ ]	NO[ ]*	YES[X]	NO[ ]

Proceed to Section 2

*, 1, 2/ See page 14

2. Technical Evaluation Factors (Subparts C-F)

	N/A	Not Significant	Significant*
a. Physical and Chemical Characteristics of the Aquatic Ecosystem (Subpart C)			
(1) Substrate impacts.		X	
(2) Suspended particulates/turbidity impacts.		X	
(3) Water column impacts.		X	
(4) Alteration of current patterns and water circulation.		X	
(5) Alteration of normal water fluctuations/hydroperiod.		X	
(6) Alteration of salinity gradients.		X	
b. Biological Characteristics of the Aquatic Ecosystem (Subpart D)			
(1) Effect on threatened/endangered species and their habitat.		X	
(2) Effect on the aquatic food web.		X	
(3) Effect on other wildlife (mammals, birds, reptiles, and amphibians).		X	
c. Special Aquatic Sites (Subpart E)			
(1) Sanctuaries and refuges.	X		
(2) Wetlands.		X	
(3) Mud flats.		X	
(4) Vegetated shallows.	X		
(5) Coral reefs.	X		
(6) Riffle and pool complexes.	X		
d. Human Use Characteristics (Subpart F)			
(1) Effects on municipal and private water supplies.		X	
(2) Recreational and commercial fisheries impacts.		X	
(3) Effects on water-related recreation.		X	
(4) Aesthetic impacts.		X	
(5) Effects on parks, national and historical monuments, national seashores, wilderness areas, research sites, and similar preserves.	X		

Remarks: Where a mark is placed under the significant category, preparer add explanation below.

Proceed to Section 3

*See page 14

3. Evaluation of Dredged or Fill Material (Subpart G) 3/

a. The following information has been considered in evaluating the biological availability of possible contaminants in dredged or fill material. (Mark only those appropriate.)

(1) Physical characteristics . . . . |X|
(2) Hydrography in relation to known or anticipated sources of contaminants . . . . |X|
(3) Results from previous testing of the material or similar material in the vicinity of the project . . . . |X|
(4) Known, significant sources of persistent pesticides from land runoff or percolation. . . . . |_|
(5) Spill records for petroleum products or designated (Section 311 of CWA) hazardous substances. . . . . |X|
(6) Other public records of significant introduction of contaminants from industries, municipalities, or other sources . . . . |X|
(7) Known existence of substantial material deposits of substances which could be released in harmful quantities to the aquatic environment by man-induced discharge activities . . . . |_|

(8) Other sources (specify) . . . . |_|

List appropriate references.
Reference: Final Environmental Impact Statement, Cape Fear - Northeast Cape Fear Rivers Comprehensive Study, New Hanover and Brunswick Counties, North Carolina

b. An evaluation of the appropriate information in 3a above indicates that there is reason to believe the proposed dredge or fill material is not a carrier of contaminants, or that levels of contaminants are substantively similar at extraction and disposal sites and not likely to result in degradation of the disposal site. The material meets the testing exclusion criteria. YES |X| NO |_|*

Proceed to Section 4

*, 3/, see page 14

4. Disposal Site Determinations (230.11(f)).

a. The following factors as appropriate, have been considered in evaluating the disposal site.

(1) Depth of water at disposal site . . . . |X|

(2) Current velocity, direction, and variability at disposal site . . . . |X|

(3) Degree of turbulence . . . . |X|

(4) Water column stratification . . . . |X|

(5) Discharge vessel speed and direction . . . . |X|

(6) Rate of discharge . . . . |X|

(7) Dredged material characteristics (constituents, amount and type of material, settling velocities). . . . . |X|

(8) Number of discharges per unit of time . . . . |X|

(9) Other factors affecting rates and patterns of mixing (specify)

List appropriate references.

Reference: Final Environmental Impact Statement, Cape Fear - Northeast Cape Fear Rivers Comprehensive Study, New Hanover and Brunswick Counties, North Carolina

b. An evaluation of the appropriate factors in 4a above indicates that the disposal site and/or size of mixing zone are acceptable . . . .YES |X| NO |_|*

5. Actions to Minimize Adverse Effects (Subpart H).

All appropriate and practicable steps have been taken, through application of recommendations of 230.70-230.77, to ensure minimal adverse effects of the proposed discharge. List actions taken. YES |X| NO |_|*

For water quality see Section 5.01 of the EIS
For benthos see Section 5.02 of the EIS.
For fisheries see Section 5.02 of the EIS.
For mitigation see Section 5.06 of the EIS.
For threatened and endangered species see Section 5.07 of the EIS.

Return to section 1 for final stage of compliance review. See also note 3/, page 14

*See page 14

6. Factual Determinations (230.11).

A review of appropriate information as identified in items 2-5 above indicates that there is minimal potential for short- or long-term environmental effects of the proposed discharge as related to:

a. Physical substrate at the disposal site (review sections 2a, 3, 4, and 5). YES |X| NO |_|*

b. Water circulation, fluctuation, and salinity (review sections 2a, 3, 4, and 5). YES |X| NO |_|*

c. Suspended particulates/turbidity (review sections 2a, 3, 4, and 5). YES |X| NO |_|*

d. Contaminant availability (review sections 2a, 3, and 4). YES |X| NO |_|*

e. Aquatic ecosystem structure ar function (review sections 2b and c, 3, and 5). YES |X| NO |_|*

f. Disposal site (review sections 2, 4, and 5). YES |X| NO |_|*

g. Cumulative impact on the aquatic ecosystem. YES |X| NO |_|*

h. Secondary impacts on the aquatic ecosystem. YES |X| NO |_|*

7. Findings.

a. The proposed disposal site for discharge of dredged or fill material complies with the Section 404(b)(1) guidelines. . . . . |X|

b. The proposed disposal site for discharge of dredged or fill material complies with the Section 404(b)(1) guidelines with the inclusion of the following conditions: |_|

*See page 14

c. The proposed disposal site for discharge of dredged or fill material does not comply with the Section 404(b)(1) guidelines for the following reasons(s):

(1) There is a less damaging practicable alternative. . . . . |_|

(2) The proposed discharge will result in significant degradation of the aquatic ecosystem . . . . |_|

(3) The proposed discharge does not include all practicable and appropriate measures to minimize potential harm to the aquatic ecosystem . . . . |_|

6.

C.E. Shuford Jr.

C.E.Shuford, Jr., P.E.
Acting Chief, Engineering and Planning Division

Date: 3 July 1996

Robert J. Sperberg,
Colonel, U.S. Army
District Engineer

Date: 3 July 96

*A negative, significant, or unknown response indicates that the permit application may not be in compliance with the Section 404(b)(1) Guidelines.

1/ Negative responses to three or more of the compliance criteria at this stage indicate that the proposed projects <u>may</u> not be evaluated using this "short form procedure." Care should be used in assessing pertinent portions of the technical information of items 2 a-d, before completing the final review of compliance.

2/ Negative response to one of the compliance criteria at this stage indicates that the proposed project does not comply with the guidelines. If the economics of navigation and anchorage of Section 404(b)(2) are to be evaluated in the decision-making process, the "short form evaluation process is inappropriate."

3/ If the dredged or fill material cannot be excluded from individual testing, the "short-form" evaluation process is inappropriate.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Raleigh Field Office
Post Office Box 33726
Raleigh, North Carolina 27636-3726

June 25, 1996

Colonel Robert Sperberg
District Engineer
U.S. Army Corps of Engineers
P.O. Box 1890
Wilmington, North Carolina 28402-1890

Dear Colonel Sperberg:

The U.S. Fish and Wildlife Service (Service) has reviewed the Biological Assessment (BA) for the Cape Fear-Northeast Cape Fear Rivers Project, Brunswick and New Hanover Counties, North Carolina. Your January 31, 1996 request for formal consultation was received on February 16, 1996. This document represents the Service's biological opinion on the effects of that action on the West Indian manatee (*Trichechus manatus*) in accordance with section 7 of the Endangered Species Act of 1973 (ESA), as amended, (16 U.S.C. 1531 *et seq.*).

<u>Consultation History</u>

The Cape Fear-Northeast Cape Fear Rivers Project, which is referred to as the Cape Fear Comprehensive (CFC) Project, is one of three projects on which the Service has consulted, both informally and formally, with the Wilmington District, U. S. Army Corps of Engineers (Corps) since 1991, due to the potential requirement of blasting in the Wilmington ship channel. The Service began working with the Corps on the CFC project in 1991. However, early project descriptions did not include a definite requirement for blasting to remove rock. The May 1991 Reconnaissance Report on the project states that data will be collected in order to separate dredgeable from nondredgeable rock (U. S. Army Corps of Engineers 1991). On October 26, 1992, the Service provided the Corps with scoping comments which noted that blasting could kill fish, sea turtles, marine mammals, and other species near the blast.

The second project was the Wilmington Harbor Ocean Bar Channel Project to deepen the most seaward portion of the ship channel to its authorized depth of 40 feet plus allowable and required overdepths. On June 7, 1993, the Corps provided the Service with a BA on the Ocean Bar Project. The BA determined that blasting associated with the project may affect the manatee. The Corps proposed several measures to protect Federally-listed species. These measures included stemming of charges, delays between charges, and observers on either boat or airplane platform for two hours prior to and one hour after each detonation. The Service issued a biological opinion for the Ocean Bar Channel on August 9, 1993. The Service found that the project was not likely to jeopardize the continued existence of the manatee.

During 1993, the Service issued both Draft and Final Fish and Wildlife Coordination Act Reports on a third project involving modifications to the ship channel. This project, the Wilmington Harbor Channel Widening (WHCW) Project, involved the construction of a 6.2 mile passing lane and the enlargement of five turns in the ship channel. However, these reports did not address impacts related to blasting since the Corps' plans at that time did not include the need to remove nondredgeable rock.

On October 5, 1994, the Department of the Army published a Notice of Intent to prepare a Draft Environmental Impact Statement (EIS) for the CFC project. This notice stated that one of the significant issues to be analyzed was blasting impacts on marine mammals and other organisms.

On June 9, 1995, the Corps informed the Service that a supplemental EIS would be prepared for the WHCW project to address the impacts associated with the removal of nondredgeable rock, primarily through blasting. A supplemental EIS was necessitated by geotechnical data from hydrographic surveys which indicated that the top of rock at sites of proposed construction of Turns 2, 3, and 4 was above -41 feet mean lower low water (mllw). The authorized depth of the current channel is -38 feet mllw with 2 feet of allowable overdepth. Corps regulations specify that ship channels over hard material must have one foot of required overdepth in addition to allowable overdepth. Therefore, new construction would require a depth of -41 feet mllw which is likely to require the removal of rock.

On August 23, 1995, a Service biologist toured the CFC and WHCW project areas with personnel of the Corps and State and Federal natural resource agencies. At that time the Service expressed concerns about possible harm to manatees during construction in the warmer months of the year.

On September 22, 1995, the Service issued a Draft Fish and Wildlife Coordination Act Report on the use of blasting for the WHCW Project. The Service recommended that the Corps should: (1) use blasting only as a last resort; (2) use equipment and a blast plan which would produce the least harm to aquatic organisms; (3) calculate a safety zone for the most important organisms which could occur in the project site; (4) develop pre-blast procedures which would include surveillance of the safety zone and means to halt blasting if Federally-listed species were within their safety zone; (5) limit blasting to the period from October 1 through January 31; and, (6) develop a post-blast monitoring plan to assess the animals killed by blasting.

On December 13, 1995, a Service biologist attended a meeting on the CFC project with the Corps and State and Federal natural resource personnel. The Service reiterated concerns about the adverse impacts of blasting on manatees during the warmer months.

On January 17, 1996, the Service sent the Corps preliminary recommendations for the CFC project. The Service recommended that blasting be limited to the period from October 1 through January 31 in order to protect the manatee; other marine mammals, such as the bottle-nosed dolphin (*Tursiops truncatus*); sea turtles, such as loggerhead sea turtle (*Caretta caretta*), green sea turtle (*Chelonia mydas*), and Kemp's ridley sea turtle (*Lepidochelys kempi*); and anadromous fish, such as the shortnose sturgeon (*Acipenser brevirostrum*). Our recommendations also included a comprehensive list of measures to minimize harm to manatees and other species in the project area.

On January 31, 1996, the Corps issued the Draft EIS for the CFC project along with the BA. This assessment determined that the project may affect the manatee. In the Draft EIS the Corps responded to the Service's preliminary recommendations on blasting. The Draft EIS states that blasting would be conducted from August 1 through January 31 over the approximately three years of construction. Blast procedures would include drilling holes for charges, stemming each hole, using delays between each charge, and surrounding each blast with an air/bubble curtain. The Corps proposed to work with the Service and other resource agencies to develop pre- and post-blast monitoring plans. With regard to the establishment of a manatee specific danger zone, the Corps indicated that monitoring zones would be based on calculations for the one percent lethal zone (LD_1), the zone in which one percent of individuals would be projected to be killed, for a two-ounce fish with a swimbladder. The Corps expressed the opinion that blasting techniques combined with the use of a bubble/air curtain and/or physical barrier could reduce the LD_1 zone down to approximately the 35,000 square feet (0.8 acre) enclosed by the bubble curtain/barrier. These measures, in conjunction with an observer program (which would halt blasting if sea turtles or marine mammals were in the project area), were considered by the Corps to be adequate protection for manatees.

On February 16, 1996, the Corps issued the Draft Supplement I to the Final EIS for the WHCW project. This document stated that blasting, if required, would follow the same procedures as those to be used in the CFC project.

On February 23, 1996, the Service released a Draft Fish and Wildlife Coordination Act Report on the CFC project. While it was acknowledged that the Corps' blast plan, the use of a bubble curtain, and pre-blast procedures would contribute to manatee protection, the Service repeated recommendations that the best way to minimize harm would be to avoid blasting during the months when manatees are most likely to occur in the project area. The Service also recommended that the Corps calculate manatee-specific danger and safety zones and develop surveillance procedures for manatees within the calculated safety zone.

BIOLOGICAL OPINION

Description of proposed action

Wilmington Harbor is a Federal navigation project of approximately 35 miles located along the Cape Fear and Northeast Cape Fear Rivers in southeastern North Carolina. The North Carolina Division of Water Resources, North Carolina State Ports Authority, the Cape Fear River Pilots Association, and other shipping interests in the harbor have requested that the U.S. Army Corps of Engineers study the deepening of the Wilmington Harbor Ship Channel. Measures to accomplish the deepening were determined to be economically feasible and in the Federal interest.

The recommended plan for the CFC Project includes dredging most of the harbor 4 feet deeper with some widening of two turning basins and the channel near Wilmington. Recommended dredging methods include hydraulic pipeline, bucket and barge, hopper, and rock cutterhead dredge. Hydraulic pipeline dredges will be used from about 4 miles south of the State Port (Upper Big Island Channel) to the upstream limit of the Federal Channel with dredged material disposal in an existing upland confined disposal facility (CDF). Beginning about 4 miles south of the State Port (Lower Big Island Channel) to Southport (Lower Swash Channel), a bucket and barge dredge will be used with disposal in the U.S. Environmental Protection Agency approved Ocean Dredged Material Disposal Site (ODMDS). From Southport (Battery Island Channel) to the Smith Island Channel, a hopper dredge will be used with disposal in the ODMDS. From the ocean bar offshore (Baldhead Shoal Channel), the rock substrate will be excavated by a rock cutterhead dredge with disposal to complete the Wilmington Offshore Fisheries Enhancement Structure (WOFES). Silty and sandy sediments will be placed in the ODMDS. Certain areas of rock in the river may require blasting for removal. Such rock from Lower Big Island Channel downstream will be removed following blasting with a bucket and barge dredge and placed on the WOFES. Rock requiring dredging or blasting at or upstream of Upper Big Island Channel, will be removed by pipeline dredge and pumped to a CDF.

This proposed action would result in the excavation of 12,825,586 cubic yards of dredged material of which 3,423,777 cubic yards are rock (about 2.4 million cubic yards would be placed in the WOFES). Approximately 564,000 cubic yards may require blasting. The Corps estimates that 558 blasts may be required. The estimated construction period would be 3 years.

Blasting, if required, would be done by detonating a frame of individual charges. Each frame would consist of 8 rows with 10 charges per row, for a total of 80 charges. Each frame would be constructed by drilling holes into the rock and inserting 98.5 pounds of explosives into each hole. The total amount of explosives in each frame would be 7,880 pounds. There would be 8-foot spacing within rows and between each row. Each hole would be 4.5 inches in diameter and 11.2 feet deep. The top one foot, or more, or each hole would be filled with crushed stone or gravel, a procedure known as stemming. A firing delay of at least 25 milliseconds would be required between each hole.

The present blast plan states that blasting would be confined to the period from August 1 through January 31. This period is based on recommendations by the North Carolina Division of Marine Fisheries for the protection of fisheries resources. The Corps will institute both pre- and post-blast monitoring programs. Each blast would be surrounded by a bubble curtain and/or a physical barrier. This measure is designed to absorb harmful shock waves from the blast and would include an area of approximately 35,000 square feet (0.8 acre).

Status of the Species

The West Indian manatee, also known as the Florida manatee, is a Federally-listed endangered mammal. Although the manatee's principle stronghold in the United States is Florida, it occasionally makes its way into the coastal waters of North Carolina (Webster et al. 1985). Generally, manatees remain in the coastal waters of the Florida peninsula during the winter and disperse during the summer months, some moving north along the Atlantic Coast to North Carolina. A small number of individuals may travel as far north as Rhode Island (Robert Turner, Regional Manatee Coordinator, USFWS, personal communication, May 1996). In the fall wandering manatees return to their core range in Florida.

Observations of manatees from within the Cape Fear River and surrounding waters are generally reported every year during the summer months. The number of sightings is usually low, but they do occur within the Cape Fear River on a regular basis during the warmer months of the year (David Webster, University of North Carolina at Wilmington, personal communication, May 1993 and Mary Clark, North Carolina Museum of Natural History, personal communication, May 1993).

In addition to protection under the ESA, the species is listed as endangered in North Carolina under the State Endangered Species Act (G.S. 113-331 to 113-337). Additional Federal protection is provided under the Marine Mammal Protection Act of 1972.

The fact that manatees spend much of their time submerged in shallow water is a factor in the ability to observe these animals. Scholander et al. (1941) reported manatee dives of up to 24 minutes. The length of time between breaths usually ranges from four minutes while resting to 30 seconds during strenuous activity (Hartman 1979).

While manatees have no natural predators, they are subject to a number of natural mortality factors. During unusually cold winters, when water temperatures drop below 60°F, manatees become sluggish, stop eating, and eventually die. Periodic red tide blooms have been associated with manatee deaths. Toxins produced by red tide algae accumulate in sea squirts which adhere to seagrasses. This poison is ingested incidentally by feeding manatees.

Current status of species

Early reports suggest that thousands of manatees once lived in Florida. By the early 18th century, some concerns were raised about the need to protect manatees from hunting. However, significant hunting pressure continued until the late 1930s and early 1940s. Manatee numbers probably reached a low around the early 1940s (Rose 1985).

O'Shea and Ludlow (1992) report that no estimates are available for the total number of manatees throughout the species range due to a lack of appropriate census methods. The species has been reduced or extirpated in many regions of former occurrence. However, the Service considers the species to have declined severely from several thousand individuals in the 1700's and early 1800's to as few as a thousand in the mid-1970's (Hartman 1974). Aerial surveys throughout the species' range in 1992 counted 1,856 individuals. A survey during February 1996 revealed that the minimum manatee population in the United States was 2,639 (U. S. Fish and Wildlife Service [hereafter USFWS] 1996). This increase in number is thought to reflect better survey methodologies and survey conditions and not an increase in manatee numbers (Robert Turner, Regional Manatee Coordinator, USFWS, personal communication, May 1996).

The manatee is generally considered a regular, but infrequent, resident of North Carolina's coastal waters. Clark (1987) states that the species appears to be only an occasional, seasonal visitor to the State. She notes, however, that the North Carolina State Museum regularly receives reports of manatees in the coastal rivers of North Carolina and suggests that the occurrence of the species in the state should not be considered exceptional. Her account postulates that there is no justification for discounting the importance of local habitats to the species, and that the present paucity of data on manatees in North Carolina results from lack of attention and the special problems associated with the study of marine mammals.

Schwartz (1995) summarized data on the sighting of 68 manatees from 59 locations in North Carolina from 1919-1994. This report indicates that manatees are now known to frequent nearly all North Carolina ocean and inland waters. Recent sightings have been subadults or young about 1.8 to 2.4 meters (5.9 to 7.9 feet) in length. The species has been recorded from 11 coastal counties. There have been nine documented sightings in New Hanover County, one of the two counties in which the Wilmington Ship Channel is located. Sightings have occurred during nine months of the year with the highest number of sightings (14) in September followed by eight sightings in both August and October. This report states that a manatee was sighted in the Northeast Cape Fear River, north of Wilmington in Pender County on July 11, 1993. Although these sightings may suggest that more young manatees are expanding their range into North Carolina, it could be an artifact of an increased public awareness of the species rather than a real population increase.

There are no data to predict the number of manatees which may be in the action area at any given time. The Service considers the species to be a possible resident of the action area during the warmer months of the year, primarily from June through the end of September. It is possible for manatees to be present in the project area at the time of a blast under the proposed work window. As might be expected for a wide-ranging, highly mobile species which has been Federally-listed as endangered for almost 30 years, occurrences outside the core range are likely to be few and sporadic.

Reasons for current status and current threats

The present plight of the manatee is the result of high mortality in association with a relatively low reproductive rate. Manatee population trends are poorly known, but deaths have increased steadily from 1976 to 1991 (USFWS 1993). The primary threat to the continued existence of the species is the aggregate mortality directly caused by human activities. The species is also harmed by the loss habitat due to coastal development, particularly the loss of seagrass beds.

The most significant mortality among manatees results directly or indirectly from human activities. Human activities are responsible for about half of annual manatee mortality for which a cause can be established (Rose 1985). Boats may run over manatees that are submerged below the surface. Encounters with boats may either kill the manatee on impact or cause injury as propeller blades cut into the skin. Mortality from collisions with watercraft has increased from 21% of all deaths in the 1976-1980 period to 29% of all deaths in the 1986-1991 period. Comparison of the same two periods indicate that deaths of dependent calves have increased from 14% to 24% of all deaths. Canal locks and flood gates of water control structures may crush or drown manatees. Discarded fishing line may cause death or injury through accidental ingestion which blocks the digestive tract or by becoming tightly wound around flippers which may cause serious infection or amputation. Harassment by divers, fishermen, or boaters can interrupt feeding and mating activity. Human activities during winter may drive manatees into cooler water where they are more susceptible to disease and cold stress.

Manatee habitat in Florida has been and continues to be greatly altered by residential and commercial development (Packard and Wetterqvist 1986). Dredge and fill activities may destroy areas of aquatic vegetation. Water pollution poses a threat to aquatic plants. Aquatic weed control programs also pose a threat to their source of food.

Effects of the action

The principal threat to the manatee from the proposed project is direct injury or death due to the shock wave produced by underwater explosions. Manatee deaths due to explosives have been reported. In 1943, the use of explosives to widen the Miami River in Florida killed at least 100 manatees (Moore 1951). O'Keeffe and Young (1984) cite studies which indicate that underwater blasting may injure marine mammals in two ways. The primary cause of injury is the creation of hemorrhaging in and around the lungs. The other way is the excitation of radial oscillations of small gas bubbles which are normally present in the intestines. Presumably, the degree of harm is directly proportional to tissue damage produced by the shock wave of the blast. Smaller animals are considered to be more susceptible to harm from underwater shock waves than larger animals (Young 1991). Therefore, all considerations for a safety zone for the species should be based on preventing harm to manatee calves. Underwater detonations could cause hearing loss or damage to manatees in the vicinity of the concussion. Although dredging activities are not likely to affect the species, collisions with hopper dredges or other vessels could potentially occur, resulting in death or injury to manatees.

Aside from direct mortality to manatees, indirect impacts are also possible. If manatees are injured during their summer residence in North Carolina, they may not be able to successfully return to their winter range and may die as a result of cold weather. To a much lesser extent, blasting may force manatees which are outside the zone of injury to alter their feeding, resting, and migratory behavior. It is possible that blasting during the late summer and early fall could cause manatees upstream from the blast area to delay their movement downstream and thereby prevent their timely return to wintering areas. Any factor causing delays in fall migrations could ultimately lead to manatees deaths if they succumb to cold temperatures. In addition, hearing loss or other injuries could reduce the ability of individual manatees to detect and avoid boat and ship collisions, resulting in their loss from the population. Although the proposed channel modifications may result in a larger number and increased size of vessels utilizing the Cape Fear shipping channel, this increase is not anticipated to significantly impact the manatee. An analysis of watercraft-related mortalities in Florida indicated that small- to medium-sized watercraft are responsible for the majority of manatee deaths (Wright et al., 1995).

Cumulative effects

Cumulative effects include the effects of future State, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA. Based on information provide in the BA, the Service does not believe that the proposed project will produce cumulative, adverse impacts on the manatee.

Conclusion

After reviewing the current status of the manatee, the environmental baseline for the action area, and the effects of the proposed work, it is the Service's biological opinion that the Cape Fear-Northeast Cape Fear Rivers Comprehensive Project, as proposed, is not likely to jeopardize the continued existence of the manatee. No critical habitat has been designated for this species in North Carolina, therefore, none will be affected.

INCIDENTAL TAKE

Sections 4(d) and 9 of ESA, as amended, prohibit taking (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct) of listed species of fish or wildlife without a special exemption. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is any take of listed animal species that results from, but is not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or the applicant. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered a prohibited taking provided that such taking is in compliance with any terms and conditions of an incidental take statement.

The Service is not including an incidental take authorization for marine mammals at this time because the regulations required for incidental take of marine mammals in this specific area or for this activity have not been issued under Section 101(a)(5) of the Marine Mammal Protection Act and/or its 1994 Amendments. In addition, the Service has reviewed the biological information relevant to the proposed action, including the Corps' monitoring plan and measures to reduce shock wave impacts from blasting. No incidental take of manatees is anticipated to occur as a result of blasting or collisions with dredges or project related vessels.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The Service's recommendations are divided in two general areas. These are general construction work and blasting operations. Unless otherwise stated, these recommendations apply only to the period when manatees are most likely to be in the project area, June 1 through September 30 of any year.

During general construction work, the Service recommends the following conservation measures for the CFC project:

1. The Corps and/or contractor shall instruct all personnel associated with the project of the potential presence of manatees during the months of June through September and the need to avoid collisions with manatees. All construction personnel are responsible for observing water-related activities for the presence of manatees.

2. The Corps and/or the contractor shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing manatees which are protected under the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973.

3. All vessels associated with the construction project shall operate at "no wake/idle" speeds at all times while in water where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels will follow routes of deep water whenever possible.

4. If a manatee is seen within 100 yards of the active construction/dredging operation or vessel movement, all appropriate precautions shall be implemented to ensure protection of the manatee. These precautions shall include the operation of all moving equipment no closer than 50 feet of a manatee. Operation of any equipment closer than 50 feet to a manatee shall necessitate the immediate shutdown of that equipment. Activities will not resume until the manatee has departed the project area on its own volition. This condition is not limited to the June 1 through September 30 period and must be enforced at all times of the year.

5. Any collision with and/or injury to a manatee shall be reported immediately. This condition is not limited to the June 1 through September 30 period and must be enforced at all times of the year. The report must be made to the Service's manatee coordinator in Jacksonville, Florida (ph. 904-232-2580), the Raleigh Field Office (ph. 919-856-4520), and the North Carolina Wildlife Resources Commission. The Corps should coordinate with the Service immediately prior to actual construction for the name and current telephone number of the individuals to be contacted.

6. A sign should be posted in all vessels associated with the project where it is clearly visible to the vessel operator. The sign should state:

   CAUTION: The endangered manatee may occur in the Cape Fear River during the warmer months, primarily from June through September. Idle speed is required if operating this vessel in shallow water. All equipment must be shut down if a manatee comes within 50 feet of operation. A collision with and/or injury to a manatee shall be reported immediately to the North Carolina Wildlife Resources Commission at 919-224-1288 and the U. S. Fish and Wildlife Service at 919-856-4520.

For construction which may require blasting, the Service recommends that:

7. Blasting should only be used in the event that rock cannot be removed by any other practical means.

8. While the Service approves of the proposed procedures to contain and minimize blasting impacts, the Service believes that the best way to protect manatees is to avoid blasting during the time of year when these animals are most likely to be in the project area. As the Service noted in our Biological Opinion on the deepening of the Ocean Bar Channel, manatees are most likely to be present from May through October.

9. If blasting occurs from June 1 through September 30 of any year, the contractor should select equipment and implement blasting procedures which minimize the impacts of blasting on manatees and other aquatic organisms. The contractor should use low velocity explosives to reduce peak pressure levels, stem all holes, use the longest possible delays between charges, and use a bubble curtain or physical barrier to contain shock waves. The project description given in the BA states that these measures will be included in the contract. The Service strongly supports these protective measures.

Regarding the use of delays, Munday et al. (1986) note that blasting caps are available in a series which can produce delays ranging from 25 milliseconds to 1,125 milliseconds. They also state that a single detonation can be effectively reduced to a series of small blasts by using such caps. They indicate that all caps for a single detonation can be initiated simultaneously, and that different burn times within each cap would produce delays between explosions. This procedure would eliminate the concerns of the Corps regarding the chance that early blasts could interrupt the initiation of later explosions. The Service believes that delays between charges in the range of 0.9 to 1.0 second would be the most effective in preventing possible overlap, and additive impact, of shock waves from separate blasts.

All blasts should be scheduled during daylight hours and during period of slack tide to allow for optimal surveillance conditions. Blasting should not occur if weather conditions are not suitable for observing manatees, such as during rain or fog.

10. The Corps should calculate a safety zone around each blast from which manatees must be excluded in order to prevent any injury. The area should be composed of a danger zone, in which injury to manatees is possible, and a buffer zone, an area from which manatees could easily enter the danger zone. The combined area of the danger zone and the buffer zone would constitute the safety zone.

The BA indicates that the bubble curtain is expected to reduce shock waves by 95 percent or more. Until the exact extent of bubble curtain efficacy is established in the project area, the Service recommends that the danger zone be based on published calculations which assume only the burial of charges, stemming, and time delays. If actual field monitoring data for this project indicate that the bubble curtain reduces the shock wave, the danger zone may be reduced to the area within the bubble curtain, currently estimated at 0.8 acre, plus a calculated radius based on the shock wave penetrating the bubble curtain. However, even with a highly effective bubble curtain, the Service recommends that a buffer zone surround the bubble curtain.

Several formulas have been developed to calculate the distance from a blast at which no significant injury occurs to an individual of a given weight. As an example, Goertner (1982) calculated the maximum horizontal distance for slight injuries by a 12-pound underwater explosion to a manatee calf of 70 pounds to be 450 feet. This calculation is based on a charge in a bolehole at a depth of 40 feet with or without time delays. The conditions used for this published calculation resemble the proposed blasting. It is possible to factor in the increased weight of a charge in the CFC project, 98.5 pounds. The Draft EIS notes that the peak pressure of a larger charge at a given distance changes by the cube root of the weight multiplier for the larger charge. The weight multiplier in this case is 8.2 (98.5 lbs/12 lbs), and the distance required to avoid injury would change by a factor of 2.0 ($\sqrt[3]{8}=2$). Therefore, the calculated distance needed to prevent slight injuries to a manatee calf in the vicinity of a buried 98.5 lbs charge would be 900 feet (2 x 450 feet).

The Corps should carefully consider the proper weight of explosives used in danger zone calculations. As currently planned, each detonation would consist of 80 separate charges of 98.5 pounds. This procedure would result in a total detonation of 7,880 pounds of explosives. With a minimum delay of 25 milliseconds between each blast, the 80 explosions will occur in two seconds. The Service believes that shock waves from 80 separate explosions may be additive in some instances. Therefore, the "effective" weight of the detonation may be more than a single 98.5 pound charge. The Service recommends that the Corps present a written justification for any weight of explosive used in calculating the danger zone for manatees.

As an added precaution, the Service recommends that a buffer area be established around the perimeter of the calculated danger zone. The purpose of this buffer zone is to allow time to halt blasting before a manatee moving toward the blast area enters the danger zone. In the case of the manatee, a buffer zone extending 300 feet from the danger zone is considered sufficient (Bob Turner, Regional Manatee Coordinator, USFWS, personal communication, February 1996).

A land mass, such as a dredge disposal island, should block the shock wave. If a land mass is within the safety zone, surveillance may terminate at the land mass and would not be necessary within the area behind the mass.

11. For any blast from June 1 through September 30, the Corps should institute a manatee surveillance program within the calculated safety zone around each blast. Pre-blast surveillance personnel should, at a minimum, consist of a surveillance coordinator, one aerial team, and one boat team. Additional boat teams may be required depending on the calculated size of the safety zone around the blast. The surveillance coordinator should

determine whether weather conditions are suitable for an acceptable survey of the blast area. If the surveillance coordinator determines that weather conditions are not suitable for a proper survey, blasting should be postponed until proper surveys can be undertaken. Aerial survey should begin at least one hour before detonation. Boat survey may include all daylight hours on the day of the blast, but should begin at least two hours before detonation.

Each surveillance team should have a minimum of two members. At least one member of each team should have experience in observing/spotting manatees. Members without previous experience should be trained in observing/spotting manatees. The surveillance program should have an adequate number of "substitute" observers who are available for work in place of any member that becomes unavailable. Each team should have two-way radio communications with the surveillance coordinator on a frequency dedicated to the surveillance. All surveillance personnel should be equipped with polarized sunglasses, binoculars, a red flag for a backup visual communication system, a log book for recording sightings, and a map for recording the location of manatees sighted.

All observers should maintain communications with the blasting contractor. If a manatee is seen within the safety zone, this fact will be immediately reported to the blasting contractor and detonation will be halted. Detonation will not occur until the safety zone is completely clear of manatees. Manatees will be allowed to leave the safety zone on their own volition and will not be herded or harassed away from the safety zone. If subsequent searches fail to locate the manatee seen in the safety zone, and movement out of the safety zone cannot be assured, the blast event will not resume until 30 minutes after the initial sighting.

Surveys for manatees may coincide with surveys for marine mammals required by the National Marine Fisheries Service provided the area surveyed includes the entire safety zone calculated for the manatee. The Corps is encouraged to determine whether telemetry data from radio-collared manatees are available for use in establishing the presence of manatees in the project area.

12. After detonation, an aerial and/or boat survey of the entire safety zone should continue for at least one-half hour. If a dead or injured manatee is seen by the aerial surveillance team, they should contact ground personnel and direct them to the site. If no dead or injured manatees are seen and no additional, pre-blast surveillance is required, the aerial survey team may leave the project area. However, this team should remain available to monitor an injured manatee which may be detected at a later time. The boat surveillance team may continue surveillance work downstream from the blast site in order to search for dead or injured manatees outside the safety zone.

If a dead or injured manatee is sighted after blasting, the surveillance coordinator should contact the Service's manatee coordinator in Jacksonville, Florida (ph. 904-232-2580), the Raleigh Field Office (ph. 919-856-4520), and the North Carolina Wildlife Resources Commission. The Corps should coordinate with the Service immediately prior to actual construction for the name and current telephone number of the individuals to be contacted. The surveillance team or construction contractor should have the capability to recover dead manatees and track injured manatees. The team should record basic biological data from dead manatee, such as sex, age class, and length, and have the capability of short-term storage of a carcass. The surveillance coordinator should contact the North Carolina Marine Mammal Stranding Network (Paul Barrington, Director, North Carolina Aquarium at Fort Fisher, ph. 910-458-8258). This network can initiate the post-mortem examination of any marine mammal carcass.

If a dead manatee is recovered within three miles up or downstream from a detonation site within 72 hours of a detonation without clear indications that the cause of death was unrelated to blasting, blasting should cease until a post-mortem examination can either confirm or reject blasting as a cause of death. Similarly, if any injured manatee is reported within this same area within 72 hours of a detonation, blasting should cease until the cause of injury can be determined.

13. If blasting associated with this project results in the death or injury of a manatee, all blasting should cease and the Corps should reinitiate formal consultation.

14. At least two months prior to the initiation of blasting during a given year, the Corps should submit a complete manatee surveillance plan to the Service. The plan should contain the names of the coordinator, primary observers, and substitute observers along with their qualifications and experience in manatee surveillance. The plan should describe the equipment to be used in the surveillance. The plan should describe the data used in the calculation of the manatee safety zone (including data on the effectiveness of the bubble curtain, if available) and the procedures to be used to detect manatees in this zone. The plan should outline the communication procedures to be used in pre-blast surveillance. The plan should outline the procedures for dealing with the occurrence of dead or injured manatees. The plan should contain sample maps and log sheets which will be used to record manatee sightings.

15. At least one month before the initiation of blasting, the Corps should hold a meeting to discuss all measures to be used to prevent harm to Federally-listed species. This meeting should include representatives of the construction contractor, the Service, the NMFS, the North Carolina Wildlife Resources

Commission, and other interested parties, such as the U. S. Coast Guard. All personnel will be informed about the possible presence of manatees in the area, and that civil or criminal penalties can result from harassment, injury, and/or death of a listed species. The construction contractor will present the protocol and logistics for blasting. The manatee surveillance coordinator will outline the equipment and procedures to be used in the surveillance program. Any unresolved issues regarding coordination between the contractor and the manatee surveillance program should be clearly established during this meeting. The Corps should release a written summary of agreements developed during the meeting, including any changes to the plans released prior to the meeting, to all attendees prior to the initiation of blasting.

16. Within one month after the end of the manatee season, June through September, the Corps should issue a written report on construction progress made during the season and a full assessment of blasting impacts on Federally-listed species and other fish and wildlife resources. This report should address any problems encountered within or between the blasting operation and the manatee surveillance program. The report may recommend ways to eliminate any problems of the past season and propose changes to the blasting and surveillance plans for the next manatee season.

17. If hopper dredges are used from June 1 through September 30, at least two qualified observers should be aboard the dredges to locate any manatees in the area. The vessel captain should be made aware of any manatees in the area and they should be avoided by reducing the speed of the vessel or by changing the course of the vessel.

18. The Service is concerned that blasting on an almost daily basis in the Cape Fear River from August 1 through the end of January could prevent manatees which moved upstream of the blasting area during early and mid-summer from returning downstream on their fall migration southward. This potential problem would be most likely to occur during blasting to enlarge and deepen the turning basin near Wilmington where the Northeast Cape Fear River is approximately 1,000 feet wide. Manatees may be reluctant to move downstream in the face of the blasting disturbances. Therefore, the Service recommends that if there are no continuous breaks in blasting of at least two days during the months of September and October, the Corps should conduct aerial surveys for manatees. If manatees are located upstream from the blast sites after October 15, the Corps should contact the Service regarding procedures to ensure that these manatees can safely return to the ocean.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION - CLOSING STATEMENT

This concludes formal consultation on the actions outlined in the request. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, in this case the death or injury of any manatee, the operations causing such injury must cease pending reinitiation.

If you have any questions regarding this opinion, please contact Howard Hall at 919-856-4520, ext. 27.

Sincerely,

John M. Hefner
Field Supervisor

FWS/R4:HHall:6/25/96:WP:A:BO CFC.696

Literature Cited

Clark, M. K. 1987. *Trichechus manatus* Linnaeus, West Indian (Florida) Manatee. pp. 18-21 in M. K. Clark (ed.) Endangered, Threatened, and Rare Fauna of North Carolina. Part I. A re-evaluation of the mammals. Occasional Papers of the North Carolina Biological Survey. No. 1987-3. North Carolina State Museum of Natural Sciences. Raleigh, NC.

Hartman, D. S. 1974. Distribution, status, and conservation of the manatee in the United States. Natl. Tech. Inf. Ser., PB81-140725, Springfield, Virginia. 246 pp.

Hartman, D. S. 1979. Ecology and behavior of the manatee (*Trichechus manatus*) in Florida. The American Society of Mammalogists, Special Publication No. 5. 153pp.

Goertner, J. F. 1982. Prediction of underwater explosion safe ranges for sea mammals. Naval Surface Weapons Center, NSWC TR 82-188. Silver Springs, Maryland. 25 pp.

Moore, J. C. 1951. The range of the Florida manatee. Quart. J. of the Florida Academy of Science. 14:1-19.

Munday, D.R., G.L. Ennis, D.G. Wright, D.C. Jeffries, E.R. Mcgreer, and J.S. Mathers. 1986. Development and evaluation of a model to predict effects of buried underwater blasting charges on fish populations in shallow water areas. Canadian Technical Report of Fisheries and Aquatic Sciences. 1418:x + 49 pp.

O'Keeffe, D.J. and G.A. Young. 1984. Handbook on the environmental effects of underwater explosions. Naval Surface Weapons Center. NSWC TR 83-240.

O'Shea, T. J. and M. E. Ludlow. 1992. Florida manatee. pp. 190-200. In S. R. Humphrey (ed.). Rare and Endangered Biota of Florida, Volume I. Mammals. University of Florida Press. Gainesville. 392 pp.

Packard, J. M. and O. F. Wetterqvist. 1986. Evaluation of manatee habitat systems on the northwestern Florida coast. Coastal Zone Manage. J. 14:279-310.

Rose, P. M. 1985. The West Indian manatee. pp. 541-546. in R. L. Silvestro (ed.). Audubon Wildlife Report 1985. The National Audubon Society. New York, New York. 671pp.

Scholander, P. F. and L. Irving. 1941. Experimental investigations of the respiration and diving of the Florida manatee. J. of Cellular and Comparative Physiology 17(2):169-911.

Schwartz, F. J. 1995. Florida manatees, *Trichechus manatus* (Sirenia: Trichechidae), in North Carolina 1919-1994. Brimleyana 22: 53-60.

U.S. Army Corps of Engineers. 1991. Reconnaissance Report on Improvements to navigation, Cape Fear - Northeast Cape Fear Rivers, Comprehensive Study. Volume II - Supporting Documentation. Wilmington District, U.S. Army Corps of Engineers, Wilmington, NC. Appendices A-G.

U. S. Fish and Wildlife Service. 1993. West Indian Manatee, Trichechus manatus (Linnaeus). Endangered and threatened Species of the Southeastern United States (The Red Book). U. S. Fish and Wildlife Service, Atlanta, Georgia. 6pp.

__________. 1996. Record number of endangered manatees succumb to unknown ailment. News release #96-17, March 28, 1996. U. S. Fish and Wildlife Service, Atlanta, Georgia. 1p.

Webster, W.D., J.F. Parnell, W.C. Biggs, Jr. 1985. Mammals of the Carolinas, Virginia, and Maryland. The University of North Carolina Press, Chapel Hill. 255pp.

Wright, S. D., B. B. Ackerman, R. K. Bonde, C. A. Beck, and D. J. Banowetz. 1995. Analysis of watercraft-related mortalities in Florida, 1979-1991. Pages 259-268 in T. J. O'Shea, B. B. Ackerman, and H. F. Percival, eds. Population Biology of the Florida manatee. National Biological Service Information and Technology Report 1.

Young, G. A. 1991. Concise methods for predicting the effects of underwater explosions on marine life. NAVSWC MP 91-220. Naval Surface Warfare Center. 22pp.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, Maryland 20910

SEP 13 1996

LTC Terry R. Youngbluth
District Engineer
Wilmington District
U. S. Army Corps of Engineers
P. O. Box 1890
Wilmington, North Carolina 28402-1890

Dear Colonel Youngbluth:

This responds to your request for an Endangered Species Act (ESA) Section 7 Consultation on the Cape Fear-Northeast Cape Fear Rivers Comprehensive Study in New Hanover and Brunswick Counties, North Carolina. The project consists of deepening most of the Wilmington Harbor with some widening of one turning basin and channel and an extension of the anchorage basin near the City of Wilmington. As proposed, the dredging would be accomplished by pipeline, bucket, hopper, and rock cutterhead dredges. The use of explosives is anticipated in six reaches and in the anchorage basin immediately upstream of the North Carolina State Port to remove rock that cannot be removed by other dredging methods. In accordance with 50 CFR 402.12(b), a Biological Assessment was submitted.

The comprehensive plan project, including blasting, is expected to take approximately three years and is tentatively scheduled to begin in 2001. A similar, but much smaller, project to construct a 6.2 mile passing lane and improve six turns in the Wilmington Harbor channel is also anticipated to use underwater explosives. This widening project is tentatively scheduled to begin in 1998 and will require about one year to complete. Separate consultations have been conducted on these two projects because they differ greatly in when they will be carried out and in the scope of the construction in the harbor.

Enclosed is the Biological Opinion prepared by the National Marine Fisheries Service (NMFS) concerning the proposed activity. Based upon the best available scientific information, NMFS concludes that this action is not likely to jeopardize the continued existence of any endangered or threatened species under its jurisdiction. The Corps of Engineers (COE) proposes to employ an air curtain or a solid physical barrier, such as a coffer dam or a sheet metal wall, to reduce the effect of the blast pressure on listed species. The COE proposes to carry out pre-blast monitoring to ensure sea turtles and manatees are not in the blast vicinity and to net and relocate shortnose sturgeons from the blast area. The COE also proposes post-blast monitoring, which includes surface observations and in-water sampling down current of the blast to detect any injury or mortality of listed species. NMFS has incorporated the COE proposed protective and monitoring measures into the biological opinion's incidental take statement. Pursuant to Section 7(b)(4) of the Endangered Species Act, a documented incidental take of two shortnose sturgeons and one loggerhead, Kemp's ridley, or green turtle is set for this activity.

I look forward to your continued cooperation in future consultations.

Sincerely,

Rennie S. Holt

Rennie S. Holt, Ph.D.
Acting Director
Office of Protected Resources

Enclosure

Endangered Species Act - Section 7 Consultation

BIOLOGICAL OPINION

Agency: U.S. Army, Corps of Engineers

Activity: Cape Fear-Northeast Cape Fear Rivers Comprehensive Plan, New Hanover and Brunswick Counties, North Carolina

Consultation Conducted by: National Marine Fisheries Service Southeast Regional Office

Date Issued: SEP 13 1996

Background:

The project area includes the ocean bar channel and channel and turning basins in the Cape Fear River and the Northeast Cape Fear River in southeastern North Carolina. The federal navigation project is approximately 35 miles long. Local interests, represented by the North Carolina State Ports Authority, North Carolina Division of Water Resources, and the Cape Fear Pilots Association, requested that the U. S. Army Corps of Engineers (COE) evaluate improving the Wilmington Harbor channel, which includes major portions of the Cape Fear River and the Northeast Cape Fear River. Navigation interests are primarily concerned with the limiting depth of the channel. The improvements, which would require dredging and the use of underwater explosives, would allow for safer and more efficient commercial vessel use of the entire channel.

This project is separate from, but related to, a smaller project involving construction of a 6.2 mile passing lane and improvements to six turns in the existing channel. It is anticipated that underwater explosives will be required in the widening project The widening project is the more immediate of the two projects, tentatively scheduled to begin in 1998, and will require about one year to complete. The comprehensive plan project, including blasting, is expected to take approximately three years and is tentatively scheduled to begin in 2001. Separate consultations have been conducted on these two projects because they differ greatly in when they will be carried out and in the extent of the construction in the harbor

The final environmental impact statement (EIS) for the comprehensive plan was completed in June 1996. The comprehensive plan anticipates the use of underwater explosives to remove approximately 601,303 cubic yards of rock. The project is expected to take approximately three years. The EIS contained a biological assessment of the project and included a list of measures to reduce and monitor take of endangered and threatened species. No prior consultation had taken place on the proposed project. However, on August 2, 1993, the COE transmitted a draft Environmental Impact Statement (DEIS) on improvements to navigation by widening the Wilmington Harbor Channel. The DEIS contained a biological assessment (BA) which concluded that the project was not likely to adversely affect listed species if the construction was carried out using a pipeline or bucket and barge dredge, and without the use of explosives. The National Marine Fisheries Service (NMFS) concurred with this determination in a September 28, 1993, letter. Since that time the COE determined that the removal of some rock in the project area, particularly in turns 2, 3, and 4, may require the use of explosives. The NMFS has prepared a biological opinion to address the use of underwater explosives in the widening project. This opinion incorporates much of the channel widening opinion.

The pressure wave created by underwater explosives is known to kill or injure aquatic organisms within a certain distance of the blast. The distance at which death or injury results depends on numerous variables including the species, size, and depth of the animal and the size and depth of the explosive. There is debate over which mathematical models produce the most accurate information on injury to marine or aquatic organisms. In their environmental assessment of this project the COE uses a mathematical model based upon the impulse strength method to predict the kill radius for swim bladder fishes. The NMFS utilizes equations derived by the Naval Surface Warfare Center (NSWC) which predict the effects of underwater explosions on various types of marine life (Young 1991). These equations predict effects at a greater distance from the blast than the model selected by the COE and are therefore considered more conservative. For fish with swim bladders, such as shortnose sturgeons, the distance from the blast which results in a 90% survivability is calculated by the equation:

$$R = 95\ W_F^{-0.13}\ W_E^{0.28}\ D^{0.22}$$

where R is the range in feet from the explosion, W_F is the weight of the fish in pounds, W_E is the weight of the explosive in pounds, and D is the depth of the burst in feet below the surface. The safety distance for sea turtles using the NSWC calculations is defined by the equation:

$$R = 560\ W_E^{1/3}$$

where R is the range in feet from the blast and W_E is the weight of the explosive in pounds.

Underwater explosives are generally used for oil and gas rig removals in the Gulf of Mexico. The majority of these rigs are removed using up to 50 pounds of high velocity explosives per leg, detonated at 0.9 second intervals, with the explosives 15 feet below the ocean floor. Since 1988, the NMFS has required pre-blast aerial surveys on all explosive rig removals to insure that sea turtles are not within the range of injury from the blast wave. The NMFS used the above formula for sea turtles to calculate the radius of the required aerial surveys. If turtles are spotted inside the danger zone, detonation is delayed until they are clear. During all observed rig removals to date, only one turtle injury has been documented.

Since the endangered shortnose sturgeon is known to occur in the project area and several species of listed sea turtles may occur in the project area, and since pipeline dredges or bucket dredges are not known to adversely affect these species, the aspect of this project likely to adversely impact listed marine species is the use of underwater explosives.

Proposed Activity:

This consultation addresses the potential effects of dredging operations, including the use of underwater explosives, in the Wilmington Harbor between the ocean bar channel of the Cape Fear River (river mile - 3.5) and the turning basin near Arcadian (approximately river mile 31). The proposed project involves deepening the channel by 4 feet from the ocean bar to the Memorial Bridge in Wilmington (approximately river mile 27) and by 9 feet from the Hilton Railroad Bridge (approximately river mile 29) to the Arcadian turning basin. The proposed project would involve the use of underwater explosives to break up approximately 601,303 cubic yards of rock in the anchorage basin and in the following reaches of the channel: Snow Marsh (approximately river miles 4.25 to 7.5), Upper Lilliput (approximately river miles 16 through 18), Keg Island (approximately river miles 18 through 19.5), Upper and Lower Big Island (approximately river miles 19.5 through 20.5), and Lower Brunswick (approximately river miles 20.5 through 22.25).

As proposed, blasting and dredging by pipeline dredge would be conducted from August 1 through January 31. Dredging by pipeline dredge is proposed in the upper portion of the project from about river mile 21 upstream. Bucket dredging would be conducted from river mile 21 to approximately river mile 4. A hopper dredge would be used from there out through the ocean bar channel. A rock cutterhead dredge is proposed to excavate the rock substrate in the ocean bar channel. The use of a hopper dredge is restricted temporally by an existing biological opinion (August 25, 1995) and other protective measures for sea turtles and whales are included in that opinion.

The COE's preliminary blast plan includes drilling eighty 4.5-inch diameter holes. Holes will be drilled with an 8-foot spacing within rows and between rows. Each frame will consist of eight rows with 10 holes per row. A maximum 98.5 pounds of explosive will be placed in each hole. Each hole will be stemmed with a foot of crushed rock, to reduce the blast pressure in the water, and there will be a 25-millisecond delay between detonation of each hole to reduce the blast to 80 separate explosions per frame. The COE anticipates that 595 frames will be necessary to complete the blasting portion of the project and that the project will take about three years to complete. The COE also proposes to employ an air/bubble curtain to reduce the impacts of the blast pressure wave and to conduct pre- and post-blast monitoring to minimize and assess the impacts to listed species.

Listed Species Likely to Occur in the Project Area:

The listed species under the jurisdiction of the NMFS that occurs in the project area and may be affected by the proposed activities are:

(1) shortnose sturgeon, *Acipenser brevirostrum* (endangered)
(2) loggerhead turtle, *Caretta caretta* (threatened)
(3) Kemp's ridley turtle, *Lepidochelys kempii* (endangered)
(4) green turtle, *Chelonia mydas* (threatened/endangered) (Green turtles in U.S. waters are listed as threatened except for the Florida breeding population which is listed as endangered)
(5) right whale, *Eubalaena glacialis* (endangered)
(6) fin whale, *Balaenoptera physalus* (endangered)
(7) humpback whale, *Megaptera novaeangliae* (endangered)

Shortnose sturgeon (*Acipenser brevirostrum*)

Shortnose sturgeons occur in rivers, estuaries, and at sea, along the east coast of North America from the Saint John River, New Brunswick, Canada (Leim and Day 1959), to the Indian River, Florida (Evermann and Bean 1898). This anadromous species migrates upriver to spawn (spawning occurs between January and May depending on latitude), and returns downstream in the fall (Dadswell et al. 1984). In some river systems during the fall, a portion of the breeding adults migrate upstream to deep, overwintering sites adjacent to the spawning grounds (Greeley 1935; Dadswell 1979; Dovel 1981; Buckley 1982); some ripening and most non-ripening adults spend the winter in deep, saline sites (Dadswell 1979; Marchette and Smiley 1982). Juveniles and post-spawning adults may move downstream to areas adjacent to the salt wedge during the summer months (June through August). As water temperatures cool, adults move to the lower estuary where salinities exceed 15 ppt.

The shortnose sturgeon is a benthic feeder whose diet is composed of small invertebrates and occasional plant material. Juvenile sturgeons feed primarily on benthic insects and crustaceans, while adult sturgeons eat mostly mollusks (Dadswell et al. 1984). The species composition of food items found in sturgeon stomachs varies according to the river system in which the animal was captured, and whether the sturgeon was taken in fresh or salt water. During the summer months, sturgeons forage at night in shallow areas over mud bottom in depths of 1-5 m. Winter feeding is restricted to deeper waters with mud bottom. In saline waters, sturgeons feed over sandy or mud bottoms in 5-10 m depths.

Moser and Ross (1993) conducted a gill net survey and sonic tracking study on shortnose sturgeons from May 1990 through September 1992 in the lower Cape Fear River system. The population was determined to be small (only seven individuals captured in 893 net days of sampling) and all specimens were caught during the spawning/migration period of early January through early May. This study documented shortnose sturgeon use of the Cape Fear River from km 15.7 (river mile 9.8) to km 96.4 (river mile 60.3) from January through July. The upstream migration of the shortnose sturgeons tracked was blocked by Lock and Dam #1 (approximately river mile 61). Historically, shortnose sturgeons probably spawned in the main stem of the Cape Fear River well upstream of Lock and Dam #1. Moser and Ross postulated that current upstream migrations may be blocked by Lock and Dam #1 because locking procedures designed to aid anadromous fish passage (locking from March 20 through May 1) are not timed properly to benefit shortnose sturgeons. Blocked migration was observed during their study; however, migrating adults may be able to pass upstream over the low-head dam during spring flooding events.

The Cape Fear River population of shortnose sturgeons is thought to be very small and there is no evidence that it displays a normal age distribution. This may be a remnant population and therefore may be highly susceptible to extinction by the loss of even a small number of individuals.

Loggerhead turtle (_Caretta caretta_)

Pursuant to the November 1994 biological opinion on the shrimp fishery, the NMFS selected an Expert Working Group (EWG) consisting of population biologists, sea turtle biologists and state and federal managers to consider the best available information to formulate population estimates for sea turtles in the Gulf of Mexico and in the Atlantic Ocean off the coast of the southeastern United States. The EWG focused on determining population estimates for Kemp's ridley and loggerhead sea turtles, the two species of greatest concern. The EWG report entitled "Status of the Loggerhead Turtle Population (*Caretta caretta*) in the Western North Atlantic" dated July 1, 1996, is incorporated by reference.

Loggerhead turtles nest at the mouth of the Cape Fear River (near river mile 0) on Bald Head Island and Oak Island. From 1990 through 1995 there was an average of 130 loggerhead nests per year laid on Bald head Island and an average of 62 loggerhead nests per year laid on Caswell Beach on Oak Island (R. Boettcher, pers. comm. 1996). Loggerhead turtles have also been sighted in the Cape Fear River but generally not further upstream than about river mile 15.

Kemp's ridley turtle (*Lepidochelys kempii*)

The EWG completed a report entitled "Kemp's ridley (*Lepidochelys kempii*) Sea Turtle Status Report" on June 28, 1996. The report is incorporated by reference.

Additionally, through August 3, 1996, 1,945 Kemp's ridley nests had been documented, including 1,264 nests from Rancho Nuevo. Unusual nesting behavior, such as two weeks of nighttime nesting, was attributed to odd climatic conditions. Up to 2,000 nests were anticipated prior to the end of the nesting season (P. Burchfield, pers. comm. 1996). The EWG observed an average Kemp's ridley population growth rate of 13% per year since 1991. Continued growth at that rate would result in 2,190 Kemp's ridley nests during 1996. While this number is not likely to be reached this year, annual fluctuations due in part to irregular inter-nesting periods are normal for sea turtle populations.

The number of Kemp's ridleys nests have been on an upward trend since the late 1980's, although the increase is not dramatic at the Rancho Nuevo camp. As of August 3, 1996, nest numbers on Rancho Nuevo were below 1995 levels. The area surveyed for ridley nests was expanded in 1990 due to destruction of the primary nesting beach by Hurricane Gilbert. The EWG assumed that the increased nesting observed particularly since 1990 was a true increase, rather than the result of expanded beach coverage. Because systematic surveys of the adjacent beaches were not conducted prior to 1990, there is no way to determine what proportion of the nesting increases are due to the increased effort rather then an expanding nesting range. As noted by the EWG, trends in Kemp's ridley nesting suggest that recovery of this population has begun but continued caution is necessary to ensure recovery and to meet the goals identified in the Kemp's ridley Recovery Plan.

Kemp's ridleys are not known to nest in the vicinity of the Cape Fear River but have been sighted in the river as far upstream as about river mile 15.

Green turtle (*Chelonia mydas*)

Green turtles are circumglobally distributed mainly in waters between the northern and southern 20° C isotherms (Hirth 1971). In the western Atlantic, several major nesting assemblages have been identified and studied (Peters 1954, Carr and Ogren 1960, Duellman 1961, Parsons 1962, Pritchard 1969a, Schulz 1975, Carr and Carr 1978). However, in the continental United States, the only major green turtle nesting occurs on the Atlantic coast of Florida (Ehrhart 1979), particularly in Brevard, Indian River, St. Lucie, Martin, Palm Beach, and Broward counties.

The major portion of the green turtle's life is spent on the foraging grounds. Some of the principal feeding pastures in the western Atlantic Ocean include: upper west coast of Florida, northwestern coast of Yucatan Peninsula, south coast of Cuba, Mosquito Coast of Nicaragua, Caribbean coast of Panama, scattered areas along Colombia, and scattered areas off the Brazilian coast (Hirth 1971). The preferred food sources in these areas are: *Cymodocea, Thalassia, Zostera, Sagittaria* and *Vallisneria* (Babcock 1937; Underwood 1951; Carr 1954; Carr 1952; Neill 1958; Mexico 1966).

Under the Endangered Species Act of 1973 green turtles are listed as threatened, except for the breeding populations in Florida and along the Pacific coast of Mexico which are listed as endangered. Green turtles face threats such as loss of nesting habitat, incidental take in fishing gear, and destruction or degradation of feeding habitat.

Green turtles nest at the mouth of the Cape Fear River (near river mile 0) on Bald Head Island and Oak Island. From 1990 through 1995 there was an average of one green nest per year laid on Bald head Island (R. Boettcher, pers. comm. 1996). There are no known confirmed reports of green turtles having been sighted in the Cape Fear River.

Right whale (*Eubalaena glacialis*)

A complete description of the natural history and taxonomy of the northern right whale can be found in the Right Whale Recovery Plan (NMFS 1991).

The northern right whale population was decimated during the 1700s by commercial whaling fleets. Shore whaling was conducted off Massachusetts, New York, New Jersey, North Carolina, and Florida beaches. By 1750, directed harvest of right whales had reduced the population to numbers no longer able to sustain a vigorous coastal fishery (Allen 1916). NMFS, in recent marine mammal stock assessment reports (SARs) (Blaylock *et al.* 1995), estimates the minimum size of the northern Atlantic right whale population to be 295. This is based on a census of individual whales identified using photo-identification techniques (Knowlton *et al.* 1992). The Right Whale Recovery Team set a recovery goal of 7,000 North Atlantic right whales, which represents 60-80 percent of the estimated pre-exploitation level (NMFS 1991).

Despite more than 50 years of protection, there is no indication that the North Atlantic right whale population is recovering from eight centuries of harvest (NMFS 1991). Schevill *et al.* (1986) compared historical whaling data and modern sighting information and concluded that there was no evidence that the right whale population in the seventeenth century was any larger than it is today. Reeves and Mitchell (1987) also compiled whaling records in an attempt to determine the pre-exploitation population levels of right whales. Their studies of the North Atlantic harvest of other mysticetes resulted in population estimates through assumptions that the sum of removals during the peak decade was comparable to a conservative minimum estimate of the pre-exploitation population size. Incomplete records and conflicting evidence indicate levels of harvest of right whales may have been sustainable, with no peak decade evident. A minimum of 245 right whales were harvested from 1700-1709; however, similar levels were believed to have been harvested in all decades between 1680 and 1719. The authors noted the possibility that Basque whaling effort prior to the 1600s off Newfoundland likely included effort on right whales of the same, or a neighboring, stock (also see Reeves and Mitchell 1986). NMFS (1991) suggests that Basque whaling activities, which ceased by the late 1600s, may have extirpated the western North Atlantic right whale along the Labrador Coast before colonial times. Reeves and Mitchell (1987) conclude that, although they believe Schevill *et al.*'s (1986) suggestion regarding the similarity in abundance of right whales now compared to colonial times is unlikely, they cannot disagree with the possibility that the seventeenth century "population in this area may not have been as large as has been supposed." Allen (1916), does not give an estimate of pre-whaling population levels, but indicated that at the time of settlement of New England and into the following century, "right whales were present in considerable numbers . . .," and cites Mayflower passengers and other writers of the period indicating whales were abundant in the 1600s. Reeves and Mitchell (1987) broadly estimate there were "some hundreds of right whales in the western North Atlantic during the late seventeenth century."

NMFS believes that because of the limited size of the right whale population, the lengthy calving interval, low population recruitment rate, and other factors placing stress upon the population (e.g., possible inbreeding depression), the incidental mortality of even one right whale could jeopardize the continued existence of the population.

Habitat degradation is cited as potentially the most important factor affecting the recovery of the species (NMFS 1991). The Right Whale Recovery Team (NMFS 1991) indicated disposal of terrestrially generated pollutants into Massachusetts and Cape Cod bays could slow the recovery of the species.

Another factor possibly inhibiting recovery of the right whale population is inbreeding depression. Schaeff *et al.* (1993) have determined through genetic analyses that western North Atlantic right whales probably represent a single breeding population based on three matrilines.

Right whales are likely to be in coastal waters near the mouth of the Cape Fear river from November through December and from April through May each year during their calving migration. Individual whales not participating in the calving migration may also be in North Carolina waters throughout the winter months.

Fin whale (*Balaenoptera physalus*)

The fin whale is considered one of the more abundant large whale species, with a worldwide population estimate of 120,000 (Braham 1991). The fin whale was a prime target for commercial whaling after the Norwegian development of the explosive harpoon in 1864. North Atlantic stocks were heavily fished and because these stocks were relatively small, they were quickly depleted.

Braham (1991) indicates that although fin whales are abundant compared to other stocks, they remain depleted relative to historic levels. Only a few thousand are believed to exist in the North Atlantic (Gambell, 1985). Current estimates for fin whales found in the northwest Atlantic are not available, although CeTAP (1982) estimated 5,423 fin whales occurred in the waters between Cape Hatteras and the Bay of Fundy in the spring, more than half of which (2,788) occur in the Gulf of Maine.

Current Marine Mammal Stock Assessment Reports (MMSARs) (Blaylock *et al.* 1995) continue to use CeTAP (1982) data as the best available. A population estimate based on an inverse variance weighted pooling of CeTAP (1982) spring and summer data is 4,680 fin whales (CV = 0.23) and includes a dive-time correction factor of 4.85. An average for these two seasons was chosen because the greatest proportion of the population off the northeast U.S. coast appears to be in the CeTAP study area in these seasons. However, this estimate is highly uncertain because the data are a decade old, and values were estimated just after cessation of extensive foreign fishing operations in the region.

Surveys conducted by NMFS in 1991 and 1992 covered a portion of the area included in the CeTAP study, produced an estimate of 2,700 fin whales (uncorrected for dive time). This figure has been used in the NMFS MMSARs (Blaylock *et al.* 1995) to estimate the minimum size of the North Atlantic fin whale population. The minimum population estimate is 1,704 fin whales, and is based on the lower limit of the two-tailed 60 percent confidence interval of the above estimate of 2,700. This is equivalent to the 20th percentile of the log-normal distribution as specified by NMFS (Anon. 1994).

Distribution: During summer in the western North Atlantic, fin whales can be found along the North American coast to the Arctic and around Greenland. The wintering areas extend from the ice edge southward to the Caribbean and Gulf of Mexico. They are widely distributed in the Gulf of Maine, and may stay in the region through the winter. Fin whales in the Gulf of Maine concentrate in the area extending from the southern base of the Great South Channel, northwest along the 50 fathom contour into the southwestern Gulf of Maine over Stellwagen Bank, to Jeffreys Ledge. Sightings are most numerous in spring and summer with peaks in May and July and occur at Jeffreys Ledge, Stellwagen Bank and the Great South Channel.

Seipt *et al.* (1990) discuss characteristics of the population of fin whales in Massachusetts Bay as observed through the photo-identification of individuals between 1980 and 1987. During that period, 156 individuals were identified. Ninety-eight were observed more than once, including 70 that were observed in more than one year. The authors suggest this information indicates that the occurrence and annual return of individual fin whales is similar to that observed for humpbacks as discussed above. They conclude that fin and humpback whales in high latitudes are distributed according to the occurrence of their prey, and return repeatedly to consistently productive habitats such as Jeffreys Ledge, Stellwagen Bank, and Massachusetts Bay. As suggested by Kenney *et al.* (1986) and Payne *et al.* (1990), regarding right and humpback whales, such a strategy would be energetically efficient.

Fin whales are often spotted in mid-Atlantic waters, although nearshore occurrences off Virginia were undocumented until recently. Some fin whales were observed off the Delmarva Peninsula during aerial surveys conducted over a decade ago (Shoop *et al.* 1982). However, since 1989, sightings of feeding juvenile fin whales have increased along the coast of Virginia in the same area as the humpback whales mentioned below (Swingle, pers. comm.). Fin whales are more difficult to study due to their speed; however, they are believed to be feeding with the humpbacks, on bay anchovies and menhaden.

Foraging: Fin whales in the North Atlantic feed on herring, cod, mackerel, pollack, sardine, and capelin, as well as squid, euphausids, and copepods. In the 1970s and 80s, fin whales were observed to feed primarily on sand lance, in proximity to humpbacks (Overholtz and Nicolas 1979, Payne *et al.* 1990). Bigelow and Schroeder (1953) reported fin whales feeding on sand lance that were abundant in Cape Cod Bay in 1880. Effects of the abundance of fin fish on the distribution of fin whales are similar to those discussed for humpback whales above. Changes in fin whale distribution have not been as distinct as those observed for humpbacks, suggesting greater success at exploiting alternative prey species.

Reproduction: The peak months for breeding are December and January in the Northern Hemisphere. A single calf averaging about 6 meters in length is produced after a gestation period of a little more than 11 months. Fully mature females may reproduce every two to three years. In the Northern Hemisphere, females become sexually mature at a length of 18.3 meters and males at 17.7 meters. Although fin whales are sometimes found singly or in pairs, they commonly form larger groups of three to 20 which may in turn coalesce into a broadly spread concentration of a hundred or more individuals, especially on the feeding grounds (Gambell 1985).

Mortality: At least two fin whales died in association with the 1987-1988 multiple mortality of humpbacks, the cause of which has been linked to ingestion of mackerel that had concentrated neurotoxins from plankton (Geraci *et al.* 1989). Lambertson (1986) identifies the occurrence of the nematode *Crassicauda* in fin whales taken in whaling efforts off Iceland, and describes the associated pathology. Known and theorized anthropogenic effects on recovery of fin whales are similar to those discussed below for humpbacks.

Humpback whale (*Megaptera novaeangliae*)

The Humpback Whale Recovery Plan (NMFS 1991b) contains information regarding humpback life history, distribution, and taxonomic parameters.

Worldwide, humpbacks are thought to number between 10,000 and 12,000 individuals (Braham 1991), down from in excess of 125,000 prior to exploitation. Humpback whales were commercially hunted from the seventeenth century into the twentieth century.

The Humpback Whale Recovery Team has recommended an interim recovery goal of twice the current population estimates within the next 20 years. The western North Atlantic population is currently estimated to include approximately 5,543 individuals (CV = 0.16, Katona *et al.* 1994). Katona and Beard (1990) estimate the population's annual growth rate at 9.4 percent (with broad confidence intervals). The current NMFS SARs (Blaylock *et al.* 1995) estimate the minimum size of the North Atlantic humpback whale population to be 4,848. This is based on the lower limit of the two-tailed 60 percent confidence interval of the above estimate by Katona et *al.* (1994). This is equivalent to the 20th percentile of the log-normal distribution as specified by NMFS (Anon. 1994).

After calving and mating in warm waters of the Caribbean, whales return to five separate foraging areas, distributed between latitudes of 42° N to 78° N. These feeding areas are (with approximate number of humpback whales in parentheses): Gulf of Maine (400); Gulf of St. Lawrence (200); Newfoundland and Labrador (2,500); western Greenland (350); and the Iceland-Denmark strait (up to 2,000) (Katona and Beard 1990). The western North Atlantic stock is considered to include all humpback whales from these five feeding areas. Courtship groups on the wintering ground contain whales from different feeding aggregations, so humpbacks from the western North Atlantic probably interbreed (Katona *et al.* 1994).

Until recently, humpback whales in the mid- and south Atlantic were considered transients. Few were seen during aerial surveys conducted over a decade ago (CeTAP 1982). However, since 1989, sightings of feeding juvenile humpbacks have increased along the coasts of Virginia and North Carolina, peaking during the months of January through March in 1991 and 1992 (Swingle *et al.* 1993). Studies conducted by the Virginia Marine Science Museum (VMSM) indicate that these whales are feeding on, among other things, bay anchovies and menhaden. Researchers theorize that juvenile humpback whales, which are unconstrained by breeding requirements that result in the migration of adults to relatively barren Caribbean waters, may be establishing a winter foraging area in the mid-Atlantic (Mayo, pers. comm.). The lack of sightings south of the VMSM study area is a function of shipboard sighting effort, which was restricted to waters surrounding Virginia Beach, Virginia.

Shipboard observations conducted during daylight hours during dredging activities in the Morehead City Harbor entrance channel during January and February 1995 documented sightings of young humpback whales on at least six days near the channel and disposal area, through January 22, 1995. Three humpback strandings were documented in North Carolina in that year, one each in February, March, and April, suggesting that humpback whales remained within South Atlantic waters through April.

The Humpback Whale Recovery Plan (NMFS 1991) identifies entanglement, ship collisions, disturbance, habitat degradation, and competition with commercial fisheries as potential sources of mortality or delayed recovery.

Volgenau and Kraus (1990) identify entanglement in fishing gear as a threat to the speed of recovery of the Gulf of Maine population of humpbacks. There is an average of four to six entanglements of humpback whales a year in waters of the southern Gulf of Maine, and additional reports of ship-collision scars (D.L. DeKing, pers. comm.). An entanglement database maintained by NMFS NE Regional Office contained 64 records of entangled or injured humpbacks from 1975-1992. Humpbacks also become entangled offshore. On January 18, 1993, a dead juvenile humpback was observed entangled in a swordfish drift net along the 200m isobath northeast of Cape Hatteras. Entangled animals are often released, although some dead or injured animals likely go unobserved and unreported. Occasionally, "floaters" are encountered at sea (NMFS, unpublished data).

Swingle *et al.* (1993) identify a shift in distribution of juvenile humpback whales in the nearshore waters of Virginia, primarily in winter months. Those whales using this mid-Atlantic area that have been identified were found to be residents of the Gulf of Maine feeding group, suggesting a shift in distribution that may be related to winter prey availability. In concert with the increase in mid-Atlantic whale sightings, strandings of humpback whales have increased between New Jersey and Florida since 1985. Strandings were most frequent during the months of September through April in North Carolina and Virginia waters, and were composed primarily of juvenile humpback whales of no more than 11 meters in length (Wiley *et al.*, 1995). Six of 18 humpbacks (33 percent) for which the cause of mortality was determined were killed by vessel strikes. An additional humpback had scars and bone fractures indicative of a previous vessel strike that may have contributed to the whale's mortality. Sixty percent of those mortalities that were closely investigated showed signs of entanglement or vessel collision (Wiley *et al.* 1995).

Observers on dredges have documented close approaches between whales and dredges. On February 6, 1988, a right whale reacted to the approach of a hopper dredge within 100 yards by orienting itself toward the vessel in a defensive profile. On February 28, 1988, during clamshell dredging of Canaveral Channel, a right whale remained in the Canaveral channel for a period of about 10 minutes; this occurred during daylight hours and when no vessels were transiting the channel. On January 12, 1995, a humpback whale was observed within a quarter of a mile of the dredge at Wilmington Channel and resurfaced near the dredge. An approaching humpback on January 13, 1995 was observed ahead of the dredge initially, but resurfaced near the stern after the vessel slowed. Dredging was stopped while this whale and two other humpbacks nearby approached within 100 yards, including one passage under the bow. On January 18, still within the Wilmington Harbor channel dredging area, one of a few humpbacks observed feeding surfaced and quickly dove again within 10 meters of the dredge. These incidents illustrate the potential for collisions between whales and vessels in coastal waters.

Assessment of Impacts:

The use of pipeline and bucket dredges is not known to take sea turtles and is thus not likely to adversely affect these species.

There is a small likelihood that shortnose sturgeons, especially small, weaker swimming specimens, may be adversely affected by a pipeline dredge although no documented evidence exists of sturgeon takes by this type of dredge.

Bucket dredges are not likely to adversely impact shortnose sturgeons.

Hopper dredges are known to take sea turtles and have been documented to take Atlantic sturgeons (*Acipenser oxyrynchus*). The NMFS biological opinion of August 25, 1995, addresses hopper dredging in the southeastern United States and requires temporal restrictions on hopper dredging and other measures to protect listed species. Because hopper dredging will be restricted to the lower most portions of the river, it is unlikely that hopper dredging would adversely impact shortnose sturgeons.

Hopper dredging may adversely affect fin, humpback, and right whales which may occur in the project area throughout the year. While dredging itself is not likely to be a problem, the transit of the hopper dredge between the channel and the disposal area may pose a ship strike potential for these whales. Although close approaches between dredges and whales have been reported by observers, there have been no documented collisions. The NMFS believes that the cooperation of the dredge operators and the endangered species observers have greatly reduced the chance of dredge/whale interactions.

Rock cutterhead dredges have not been documented to take sea turtles or sturgeons and are not believed to pose a significant risk because of their extremely slow movement. However, during May 1996 while a rock cutterhead dredge was operating in the Wilmington Harbor entrance channel 25 sea turtles stranded on beaches immediately adjacent to the dredging. Thirteen of these turtles exhibited crushed carapaces or stranded in large pieces. A beam dredge had also been in use just prior to the strandings. The actual cause of the crushed turtles is still unknown.

Adult and large juvenile sturgeons have been tracked in the project area where explosive use is expected (river miles 16 through 31). Sturgeon eggs, larvae, and larger fry are not expected to be in the project area but probably remain in freshwater upstream of the project area.

Loggerhead and Kemp's ridley turtles have been sighted in the river as far upstream as river mile 15. This is within a mile of proposed explosive use. Loggerhead and green turtles are known to nest on Bald Head Island which is within 4 miles of where underwater explosive use is planned. The use of underwater explosives is known to kill or injure marine and aquatic organisms. The COE expects to use a maximum of 98.5 pounds of explosives per hole and a minimum of a 25-millisecond delay between detonation of each charge. Each hole will also be "stemmed" with a foot of crushed rock to reduce the explosive pressure wave. Thus, each explosion may be treated as a separate event for the purpose of calculating protective distances. Based upon the NSWC's equation for fish with swim bladders, using an average adult weight of 7 pounds, and using 40 feet as the blast depth, the safe range (90% survivability) for an adult shortnose sturgeon would be 600 feet. Under the same conditions a 2-pound juvenile would require a safe range of 707 feet. Using the NSWC's equation for sea turtles, the safe range for an explosive weight of 98.5 pounds is 2,586 feet.

According to literature cited in the COE's draft supplement to the final environmental impact statement, the use of air/bubble curtains has been demonstrated to significantly reduce the pressure wave produced by detonating explosives underwater. If the air/bubble curtain or physical barrier placed to protect aquatic animals is successful in reducing the peak pressure wave by 95% then the above calculated distances would be reduced to 30 and 35 feet from the blast for sturgeons and 130 feet from the blast for sea turtles. Since the air curtain or physical barrier will be placed some distance from the actual explosives the above calculated safety distances would be most conservatively measured from the curtain or barrier.

Pre-blast monitoring will be required to ensure sea turtles are not within range of the potentially damaging pressure wave to minimize the likelihood of adverse effect to sea turtles. Pre-blast gill netting to capture and relocate shortnose sturgeons, stemming the charges, and the use of the air curtain or physical barrier will minimize the possibility of adverse impact to this species. The COE proposed a blasting "window" of August 1 through January 31. Based upon the work of Moser and Ross (1993), who documented shortnose sturgeon use of the lower Cape Fear River from January through July, blasting should only take place from August 1 through December 31.

Post-blast monitoring (visual survey, netting, etc.) is necessary to document any listed species takes. Capture of dead or moribund shortnose sturgeons is likely to be difficult and may require several different capture/collection methods. The COE should work with local sturgeon biologists to develop a sampling method that is acceptable to the NMFS.

The COE has proposed, and will likely carry out, a project in Wilmington Harbor to widen the channel to create a passing lane and to make several turns in the channel safer. This project also proposes the use of underwater explosives to remove rock that cannot be dredged. In the biological opinion on the widening project, the NMFS has required measures to protect shortnose sturgeons and sea turtles from the effect of underwater blasting. The widening project is scheduled to begin in 1998 and last approximately one year. The comprehensive plan is scheduled to begin in 2001 and continue for about three years. Because of the critically low level of shortnose sturgeon abundance in the Cape Fear River, information collected during the widening project may substantially change the assessment of impacts for the comprehensive project.

Conclusion:

The NMFS concludes that the proposed dredging is not likely to jeopardize the continued existence of the shortnose sturgeon, green, loggerhead, or Kemp's ridley sea turtles or fin, humpback, or right whales. However, the use of underwater explosives is likely to adversely impact shortnose sturgeons and the three sea turtle species. The use of hopper dredges may adversely impact sea turtles and the three whale species. The use of protective measures and the take monitoring described in the incidental take statement is expected to minimize these impacts. This opinion considers the likely small population size of adult shortnose sturgeons in the lower Cape Fear River and the possibility that loggerhead, Kemp's ridley, and green turtles may be occasionally found in the project area.

Critical Habitat:

No critical habitat has been designated inside the operational areas of the proposed activity.

Cumulative Effects:

"Cumulative effects" are those effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the federal action subject to consultation. The state of North Carolina currently allows gill net fishing for American shad in the Cape Fear River. This fishery may incidentally take shortnose sturgeons but in most cases incidentally caught sturgeons can be released unharmed.

The operation of the federal locks and dams on the Cape Fear River probably prevents, or at least greatly restricts, shortnose sturgeon spawning migration to the upper portions of the river. The City of Wilmington has a freshwater supply intake just upstream of Lock and Dam #1 which would need to be relocated at considerable cost if Lock and Dam #1 were to be removed. This is one of the primary stumbling blocks to the removal of the dam.

The introduction of non-native fish and invertebrate species upstream of Lock and Dam #1 have resulted in degraded shortnose sturgeon habitats and some of the fish species may directly compete with sturgeon for feeding and spawning areas.

Nearshore fishing activities pose a threat to sea turtles. For example, coastal gill netting is known to kill sea turtles.

Vessel activities pose a lethal threat to whales in shipping lanes.

Reinitiation of Consultation:

Reinitiation of formal consultation is required if: (1) the amount or extent of taking specified in the incidental take statement is exceeded, (2) new information reveals effects of the action that may affect listed species or critical habitat (when designated) in a manner or to an extent not previously considered, (3) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the Biological Opinion, or (4) a new species is listed or critical habitat designated that may be affected by the identified action.

Conservation Recommendations:

Pursuant to Section 7(a)(1) of the Endangered Species Act of 1973 the following conservation recommendation is made to assist the COE in reducing/eliminating adverse impacts to shortnose sturgeons in the Cape Fear River.

Consultation should be initiated by the COE on the continued operation of the lock and dam system on the Cape Fear River. As part of this consultation:

A) The COE should consider the possibility of removing the three sets of locks and dams on the Cape Fear River. The adult shortnose sturgeon population below Lock and Dam #1 is estimated to be small. It is highly likely that the dams are severely inhibiting the migration of adults upstream and they may be restricting juveniles from moving into the lower portions of the Cape Fear River. Removal of these dams would increase the chances of the recovery of this shortnose sturgeon population segment.

B) If the removal of the lock and dam system is not feasible, the COE should actively investigate changing the timing of their lock openings to allow shortnose sturgeon passage.

Incidental Take Statement

Section 7(b)(4) of the Endangered Species Act (ESA) requires that when a proposed agency action is found to be consistent with Section 7(a)(2) of the Act and the proposed action may incidentally take individuals of listed species, the NMFS will issue a statement that specifies the impact (amount or extent) of such incidental taking and the terms and conditions that must be followed. Only incidental taking by the Federal agency or applicant that complies with the specified terms and conditions of this statement is authorized and exempt from the taking prohibition of the ESA.

Pursuant to Section 7(b)(4) of the ESA an documented incidental take of two shortnose sturgeons and one loggerhead, green, or Kemp's ridley turtle is set for this activity. If the incidental take meets or exceeds this level, the COE must reinitiate consultation. The NMFS Southeast Region will cooperate with the COE in a review of the incident to determine the need for developing further protective measures.

The following are reasonable and prudent measures that the NMFS believes are necessary to avoid the take of endangered whales and to minimize the take of shortnose sturgeons and sea turtles in the Wilmington Harbor Channel and to determine the actual take levels of this action:

1) The use of underwater explosives may only occur from August 1 through December 31 to reduce the likelihood of interaction with shortnose sturgeons.

2) An air/bubble curtain or a physical barrier, such as a cofferdam, must be used that will reduce the blast pressure of the underwater explosives by a minimum of 95%. Testing must be conducted prior to the full construction blasting to determine that this reduction is occurring. The test blasts should be carried out in the project area as part of the construction blasting so as to keep redundant explosive use to a minimum. The COE must submit the results of the testing to the NMFS Southeast Regional Office for evaluation prior to full construction blasting.

3) Prior to deploying the air curtain or physical barrier, gill netting will be conducted to capture and relocate any shortnose sturgeon in the vicinity of the blasting area. Captured shortnose sturgeons will be relocated to an area or areas pre-determined by NMFS (in consultation with local shortnose sturgeon experts).

4) Pre-blast surveys (aerial or vessel) for sea turtles will be conducted for one hour before, and one-half hour after, the air/bubble curtain or physical barrier is in place to ensure no turtles are trapped within the blasting zone. Surveys will continue throughout blasting activities to ensure no sea turtles

are within 150 feet of the air curtain or physical barrier. Blasting activities will not be carried out if a sea turtle is inside 150 feet of the curtain or barrier.

5) Post-blast monitoring for shortnose sturgeons and sea turtles must be conducted by NMFS-approved biologists using NMFS-approved sampling gear and methodology. Gear types may include, but are not limited to, trawls, gill nets, and channel nets. Gear testing must be conducted prior to blasting to determine the efficacy of the gear and method. A final monitoring plan must be submitted to the NMFS Southeast Regional Office and approved prior to construction blasting.

6) Any shortnose sturgeon or sea turtle takes must be reported immediately to the NMFS Southeast Regional Office.

7) Any data obtained during the COE project to widen portions of Wilmington Harbor, especially those related to the use of underwater explosives, may constitute new information and require the COE to reinitiate consultation on this project.

8) Hopper dredging operations are restricted in accordance with the August 25, 1995 biological opinion to avoid whale takes and to minimize sea turtle takes.

REFERENCES

Allen, G.M. 1916. The whalebone whales of New England. Memoirs of Boston Society of Natural History 8(2):106-175.

Anonymous. 1994. Report of the PBR (Potential Biological Removal) workshop. June 27-29, 1994. NOAA, NMFS Southwest Fisheries Science Center, La Jolla, California, 13 pp. plus Appendices.

Babcock, H. L. 1937. The sea turtles of the Bermuda Islands, with a survey of the present state of the turtle fishing industry. Proc. Zool. Soc. Lond. 107: 595-601.

Bigelow, H.B. and W.C. Schroeder. 1953. Fishes of the Gulf of Maine. U.S. Fish and Wildlife Service Fishery Bulletin, 53. 577 pp.

Blaylock, R.A., J.W. Hain, L.J. Hansen, D.L. Palka, and G.T. Waring. 1995. U.S. Atlantic and Gulf of Mexico marine mammal stock assessments. NOAA Tech. Mem. NMFS-SEFSC-363. 211 pp.

Boettcher, R. 1996. North Carolina Wildlife Resources Commission. Personal communication, August 5, 1996.

Braham, H.W. 1991. Endangered Whales: Status Update, June 1991. NMFS, National Marine Mammal Lab.

Buckley, J. L. 1982. Seasonal movement, reproduction, and artificial spawning of shortnose sturgeon (*Acipenser brevirostrum*) from the Connecticut River. M.S. Thesis, University of Massachusetts, Amherst. 64pp.

Burchfield, P. 1996. Gladys Potter Zoo. Personal communication. August 5, 1996.

Carr, A. F. 1952. Handbook of turtles. Ithaca, New York: Cornell University Press.

Carr, A. F. 1954. The passing of the fleet. A.I.B.S. Bull., 4(5): 17-19.

Carr, D. and P. H. Carr. 1978. Survey and reconnaissance of nesting shores and coastal habitats of marine turtles in Florida, Puerto Rico and the U.S. Virgin Islands. NMFS report. 34pp.

Carr, A. F. and L. Ogren. 1960. The ecology and migrations of sea turtles 4. The green turtle in the Caribbean Sea. Bull. Amer. Mus. Nat. Hist. 131(1): 1-48.

CeTAP. 1982. A characterization of marine mammals and turtles in the mid- and north-Atlantic areas of the U.S. outer continental shelf, Final Report. U.S. Dept. of Interior, Bureau of Land Management, Contract No. AA551-CT8-48, Washington, D.C. 538 pp.

Clapham, P.J., and Mayo, C.A. 1987. Reproduction and recruitment of individually identified humpback whales, *Megaptera novaeangliae*, observed in Massachusetts Bay, 1979-1985. Can. J. Zool. 65:2853-2863.

Dadswell, M. J. 1979. Biology of the shortnose sturgeon (*Acipenser brevirostrum*) in the Saint John River estuary, New Brunswick, Canada. Trans. Atl. Chap. Can. Soc. Environ. Biol. Annu. Meet. 1975: 20-72.

Dadswell, M. J., B. D. Taubert, T. S. Squires, D. Marchette and J. Buckley. 1984. Synopsis of biological data on shortnose sturgeon, *Acipenser brevirostrum* LeSueur 1818. FAO Fisheries Synopsis No. 140. NOAA Tech Report NMFS 14, U.S. Dept. of Commerce, 3300 Whitehaven St., Washington, D.C.

Dovel, W. L. 1981. The endangered shortnose sturgeon of the Hudson estuary: Its life history and vulnerability to the activities of man. An investigation by the Oceanic Society under contract (No. DE-AC-39-79-RC-10074) to the Federal Energy Regulatory Commission, Washington, D.C. 139pp.

Duellman, W. E. 1961. The amphibians and reptiles of Michoacan, Mexico. Publ. Univ. Kans. Mus. Nat. Hist., 15: 1-148.

Ehrhart, L. M. 1979. A survey of marine turtle nesting at Kennedy Space Center, Cape Canaveral Air Force Station, North Brevard County, Florida, 1-122. Unpublished report to Division of Marine Resources, St. Petersburg, Florida, Fla. Dept. Nat. Res.

Ernst, L. H. and R. W. Barbour. 1972. Turtles of the United States. Univ. Kentucky Press, Lexington, Ky.

Evermann, B. W. and B. A. Bean. 1898. Indian River and its fishes. Rep. U.S. Fish. 896:227-248.

Fritts, T. H., A. B. Irvine, R. D. Jennings, L. A. Collum, W. Hoffman and M. A. McGehee. 1983. Turtles, birds and mammals in the northern Gulf of Mexico and nearby Atlantic waters. U.S. Fish and Wildlife Serv. Div. Biol. Ser., Washington, D.C.

Gambell, R. 1985. Fin whale (*Balaenoptera physalus*). In: S.H. Ridgeway and R. Harrison (Eds.). Handbook of Marine Mammals. Vol. 3: The Sirenians and Baleen Whales. Academic Press, London.

Gaskin, D.E. 1991. An update on the status of the right whale *Eubalaena glacialis*, in Canada. Canadian Field-Naturalist. 105:198-205.

Geraci, J.R., D.M. Anderson, R.J. Timperi, D.J. St. Aubin, G.A. Early, J.H. Prescott and C.A. Mayo. 1989. Humpback whales (*Megaptera novaeangliae*) fatally poisoned by dinoflagellate toxin. Canadian Journal of Fisheries and Aquatic Science. 46:1895-1898.

Goodale, D.R. 1981. The temporal and geographic distribution of humpback, finback, and right whales calves. M.S. thesis, University of Rhode Island, Kingston.

Greeley, J. R. 1935. Fishes of the watershed with annotated list. In A biological survey of the Mohawk-Hudson Watershed. Rep. N.Y. State Conserv. Dep., Suppl. 24: 63-101.

Hamilton, P.K. and C.A. Mayo. 1990. Population characteristics of right whales (*Eubalaena glacialis*) observed in Cape Cod and Massachusetts bays, 1978-1986. Rep. Int. Whal. Comm (Special Issue 12):203-208.

Henwood, T. A. and W. E. Stuntz. 1987. Analysis of sea turtles captures and mortalities during commercial shrimp trawling. Fishery Bulletin Vol. 85, No. 4.

Hildebrand, H. H. 1982. A historical review of the status of sea turtle populations in the western Gulf of Mexico. pp 447-453, In: Biology and conservation of sea turtles. K. A. Bjorndal. (ed.) Smithsonian Institution Press, Washington, D.C.

Hirth, H. F. 1971. Synopsis of biological data on the green turtle *Chelonia mydas* (Linnaeus) 1758. FAO Fisheries Synopsis No. 85: 1-77.

Katona, S.K., J.M. Allen, and P. Stevick. 1994. Maintaining the North Atlantic humpback whale catalog. Progress report to the Northeast Fisheries Science Center, Contract No. 50EANF-1-00056, May 1994. 26 pp.

Katona, S.K. and J.A. Beard. 1990. Population size, migrations, and feeding aggregations of the humpback whale (*Megaptera novaeangliae*) in the western North Atlantic ocean. Rep. Int. Whale Comm (Special Issue 12):295-306.

Kenney, R.D., M.A. Human, R.E. Owen, G.P. Scott and H.E. Winn. 1986. Estimation of prey densities required by western North Atlantic right whales. Marine Mammal Science. 2(1):1-13.

Knowlton, A.R. Personal Communication. New England Aquarium, Boston, Massachusetts. 1992.

Knowlton, A.R. and S. Kraus. 1989. Calving intervals, rates, and success in North Atlantic right whales. Unpubl. report to the 8th Biennial Conference on the Biology of Marine Mammals.

Knowlton, A.R., J. Sigurjonsson, J.N. Ciano, and S.D. Kraus. 1992. Long-distance movements of North Atlantic Right whales (*Eubalaena glacialis*). Mar. Mam. Sci. 8(4):397-405.

Kraus, S.D. 1990. Rates and potential causes of mortality in North Atlantic right whales (*Eubalaena glacialis*). Marine Mammal Science. 6(4):278-291.

Lambertson, R.H. 1986. Disease of the common fin whale (*Balaenoptera physalis*): Crassicaudiosis of the urinary system. Journal of Mammalogy. 67(2):353-366.

Leim, A. H. and L. R. Day. 1959. Records of uncommon and unusual fishes from eastern Canadian waters, 1950-1958. J. Fish. Res. Board Can. 16: 503-514.

Marchette, D. E. and R. Smiley. 1982. Biology and life history of incidentally captured shortnose sturgeon, *Acipenser brevirostrum*, in South Carolina. S.C. Wildl. Mar. Res. unpubl. ms 57pp.

Mayo, C. 1993. Personal Communication. Center for Coastal Studies, Provincetown, Massachusetts.

Mayo, C.A. and M.K. Marx. 1990. Surface foraging behavior of the North Atlantic right whale, *Eubalaena glacialis*, and associated zooplankton characteristics. Canadian Journal of Zoology. 68:2214-2220.

Mead, J.G. 1986. Twentieth-Century records of right whales (*Eubalaena glacialis*) in the Northwestern Atlantic Ocean. Rep. Int. Whal. Commn (Special Issue 10):109-119. Variability of primary production in Boston Harbor, Massachusetts and Cape Cod Bays. M.S. Thesis, Boston University. 64 pp.

Mexico. 1966. Instituto Nacional de Investigaciones Biologico-Pesqueras. Programa nacional de marcado de tortugas marinas. Mexico, INIBP: 1-39.

Mitchell, E. 1975. Trophic relationships and competition for food in Northwest Atlantic whales. Proc. Can. Soc. Zool. Ann. Mtg. 1974:123-132.

Mitchell, E.D. and R.R. Reeves. 1983. Catch history, abundance, and present status of northwest Atlantic humpback whales. Rep. Int. Whal. Commn. (Special Issue 5):153-212.

Mortimer, J. 1982. Feeding ecology of sea turtles. pp 103-109, In: Biology and conservation of sea turtles. K. A. Bjorndal (ed.) Smithsonian Institution Press, Washington, D.C.

Moser, M. L. and S. W. Ross. 1993. Distribution and movements of shortnose sturgeon (*Acipenser brevirostrum*) and other anadromous fishes of the lower Cape Fear River, North Carolina. Final Rpt. to the U.S. Army Corps of Eng., Wilmington District.

Murison, L.D and D.E. Gaskin. 1989. The distribution of right whales and zooplankton in the Bay of Fundy, Canada. Can. J. Zool. 67:1411-1420.

Neill, W. T. 1958. The occurrence of amphibians and reptiles in salt water areas, and a bibliography. Bull. Mar. Sci. Gulf Caribb. 8: 1-97.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1991. Recovery plan for the U.S. population of Atlantic green turtle. National Marine Fisheries Service, Washington, D.C.

NMFS. 1991a. Recovery Plan for the Northern right whale (*Eubalaena glacialis*). Prepared by the Right Whale Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland. 86 pp.

Overholtz, W.J. and J.R. Nicolas. 1979. Apparent feeding by the fin whale (*Balaenoptera physalis*) and humpback whale (*Megaptera novaeangliae*) on the American sand lance (*Ammodytes americanus*) in the northwest Atlantic. Fishery Bulletin. 77(1).

Parsons, J. J. 1962. The green turtle and man. Gainesville, University of Florida Press.

Payne, P.M., J.R. Nicolas, L. O'Brien and K.D. Powers. 1986. The distribution of the humpback whale, *Megaptera novaeangliae*, on Georges Bank and in the Gulf of Maine in relation to densities of the sand eel, *Ammodytes americanus*. Fishery Bulletin. 84(2).

Peters, J. A. 1954. The amphibians and reptiles of the coast and coastal sierra of Michoacan, Mexico. Occ. Pap. Mus. Zool. 554:1-37.

Pritchard, P. C. H. 1969a. Sea turtles of the Guianas. Bull. Fla. State Mus. 13(2): 1-139.

Pritchard, P. C. H. 1969b. The survival status of ridley sea turtles in American waters. Biol. Cons. 2(1): 13-17.

Reeves, R.R., J.G. Mead. and S. Katona. 1978. The right whale (*Eubalaena glacialis*) in the Western North Atlantic. Rep. Int. Whal. Commn 28:303-312.

Reeves, R.R. and E. Mitchell. 1986. The Long Island, New York, right whale fishery: 1650-1924. Rep. Int. Whal. Commn. (Special Issue 10):201-220.

Reeves, R.R. and E. Mitchell. 1987. Shore whaling for right whales in the Northeastern United States. Final Report to the NMFS in partial fulfillment of Contract NA85-WC-C-06194.

Reeves, R.R. and E. Mitchell. 1986. The Long Island, New York, right whale fishery: 1650-1924. Rep. Int. Whal. Commn. (Special Issue 10):201-220.

Reeves, R.R. and E. Mitchell. 1987. Shore whaling for right whales in the Northeastern United States. Final Report to the NMFS in partial fulfillment of Contract NA85-WC-C-06194.

Schaeff, C.M., S.D. Kraus, M.W. Brown, and B.N. White. 1993. Assessment of the population structure of the western North Atlantic right whales (*Eubalaena glacialis*) based on sighting and mtDNA data. Can. J. Zool. 71:339-345.

Schevill, W.E., W.A. Watkins and K.E. Moore. 1986. Status of *Eubalaena glacialis* off Cape Cod. Rep. Int. Whal. Commn. (Special Issue 10):79-82.

Schulz, J. P. 1975. Sea turtles nesting in Surinam. Sool. Verh. 143: 1-143.

Seipt, I.E., P.J. Clapham, C.A. Mayo and M.P. Hawvermale. 1990. Population characteristics of individually identified fin whales (*Balaenoptera physalis*) in Massachusetts Bay. Fishery Bull. 88(2):271-278.

Shoop, C., T. Doty and N. Bray. 1982. A characterization of marine mammals and turtles in the mid- and north-Atlantic areas of the U.S. outer continental shelf: Final Report, December 1982. Univ. Rhode Island, Kingston.

Shoop, C., T. Doty and N. Bray. 1981. Sea turtles in the region between Cape Hatteras and Nova Scotia in 1979. pp 1-85 In: A characterization of marine mammals and turtles in the mid- and north-Atlantic areas of the U.S. outer continental shelf: Annual report for 1979. Univ. Rhode Island, Kingston.

Swingle, M., S. Barco, T. Pitchford, W. McLellan and D.A. Pabst. 1993. The occurrence of foraging juvenile humpback whales (*Megaptera novaeangliae*) in Virginia Coastal Waters. Marine Mammal Science. 9(3):309-315.

Underwood, G. 1951. Introduction to the study of Jamaican reptiles. Part 5. Nat. Hist. Notes Nat. Hist. Soc. Jamaica 46: 209-213.

Volgenau, L. and S.K. Kraus. 1990. The impact of entanglements on two substocks of the Western North Atlantic humpback whale, *Megaptera novaeangliae*. Report submitted to NMFS Marine Entanglement Research Program Contract No. 43ABNF002563.

Wiley, D.N., R. A. Asmutis, T.D. Pitchford, and D.P. Gannon. 1995. Stranding and mortalities of humpback whales, *Megaptera novaeangliae*, in the mid-Atlantic and southeast United States, 1985-1992. Fishery Bull. 93:196-205.

Winn, H.E., Price, C.A. and Sorensen, P.W. 1986. The distributional biology of the right whale (*Eubalaena glacialis*) in the western North Atlantic. Rep. Int. Whal. Commn (Special Issue 10):129-138.

Young, G. A. 1991. Concise methods for predicting the effects of underwater explosions on marine life. NAVSWC MP 91-220. 13pp. Naval Surface Warfae Center, Silver Spring, MD.

FINAL
FEASIBILITY REPORT ON IMPROVEMENT OF NAVIGATION
CAPE FEAR - NORTHEAST CAPE FEAR RIVERS
COMPREHENSIVE STUDY
WILMINGTON, NORTH CAROLINA

SECTION I - INTRODUCTION

Wilmington Harbor is a Federal navigation project located along the Cape Fear and Northeast Cape Fear Rivers in southeastern North Carolina. The project extends from the Atlantic Ocean to the Port of Wilmington. Harbor dimensions have been increased incrementally for over 100 years. However, channel depths are not adequate for the fleet now calling at the port. As a result, shippers must lightload vessels to enter or leave the port, and delay transits waiting for high tide. Due to these depth constraints, shipping costs are increased.

STUDY AUTHORITY

This study was conducted under authority of the following resolution, adopted 8 September 1988, by the Committee on Public Works and Transportation of the United States House of Representatives:

> Resolved by the Committee on Public Works and Transportation of the United States House of Representatives, That the Board of Engineers for Rivers and Harbors is hereby requested to review the reports of the Chief of Engineers on Wilmington Harbor, North Carolina, published as Senate Document numbered 114, Eighty-seventh Congress, Second Session; Northeast (Cape Fear) River, North Carolina, published as House Document numbered 185, Ninety-eighth Congress, Second Session; Cape Fear River above Wilmington, North Carolina, published as House Document numbered 252, Eighty-ninth Congress, First Session; and other pertinent reports, with a view to determining whether any modifications of the recommendations contained therein are advisable at this time with particular reference to the commercial navigation needs from the Atlantic Ocean to the upper ends of navigation on the Cape Fear River above Wilmington to Fayetteville, North Carolina, and to Kornegays Bridge on the Northeast (Cape Fear) River.

PURPOSE AND SCOPE OF THE STUDY

The purpose of this study is to determine whether the Wilmington Harbor project should be modified, and if so, to identify a project for implementation. This report is submitted in final response to the congressional resolution quoted above.

The resolution directs review by the Board of Engineers for Rivers and Harbors. The Board was disbanded in 1993 in accordance with Public Law 102-580, Section 223. Responsibility for the review directed in the resolution now rests with the Assistant Secretary of the Army for Civil Works. Following approval by the Assistant Secretary, this report will be submitted to Congress for authorization of the recommended improvements.

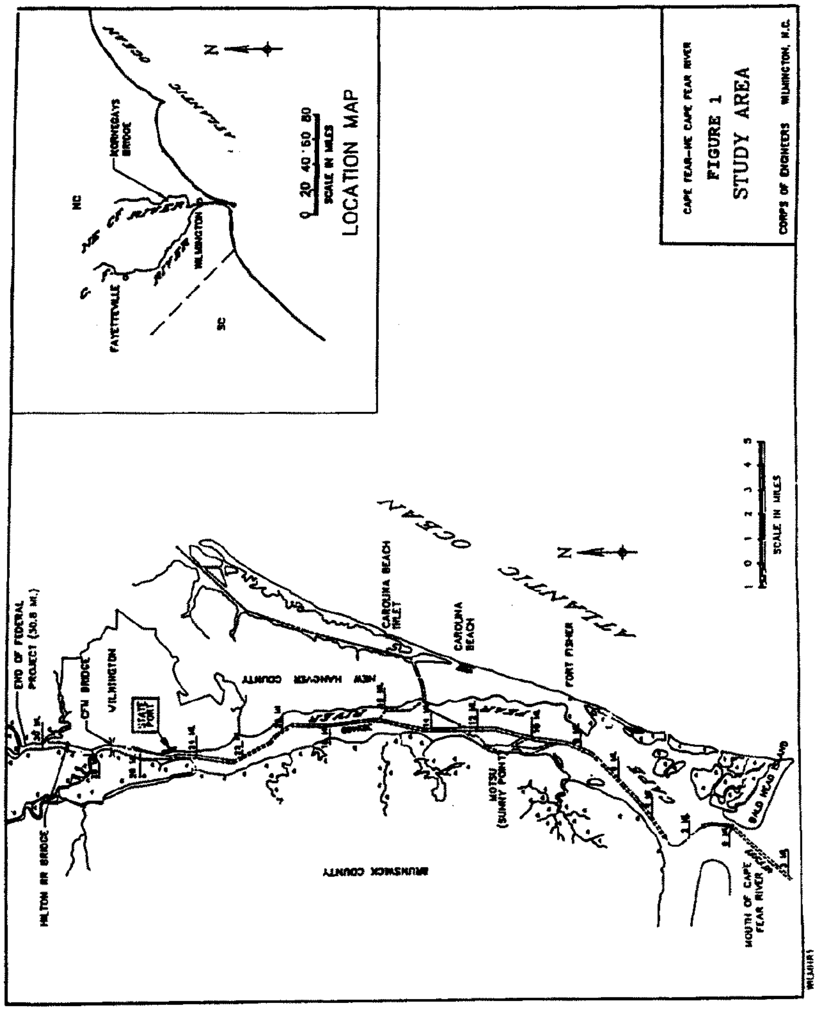
The study authority directs studies of the Federal project from the Atlantic Ocean to the upper limits of navigation on the Cape Fear River above Wilmington at Fayetteville, and to Kornegays Bridge at river mile 103 on the Northeast Cape Fear River (see inset map in figure 1, following page). Note: the authorizing resolution uses the spelling "Northeast (Cape Fear) River;" this report will use "Northeast Cape Fear River," which is now more commonly used.

The authorized Federal project above Wilmington on the Northeast Cape Fear River consists of clearing and snagging to Kornegays Bridge. The authorized Federal project above Wilmington on the Cape Fear River consists of a 25-foot channel to Navassa (river mile 2.9) and a 12-foot channel to river mile 30. No navigation concerns have been identified in the project reaches above Wilmington.

As used in this report, the term, "Wilmington Harbor," will refer to the Federal navigation project on the Cape Fear and Northeast Cape Fear Rivers, extending from the Atlantic Ocean upriver to Wilmington, then upstream on the Northeast Cape Fear River to the point shown on figure 1 (project mile 30.8). Project miles are measured from the mouth of the Cape Fear River (mile "0" on figure 1). The overall length of the existing project includes the 30.8 miles of river channel referred to above, plus the ocean bar channel which extends seaward 5.8 miles. Thus, the total length of the existing project is approximately 37 miles (30.8 miles river channel plus 5.8 miles ocean bar channel).

STUDY PARTICIPANTS AND COORDINATION

This feasibility study is a cooperative effort between the State of North Carolina and the Wilmington District, U.S. Army Corps of Engineers. The State contributed one half of the study costs. The U.S. Fish and Wildlife Service also participated in the study. The Service's report is included with the attached Final Environmental Impact Statement. Coordination was also conducted with shipping interests and the Cape Fear Pilots Association. Coordination with agencies and individuals having interests and responsibilities related to environmental quality is discussed in the Final Environmental Impact Statement.



CAPE FEAR–NE CAPE FEAR RIVER
FIGURE 1
STUDY AREA

PRIOR REPORTS

Wilmington Harbor has grown incrementally for more than 100 years and numerous reports have been prepared for this harbor. Three reports are particularly significant since they include modifications to the existing project. The improvements recommended in these reports are assumed to be constructed prior to implementation of any improvements recommended in this report (see plate 5 for implementation schedule for these improvements). Locations of the improvements included in these reports are shown on figures 2 and 3. Each report and recommended improvements is discussed below.

- Wilmington Harbor - Northeast Cape Fear River, General Design Memorandum, Wilmington District, April 1990. Improvements recommended in this design memorandum were authorized by the Water Resources Development Act of 1986 (P.L. 99-662). The General Design Memorandum recommended widening the Fourth East Jetty Channel on the Cape Fear River from its existing width of 400 feet to 500 feet, and deepening a portion of the project on the Northeast Cape Fear River from its existing depths of 32 and 25 feet to 38 feet (see figure 2). These improvements are referred to as the "Wilmington Harbor - Northeast Cape Fear River project." Due to modifications of the project since authorization, congressional reauthorization is required. Completion of this project is scheduled for year 2000.

- Wilmington Harbor Ocean Bar - General Design Memorandum Supplement and Environmental Assessment, Wilmington District, September 1993. This report recommended removal of rock in the Wilmington Harbor Ocean Bar (Baldhead Shoal) Channel. The authorized, 40-foot depth was not achieved at the time of project construction (1973). Construction of the 40-foot bar channel is in progress (June 1996). Completion of this project is scheduled for 1996.

- Interim Feasibility Report and Environmental Impact Statement on Improvement of Navigation, Wilmington Harbor Channel Widening, Wilmington District, March 1994. This report was prepared in partial response to the authorizing resolution quoted on page 1. The improvements recommended in this report were submitted to Congress in House Document 102-303. The channel widening project, illustrated on figure 3, consists of widening the existing, 400-foot-wide channel to 600 feet over a reach of 6.2 miles, and widening five turns. The reach to be widened to 600 feet is located approximately halfway between the Port of Wilmington and the Ocean Bar Channel, and will provide a passing lane for the larger vessels using the port. The turns to be widened are currently too narrow for the larger vessels to negotiate safely without substantially reducing speeds. Completion of this project is scheduled for 1999.

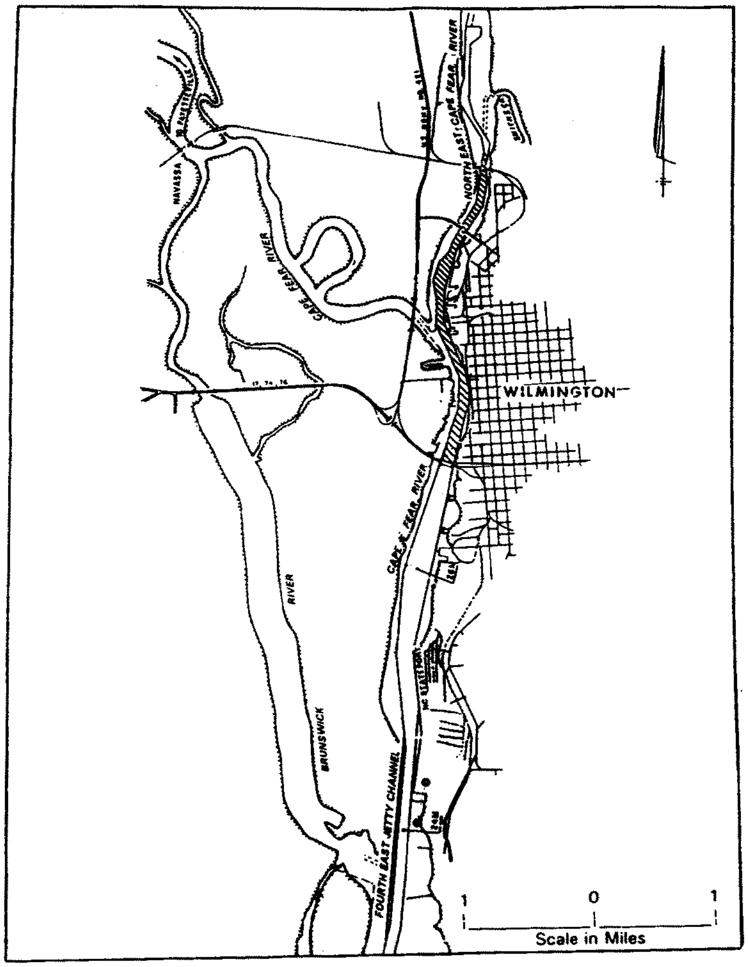


FIGURE 2. Wilmington Harbor - Northeast Cape Fear River Project. The hatched areas show project improvements. These improvements include widening the Fourth East Jetty Channel on the Cape Fear River from its existing width of 400 feet to 500 feet, and deepening a portion of the project on the Northeast Cape Fear River from its existing depths of 32 and 25 feet to 38 feet.

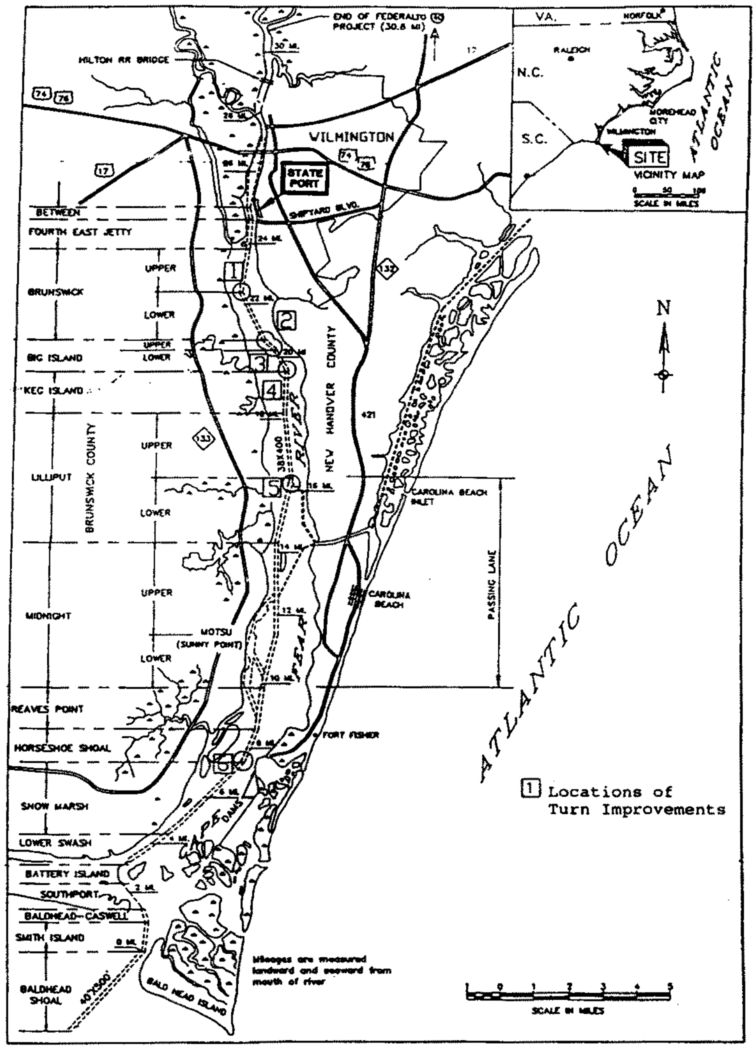


FIGURE 3 - Wilmington Harbor Channel Widening Project. This project consists of widening the existing, 400-foot-wide channel to 600 feet over a reach of 6.2 miles (Upper and Lower Midnight and Lower Lilliput Channels), and widening six turns.

SECTION II - PROBLEM IDENTIFICATION

This report section analyzes the navigation problems associated with Wilmington Harbor and estimates the potential economic benefits which could be realized with navigation improvements. The primary concern of harbor users is the limiting depths of the navigation channels.

PUBLIC CONCERNS

The North Carolina State Ports Authority and navigation interests utilizing the Port of Wilmington have requested that the Federal Government evaluate improvements to Wilmington Harbor. Navigation interests are primarily concerned with the limiting depths of Wilmington Harbor. Agencies and individuals have expressed concern that any harbor improvements be undertaken in a manner which minimizes adverse environmental impacts. Therefore, environmental planning has been an integral part of the study. Environmental concerns are addressed in the Final Environmental Impact Statement.

THE FEDERAL OBJECTIVE

The Federal objective in water resources planning is to contribute to the National Economic Development in a manner consistent with protection of the Nation's environment. If navigation improvements for Wilmington Harbor are economically feasible (benefits exceed costs), Federal action to improve the harbor will contribute to the National Economic Development.

STUDY AREA

The primary study area for this feasibility study includes the existing Federal project for Wilmington Harbor, shown on figure 1. The infrastructure which serves this navigation system is also included in the study area, as are the natural resources which may be affected by harbor improvements (see the Final Environmental Impact Statement for discussion of environmental resources).

PORT FACILITIES, WILMINGTON HARBOR

Wilmington Harbor includes two primary components: a system of deepdraft channels, maintained by the Federal Government, and berthing and loading facilities, including the North Carolina State Port. There are 47 piers, wharves, docks, and mooring dolphins in Wilmington Harbor.

The State Port operates five container cranes and three container berths. The port is served by air, rail, and major highway links. A particularly significant event in the recent history of the port has been the completion of Interstate 40, which connects Wilmington to the interstate highway system.

Figure 4 shows the location of the State Port and industries located along the Wilmington waterfront. The major harbor industries include the petroleum, chemical, and fertilizer industries.

The Department of Defense uses the North Carolina State Ports Authority docks and operates the Military Ocean Terminal at Sunny Point, located approximately 10 miles above the mouth of the river (see plate 1 for location). The Military Ocean Terminal at Sunny Point is used for shipments of explosives, while general cargo is shipped through the State Ports terminal.

EXISTING FEDERAL PROJECT

Wilmington Harbor is divided into three reaches for this analysis:

- Reach 1 is the main harbor from the ocean bar to the Cape Fear Memorial Bridge in downtown Wilmington;

- Reach 2 extends from the Cape Fear Memorial Bridge to 750 feet above the Hilton Railroad Bridge and includes the confluence of the Cape Fear and Northeast Cape Fear Rivers;

- Reach 3 extends from 750 feet above the Hilton Bridge to the upstream limit of the Federal project on the Northeast Cape Fear River.

Each of the reaches described above is shown on figure 4. Channel dimensions are shown in table 1, following figure 4. Dimensions in table 1 are shown both for the harbor as it exists at the time of this report (June 1996), and with improvements assumed to be completed prior to construction of any improvements recommended as a result of this study. Depths shown in the table are feet below mean lower low water (MLLW).

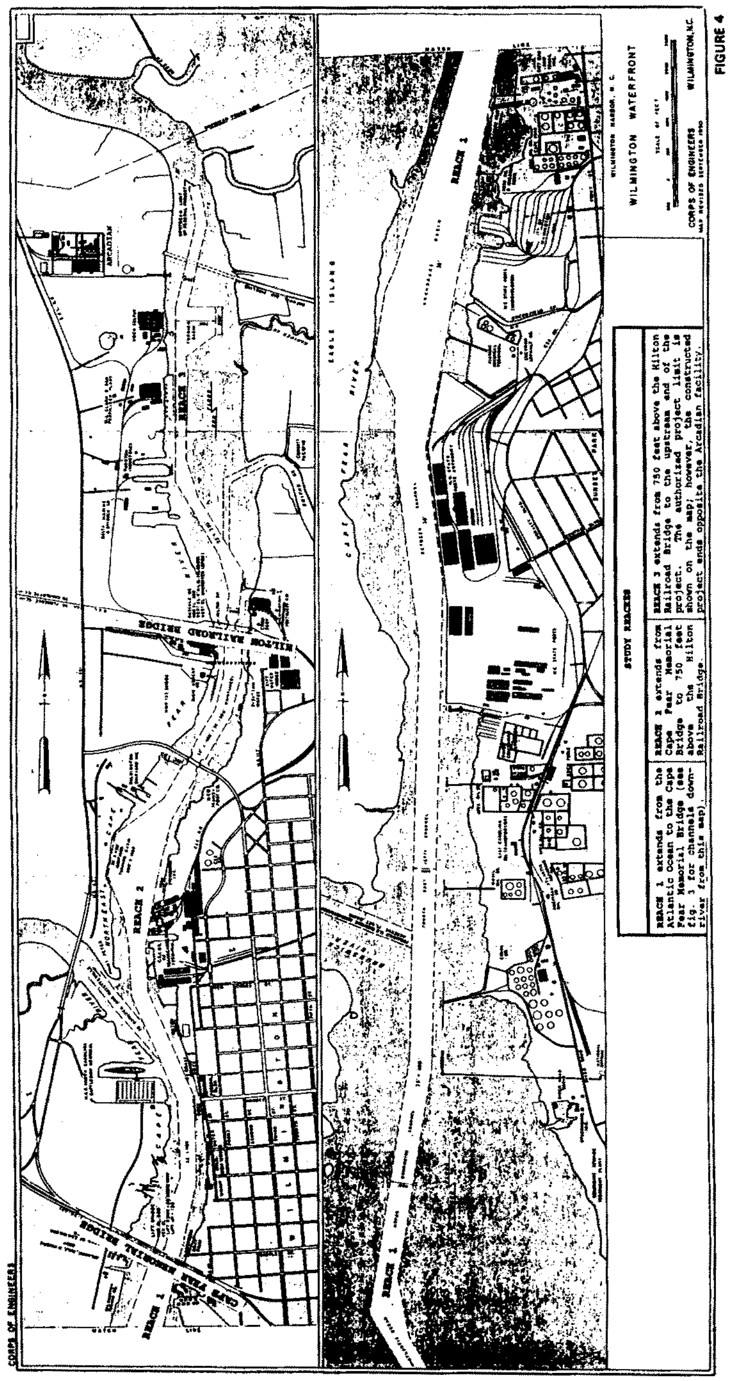

CORPS OF ENGINEERS
HILTON RAILROAD BRIDGE
CAPE FEAR MEMORIAL BRIDGE
ARCADIAN
REACH 1
REACH 2
REACH 3
EAGLE ISLAND
CAPE FEAR RIVER
STUDY REACHES
REACH 1 extends from the Atlantic Ocean to the Cape Fear Memorial Bridge (see fig. 3 for channels downriver from this map).
REACH 2 extends from Cape Fear Memorial Bridge to 750 feet above the Hilton Railroad Bridge.
REACH 3 extends from 750 feet above the Hilton Railroad Bridge to the upstream end of the project. The authorized project limit is shown on the map; however, the constructed project ends opposite the Arcadian facility.
WILMINGTON HARBOR, N.C.
WILMINGTON WATERFRONT
CORPS OF ENGINEERS
WILMINGTON, N.C.

FIGURE 4

TABLE 1

Federal Navigation Project, Wilmington Harbor
(see plate 1 and figure 4 for detailed maps)

Reach and Channels	Channel Dimensions (width x depth MLLW) (June 1996)	Dimensions Assumed as "Without Project" Condition
REACH 1: CHANNEL FROM OCEAN BAR TO CAPE FEAR MEMORIAL BRIDGE		
Channels in Reach 1:		
Baldhead Shoal (Ocean Bar Channel)	*500' x 40'	500' x 40'
Smith Island	"	"
Baldhead-Caswell	"	"
Southport	"	"
Battery Island	"	"
Lower Swash	400' x 38'	400' x 38'
Snow Marsh	"	"
Horseshoe Shoal	"	"
Reaves Point	"	"
Lower Midnight	"	600' x 38'
Upper Midnight	"	"
Lower Lilliput	"	"
Upper Lilliput	"	400' x 38'
Keg Island	"	"
Lower Big Island	"	"
Upper Big Island	"	"
Lower Brunswick	"	"
Upper Brunswick	"	"
Fourth East Jetty	"	500' x 38'
Between	550' x 38'	550' x 38'
Turning Basin at State Port	1,200' x 38'	1,200' x 38'

*Under construction.

TABLE 1

Federal Navigation Project, Wilmington Harbor--continued
(see plate 1 and figure 4 for detailed maps)

Reach	Channel Dimensions (width x depth MLLW) (June 1996)	Dimensions Assumed As "Without Project" Condition
REACH 2: Cape Fear Memorial Bridge to 750 Ft above Hilton Railroad Bridge		
Cape Fear Memorial Bridge to Hwy. 133 Bridge	400' x 32'	400' x 38'
Turning Basin Above Mouth of NE Cape Fear (opposite Almont Shipping)	700' x 32'	700' x 38'
Hwy. 133 Bridge to Hilton RR Bridge	300' x 25'	300' x 38'
Hilton RR Bridge upriver 750 ft.	200' x 25'	200' x 38'
Reach 3: 750 Feet Above Hilton Railroad Bridge to Upstream Limit of Project		
750 Feet Above Hilton RR Bridge to Upstream Project Limit	200' x 25'	200' x 25'
Turning Basin at Upstream Project Limit	700' x 25'	700' x 25'

PROBLEMS, NEEDS, AND OPPORTUNITIES

In recent years draft constraints in Wilmington Harbor have become an increasing concern to the North Carolina State Port and the industries which depend on oceangoing carriers. The main harbor (Reach 1) was last deepened in 1970. The project completed in 1970 provided a 38-foot deep river channel, and was designed to allow 34-foot-draft (26,000 deadweight ton) vessels to call at any tide. At that time, the 34-foot draft accommodated most vessels calling at the port.

However, vessel sizes, both in the world fleet and in Wilmington Harbor, have increased since 1970. During the 1990's, approximately 50 percent of the oceangoing ships calling in Wilmington Harbor were larger than the 26,000 deadweight ton (DWT) design vessel, and could enter or leave the harbor only at high tide, or when lightloaded. When vessels wait for the tide, operating costs continue to be incurred; when vessels are lightloaded, shippers pay for unused space. In either case, shipping costs are increased.

Draft restrictions above apply specifically to the Main Harbor (Reach 1), but similar draft restrictions exist in Reaches 2 and 3.

REACH 1 - NAVIGATION PROBLEMS AND IMPROVEMENTS CONSIDERED

Reach 1 includes the majority of docks and commerce in Wilmington Harbor. Reach 1 consists of 20 named channels, and an anchorage basin at its upstream terminus. As shown on figure 1, river miles are measured landward and seaward from the mouth of the Cape Fear River at the intersection of Baldhead Shoal and Smith Island Channels; Baldhead Shoal Channel, referred to as the "Ocean Bar Channel," extends seaward approximately 5.8 miles to deep water. Including the Ocean Bar Channel, Reach 1 is approximately 33 miles long.

Navigation Problems, Reach 1 - Reach 1 has an authorized depth of 38 feet in the river channels and 40 feet in the ocean bar and entrance channels (entrance channels include Smith Island, Baldhead-Caswell, Southport, and Battery Island). As discussed previously (page 4), dredging is now (June 1996) underway to remove rock obstructions and provide the authorized, 40-foot depth in the Ocean Bar Channel.

Ships entering and leaving Wilmington Harbor operate at drafts set by the Cape Fear Pilots. The pilots board incoming vessels at the mouth of the Cape Fear River and control vessel speed and steerage to the Wilmington terminals. Transit time is about 3 hours. Outgoing vessels are boarded by pilots at the docks for the return voyage.

Draft limitations, published in pilots' notices, are based on the pilots' observations, as well as hydrographic data provided by the Wilmington District. Pilots bringing vessels into the harbor require about 4 feet underkeel clearance in the river channels and 6 feet in the ocean bar channel.

Average harbor depths are about 1 foot less than the authorized river-channel depth of 38 feet. This decrease in draft availability is due to shoaling between maintenance operations, and is reflected in the pilots' notices referred to above. Vessel draft availability, assuming 1 foot of shoaling, is as follows:

TABLE 2

Vessel Draft Availability, Assuming 1 Foot Shoaling
(saltwater drafts)

	Maximum Draft, Any Tide	Maximum Draft, High Tide
Inbound Vessels	33' (37' channel - 4' clearance)	37' (37' channel - 4' clearance + 4' tidal advantage)
Outbound Vessels	33' (37' channel - 4' clearance)	36' (37' channel - 4' clearance + 3' tidal advantage)

As shown above, the average maximum inbound draft at Wilmington Harbor is 37 feet. Since tidal advantage is 1 foot less for outbound traffic, the maximum outbound draft is 36 feet. This draft difference is due to the time required for the voyage from Wilmington to the ocean; inbound vessels can move with the tide, maintaining full tidal advantage. However, outbound vessels cannot complete the 3-hour voyage to the ocean before the tide begins to fall.

Table 3 demonstrates the effect of vessel lightloading. The tonnage/draft relationship in table 3 is for container vessels, which call regularly at the State Port. Tonnage/draft relationships for other large vessels, including tankers and bulk carriers, are similar.

TABLE 3

Draft Constraints in Reach 1
For Container Vessels

Vessel Design Draft in Feet	Vessel Size, In Deadweight Tons
43	58,000
42	55,000
41	50,000
39	42,000
36	32,000
33	24,000
29	16,000
SHADED AREA = MAXIMUM AVERAGE DRAFT OF 37 FEET INBOUND, 36 FEET OUTBOUND IN REACH 1	

Improvements Considered, Reach 1 - Shipping interests have requested that the Federal Government evaluate deepening Reach 1 to 42 feet. This depth would provide adequate draft for PANAMAX class vessels. PANAMAX vessels are designed to the draft limits of the Panama Canal, with drafts ranging up to 40 feet. As will be discussed in subsequent report sections, three alternative depths were evaluated for Reach 1 in order to optimize economic benefits. These depths are 40, 42, and 44 feet in the river channels, with 2 feet additional depth in the entrance channels and Ocean Bar Channel.

As discussed on page 4, construction of a passing lane and widening of six turns in Reach 1 (see figure 3) is expected to be completed prior to implementation of any improvements recommended herein. With these improvements assumed to be in place, channel widths in Reach 1 are generally considered satisfactory; however, the vessel pilots have requested that the 1,200-foot-wide anchorage basin at the upstream end of Reach 1 be extended northward for 300 feet. The additional width is needed for tugboat maneuvers during vessel turning operations.

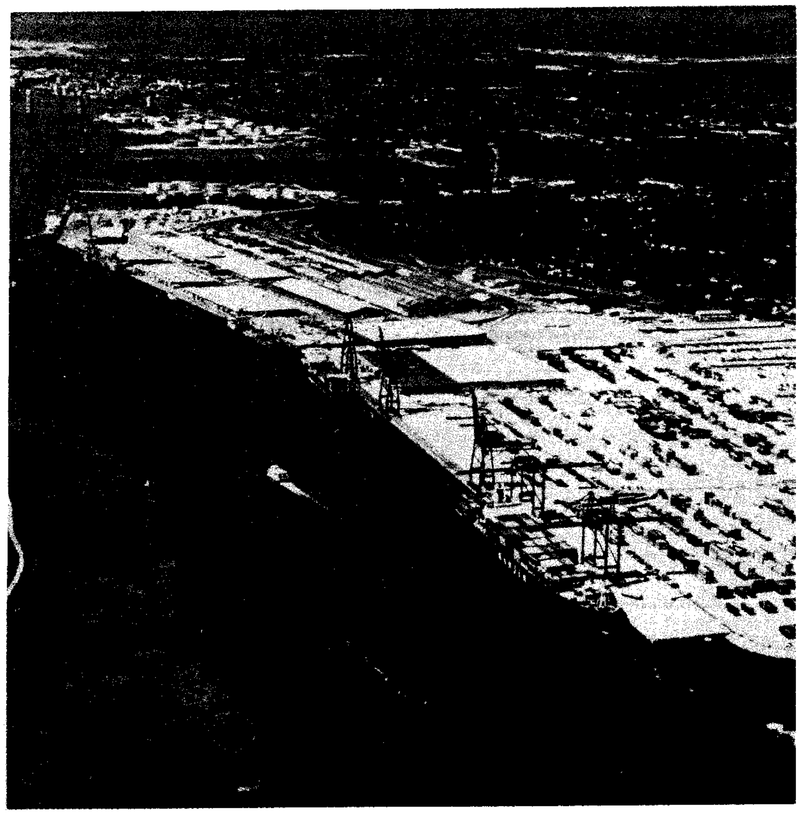


FIGURE 5. State Port. Photograph shows the State Port docks, looking upstream toward the anchorage basin at the upstream end of Reach 1. A container vessel is being worked by one of the Port's five cranes. The vessel has already been turned to face downstream. Liquid bulk storage tanks and docks are visible in the upper left corner of the photograph, as is the Cape Fear Memorial Bridge, upstream terminus of Reach 1 and the current (1996) upstream limit of the 38-foot navigation project. The bridge is the beginning point for Reach 2, discussed on the following page.

REACH 2 - NAVIGATION PROBLEMS AND IMPROVEMENTS CONSIDERED

Reach 2 extends from the Cape Fear Memorial Bridge to a point 750 feet upstream of the Hilton Railroad Bridge. This reach is discussed as an entity since it is scheduled to be deepened to 38 feet as part of the Wilmington Harbor - Northeast Cape Fear River project. The existing (1996) Federal project for Reach 2 consists of a channel 32 feet deep and 400 feet wide from the Cape Fear Memorial Bridge to the NC Highway 133 Bridge; 32 feet deep and 300 feet wide from the NC Highway 133 Bridge to the Hilton Railroad Bridge; and 25 feet deep and 200 feet wide for the remaining 750 feet, above the Hilton Railroad Bridge (see figure 4). The length of this reach is approximately 2.4 miles.

Navigation Problems, Reach 2 - Navigation constraints and vessel operating procedures for Reach 2, with the 38-foot channel in place, will be similar to those described previously for Reach 1; vessels drafting over 37 feet will generally be lightloaded. However, ships operating in Reach 2 require about 1 foot less clearance than vessels in Reach 1, since they are moving slower and with tug assistance. Also, shoaling is less severe in Reach 2 than in Reach 1. Since shoaling downriver in Reach 1 constrains vessels entering the harbor to an average maximum inbound draft of 37 feet, this restriction will also prevail in Reach 2.

Improvements Considered, Reach 2 - Vessels calling in this reach are primarily tankers and bulk carriers. The vessels using Reach 2 are generally smaller than the PANAMAX vessels calling at the State Port, although their dimensions approach this class. Increasing the depth of this Reach from 38 feet (authorized depth) to 40 feet would accommodate most harbor users, and will be evaluated in subsequent report sections. Depths greater than 40 feet were not evaluated. Other dimensions in Reach 2, including channel widths, are considered satisfactory.

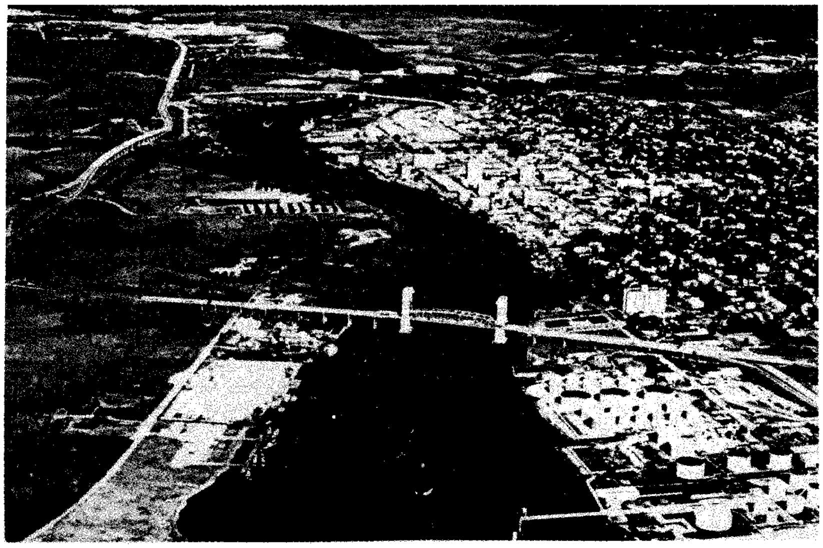


FIGURE 6. Upper Wilmington Harbor. Reach 2 (looking upriver) extends from the Cape Fear Memorial Bridge (foreground) past the NC Highway 133 Bridge to 750 feet above the Hilton Railroad Bridge, visible in the upper center of the photograph. This reach includes the portion of the harbor in downtown Wilmington. The principal commodities handled at the docks in this reach are dry and liquid bulk. The confluence of the Northeast Cape Fear and Cape Fear Rivers is just above the Battleship North Carolina, moored on the left bank. The Cape Fear River enters from the left, passing under the US 421 Bridge. Reach 3, discussed on the following page, begins 750 feet upstream of the Hilton Railroad Bridge, and is located entirely on the Northeast Cape Fear River.

REACH 3 - NAVIGATION PROBLEMS AND IMPROVEMENTS CONSIDERED

Reach 3 begins at the upstream limit of Reach 2 (750 feet above Hilton Railroad Bridge), and extends up the Northeast Cape Fear River to a point opposite the docks of the Arcadian Corporation (see figure 4). The authorized, maintained dimensions are a depth of 25 feet and a width of 200 feet. A turning basin with an existing width of 700 feet is located at the upstream end of this reach. Length of this reach is approximately 1.9 miles.

Navigation Problems, Reach 3 - Most of the oceangoing commerce in Reach 3 is liquid fertilizer materials, which are imported in liquid gas carriers. Reach 3 has several property owners that use the river in their business. The principal user is the Arcadian Corporation, which uses liquid ammonia carriers. Koch fuels, located just downstream from Arcadian (see figure 4) has plans to develop their site for additional use. With the existing 25-foot channel, vessels are limited to a draft of about 24 feet at high tide. With this depth constraint, vessels over about 11,000 deadweight tons must be lightloaded.

Improvements Considered, Reach 3 - Deepening of Reach 3 from its current depth of 25 feet to depths of 30, 32, and 34 feet will be evaluated, along with widening the channel in this reach from its existing width of 200 feet to 250 feet. Widening of the turning basin opposite the Arcadian facility from its current width of 700 feet to 800 feet will also be considered. Depths greater than 34 feet were not evaluated for Reach 3. Based on information from shippers, the 34-foot channel would accommodate most vessels expected to use this reach, and additional depth would not be justifiable.

SUMMARY OF PROBLEMS, NEEDS, AND OPPORTUNITIES

Local interests have indicated a need for channel improvements in Wilmington Harbor. The following improvements will be evaluated in this report:

- Reach 1 - deepening from the authorized depth of 38 feet to depths of 40, 42, and 44 feet, with 2 feet additional depth in the ocean bar and entrance channels; and extending the anchorage basin northward 300 feet;

- Reach 2 - deepening from the authorized depth of 38 to 40 feet;

- Reach 3 - deepening from the authorized depth of 25 feet to depths of 30, 32, and 34 feet, along with widening the river channel from the existing width of 200 feet to 250 feet, and widening the turning basin in this reach from 700 to 800 feet.

SECTION III - POTENTIAL ECONOMIC BENEFITS FOR HARBOR IMPROVEMENTS

Potential economic benefits for each of the improvements requested by local interests were evaluated based on channel deepening. No separable benefits were computed for channel widening. The channel widening considered herein is an essential, complementary feature for harbor deepening, and not a separable project feature.

The potential economic benefits for deepening Wilmington Harbor consist of cost savings for shippers who could use larger, more fully loaded ships, and reductions in delays waiting for high tide. The principal steps in benefit computation involved determining the following:

- Existing and Future Commerce - Wilmington Harbor commerce is identified for existing and future conditions. From these data, the tonnages of commerce to be benefitted by reduced shipping costs is determined; this commerce includes tonnages for each of the three harbor reaches.

- Destination Ports and Vessel Fleet - Once tonnages for existing and future ships are estimated, two conditions must be met in order to identify potential economic benefits: (1) compatible depths must be available at destination and origin ports; and (2) larger, deeper draft vessels must be available to carry the commerce on the various trade routes.

- Cost per Ton Savings - Transportation savings are computed by subtracting the estimated cost of shipping a ton of cargo under improved conditions from the cost of shipping the same cargo under existing conditions. The primary determinants of shipping costs for a given trade route and commodity are the size of vessel, since larger vessels generally have a lower per ton cost, and whether the vessel can sail fully loaded or lightloaded. Cost savings are estimated for each trade route served by the Wilmington Harbor fleet.

WILMINGTON HARBOR COMMERCE

Waterborne commerce and vessel calls for Wilmington Harbor during 1990 - 1994 are shown in table 4. About 82 percent of the tonnage is deepdraft, oceangoing trade, carried in vessels drafting 25 feet or more. The remaining 18 percent is riverine commerce, carried in shallowdraft barges. The deepdraft commerce is almost equally divided between foreign trade and coastwise receipts. Import and export commerce is also approximately equally divided.

TABLE 4

Commerce and Vessel Calls, Wilmington Harbor

Year	Vessel Calls	Commerce (in metric tons)
1990	881	6,444,000
1991	889	6,511,000
1992	823	6,557,000
1993	811	7,090,000
1994	773	7,179,000

HISTORIC COMMERCE

Table 5, following page, provides a breakdown of harbor commerce by commerce categories. Where applicable, commerce is identified as "coastwise or foreign." The categories shown in table 5 are vessel-specific, and reflect the four principal types of vessels which call on Wilmington Harbor: dry bulk carriers, liquid bulk carriers, breakbulk carriers, and container vessels. Commodities carried on these vessels include the following:

- Dry Bulk - Major categories are fertilizer materials, including nitrates, potash, and urea.

- Liquid Bulk - Includes industrial chemicals, fuel oil, and gasoline.

- Breakbulk - Includes steel and wood products.

- Container - Consists of general cargo shipped in steel containers, offloaded by crane at the State Port for transshipment.

The reviewer will note that tonnage totals in table 4 exceed the totals in table 5. Table 4 includes all harbor commerce, while table 5 includes only oceangoing commerce.

TABLE 5

Wilmington Harbor Oceangoing Commerce:
Tonnages for 1990 - 1994
(metric tons)

Commodity:	Tonnages, 1990	Tonnages, 1991	Tonnages, 1992	Tonnages, 1993	Tonnages, 1994
Foreign Dry Bulk	801,000	745,000	749,000	988,000	985,000
Coastwise Dry Bulk	0	0	0	71,000	0
Foreign Liquid Bulk	941,000	720,000	959,000	773,000	984,000
Coastwise Liquid Bulk	2,310,000	2,495,000	2,359,000	2,669,000	2,540,000
Breakbulk	687,000	684,000	711,000	743,000	761,000
Container	594,000	594,000	583,000	590,000	700,000
Specialized (NOTE 1)	103,000	108,000	116,000	91,000	110,000
Totals	5,436,000	5,346,000	5,478,000	5,925,000	6,080,000

NOTE 1: "Specialized" refers to liquid ammonia carriers which call in Reach 3.

FUTURE COMMERCE

Waterborne commerce in Wilmington Harbor has been growing over the past decade and is expected to increase in the future. Harbor tonnage increased 54 percent between 1983 and 1994, for an average annual growth rate of 4 percent. Commerce projections for the commodities shown in table 5 are given in table 6. Table 6 includes the following:

- Normalized Commerce, Year 1995 - Commerce for 1995 is referred to as "normalized." This figure does not represent commerce for the historical year 1995. Rather it is "normalized" in the sense that it reflects historic growth, as well as adjustments for market conditions which may have caused abnormally high or low levels of commerce growth in certain years. Thus, Year 1995 normalized commerce represents the baseline for "existing commerce." Future commerce, discussed below, is projected based on this normalized tonnage.

- Commerce for Base Year, Year 2004 - Year 2004 is the year in which it is assumed the improvements recommended as a result of this study will be in service. The overall growth of commerce from 1995 through 2004 is 2.8 percent. This growth rate is a composite of growth rates for the individual commodities, which vary from 0.6 percent per year to 6.7 percent per year during this period. Growth rates were based on various indexes and projections.

- Commerce for Year 2020, End of Projection Period - Although vessel traffic will logically increase beyond this year and benefits for channel improvement will continue to accrue, projections of increased commerce beyond year 2020 were not considered practicable. Therefore, commerce is assumed to remain constant after year 2020.

TABLE 6

<u>Wilmington Harbor Commerce:</u>
<u>Projected Tonnages Through Year 2020</u>
(metric tons)

Commodity:	Normalized Tonnage, year 1995	Projected Tonnage, year 2000	Projected Tonnage, year 2004	Projected Tonnage, year 2005	Projected Tonnage, year 2010	Projected Tonnage, year 2020
Dry Bulk	1,267,000	1,376,000	1,449,000	1,467,000	1,544,000	1,635,000
Foreign Liq. Bulk	1,124,000	1,214,000	1,284,000	1,302,000	1,376,000	1,521,000
Coast. Liq. Bulk	2,930,000	3,157,000	3,332,000	3,378,000	3,562,000	3,935,000
Breakbulk	780,000	1,013,000	1,229,000	1,291,000	1,659,000	2,377,000
Container	782,000	1,066,000	1,302,000	1,369,000	1,758,000	2,624,000
Specialized	125,000	137,000	144,000	146,000	154,000	164,000
Totals	7,008,000	7,963,000	8,740,000	8,953,000	10,053,000	12,256,000

VESSEL FLEET, WILMINGTON HARBOR

Deepening Wilmington Harbor will allow larger, more fully loaded vessels to serve the port. However, in order to establish economic justification for Federal harbor improvements, it is necessary to establish that sufficient vessels will be available in the world fleet to allow shippers to realize this benefit. Analysis of fleet availability consisted of the following steps: (1) The existing vessel fleet was analyzed to determine the sizes, including tonnage and draft, of the vessels now serving the harbor; and (2) fleet projections were done to determine if the world fleet will contain the proper range of vessel sizes to serve the future needs of the harbor.

EXISTING VESSEL FLEET

Data for the analysis of the existing fleet in Wilmington Harbor were developed from 8 years of pilots' logs.

Table 7, following page, shows calls and drafts for container vessels during this period. This table is presented as an example. Vessel size distributions for other vessel categories (bulk hauler and tanker) are similar.

The data in table 7 demonstrate two significant points concerning the existing vessel fleet for Wilmington Harbor:

(1) the most commonly used vessels, in terms of vessel calls and tonnages, are those which maximize available drafts; in the case of container vessels, a 32,000 DWT vessel approximates the largest vessel which can enter and leave Wilmington Harbor without lightloading; and

(2) significant numbers of vessels exceeding 32,000 DWT are now using the harbor, and must be lightloaded. Obviously, deepening of the harbor would provide immediate benefits for these vessels.

However, in order for benefits to be projected for all commodities moving through Wilmington Harbor, vessel sizes must also be projected over the same period of analysis. Fleet projections are discussed on the following page.

TABLE 7

Vessel Calls, Wilmington Harbor Container Fleet
(1987-1994)

Vessel Calls	Vessel Size (DWT)	Tonnages	Approximate Feet Lightloaded
280	16,000	4,480,000	0
276	24,000	6,624,000	0
859	32,000	27,488,000	0
371	42,000	15,582,000	3
121	50,000	6,050,000	5
9	55,000	495,000	6
2	58,000	116,000	7
Totals: 1,918		60,835,000	

Vessels shown in shaded area exceed average available draft of 37 feet inbound, 36 feet outbound in Wilmington Harbor, indicating they were lightloaded.

FLEET PROJECTIONS

Fleet projections were developed from a composite of all ships expected to handle commodities on the various trade routes served by the Wilmington Harbor fleet. Generally, the projections reflect a trend toward larger, more efficient vessels as older vessels are replaced. No future increases in vessel sizes were projected beyond the project base year (2004).

TRADING PORTS

Numerous United States ports and foreign countries ship commodities to and from terminals at Wilmington. The principal United States ports include Port Arthur, Beaumont, and Galveston, Texas. Foreign ports are located in Canada, the Caribbean, South America, the Middle and Far East, Europe, the Mediterranean, and South America. Most of the trading ports have depths available greater than Wilmington Harbor's (Reaches 1 and 2) authorized depth of 38 feet.

MOST EFFICIENT VESSEL SIZES WITH VARIOUS CHANNEL CONSTRAINTS

It has been determined that (1) deeper drafts are available at trading ports than are available at the Port of Wilmington; (2) shipments to and from these ports are expected to increase; and (3) larger, more efficient vessels will be available in the world fleet. Tables 8 and 9 show the most efficient vessels at two different drafts: the existing average controlling draft of 36 feet and at 40 feet. These drafts are for outbound vessel traffic. Drafts for inbound vessels would be 1 feet deeper.

The costs per ton in these tables were derived by computing hourly operating costs for a given size vessel, and multiplying this figure by the sailing time between the trading port and Wilmington. Other costs, including time at dock, tidal delays, and docking fees are also included in this cost per ton. As shown, in some instances it is more economical to use a larger vessel lightloaded than a smaller vessel fully loaded. This economy is primarily due to the additional tons per inch which a larger displacement vessel can carry at a given draft. Tables 8 and 9 are presented as sample computations only. Similar computations were made for each vessel class, trade route, and alternative channel depth considered for the three reaches of Wilmington Harbor.

TABLE 8

Costs Per Ton for Container Ship
Wilmington - Far East Trade Route
With 36-Foot Outbound Draft Available in Wilmington Harbor

Vessel Class(DWT)	16,000	24,000	32,000	42,000	50,000	55,000	58,000
Cargo at Design Draft(tons)	13,600	20,400	27,200	35,700	42,500	46,750	49,300
Tons/Inch	95	119	141	166	185	196	203
Trip Cost($)	592,580	763,628	945,470	1,129,890	1,266,170	1,364,540	1,425,657
Design Draft (ft)	29	33	36	39	41	42	43
$/Ton 0' Light	43.57	37.43	34.76	31.65	29.79	29.19	28.92
1' Light	47.56	40.25	37.07	33.52	31.43	30.73	30.42
2' Light	52.35	43.53	39.70	35.63	33.27	32.45	32.09
3' Light	58.21	47.38	42.74	38.01	35.33	34.38	33.95
4' Light	65.55	51.99	46.27	40.74	37.66	36.54	36.04
5' Light	75.01	57.59	50.45	43.90	40.32	39.00	38.41
6' Light	87.66	64.54	55.46	47.58	43.39	41.81	41.10
7' Light	105.44	73.40	61.57	51.93	46.96	45.06	44.21
8' Light	132.27	85.07	69.19	57.17	51.18	48.85	47.82

Shaded $/ton = $/ton with 36-foot outbound draft available in Wilmington Harbor; most efficient vessel at this draft is 32,000 DWT fully loaded ($34.76/ton)

TABLE 9

Costs Per Ton for Container Ship
Wilmington - Far East Trade Route
With 40-Foot Outbound Draft Available in Wilmington Harbor

Vessel Class (DWT)	16,000	24,000	32,000	42,000	50,000	55,000	58,000
Cargo at Design Draft (tons)	13,600	20,400	27,200	35,700	42,500	46,750	49,300
Tons/Inch	95	119	141	166	185	196	203
Trip Cost($)	592,580	763,628	945,470	1,129,890	1,266,170	1,364,540	1,452,657
Design Draft (ft)	29	33	36	39	41	42	43
$/Ton 0' Light	43.57	37.43	34.76	31.65	29.79	29.19	28.92
1' Light	47.56	40.25	37.07	33.52	31.43	30.73	30.42
2' Light	52.35	43.53	39.70	35.63	33.27	32.45	32.09
3' Light	58.21	47.38	42.74	38.01	35.33	34.38	33.95
4' Light	65.55	51.99	46.27	40.74	37.66	36.54	36.04
5' Light	75.01	57.59	50.45	43.90	40.32	39.00	38.41
6' Light	87.66	64.54	55.46	47.58	43.39	41.81	41.10
7' Light	105.44	73.40	61.57	51.93	46.96	45.06	44.21
8' Light	132.27	85.07	69.19	57.17	51.18	48.85	47.82

Shaded $/ton = $/ton with 40-foot outbound draft available;
most efficient vessel at this draft is 50,000 DWT lightloaded 1 foot ($31.43 ton).

VESSEL FLEET DISTRIBUTION AND COSTS SAVINGS

As illustrated in tables 8 and 9, substantial cost savings would be realized by using larger, more fully loaded vessels in Wilmington Harbor. Table 10 applies these cost savings to various alternative channel depths for the main harbor in Wilmington (Reach 1). The example shown in table 10 is a container vessel serving the Far East trade route and calling at the State Port. Percent tonnage for each vessel class shown in table 10 was assigned based on historic data and discussions with shippers. In this example, the savings per ton are constant above the 40-foot draft because of the draft limitations of the Panama Canal (maximum draft approximately 40 feet). Similar computations were performed for the other classes of vessels and trade routes involved in Wilmington Harbor commerce.

TABLE 10

Vessel Fleet Distribution and Cost Savings with Harbor Improvement, Container Ship, Wilmington - Far East Trade Route
Outbound Vessel Traffic

Vessel Class(DWT)	32,000	42,000	50,000	55,000	58,000		
Cargo at Design Draft(tons)	27,200	35,700	42,500	46,750	49,300		
Tons/Inch	141	166	185	196	203		
Trip Cost($)	945,470	1,129,890	1,266,170	1,364,540	1,425,657		
						Totals (100%)	Savings Per ton
% of tonnage at 35' draft: Cost/ton:	10% $3.71	25% $10.19	25% $10.85	25% $11.26	15% $7.17	100% $43.18	$0.00
% of tonnage at 36' draft: Cost/ton:	10% $3.48	25% $9.50	25% $10.08	25% $10.45	15% $6.63	100% $40.14	$3.03
% of tonnage at 37' draft: Cost/ton:	10% $3.48	25% $8.91	20% $7.53	20% $7.80	25% $10.28	100% $37.99	$5.19
% of tonnage at 38' draft: Cost/ton:	0% $3.48	25% $8.38	20% $7.07	20% $7.31	25% $9.60	100% $35.83	$7.35
% of tonnage at 39' draft: Cost/ton:	0% $0.00	20% $6.33	20% $6.65	30% $10.31	30% $10.81	100% $34.11	$9.07
% of tonnage at 40' draft: Cost/ton:	0% $0.00	20% $6.33	20% $6.47	30% $10.02	30% $10.50	100% $33.32	$9.85
% of tonnage at 41' draft: Cost/ton:	0% $0.00	20% $6.33	20% $6.47	30% $10.02	30% $10.50	100% $33.32	$9.85

COMPUTATION OF POTENTIAL ECONOMIC BENEFITS

Benefits are computed for the following channel deepening alternatives: (1) deepening the Main Harbor (Reach 1) from its existing depth of 38 feet to depths of 40, 42, and 44 feet, with 2 additional feet provided in the ocean bar and entrance channels; (2) deepening Reach 2 from 38 feet to 40 feet; and (3) deepening Reach 3 from 25 feet to depths of 30, 32, and 34 feet

EXISTING BENEFITS

Expected benefits were calculated for each reach based on the location of the dock where the commodity is expected to be handled. As shown in table 11, savings per ton are combined for Reaches 1 and 2, since commerce in these reaches involves many of the same commodities. An optimization analysis dividing the benefits between these two reaches is presented on page 34.

TABLE 11

Benefits for Harbor Deepening
Existing (Normalized 1995) Commerce

Alternative Channel Depths	Annual Tonnage (metric tons)	Average Savings Per Ton ($/ton)	Expected Annual Benefits ($)
Reaches 1 and 2:			
40 ft. Reach 1, 40 ft. Reach 2	6,883,000	1.25	8,582,000
42 ft. Reach 1, 40 ft. Reach 2	"	2.14	14,747,000
44 ft. Reach 1, 40 ft. Reach 2	"	2.61	17,995,000
Reach 3:			
30 ft.	125,000	4.68	585,000
32 ft.	"	8.55	1,069,000
34 ft.	"	13.00	1,625,000

SUMMARY OF POTENTIAL ECONOMIC BENEFITS

Potential economic benefits for channel depths to be considered in this study are as follows:

- Base Year Benefits - These benefits were computed using the 1995 benefit baseline (see table 11), and reflect expected increases in commerce by year 2004.

- Future Benefits - The base-year (2004) benefits are assumed to continue to accrue each year over a 50-year period of analysis. However, additional benefits will accrue due to increases in commerce beyond year 2004. Future benefits are computed over a 50-year analysis period, but no increases are projected beyond year 2020. Future benefits are converted to present worth using an interest rate of 7-5/8 percent.

- Expected Annual Benefits - Expected annual benefits are computed as the sum of base year benefits plus future benefits, as illustrated in table 12.

TABLE 12

Expected Annual Benefits for Harbor Deepening
(50-year period of analysis, interest rate of 7-5/8%

Alternative Channel Depths	Benefits for Base year (2004) ($)	Present worth of future benefits (through year 2054) ($)	Total Expected Annual Benefits ($)
Reaches 1 and 2:			
40 ft. Reach 1, 40 ft. Reach 2	11,040,000	3,126,000	14,166,000
42 ft. Reach 1, 40 ft. Reach 2	18,871,000	5,241,000	24,112,000
44 ft. Reach 1, 40 ft. Reach 2	22,523,000	5,833,000	28,356,000
Reach 3:			
30 ft.	676,000	56,000	732,000
32 ft.	1,235,000	102,000	1,337,000
34 ft.	1,877,000	155,000	2,032,000

SECTION IV - PLAN FORMULATION

The principal navigation problem in Wilmington Harbor is inadequate depths. Therefore, plan formulation consisted primarily of evaluating alternative channel depths, and identifying the channel depth for each harbor reach which would produce the maximum net benefits.

PLAN FORMULATION CRITERIA

Plan formulation criteria for this study include the economic, engineering, and environmental criteria listed below.

ECONOMIC CRITERIA

- Any plan recommended for Federal implementation must produce benefits which exceed costs. Also, under current Federal policy, a plan must be developed which maximizes net economic benefits, measured as the difference between average annual benefits and average annual costs. This plan is referred to as the National Economic Development (NED) Plan. Unless there are overriding considerations which favor implementation of another plan, the NED plan will be recommended for Federal implementation.

- Benefits and costs were based on a 7-5/8 percent interest rate and a 50-year period of analysis. October 1995 price levels were used. The project base year is 2004.

ENGINEERING CRITERIA

- Criteria specified in EM 1110-2-1613 were used as a guide in determining channel dimensions. The views and recommendations of the Cape Fear River pilots were also considered.

- All alternatives will be constructed using the least costly techniques available, if these techniques are determined to be environmentally acceptable.

ENVIRONMENTAL CRITERIA

- Any plan of improvement to be recommended for Federal implementation must comply with the National Environmental Policy Act, and other Federal and State laws; a Final Environmental Impact Statement is included in this report.

- Mitigation measures will be considered to offset project-induced losses of resources.

DESIGN VESSEL

The term "Design Vessel" refers to the largest vessel considered likely to call at the Port of Wilmington on a regular basis. In order for the port to operate safely and efficiently, channel dimensions must accommodate this vessel with adequate clearances. In developing plans of improvement, a different design vessel was considered for each of the three reaches of Wilmington Harbor (table 13). The design vessel for Reach 1 is a PANAMAX class vessel.

The design vessel for Reach 2 is slightly smaller, and is typical of the large bulk carriers (tankers and dry bulk) which call in this reach. Vessels in these classes are currently being used in Reaches 1 and 2, although they must be lightloaded.

The design vessel for Reach 3 approximates the liquid gas carriers which are expected to call in the upriver portion of Wilmington Harbor if the channel is deepened. Under current conditions, with a controlling depth of 25 feet, ships smaller than the design vessel must be used in Reach 3.

TABLE 13

Design Vessel Dimensions

Channel Reaches	Length (ft)	Beam (ft)	Draft Range (ft)
Reach 1	965	106	38 - 40
Reach 2	712	106	32 - 38
Reach 3	606	88	32 - 38

PLAN FORMULATION RATIONALE

Three alternative depths were considered for Reaches 1 and 3, and one deepening alternative was considered for Reach 2. In addition, widening at certain locations in the river has been requested by local interests. Widening improvements were evaluated in accordance with criteria in EM 1110-2-1613, and were included as common elements of each channel deepening alternative. No separable economic benefits were computed for channel widening.

OPTIMIZATION OF CHANNEL DEPTHS

Table 14 shows benefits and costs for various channel depths at 2-foot increments. The alternatives for Reach 1 include an additional 2 feet of deepening in the ocean bar and entrance channels. The costs shown include construction and average annual maintenance costs, along with interest and amortization of the project first cost.

TABLE 14

Benefits and Costs for Alternative Channel Depths

Reach and Channel Depth (ft.)	First Cost ($)	Average Annual Costs ($)	Expected Annual Benefits ($)	Net Annual Benefits ($)
REACH 1:				
40	116,594,000	10,166,000	12,685,000	2,519,000
42	222,496,000	19,288,000	22,631,000	3,343,000
44	483,455,000	64,542,000	26,875,000	-37,667,000
REACH 2:				
40	25,300,000	2,164,000	1,481,000	-683,000
REACH 3:				
30	4,471,000	383,000	732,000	349,000
32	5,029,000	431,000	1,337,000	906,000
34	5,955,000	511,000	2,032,000	1,521,000
CHANNEL DEPTHS IN SHADED AREAS ARE INCLUDED IN SELECTED PLAN, DISCUSSED ON THE FOLLOWING PAGE				

As shown in table 14, benefits among the alternative depths at 2-foot increments are maximized with the 42-foot alternative in Reach 1 and the 34-foot alternative in Reach 3. No improvements are economically feasible in Reach 2 and none will be recommended.

In order to confirm the optimization of net benefits for Reach 1, channel depths were further evaluated in 1-foot increments. This optimization included only Reach 1, since depths greater than 34 feet were not determined to be needed in Reach 3, and no feasible alternative was identified for Reach 2. The results of the optimization analysis at 1-foot depth intervals is shown in figure 7, following page.

Figure 7 shows an exponential graph of average annual costs, expected annual benefits, and net benefits for the 40-, 41-, 42-, 43-, and 44-foot depths in Reach 1 (costs exceeded benefits for the 44-foot alternative; thus net benefits were negative and are not shown on the graph). Costs and benefits for the 41- and 43-foot depths were computed through interpolation. As shown, net benefits are optimized at approximately the 42-foot depth alternative, and deepening to 43 feet does not appear to be feasible. Based on the computations shown in table 14 and figure 7, net economic benefits are optimized with a 42-foot deep channel in Reach 1, no work in Reach 2, and a 34-foot channel in Reach 3.

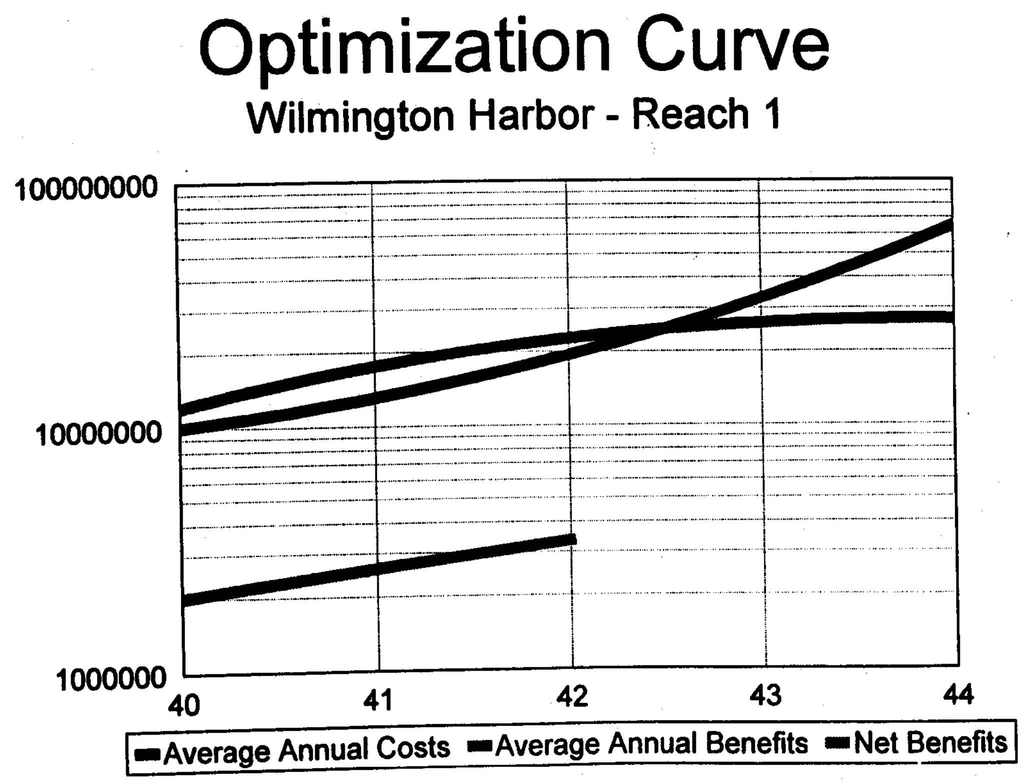

Optimization Curve
Wilmington Harbor - Reach 1
100000000
10000000
1000000
40
41
42
43
44
Average Annual Costs
Average Annual Benefits
Net Benefits

FIGURE 7

SELECTION OF CHANNEL WIDTHS

Channel widths for the project were evaluated in accordance with Corps of Engineers criteria (EM 1110-2-1613). The Cape Fear pilots were also consulted. Generally, harbor widths are adequate for one-way traffic. However, widening was determined to be needed in Reach 1 (extend anchorage basin approximately 300 feet north) and in Reach 3 (widen river channel from existing width of 200 feet to 250 feet, and widen turning basin at upstream terminus of Reach 3 from existing width of 700 feet to 800 feet). These widening components, along with deepening of Reaches 1 and 3, are included in the Selected Plan of Improvement.

RATIONALE FOR PLAN SELECTION AND DESIGNATION OF NED PLAN

The Selected Plan of Improvement includes, as its central feature, deepening Reaches 1 and 3 of Wilmington Harbor to 42 and 34 feet, respectively. Economic benefits among the alternatives are maximized at these depths. The Selected Plan of Improvement is designated as the National Economic Development (NED) Plan.

The plan of improvement to be recommended for Federal implementation must be environmentally acceptable. Environmental impacts associated with the shallower depths considered for Reaches 1 and 3 would be less than those associated with the NED Plan (see EIS). However, the reduction in impacts is not considered sufficient to justify recommendation of lesser project depths in either of these reaches.

SECTION V - SELECTED PLAN OF IMPROVEMENT

The Selected Plan of Improvement is shown on plates 1 through 3. Plan features are listed below.

CHANNEL IMPROVEMENTS, REACH 1

The Selected Plan of Improvement includes deepening the river channels in Reach 1 from 38 to 42 feet. The ocean bar and entrance channels will be deepened from 40 to 44 feet. The existing bottom widths (500 feet in the ocean bar and entrance channels and 400 feet in the river channels) will be maintained. Channel side slopes from the Baldhead Shoal (ocean bar) Channel to Battery Island Channel will be 5 horizontal to 1 vertical. Side slopes for the remaining project reaches, including the anchorage basin, will be 3 horizontal to 1 vertical (see table 15). The improved channel will utilize the existing alignments and will require extending the ocean bar channel seaward approximately 3.5 miles.

The anchorage basin upriver from the State Ports Authority will remain at a maximum width of 1,200 feet; however, the 1,200-foot-wide portion will be extended northward 300 feet (see plate 2).

CHANNEL IMPROVEMENTS, REACH 3

The Selected Plan of Improvement includes deepening this reach of the Northeast Cape Fear River from its existing depth of 25 feet to 34 feet (see plate 1).

The Selected Plan also includes widening the existing, 200-foot-wide channel in Reach 3 to 250 feet. In addition, the turning basin at the upstream end of Reach 3 will be widened from 700 to 800 feet (see plate 3).

PLAN ACCOMPLISHMENTS

The Selected Plan of Improvement will allow larger, more fully loaded vessels to use Wilmington Harbor. Deepening of Reach 1 from 38 to 42 feet will allow vessels to arrive and depart at docks within this reach at drafts approximately 4 feet deeper than under existing conditions. In Reach 3, the channel will be deepened from 25 to 34 feet, allowing vessels to arrive and depart at drafts approximately 9 feet deeper than under current conditions. In Reach 2, no work will be performed. However, since shoaling in Reach 1 currently restricts the maximum operating depths in Reach 2, the plan of improvement will also benefit this reach, allowing draft increases of approximately 1 foot in Reach 2.

TABLE 15 PERTINENT DATA, SELECTED PLAN

Cape Fear - Northeast Cape Fear River Comprehensive

(44' Ocean Bar / 42' interior / 1200' wide Anchorage Basin - extended 300'-north / 34' above Chemserve / 800' turning basin) - Volume Summary

Reach (Name)	Depth Project	Depth Required	Depth Allowable	Width/Dim (Ft)	Slope (3/1, 5/1)	Rock Reach (Y/N)	Selected Plan Depths	Total Volume (CY)	Overburden Vol (CY)	Rock Contingency (%)	Rock Volume Total (CY)	Rock Volume Dredge (CY)	Rock Volume Blast (CY)	Disposal (Location)	Dredge Type
REACH 1															
Baldhead Shoal 305+00 to 461+00	42, 44, 46	1	2	500'	5H:1V	Y	44 + 1 + 2(1/2)	965,990	0	0	965,990	965,990	0	ODMDS	30' cutter suction
Baldhead Shoal 305+00 - 125+00	42, 44, 46	1	2	800'	5H:1V	Y	44 + 1 + 2(1/2)	1,484,090	70,563	0	1,413,527	1,413,527	0	ODMDS	30' cutter suction
Baldhead Shoal 125+00 in	42, 44, 46	0	2	800'	5H:1V	N	44 + 0 + 2(1/2)	579,410	579,410	0	0	0	0	ODMDS	30' cutter suction
Smith Island	42, 44, 46	Rock-1, Non-0	2	800'	5H:1V	N	44 + 0 + 2(1/2)	119,630	119,630	0	0	0	0	ODMDS	3600 cyd hopper
Baldhead - Caswell	42, 44, 46	Rock-1, Non-0	2	800'	5H:1V	N	44 + 0 + 2(1/2)	57,810	57,810	0	0	0	0	ODMDS	3600 cyd hopper
Southport	42, 44, 46	Rock-1, Non-0	2	800'	5H:1V	N	44 + 0 + 2(1/2)	43,790	43,790	0	0	0	0	ODMDS	3600 cyd hopper
Battery Island	42, 44, 46	Rock-1, Non-0	2	800'	5H:1V	N	44 + 0 + 2(1/2)	45,490	45,490	15	0	0	0	ODMDS	3600 cyd hopper
Lower Swash	40, 42, 44	Rock-1, Non-0	2	400'	3H:1V	N	42 + 0 + 2(1/2)	119,940	119,940	25	0	0	0	ODMDS	26 cy clamshell
Snow Marsh	40, 42, 44	Rock-1, Non-0	2	400'	3H:1V	Y	42 + 1 + 2(1/2)	392,350	390,983	15	1,367	1,367	0	ODMDS	26 cy clamshell
Horseshoe Shoal	40, 42, 44	Rock-1, Non-0	2	400'	3H:1V	N	42 + 0 + 2(1/2)	270,110	270,110	0	0	0	0	ODMDS	26 cy clamshell
Reaves Point	40, 42, 44	Rock-1, Non-0	2	400'	3H:1V	N	42 + 0 + 2(1/2)	323,280	323,280	0	0	0	0	ODMDS	26 cy clamshell
Lower Midnight	40, 42, 44	Rock-1, Non-0	2	600'	3H:1V	N	42 + 0 + 2(1/2)	626,770	626,770	0	0	0	0	ODMDS	76 cy clamshell
Upper Midnight	40, 42, 44	Rock-1, Non-0	2	600'	3H:1V	N	42 + 0 + 2(1/2)	1,087,510	1,087,510	0	0	0	0	ODMDS	26 cy clamshell
Lower Lilliput	40, 42, 44	Rock-1, Non-0	2	600'	3H:1V	N	42 + 0 + 2(1/2)	847,860	847,860	0	0	0	0	ODMDS	26 cy clamshell
Upper Lilliput	40, 42, 44	Rock-1, Non-0	2	400'	3H:1V	Y	42 + 1 + 2(1/2)	661,050	653,810	25	7,240	7,240	0	ODMDS	26 cy clamshell
Keg Island	40, 42, 44	Rock-1, Non-0	2	400'	3H:1V	Y	42 + 1 + 2(1/2)	570,300	541,720	25	28,580	7,338	21,242	ODMDS	26 cy clamshell
Lower Big Island	40, 42, 44	Rock-1, Non-0	2	400'	3H:1V	Y	42 + 1 + 2(1/2)	334,780	237,033	25	97,747	21,247	76,500	ODMDS	26 cy clamshell
Upper Big Island	40, 42, 44	Rock-1, Non-0	2	400'	3H:1V	Y	42 + 1 + 2(1/2)	358,250	175,503	25	182,747	32,426	100,321	Eagle Is (15)	30' cutter suction
Lower Brunswick	40, 42, 44	Rock-1, Non-0	2	400'	3H:1V	Y	42 + 1 + 2(1/2)	606,300	579,803	25	26,497	13,626	12,871	Eagle Is (15)	30' cutter suction
Upper Brunswick	40, 42, 44	Rock-1, Non-0	2	400'	3H:1V	Y	42 + 1 + 2(1/2)	368,000	363,871	25	4,129	4,129	0	Eagle Is (15)	30' cutter suction
Fourth East Jetty	40, 42, 44	Rock-1, Non-0	2	500'	3H:1V	Y	42 + 1 + 2(1/2)	546,690	542,714	35	3,976	3,976	0	Eagle Is (15)	30' cutter suction
Between Channel	40, 42, 44	Rock-1, Non-0	2	500'	3H:1V	Y	42 + 1 + 2(1/2)	216,080	191,211	30	24,869	24,869	0	Eagle Is (15)	30' cutter suction
Anchorage Basin - 1200' basin extend 300' N	40, 42, 44	Rock-1, Non-0	2	1200	3H:1V	Y	42 + 1 + 2(1/2)	1,295,553	673,522	30	622,031	268,854	353,177	Eagle Is (15)	30' cutter suction
REACH 3															
750' Chemserve to Arcadian	30, 32, 34	1	2	250'	3H:1V	Y	34 + 1 + 2(1/2)	904,553	859,476	0	45,077	45,077	0	Eagle Is (15)	30' cutter suction
(turning basin)	30, 32, 34	1	2	800'	3H:1V	Y	34 + 1 + 2(1/2)	-	-	0	-	-	-	Eagle Is (15)	30' cutter suction
							TOTALS	12,825,586	9,401,809		3,423,777	2,859,666	564,111, ##		

NOTES:

1. The volumes shown in this spread sheet are the project depth + required depth + 1/2 of the allowable overdepth.
2. The material dredged from Baldhead Shoal Channel through Battery Island Channel are Ocean Source Sediments.
3. The material dredged from Lower Swash Channel to Lower Big Island Channel are River Source Sediments.
4. The material dredged from Upper Big Island Channel to the turning basin near Arcadian are sediments which must be placed in a diked upland disposal area.

** Quantities .'O NOT include maintenance volumes.

** Quantities are adjusted for volume contingencies.

Rock Blasting quantity may differ from that shown in the cost estimate due to the method of construction selected.

COMPMNR.XLS

1 of 1

Without Project Assumptions:

1. Ocean Bar project constructed.
2. Channel Widening (Turns & Bends / Passing Lane) project constructed.
3. Northeast Cape Fear River project constructed.

Turns & Bends:

Turn 1 between Upper Brunswick and Lower Brunswick

Turn 2 between Lower Brunswick and Upper Big Island

Turn 3 between Upper Big Island and Lower Big Island

Turn 4 between Lower Big Island and Keg Island

Turn 5 between Horseshoe Shoal and Snow Marsh

Passing Lane:

Transition in Upper Lilliput

Passing Lane in: Lower Lilliput, Upper Midnight and Lower Midnight

Transition in Reaves Point

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ECONOMIC BENEFITS

Economic benefits for channel deepening are shown in table 16, and consist of transportation savings for shippers utilizing Wilmington Harbor.

TABLE 16

Summary of Average Annual Benefits, Selected Plan of Improvement
(7-5/8 percent interest rate; 50-year period of analysis)

Transportation Savings, Reach 1:	
Base Year Benefits	$17,512,000
Future Benefits	5,119,000
TOTAL EXPECTED ANNUAL BENEFITS, REACH 1	$22,631,000
Transportation Savings, Reach 3:	
Base Year Benefits	$1,877,000
Future Benefits	155,000
TOTAL EXPECTED ANNUAL BENEFITS, REACH 3	$2,032,000
TOTAL EXPECTED ANNUAL BENEFITS, SELECTED PLAN OF IMPROVEMENT	$24,663,000

PROJECT COSTS

Economic costs of the Selected Plan include project first costs, interest during construction, and average annual costs. First costs include expenditures for project design and construction and costs of supervision and administration. Interest during construction is added to the construction first cost. This figure represents project financial costs, and is used in computing average annual costs. Average annual costs consist of interest and amortization of the initial investment, and the annual cost of project operation and maintenance.

PROJECT FIRST COST

The project first cost is estimated at $228,435,000. Costs are summarized in table 17, following page.

TABLE 17

Summary of Project First Costs

Oct 1995 Price Level

Account Code	Description	Quantity	Unit	Unit Price	Amount	Contingency	Total Cost
01.	LANDS AND DAMAGES	1	JOB	LS	329,000	82,000	$ 411,000
02.	RELOCATIONS (noncompensable)	1	JOB	LS	2,500,000	500,000	3,000,000
12.	NAVIGATION, PORTS AND HARBORS						
12.02.	HARBORS						
12.02.01	Mobilization, Demobilization, and Preparatory Work						
	Mechanical Dredging	1	EA	207,755	208,000	42,000	250,000
	Pipeline Dredging						
	Baldhead Shoal Channel (Bar)	1	EA	2,698,611	2,699,000	540,000	3,239,000
	Inside Channels - Reach 1	3	EA	1,908,524	5,726,000	1,145,000	6,871,000
	Inside Channels - Reach 3	1	EA	190,565	191,000	38,000	229,000
	Hopper Dredging	1	EA	205,915	206,000	41,000	247,000
	Blasting	8	EA	249,680	1,997,000	399,000	2,396,000
12.02.15	Mechanical Dredging						
	Overburden	5,099,016	CY	$ 4.74	24,169,000	4,834,000	29,003,000
	Blasted Rock	134,934	CY	$ 4.72	637,000	127,000	764,000
12.02.16	Pipeline Dredging						
	Baldhead Shoal Channel (Bar)	3,029,490	CY	$ 22.00	66,649,000	13,330,000	79,979,000
	Inside Channels - Reach 1	3,390,873	CY	$ 4.34	14,716,000	2,943,000	17,659,000
	Inside Channels - Reach 3	904,553	CY	$ 1.95	1,764,000	353,000	2,117,000
12.02.17	Hopper Dredging	266,720	CY	$ 2.98	795,000	159,000	954,000
12.02.20	Disposal Areas	1	JOB	LS	6,272,000	1,187,000	7,459,000
12.02.99	Associated General Items						
	Rock Blasting	601,303	CY	$ 43.43	26,115,000	5,223,000	31,338,000
	Bubble Curtain	1	JOB	LS	8,876,000	1,775,000	10,651,000
	Mitigation Areas	27	ACRE	105,000	2,835,000	567,000	3,402,000
	Turtle Monitoring	1	JOB	LS	175,000	35,000	210,000
	Sturgeon Monitoring	1	JOB	LS	235,000	47,000	282,000
	Navigation Aids	1	JOB	LS	100,000	20,000	120,000
	Berthing Areas (noncompensable)	1	JOB	LS	14,551,000	3,612,000	18,163,000
	TOTAL, NAVIGATION, PORTS AND HARBORS				178,916,000	36,417,000	$ 215,333,000
30.	PLANNING, ENGINEERING, AND DESIGN				5,350,000	620,000	$ 5,970,000
31.	CONSTRUCTION MANAGEMENT				3,266,000	455,000	$ 3,721,000
	TOTAL PROJECT COST				190,361,000	38,074,000	$ 228,435,000

INTEREST DURING CONSTRUCTION

Interest during construction (7-5/8 percent interest rate, 3-year construction period) is estimated at $21,104,000. The sum of the project first cost and interest during construction is referred to as the project financial cost, and is used in computing average annual costs, discussed below. The project financial cost is $249,539,000 ($228,435,000 + $21,104,000).

AVERAGE ANNUAL COSTS

Average annual costs, shown in table 18, consist of interest and amortization of the initial investment over an assumed project life of 50 years. Operation and maintenance costs are also included.

TABLE 18

Average Annual Costs, Selected Plan of Improvement
(7-5/8 percent interest rate; 50-year period of analysis)

Interest and Amortization	$19,519,000
Annual Maintenance	280,000
Total Average Annual Cost	$19,799,000

BENEFIT-COST RATIO

With average annual benefits of $24,663,000 and average annual costs of $19,799,000, the benefit-cost ratio for the Selected Plan is 1.2.

SENSITIVITY ANALYSIS

The economic feasibility of the Selected Plan of Improvement is sensitive to the volume of commerce shipped through the Port of Wilmington, along with the timing and costs of these shipments. Sensitivity of these elements to various alternative assumptions is discussed below.

ALTERNATIVE BASE YEAR CONDITIONS

The project economic analysis uses year 2004 as the project base year, and assumes increases in commerce to that base year. Using the expected normalized traffic for 1995 and assuming no increases between 1995 and 2004, the project benefit-cost ratio would be 0.98. Using only normalized 1995 benefits and no increases over the 50-year project life, the project benefit-cost ratio would be 0.8.

ALTERNATIVE GROWTH PROJECTIONS

The growth in harbor commerce and related economic benefits for this analysis were based on national and regional studies, and assumed that Wilmington Harbor will grow proportionally with other ports. In order to test the sensitivity of the analysis to varying assumptions, the following two alternative projections were made:

- Cargo specific projections were used for container and tanker traffic, rather than projected regional and national growth rates; using this projection technique, the project benefit-cost ratio would be 1.4.

- Growth in commerce was also projected based on historic trends in the harbor. Using this methodology, the project benefit-cost ratio would be 1.4.

ALTERNATIVE 1995 COMMERCE

One of the decisions made during this study was to use the normalized 1995 commerce as the base to project to the base year and for future growth through 2020. The 1995 commerce was developed using 1994 data and increasing the average annual growth rate from 1990 through 1994 by commodity type. These growth rates ranged from 1.1 to 5.3 percent and averaged 4.2 percent. Using this 1995 commerce to develop base year and future tonnages gives a benefit-cost ratio of 1.2.

PROJECT CONSTRUCTION AND MAINTENANCE

The Selected Plan of Improvement will be constructed by private contractors under contract to the Federal Government. The estimated construction period is 3 years.

Construction quantities for the project are based on presently available information and are shown in table 15, page 39. Project construction is estimated to require excavation of 12,825,586 cubic yards of material, of which 3,423,777 cubic yards are estimated to be rock. The rock is presently expected to be primarily limestone. The non-rock material to be dredged is expected to be primarily silt and sand.

Based on recent Wilmington District experience in removing rock in the Ocean Bar (Baldhead Shoal) Channel, the rock in that channel can be removed by cutterhead dredge. However, available data indicate that blasting is expected to be required for 564,000 cubic yards of rock in the upriver reaches of the project.

Project dredging requirements include 1 foot of required overdepth in areas of rock, and 2 feet of allowable overdepth in all areas. Allowable overdepth is dredging for which the contractor will be paid in order to compensate for dredging irregularities and survey uncertainties. Required overdepth is required for safety clearance and maintenance in rock areas. In computing project quantities the assumption was made that one-half of the allowable overdepth would be dredged.

Dredging methods are expected to be similar to those used for harbor maintenance, with the exception of the Ocean Bar Channel, which is usually maintained using a hopper dredge. For construction of the improvements recommended herein, a rock cutterhead and pipeline dredge is expected to be used for the Ocean Bar Channel, with rock hauled to the Ocean Dredged Material Disposal Site (ODMDS) by scows. A hopper dredge is expected to be used from Smith Island Channel through Battery Island Channel. A bucket and barge system is expected to be used from Lower Swash Channel through Lower Big Island Channel. From the Upper Big Island Channel through the end of the project a pipeline dredge is expected to be used.

PROJECT MAINTENANCE

The Federal Government will be responsible for maintaining the project, with the non-Federal sponsor required to provide disposal areas. The improved channels will be maintained in conjunction with maintenance of the overall navigation project. Increased maintenance dredging requirements are anticipated only in the Ocean Bar Channel. Additional annual maintenance requirements due to construction of the Selected Plan of Improvement are estimated at 117,700 cubic yards.

DISPOSAL AREAS

Dredged material from project construction will be placed in two disposal areas, which are used for maintenance of the existing project. These areas include the ODMDS (identified as Area 1 on figure 8) and the Eagle Island disposal site (identified as Area 15 on figure 8). These sites, along with a third area, identified as Area 18 on figure 8, will also be used for disposal of project maintenance dredging material.

The ODMDS is located approximately 3 nautical miles south of the mouth of the Cape Fear River. The site encompasses 2.3 square miles, and has been designated by the U.S. Environmental Protection Agency as an approved site for suitable dredged material disposal. Water depth at the ODMDS ranges from 21 to 42 feet below MLLW. The average water depth at the ODMDS is approximately 37 feet below MLLW. Rock dredged from the ocean bar channel and the lower reaches of the river will be placed on an existing fish attraction structure constructed by the Wilmington District adjacent to the ODMDS.

The ODMDS does not require improvements to accept the material from the deepening project. Additional diking will be needed at Eagle Island and Area 18. Costs for improvement of the disposal sites are included in the project cost estimate.

ALTERNATIVE DISPOSAL LOCATIONS

The construction and maintenance techniques and disposal locations described above appear to be the most effective among the available options, based on feasibility level studies. However, several other construction and dredged material disposal options will be considered during detailed design studies. These options include disposal of dredged material in the littoral zone or on beaches near the project area where it would provide beach nourishment.

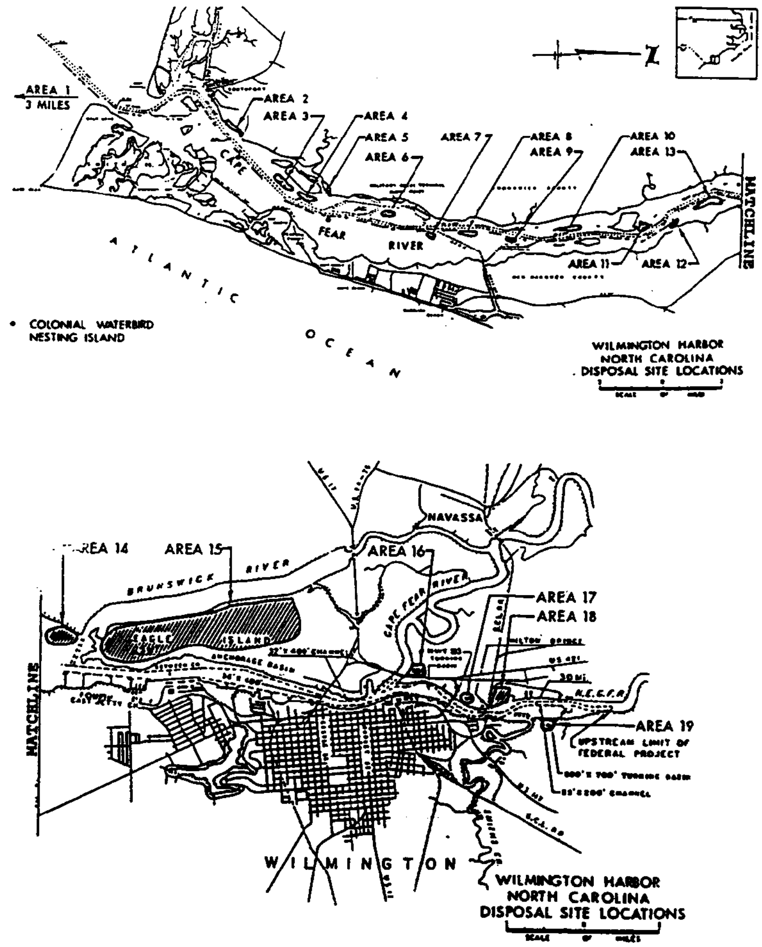


FIGURE 8

Dredged Material Disposal Sites

REAL ESTATE AND RELOCATIONS

The real estate requirements for the Selected Plan of Improvement are 27 acres of mitigation lands and 23 acres for dredged material disposal. The 27 acres of mitigation land are needed for implementation of the "restoration" option described on page 50. The lands to be acquired for restoration consist of spoil disposal islands. These sites were created with dredged material and are subject to navigational servitude. Under North Carolina law, the State holds title to these lands. However, since they are considered within navigational servitude, being created by manmade accretion, no value or credit will be given on these lands.

The Eagle Island disposal site is Government owned. A perpetual disposal easement is proposed for 23 acres at the Area 18 site (see figure 8). The Area 18 site is owned by New Hanover County, which acquired the lands for borrow material and dredged material disposal. These lands have not been used for federally assisted projects, and no credits have been given for these lands.

Most utilities crossing the river will be relocated in connection with other deepening projects that will be completed before the work covered by this report begins. However, four electric cables in Reach 1 will require relocation. The owner's right to construct, operate, and maintain the facility is by permit signed by the Wilmington District. Under the terms of this permit, the permit holder is not entitled to compensation if relocation is required. Under Federal law, this noncompensable relocation is not considered creditable as part of the non-Federal project costs (see page 55).

MODIFICATIONS OF BERTHING AREAS

Dredging of private and State owned berthing areas, along with modifications of bulkheads and other docking facilities, will be required to provide access to the improved channel. The principal construction item will be dredging and bulkhead modification at the State Ports Authority docks. Costs for modifications of berthing areas are included in the project cost estimate (table 17).

ENVIRONMENTAL IMPACTS

As discussed in the attached Final Environmental Impact Statement, the principal environmental concerns associated with the Selected Plan of Improvement are the possible effects of blasting on five threatened or endangered species, dredging in wetlands and primary nursery areas, and potential impacts on water quality. Areas of concern are summarized below.

ENDANGERED AND THREATENED SPECIES

The following threatened or endangered species occur in the project area and may be affected by project construction: manatee, green sea turtle, loggerhead sea turtle, Kemp's Ridley sea turtle, and shortnose sturgeon. Biological assessments concerning possible impacts on each of these species are included with the EIS. Several measures are included in the project plan to monitor and minimize these impacts to the extent practicable.

WETLANDS

Construction of the project plan will result in the loss of 0.13 acre of mixed tidal marsh due to deepening of the Fourth East Jetty Channel. Mitigation measures are included in the project plan to compensate for this loss.

PRIMARY NURSERY AREAS

Construction of the project plan will result in the loss of 13.22 acres of estuarine bottom designated primary nursery areas by the State of North Carolina. Mitigation measures are included in the project plan to compensate for this loss.

WATER QUALITY

The principal water quality concerns associated with the Selected Plan of Improvement are salinity intrusion in ground and surface waters, along with possible increases in salinity due to increased tidal ranges. Based on studies to date, no significant adverse impact is expected. Results and future directions of these studies are summarized below, and are discussed in detail in the Final Environmental Impact Statement.

- Groundwater Studies - A groundwater model study is underway to define changes in the groundwater system due to the proposed channel modifications. This study is a combined effort of the Corps of Engineers, Waterways Experiment Station (WES) and the State of North Carolina.

Preliminary results of the groundwater model, presented at an April 18, 1996, agency meeting at the Wilmington District, indicated that "...dredging of the Wilmington Harbor shipping channel to the proposed depths will not produce detrimental changes to the aquifer system." Comments received at the meeting and in follow-up correspondence will require additional modelling efforts and clarification of model performance for resolution. Additional efforts will include modelling for potential impacts up to the year 2020, if practicable. These efforts and model clarification will be included in a final report which will be coordinated with all concerned agencies.

- Saltwater Intrusion and Hydrology - During the course of this study, a surface water model was developed by WES to determine salinity changes for the Cape Fear and Northeast Cape Fear Rivers due to the proposed project, along with other Federal improvements expected to be constructed prior to construction of the Selected Plan of Improvement (see page 4 and plate 5). Preliminary results of this model were presented to Federal and State agencies at August 22, 1995, and April 18, 1996, meetings at the Wilmington District.

The modelling referred to above indicated that the project would not result in a significant movement of salinity upstream. However, the modelling also indicated a 2-inch increase in the height of high tide at Wilmington (about a 4-inch increase in the tidal range, i.e. high and low tides about 2 inches higher and lower, respectively) in the Wilmington area. The projected change decreases upstream and downstream from Wilmington (see EIS, section 5.01).

Even though the proposed action is not expected to significantly impact salinity movement upstream, the projected increase in tide height may cause some non-tidal areas (e.g., wooded swamp) to become tidal. Increased tidal inundation, along with the associated salt content, could result in a gradual change from swamp tree species to brackish marsh along the edge of tidal rivers and creeks. However, accurately quantifying the resulting change in vegetation is not practicable due to the variable topography in the swamp. Generally, there may be a gradual change in the vegetation along the tidal rivers and creeks, and the overall areas of wetlands and waters will increase. The 2-inch change in tidal amplitude predicted by the model may also result in the gradual upland shift of the wetland-upland ecotone. However, quantifying these changes is likewise not practicable.

Since conversion of swamp to tidal brackish marsh would result in a wetland system still having major wetland values and the overall size of waters and wetlands would be increased, the impacts on tidal creeks and wetlands due to increased tidal height are not considered significant.

However, there is some uncertainty in the results of the model discussed above. Therefore, the Wilmington District will monitor pre- and post-project conditions in the potentially affected area. Details of this monitoring effort will be developed in coordination with all known interested parties. Results will also be coordinated with all known interested parties to determine if impacts different from those anticipated have occurred.

EFFECTS ON HAZARDOUS AND TOXIC WASTES

Based on evaluations of the material to be dredged, no contaminants are expected to be mobilized as a result of project construction. No hazardous waste sites are known to occur in the areas where the channel will be widened.

MITIGATION MEASURES

Approximately 13.4 acres of existing marsh and shallow water habitat will be lost with the project.

Two mitigation options were developed to offset these habitat losses:

- Habitat Restoration - This option consists of restoring upland sites which have been converted from tidal wetlands. Seven upland sites in the project vicinity are under consideration for habitat restoration. These areas are river islands or upland areas that occur in tidal wetlands located adjacent to designated primary nursery areas. Based on investigations to date, suitable replacement habitat could be restored on any of these sites by excavation and construction of a creek and marsh system. Under this option, approximately 27 acres of upland sites would be restored to mitigate the 13.4 acres of marsh and shallow water habitat lost with the project (2:1 ratio).

- Habitat Restoration and Prevent of Degradation (POD) - This option consists of a combination of restoration, described above, and prevention of degradation of existing nursery areas, including tidal marsh and shallow estuarine bottoms. Under this option, approximately 13 acres of primary nursery area would be restored, and approximately 29 acres of primary nursery area would be protected under POD. POD includes the purchase of swamp and upland buffer or obtaining conservation easements to prevent future activities, such as development or forestry, which would degrade habitat values. Presently cleared lands would be allowed to revegetate. All lands acquired under this option would be transferred to an appropriate agency or land trust for management.

Evaluations to date indicate that the combined plan described on the previous page is the most effective means of mitigation for the project. However, final selection and design of mitigation areas will be accomplished during detailed engineering and design studies. If detailed evaluation shows POD to be economically infeasible or it is determined to be unacceptable to regulatory agencies, the restoration proposal described previously will be implemented. For purposes of estimating project costs, the costs for the restoration option were used. These costs were used since, based on preliminary cost analyses, this would be the more costly of the options. The principal cost item would be excavation of the restored sites.

ENVIRONMENTAL COMMITMENTS

The Selected Plan of Improvement includes measures to minimize the adverse effects of project construction and maintenance on endangered and threatened species and other aquatic resources. These measures include:

- Delays in Blasting Charges - The use of delays effectively reduces each detonation to a series of small explosions. Using this technique, the total number of blast events required to construct the project can be minimized.

- Blast Monitoring - Prior to blasting, the blast area will be monitored to assure that no sea turtles or marine mammals (dolphins, manatees) are in the danger zone. Observers will also monitor postblast conditions to determine if any protected species has been affected.

- Stemming of Blast Holes - Stemming is a procedure in which the top 1 foot or more of each blast hole is filled with gravel. This process partially contains the explosive force, and reduces the impact to the aquatic environment.

- Protective Barriers - Air curtains, generated by compressed air pumped through a piping system, and/or physical barriers, such as a sheet wall suspended from a barge, will be employed to attenuate blast effects.

- Seasonal Blasting and Dredging Restrictions - Except for bucket and barge dredging, dredging and blasting during construction and maintenance will be conducted during the North Carolina Division of Marine Fisheries dredging window (August 1 - January 31) whenever feasible.

- Monitoring of Dredging Activities - In order to determine the potential taking of shortnose sturgeon and other species by bucket and barge operations, observers will be on board the bucket and barge during the first full year of construction. If a manatee is observed within 100 yards of dredging operations, all operations will cease until the manatee has left the area.

- Protective Measures, Hopper Dredging - Hopper dredging activities will comply with turtle deflecting draghead and whale protective measures.

- Erosion and Sedimentation Control Measures - These measures will be applied during construction and subsequent maintenance operations. Erosion and sedimentation control measures will be reviewed by the North Carolina Division of Land Resources, Land Quality Section.

- Continued Studies of Groundwater and Surface Water Effects - The District will work with the State of North Carolina and the Waterways Experiment Station to finalize the groundwater and surface water model studies now underway. The reports will be coordinated with all interested parties.

- Monitoring of Salinity and Tidal Range Effects - A pre- and post-construction monitoring effort will be conducted in areas potentially affected by increased tidal range and associated saline waters. Details of this monitoring effort will be developed in coordination with all known interested parties. Results will also be coordinated with all known interested parties.

- Mosquito Control - Diked disposal areas will be monitored and treated for mosquitoes.

- Nesting Site Management - The Wilmington District will continue to support efforts to manage waterbird nesting sites in the lower Cape Fear River in all future projects and maintenance activities.

PLAN IMPLEMENTATION

.A schedule for plan implementation is shown on plate 4. Planning, Engineering, and Design (PED) studies are scheduled to begin in October 1996. During PED, primary activities will involve surveys, geological investigations, and preparation of plans and specifications for the mitigation portion of the proposed project. Engineering and design activities will continue after PED is completed in September 1997. These activities will include completion of ship simulation modelling, geotechnical subsurface investigations, geotechnical Feature Design Memorandum, a Limited Reevaluation Report, continued environmental coordination, and preparation of the plans and specifications for the disposal area modifications and channel improvements.

VIEWS OF NON-FEDERAL SPONSOR

The project's non-Federal sponsor is the State of North Carolina. The State's letter of intent to sponsor the project (letter dated May 16, 1996) is included in appendix A.

DIVISION OF PLAN RESPONSIBILITIES

The Federal Government and the non-Federal sponsor will share in the cost of general navigation facilities assigned to commercial navigation. Such costs include construction costs, costs of preparation of contract plans and specifications, costs of relocations not performed by or on behalf of the non-Federal sponsor, costs of engineering and design, supervision and administration costs, and costs of contract dispute settlements and awards. The non-Federal sponsor is responsible for lands, easements, rights of way, dredged material disposal areas, and modifications to bulkheads or wharfs or construction of other landside facilities which are necessary for the project. Navigation aids are a Federal responsibility.

Costs for general navigation are shared differently depending upon the depth of project being proposed. In the case of a project having a depth in excess of 20 feet, but not in excess of 45 feet, the non-Federal sponsor is required to provide during the period of construction a contribution equal to 25 percent of the total cost of construction of the general navigation facilities assigned to commercial navigation. An additional 10 percent of the cost of general navigation features of the project will be paid by the non-Federal sponsor in cash over a period not to exceed 30 years (with interest). Values of lands, easements, rights of way, relocations, and dredged material disposal areas provided by the sponsor will be credited toward the additional 10 percent payment required.

Since the proposed project includes dredging within the range of 20 to 45 feet, the project construction costs will be cost-shared 65 percent Federal and 35 percent non-Federal. The Federal Government will be responsible for all operation, maintenance, and replacement costs. The non-Federal sponsor will be required to provide dredged material disposal areas.

Table 19, following page, shows apportionment of project first costs. The Federal and non-Federal shares shown in table 19 are based on the current fully funded cost estimate. The fully-funded cost estimate for this project includes estimated inflation based on Office of Management and Budget guidelines and the expected construction schedule.

TABLE 19

Cost Apportionment, Selected Plan of Improvement
(NOTE: Costs based on fully funded cost estimate, adjusted for inflation)
($)

Item	Total	Non-Federal	Federal
General Navigation Features (75% Federal, 25% Non-Federal)			
Channel Improvements	226,363,000	56,854,000	169,509,000
Plng., Eng., and Design	6,634,000	1,658,000	4,976,000
Construction Management	4,686,000	1,171,000	3,515,000
Subtotal, General Navigation	237,683,000	59,683,000	178,000,000
Associated Costs			
Navigation Aids	137,000	0	137,000
Noncompensable Relocations	3,309,000	3,309,000	0
Berthing Areas	21,881,000	21,881,000	0
Subtotal, Associated Costs	25,327,000	25,190,000	137,000
LERRD			
Disposal Areas	8,634,000	8,634,000	0
Lands	*356,000	356,000	0
Subtotal, LERRD	8,990,000	8,990,000	0
TOTAL PROJECT COSTS	272,000,000	93,863,0000	178,137,000
10% of Gen. Nav. Features (GNF)		23,800,000	
LERRD's Credit		-8,990,000	
Sponsor's Estimated Future Reimbursement		14,800,000 (rounded)	
Federal Adjustment for LERRD			-14,800,000
Ultimate Cost Apportionment	272,000,000	108,663,000	163,337,000
Future Reimbursement		-14,800,000	+14,800,000
Initial Cost Apportionment	272,000,000	93,863,000	178,137,000

*The lands costs shown in this table differ from the "lands and damages" costs shown in table 17, page 41. The costs for this item in table 17 include real estate administration costs, which are not included in LERRD.

SECTION VI - CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

I have given consideration to all significant aspects in the overall public interest, including engineering feasibility and economic, social, and environmental effects. The Selected Plan of Improvement described in this report provides the optimum solution for harbor improvement at Wilmington Harbor, North Carolina.

I have also assessed the State of North Carolina's financial capability. The results of this assessment are shown in appendix B of this report. I have ascertained that it is reasonable to expect that ample funds will be available to satisfy the non-Federal sponsor's financial obligations for the project.

RECOMMENDATIONS

I recommend that the existing project for deepdraft navigation at Wilmington Harbor be modified to provide a Federal project for deeper commercial navigation. Recommended improvements consist of (1) deepening the ocean bar and entrance channels from the authorized depth of 40 feet to 44 feet; (2) deepening the authorized 38-foot project to 42 feet up to and including the Anchorage Basin immediately upriver from the State Ports Authority dock; (3) extending the Anchorage Basin northward by 300 feet; (4) deepening the existing 25-foot channel in the Northeast Cape Fear River from 750 feet upstream of Hilton Railroad Bridge to the turning basin near the upstream limits of the project to 34 feet, along with widening the channel from 200 to 250 feet; and (5) widening the turning basin near the upstream limits of the project from its existing width of 700 feet to 800 feet. Project dredging requirements include 1 foot of required overdepth in areas of rock, and 2 feet of allowable overdepth in all areas. These recommendations are made subject to such further modifications thereto as in the discretion of the Chief of Engineers may be advisable, at a first cost to the United States presently estimated at $178,137,000 (fully funded cost).

These recommendations are made with the provision that the exact amount of the non-Federal contribution shall be determined by the Chief of Engineers prior to project implementation in accordance with the following requirements to which non-Federal interests must agree prior to implementation:

a. Provide and maintain, at its own expense, the local service facilities necessary to realize the benefits of the general navigation features of the project.

b. Provide all lands, easements, rights of way, and suitable borrow and dredged or excavated material disposal areas, and perform or ensure the performance of all relocations determined by the Federal Government to be necessary for the construction, operation, and maintenance of the general navigation features and the local service facilities.

c. Provide all improvements required on lands, easements, and rights of way to enable the proper disposal of dredged or excavated material associated with the construction, operation, and maintenance of the general navigation features and the local service facilities. Such improvements may include, but are not necessarily limited to, retaining dikes, waste weirs, bulkheads, embankments, monitoring features, stilling basins, and dewatering pumps and pipes.

d. Provide, during the period of construction, a cash contribution equal to the following percentages of the total cost of construction of the general navigation features: 25 percent of the costs attributable to dredging to a depth in excess of 20 feet, but not in excess of 45 feet; repay with interest, over a period not to exceed 30 years following completion of the period of construction of the project, an additional 0 to 10 percent of the total cost of construction of general navigation features depending upon the amount of credit given for the value of lands, easements, rights of way, relocations, and borrow and dredged or excavated material disposal areas provided by the non-Federal sponsor for the general navigation features. If the amount of credit exceeds 10 percent of the total cost of construction of the general navigation features, the non-Federal sponsor shall not be required to make any contribution under this paragraph, nor shall it be entitled to any refund for the value of lands, easements, rights of way, relocations, and dredged or excavated material disposal areas, in excess of 10 percent of the total cost of construction of the general navigation features.

e. For so long as the project remains authorized, operate and maintain the local service facilities and any dredged or excavated material disposal areas in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government.

f. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the general navigation features for the purpose of inspection, and, if necessary, for the purpose of operating and maintaining the general navigation features.

g. Hold and save the United States free from all damages arising from the construction, operation, and maintenance of the project, any betterments, and the local service facilities, except for damages due to the fault or negligence of the United States or its contractors.

h. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, and other evidence is required, to the extent and in such detail as will properly reflect total cost of construction of the general navigation features, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 CFR, Section 33.20.

i. Perform, or cause to be performed, any investigations for hazardous substances as are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements, or rights of way that the Federal Government determines to be necessary for the construction, operation, and maintenance of the general navigation features. However, for lands that the Government determines to be subject to the navigation servitude, only the Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction.

j. Assume complete financial responsibility, as between the Federal Government and the non-Federal sponsor, for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights of way that the Federal Government determines to be necessary for the construction, operation, or maintenance of the general navigation features.

k. To the maximum extent practicable, perform its obligations in a manner that will not cause liability to arise under CERCLA.

l. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights of way required for construction, operation, and maintenance, of the general navigation features, and inform all affected persons of applicable benefits, policies, and procedures in connection with said act.

m. Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (43 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-78, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army."

n. Provide a cash contribution equal to 25 percent of the total historic preservation mitigation and data recovery costs attributable to commercial navigation that are in excess of one percent of the total amount authorized to be appropriated for commercial navigation.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program nor the perspective of higher level review within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization or implementation funding.

for ROBERT J. SPERBERG
Colonel, EN
Commanding

[First Endorsement]

CESAD-ET-PL (CESAW-EP-PL/7 Jun 96)
Ms. Ashford\bg\404-331-4326
SUBJECT: Cape Fear - Northeast Cape Fear Rivers Comprehensive Study, Navigation Improvement Project, Feasibility Report

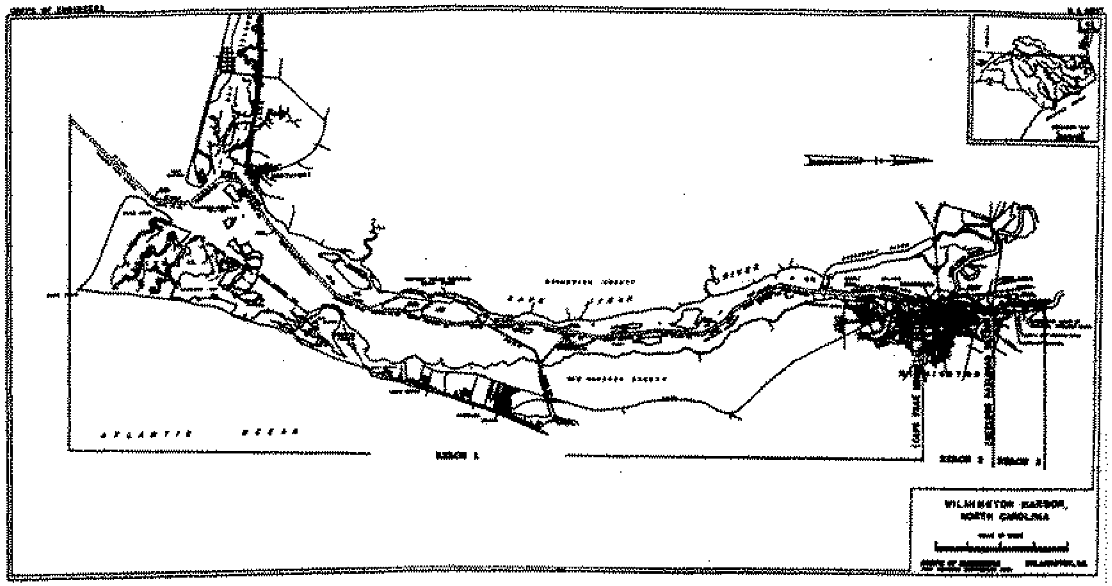
Commander, South Atlantic Division, U.S. Army Corps of Engineers, Room 322, 77 Forsyth Street, SW., Atlanta, Georgia 30303- 3490
17 JUN 1996

FOR CDR, HQUSACE, ATTN: CECW-ZA, WASH DC 20314-1000

I concur in the recommendation of the District Engineer to modify the existing deepdraft navigation project at Wilmington Harbor by deepening the ocean bar and entrance channel from the authorized depth of 40 feet to 44 feet; deepening the authorized 38-foot project to 42 feet up to and including the anchorage basin immediately upriver of the State Ports authority dock; extending the Anchorage Basin northward by 300 feet; deepening the existing 25-foot channel to 34 feet in the Northeast Cape Fear river from 750 feet upstream of Hilton Railroad Bridge to the turning basin near the upstream limits of the project and along with widening the channel from 200 to 250 feet; and widening the turning basin near the upstream limits of the project from its existing width of 700 feet to 800 feet.

Encl

R. L. VANANTWERP
Brigadier General, USA
Commanding



RECOMMENDED PLAN OF IMPROVEMENT

PLATE 1

Reach 1:

- Deepen ocean bar channel to 44 feet; deepen remainder of Reach to 42 feet;
- Extend Anchorage Basin above State Port northward by 300 feet (see plate 2).

REACH 3:

- Deepen channel to 34 feet;
- Widen channel to 250 feet;
- Widen Turning Basin to 800 feet (see plate 3).

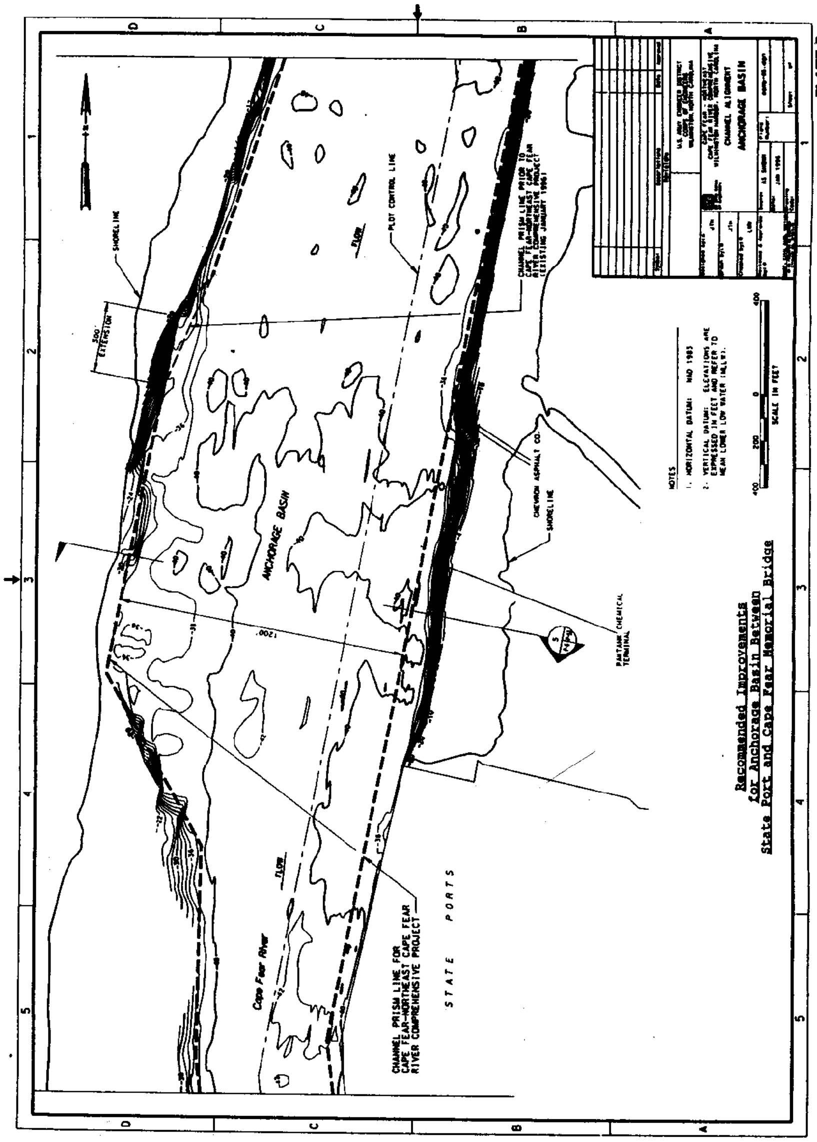
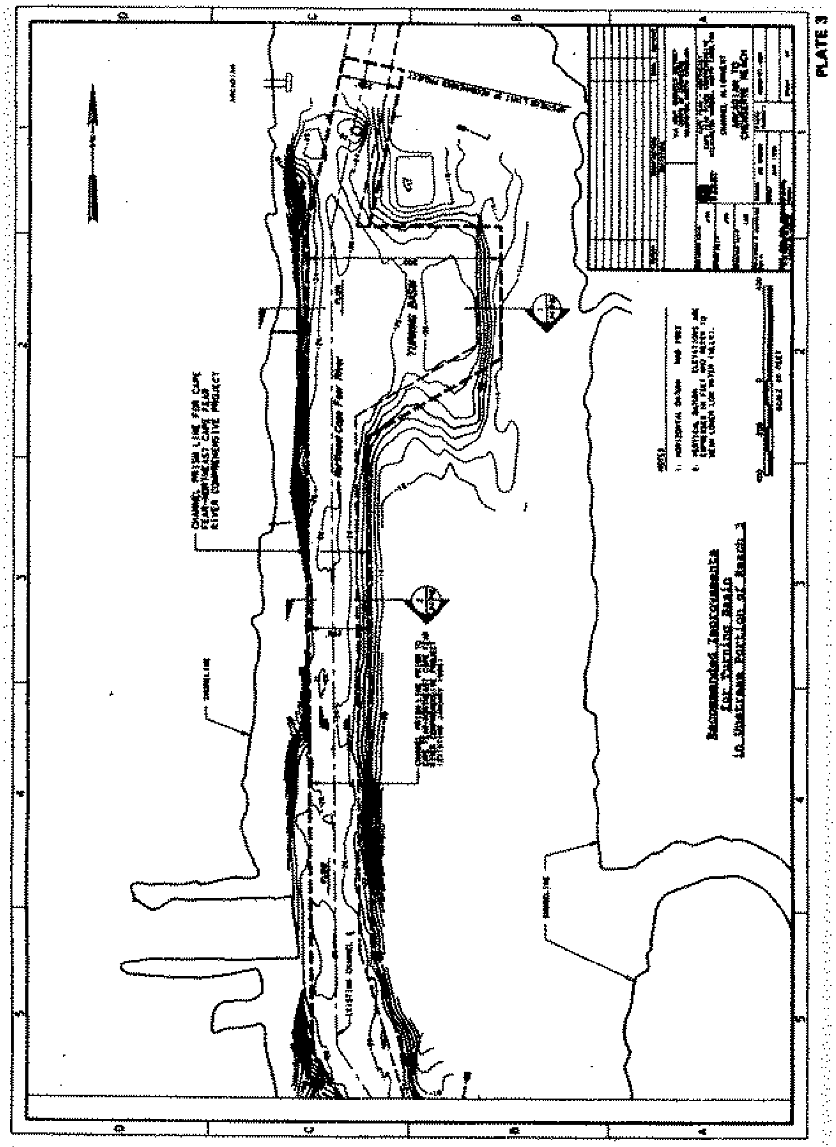


PLATE 2
ANCHORAGE BASIN
Cape Fear River
STATE PORTS
FLOW
SHORELINE
PLOT CONTROL LINE
500' EXTENSION
CHANNEL PRISM LINE PRIOR TO CAPE FEAR-NORTHEAST CAPE FEAR RIVER COMPREHENSIVE PROJECT (EXISTING JANUARY 1996)
CHANNEL PRISM LINE FOR CAPE FEAR-NORTHEAST CAPE FEAR RIVER COMPREHENSIVE PROJECT
CHEVRON ASPHALT CO.
PANTANK CHEMICAL TERMINAL
NOTES
1. HORIZONTAL DATUM: NAD 1983
2. VERTICAL DATUM: ELEVATIONS ARE EXPRESSED IN FEET AND REFER TO MEAN LOWER LOW WATER (MLLW).
SCALE IN FEET
Recommended Improvements for Anchorage Basin Between State Port and Cape Fear Memorial Bridge


Recommended Improvements
for Turning Basin
in Upstream Portion of Reach 3
TURNING BASIN
CHANNEL PRISM LINE FOR CAPE FEAR-NORTHEAST CAPE FEAR RIVER COMPREHENSIVE PROJECT
PLATE 3

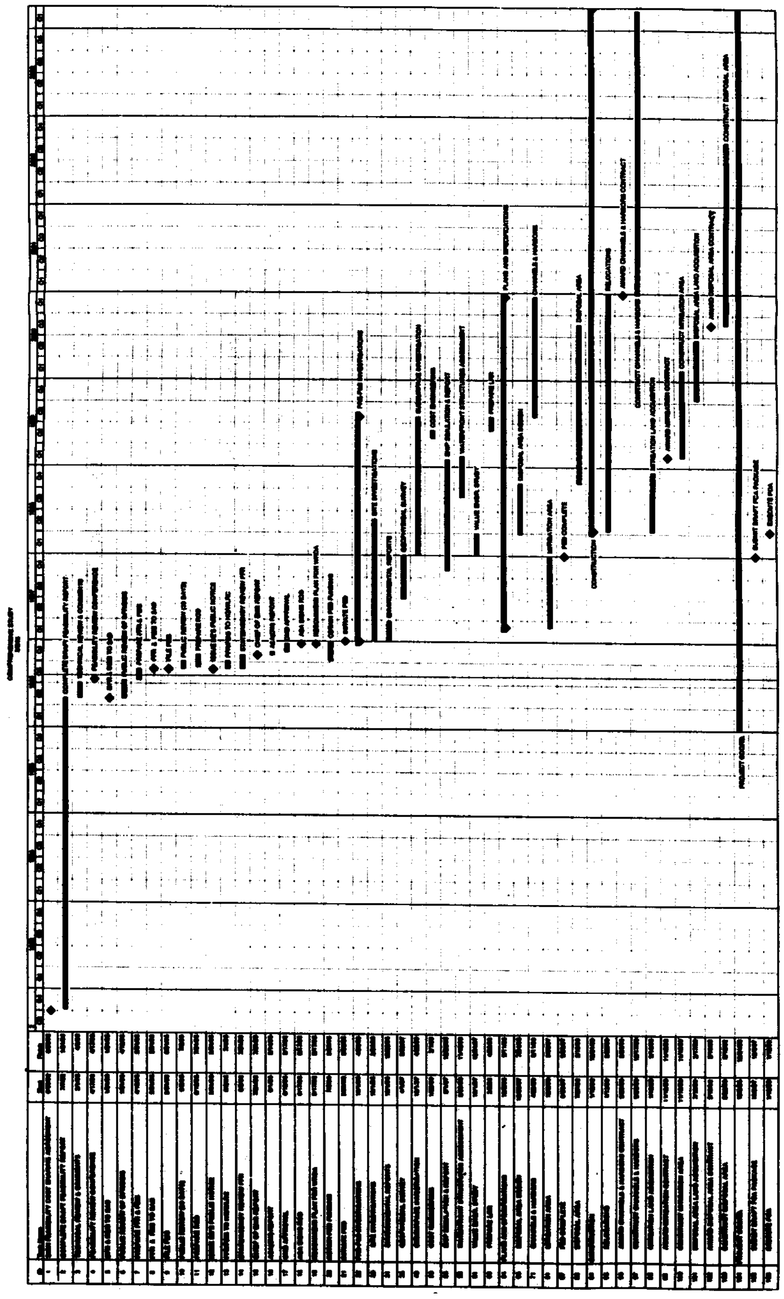


PLATE 4

SCHEDULE FOR IMPLEMENTATION OF OTHER FEDERAL PROJECTS

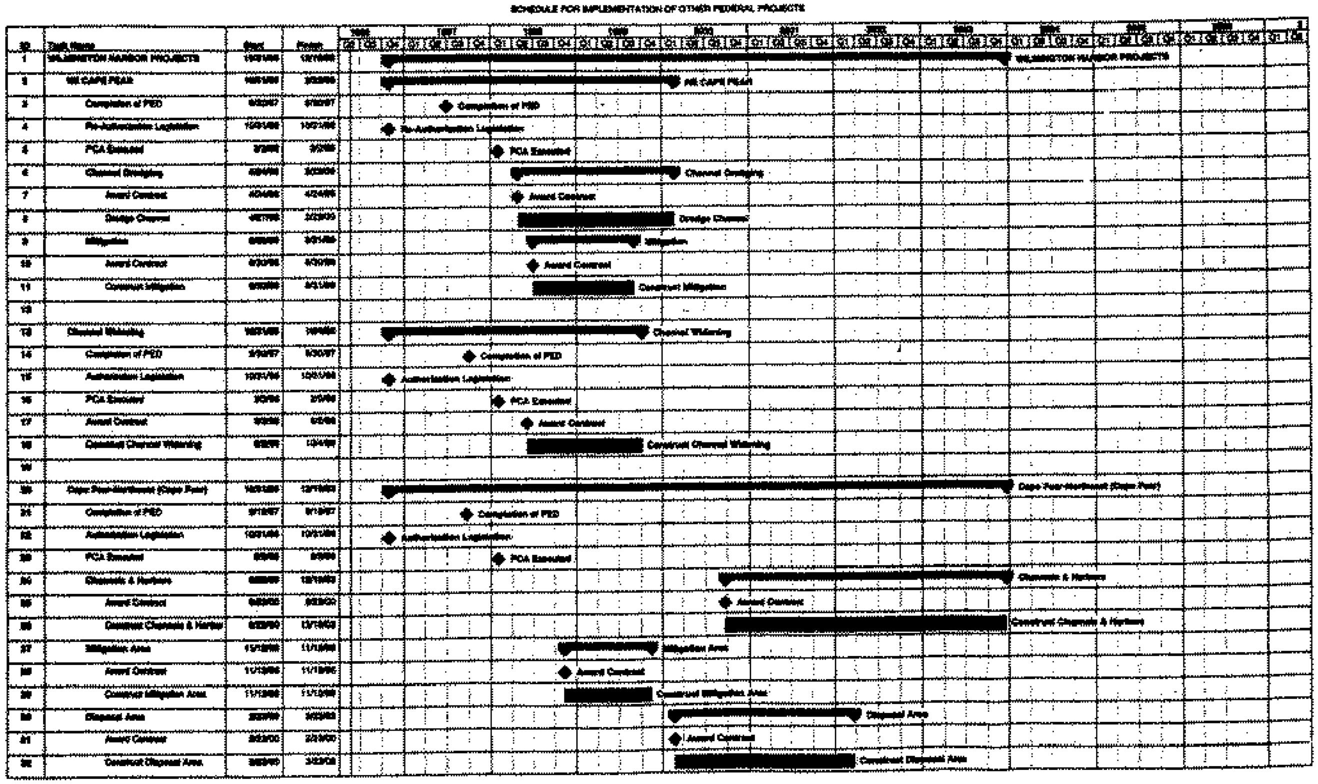


PLATE 8

TIMESCALE IS IN FISCAL YEARS (1 OCT - 30 SEP)

FINAL
ENVIRONMENTAL IMPACT STATEMENT
FOR
CAPE FEAR - NORTHEAST CAPE FEAR RIVERS
COMPREHENSIVE STUDY
NEW HANOVER AND BRUNSWICK COUNTIES, NORTH CAROLINA

The responsible lead agency is the US Army Engineer District, Wilmington.

ABSTRACT: Wilmington Harbor is an approximately 37-mile Federal navigation project located along the Cape Fear and Northeast Cape Fear Rivers in southeastern North Carolina. Local interests, represented by the North Carolina Division of Water Resources, North Carolina State Ports Authority, the Cape Fear River Pilots Association, and other shipping interests in the harbor have requested that the US Army Corps of Engineers study the deepening of the Wilmington Harbor Ship Channel. Measures to accomplish this were determined to be economically feasible and in the Federal interest.

The recommended plan includes dredging most of the harbor 4 feet deeper with some widening of one turning basin and channel and extension of the anchorage basin near Wilmington. Dredging methods recommended include hydraulic pipeline, bucket and barge, hopper, and rock cutterhead dredge. Hydraulic pipeline dredges will be used from about 4 miles south of the State Port (Upper Big Island Channel) to the upstream limit of the Federal Channel with disposal in an existing upland confined disposal facility (CDF, Eagle Island). Beginning about 4 miles south of the State Port (Lower Big Island Channel) to Southport (Lower Swash Channel) a bucket and barge dredge will be used with disposal in the US Environmental Protection Agency (USEPA) approved Ocean Dredged Material Disposal Site (ODMDS). From Southport (Battery Island Channel) to the Smith Island Channel, a hopper dredge will be used with disposal in the ODMDS. From the ocean bar offshore (Baldhead Shoal Channel), the rock substrate will be excavated by a rock cutterhead dredge with disposal to complete the Wilmington Offshore Fisheries Enhancement Structure (WOFES). Silty and sandy sediments will be placed in the ODMDS. Certain areas of rock in the river will require blasting for removal. Such rock from Lower Big Island Channel downstream will be removed following blasting with a bucket and barge dredge and placed on the WOFES. Rock requiring dredging or blasting at or upstream of Upper Big Island Channel, will be removed by pipeline dredge and pumped to Eagle Island.

This proposed action would result in the excavation of 12,825,000 cubic yards of dredged material of which 3,423,000 cubic yards are rock (about 2.4 million cubic yards would be placed in the WOFES). Approximately 801,000 cubic yards will require blasting. The total estimated construction period would be 3 years.

The project could affect marine mammals (including manatees and bottlenose dolphins) and turtles, endangered species, primary nursery areas, adult fish and larval life forms, benthic resources, and anadromous fish migration. These potential impacts could occur through blasting rock, saltwater intrusion due to deepening the harbor, and through direct sediment removal via dredging (especially as it would impact primary nursery area and tidal marsh). All these impacts are discussed in detail in the Final Environmental Impact Statement (EIS) and

impacts are avoided or minimized to the maximum extent possible. Mitigation is proposed for unavoidable impacts to primary nursery area and loss of tidal marsh.

A Notice of Intent (NOI) to prepare a Draft EIS for this project was filed with the USEPA on October 5, 1994. A scoping letter dated September 18, 1992, was sent to the public, as well as all interested State and Federal agencies. A list of commentors are presented in Section 7.01 of this EIS. All comments received on the NOI, scoping letter, and **Draft EIS** were considered during project planning and design, and writing of this **Final** EIS.

SEND YOUR COMMENTS TO THE DISTRICT ENGINEER.

If you would like further information on this **Final** EIS, please contact:

Frank Yelverton
Environmental Resources Section
US Army Engineer District, Wilmington
P.O. Box 1890
Wilmington, N.C. 28402-1890
Phone No. (910) 251-4640

NOTE: ALL CHANGES MADE IN THE DRAFT EIS ARE INDICATED IN <u>BOLD</u> PRINT IN THIS FINAL EIS.

FINAL
ENVIRONMENTAL IMPACT STATEMENT
FOR
CAPE FEAR - NORTHEAST CAPE FEAR RIVERS
COMPREHENSIVE STUDY
NEW HANOVER AND BRUNSWICK COUNTIES, NORTH CAROLINA

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**FINAL
ENVIRONMENTAL IMPACT STATEMENT
FOR
CAPE FEAR - NORTHEAST CAPE FEAR RIVERS
COMPREHENSIVE STUDY
NEW HANOVER AND BRUNSWICK COUNTIES, NORTH CAROLINA**

1.00 SUMMARY

1.01 Major Conclusions and Findings

This project could affect marine mammals (including manatees and bottlenose dolphins) and turtles, endangered species, primary nursery areas, adult fish and larval life forms, benthic resources, and anadromous fish migration. These potential impacts could occur through blasting rock, saltwater intrusion due to deepening the harbor, and through direct sediment removal via dredging (especially as it would impact primary nursery area and tidal marsh). All these impacts are discussed in detail in the **Final** EIS and impacts are avoided or minimized to the maximum extent possible. Mitigation is proposed for impacts to primary nursery area and loss of tidal marsh.

1.02 Areas of Concern and Issues

Meetings were held August 22 and December 13, 1995 and April 18, 1996, with State and Federal resource agencies to discuss concerns with rock blasting, saltwater intrusion, and other impacts related to the proposed project. The conclusions from **these meetings** and subsequent comments are incorporated into this EIS. The blasting and dredging impacts have been minimized to the extent feasible, and loss of primary nursery area and tidal marsh will be mitigated. **Additional groundwater and surface water modeling results are presented in this Final EIS.**

1.03 Relationship of the Proposed Action to Environmental Requirements

Table 1, next page, summarizes the relationship of the proposed action to environmental requirements. Compliance with all applicable Federal, State, and local policies has been examined in this **Final** EIS.

1.04 Previous Corps of Engineers Reports Related to Wilmington Harbor

Dredging and disposal methods for the Wilmington Harbor project have been addressed in previous environmental documents which were circulated for public and environmental agency review. These documents indicate the environmental acceptability of the methods planned for the improvements. Much of the information from these documents is included in this **Final** EIS for easier reference by the reader.

TABLE 1. RELATIONSHIP OF PROPOSED ACTION TO ENVIRONMENTAL REQUIREMENTS.

Federal Laws and Policies	Proposed Action
Abandoned Shipwreck Act of 1987	Full Compliance, see 4.12, and 5.08
Clean Water Act of 1977, as amended	Full Compliance, see 4.09 and 5.05
Clean Air Act, as amended	Full Compliance, see 5.15 and 5.17
Coastal Zone Management Act of 1972, as amended	Full Compliance, see 5.12
Coastal Barrier Resources Act of 1982	Full Compliance, see 4.10
Endangered Species Act of 1973, as amended	Full Compliance, see 4.11 and 5.07
Estuary Protection Act of 1968	Full Compliance, see 4.07 and 5.04
Federal Water Project Recreation Act of 1968, as amended	Not Applicable
Fish and Wildlife Coordination Act of 1934, as amended	Full Compliance, see 7.02
Fishery Conservation and Management Act of 1976	Full Compliance, see 4.06 and 5.02
Hazardous and Toxic Materials Issues	Full Compliance, see 4.02 and 5.16
Land and Water Conservation Act of 1964, as amended	Not Applicable
Marine Protection, Research, and Sanctuaries Act of 1972, as amended	Full Compliance, see 4.02 and 5.02
Marine Mammal Protection Act of 1972, as amended	Full Compliance, see 4.02, 4.11, and 5.07
Migratory Bird Treaty Act of 1918, as amended	not applicable
Migratory Bird Conservation Act of 1929, as amended	not applicable

TABLE 1. RELATIONSHIP OF PROPOSED ACTION TO ENVIRONMENTAL REQUIREMENTS. (cont.)

Federal Laws and Policies	Proposed Action
National Historic Preservation Act of 1966, as amended	Full Compliance, see 4.12, 5.08, and 7.02
National Environmental Policy Act of 1969, as amended	Full Compliance, see 1.00 and 7.02
Prime and Unique Farmland	Not Applicable
River and Harbor Act of 1970, Public Law 91-611, Section 122	Full Compliance, see 5.15
Submerged Lands Act of 1953, as amended	Full Compliance, see 3.07
Water Resources Development Act of 1976, Public Law 94-587, Section 150	Not applicable
Water Resources Development Act of 1986, Public Law 99-662, Section 906	Full Compliance, see 5.06
Watershed Protection and Flood Prevention Act of 1954, as amended	Not Applicable
Wild and Scenic Rivers Act of 1968, as amended	Not Applicable
Executive Orders (EO), Memoranda, etc.	
EO 11988, Flood Plain Management	Full Compliance, see 4.09, 5.06, and 7.02
EO 11990, Protection of Wetlands	Full Compliance, see 4.09 and 5.05
EO 11593, Protection and Enhancement of the Cultural Environment	Full Compliance, see 4.12 and 5.08
EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations	Not Applicable

TABLE 1. RELATIONSHIP OF PROPOSED ACTION TO ENVIRONMENTAL REQUIREMENTS. (cont.)

State Law and Local Policies	Proposed Action
Coastal Area Management Act (CAMA) of 1974	Full Compliance, see 5.12
New Hanover and Brunswick Counties Comprehensive Land Use Plans	Full Compliance, see 4.03 and 5.12

Note: Full compliance is defined as having met all the requirements of the statute, Executive Order, or other environmental requirement for the current stage of planning.

Previous Reports Include:

US Army Corps of Engineers, Wilmington District. 1989. Final Environmental Impact Statement (FEIS), Long-Term Maintenance of Wilmington Harbor, North Carolina.

US Army Corps of Engineers, Wilmington District. 1990. Final Supplement to the Final Environmental Impact Statement, Wilmington Harbor-Northeast Cape Fear River, North Carolina.

US Army Corps of Engineers, Wilmington District. 1991 Environmental Assessment and Finding of No Significant Impact, Maintenance Dredging in Wilmington Harbor Ocean Bar Channels by Ocean-Certified Pipeline, or Bucket and Barge Dredge with Disposal in the Wilmington Harbor Ocean Dredged Material Disposal Site.

US Army Corps of Engineers, Wilmington District. 1991. Environmental Assessment and Finding of No Significant Impact, Excavation of Pits, Wilmington Harbor, Baldhead Shoal Channel, Brunswick County, North Carolina.

US Army Corps of Engineers, Wilmington District. 1991. Reconnaissance Report on Improvement of Navigation, Cape Fear River-Northeast Cape Fear Rivers, Comprehensive Study, Wilmington Harbor, Wilmington, North Carolina.

US Army Corps of Engineers, Wilmington District. 1993. Environmental Assessment and Finding of No Significant Impact, Wilmington Harbor Ocean Bar Channel Deepening, Wilmington, North Carolina.

US Army Corps of Engineers, Wilmington District. 1994. Interim Feasibility Report and Final Environmental Impact Statement on Improvement of Navigation, Wilmington Harbor Channel Widening, Wilmington, North Carolina.

US Army Corps of Engineers, Wilmington District. 1994. Environmental Assessment, Beneficial Use of Dredged Material, Wilmington Harbor Offshore Fisheries Enhancement Structure, Wilmington Harbor Ocean Bar Channel Deepening. Wilmington, North Carolina.

US Army Corps of Engineers, Wilmington District. 1996. Draft Supplement I to the Final Environmental Impact Statement on Improvement of Navigation, Wilmington Harbor Channel Widening, Wilmington, North Carolina.

US Environmental Protection Agency. 1983. Final Environmental Impact Statement (FEIS), Savannah, GA; Charleston, SC; and Wilmington, NC. Ocean Dredged Material Disposal Sites Designation.

2.00 NEED FOR AND OBJECTIVE OF ACTION

2.01 Introduction

Draft restrictions on Wilmington Harbor increase the cost of shipping. Deepening the harbor to the proposed depth is expected to save annually about 19.4 million dollars in shipping costs using the 2004 level of commerce and 24.7 million dollars including commerce growth through 2020. Savings in liquid bulk, dry bulk, breakbulk, and containerized transportation costs would result from using more fully loaded and deeper draft vessels. Increasing the channel depth allows vessels to transport the same amount of commodities in less trips using the greater operating drafts. Regional and national projections and expected commerce for the South Atlantic coast were used to project commerce for Wilmington Harbor. Project benefits are expected to increase with the growth in commerce.

2.02 Public Concerns

Agencies and individuals having concerns and responsibilities related to environmental resources have expressed interest that navigation improvements implemented as a result of this study be constructed and maintained in a manner which minimizes environmental impacts. As indicated in Section 1.01, areas of concern include possible adverse impacts on marine mammals (including manatees and bottlenose dolphins) and turtles, endangered species, primary nursery areas, adult fish and larval life forms, benthic resources, and anadromous fish migration. Identification of public concerns will continue with circulation of this Final EIS.

2.03 Study Authority

This study was conducted under authority of the following resolution adopted 8 September 1988 by the Committee on Public Works and Transportation of the United States House of Representatives:

> Resolved by the Committee on Public Works and Transportation of the United States House of Representatives, that the Board of Engineers for Rivers and Harbors is hereby requested to review the reports of the Chief of Engineers on Wilmington Harbor, North Carolina, published as Senate Document numbered 114, Eighty-seventh congress, Second Session; Northeast (Cape Fear) River, North Carolina, published as House Document numbered 185, Ninety-eight congress, Second Session; Cape Fear River above Wilmington, North Carolina, published as House Document numbered 252, Eighty-ninth congress, First Session; and other pertinent reports, with a view to determining whether any modifications of the recommendations contained therein are advisable at this time with particular reference to the commercial navigation needs from the Atlantic Ocean to the upper ends of navigation on the Cape Fear River above Wilmington to Fayetteville, North Carolina, and to Komegays Bridge on the Northeast Cape Fear River.

2.04 Planning Objectives

The major planning objectives are:

- To increase navigation efficiency;

- To minimize adverse environmental impacts associated with the proposed action. See Section 5.13 for a discussion of environmental commitments incorporated into the proposed plan.

- Provide adequate dredged material disposal capacity for the construction of the project and for the 50 year project life.

3.00 ALTERNATIVES

3.01 Alternative Plans

Four basic harbor deepening plans (in addition to a no-action alternative) were considered for Wilmington Harbor. For all dredging alternatives, dredging depths will include 2 feet of allowable overdepth in non-rock areas and, in rock areas, 1 foot of required overdepth plus an additional 2 feet of allowable overdepth. The overdepths are to allow for dredging inaccuracies and to allow the project to remain at project depth between maintenance events. The channel side slopes will be 5H:1V in the ocean bar area (Baldhead Shoal through Battery Island Channels, inclusive) and 3H:1V in the rest of the harbor.

For each of the alternative plans, the turning basin at the upper end of the project near Arcadian would be widened from 700 to 800 feet. **The existing 25 foot deep and 200 foot wide channel from 750 feet above the Hilton Railroad Bridge to the Arcadian Plant will be widened to 250 feet.** The 1200-foot-wide Anchorage Basin adjacent to the State Port would be extended north 300 feet. The average increased width in this extension would be about 55 feet.

The proposed action assumes that the project features associated with the Wilmington Harbor Ocean Bar (USACE, 1994), Wilmington Harbor-Northeast Cape Fear River (USACE, 1990), and the Wilmington Harbor Channel Widening (USACE, 1994) project have been constructed.

Wilmington Harbor Ocean Bar includes establishing the authorized depth of 40 feet.

The Northeast Cape Fear River Project includes:

1. Widening the Fourth East Jetty Channel 100 feet to the west at the existing project depth of 38 feet for a distance of about 8,000 feet.
2. Deepening the navigation channel from the project depth of 32 feet to 38 feet at a width of 400 feet between Cape Fear Memorial Bridge and the NC Highway 133 Bridge.
3. Deepening the navigation channel from a project depth of 32 feet to 38 feet at a width of 300 feet from NC Highway 133 Bridge to the Hilton Railroad Bridge, located 2,600 feet upstream, and deepening the navigation channel from a project depth of 25 feet to 38 feet at a width of 200 feet from the Hilton Railroad Bridge to a point approximately 750 feet upstream (to Chemserve).

The Channel Widening Project features includes:

1. Widening five turns and bends by 75 to 200 feet with a project depth of 38 feet.
2. Construction of a 6.2-mile by 200 feet wide passing lane in the lower harbor to a project depth of 38 feet.

ALTERNATIVE PLANS (See Table 2 for a summary comparison of alternatives)

PLAN 1: This plan would involve dredging the harbor 2 feet deeper from the ocean bar through the Memorial Bridge inclusive (40 to 42 feet from Baldhead Shoal to Battery Island Channel and 38 to 40 feet from Lower Swash through the Memorial Bridge). **From the Memorial Bridge to 750 feet above the Hilton Railroad Bridge, the channel would be deepened by 2 feet (38 to 40 feet).** From 750 feet above the Hilton Railroad Bridge to the turning basin at the upper end of the project at Arcadian, the channel would be deepened by 5 feet (25 to 30 feet). The total volume of excavated material associated with this project is about 6,154,000 cubic yards including about 1,687,000 cubic yards of rock. About **210,000** cubic yards of this rock **will** require blasting. This results in **284** blasts covering **44.5** acres of channel bottom.

PLAN 2: This plan would involve dredging the harbor 4 feet deeper from the ocean bar through the Memorial Bridge inclusive (40 to 44 feet from Baldhead Shoal to Battery Island Channel and 38 to 42 feet from Lower Swash through the Memorial Bridge). **From the Memorial Bridge to 750 feet above the Hilton Railroad Bridge, the channel would be deepened by 2 feet (38 to 40 feet).** From 750 feet above the Hilton Railroad Bridge to the turning basin at the upper end of the project at Arcadian, the channel would be deepened by 7 feet (25 to **32** feet). The total volume of excavated material associated with this project is about **13,165,000** cubic yards including about **3,738,000** cubic yards of rock. About **704,000** cubic yards of this rock **will** require blasting. This results in **768** blasts covering **115.1** acres of channel bottom.

PLAN 3: This plan would involve dredging the harbor 6 feet deeper from the ocean bar through the Memorial Bridge inclusive (40 to 46 feet from Baldhead Shoal to Battery Island Channel and 38 to 44 feet from Lower Swash through the Memorial Bridge). **From the Memorial Bridge to 750 feet above the Hilton Railroad Bridge, the channel would be deepened by 2 feet (38 to 40 feet).** From 750 feet above the Hilton Railroad Bridge to the turning basin at the upper end of the project at Arcadian, the channel would be deepened by 9 feet (25 to 34 feet). The total volume of excavated material associated with this project is about 21,723,000 cubic yards including about 6,485,000 cubic yards of rock. About **5,844,000** cubic yards will require blasting. This results in **1,443** blasts covering **211.6** acres of channel bottom.

The **RECOMMENDED PLAN**, National Economic Development (NED) Plan, is **as follows: This plan would involve dredging the harbor 4 feet deeper from the ocean bar through the Memorial Bridge inclusive (40 to 44 feet from Baldhead Shoal to Battery Island Channel and 38 to 42 feet from Lower Swash through the Memorial Bridge). From 750 feet above the Hilton Railroad Bridge to the turning basin at the upper end of the project at Arcadian, the channel would be deepened by 9 feet (25 to 34 feet). The total volume of excavated material associated with this project is about 12,825,000 cubic yards including about 3,423,000 cubic yards of rock. About 601,000 cubic yards of this rock will require blasting. This results in 595 blasts covering 89.3 acres of channel bottom. This plan has the same dimensions as Plan 2 from the ocean bar to the Memorial Bridge and the same as Plan 3 from 750 feet above the Hilton Railroad Bridge to the turning basin at the upper end of the project at Arcadian.**

Table 2. Comparison of Alternatives

Cape Fear - Northeast Cape Fear Rivers Comprehensive Study

	Plan 1	Plan 2	Plan 3	Recommended Plan
Construction Period (years)	3	3	>3	3
Excavation Volume (yds^3) #				
Sediment	4,467,000	9,427,000	15,236,000	9,402,000
Rock	1,687,000	3,738,000	6,485,000	3,423,000
Total	6,154,000	13,165,000	21,723,000	12,825,000
Rock Blasting #				
Volume (yds3)	210,000	704,000	5,844,000	601,000
Channel Bottom Area (acres)	44.5	115.1	438.6	89.3
No. of Blasts	264	768	2,924	595
Impact Area (acres)				
Primary Nursery Area	11.2	12.64	14.46	13.22
Tidal Marsh	0.09	0.13	0.15	0.13
In-Kind Mitigation Areas Available	Yes	Yes	Yes	Yes
Saltwater Intrusion				
Groundwater	NS	NS	Not Modelled	NS
Surface water	NS	NS	Not Modelled	NS
Tide Range Change	PI	PI	PI	PI
Cultural Resources	NS*	NS*	NS*	NS*
Utility Relocations	1	1	1	1
Air Pollution	NS	NS	NS	NS
Hazardous Materials	None	None	None	None
Socioeconomics	Positive	Positive	Positive	Positive
NED Plan	No	No	No	Yes
Benefit/Cost Ratio	1.2	1.2	0.5	1.2

\# - Potential impacts to marine fisheries, benthos, endangered and threatened species, water quality (e.g. turbidity), etc. are directly related to the volume of excavation and number of blasts.

NS - Not Significant

NS* - Not Significant based on existing surveys but additional surveys in the lower river are needed.

PI - Possible Impact, monitoring plan will be developed

The improvements from the Memorial Bridge to 750 feet above the Hilton Railroad Bridge are not included in the recommended plan.

ROCK REMOVAL

For the removal of rock, several alternatives were considered:

The District has reviewed several alternatives to the use of explosives for the removal of nondredgeable rock. **These include a backhoe mounted ripper tooth, a large punch or chisel dropped onto the rock surface to pulverize rock, a dipper dredge, and a rock cutterhead hydraulic dredge. However, based on the analysis in Appendix G of Volume II, there are no feasible alternatives to blasting in the reaches indicated in Table 3.**

A dipper dredge was used briefly in 1994 on the ocean bar with mixed results. The rock cutterhead dredge can probably be used on the ocean bar **for the recommended plan**. Such a dredge is currently being successfully used to establish the authorized depth on the bar channel of -40 feet **mean lower low water (mllw)**. This depth had not been previously established due to the presence of rock. A rock cutterhead dredge probably can also be used in the harbor above the Hilton Railroad Bridge. The rock in the rest of the harbor, Keg Island Channel through the Memorial Bridge, is such that blasting **will** be necessary **(Appendix G of Volume II)**. Also deepening of the harbor to 38 feet **mllw** downstream of the Memorial Bridge in the late 1960's and early 1970's required blasting of rock from Keg Island to the vicinity of the Memorial Bridge.

Approximately **601,000** cubic yards of rock **will** have to be blasted within the project limits between the Keg Island Channel and the Memorial Bridge (see Table 3). The percentage of blasted rock to the total quantity dredged for the 42-foot project is about **4.7** percent (**601,000** cubic yards/12,825,000 cubic yards). The removal of **601,000** cubic yards of nondredgeable rock translates to about **89.3** acres of river bottom that **will** be affected, most of which is in the existing channel. This **89.3** acres of river bottom would be removed by dredging (bucket and barge and\or hydraulic dredge) even if no blasting **occurred. When** rock is blasted in the Lower Big Island and Keg Island Channels (total of about 98,000 cubic yards) , it will be removed by bucket and barge dredge and placed on the Wilmington Offshore Fisheries Enhancement Structure (WOFES). Rock blasted upstream of Lower Big Island Channel will be removed by hydraulic pipeline dredge and pumped to Eagle Island. **If pieces are too large to be removed by hydraulic pipeline dredge, they will be removed by bucket and barge and either placed on Eagle Island or in the WOFES.**

3.02 Plans Considered in Detail

The **four** alternative plans of improvement were evaluated in order to identify the plan which maximized net economic benefits. This analysis (Appendix F of the Feasibility Report) indicated that net economic benefits are maximized with **the recommended plan**.

3.03 Comparative Impacts of Alternatives

The adverse environmental impacts associated with each of the alternative plans are related to the excavation requirements associated with each plan. **As indicated in Section 3.04, Plan 1 and the recommended plan are discussed in detail in this Final EIS.**

Table 3. RECOMMENDED PLAN

Cape Fear - Northeast Cape Fear River Comprehensive
(44' Ocean Bar/42' Interior/1200' wide Anchorage Basin-extended 300' north/34' above Chemserve/800' turning basin)

Reach (Name)	Width/Dim (Ft)	Depths	Total Vol. (CY)	Rock Volume Total (CY)	Rock Volume Blast (CY)	Num. of Blasts	Disposal (Location)	Dredge Type
Baldhead Shoal 305+00 to 491+00	500'	44 + 1 + 2(1/2	965,990	965,990	0	0	ODMDS	suction
Baldhead Shoal 305+00 - 125+00	500'	44 + 1 + 2(1/2	1,484,090	1,413,527	0	0	ODMDS	suction
Baldhead Shoal 125+00 in	500'	44 + 0 + 2(1/2	579,410	0	0	0	ODMDS	suction
Smith Island	500'	44 + 0 + 2(1/2	119,630	0	0	0	ODMDS	hopper
Baldhead - Caswell	500'	44 + 0 + 2(1/2	57,810	0	0	0	ODMDS	hopper
Southport	500'	44 + 0 + 2(1/2	43,790	0	0	0	ODMDS	hopper
Battery Island	500'	44 + 0 + 2(1/2	45,490	0	0	0	ODMDS	hopper
Lower Swash	400'	42 + 0 + 2(1/2	119,940	0	0	0	ODMDS	clamshell
Snow Marsh	400'	42 + 1 + 2(1/2	392,350	1,367	1,367	1	ODMDS	clamshell
Horseshoe Shoal	400'	42 + 0 + 2(1/2	270,110	0	0	0	ODMDS	clamshell
Reaves Point	400'	42 + 0 + 2(1/2	323,280	0	0	0	ODMDS	clamshell
Lower Midnight	600'	42 + 0 + 2(1/2	626,770	0	0	0	ODMDS	clamshell
Upper Midnight	600'	42 + 0 + 2(1/2	1,087,510	0	0	0	ODMDS	clamshell
Lower Lilliput	600'	42 + 0 + 2(1/2	847,860	0	0	0	ODMDS	clamshell
Upper Lilliput	400'	42 + 1 + 2(1/2	661,050	7,240	7,240	7	ODMDS	clamshell
Keg Island	400'	42 + 1 + 2(1/2	570,300	28,580	28,580	28	ODMDS	clamshell
Lower Big Island	400'	42 + 1 + 2(1/2	334,780	97,747	97,747	97	ODMDS	clamshell
Upper Big Island	400'	42 + 1 + 2(1/2	358,250	182,747	100,321	129	Eagle Is.	suction
Lower Brunswick	400'	42 + 1 + 2(1/2	606,300	26,497	12,871	17	Eagle Is.	suction
Upper Brunswick	400'	42 + 1 + 2(1/2	368,000	4,129	0	0	Eagle Is.	suction
Fourth East Jetty	500'	42 + 1 + 2(1/2	546,690	3,976	0	0	Eagle Is.	suction
Between Channel	550'	42 + 1 + 2(1/2	216,080	24,869	0	0	Eagle Is.	suction
Anchorage Basin - 1200' basin extend 300'	1200	42 + 1 + 2(1/2	1,295,553	622,031	353,177	316	Eagle Is.	suction
750' Chemserve to Arcadian	250'	34 + 1 + 2(1/2	904,553	45,077	0	0	Eagle Is.	suction
(turning basin)	800'	34 + 1 + 2(1/2	-	-	-	0	Eagle Is.	suction
		TOTALS	12,825,586	3,423,777	601,303	595		

Without Project Assumptions:
1. Ocean Bar project constructed.
2. Channel Widening (Turns & Bends / Passing Lane) project constructed.
3. Northeast Cape Fear River project constructed.

3.04 Rationale for Plan Selection

Economic benefits are maximized with the recommended plan (Appendix F). Therefore, this is the NED Plan, digging the harbor generally 4 feet deeper, and is the plan recommended for implementation. Under current Federal planning policy, the NED plan will be recommended for implementation unless there are overriding considerations which favor recommendation of another plan. Impacts associated with a shallower depth (Plan 1) would be less than those associated with the NED plan, but the lesser impacts of Plan 1 are not considered sufficient to justify recommendation of this plan instead of the NED Plan. Environmental impacts of Plan 1 and **the recommended plan** are discussed in Section 5 of this EIS. **Plans 2 and 3 have greater environmental impacts (primarily more dredging and blasting) than the recommended plan and have a greater cost (Appendix E).** Plan 3 has a benefit cost ratio of **0.5** (Appendix F). A project with a benefit cost ratio less than 1.0, can not be authorized for construction. **Therefore, Plans 2 and 3 are not discussed further in the EIS.**

Benefits which will accrue from the deepening of Wilmington Harbor include reductions in light loading of vessels and vessel delays. Shippers will also be able to use larger, more efficient vessels. The total project costs for **the recommended plan** are **$228,435,000**, average annual costs are **$19,799,000**, and average annual benefits are **$24,663,000**. The benefit-cost ratio is **1.25 ($24,663,000/$19,799,000)**. The total project costs for **plan 1** are **$146,365,000**, average annual costs are **$12,713,000**, and average annual benefits are **$14,898,000**. The benefit-cost ratio is **1.17 ($14,898,000/$12,713,000)**. The economic benefits are maximized with **the recommended plan.**

3.05 Recommended Plan

The recommended plan is described in detail below. Locations of these improvements are shown on Figure 1.

Deepening of the existing channel from the ocean bar to the Port of Wilmington is the central feature of the proposed action. The total length of improvements is approximately **38** miles **(including the river and ocean bar channels)**. This project will require removal of about 12,825,000 cubic yards of dredged material of which about 3,423,000 cubic yards are rock. About **601,000** cubic yards of this rock will require blasting for removal. The construction period for the entire project will be about 3 years.

The recommended project provides for a navigation channel 44 feet deep and 500 feet wide from the Atlantic Ocean through Baldhead Shoal Channel to Lower Swash Channel near Southport, North Carolina. From Lower Swash Channel through the anchorage basin, located at the foot of Castle Street in Wilmington, N.C., the channel will be 42 feet deep and 400 feet wide. The five turn wideners and 6.2-mile passing lane (both a part of the Wilmington Harbor Channel Widening Final EIS, USACE, 1994) will be deepened to 42 feet. The anchorage basin, which extends from the N.C. State Ports Authority to the Cape Fear Memorial Bridge near the foot of Castle Street, will remain at a width of 1200 feet but this width will extend an additional 300 feet northward (This project will not involve work between the Memorial Bridge and 750 feet above the Hilton Railroad Bridge). The existing 25-foot deep and 200-foot wide channel from 750 feet above the Hilton Railroad Bridge to the Arcadian Plant will be deepened to 34 feet and widened to 250 feet. The turning basin located at the Arcadian Plant will be widened to 800 feet. The recommended project ends at the Arcadian Plant

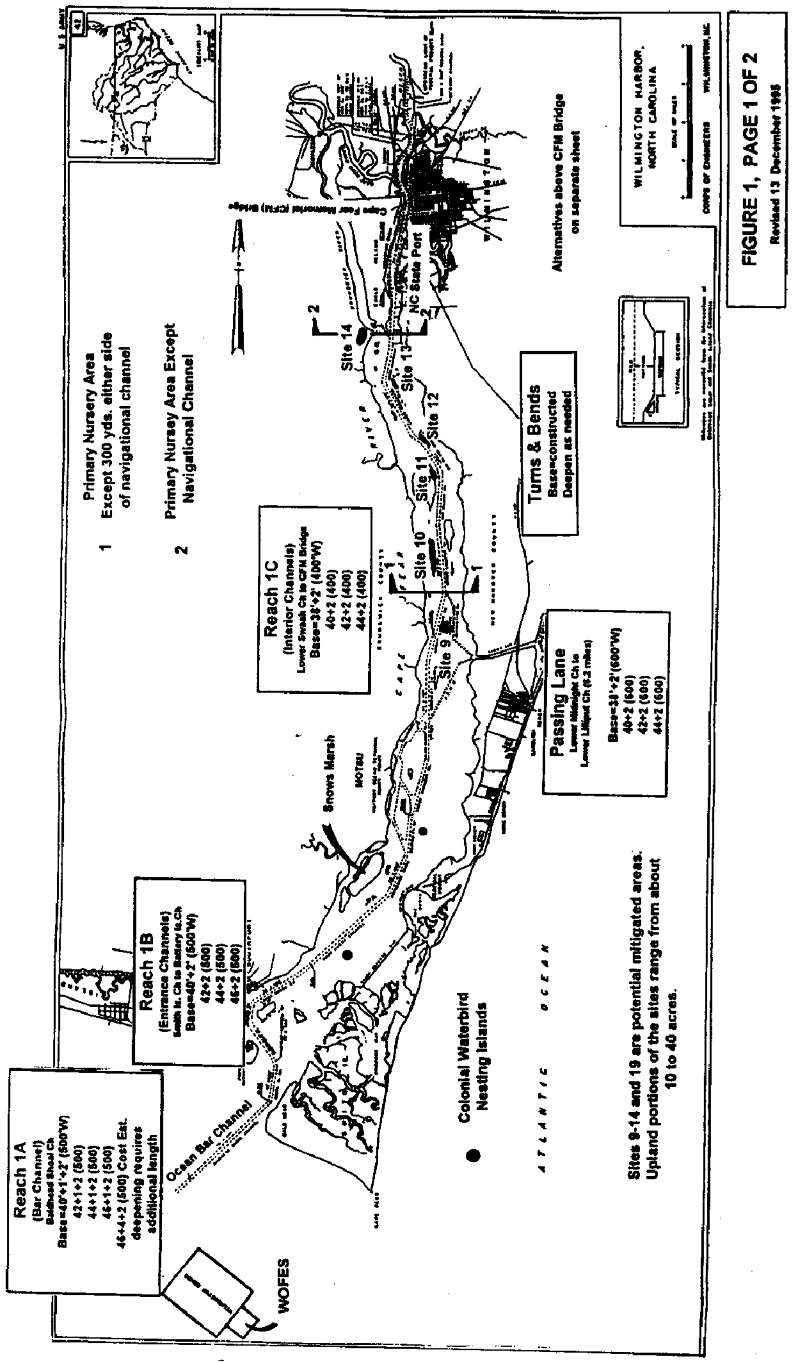

FIGURE 1, PAGE 1 OF 2
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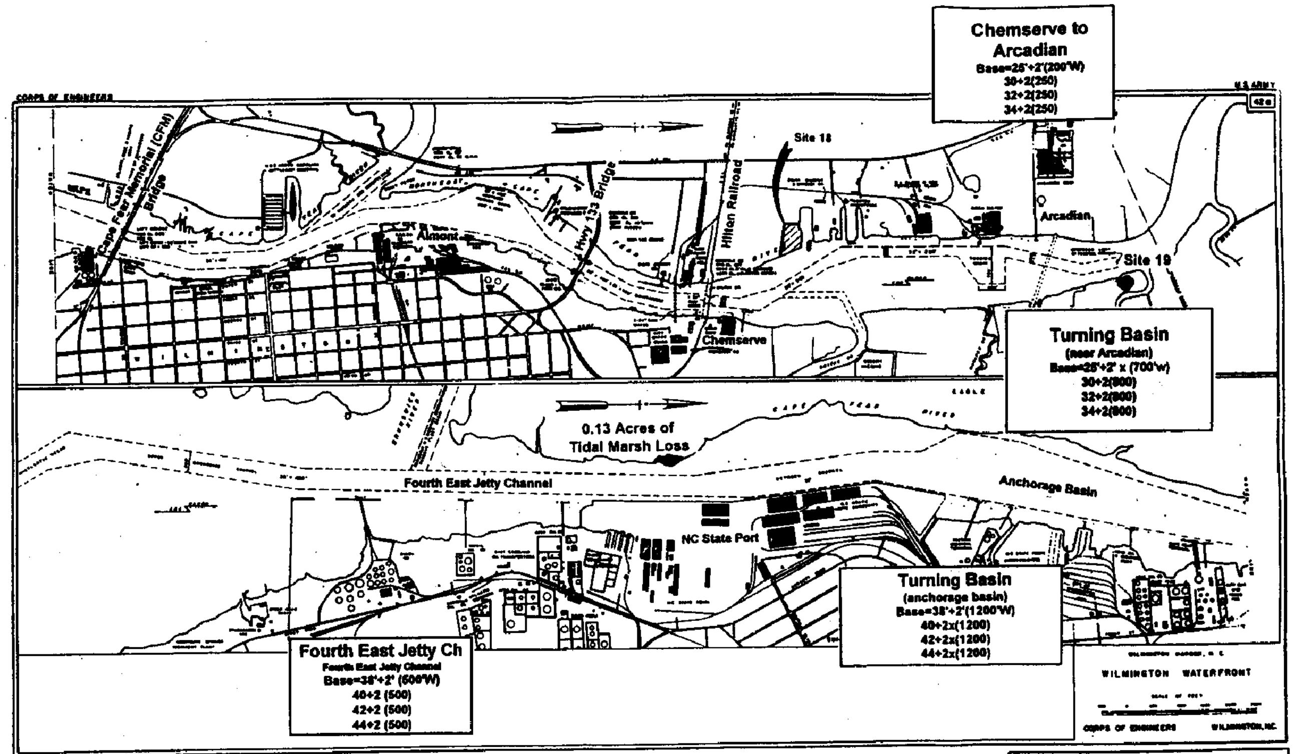

FIGURE 1, PAGE 2 OF 2
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located 1.6 miles above the Hilton Railroad Bridge. Channel side slopes from the Baldhead Shoal Channel to Battery Island will be 5H:1V. Side slopes for the remaining project reaches including the anchorage basin and Arcadian turning basin will be 3H:1V. In addition to the required project depths, dredging depths associated with all of the project features will include 2 feet of allowable overdepth in non-rock areas and 1 foot of required overdepth plus an additional 2 feet of allowable overdepth in rock areas.

3.06 Dredging and Disposal Methods

Excavation methods include use of hydraulic pipeline dredges, bucket and barge dredges, hopper dredges and blasting. **However, if the dredging contractor provides sufficient evidence that other dredging methods with less potential impact than blasting are feasible, these methods will be evaluated in detail, and appropriate National Environmental Policy Act (NEPA) documentation performed.** Hydraulic pipeline dredges will be used from about 4 miles south of the State Port (Upper Big Island Channel) to the upstream limit of the Federal Channel with disposal in an existing upland confined disposal facility (CDF, Eagle Island, Figure 1). Beginning about 4 miles south of the State Port (Lower Big Island Channel) to Southport (Lower Swash Channel) a bucket and barge dredge will be used with disposal in the USEPA approved ODMDS. From Southport (Battery Island Channel) through the Smith Island Channel, a hopper dredge will be used with disposal in the ODMDS. From the ocean bar channel offshore (Baldhead Shoal Channel), the rock substrate will be excavated by a rock cutterhead dredge with disposal to complete the WOFES (Figure 1). Silty and sandy sediments will be disposed in the ODMDS. In the river from Lower Big Island Channel downstream, in areas requiring rock blasting, the rock will be removed following blasting with a bucket and barge dredge and placed on the WOFES. Rock requiring dredging or blasting from Upper Big Island channel upstream, will be removed by pipeline dredge and pumped to a Eagle Island. **If pieces are too large to be removed by hydraulic pipeline dredge, they will be removed by bucket and barge and either placed on Eagle Island or in the WOFES.** Blasting and hydraulic pipeline dredging in the river will be restricted to August1 to January 31. Dredging by bucket and barge in the river, hopper dredge in the lower river and ocean, and rock **cutterhead** dredge in the ocean will be performed year-round. None of the proposed year-round dredging actions will be located contiguous to a primary nursery area.

Over flow from bucket and barge dredging in sandy areas, hopper dredging from the Southport channel offshore into the ocean through the Baldhead Shoal Channel, and overflow of barges associated with hydraulic/rock dredging in the ocean (Baldhead Shoal Channel) will be performed in order to have an economic load. In the areas of proposed overflow for the dredges, the sediments are generally rock or greater than 95% sand. However for hopper dredging and rock dredging in the ocean, in the offshore portion of the Baldhead Shoal Channel (beginning about 2 or more miles offshore of the inlet), the sediment contains up to about 30% silt and clay.

3.07 Alternative Disposal Methods

In addition to the dredge material disposal plans above, several alternative disposal plans were considered, including beneficial uses of dredged material. These alternatives follow:

o Two proposals to provide beneficial uses of dredge material will be investigated during the Preconstruction Engineering and Design Studies (PED). If either one of these proposals is determined to be feasible (considering environmental and economic costs) during PED, they will be discussed in a supplement to the EIS. The first proposal will utilize a 30-inch hydraulic pipeline dredge to construct the project from the Baldhead Shoal Channel to Battery Island Channel and pump the sandy material to the beaches at Baldhead or Oak Island. The pipeline dredge **could** continue to construct the project between Lower Swash and Reaves Point Channel and pump the sandy material directly to either Fort Fisher or Kure Beach or to a stockpile site. The material from the stockpile site could be pumped periodically to the beach. The exact location of these disposal sites **will** depend on the need and the willingness of the local communities to cost share in any added costs for this disposal method. Similar alternatives will be considered for maintenance.

o The second proposal **could** utilize a hopper dredge to construct the deepening project and maintenance from the Baldhead Shoal Channel extension through Battery Island Channel and deposit the sandy material in the littoral zone either off Baldhead Island or off Oak Island, which lies just west of the Cape Fear River entrance. The long-term maintenance study for Wilmington Harbor (USACE, 1989) found the area off Oak Island to be the most feasible area in Brunswick County due to the fact that the barges can get relatively close to the beach. A bucket and barge or **hopper dredge** could dredge from Lower Swash Channel through Reaves Point Channel and deposit the sandy material in the same littoral zone. Similar alternatives will be considered for maintenance.

If the costs of either of the above alternatives exceeds the costs for ocean disposal, cost sharing partners will be required for these alternatives.

o Renourishment of Colonial Waterbird Nesting Island (see Figure 1 for locations) - Disposal of dredged material **to nourish these** nesting areas **has occurred as a part of past maintenance dredging. Similar disposal** will be considered as a management measure **for the proposed action** and will be coordinated with natural resource agencies prior to deposition.

o Wetlands Creation - Disposal of dredged material into the estuary to create wetlands was considered. This alternative **will** require **filling** of estuarine bottom, and was not determined to be **a viable option at this time.**

3.08 Preliminary Blast Plan

The preliminary blast plan developed by the Wilmington District reflects industry standards for underwater blasting. This preliminary blast plan balances the two issues: the cost-effective production of rock removal and minimizing the impacts of blasting on the estuarine environment. Normal industry procedure requires that the contractor perform limited onsite blasting tests and adjust the final plan to actual site conditions, so some plan modifications may occur. **The bubble curtains and/or physical barrier will also be tested during this period.**

The plan includes the drilling of holes on 8-foot spacing within rows and between each row, 10 holes per row, and 8 rows per frame for a total of 80 holes. Hole diameter woud be 4.5 inches. Stemming (filling the top of the holes with angular rock) would be 1 foot. Inserting one delay per hole, charge weight would be 98.5 pounds per hole. Total weight of charges per frame (i.e., 80 holes) would be 7,880 pounds. A bubble curtain and/or a physical barrier (see Section 5.02) would be placed completely around the blast area (about 35,000 square feet, including about a 40 foot safety set-back of the curtain from the nearest blast hole).

Blasting (only during construction) will be conducted during the North Carolina Division of

Marine Fisheries (NCDMF) dredging window (August 1 to January 31) to the maximum extent practicable. A requirement to blast outside the specified window may arise. If this occurs, prior approval will be sought from the North Carolina Division of Coast Managment (NCDCM) and the NCDMF. Examples of conditions which may lead to a need to blast outside the dredging window include unpredictable weather conditions, mechanical failures with the drill barges operational considerations such as drill barge availability and capabilities. Historically, the Wilmington District has complied with the NCDMF dredging window.

3.09 Dredging Quantities for Construction of Selected Plan

Estimated volumes for construction of the Selected Plan are indicated in Table 3.

3.10 Maintenance Dredging Requirements

The improvements included in the selected plan will be maintained in conjunction with maintenance of the overall Wilmington Harbor project. Maintenance dredging will continue to be conducted at the same frequency, generally every 1 to 5 years depending on the shoaling rate. Dredging methods and disposal locations described above will be used for maintenance **with the exception that disposal area 18 (Figure 1 and Appendix C) will be also be used for maintenance of the upper reaches of the project. The use of site 18 for disposal of maintenance dredged material was evaluated in the Long-Term Maintenance of Wilmington Harbor EIS (USACE, 1989). All required environmental clearances for use of site 18 were obtained through that EIS process.** Average annual maintenance dredging requirements for the selected plan and alternatives would essentially be the same. Table 4 includes total and incremental (increase due to the proposed project) maintenance dredging requirements. The incremental increase is about 10 percent more than existing maintenance volumes.

3.11 50-Year Maintenance Plan and Periodic Review

Disposal capacity is available for construction of the project and 50 year maintenance in the ODMDS, the existing CDF upstream (Eagle Island) **and site 18**. The long-term maintenance of Wilmington Harbor will be reviewed every 5 years to consider new dredging technologies, shoaling rates, environmental conditions, laws, and regulations.

3.12 Without Condition (no-action alternative)

If the proposed project is not constructed, including blasting not performed to remove the nondredgeable rock problems identified at Wilmington Harbor, vessel operators will continue to incur costs due to vessel delays and light loading of vessels. Shippers will also not be able to use larger, more efficient vessels. **However, the no-action alternative would preclude potential adverse impacts to the environment such as increased turbidity, blasting, changes in tidal range, deepening of primary nursery areas and disposal of more dredged material.**

3.13 Relationship of Proposed Action to Other Federal Projects

As indicated in Section 3.01 of this **Final** EIS, the proposed action assumes that the project features associated with the Wilmington Harbor-Northeast Cape Fear River (USACE, 1990) and the Wilmington Harbor Channel Widening (USACE, 1994) project have been constructed.

Table 4. Estimated Average Annual Maintenance Dredging Quantities, Selected Plan of Improvement

Reach	Average Annual Volume cu. yds./ yr.	Maintenance Schedule
Baldhead	see note 1	yearly
Smith Island	120,400	yearly
Baldhead - Caswell	see note 2	yearly
Southport	see note 2	yearly
Battery Island	see note 2	yearly
Lower Swash	12,000	2-years
Snows Marsh	15,300	2-years
Horseshoe Shoal	47,000	2-years
Reaves Point	21,200	2-years
Lower Midnight	39,200	2-years
Upper Midnight	161,900	2-years
Lower Lilliput	65,900	2-years
Upper Lilliput	48,900	2-years
Keg Island	35,300	2-years
Lower Big Island	8,900	2-years
Upper Big Island	2,600	4-years
Lower Brunswick	34,000	4-years
Upper Brunswick	18,100	4-years
Fourth East Channel	25,900	2-years
Between Channel	61,500	yearly
Anchorage Basin	932,900	yearly
Memorial Bridge to Chemserve	70,600	3-years
25 ft. Project	12,640	5-years
Subtotal	1,734,240	

note 1:	822,500	Plan 40
	852,700	Plan 42
	901,300	Plan 44

note 2: included in Baldhead & Smith Is.

Plan 40	2,556,740 total
Plan 42	2,586,940 total
Plan 44	2,635,540 total

4.00 AFFECTED ENVIRONMENT

4.01 Study Area

The study area for this analysis is continuous from the nearshore ocean area (including the bar channel and ODMDS) at the mouth of the Cape Fear River to the upstream limit of the Federal Project in the Northeast Cape Fear River near Arcadian, a distance of approximately 38 miles (**30.8 miles of river channel plus 5.8 miles of ocean bar channel, see Figure 1**). The Cape Fear River in the project area generally flows from north to south. The existing 38-foot-deep by 400-foot-wide Wilmington Harbor ship channel extends through the approximate center of the river and small islands border the channel for much of its length. These islands were created by disposal of dredged material in open water prior to the early 1970's. Since the early 1970's, most of the disposal islands have been diked for disposal of dredged material; therefore, most of these terrestrial habitats are maintained in an early stage of succession. Salt marsh borders most of the disposal islands and mainland in the project area. The tide range in the project area is about 4 feet and salinity ranges from a few parts per thousand (ppt) in the upper harbor to almost sea strength (35 ppt) in the ocean. The width of the river varies from almost 4 miles near its mouth to about 1,000 feet at Arcadian. Significant resources are discussed in detail under "Significant Resources," Section 4.04.

4.02 Sediment Types and Rock Locations

Sediment. The sediment types in the harbor generally consist of silt, sandy silt, and silty sand with some clay and peat. These alluvial soils are interbedded, generally unconsolidated, and relatively soft. The subsurface sediments are generally silty sands. Table 5 lists river sediment characteristics by channel. These sediment characteristics were determined by the South Atlantic Division Laboratory in Marietta, Georgia, and the USEPA Environmental Research Laboratory in Gulf Breeze, Florida. Sand is defined as grain size between 0.07 and 5.0 mm while silt and clay measures less than 0.07 mm in diameter.

Analyses of Wilmington Harbor Sediments for Ocean Disposal. As discussed previously, sediments (that are not predominantly rock) dredged from Lower Big Island Channel downstream will be disposed of in the Wilmington ODMDS. Samples of bottom sediments from the project area (Keg Island and Baldhead Shoal Channels) were tested to evaluate the toxicity and bioaccumulation potential of chemical contaminants which may be associated with those maintenance sediment materials (Ward et al, 1993). These site-specific test results indicate that the maintenance sediments meet the testing criteria of the EPA Ocean Dumping Regulations and Criteria and are, therefore, acceptable for transportation for ocean dumping under Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972, as amended. USEPA, Region IV, concurred with this determination by letter dated December 21, 1993. Based on these results, the new work material should also be acceptable for ocean disposal. However, a Section 103 evaluation including testing of the new work material for disposal in the Wilmington ODMDS will be performed prior to construction. Both Plan 1 and the **recommended plan** would use the ODMDS.

Rock Locations. Table 3 indicates the rock locations and areas that need blasting. Limestone and sandstone are the underlying bedrock in the harbor channels. Rock units encountered in the areas proposed for blasting are Castle Hayne Limestone, Rocky Mount member (of the Peedee Formation), and the Peedee Formation rocks underlying the Rocky Mount member.

TABLE 5. CHARACTERISTICS OF SURFACE SEDIMENTS IN THE CHANNELS.

Channel	%Gravel	%Sand	% Silt & Clay
Baldhead Shoal			
Offshore reaches	0.0	73.2	26.8
Inside Reaches	0.0	98.7	1.3
Smith Island	7.9	92.0	0.1
Baldhead-Caswell	18.0	80.5	1.5
Southport	12.5	85.5	2.0
Battery Island	38.0	61.0	1.0
Lower Swash	27.0	70.0	3.0
Horseshoe Shoal	0.0	98.0	2.0
Reaves Point	0.0	99.0	1.0
Lower Midnight	0.0	76.0	24.0
Upper Midnight	0.0	82.5	17.5
Lower Lilliput	0.0	53.5	46.5
Upper Lilliput	0.0	98.0	2.0
Keg Island	0.0	63.0	37.0
Upper and Lower Big Island	2.0	94.0	3.0
Lower Brunswick	0.0	92.7	7.3
Upper Brunswick	0.0	57.0	43.0
Fourth East Jetty and Between	0.0	80.0	20.0
Anchorage Basin	0.0	6.0	94.0
Between Memorial and Hilton Railroad Bridges	10.0	55.0	35.0
Above Hilton Railroad Bridge	0.0	58.0	42.0

4.03 Land Use

In accordance with the North Carolina Coastal Area Management Act (CAMA), New Hanover and Brunswick Counties have developed land use plans. The dredged material disposal areas fall in one of two classifications: transition or conservation. The "transition" classification provides for future intensive urban development within the ensuing 10 years. The "conservation" classification provides for effective long-term management of significantly limited or irreplaceable areas. These areas include wetlands, unique shoreline areas, and areas hazardous for development. The area to be dredged is under the conservation classification. All project disposal areas have previously been used for harbor maintenance activities, and are either owned by the Federal Government or are available to the local sponsor.

4.04 Significant Resources

Significant resources identified in the study area included water quality, terrestrial and aquatic resources, wetlands, primary nursery areas, endangered species, recreational and esthetic resources, cultural resources, and utility crossings. Each resource identified or considered likely to exist in the study area is discussed below.

4.05 Water Quality

Groundwater. The draft Final Report of the Wilmington Harbor Ground Water Study (Lautier, 1996) discusses regional hyrogeology and also presents preliminary results of the three-dimensional finite element model used jointly by the US Army Corps of Engineers, Waterways Experiment Station (WES), Vicksburg, Mississippi, and the State of North Carolina's Department of Environment, Health, and Natural Resources, Division of Water Resources, Raleigh, North Carolina. **The model simulates current and future ground water conditions with respect to channel deepening. The results of the model are discussed in Section 5.01. The draft report** indicates the following hydrogeologic framework and ground water conditions:

The Wilmington Harbor Project study area is situated in the Tidewater region of the North Carolina Coastal Plain physiographic province. The region is generally of low relief. Land surface elevations range from sea level to about 80 feet above sea level. The region is characterized by a multiaquifer system of interbedded sand, silt, and clays often overlying a fractured rock aquifer. The hydrogeologic units between the top of the Black Creek aquifer and the water table include the surficial, Castle Hayne, and Pee Dee aquifers and the Castle Hayne, Pee Dee, and Black Creek confining units. The Castle Hayne and Pee Dee aquifers are semi-confined aquifers.

(Lautier, 1996) indicates that the surficial, Castle Hayne, and Pee Dee aquifers exhibit primarily a discharge relationship to the Cape Fear River along the length of the shipping channel as evidenced by the higher elevations of water level contours relative to the elevations of the surface of the river. The flow trend may be interrupted locally by streams, lakes, ponds, ground water withdrawal, and other natural and human activities. Monitoring data along the Cape Fear River in Brunswick County indicates an upward component of ground water flow from the Pee Dee aquifer to the Castle Hayne aquifer. This is indicated by lower values of hydraulic head in the Castle Hayne aquifer than in the Pee Dee aquifer. Head values along the river are generally higher in the surficial aquifer than in the Castle Hayne aquifer, indicating downward leakage from the surficial aquifer.

The recharge to the aquifers is primarily from precipitation, by lateral inflow from areas adjacent to the study area, and from interaquifer leakage. Areas of highest recharge are located in north central New Hanover County and eastern Brunswick County.

Surface Water Hydrology. The Cape Fear River estuary has relatively free access to the ocean which results in significant tidal range. An average tidal range of about 1 foot extends as far north as Lock and Dam No. 1, approximately 65 miles from the mouth of the river. The average tidal range in the estuary below Wilmington is about 4 feet. Regular reversals of flow occur with each tide except during periods of high fresh water flow. The average freshwater inflow to the Cape Fear River Estuary is about 9,700 cubic feet per second (cfs).

Saltwater Intrusion. The Cape Fear River may be classified under some flow conditions as a partially-mixed estuary (Ragland et al., 1987). There exists a definite salinity gradient with depth. The lower reaches of the estuary may have bottom salinities ranging from one-half to three times greater than surface salinities. However, turbulence within the river frequently does not allow the formation of a distinct saltwater wedge. The salinity of the estuary is constantly changing due to tidal action, freshwater inflow, and wind so that for any location within the river the salinity might range from a few parts per thousand (ppt) to almost normal ocean salinity (35 ppt).

In 1987, the State of North Carolina performed a brief study of the problem of recent (circa 1982 - 1987) tree mortality in the swamps of the lower Northeast Cape Fear River estuary. That study concluded that tree death in the affected areas was attributable to high levels of salinity in the river. Site inspections by the Corps (January and May 1988) found that tree mortality was evident throughout the lower Northeast Cape Fear River estuary. Salinity stress was noted on Smith Creek to a point approximately 1.5 miles upstream of the Southern Coastline Railroad (SCLRR) bridge. On the Northeast Cape Fear River, the upstream limit was a point approximately 4 miles above the Hilton Railroad Bridge.

Salinity damage to trees is often first noticed as leaf injury and ultimately leads to defoliation. The tree species most affected by the salt water encroachment to date are bald cypress (*Taxodium distichum*), tupelo gum (*Nyssa aquatica*), sweet gum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), ash (*Fraxinus sp.*) and oaks (*Quercus sp.*). The salinity tolerances of these species and other species occurring in the swamp forests of the area are not well documented but are assumed to be quite low. Some work on salinity tolerances of freshwater wetland species of plants has been done. Pezeshki et al. (1987a) found that stomatal conductance and net photosynthesis of bald cypress seedlings declined significantly at salinities as low as 2 ppt (approximately 1,091 mg chloride/L). Similarly, significant reductions in stomatal conductance and net photosynthesis have also been reported for green ash (*Fraxinus pennsylvanica*) seedlings with salinities at approximately 1.95 ppt (1,064 mg chloride/L) (Pezeshki and Chambers, 1986) and for maidencane (*Panicum hemitomon*) with salinities ranging from 5 to 7 ppt (approximately 2,754 to 3,862 mg chloride/L) (Pezeshki et al., 1987b).

A recent study performed in the Cape Fear River in the project area has demonstrated that major changes in the salinity regime have occurred in the past and that these changes are attributable to rising sea level and to navigation improvements (Hackney and Yelverton, 1990). Both of these factors allow ocean derived salts to encroach further upstream due to increased tidal amplitude.

Water Quality Classification. The State of North Carolina has placed the lower Cape Fear River into two water classifications (NC Department of Natural Resources and Community

Development 1989). The Cape Fear River from the mouth of the Northeast Cape Fear River to a line across the river between Snows and Federal Points is "SC"; and the Cape Fear River at the line across the river between Snows and Federal Points to the Atlantic Ocean is "SA" (except for a segment west of the Cape Fear River Channel that is classified "SC"). "SC" waters are suitable for fishing, fish and wildlife propagation, secondary recreation, and other uses requiring water of lower quality. "SA" means that in addition to the "SC" uses, the waters are acceptable for shell fishing for market purposes and the water will meet accepted sanitary standards of water quality for outdoor bathing. The waters north of a line from Snows Point to Federal Point and west of the channel between Snows Point and Southport are prohibited (closed) shellfish areas.

4.06 Aquatic Resources

Nekton. Schwartz et al., (1981) reported the collection of 249 species of fish from a 1973-1980 survey of the saline lower Cape Fear River watershed. The Cape Fear estuary including the adjacent Atlantic Ocean is characterized, however, by a few species which occur very abundantly and others which occur only incidentally (CP&L, 1980). EA Engineering (1991) has provided an excellent fisheries literature review for the Cape Fear River basin.

The nekton of the Cape Fear River estuary are dominated by species residing in the estuary as larvae or juveniles, using the estuary as nursery or feeding habitat, but spawning offshore in the Atlantic Ocean (Birkhead et al., 1979). Abundant species in the "nursery use" category include Atlantic menhaden, (*Brevoortia tyrannus*); Atlantic croaker, (*Micropogon*); spot, (*Leiostomus xanthurus*); star drum, (*Stellifer lanceolatus*); penaeid shrimp; mullet, (*Mugil* spp.); and weakfish, (*Cynoscion regalis*). Species that are estuarine endemics or permanent residents are also abundant, namely, bay anchovies, (*Anchoa mitchilli*); killifishes, (*Fundulus* spp.); and silversides, (*Menidia* spp.) (Weinstein, 1979). Anadromous species such as blueback herring, (*Alosa aestivalis*); American shad, (*Alosa sapidissima*); hickory shad, (*Alosa mediocris*); alewife, (*Alosa pseudoharengus*); striped bass, (*Morone saxatilis*); and Atlantic sturgeon, (*Acipenser oxyrhynchus*) use the Cape Fear River estuary as a transportation route to upper river spawning and nursery areas (Walburg and Nichols, 1967; Nichols and Louder, 1970). The shortnose sturgeon (*Acipenser brevirostrum*) is also present in the harbor (Attachment B). Anadromous fish use is highest from mid-winter to mid-spring. The catadromous American eel, (*Anguilla rostrata*) is widely distributed in the Cape Fear River estuary (Schwartz et al., 1981).

Since 1974, Carolina Power and Light Company, Inc., (CP&L), and various investigators have conducted biological monitoring in the Cape Fear River. The following information was taken from the CP&L Brunswick Steam Electric Plant 1993 Biological Monitoring Report (CP&L, 1994). Their investigation indicate that larval species composition and density (number/1000 cubic m) in the upper estuary were predominantly anchovy (545), croaker (364), spot (76), Megalops (65), (*Penaeus* spp.) (35), (*Gobiosoma* spp.) (26), and other taxa (62) for a total mean density of 1,173. Overall the daily mean density of larvae in the Cape Fear River estuary (from Wilmington to the ocean) was 1902/1000 cubic m in 1993, which was made up of *Anchoa* spp. (936), *Portunid megalops* (250), Croaker (215), Spot (131), *Gobiosoma* spp. (129), *Penaeus* spp. (117), *Gobionellus* spp. (17), Pinfish (13), Atlantic menhaden (11), *Microgobius* spp. (9), and other taxa (74)."

Settle and Fuss (1995) reviewed the existing literature and summarized the life-history of larval life forms in the Cape Fear River estuary. This report includes the relative abundance, spawning season and location, larval duration and size, seasonal distribution of estuarine larvae, and the presence or absence of a swim bladder in either larvae or young juveniles. Settle and Fuss

(1995) state, "Species richness is highest from May through August and lowest from November through February, although, the proportion of abundant species is highest during winter." Abundant species are anchovies (*Anchoa* spp.), Atlantic croaker (*Micropogonias undulatus*), spot (*Leiostomus xanthurus*), Atlantic menhaden (*Brevoortia tyrannus*), gobies (*Gobiosoma* spp., *Gobionellus* spp., *Microgobius* spp.), and pinfish (*Lagodon rhomoides*). This summary indicates that though the diversity of fish larvae are higher from May through August, the larval concentrations of the most abundant species are approximately the same throughout the year. Consequently, there is no time or season when blasting or dredging could be conducted without impacting fish larvae in the Cape Fear River estuary.

Recently, studies of the shortnose sturgeon population in the Cape Fear River system have been conducted by Moser and Ross (1993). This work consisted of a fishery-independent gillnet survey and sonic tracking study, conducted from May 1990 to September 1992, to establish the distribution and movement patterns of shortnose sturgeon and other anadromous fishes in the Cape Fear estuary. Intensive gillnet sampling (893 days) took place within the study area, but only seven shortnose sturgeon were captured, three of the seven were recaptured. Results from this study indicate that dredging and blasting operations in the inner Wilmington Harbor should be limited to the period from August to November to reduce the risks of disrupting spawning migrations of shortnose sturgeon and other anadromous fishes. No juvenile shortnose sturgeon have been caught in the Cape Fear River basin, which may mean that this species may not be spawning successfully here (Moser and Ross, 1995). Additional information on this endangered species may be found in the Biological Assessment (see Attachment B of the **Final** EIS).

The nekton of the ocean waters in the area of the Wilmington Harbor ODMDS and along the southeastern North Carolina coast can be placed into three categories: estuarine-dependent species; seasonal, north-south or warm water migrant species; and permanent resident species. The most abundant nekton of these nearshore marine waters are the estuarine-dependent species such as sciaenid fish, including croakers; spot; weakfish; star drum; red drum, (*Sciaenops ocellatus*); mullets; flounders, (*Paralichthys* spp.); and penaeid shrimp (Struhsaker, 1969; Schwartz et al., 1981). Some species are permanent residents of the nearshore marine waters and may include the black sea bass, (*Centropristis striata*); longspine porgy, (*Stenotomus caprinus*); Atlantic bumper, (*Chloroscombrus chrysurus*); inshore lizardfish, (*Synodus foetens*); and searobins, (*Prionotus* spp.). Common warm water migrant species include bluefish, (*Pomatomus saltatrix*); spanish and king mackerel, (*Scomberomorus maculatus* and *S. cavalla*); cobia, (*Rachycentron canadum*); Florida pompano, (*Trachinotus carolinus*); and spiny dogfish, (*Squalus acanthias*).

The side slopes of Upper Midnight and Lower Lilliput Channels (approximately 40,000 feet) are trawled by small shrimp trawlers. The channel bottom is generally avoided by trawlers since it contains snags.

Benthos. According to Birkhead et al. (1979), benthic density in the lower Cape Fear region was highest in the ocean nearshore organic sediment and lowest in the sandy estuarine areas. Downstream of MOTSU, the dominant organisms were polychaetes especially a spionid polychaete (*Spiophanes bombyx*). Other abundant organisms were the little surf clam (*Mulinia lateralis*), sea pansy (*Renilla reniformis*), mud snails (*Ilynassa obsoleta*) and brittlestars (subclass *Ophiuroidea*).

Lawler, Matusky & Skelly Engineers (1975) conducted a benthic investigation at six stations ranging from near the mouth of the Cape Fear River up to the mouth of Smith Creek in the Northeast Cape Fear River. Polychaetes dominated the benthic fauna below MOTSU. Of the 21 species collected, only 5 species occurred above Lower Lilliput channel and only 1 species at Smith Creek. Species included (*Scolecolepides virdis*), (*Capitella capitata*), (*Branchioasylis americana*). (*Drilonereis longa*) and (*Nereis succinea*). Oligochaetes were the most abundant group in the entire river, comprising 35 percent of all collected fauna. They were most abundant from Campbell Island to the Anchorage Basin. Amphipods (*Gammarus spp.*) occurred in all samples but were most abundant near MOTSU, the Anchorage Basin and at Smith Creek. Other common species collected were Cumaceans and Isopods.

Woodward-Clyde Consultants (1980) surveyed the benthos in the vicinity of the anchorage basin. Nematodes, the spionid polychaete (*Scolecolepides viridis*), and the isopod (*Chiridotera almyra*) were dominant in the medium-fine sand. The silty clay substrate was dominated by the oligochaete (*Peloscoles benedeni*) and by an amphipod (*Gammarus sp*).

The North Carolina Division of Environmental Management (NCDEM) performed benthic sampling at Snows Marsh in 1985. Of the 38 species collected, polychaetes, molluscs, amphipods and decapods dominated the site (NCDEM unpublished data). Sediments ranged from coarse sand to fine silty clays. Common species collected were the polychaetes *(Leitoscoloplos variabilis)* and (*Paraprionospio pinnata*) and the molluscs *(Ilyanassa obsoleta)* and (*Crassostrea virginica*).

Shellfish beds are also present in the Cape Fear Estuary, primarily south of Snows Cut (Woodward-Clyde Consultants, 1980). All significant beds are in shallow water east of the ship channel. The dominant species are the American oyster (*Crassostrea virginica*) and the clam (*Mercenaria*). In this area, both species are harvested for sale and personal consumption.

A **draft final** report on the distribution and relative abundance of the epibenthic fauna within portions of the Cape Fear River has been recently written by **Posey et al (1996)**. Sampling was conducted in **May and October 1995**. Eight transects, including six channel transects with a combination of sand and silt; deep and shallow habitat; and dredging frequencies were sampled. Epibenthos were sampled by pulling a modified epibenthic sled. Twenty-six higher taxa, including the zoeal and megalopal stages for anomuran/brachyuran crabs, were recognized from the epibenthic sled tows. Most of these taxa are relatively rare. **The community** was strongly dominated by mysids, **at least during the May sampling with over fifty times greater abundances in the deep channel versus the shallow sites.** Anomuran/brachyuran larvae, carid shrimp, and gammarid amphipods as less common co-dominants. **Two taxa mysids and anomuran/brachyuran megalopae, exhibited significant differences in abundance between shallow and deep sampling sites with both more abundant in deep compared to shallow areas. However, there was a large decline in numbers of mysids from May to October. Anomuran/brachyuran zoea and carid shrimp abundance also declined in numbers from May to October. Anomuran/brachyuran juveniles and mysids had greater abundances over sand substrates compared to silt sites. Anomuran/brachyuran juveniles and mysids and carid shrimp all had highest abundances in May in the most frequently disturbed sites. Grammaridae amphipods were most abundant in silt substrate with a low frequency of disturbance while isopods were most abundant at frequently disturbed silt sites but only during May. No epibenthos were taken in nighttime tows, suggesting movement away from the bottom during early night periods. This draft epibenthic report was, and the final report will be, circulated to all interested parties for review and comments.**

A **draft** report on the distribution and relative abundance of the benthic fauna within portions of the Cape Fear River has been recently provided by **Ray (1996)**. Data was collected from 14 transects from the ocean to the upper limits of the project. Taxa richness (number of taxa) is highest in the ocean and lower estuary. Annelids dominate taxa richness through most of the estuary with Arthropods becoming important only in the mid-reaches and Insects becoming dominate in the upper reaches. Abundances (number of individuals) are generally highest in the ocean and lower estuary and decline slightly with distance upstream. As with taxa richness, Annelids dominate abundance throughout most of the estuary with Arthropods becoming numerous in the mid-reaches and Insects in the upper reaches. Biomass (weight of all benthos) tends to follow a similar pattern as abundance.

Regardless of sediment type, channel sites dredged one or two years prior to sampling had lower values for all biological parameters (i.e., taxa richness, abundances and biomass) compared to controls or sites dredged earlier. Three year post-dredging sites generally had the same or greater values than channel control stations.

This draft benthic report was, and the final report will be, circulated to all interested parties for review and comments. Additional benthic data was collected in the Fall of 1995, but the draft report has not been received to date. The results of this collection will also be fully coordinated with all interested parties.

A population of Greenfield Ramshorn snails *(Helisoma eucosmium)*, a small freshwater planorbid snail has been discovered in Town Creek, a tributary on the west side of the Cape Fear River near the Lower Big Island Channel (Adams and Brady, 1995). This snail was previously thought to be extinct by some authors. The Wilmington District funded a study by UNC-W to investigate the habitat requirements of this snail and its distribution in southeastern North Carolina **(Hackney and Brady, 1996). Despite intensive investigations in 32 streams in southeastern North Carolina, the snail was only found in the freshwater portions of Town Creek. The snail probably only occurred in Town Creek because of an open canopy allowing growth of submerged aquatic vegetation on which the snail was exclusively found, and Town Creek has a large percentage of the stream flow coming from ground water discharge which results in higher pH and water hardness levels than the other creeks. Also pollution is probably minimal in Town Creek.**

<u>Plankton</u>. Carpenter (1971) studied phytoplankton populations in the Cape Fear estuary and nearby ocean waters. Carpenter found the diversity to be greater at the mouth of the estuary than in either the coastal waters or the up-river areas. The dominant phytoplankton was the diatom *Skeletonema costatum*. Other common species included the diatoms *Asterionella japonica* and *Thalassionsina nana*, the dinoflagellate *Katodinium rotundatum*, and the loricate flagellate *Calycomonas ovalis*. Birkhead et al. (1979) indicated that diatoms were more abundant in the ocean and flagellates more abundant in the estuary.

According to Birkhead et al. (1979), the calanoid copepods (Acartia tonsa and *Paracalanus crassirostris*) and barnacle nauplii were the dominant taxa comprising zooplankton samples in the Cape Fear estuary and nearshore ocean waters. Other organisms consistently present were bivalve veligers, copepod nauplii, cyclopoid copepods, crab zoea, gastropod veligers, and polychaete larvae.

4.07 Primary Nursery Areas

The most abundant nekton species in the Cape Fear River estuary are those species residing in the estuary as larvae or juveniles and using the estuary as nursery or feeding habitat. The Wilmington Harbor Channel upstream of the intersection of the Upper and Lower Lilliput reaches extends through areas designated by the NCDMF as "primary nursery" areas (Figure 1). However, 300 yards east and west of the centerline of the main shipping channel from the intersection of the Upper and Lower Lilliput reaches to the mouth of the Brunswick River is excluded from the primary nursery area designation. From the mouth of the Brunswick River upstream, the maintained channel, turning basins, and side slopes are excluded from the primary nursery area designation. The State of North Carolina defines primary nursery areas as those areas in the estuarine system where initial post-larval development takes place.

4.08 Terrestrial Resources

The only terrestrial habitat that will be affected by the proposed action is Eagle Island. This facility has been used for the disposal of dredged material before, was discussed in detail in the 1989 Final EIS (USACE, 1989) and all required environmental clearances have been obtained for disposal of dredged material in this site. Both Plan 1 and the **recommended plan** would use this disposal area.

Several formerly used disposal islands are being considered as mitigation sites for impacts related to this project (Figure 1). The upland portions of these areas contain domes created by disposal of dredged material. Many of these domes are still relatively barren sand. In the vicinity of the Keg Island and Big Island Channels, the domes are covered with marl resulting from the previous rock dredging in the late 1960's and early 1970's. Terrestrial vegetation surrounding these domes generally consists of mixed forest and shrubs. The dominant trees are Live oaks (*Quercus virginia*), loblolly pine (*Pinus taeda*), black cherry (*Prunus serotina*), red maple (*Acer rubrum*), and common cottonwood (*Populus deltoides*). Dominant shrubs are groundsel tree (*Baccharis halimifolia*), marsh elder (*Iva frutescens*), wax myrtle (*Myrica cerifera*), yaupon (*Ilex vomitora*) and blackberry (*Rubus* spp.). Due to past dredging frequency, the terrestrial vegetation is generally less than 30 years old.

4.09 Wetlands and Flood Plains

The only wetlands directly impacted by the project are 0.13 acres of mixed tidal marsh on a small point on Eagle Island adjacent to the Fourth East Jetty Channel (Figure 1). This marsh consists of a 5 to 30 foot wide (average 15 feet wide) border of saltmarsh cordgrass (*Spartina alterniflora*) along the river edge. Adjacent to this marsh, is a 10 to 20 foot wide (average 15 feet wide) border of giant cordgrass (*Spartina cynosuroides*).

Several formerly used disposal islands are being considered as mitigation sites for impacts related to this project (Figure 1). Narrow borders (10 to 20 feet wide) of mixed tidal marsh, primarily saltmarsh cordgrass (*Spartina alterniflora*). salt meadow hay (*Spartina patens*) exist along the shoreline of the sites. All these sites were discussed in detail in the 1989 EIS (USACE, 1989). These marsh areas and non-diked portions of these potential mitigation sites are located within the 100-year flood plain.

Some of the shoreline and marsh along Eagle Island and down river disposal areas are eroding due to wind waves and boat wakes.

4.10 Coastal Barrier Resources System

Review of the "Report to Congress: Coastal Barrier Resources System," Volume 11, dated 1988, indicates that the proposed project will not impact any Coastal Barrier Resources System (CBRS) units.

4.11 Threatened and Endangered Species

An updated list of threatened or endangered species was obtained from both the US Fish and Wildlife Service (USFWS, Raleigh, North Carolina, Field Office) and the National Marine Fisheries Service (NMFS, Southeast Regional Office) on October 2, 1995. The species on this list were considered in the development and documentation of the proposed project. The lists provided by these agencies are indicated below:

Mammals

Eastern cougar	(*Felis concolor couguar*)	Endangered
West Indian manatee	(*Trichechus manatus*)	Endangered
Finback whale	(*Balaenoptera physalus*)	Endangered
Humpback whale	(*Megaptera novaeangliae*)	Endangered
Right whale	(*Eubaleana glacialis*)	Endangered
Sei whale	(*Balaenoptera borealis*)	Endangered
Sperm whale	(*Physeter catadon*)	Endangered

Birds

Bald eagle	(*Haliaeetus leucocephalus*)	Endangered
Piping plover	(*Charadrius melodus*)	Threatened
Wood Stork	(*Mycteria americana*)	Endangered
Peregrine falcon	(*Falco peregrinus*)	Threatened
Red-cockaded woodpecker	(*Picoides borealis*)	Endangered

Reptiles

Loggerhead sea turtle	(*Caretta caretta*)	Threatened
Kemp's ridley sea turtle	(*Lepidochelys kempii*)	Endangered
Green sea turtle	(*Chelonia mydas*)	Threatened
Hawksbill sea turtle	(*Eretmochelys imbricata*)	Endangered
Leatherback sea turtle	(*Dermochelys coriacea*)	Endangered

Fish

Shortnose sturgeon	(*Acipenser brevirostrum*)	Endangered

Plants

Cooley's meadowrue	(*Thalictrum cooleyi*)	Endangered
Rough-leafed loosestrife	(*Lysimachia asperulaefolia*)	Endangered
Sea-beach amaranth	(*Amaranthus pumilis*)	Threatened

See Section 7.02 for discussion of the consultation process on these species.

4.12 Cultural Resources

The Cape Fear River has a long and active history as one of the earliest and most significant waterways in North Carolina. Several towns, plantations, and farmsteads flourished along the river, and by the mid 19th century there were over 140 named landings located along the 115 miles of river between Wilmington and Fayetteville. These landings were regularly visited by pole and steam powered barges and steamships serving farms, mills, and small industrial and commercial centers at and between Smithville (Southport), Navassa, Elizabethtown, Wilmington, and earlier Colonial towns of Brunswick Town and Livingston.

Thirty-seven historic shipwrecks are listed on the 1985 National Register of Historic Places Registration addendum for the Wilmington Historic District prepared by the North Carolina Division of Archives and History (Pleasants, 1977; Lawrence, 1985). In addition, over 130 shipwrecks are known from the lower Cape Fear - Northeast Cape Fear River vicinity. Additional information is in Attachment F.

4.13 Socioeconomic Resources

Population. North Carolina had an estimated population of 7,069,836 on July 1, 1994, an increase of 6.6 percent since 1990. The population of 6,628,637 on April 1, 1990, was an increase of 12.7 per cent since the 1980 census. North Carolina is presently growing about 1.6 percent annually, and is one of the fastest growing states in the nation.

The area including New Hanover, Brunswick, and Pender counties, had an estimated 1994 population of 228,000; an increase of 14 per cent since 1990. While the state was growing at 1.6 per cent a year, the 3 county area was growing at 3.3 per cent per year. Pender and Brunswick Counties have been among the fastest growing counties in the state over the last 4 years, growing at 3.6 per cent per year.

Income and Employment. The latest economic data from 1994 show that North Carolina has a labor force of 3,609,000 and employment of 3,386,000; giving an unemployment rate of 4.4 per cent. New Hanover and Brunswick Counties have a labor force of 98,439, an employment of 91,560 and an unemployment rate of 7.0 per cent. The latest earnings data from 1993 showed salaried workers, which excludes self-employed, at 3,245,000 employees for the state and a first quarter payroll of about 14 billion dollars. Of those, about 845,000 work in manufacturing. The Wilmington area, including New Hanover and Brunswick counties, has about 84,000 salaried employees, including 11,340 in manufacturing, making a first quarter payroll of about 325 million dollars. The area had a per capita income of $14,834 for Brunswick county and $18,931 for New Hanover County. Retail sales in the two counties was 2.4 billion dollars. The per capita income for the state is about 90 per cent of the US

The largest employment sector is manufacturing with about 12,000 workers in the 2-county (New Hanover and Brunswick Counties) region. Retail trade with about 11,000 workers and services with about 10,000 are the next largest. About 5,000 people work in transportation and public utilities, with about 800 in water transportation. Travel and tourism are very important in the regional economy, but their effect is spread over several economic sectors (construction, services, retail trade, etc.).

The 3-county region has a large resort population located along the sounds and beaches. Tourism is one of the largest economic factors in the area, along with retirement and vacation home development. Building along the beaches is beginning to slow and has a continuing problem with beach erosion. The influx of retired persons is a large component of the population and economic growth of the region.

Historic Commerce. Tonnage in Wilmington Harbor has increased 54 percent between 1983 and 1994, an average annual growth rate of 4 percent. In the period from 1981 to 1983, total tonnage in the harbor dropped, due primarily to significant reductions in petroleum products and iron ore traffic. Tonnage handled in 1987 and 1988 was almost back to 1981 levels as a result of increases in basic chemicals and petroleum products. Tonnage for 1989 fell somewhat due to decreases in petroleum products. Tonnage has steadily increased from 1990 to 1994, and has almost returned to 1980 levels. Overall, vessel movements and commodities have been reliable and mostly increasing through the years, due primarily to favorable economic conditions in the markets for local products.

Approximately 90 percent of the total commodity tonnage carried in recent years include the categories of (1) petroleum products, including asphalt; (2) industrial chemicals and fertilizer materials; (3) pulp, paper, and allied products; (4) non-metallic minerals, including gypsum, salt, and cement; and (5) iron and steel products and chrome ore. The largest tonnage of a single commodity handled in 1993 was chemicals and related products, which includes paraxylene, a feedstock for 2 local DMT plants. DMT is a raw material used in the production of polyester fibers. In that year, a total of nearly 2.8 million tons were carried, or approximately 36 percent of the total.

About 82 percent of the commerce in the harbor is deep-draft oceangoing trade. This amount is almost equally divided between foreign trade and coastwise receipts. The principal liquid bulk commodities are petroleum products, industrial chemicals, and molasses. The major dry bulk commodities are fertilizer materials, gypsum, chrome ore, salt, and building cement. The main containerized and general cargo commodities are wood pulp, tobacco, farm products, paper products, steel, lumber, DMT, furniture, textiles, machinery, and electronics. See Appendix F for more details.

4.14 Recreation and Esthetics

Wilmington Harbor has a large amount of recreational boating traffic in the area below Snows Cut and a smaller amount above there. The Atlantic Intracoastal Waterway follows the Cape Fear River channel from Fort Caswell up to Snows Cut. It carries a large amount of transient recreational boating, as well as local recreation in the vicinity of Southport. On calm summer days the area from Southport to the mouth of the river near Baldhead Island is heavily used by all types of recreational boating. The lower Cape Fear River region is very scenic, with many miles of ocean beach, historic homes and lighthouses, and large expanses of salt marsh bordering the river.

4.15 Utility Crossings, Structures and Aids to Navigation

CP&L has an existing overhead power line crossing of the Cape Fear River near the middle of the Lower Brunswick Channel . The western tower (of the overhead power cable) would be the closest utility to the area that will require blasting. The only other utilities located in the area to be dredged are down river in the Smith Island, Baldhead Shoal and Baldhead-Caswell Channels. In this area, there are 4 CP&L submarine cables that are 4 to 8' below the existing channel bottom.

Several structures are present in areas needing blasting. For example in the Fourth East Jetty and Anchorage Basin areas, structures include the North Carolina State Ports Authority, Chevron and Paktank terminals, and smaller docking facilities. Other structures in the blasting areas include US Coast Guard navigational channel markers, which are beacons and buoys.

5.00 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION

Effects including cumulative impacts of the proposed action on significant resources are described below. Dredging methods, and disposal locations are the same for Plan 1 and the **recommended plan.**

5.01 Water Quality

Surface Water Quality. Impacts of construction activities including blasting are discussed below.

o **Hydraulic Pipeline Dredge Including Rock Cutterhead Dredge** - Turbidity associated with dredging activities will be due to suspended materials that are loosened by the cutterhead but not picked up by the suction. The water quality impacts associated with the resuspension of sediment particles into the water column during a dredging operation are short-term but unavoidable. A result of the resuspension is an increase in the suspended sediment (non-filterable residue expressed as mg/l) concentration in the water column. Concentrations of suspended sediments near the cutterhead vary with sediment type, rotation rate of the cutterhead, and depth of cut. Generally, suspended sediment concentration within 200-600 feet of the cutterhead are less than 100 mg/l above background (McLellan, 1989).

Disposal of dredged material into the CDF, Eagle Island, for construction of the project will not adversely impact water quality. The discharge of effluent from diked upland disposal areas is covered under a Section 401 (P.L. 95-217) General Water Quality Certification No. 2668 issued January 21, 1992, for Nationwide Permit No.33 C.F.R. 330.5(a)(16), "Return Water From Upland Contained Disposal Areas". Written concurrence from the NCDEM will be obtained prior to construction.

The difference in impacts associated with the rock cutterhead dredge will be the disposal operation. The rock cutterhead dredge on the Ocean Bar **(Baldhead Shoal Channel)** will pump dredged material into a barge. In order to maximize the efficiency of the load, water will be allowed to overflow the barge. **The inshore reaches of Baldhead Shoal Channel has sandy sediments; however, in the offshore reaches of the channel (about 2 or more miles offshore of the inlet), the sediment contains up to about 30percent silt and clay. As indicated in Section 4.02, such sediments have been determined free of contaminates. Overflow of such sediments in the ocean environment should cause only short-term turbidity.** Environmental impacts associated with creation of the WOFES are addressed in the environmental assessment prepared for the WOFES construction (USACE, 1994).

o **Bucket and Barge Dredge** - The Wilmington District, US Army Corps of Engineers conducted a field study of bucket dredging and barge overflow at the Military Ocean Terminal, Sunny Point (MOTSU), North Carolina in 1987. The results of this study are presented in Payonk et al. (1988) and Palermo et al. (1988) and summarized in the following paragraphs.

Sediments dredged during the maintenance dredging of MOTSU were predominantly highly plastic clays with traces of sand. The bucket and barge dredging produced visible plumes of turbid water. Because of the cyclic nature of the bucket and barge operation, plumes resulting from bucket spillage and overflow formed a series of patches which, as they were advected down-current, tended to spread and merge. The plumes were not visible at distances greater than approximately

1,000 feet down-current to observers in boats.

Approximately 600 water samples were taken from set grid stations. This total sampling effort produced 4 measurements which exceeded 25 nephelometric turbidity units (NTUs), the North Carolina water quality standard for turbidity in the waters of the Cape Fear River at MOTSU. All values greater than 25 NTUs (approximately 100 mg/l suspended sediments) were from bottom (30 feet) samples and ranged from 27 to 33 NTUs (146 to 155 mg/l suspended sediments).

In addition to the above described observations made within a grid of stations in the MOTSU navigation basin, turbidity and suspended sediments concentrations "spot" samples were taken very close to the dredge and in the sediment plume. A conscious effort was made to take these samples from the sediment plume. The plume was located either by fathometer or by in situ nephelometric measurements before the sample was taken. Maximum turbidities, measured within 10 feet of the transportation barge during barge overflow, were 72 NTUs at the surface and 150 NTUs at a depth of 30 feet. Suspended sediments concentrations in the water samples with 72 and 150 NTUs were 327 mg/l and 739 mg/l, respectively. The results of plume sampling down-current from bucket and barge dredging and simultaneous dredging and overflow activities indicate that turbidity returns to near-background levels generally within 1,600 feet down-current from bucket dredging and barge overflow activities. The water quality effects of bucket and barge dredging with **overflow restricted to sandy** material should be even more restricted to the dredging site than those observed with this study.

The water quality impacts resulting from the disposal of dredged material within the Wilmington Harbor ODMDS were discussed in USEPA's final environmental impact statement for designation of the ODMDS (USEPA, 1983). According to that document, the disposal of dredged material at the Wilmington Harbor ODMDS should not significantly degrade water quality in regions adjacent to the disposal site. Water quality impacts will include minimal and short-term suspended sediments plumes and releases of soluble trace constituents. In addition, as indicated in Section 4.02, the new work material excavated by bucket and barge should be acceptable for ocean disposal. However, a Section 103 evaluation including testing of the new work material for disposal in the Wilmington ODMDS will be performed prior to construction.

o **Hopper Dredge** - Resuspended sediment results from material loosened by the action of the draghead and not picked up by the drag arm section, hopper overflow during loading, and turbulence generated by the vessel and its propwash. In the immediate vicinity of a hopper dredge working in fine grained material in Grays Harbor, Washington, the surface plume of suspended solids behind the dredge was 200 feet wide by 4,000 feet long with suspended solids concentrations reaching 891 mg/l at a distance of 100 feet behind the dredge. Suspended solids concentrations in the surface waters were less than 100 mg/l, 1000 feet astern of the dredge. The near bottom plume had a width of greater than 400 feet and a length of approximately 8,500 feet. Near bottom suspended solids concentrations remained grater than 100 mg/l at 1500 feet behind the dredge. Such suspended sediments loads should not **generally** be evident with use of a hopper dredge for this project since the hopper dredge will **primarily** be used in areas that are predominantly sand. The sandy material to be disposed in the ODMDS is excluded from testing requirements for ocean disposal. **However in the offshore reaches of the Baldhead Shoal Channel (about 2 or more miles offshore of the inlet), the sediment contains up to about 30 percent silt and clay. As indicated in Section 4.02, such sediments have been determined free of contaminates. Overflow of such sediments in the ocean environment should cause only short-term turbidity.** As indicated in the Bucket and Barge discussion, disposal of sediments in the ODMDS is discussed in USEPA (1983).

o **Blasting** - Turbidity associated with blasting activities will be caused by suspended materials that are loosened by the explosive charges. The water quality impacts associated with the resuspension of sediment particles into the water column during a blasting operation are short-term but unavoidable. Approximately **595** blasts will occur in about an **89.3**-acre area. Thus at any one time about 0.15 acres will be impacted **(89.3/595)**. Plan 1 would involve **284** blasts/**44.5** acres. Blasting will be limited to **1 to 2 times** per day, none of these blasts will be directly in a primary nursery area and blasting will be restricted to August 1 through January 31 to the maximum extent feasible, the construction window requested by the NCDMF. The District believes that turbidity will quickly dissipate in the river currents and any short-term impacts of turbidity caused by blasting are not significant. The explosives will be restricted to those products and byproducts that will not adversely impact water quality.

<u>**Groundwater**</u>. Rock dredging or blasting has the potential to affect groundwater of the area. The Castle Hayne Limestone formation at the channel bottom is already exposed to salt water. Groundwater in the area moves generally east and southeast along a regional gradient of about 8 feet per mile **for the deeper aquifers (Lautier, 1996)**. The potential for saltwater intrusion into groundwater does not exist unless a reversal of hydrologic gradient occurs due to excessive groundwater pumping. **Blasting or rock dredging will cause the upper areas of rock to** be fragmented and/or removed and some permeability increase may occur.

Preliminary results of the groundwater model were presented at an April 18, 1996, agency meeting in Wilmington, and are included in Lautier, 1996: "... dredging of the Wilmington Harbor shipping channel to the proposed depths will not produce detrimental changes to the aquifer system". Comments were received at the meeting and in follow-up written comments that will require additional modeling efforts and clarification of model performance. Additional efforts include modeling for potential impacts up to the year 2020, if practicable. These efforts and model clarifications will be included in a final report which will be fully coordinated with all concerned agencies.

Disposal of dredged material into the CDF, Eagle Island, for construction of the project will not adversely impact groundwater quality. Groundwater gradients are into the river and dredged materials have chloride contents equal to or less than those of the river at the disposal locations.

<u>**Saltwater Intrusion and Hydrology.**</u> During the course of this study, a three dimensional surface water model was developed by the Corps of Engineers Waterways Experiment Station to determine the total salinity changes for the Cape Fear River and the Northeast Cape Fear River due to the proposed project (which assumes the Channel Widening, Northeast Cape Fear River and Proposed Project are in place). Preliminary results of this model were presented to the Sponsor and Federal and State Agencies at August 22, 1995 **and April 18, 1996 meetings** in Wilmington, North Carolina. **By letter of April 9, 1996 (USACE, 1996a), we responded to comments resulting from the August 22, 1995 meeting, summarized results of additional modeling efforts (second and third efforts described below), and provided additional information on increased tidal range. A final report will be fully coordinated with all concerned agencies.**

In summary, **three basic modeling efforts were performed. The first effort was** based on the low freshwater flow of record since September 1981, when B. Everett Jordan Dam began to

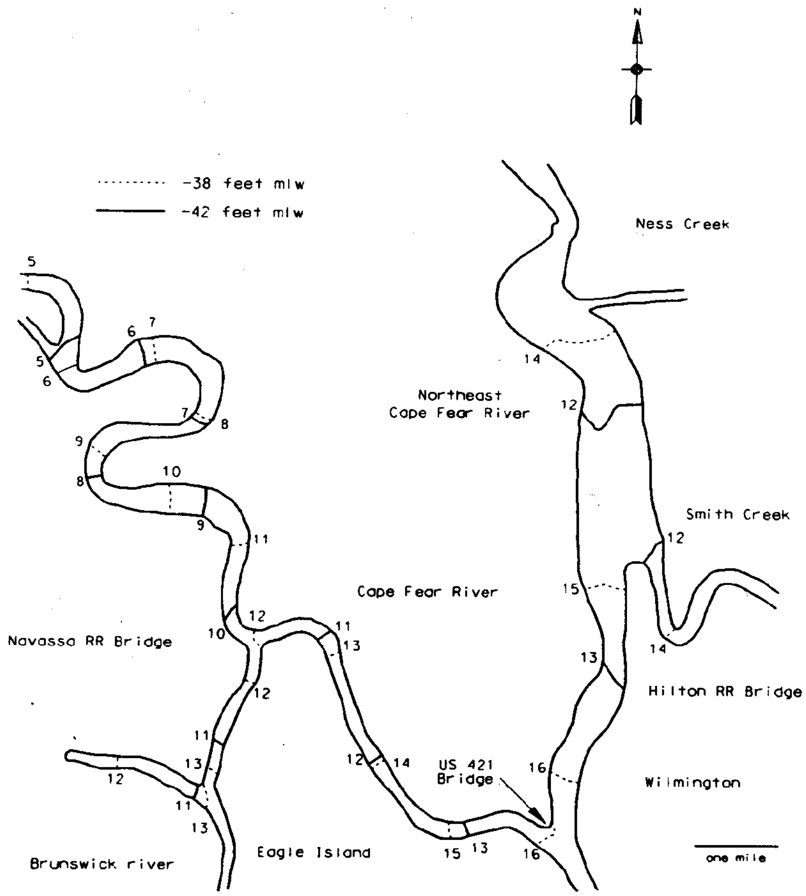

Figure 2. Upper Cape Fear River System surface isohalines for existing conditions (generally -38 feet mllw) and for 4 feet deeper conditions (generally -42 feet mllw) with low fall freshwater inflow (1,000 cfs).

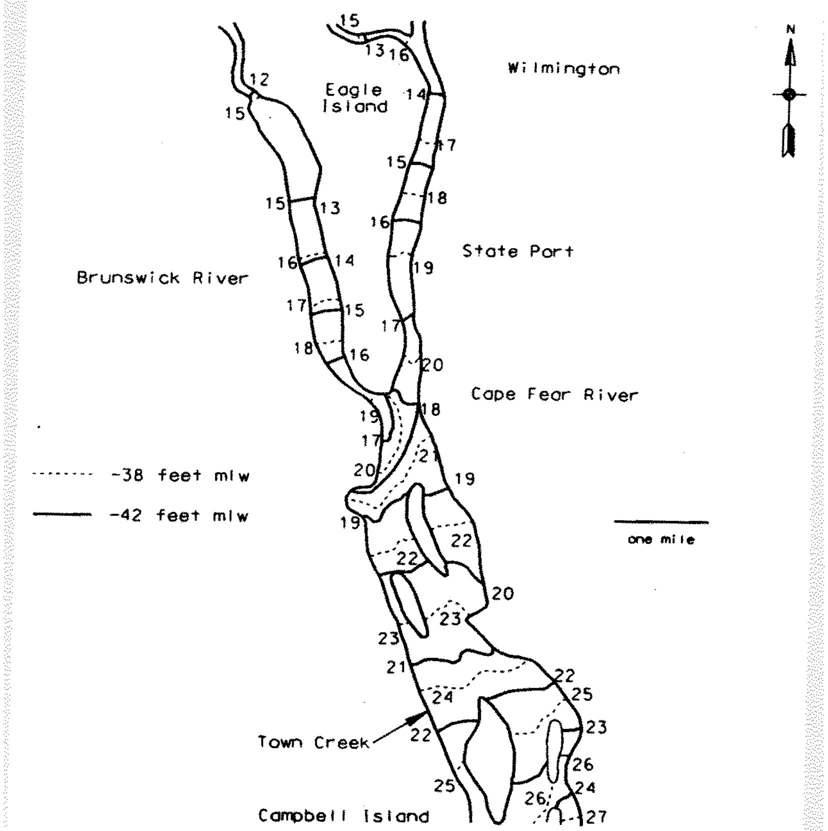

Figure 3. Lower Cape Fear River System surface isohalines for existing conditions (generally -38 feet mllw) and for 4 feet deeper conditions (generally -42 feet mllw) with low fall freshwater inflow (1,000 cfs).

regulate flows in the Upper Cape Fear River Basin. The isohalines (salinities in parts per thousand) presented in the Figures 2 and 3 are one of a series of 3-day averages predicted during the low flow period (<1000 cfs, approximately 18 days total). A low flow period was chosen since we assumed that saltwater intrusion will be maximum during such conditions (i.e., worst case). Figures 2 and 3 indicate what the model predicts the change in surface isohalines (1 part per thousand increments) will be in the vicinity of Wilmington for the existing project, generally 40 feet deep mean low water in the river (38 feet deep plus 2 feet of allowable overdepth), versus the proposed project with the harbor being deepened generally 4 feet (results were similar for Plan 1). Whether the channel bottom was assumed flat or to have the existing irregular bottom made minimal difference in the model predictions.

The second effort had similar conditions to the first except that the flows were average fall flow conditions (3,515 cfs, Figures 4 and 5). Compared to the low flow conditions, the average fall flows had the 38 and 42-foot project isohalines closer together and further downstream. From Figures 2-5, it is apparent that the proposed project should not result in salt water moving further upstream. Salinity may slightly decline under low flow conditions and be essentially unchanged under normal flow conditions.

The third effort was to determine how salinity conditions changed with historic deepening of Wilmington Harbor. Model results summarized in Figures 6 and 7 indicate that as the channel was deepened from the 32-foot depth in 1949, to 34 feet in 1958 and then to the current project depth of 38 feet in the late 1960's and early 1970's, salinity generally increased. This trend agrees with Hackney and Yelverton (1990) that indicated major changes in the salinity regime have occurred in the past and that these changes are attributable to rising sea level and to navigation improvements. However, the model indicates that deepening the harbor to 42 feet deep will slightly reduce salinities. This slight reduction in salinity is thought to result from increased mixing caused by increased tidal range and the resultant decreased salinity intrusion (USACE, 1996a).

The modeling results indicate about a 2 inch increase in the height of high tide (about a 4 inch increase in the tidal range, i.e., high and low tide about 2 inches higher and lower, respectively) in the Wilmington area, but the change decreases up and downstream (Figures 8-10). Even though the proposed action should not appreciably impact salinity movement upstream, an increase in tide height may cause some areas (e.g., wooded swamp) to become tidal that were not tidal before, and result in salt water entering such areas that routinely did not receive salt water. Increased tidal inundation, along with the associated salt content, could result in a gradual change from swamp tree species to brackish marsh along the edge of the tidal rivers and creeks. Tidal brackish marsh still has major wetland values. Accurately quantifying the areal extent of a change in vegetation would be impossible due to the variable microtopography in the swamp. For example, the best contour maps available for the Northeast Cape Fear River are in 2-foot contour intervals. Interpolation of this topography indicates that the slope in the swamp averages approximately 1':400' but varies from 1':1' at bluffs to greater than 1':2,000' in other locations. Obtaining topography in inches for all the swamps above Wilmington is not feasible.

While there may be a gradual change in the vegetation along the tidal rivers and creeks, the overall area of wetlands and waters will increase. If the average high tide increases about 2 inches (Figures 8-10), this high tide increase will cause all events that

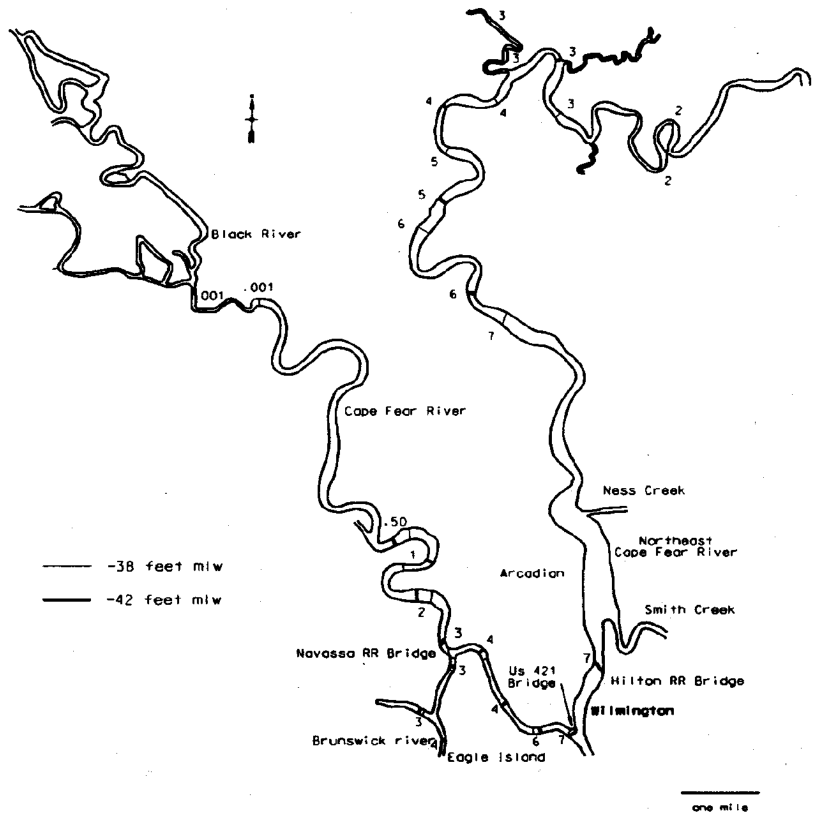

Figure 4. Upper Cape Fear River System surface isohalines for existing conditions (generally -38 feet mllw) and for 4 feet deeper conditions (generally -42 feet mllw) with average Fall freshwater inflow (3,515 cfs).

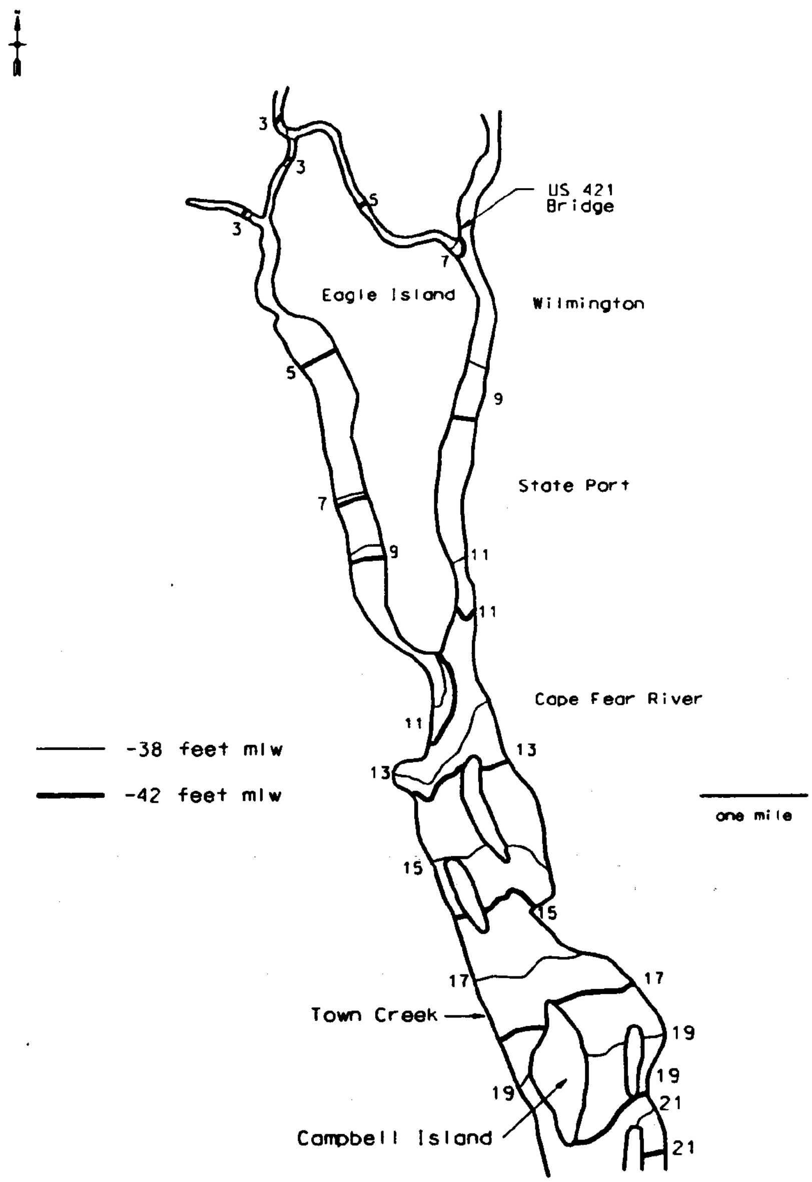

Figure 5. Lower Cape Fear River System surface isohalines for existing conditions (generally -38 feet mllw) and for 4 feet deeper conditions (generally -42 feet mllw) with average Fall freshwater inflow (3,515 cfs).

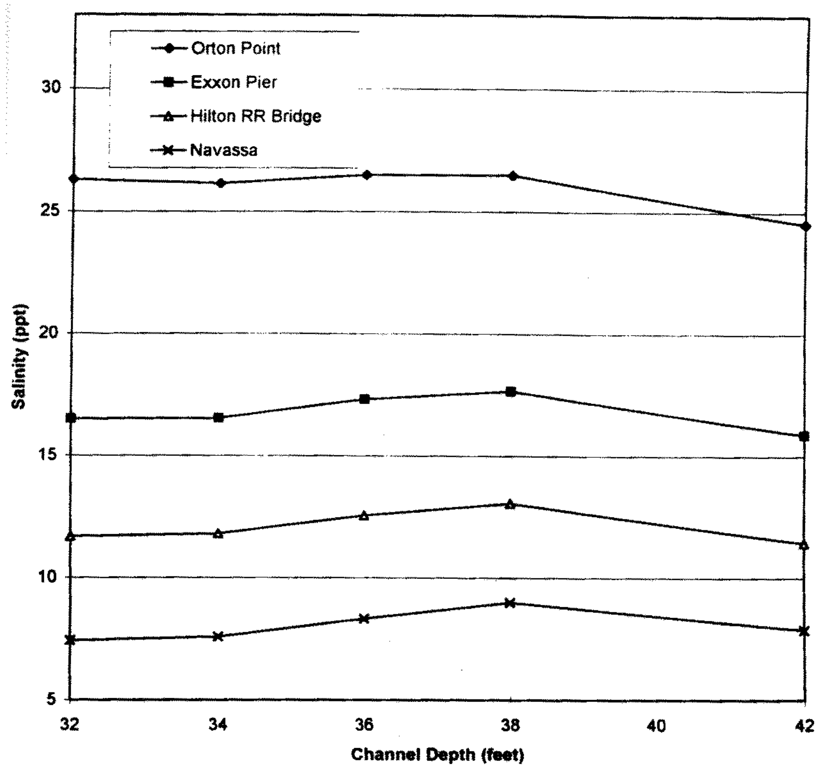

Figure 6. Cape Fear System predicted historic and future surface salinity conditions with low freshwater inflow (<1,000 cfs)

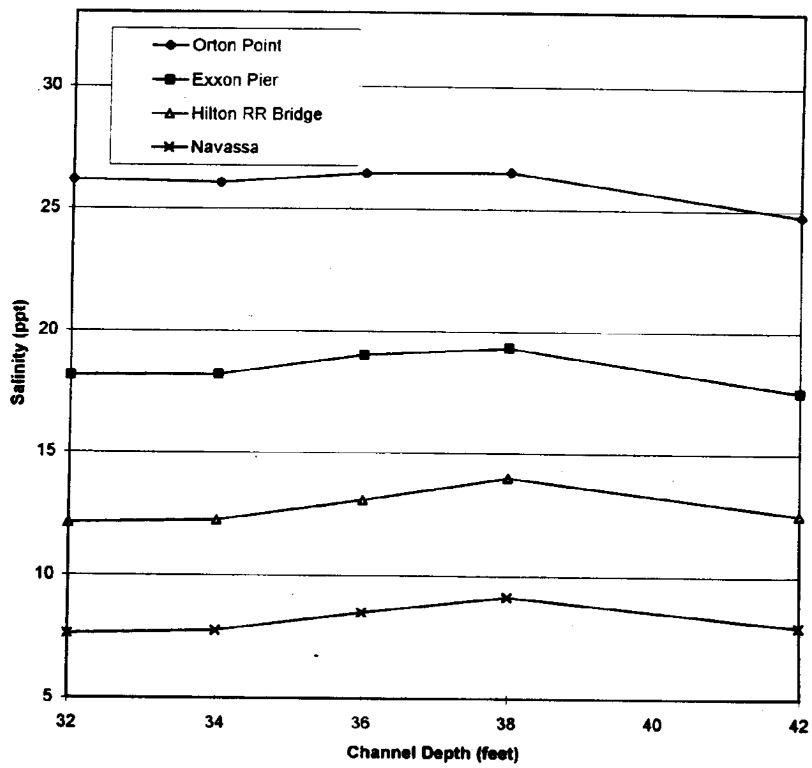

Figure 7. Cape Fear System predicted historic and future surface salinity conditions with low freshwater inflow (<1,000 cfs)

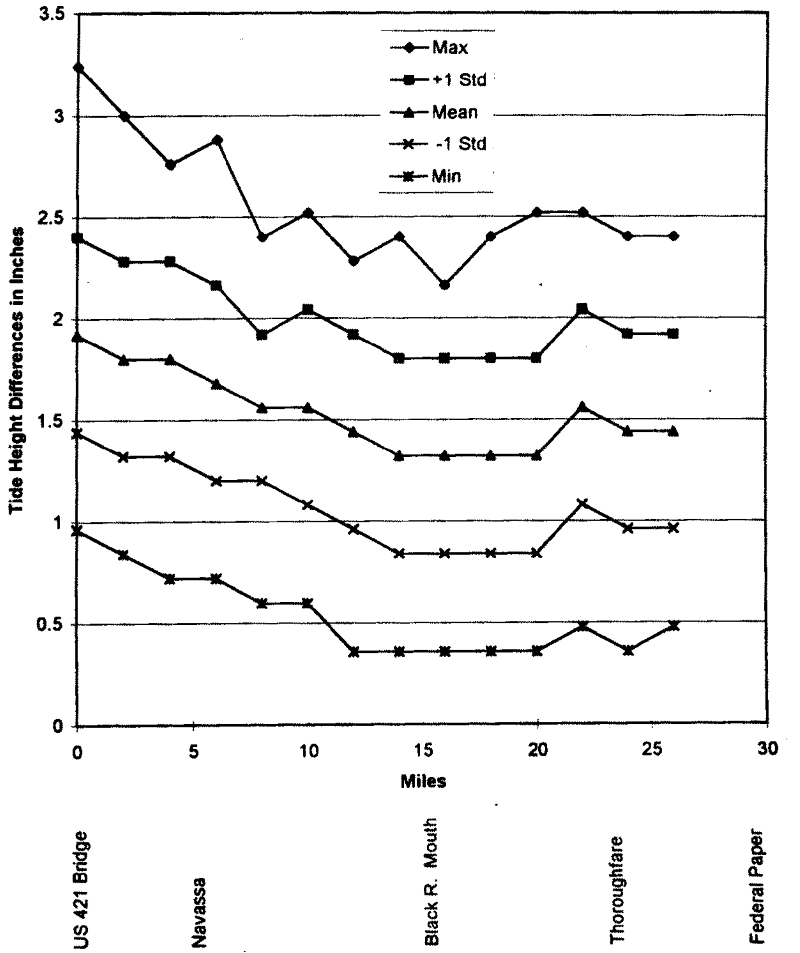

Figure 8. Upper Cape Fear System predicted high tide changes between the existing conditions (generally -38 feet mllw) and for 4 feet deeper conditions (generally -42 feet mllw).

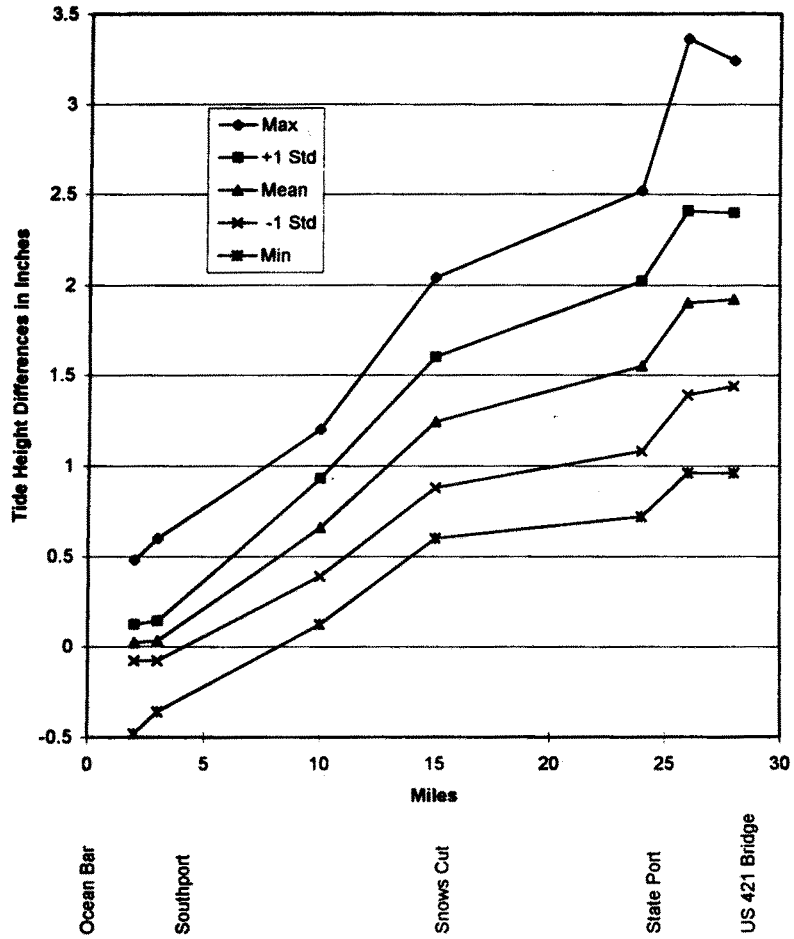

Figure 9. Lower Cape Fear System predicted high tide changes between the existing conditions (generally -38 feet mllw) and for 4 feet deeper conditions (generally -42 feet mllw).

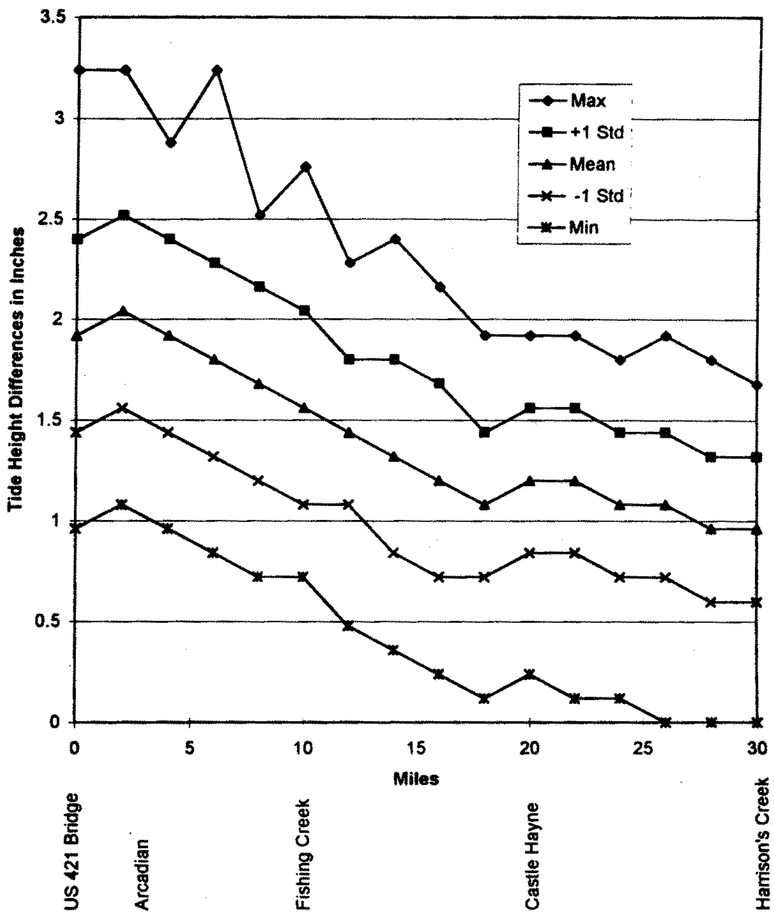

Figure 10. Northeast Cape Fear System predicted high tide changes between the existing conditions (generally -38 feet mllw) and for 4 feet deeper conditions (generally -42 feet mllw).

currently result in flooding of the swamp to have their height increased by 2 inches. This 2-inch change may result in the gradual shift upland of the wetland-upland line, thus increasing wetland acreage. Quantifying the extent of change is not feasible due to the microtopography in the swamp.

In conclusion, because changing swamp to tidal brackish marsh would result in a wetland system still having major wetland values and the overall size of waters and wetlands will be increased, the impacts on tidal river and creek wetlands due to increased tidal height are not considered significant. However, we realize there is some uncertainty in the model results. Due to the variable microtopography in the swamp, it is not feasible to determine the areal extent of changes, but we commit to a pre- and post-monitoring effort of measurable changes in the potentially affected area. This monitoring could include changes in tide levels, soil pore water chemistry and vegetation on selected plots, and other appropriate items. Details of this monitoring effort will be developed in coordination with all known interested parties. Results will also be coordinated with all known interested parties to determine if impacts different than those anticipated have occurred.

5.02 Aquatic Resources

Nekton and Benthos. Potential impacts on fish and shellfish associated with the proposed project are discussed below. Nekton are free swimming organisms.

o **Dredging Impacts** - Pipeline dredging consists of mechanical action of a rotating cutterhead to loosen bottom material and hydraulic action by a pump to transport it to the disposal area. The material transported consists of a slurry of approximately 15-20 percent solids and 80 percent water, depending on the characteristics of the bottom sediment. The suction-velocity field or entrainment field will extend over only a small area in the vicinity of the cutterhead at the river bottom.

The biological effect of hydraulic entrainment has been a subject of concern for more than a decade, and a number of studies have been conducted nationwide to assess its impact on early life stages of marine resources, including larval oysters (Carrier et al., 1986), post-larval brown shrimp (Van Dolah et al., 1994), striped bass eggs and larvae (Burton et al., 1992), juvenile salmonid fishes (Buell, 1992), and Dungeness crabs (Armstrong et al., 1982). These studies indicate that the primary organisms subject to entrainment by hydraulic dredges are bottom-oriented fishes and shellfishes. The significance of this impact depends upon the species present; the number of organisms entrained; the relationship of the number entrained to local, regional, and total population numbers; and the natural mortality rate for the various life stages of a species.

A hydraulic dredge with a discharge pipe no larger than 30 inch diameter would be capable of transporting about 40,000 cubic yards of sand per day, which would be pumped as a slurry containing about 15 percent sand by volume. The volume of water discharged would, thus, be about 226,700 cubic yards per day, or about 70 cfs. In contrast, the average daily freshwater inflow of the Cape Fear River is about 9,700 cfs. Therefore, the amount of water intercepted by the operating dredge (70 cfs divided by 9,700 cfs) is estimated to be less than 8/10ths of one percent of the daily freshwater flow in the river.

Assessment of the significance of entrainment is difficult, but it is believed that impact is minimal. Reasons for the low levels of impact include: (1) the very small volumes of water pumped by dredges relative to the total amount of water in the vicinity, thereby impacting only a small proportion of organisms, and (2) the extremely large numbers of larvae produced by most estuarine-dependent species. Since natural larval mortalities may approach 99 percent (Dew and Hecht, 1994; Cushing, 1988), entrainment by a hydraulic dredge should not pose a significant additional risk in most circumstances. Neither direct quantification studies nor modeling efforts have demonstrated population level impacts due to larval entrainment by hydraulic dredges (Memorandum dated 8 August 1995 from Douglas Clarke, PhD, Coastal Ecology Branch, Waterways Experiment Station, Corps of Engineers, DOTS Request for Assistance).

Fish and shellfish species inhabiting the Wilmington Harbor project vicinity are adapted to, and highly tolerant of, naturally elevated suspended sediment concentrations. In reviews of laboratory tests, Hirsch et al. (1978) and Stern and Stickle (1978) found marine and estuarine organisms to be very tolerant of the effects of sediment suspensions. Lethal or sublethal effects on larval or adult fish or shellfish occur after longer exposures to higher concentrations of suspended sediment than typically occur in the water column during dredging and disposal (Peddicord and McFarland, 1978; Preist, 1981). In addition, sediments that are resuspended during dredging operations will not be contaminated with toxic substances (Section 4.02).

The potential for interruption of the movement of estuarine fish and shellfish and particularly anadromous fishes to and from nursery and spawning areas in the Cape Fear estuary by the physical presence of dredging equipment or by the physical-chemical water quality alterations associated with dredging is an issue of concern. However, river currents or flows upon which larval organisms depend for transport will not be interrupted or reduced. Dredge induced water quality conditions will only be short-term and impact a small cross-sectional area of the Cape Fear River; therefore, the potential for blockage of migration routes will be minimal. Maintenance frequency should not be significantly different than what occurs now in the routine maintenance of Wilmington Harbor.

In the areas where commercial fishermen use trawlers (side slopes of the channel in the lower river), excavation will only occur in the existing channel bottom. The increased depth of 4 feet will eventually modify the slope of the existing side slopes. However, this change will occur at a gradual rate and should not adversely affect trawling.

Removal of the substrate within the recommended plan will eliminate all benthic **and much of the epibenthic** resources in the dredged or blasted areas. However, an irreversible loss of resources will not occur since those areas will be available for recolonization and use by benthic and **epibenthic** organisms after dredging or blasting. The populations that reestablish should be similar to those eliminated, since the species are substrate dependent and the sediments that create shoals in the channel and adjacent areas now will continue to do so after the proposed dredging. **As indicated in Section 4.06, many of the epibenthic resources were most abundant in frequently disturbed substrates.** Maintenance will not limit the density and diversity of the benthic community that becomes reestablished any more so than existing maintenance activities. Benthic populations in the vicinity are in a state of flux due to the continual sedimentation and shoaling which creates the need for maintenance dredging.

The Greenfield Ramshorn snail should not be impacted by the proposed action. **No dredging or blasting is proposed near Town Creek. The groundwater model results (Section 5.01) do not indicate a change in groundwater flow or level on a regional basis and no changes in groundwater conditions related Town Creek are anticipated. Also the surface**

water model results (Section 5.01) do not indicate an increase in salinity in the vicinity of Town Creek.

o **Blasting Impacts** - The preliminary blast plan developed by the Wilmington District for the project reflects industry standards for underwater blasting. This preliminary blast plan balances the two issues: the cost-effective production of rock removal and minimizing the impacts of blasting on the estuarine environment. Normal industry procedure requires that the contractor perform limited onsite blasting tests and adjust the final plan to actual site conditions, so some plan modifications may occur.

When blasting is conducted to remove the nondredgeable rock, some losses of nekton are expected to occur in the immediate vicinity of the blasts. Explosions in the estuarine environment can injure and/or kill fish, marine mammals (including manatees and bottlenose dolphins), sea turtles, and other marine life. Underwater shock waves from high-velocity explosives have been reported to result in the rupture of the swim bladder and other internal organs of fish, and damage to the lungs, intestines, and the auditory systems of marine mammals. Damage to sea turtles is thought to resemble that observed in mammals, i.e., to lungs, intestines, and auditory systems (O'Keeffe and Young, 1984).

Studies have shown that the degree of impact experienced by fish as a result of explosions is determined by several factors, including physical characteristics of the fish, the weight of the explosive charge, and the distance of the fish from the charge. Swim bladder fish have been found to be more susceptible to damage from shock waves than non-swim bladder fish (most common estuarine fish except flounders have swim bladders), and smaller fish are more susceptible to damage than larger fish of the same species (Wright, 1982). Larval fish are less sensitive to the effects of shock waves than eggs or than post-larval fish in which the swim bladder has developed (Rasmussen, 1967; as cited in Wright, 1982). The damaging effects on marine life increase in relation (but not in direct proportion) to increasing the weight of the explosive charge. The shock wave from an underwater explosion diminishes over distance at a rate proportional to the cube root of the weight of the explosive charge. Therefore, the peak pressure generated by an 8-pound charge at a specific distance is only about twice the peak pressure of a 1-pound charge at the same distance (2 is the cube root of 8). Thus, doubling the weight of an explosive charge does not double the impact to marine life (Young, 1991). Also, the further an animal is located from an explosive charge, the greater will be its chances of survival.

Mitigative measures will be employed during underwater blasting in order to reduce potential impacts to estuarine life. These measures include the stemming of the holes in which the explosive charges are placed, the use of delays between each charge, reducing the overall number of blasting events, and the construction of a bubble curtain and/or a physical barrier around the blast zone. Stemming is a procedure in which the top 1 foot, or more, of each hole containing an explosive charge is filled with crushed stone or gravel. This process partially contains the explosive force, increases the amount of work done to surrounding rock, and reduces the impact to the aquatic environment above. The use of delays effectively reduces each detonation into a series of small explosions. The resulting blast overpressure levels are directly related to the size of the charge in each delay rather than the summation of charges detonated in all holes (Munday et al., 1986). Thus, a large weight of explosive charge can be fired as a series of smaller charges with a major reduction in impacts. Reduction of the number of blasting events required to perform a job can be achieved by drilling the maximum number of holes per day and then firing them as a unit making up one blast (but including the delays mentioned above to prevent cumulative impact from the increased weight of explosive charge).

The potential use of small 'scare' charges detonated within one minute prior to each blast will be investigated. Sometimes these scare charges frighten shad and herring from the site, but sometimes such charges attract predators to the site.

Air/bubble curtains are walls of bubbles rising from a bottom resting bubbler manifold supplied with compressed air. Bubbler manifolds are typically constructed using rows of parallel pipes with small holes drilled along their length. Water currents or tides may deflect these walls of bubbles, but they remain intact and functional (Personal Communication, June 12, 1995, Mr. Thomas M. Keevin, St. Louis District Corps of Engineers). Air/bubble curtains are either required or recommended as a mitigative measure by four states (Alaska, New Jersey, Oregon, and Washington) and two Canadian provinces (Alberta and Ontario) (Keevin et al, 1995). Air bubbles in water substantially increase its compressibility, which in turn greatly reduces the peak pressure wave (Domenico, 1982a and, 1982b and Strange, 1963). A review of the existing literature indicates that air/bubble curtains may reduce the overall peak pressure wave up to 98 percent (Domenico, 1982b, Alberta's Fisheries Habitat Protection Guidelines No. 15, dated 1987, Keevin et al, 1995, and Strange, 1963). Air/bubble curtains have been used successfully to protect underwater structures from underwater explosions (Domenico, 1982a; Keevin and Hempen, unpublished data). Additionally, air/bubble curtains were used effectively during explosive demolition of Lock and Dam No. 26 on the Mississippi River. Freshwater flows in the Mississippi River averages about 300,000 to 400,000 c.f.s. compared to Cape Fear River average inflow of 9,700 c.f.s (Keevin and Hempen, unpublished data). .However, the velocities of around 3 miles per hour (mph) are similar.

Physical barriers include any solid barrier that contains or reduces the explosive pressure wave. The Connecticut Department of Environmental Protection required that the State Department of Transportation use a cofferdam system in order to use explosives to remove bridge piers and abutments in the Connecticut River. These restrictions were imposed because the endangered shortnose sturgeon resides in this river. Sonalysts Inc. (who worked with the contractor on this project) indicated that a partially dewatered double wall cofferdam was used to remove these structures within the Connecticut River (Personal communication, September 6, 1995, Mr. Stephen W. Dolat, Vice President, Acoustic Systems, Sonalysts Inc.). About 70 boreholes were drilled within the bridge pier and loaded with 1,050 pounds of explosive. Monitors indicated a maximum of 37 pounds per square inch (psi) in the water column outside of the cofferdam. No shortnose sturgeon or any commercially important fish species were impacted during this blasting activity (Personal Communication, Mr. Mike Ludwig, NMFS, September 14, 1995).

Because of the harmful impacts of blasting on estuarine life, much research has focused on the development of models to predict the lethal distances of underwater explosions. Knowledge concerning potential lethal distances is useful in assessing potential adverse impacts on estuarine life and in establishing preventive measures. Models have been developed that are based upon various methodologies, but the impulse strength model appears to be the best at predicting lethal and safe ranges under various sets of conditions and assumptions (Wright, 1982). The St. Louis District (SLD), Corps of Engineers has developed a computer mathematical model, based upon the impulse strength method, to predict the kill radius for swim bladder fish from explosions that are buried in holes drilled in a rock substrate. This model takes into account (1) the effects of different explosive charge weights, (2) the greater susceptibility of smaller fish to blast damage, (3) the constraining effects of stemming on the overall explosive impact, and (4) the impact reduction achieved by employing delays. This model was used to predict the potential impact zone associated with blasting.

Results from the SLD model (stemming the top 1 foot of holes and inserting delays after each row), using 2-ounce swim bladder fish as a worst-case example, show that the blast created by the general blast plan would kill about 50 percent of the fish at a distance of 1,610 feet (lethal distance 50 percent, or LD50) and about 1 percent of the fish at a distance of 2,780 feet (lethal distance 1 percent, or LD1). The circular areas enclosed by these two distances are 196 and 573 acres, respectively. Larger fish are more resistant to blasting impacts, and 1-pound fish would experience an LD50 of about 899 feet and an LD1 of about 1,550 feet. Fish of 12-pound size would experience an LD50 of about 446 feet and an LD1 of about 768 feet. These distances and their associated area are in Table 6.

TABLE 6
BLASTING IMPACTS ESTIMATED FOR A GENERAL UNDERWATER BLASTING PLAN
(STEMMING THE TOP 1 FOOT OF HOLES AND INSERTING DELAYS AFTER ROWS)

Fish Weight In Lbs.	LD50 Feet	Acres for LD50	LD1 Feet	Acres for LD1
0.125	1,610	196	2,780	573
1.000	899	63	1,550	181
12.000	446	17	768	47

Results from the SLD model (stemming the top 1 foot of holes and inserting delays at each hole), using 2-ounce swim bladder fish as a worst-case example, show that the blast created by the general blast plan would kill about 50 percent of the fish at a distance of 381 feet (lethal distance 50 percent, or LD50) and about 1 percent of the fish at a distance of 656 feet (lethal distance 1 percent, or LD1). The circular areas enclosed by these two distances are 12.5 and 34.5 acres, respectively. Larger fish are more resistant to blasting impacts, and 1-pound fish would experience an LD50 of about 213 feet and an LD1 of about 364 feet. Fish of 12-pound size would have an LD50 of about 105 feet and an LD1 of about 180 feet. These distances and their associated area are in Table 7.

TABLE 7
BLASTING IMPACTS ESTIMATED FOR A GENERAL UNDERWATER BLASTING PLAN
(STEMMING THE TOP 1 FOOT OF HOLES AND INSERTING A DELAY AT EACH HOLE)

Fish Weight In Lbs.	LD50 Feet	Acres for LD50	LD1 Feet	Acres for LD1
0.125	381	12.5	656	34.5
1.000	213	4.5	364	11.5
12.000	105	1.4	180	3.4

It is evident from the SLD model that stemming and inserting delays (a minimum of 25 milliseconds) on each hole reduces the size of the blast impact zone for the worst-case scenario, (i.e., LD1 for a 2-ounce swim bladder fish) by approximately 94 percent (from 573 acres to 34.5 acres). In addition to requiring the contractor to stem and insert a delay in each hole, the Wilmington District will require the contractor to construct a bubble/air curtain and/or a physical barrier around the blast zone. In this way, the blast zone impact area (LD1) for a 2-ounce swim bladder fish may be further reduced from 34.5 acres to about 0.8-acre (35,000 square feet).

Due to special concerns for the safety of endangered and threatened animals, this group is addressed separately in Section 5.07 and in the Biological Assessment (see Attachment B of this **Final** EIS). However, the observer program noted as a potential protective measure for these animals is also applicable for marine mammals (including manatees and bottlenose dolphins) in general. Such measures would include observers to detect the presence of mammals in the project area prior to blasting events. Should they be observed, blasting would be delayed. After blasting, observers would also examine the area to determine if any previously undetected mammals were killed or stunned as a result of a blast. Through implementation of such protective measures, it is believed that potential impacts can be minimized (**see Attachment C**).

Plan 1 and **the recommended plan** will require blasting of **44.5** and **89.3** acres or existing channel bottom, respectively. While the blast area is different, with the mitigation measures in place, the impacts of **the recommended plan** will not be appreciably greater than those associated with Plan 1. Therefore, blasting of rock should not result in significant adverse impacts to estuarine nekton populations whether Plan 1 or **the recommended plan** is constructed.

Larval life forms. The use of bubble curtains is justified based on the presence of threatened and endangered species and marine mammals in the harbor (Section 5.07 and Attachment B). Bubble curtains would provide additional benefits to larval life forms and primary nursery areas. The impacts to larval life forms are discussed below and impacts to primary nursery areas are discussed in Section 5.04.

The blast area within the bubble curtain and/or physical barrier would be about 35,000 square feet. For purposes of this analysis, we assumed that 25 millisecond delays are placed in the 80 production holes that make up one frame to be blasted during 1 day. The daily blast would take 2.0 seconds (80 times 0.025 seconds). There are 86,400 seconds per day (24 hours times 60 minutes times 60 seconds). The worst-case of **two blasts per day would take up less than 0.00462 percent (less than 5 one-thousandths of 1 percent) of the day.**

The volume of water within the 35,000-square-foot blast area is about 1,330,000 cubic feet (35,000 square feet times 38 feet depth) or about 38,000 cubic meters of water. If the daily mean density is 1,902 larvae per 1,000 cubic meters of water (CP&L, 1994), about 73,000 larvae (38 times 1,902) may be found within the blast area at any given time.

Within the ship channel, one would calculate the number of larvae within the ship channel by multiplying the distance (about 27 miles from the Memorial Bridge to the Ocean Bar) times the width (400 feet) times the depth (38 feet), divide this result by 35.3 to convert cubic feet to cubic meters and finally multiple by 1,902/1000 cubic meters (CP&L, 1994). This yields a daily mean density of larvae in the ship channel of about 116,755,429. This number only reflects the number of larvae in the 400-foot wide ship channel, not the number of larvae in the entire Cape Fear River estuary, a body of water which, at points, is several miles wide.

Comparing these numbers (i.e., the number of larvae in the blast area to the ship channel), about 0.06 percent (6 one-hundredths of 1 percent) of the larvae in the ship channel will be affected by one blast. If the 35,000-square-foot blast area was multiplied by a factor of 10 (i.e., approximately 8 acres within the blast area), only 0.6 percent (six-tenths of 1 percent) of the larvae in the ship channel will be affected.

Each blast (whether a total of **284** or **595** for Plan 1 and **the recommended plan**, respectively), will cause mortality to larval fish. However, the impact of the necessary blasting on recruiting larvae is not significant because the mean density of larvae in the Cape Fear River is 1902/1000 cubic meters (CP&L, 1994) daily. This means that the density of the above larvae in the blast area is only 0.06 percent (6 one-hundredths of 1 percent) of the larval density in the ship channel altogether on any given day throughout the year.

The contractor will be required to monitor the reduction in the pressure wave for each blast and report the results of each blast to the Corps of Engineers to assure that 95 percent or greater reduction is met. When the potential loss of recruiting larvae is measured against the entire estuary, the given protective measures are in place, and that blasting will be restricted to the window (August 1 to January 31) recommended by the NCDMF, impacts on recruiting larval are not considered significant. Therefore monitoring the impacts on recruiting larvae is not needed.

Benthos. Marine invertebrates, including clams, oysters, and crabs have been found to be highly resistant to explosive shock (Gaspin, 1975; Gaspin et al., 1976; as cited in O'Keefe and Young, 1984). Experimental studies have shown that many types of bottom-dwelling invertebrates such as sea anemones, polychaete worms, isopods, and amphipods exhibit no damage from blasting (Gaspin, 1975; Gaspin et al., 1976; as cited in O'Keefe and Young, 1984). Due to the very high resistance of benthic animals to blast impacts, any damage sustained by these populations should be negligible outside the immediate blast vicinity.

Impacts to benthos within the project area will be the same whether or not blasting takes place. The estuarine bottom will be removed either by dredging (bucket and barge and/or hydraulic pipeline) or by blasting the nondredgeable rock.

Plankton. The primary potential impacts of dredging activities on phytoplankton and zooplankton are the increase in suspended sediment concentrations and turbidity and entrainment of organisms by pipeline dredges. Because of tidal currents, turbidity and suspended sediment caused by dredging will essentially be confined to the navigation channel down current of the dredge and will dissipate generally within 1,600 feet of the dredge (Payonk et al., 1988, Palermo et al., 1988, and McLellan, 1989). Effluent from diked disposal areas will be returned to the vicinity of the navigation channel and the turbidity from all diked disposal sites should be minimal since the effluent is controlled by adjustable spillways.

Phytoplankton are concentrated near the surface and zooplankton (depending on species) are scattered throughout the water column and both are found in and out of the ship channel. Therefore, removal of these organisms by the dredges is not deemed significant.

Blasting impacts on plankton will not be significant because of the relatively small area (about 35,000 square feet) that will be impacted versus the total area (19,400 acres, CP&L, 1980) within the Cape Fear River, downstream of the Memorial Bridge. Moreover, as indicated previously in this Section, underwater shock waves from high-velocity explosives result in the rupture of the swim bladder and other internal organs of fish, and damage to the lungs, intestines, and the auditory systems of marine mammals. Plankton are without air bladders or other organs which may rupture.

5.03 Terrestrial Resources

Blasting. Blasting will be located in the immediate vicinity of two highway bridges and one railroad bridge. Protective measures such as bubble curtains will be used to minimize potential impacts on these structures. Temporary traffic stoppages will be necessary for safety reasons. Seismic sensors and air blast monitors will be placed in a circumference around the blast area. The Contractor's blasting specialist will help in establishing the exact locations. The contract specifications will state allowable maximum seismic energy and maximum air blast energy. If blasting is very near submerged utility lines, then the utility lines will require special protection. The amount and kind of protection will be determined on a case-by-case basis. Impacts of blast vibrations will also be minimized to preclude other possible problems such as subsidence of unconsolidated fill.

Flora. As a result of dredged material deposition, Eagle Island can be expected to continue mixed early successional stage plant communities within diked areas. **Site 18 is currently wooded.** With disposal of dredged material, both Eagle Island **and Site 18** will probably be dominated by common reed, a hardy competitor which dominates the interiors of the diked disposal areas in the region today. Eagle Island is also to be used in conjunction with the long-term maintenance of Wilmington Harbor and the impacts associated with its use are described in detail in the Final EIS (USACE, 1989).

The impacts of dredge pipeline laid across marsh or other vegetation to reach the disposal area should be short-term and minor. The vegetation should quickly recover following pipeline removal.

When dikes are constructed or rebuilt, heavy equipment such as bulldozers, backhoes, and draglines are used. Eagle Island has upland access; therefore, temporary earth loading and unloading ramps from barges will not be needed to get the heavy equipment to the sites. Depending on the mitigation site chosen, access to islands by barges may be necessary. The impacts associated with this can not be assessed until the site is selected, but impacts will be minimized to the maximum extent feasible.

Fauna. Eagle Island **and site 18** are also to be used in conjunction with the long-term maintenance of Wilmington Harbor and the impacts associated with their use are described in detail in the Final EIS (USACE, 1989). The impacts associated with construction of the mitigation site can not be assessed until the site is selected, but impacts will be minimized to the maximum extent feasible. The site selected will probably be an island formally used for the disposal of dredged material and will have minimal habitat value (Attachment D).

Dredged material disposal sites which receive a high percentage of fine materials (silts and clays), have the potential to become ideal mosquito breeding habitat. As it dries and compacts, dredged material will form a network of cracks, extending from the surface down to a depth of nearly 1 foot. The sides of these cracks are used as attachment sites for mosquito eggs. In the past, there have been several instances of nuisance mosquito outbreaks from the Eagle Island disposal area located directly across the river from the City of Wilmington.

Management recommendations for mosquito surveillance and control on Eagle Island was prepared by Brunswick and New Hanover Counties, the State of North Carolina, and the Corps of Engineers (USACE, 1996b). Negotiations are continuing, but the recommendations include surveillance, surface water management, and chemical and biological control measures. **In a January 26, 1996 meeting, the Eagle Island Mosquito Control Work Group agreed to implement the management recommendations for the Eagle Island Confined Disposal Facility, Mosquito Surveillance and Control, in Brunswick and New Hanover Counties, prepared by Brunswick and New Hanover Counties, the State of North Carolina, and the Corps of Engineers (USACE, 1996b). The USACE will abide by these recommendations.**

5.04 Primary Nursery Areas

Impacts to primary nursery areas have been minimized to the maximum extent possible. Blasting has been designed to minimize impacts on primary nursery areas (occur only from August 1 to January 31, stemming and inserting single delays per hole, and the placement of an air/bubble curtain and/or a physical barrier), and no disposal for any Plan is to occur anywhere in estuarine waters. South of the mouth of the Brunswick River (Upper Brunswick Channel downstream), the primary nursery area does not come within 300 yards of the **centerline** of the main shipping channel. Considering the 400-foot width of the channel and widths of some of the wideners proposed under the Channel Widening project, from Upper Brunswick Channel downstream no dredging (including year round dredging with bucket and barge) or blasting is to occur within about 100 yards of a primary nursery area.

From the mouth of the Brunswick River to the Memorial Bridge, blasting will occur contiguous to primary nursery areas, but protective measures as indicated above will be used. Also north of the Brunswick River 13.2 acres of primary nursery area will be dredged to a depth greater than 10 feet **under the recommended plan**. For Plan 1, 11.2 acres of primary nursery area will be excavated. The loss of primary nursery area will be mitigated as indicated in Attachment D and Section 5.06. Therefore, the impacts to primary nursery areas between Plan 1 and **the recommended plan** are not considered significant.

5.05 Wetlands and Flood Plains

The proposed action will eliminate about 0.13 acres of mixed tidal marsh due to deepening work at the Forth East Jetty Channel. This marsh will not be dredged directly, but will be lost if the side slopes of the deepened channel reestablish at a 3:1 ratio. For Plan 1, 0.9 acres of similar tidal marsh will be eliminated. The loss of tidal marsh will be mitigated as indicated in Attachment D and Section 5.06. Therefore, the impacts to tidal marsh between Plan 1 and **the recommended plan** are not considered significant. The proposed action conforms to State and local flood plain protection standards.

Erosion of shorelines and marsh should not increase due to the proposed project. **For vessels whose submerged cross section does not block a large portion of the channel cross section such as tugs or pleasure craft, the waves produced will slightly decrease. The change in wave height generated by a ship doing 10 knots in 38 feet of water would decease 0.02 feet if the water depth were increased to 42 feet (Das, 1969). For larger vessels which block a large portion of the channel cross section, the generated waves would slightly increase. The increase in wave height would be 0.06 feet or about 1 percent change in wave**

height for a ship doing 10 knots with an increase in ship draft from 35 to 39 feet (Camfield, 1980).

Also, the number of vessel trips will probably not increase appreciably. With the deeper draft project constructed, vessels will not be light-loaded and thus will carry more tonnage per vessel trip. Therefore, the number of vessels calling on Wilmington will not be greater to transport the same or a reasonable increase in tonnage.

The vessel speeds are also not expected to increase. Since the under the hull clearance will remain about the same, for safety reasons vessel speeds are not anticipated to increase as a result of the proposed project.

5.06 Mitigation

Attachment D indicates the details of the proposed mitigation **options** for the loss of shallow primary nursery habitat and tidal marsh **(approximately 13.4 acres total habitat loss). One option for the habitat loss is the restoration** of about 27 acres (2:1 ratio) of marsh/shallow estuarine habitat (about 24 acres restored for Plan 1). Seven upland sites (totaling about 166 acres) located in the general vicinity of the project are under consideration for habitat restoration. All of these areas are river islands or upland areas that occur in tidal wetlands located adjacent to designated primary nursery. It is expected that equally suitable replacement habitat could be restored on any of these sites. Because of the land disturbing activities on these sites, the plans and specs will be reviewed by the North Carolina Land Quality Section in accordance with the Memorandum of Agreement (MOA) between the Corps of Engineers and the North Carolina Sediment and Erosion Control Commission.

Another option is a combination of restoration and prevention of degradation of existing primary nursery areas. This option is also discussed in Attachment D. All options will fully mitigate for the 13.4 acres of habitat loss. These options were coordinated with interested agencies during a meeting on April 18, 1996. Those agency representatives that commented orally and/or in writing favored a combination of restoration and prevention of degradation. The mitigation plan will be finalized during Preconstruction Engineering and Design Studies (PED).

5.07 Threatened and Endangered Species

Under Section 7 of the Endangered Species Act of 1973, as amended, a biological assessment (BA) of the effects of the construction and maintenance of Cape Fear-Northeast Cape Fear Rivers Feasibility Study was prepared on those species listed in Section 4.11. This assessment was provided to the USFWS and the NMFS and the BA is included in Attachment B of this EIS. Evaluations of the potential effects of the proposed action on these species and their habitats are included in the BA. **The USFWS in their May 17, 1996 draft biological opinion (BO, Attachment B) indicates that "no incidental take of manatees is anticipated to occur as a result of blasting or collisions with dredges or project related vessels". The BO from NMFS was not been received in time to be printed with this EIS. Coordination is continuing with NMFS and the BO will be available prior to preparation of the Record or Decision (ROD).**

Since blasting will be required and a hopper dredge will be used, the BA indicates that the following species may be affected: West Indian manatee, sea turtles, and shortnose sturgeon.

Required coordination on this project will be completed prior to the initiation of the proposed construction. In order to assure that endangered and/or threatened species will not be adversely affected by rock blasting, any protective agreements reached through this coordination will be incorporated into the contract for the proposed work.

At this time we believe that pre-blast monitoring, the use of bubble curtains or physical barriers, and seasonal restrictions will be the most effective measures to minimize potential impacts to listed species. Anticipated protective measures will include, at a minimum:

- A pre- and post blast monitoring program will implemented for the project (Attachment C). Pre-blast monitoring will include, at a minimum, deployment of NMFS-approved observers to assure that no sea turtles, marine mammals (primarily manatees and bottlenose dolphins) are present in the vicinity of any blast. In addition, gillnet surveys will be performed in order to remove shortnose sturgeons from the impact area. Any captured shortnose sturgeon will be relocated to a holding area well removed from the blast site. Should listed species be observed, blasting will be delayed. After blasting, observers will also examine the area to determine if incidental take of any listed species resulted from a blast.

- Stemming each hole, a delay per hole, and a bubble curtain and/or a physical barrier will be placed completely around the blast area (about 35,000 square feet).

- Hydraulic pipeline dredging (during construction and maintenance) and blasting will be conducted during the NCDMF dredging window (August 1 through January 31) to the maximum extent practicable.

- Hopper Dredging activities will comply with the turtle deflecting draghead and whale protective measures.

- In order to determine the potential taking of shortnose sturgeon and other species by bucket and barge operations, observers will be on board the bucket and barge during for the first full year of construction. To the maximum extent feasible, the observers will record all species captured along with length and weight and any unusual circumstances which might have led to the species capture.

- If a manatee is observed within 100 yards of dredging operations, all operations will cease until the manatee has left the area. Any observations of or injuries to manatees will be reported to the USFWS.

Through implementation of such protective measures, it is believed that potential impacts to listed species can be minimized.

5.08 Cultural Resources

In order to evaluate the effects of the proposed project on underwater shipwreck sites located adjacent to the channels and basins, a cooperative remote survey and diver investigation was undertaken by the North Carolina Division of Archives and History and the US Army Corps of

Engineers, Wilmington District. Remote sensing and diver investigations indicate that none of the known or newly discovered shipwreck sites are sufficiently close to navigation channels to require evaluation during construction of the proposed project.

However, a review of the past dredging history of the various ranges of the river indicated that portions of the Lower Swash, Battery Island, Southport, Baldhead-Caswell, and Smith Island ranges near the river's mouth have never been dredged and thus may contain significant, undisturbed cultural resources. Therefore, a magnetometer survey will be conducted of those ranges and any targets located during the survey will be investigated and evaluated during Preconstruction Engineering and Design Studies (PED).

5.09 Socioeconomic Resources

Benefits from Wilmington Harbor to the national and regional economy are substantial and reach well beyond the immediate vicinity of Wilmington. Personal income resulting from the commerce through Wilmington Harbor totaled about 2.4 billion dollars in 1994. This trade provided jobs for about 96,000 workers. Each 1,000 tons of cargo moved across Wilmington's docks in 1994 generated about $306,000 in income and an estimated 12 jobs. This income and employment will be helped by deepening the harbor to 42 feet.

As indicated in Section 3.06, benefits which will accrue from the deepening of Wilmington Harbor include reductions in light loading of vessels and vessel delays. Shippers will also be able to use larger, more efficient vessels. The total project costs for **the recommended plan are $228,435,000**, average annual costs are **$19,799,000**, and average annual benefits are **$24,663,000**. The benefit-cost ratio is **1.25 ($24,663,000/$19,799,000)**. See Appendix E and F for details.

5.10 Recreation and Esthetics

The proposed action is not expected to have a significant impact on recreational resources in the river or ocean. Hunting activities on the river may be temporarily disrupted during the winter. The presence of dredges and barges in the river should not impact esthetics or recreation. Such activity has taken place in the harbor for decades. Esthetic impacts will be affected by elevated turbidities due to dredging and blasting, but turbidity levels will return to background readings shortly after cessation of activities. **Blasting** will temporarily disrupt recreation use of the river. **For blasting, the contractor will be required to adopt safety procedures in consultation with the US Coast Guard.**

5.11 Cumulative Impacts

Cumulative impacts of the proposed action and other scheduled navigation improvements (Section 3.01) evaluated herein include potential increases in saltwater intrusion, deepening of primary nursery area, elimination of tidal marsh, and blasting. **Additional modeling efforts presented in Section 5.01 indicate that saltwater intrusion into the surface or groundwater should not be a problem. However, because of the uncertainties in the model results and predicted increase in tidal range, a monitoring plan will be developed.** The change in primary nursery area and loss of marsh will be adequately mitigated (Section 5.06) for this project and all other proposed projects. **Blasting to remove nondredgeable rock for the proposed project and**

other scheduled navigation improvements, should not result in significant cumulative impacts since the following mitigative measures will be in place: each hole stemmed, delays inserted in each hole, and a bubble curtain and/or physical barrier surrounding the blast area (bubble curtains/physical barriers were not a part of the original Northeast Cape Fear River plan, but are being evaluated for that project). Additionally, the blast monitoring plan discussed in Attachment C will be initiated.

It is unlikely that the project will be deepened greater than that indicated for the proposed project. The sponsor has only requested the proposed depth, and a deeper project is extremely expensive (Appendix E). In addition, most of the class of vessels that call at Wilmington Harbor are designed to pass through the Panama Canal. The controlling depth in the Canal is 39.5 feet. With the proposed project in place, ships with a draft of 39.5 feet can traverse Wilmington Harbor due to adequate safety clearances provided by the additional depth. Dredging the harbor deeper will not provide a pronounced advantage. Also **fully-loaded** ships will not appreciably increase shoreline erosion **(Section 5.05)**.

5.12 Consistency Determination for North Carolina Coastal Management Program

The proposed action is consistent with the Coastal Management Program of the State of North Carolina. The following information supports the consistency determination:

1. Areas of Environmental Concern (AEC's)

a. Estuarine System - The proposed project will not have significant adverse effects on estuarine waters. **During blasting,** only 35,000 square feet out of 19,400 acres of total estuarine bottom will be impacted by **an individual blast**. About **89.3** acres of estuarine bottom will be effected by the blasting of nondredgeable rock, but acreage of river bottom will have been removed by dredging (bucket and barge and\or hydraulic dredge) even if no blasting occurs. Blasting has been designed to minimize impacts (stemming, inserting delays, and the placement of an air/bubble curtain and/or a physical barrier) on nursery areas. Also, the excavation of marsh and deepening of primary nursery area to less than 10 feet **mllw will be mitigated** (Section 5.06).

b. Public Trust Areas - The proposed project will not have any significant adverse effects on the biological and physical functions of the estuary. **During blasting**, each hole will be stemmed and a delay will be inserted. An air/bubble curtain and/or physical barrier will be placed completely around the 35,000-square-foot blast area. **Moreover, blasting will be conducted** within the NCDMF recommended dredging window (August 1 through January 31) **whenever possible**, and will have the blast monitoring plan in place.

c. Ocean Hazard System - The proposed project will not have any significant adverse effects on ocean beaches, primary dunes, or frontal dunes.

2. Land Use Plans - The proposed action is consistent with local land use plans.

3. Disposal of dredged material within the Wilmington ODMDS will occur outside the territorial seas and a S' ·te Section 401 (P.L. 95-217) Water Quality Certification is not required. For the upland diked disposal areas to be used for the proposed action, a Section 401 (P.L. 95-217) General Water Quality Certification No. 2668 was issued January 21, 1992, for Nationwide Permit No. 16, 33 CFR 330 **Appendix A**, "Return Water From Upland Contained Disposal Areas". Written

concurrence from the NCDEM will be obtained prior to construction.

4. **Deployment** of rock at the WOFES **will** be a beneficial use and **will** support and **enhance the fishery habitat values** of the site. Appropriate interagency coordination will be accomplished prior to the transportation and deployment of rock to at this site.

5. **Beneficial uses of sandy dredged material will be considered as indicated in Section 3.07.**

5.13 Environmental Commitments

The following list is a summary of environmental commitments related to the construction and maintenance of the proposed project. These commitments address agreements with agencies and construction practices.

1. **During blasting**, the Corps of Engineers will **stem each** hole, insert a delay in **each hole**, and **place** a bubble curtain and/or physical barrier around the blast area. We agree to work with the USFWS, NMFS, and NCDMF toward the development of a pre- and post blast monitoring plan **(Attachment C)** during the preparation of plans and specifications for the proposed work. **This plan will incorporate endangered and threatened species commitments indicated in Attachment B. Normal industry procedure requires that the contractor perform limited onsite blasting tests and adjust the final (blasting) plan to actual site conditions. During the limited onsite blasting tests, the effectiveness of the bubble curtain and/or physical barrier will be tested. As indicated in Section** 5.02 **and Attachment C, the contractor will be required to reduce the pressure wave created by the blast by ≥95 percent. The monitoring could be done by setting up a series of hydrophones within and without the blast area to measure the effectiveness of the bubble curtain and/or physical barrier. An appropirate pre-blast monitoring area will be coordinated with all concerned agencies; however, with the use of bubble curtains that must contain ≥95 percent of the pressure wave, the area of impact should be much smaller than that indicated in Table 7 of the EIS (34.5, acres, 656-foot radius) for LD 1 percent (0.125 pound fish). If there is no take of listed species or other significant resources within the first series of blasts (e.g., 30), we propose to reduce the monitoring zone to the immediate vicinity of the bubble curtains (e.g,. 300-foot radius from the bubble curtain).**

2. Appropriate erosion and sedimentation control measures will be applied during construction. The plans and specifications will be reviewed by the North Carolina Division of Land Resources, Land Quality Section in accordance with the MOA between the Corps and the North Carolina Sediment and Erosion Control Commission.

3. **The District will work with the State or North Carolina and the Waterways Experiment Station to finalize the groundwater and surface water model reports. The reports will be fully coordinated with all interested parties.**

4. Dredging and blasting during construction and maintenance will be conducted during the NCDMF dredging window (August 1 - January 31), except for bucket and barge **and hopper** dredging, whenever feasible. **Hopper dredging activities will comply with the turtle deflecting draghead and whale protective measures. In order to determine the potential taking of shortnose sturgeon and other species by bucket and barge operations, observers will be on**

board the bucket and barge during the first full year of construction. To the maximum extent feasible, the observers will record all species captured along with length and weight and any unusual circumstances that might have led to the species capture. If a manatee is observed within 100 yards of dredging operations, all operations will cease until the manatee has left the area. Any observations of or injuries to manatees will be reported to the USFWS.

5. Diked disposal areas will be monitored and treated for mosquitoes as appropriate.

6. The Wilmington District will continue to support efforts to manage waterbird nesting sites in the lower Cape Fear River in all future projects and maintenance activities.

7. Significant adverse impacts will be mitigated as indicated in Section 5.06 and Attachment D.

8. A pre- and post-monitoring effort will be conducted in areas potentially affected by increased tidal range and associated saline waters. This monitoring could include changes in tide levels, soil pore water chemistry and vegetation on selected plots, and other appropriate items. Details of this monitoring effort will be developed in coordination with all known interested parties. Results will also be coordinated with all known interested parties to determine if impacts different than those anticipated have occurred.

5.14 Unavoidable Effects and Commitment of Resources

The proposed action is not expected to result in significant irreversible and irretrievable commitments of resources. The endangered shortnose sturgeon, sea turtles, and the West Indian manatee may be affected by blasting. Additionally, larval life forms, marine mammals, and anadromous fish migrations may also be impacted by blasting. These impacts have been minimized to the extent possible and these actions should not significantly impact the long-term productivity of the Cape Fear River estuary.

5.15 Other Environmental Effects (Section 122)

Section 122 of the River and Harbor Act of 1970 (P.L. 91-611) lists several factors to be considered in an EIS. Most of these factors are discussed in the EIS. The following listed factors will not be significantly affected by the proposed action: noise pollution, man-made resources, community cohesion, public facilities and services, or displacement of people, businesses, or farms.

5.16 Hazardous and Toxic Wastes Associated with Proposed Action

The dredged material for ocean disposal have been previously evaluated **for contaminants** (Ward et al, 1993). These site specific test results indicate that the maintenance sediments meet the testing criteria of the EPA Ocean Dumping Regulations and Criteria and are, therefore, **not considered contaminated and are** acceptable for transportation for ocean dumping under Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972, as amended. USEPA, Region IV, concurred with this determination by letter dated December 21, 1993. Based on these results, the new work material should also be acceptable for ocean disposal. The dredged material to be placed in CDF's was evaluated using Section 404(b)(1) guidelines (40 CFR 230) which implement environmental protection provisions of the Clean Water Act. These evaluations consider potential contaminants and potential migration pathways of contaminants to the environment when evaluating dredging and dredged material disposal alternatives. The Ocean Dumping Regulations and Section 404(b)(1) guidelines result in an equivalent level of environmental protection as will occur under a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or Resource Conservation and Recovery Act (RCRA) investigation. Based on appropriate dredged material evaluations, there is no reason to believe that the material within the Wilmington Harbor project is contaminated. There is no reason to believe that contaminants will be mobilized in the environment as a result of the dredging, blasting and dredged material disposal.

5.17 Air Pollution

Even if traffic volumes increase as a result of the project, there should be no significant impacts to air quality. Temporary increases in exhaust emissions from construction equipment are expected during the construction period (about 3 years). The project is in compliance with Section 176 (c) of the Clean Air Act, as amended. Air quality in New Hanover and Brunswick Counties, North Carolina is designated as an attainment area (North Carolina Department of Environment, Health and Natural Resources [NCDEHNR]). The State of North Carolina does have a State Implementation Plan ("SIP") approved or promulgated under Section 110 of the CAA. However, for the following reasons, a conformity determination is not required:

a. Section 93.153 (b) states, "For Federal actions not covered by paragraph (a) of this section, a conformity determination is required for each pollutant where the total of direct and indirect emissions in a nonattainment or maintenance area (emphasis added by the writer) caused by a Federal action would equal or exceed any of the rates in paragraphs (b)(1) or (2) of this section." However since both New Hanover and Brunswick Counties have been designated by the State of North Carolina as an attainment area, a conformity determination is not required.

b. The direct and indirect emissions from the project fall below the prescribed de minimus levels (58 Fed. Reg. 93.153(c)(1)) and, therefore, no conformity determination will be required. Construction at the project site will take approximately 3 years, but will not be continuous (i.e., 7 days a week, 24 hours a day). Even though the initial emissions may be slightly higher because of construction activities, after the project is completed, the direct and indirect emissions should be lower since the project will increase navigational efficiency.

c. The project is located within the jurisdiction for air quality of the Wilmington Regional Office of the NCDEHNR. The ambient air quality for New Hanover and Brunswick Counties has been determined to be in compliance with the National Ambient Air Quality Standards. It is not anticipated that this project will create any adverse effect on the air quality of this attainment area.

5.18 Utility Crossings, Structures, and Aids to Navigation

A preliminary analysis indicates that no utilities or structures will be impacted by the proposed blasting. As indicated above, the top 1 foot, or more, of each hole will be filled with crushed stone or gravel, a procedure known as stemming. Also, a firing delay of at least 25 milliseconds will be required for each hole. An air/bubble curtain and /or a physical barrier will be placed completely around the blast area (about 35,000 square feet). All these measures should help prevent structural impacts. If blasting causes damage to any aids to navigation (i.e., existing beacons, electronic components in the lighted buoys or their hulls), we will work with the US Coast Guard to move, repair, and/or replace these existing navigational markers.

The 4 existing submarine cables near the mouth of the river that are owned by CP&L (Section 4.15) will be impacted by dredging the channel deeper. Therefore, these lines will be replaced as a part of the proposed action, but only two new lines will be required.

6.00 LIST OF PREPARERS

The following Corps of Engineers personnel were primarily responsible for preparing the DEIS:

Name	Discipline/ Expertise	Experience	Role in Preparin ı EIS
Coleman Long	Environmental Impact Assessment	4 years Chief, Environmental Resources Section; 4 years Assistant Chief, Environmental Resources Branch 6-1/2 years, Chief, Environmental Analysis Section; 4 years Environmental Resources Branch; 2 years Master Planning	Supervision
Beverly McKim	Civil Engineer	4 years, Navigation Branch;.5 years, Civil Engineering Section; 1 year, Project Management Branch; 5 years, Plan Formulation and Economic Section, Wilmington District	Study Manager
Wayne Bissette	Civil Engineer	5 years Flood Plain Management; 9 years Civil Engineering; 4 years Project Management	Project Manager
Tong C. Haw	Geology	17 years experience in engineering geology, Wilmington District	Senior Geologist
Ben Lackey	Civil and Soils Engineer	1 year cost estimating, 17 years soil channel engineering, Wilmington District	Dike design, channel cut slopes/disposal area analysis
Richard H. Kimmel	Anthropology/ Archaeology	1.3 years research assistant, Institute for Archaeology and Anthropology, Univ. of South Carolina; 1.5 years research assistant, UNC-Chapel Hill; 1.5 years research associate, Policy Research and Planning Group, Inc.; 17 years archaeologist, Wilmington District	Historical and Underwater archaeologist

Name	Discipline/ Expertise	Experience	Role in Preparing EIS
Frank Reynolds	Economics	2 years water quality, State of SC; 7 years flood plain management, 13 years economics, Wilmington District	Prepare economic and social analysis
Frank Yelverton	Biology/Statistics	9 years Regulatory Branch, 11 years Environmental Resources Section, Wilmington District	Final EIS Manager
James Hargrove	Civil Engineer	10 years Civil Engineering Section	Dredging volumes, Dike design, and quantities
Doug Wall	Civil Engineer/	3 years Civil Engineer/CADD System Manager; 6 years Mapping/Master Planning	Surface modeling of channel designs, river bottom and subsurface
David Leitch	Hydraulic Engineer	26 years, Coastal, Hydraulics and Hydrology	Channel design, ship traffic analysis, dredging volumes, and disposal options
Selby Hannah	Technical Writer	23 years, Plan Formulation	Preparation of Main Report
Carroll Niesen	Civil Engineer	1 year, Cost Engineering Section; 8 years, Plan Formulation Branch; 8 years, Civil Engineering Section; 1 year EPA.	Cost Engineering
Mark Benton	Structural Engineer	4 years bridge and floodwall design, Structures Section	Analysis of Impacted Structures
Claudette Tucke.	Real Estate	11 Years, Real Estate Division, Savannah District	Real Estate Appendix
Chuck Wilson	Biology	16 Year Environmental Resources Section, Wilmington District	Mitigation Planning

7.00 PUBLIC INVOLVEMENT, REVIEW, AND COORDINATION

7.01 Public Involvement and Review

A Notice of Intent (NOI) to prepare a Draft EIS for this Feasibility Study was published in the Federal Register on October 5, 1994. A scoping letter dated September 18, 1992 was sent to the public, as well as all interested State and Federal agencies. Response to the NOI was received from the USFWS and comments on the scoping letter were received from:

US Fish and Wildlife Service
National Marine Fisheries Service
NC Wildlife Resources Commission
NC Division of Environmental Management
NC Division of Coastal Management
NC Department of Cultural Resources
Chemserve, Terminal, Inc.
South Atlantic Services, Inc.
Wilmington Iron Works, Inc.
Oakley Plantation
Almont Shipping Company, Inc.

Comments and concerns expressed in these letters were used in the preparation of this EIS. The **Final** EIS mailing list is included as Table 8. A notice of availability of the DEIS was issued and a copy of the DEIS was sent to anyone requesting it. Comments were requested from all recipients of the Draft EIS and was used in preparation of the Final EIS.

7.02 Required Coordination

Cultural resources investigations and reconnaissance have been coordinated with the North Carolina Division of Archives and History, Underwater Archaeology Unit, and with the North Carolina State Historic Preservation Officer, pursuant to the Abandoned Shipwreck Act of 1987 and the National Historic Preservation Act of 1966, as amended.

The North Carolina Division of Coastal Management (NCDCM) will review this **Final** EIS to determine if the proposed project is consistent with the Coastal Management Program of the State of North Carolina.

Based on information included in (Ward et al, 1993), the USEPA, by letter of December 21, 1993, indicated that the maintenance sediments in the area to be ocean disposed are acceptable for disposal in the ODMDS. This should also mean that the new work material will be acceptable for ocean disposal. The District will provide the USEPA with an updated Section 103 Evaluation of the Marine Protection, Research, and Sanctuaries Act of 1972, as amended. The updated Section 103 evaluation will be submitted after project authorization and will include full-depth sediment testing information.

Consultation under Section 7(c) of the Endangered Species Act of 1973, as amended, has been initiated with the US Department of the Interior, FWS and the US Department of Commerce, NMFS. The BA addressing these issues is included in Attachment B of this **Final** EIS. The draft BO from the USFWS is also included in Attachment B. **The BO from NMFS was not been received in time to be printed with this EIS. Coordination is continuing with NMFS and the BO will be**

available prior to preparation of the ROD.

The additional required coordination under the Fish and Wildlife Coordination Act, as amended (16 USC. 661, et seq), is currently being conducted and the **Final** Fish and Wildlife Coordination Act Report on the proposed project is presented in Attachment E of this **Final** EIS. The USFWS provided a list of project-related recommendations. The following paragraphs present the Service's recommendations. The Corps of Engineers response to each is also provided.

1. **USFWS Recommendation.** The Corps should use all available construction techniques to avoid or minimize the creation of excessive turbidity during dredging operations.

Corps Response. Agreed.

2. **USFWS Recommendation.** The Corps should have sufficient bioassay and bioaccumulation data from sediment of representative areas throughout the project area to insure that the project will not produce a significant toxicological risk to organisms at the dredging site, any offshore disposal areas, or any inland disposal areas. The Corps should develop plans for the special handling and disposal of contaminated sediment, **if such sediment must be dredged**.

Corps Response. There is no evidence of contaminated sediments in the harbor. As indicated in Sections 4.02 and 5.16 of the EIS, the dredged material for ocean disposal have been previously evaluated (Ward et al, 1993). These site specific test results indicate that the maintenance sediments meet the testing criteria of the EPA Ocean Dumping Regulations and Criteria and are, therefore, acceptable for transportation for ocean dumping under Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972, as amended. USEPA, Region IV, concurred with this determination by letter dated December 21, 1993. Based on these results, the new work material should also be acceptable for ocean disposal. The dredged material to be placed in CDF's were evaluated using Section 404(b)(1) guidelines (40 CFR 230) which implement environmental protection provisions of the Clean Water Act. These evaluations consider potential contaminants and potential migration pathways of contaminants to the environment when evaluating dredging and dredged material disposal alternatives. The Ocean Dumping Regulations and Section 404(b)(1) guidelines result in an equivalent level of environmental protection as will occur under a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or Resource Conservation and Recovery Act (RCRA) investigation. Based on appropriate dredged material evaluations, there is no reason to believe that the material within the Wilmington Harbor project is contaminated. There is no reason to believe that contaminants will be mobilized in the environment as a result of the dredging, blasting and dredged material disposal.

3. **USFWS Recommendation.** The Corps should plan construction in a manner which will avoid or minimize adverse impacts to fisheries resources, sea turtles, and marine mammals due to the offshore disposal of dredge material. These plans should incorporate all reasonable technology which would detect species of concern in the immediate disposal area and procedures to delay disposal, if necessary.

Corps Response. As detailed below and in the EIS, the Corps will take all appropriate measures to minimize adverse impacts to all resources including fisheries, sea turtles, and marine mammals.

4. **USFWS Recommendation. The Corps should not dispose of dredge material in inland disposal sites in a manner which would be harmful to nesting colonial waterbirds.**

Corps Response. Agreed.

5. **USFWS Recommendation.** The Corps should use all feasible design features and construction techniques to minimize direct harm or death to animals during routine dredging of soft sediment. Dredging personnel should watch for sea turtles and manatees during all periods of warm weather and cease operations if these species are seen in the immediate vicinity of construction activities. The standard manatee conditions should be strictly enforced during the most likely period of manatee presence, June throught September.

Corps Response. The Corps' responsibilities related to sea turtles while in the water are addressed in the August 25, 1995 letter from NMFS to our Division Office in Atlanta. The Corps will fully comply with these responsibilities.

Manatees are rare visitors to the Cape Fear River Region. From 1952 to 1994, there have been only 7 known observations in the Cape Fear System (Schwartz, 1995). One of these manatees was dead (1986) but no data were gathered on the cause of death (Schwartz, 1996). **Three additional live manatee have been sited in Wilmington Harbor since the Schwartz publication. One was sited near Southport in the Fall of 1995, and two (probably a calf and its mother) were sited near Wilmington in the Spring of 1996. Except for the 1996 siting, each siting in the Cape Fear Region has been of a single manatee. During the most frequent period of observations (1993-1996), there was one observation per year except for the 1996 siting.** All dredging locations are in the existing ship channel, 38 feet deep or greater, where no possible food source exists. Thus, any manatee that may come close to a dredge will be a transient. Dredging, commercial, and recreational traffic have existed in the Wilmington Harbor Channel for decades with no known injury or mortality attributed to dredging activities. Therefore, we do not believe that standard manatee conditions (such as idle speeds, and signs) should be enforced in Wilmington Harbor. If a manatee is observed within 100 yards of dredging operations, all operations will cease until the manatee has left the area. Any observations of or injuries to manatees will be reported to the USFWS. Since this will be the first operation where bucket and barge operations do not have seasonal restrictions, an observer will be on board for the first year of construction to watch for listed species and record any species taken by the dredging operation.

6. **USFWS Recommendation.** Project contracts should state clearly that blasting will not be authorized until data are supplied to the Corps which verify that rock can not be removed with a cutterhead dredge.

Corps Response. Existing core borings indicate that blasting will be required (Section 3.01 **and Appendix G**). The Corps' specifications will limit the contractors' blasting efforts to the drilling and blasting window of August 1 to January 31. In addition, contractors generally do not want to drill and blast any more material than they have to because the drilling and blasting is extremely time consuming and expensive.

If it is determined that blasting is required, the following procedures should be implemented:

a. **USFWS Recommendation.** All blasting should be limited to the time of year with the lowest biological activity. Current plans to protect fisheries resources limit blasting to the 6-month period from August 1 through January 31. The Service supports this effort to protect fish in the project area. However, the Service is very concerned about possible mortality among manatees which are most common in the area from June through September. The Service is also concerned about harm to sea turtles which are most abundant in the lower Cape Fear from April through September.

Therefore, the Service recommends that blasting be limited to the four-month period from October 1 through January 31 of any year, a period of 123 days. With proper planning, the Service believes that the estimated 558 blasts over a period of three years could be accomplished within an annual, four-month blasting period. This procedure would allow a total of 12 months for blasting over the proposed three year construction period. Sufficient personnel would allow for multiple blasts during a single day within the blast period.

Corps Response. The District proposes to blast within the August 1 through January 31 dredging window proposed by the NCDMF. An observer program for endangered and threatened species, as well as marine mammals (including manatees and dolphins) will be instituted. This observer program will **minimize the likelihood that these species are present** within the blast impact zone or adjacent areas (Attachment C of the EIS).

Due to the infrequent observations of manatees in the harbor (see response to recommendation 5 above), and low frequency of occurrence of sea turtles in the upper estuary (where blasting is to occur), reducing the blasting period to 4 months is not warranted. In addition, the full 6-month window for blasting each of the 3 construction years is needed to accomplish the anticipated number of blasts. Even with this 18-month period multiple drilling platforms and crews will be required. **Also due to a change in computations, the number of blasts needs to be increased from 558 to 595.**

b. **USFWS Recommendation.** The type of explosive used and the blast plan selected should be those which can be expected to produce the least harm to aquatic organisms. The Service supports the use of stemming and delays between each charge. The Service recommends that delays in the range of 0.9 to 1.0 second be used to further minimize adverse shock waves. Since low velocity explosives produce shock waves with lower peak pressure, explosives with the lowest velocity consistent with achieving project goals should be used.

Corps Response. The blasting contract will include provisions for drilling holes for explosive charges, stemming the holes, and using delays within each hole. Additionally, an air/bubble curtain and/or physical barrier will be placed completely around the 35,000-square-foot blast area. The contractor will be encouraged to use explosives having the lowest detonation velocity that will allow a reasonable and cost-effective production rate, given the other constraints noted. As indicated in Section 3.08 of the EIS, the preliminary blast plan developed by the Wilmington District reflects industry standards for underwater blasting and is considered representative with respect to the technical aspects of the job. This preliminary blast plan balances the two issues: the cost-effective production of rock removal with the impacts of blasting on the estuarine environment. Increasing the length of delays between each hole will cause the actual blast event to increase from 2.0 seconds (80 holes times 0.025 seconds) to 80 seconds (80 holes times 1 second), thereby reducing the amount of rock fractured and increasing the likelihood of "cutoff" (Personal Communication, Mr. Greg Hempen, St. Louis District Corps of Engineers, September 25, 1995). Each of the 80 holes in the frame are connected to the surface by wires, which control the detonation. Increasing the delays from 0.025 to .9 or 1.0 seconds may cause some of these wires to be "cutoff" or disconnected from the stemmed charges in the rock. This live, unexploded charge in the rock could be very hazardous to the dredging contractor as well as the boating public. Moreover, if less rock is fractured per blast frame (with longer delays), this will decrease efficient production and may mean that additional days blasting may be required to remove the nondredgeable rock.

c. **USFWS Recommendation.** The Corps should develop pre-blast procedures which fully utilize existing biological data on species likely to be present near the blast site and the danger or safety zones for these species. Pre-blast procedures should include: **1) a determination of significant species, including all Federally-listed species, which may occur in the project area during blasting and the Corps is committed to protecting from any blasting impacts; (2) a method to calculate a danger zone for the designated significant species;** (3) **the determination of an adequate buffer zone to add to the calculated danger zone in order to create a larger safety zone;** (4) a surveillance plan to detect the significant species within their respective safety zones; (5) procedures, such as detonation of small pre-blast, which may cause significant species to leave the blasting area; and, (6) an effective procedure to halt blasting if significant species are detected within their safety zone. ***The Corps should specifically address blasting impacts on early life stages of fish in the project area.***

Corps Response. 1) The Corps is committed to protecting listed species to the maximum extent feasible. Biological assessments evaluating potential project-related impacts on endangered and threatened species (manatees, sea turtles, and shortnose sturgeon) have been prepared and **has been** coordinated with the USFWS and NMFS (see Attachment B). **2) Normal industry procedure requires that the contractor perform limited onsite blasting tests and adjust the final (blasting) plan to actual site conditions. During the limited onsite blasting tests, the effectiveness of the bubble curtain and/or physical barrier will be tested. As indicated in Section 5.02 and Attachment C, the contractor will be required to reduce the pressure wave created by the blast by ≥95 percent. This could be done by setting up a series of hydrophones within and without the blast area to measure the effectiveness of the bubble curtain and/or physical barrier. An appopirate pre-blast monitoring area will be coordinated with all concerned agencies; however, with the use of bubble curtains that must contain ≥95 percent of the pressure wave, the area of impact should be much smaller than that indicated in Table 7 of the EIS (34.5, acres, 656-foot radius) for LD 1 percent (0.125 pound fish). If there is no take of listed species or other significant resources within the first series of blasts (e.g., 30), we propose to reduce the monitoring zone to the immediate vicinity of the bubble curtains (e.g., 300-foot radius from the bubble curtain). 3) Because of the use of bubble curtains or physical barriers, adding a buffer zone to a danger zone is not reasonable. 4) See Attachment C. 5)** Sonalysts, Inc. has developed technology ("Fish Startle") that uses underwater transducers to emit high-frequency sound waves to scare fish. Our conversations with Mr. Mike Curtin, Project Manager, Sonalysts, Inc. indicate that their technology has been very successful at several locations with several fish species, namely shad, herring, and alewives. However, their technology involves sound emissions at specific frequencies for specific fish species, and, at present, the details have been worked out for only a limited number of species. It is, therefore, not possible to purchase off-the-shelf technology for a wide variety of species. Since this is developing technology, it has not been proven nor accepted by resource agencies as an alternative to other measures such as monitoring. It is expensive to use (around $100,000 or more per month to deploy from boats). We do believe, however, that the technology could be very useful after further development. Also, small pre-blast charges have been used in several blasting projects in attempt to deter fish from the blast sites. These pre-blast actions have had mixed results. However, we will explore all appropriate methods **prior to initiation of blasting. 6) See Attachment C.**

The USACE has considered the impacts of blasting on larval life forms and juvenile fish. Please review Section 5.02 in the Draft and Final EIS. Blasting impacts on these larval life forms were not considered significant for the following reasons: a) the daily blast(s) will take up less than 0.00462 percent (less than 5 one-thousands of 1 percent) of the day, b) about 0.06 percent (6 one-hundredths of 1 percent) of the larvae in the ship channel will be affected by individual blasts, c) the daily mean average density of larvae in the Cape Fear

River is 1902/1000 cubic meters (CP&L, 1994), and d) natural larval mortalities may approach 99 percent (Dew and Hacked, 1994). Moreover, the USACE has decided to implement the following protective measures in order to minimize impacts:

1. Each hole will be stemmed and a delay will be installed per hole, and a bubble curtain and/or physical barrier will be placed completely around the blast area (about 35,000 square feet).

2. Dredging and blasting will be conducted during the NCDMF dredging window (August 1 through January 31), whenever possible.

d. **USFWS Recommendation.** A comprehensive post-blasting monitoring plan should be developed and implemented so that the number of organisms by species killed by the blasts can be determined. The monitoring plan should be developed in coordination with the Service, the North Carolina Division of Marine Fisheries, and the National Marine Fisheries Service. The plan should involve surveying the blast impact area by boat and counting and identifying dead or injured organisms which float to the surface. Although all dead organisms may not float to the surface immediately, this method should give an indication of the extent of the impacts to finfish and other organisms. ***Part of post-blast monitoring should include sampling of the river bottom.*** These data should be complied in an annual report and supplied to State and Federal resource agencies.

Corps Response. We agree to work with the USFWS, NMFS, and NCDMF toward the development of a pre- and post blast monitoring plan. Attachment C of the FEIS contains the preliminary pre- and post-blast monitoring plan. At this time we believe that pre-blast monitoring, use of bubble curtains, stemming, single delays per hole, and seasonal restrictions will be the most effective measures to minimize potential impacts to listed species.

e. **USFWS Recommendation.** The Service supports the use of bubble curtains and/or physical barrier to exclude animals and absorb shock waves. However, in the absence of specific data on the protective value of these devices for the species of concern and the conditions present in the Cape Fear River, these protective devices should be used in conjunction with other protective measures, particularly a careful consideration of limiting blasting to the time of year with low biological activity. ***During early blasts, the safety zone to be surveyed should not assume any protective value for the bubble curtain. If field data should show that shock waves are contained by the curtain, the surveillance zone may be reduced.***

Corps Response. Blasting will be restricted to the August 1 to January 31 window recommended by the NCDMF to the maximum extent feasible. We agree that a reasonable danger zone should be surveyed, but since the bubble curtain will provide some protection, adding in a safety zone is not reasonable.

f. **USFWS Recommendation.** In addition to the protective measures recommended above, if blasting will occur during a time of year when species protected by either the Endangered Species Act or the Marine Mammal Protection Act may be in the project area, the Corps should use the best available data and models to calculate danger **and safety zones** for these species. The radius of this danger zone could be based on a calculated radius at which very low mortality, such as 1 percent (LD1), would be produced. The radii of danger zones for Federally-listed species should be increased by approximately one-third to create a buffer, or safety, zone. All protective measures for Federally-listed species should be based upon the larger safety zone.

Corps Response. See response to 6c, above.

g. **USFWS Recommendation.** Based on data regarding the species which may be present in the project area during blasting and calculations on the size of danger and safety zones, project plans should include measures to exclude species of concern from the blast zone. The Service developed a "manatee watch plan" to protect manatees at a Florida construction site which required blasting **(Appendix C to the final FWSCAR)** which may serve as a model for the proposed project if blasting is scheduled during the period, June through September, when manatees are most likely to be in the Cape Fear River.

Corps Response. Based on the infrequent occurrence of manatee observations in the Cape Fear River, and the pre- and post-monitoring plan indicated in Attachment C of the EIS, all listed species should be adequately protected.

7. **USFWS Recommendation.** The Corps should insure that the project does not result in a permanent loss of primary nursery areas. These highly productive, shallow water areas contain organisms which form the base for important estuarine food chains. Construction for the project should either avoid these areas or in-kind compensatory mitigation should be provided in the immediate vicinity of the areas lost. If compensation is required, the Corps should develop a comprehensive mitigation plan which describes the functions and values of the areas lost, the manner in which these functions and values will be replaced, details for restoring or creating the mitigation site, success criteria for various time periods of the mitigation effort, and the long-term plan for the protection of the mitigation area. ***If shallow water wetlands are created from spoil disposal islands, the Corps should ensure that there is no loss of nesting habitat for colonial waterbirds.***

Corps Response. Primary nursery area and marsh will be avoided to the maximum extent feasible. Where impacts can not be avoided these resources will be mitigated as indicated in Section 5.06 and Attachment D of the EIS. Additional details on site location, construction, success criteria, etc, will be provided during the Preconstruction Engineering and Design (PED) phase of the project. **Colonial waterbirds do not nest on the islands that may be used for mitigation.**

8. **USFWS Recommendation.** The Corps should fully assess the potential for an increase in erosion along riparian area in the project area which will be subject to the impacts of wakes from larger ships. If this assessment indicates that shoreline erosion is likely to increase as a long-term impact of the project, the Corps should present a plan to mitigate this damage and insure the continued existence of the important biological communities in these areas.

Corps Response. As indicated in Section 5.05 of the EIS, the proposed project should not appreciably increase erosion along riparian areas.

9. **USFWS Recommendation.** The Corps should fully assess the potential impacts of the proposed project on the long shore sediment transport system. This assessment should either present evidence that the proposed project will not adversely affect beaches on either side of the mouth of the Cape Fear River or present a plan to mitigate the consequences of the project on area beaches. The Corps should consider the feasibility of placing all beach quality sand within the littoral zone of the project area.

Corps Response. There is no direct relationship between the proposed modifications to the navigation channel and the existing long shore sediment transport system associated with the beaches adjacent to the mouth of the Cape Fear River. **In other words, the channel is so deep now that dredging 4 feet deeper will trap no more sand than the current deep channel.** However, a complete assessment of the impacts of placing beach quality sand on these beaches and in the littoral zone adjacent to these beaches will be conducted during Preconstruction Engineering and Design studies.

10. **USFWS Recommendation.** Corps should complete the planned assessment of potential impacts of the project on groundwater resources in the lower Cape Fear River watershed. This assessment should look beyond current conditions in which pressure within the aquifer seems sufficient to exclude salt water and consider the consequences of increased groundwater withdrawals which will result from increased development in the area. In particular, the assessment should give an evaluation of groundwater conditions at 50 years after project construction, a time period used to calculate the economic benefits of channel modifications. This assessment should consider a "worst-case" scenario and evaluate the impacts associated with constructing facilities to replace water which was previously withdrawn from aquifers and possible sources of freshwater which would replace existing groundwater resources. All costs associated with replacing existing groundwater resources should be completely evaluated in the benefit-cost analysis of the project.

Corps Response. The North Carolina Division of Water Resources (DWR) plans to model for potential impacts up to the year 2020, if practicable, using the FEMWATER or SHARP model. If modeling results indicate a potential for damage to the aquifer system up to the year 2020, they will attempt to model for a longer period of time. The DWR will model for a worst-case scenario within the area of potential impact. However, the scope of their investigation at this point is to determine potential impacts to groundwater resources, not to make recommendations on how to replace resources, if lost.

11. **USFWS Recommendation.** The Corps should complete the current modeling effort on the potential for increased salt water intrusion as a result of the proposed channel modifications. On the completion of this effort, the Corps should release a written report on the salt water intrusion model which contains a detailed description of field data which was used in the model and data collection procedures. This report should also include all major assumptions and mathematical relationships which were used in the model. This report should be made available to all State and Federal resource agencies for both internal review and submission to independent experts for evaluation.

In the absence of sufficient data to predict the actual effect of the project on the intrusion of salt water intrusion into surface water, the Corps should develop a long-term program to monitor actual changes in both salinity and riparian vegetation. Permanent sampling stations should be established for sampling water, vegetation, and animal communities. The Corps should also develop a general plan for remedial action in the event that a significant increase in salt water intrusions occurs.

Corps Response. The surface salt water intrusion modeling effort will be completed and a report prepared. The report will be provided to all interested groups for review and comment. **However, we realize there will be some uncertainty in the model results. As indicated in Sections 5.01 and 5.13 of the Final EIS, we commit to a pre- and post-monitoring effort in the potentially affected area. This monitoring could include changes in tide levels, soil pore water chemistry and vegetation on selected plots, and other appropriate items. Details of this monitoring effort will be developed in coordination with all known interested parties. Results will also be coordinated with all known interested parties to determine if impacts different than those anticipated have occurred.**

12. **USFWS Recommendation.** The Corps should insure that the operation and maintenance plan of the proposed project includes: (1) enforceable measures to minimize the risk of shipping accidents; (2) a permanent, fully-funded emergency response plan based on the types of cargo which will be carried in the ship channel; and, (3) specific provisions to insure that the owners of all ships using the Port of Wilmington have the financial resources to pay for any environmental cleanup for which they may be found liable.

Corps Response. The Corps' Federal authority does not cover these areas of concern. The US Coast Guard as well as the insurance companies of the ship owners have provisions to cover these concerns.

The Service makes the following recommendations to minimize the potential cumulative effects of the proposed project:

13. **USFWS Recommendation.** The Corps should assess past, current, and anticipated construction projects in North Carolina which have had, are having, and/or will have adverse, environmental impacts on estuarine ecosystems in order to insure that the proposed project will not contribute to a Statewide decline in either the areal extent or functions of these ecosystems.

Corps Response. Sections 5.01, 5.02, 5.06, and 5.11 of the EIS adequately addresses the potential impacts of the proposed projects in Wilmington Harbor.

This EIS is not the appropriate forum for assessing the impacts of construction projects in all of North Carolina. Impacts related to construction projects in Wilmington Harbor have been adequately addressed in this EIS.

14. **USFWS Recommendation.** The Corps should assess past, current, and anticipated construction projects in North Carolina which have had, are having, and/or will have adverse, environmental impacts on freshwater, tidal ecosystems in order to insure that the proposed project will not contribute to a State-wide decline in either the areal extent or functions of these ecosystems.

Corps Response. See response to recommendation 12 above.

The Service recommends the following actions to benefit and enhance the fish and wildlife resources in the project area:

15. **USFWS Recommendation. The Corps should assess the feasibility of disposing of beach quality sand in a manner and at a location which would benefit nesting habitat for sea turtles.**

Corps Response. The potential alternative of placing sand on area beaches is discussed in Section 3.07 of the Final EIS.

16. **USFWS Recommendation.** If material removed during project construction is suitable for disposal on colonial waterbird nesting islands in the lower Cape Fear River, the Corps should place this material, as needed for habitat improvement, on colonial waterbird nesting islands in the area, as they have done in the past. The Corps, in accordance with the 1988 Cooperative Agreement to implement the State-wide Colonial Waterbird Management Plan, should continue to coordinate such activities with the North Carolina Colonial Waterbird Management Committee to develop a plan for the

beneficial disposal of this material.

Corps Response. As indicated in Section 3.07 of the EIS, renourishing the colonial waterbird nesting islands is a disposal alternative being considered. Renourishing of these islands has occurred with past maintenance actions and will be evaluated for all construction and maintenance actions. We will continue to coordinate this issue with the North Carolina Colonial Waterbird Management Committee.

17. **USFWS Recommendation.** The Corps should implement the current proposal for using rock removed from the channel for artificial reef creation in close cooperation with the National Marine Fisheries Service or the North Carolina Division of Marine Fisheries. However, only material which is of appropriate size and is free of contaminants should be used for artificial reef creation.

Corps Response. Agreed, artificial reef creation will be coordinated with all appropriate agencies. None of the rock proposed for disposal in the WOFES will contain contaminated material.

18. **USFWS Recommendation.** The Corps should make every effort to "reschedule" and pursue the acquisition of the 2,800-acre tract of conservation lands along the Northeast Cape Fear River. This acquisition was an original element in the Wilmington Harbor-Northeast Cape Fear River Project, but this effort to preserve important wetlands and river bluffs along the lower Northeast Cape Fear River was subsequently designated as "unscheduled."

Corps Response. The 2,800-acre tract was not proposed to mitigate to direct impacts of the proposed Wilmington Harbor - Northeast Cape Fear River project. Therefore, this tract is considered a "separable" element. The current Corps of Engineers policy is that this tract remains "unscheduled".

TABLE 8. MAILING LIST FOR THE FINAL EIS.

Federal Agencies

Environmental Protection Agency
National Oceanic and Atmospheric Administration
Forest Service, USDA
Federal Emergency Management Administration
Regional Environmental Officer
HUD, Atlanta Regional Office
Advisory Council on Historic Preservation
US Fish and Wildlife Service
Natural Resources Conservation Service
Commander, Military Ocean Terminal, Sunny Point
Department of Health and Human Services
National Marine Fisheries Service
US Department of the Interior
Fifth Coast Guard District
Federal Highway Administration

Conservation Groups

National Wildlife Federation
Capitol Group, Sierra Club
Conservation Council of N.C.
Izaac Walton League
National Audubon Society
N.C. Coastal Federation
N.C. Wildlife Federation
Environmental Defense Fund, Inc.
State Conservationist, Sierra Club
Cape Fear Group Sierra Club

State Agencies and Officials

State Clearinghouse
N.C. State Ports Authority
Mr. John N. Morris, Director
Division of Water Resources
N.C. Wildlife Resources Commission

Local Agencies

North Carolina Council of Governments, Region O
New Hanover County Engineer
New Hanover County Planning Department
New Hanover County Manager
Brunswick County Manager
CAMA Officer, Town of Southport

TABLE 8. MAILING LIST FOR THE FINAL EIS (Cont.)

Local Agencies Cont.)

CAMA Officer, Brunswick County
CAMA Officer, New Hanover County
Town Manager,
Town of Southport
Greater Wilmington Chamber of Commerce

Elected Officials

Hon. Jesse Helms
Hon. Lauch Faircloth
Hon. Eva Clayton
Hon. Charles G. Rose, III
Hon. Luther Jordan
Hon. Patrick Ballantine
Hon. R.C. Soles, Jr.
Hon. Thomas Wright
Hon. Tom B. Rabon, Jr.
Hon. Daniel F. McComas
Hon. Dewey Hill
Hon. E. David Redwine
Hon. Edd Nye
Mr. Edmund B. Welch
Mayor of Wilmington
New Hanover County Commissioners
Brunswick County Commissioners

Interested Groups and Individuals

Dr. Vince Bellis
Dr. James F. Parnell
Wilmington-Cape Fear Pilots Association
Dr. David Weaver
Mr. A.D. Royal
Mr. William S.R. Beane
Stevedores, Inc.
Koch Refining Company
Koch Sulfur Products Company
Chemserve Terminal, Inc.
Cape Fear Community College
Dixie Cement Company, Inc.
Wilmington Shipyard, Inc.
Almont Shipping Company
Star-News Newspaper, Inc.
Delta Marine, Inc.
Pfizer Chemical Company

TABLE 8. MAILING LIST FOR THE FINAL EIS. (Cont.)

Interested Groups and Individuals (Cont.)
Oakley Plantation
Ms. Sally Lentz
Amerada Hess Corporation
Amoco Oil Company
Apex Oil Company
Carolina Power and Light Company
Spraque Energy
W. K. Hobbs, Inc.
Springer-Eubank Oil Company
Cape Fear Oil
O. E. Durante
William H. Swan & Sons
Law and Company
South Atlantic Service, Inc.
Chestnut Enterprises, Inc.
A. J. Fritz & Company
The Hipage Company, Inc.
John S. James Company
Rogers & Brown Custom Brokers, Inc.
Southern Overseas Corporation
Waters Shipping Company
Bordeaux Salvage & Construction Company
Wilmington Iron Works
Cape Fear Docking Pilots, Inc.
Wilmington Docking Pilots Association
Anders Williams & Co., Inc.
Harrington Ship Agencies, Inc.
International Shipping Company
Southeast Crescent Shopping Company
Tagship South Atlantic, Inc.
Ceres Stevedoring
Cooper T. Smith Stevedoring
Ryan-Walsh, Inc.
Sea Tow Services Cape Fear
McAllister Towing of Wilmington, Inc.
Mr. John H. Swope

Libraries

Wilson Library
Chapel Hill
Randall Library
UNCW
New Hanover County Library
N.C. State Library

8.00 REFERENCES

Adams, W.F. and S.G. Brady. 1995. Rediscovery of the Aquatic Gastropod *Helisoma eucosmium*. Brimleyana. 22:23-29.

Alberta's Fisheries Habitat Protection Guidelines, Guideline No. 15, dated May 1987. 5pp.

Alford, Michael B. n.d. A Flat-Bottomed Sailing Craft from the Cape Fear River at Sugar Loaf, Carolina Beach State Park, New Hanover County, North Carolina. Manuscript on file, North Carolina Maritime Museum, Beaufort.

American Cyanamid Company. 1986. Technical Information, Cythion Insecticide, the Premium Grade Malathion

Angley, Wilson. 1981. A Historical Overview of the Northeast Cape Fear River. Manuscript on file, North Carolina Division of Archives and History, Raleigh.

Angley, Wilson. 1983. An Historical Overview of the Sunny Point Terminal Area on the Lower Cape Fear River. Report prepared by the North Carolina Division of Archives and History, Raleigh.

Anuskiewicz, Richard J. 1982. Magnetometer Survey and Cultural Resource Assessment of Selected Magnetic Anomalies, Military Ocean Terminal, Sunny Point, North Carolina. Report on file, U. S. Army Corps of Engineers, Wilmington.

Anuskiewicz, Richard J. 1983. Diver Hands-On Cultural Resource Assessment of Selected Magnetic Anomalies at the North Wharf, Military Ocean Terminal, Sunny Point, North Carolina: A Report of Negative Findings. Report on file, U. S. Army Corps of Engineers, Wilmington.

Armstrong, D.A., Stevens, B.C., and Hoeman, J.C. 1982. Distribution and Abundance of Dungeness Crab and Crangon Shrimp and Dredging-Related Mortality of Invertebrates and Fish in Gray's Harbor, Washington. Report No. DA-80-86 Washington Department of Fisheries and US Army Corps of Engineers, Seattle District.

Arseneault, J.S. 1981. Dredge Monitoring Program - 1981, Memorandum No. 5902-121-50-2, Field Services Branch, Environment Canada, Vancouver.

Baker, Michael. 1981a. An Intensive Archaeological Reconnaissance of Areas Bordering Snows Cut, New Hanover County, North Carolina. Report prepared by Archaeological Research Consultants Inc., Chapel Hill, North Carolina.

Baker, Michael. 1981b. An Intensive Archaeological Reconnaissance of the Carolina Beach Borrow Area, New Hanover County, North Carolina. Report prepared by Archaeological Research Consultants, Inc., Chapel Hill, North Carolina.

Barnard, W.D. 1978. Prediction and Control of Dredged Material Dispersion Around Dredging and Open-Water Pipeline Disposal Operations. Technical Report DS-78-13. US Army Engineer Waterways Experiment Station, August 1978.

Birkhead, W.A., B.J. Copeland, and R.G. Hodson. 1979. Ecological Monitoring in the Lower Cape Fear Estuary, 1971-1976. Report 79-1 to the Carolina Power and Light Company, Raleigh, N.C.

Brooks, Barbara Lynn and Mark Wilde-Ramsing. 1988. Bibliography of North Carolina Underwater Archaeology. North Carolina Division of Archives and History, Underwater Archaeology Unit, Kure Beach.

Broome, S.W., E.D. Seneca, and W.W. Woodhouse, Jr. 1981. Planting marsh grasses for erosion control. UNS Sea Grant Publication 81-09. Raleigh, N.C.

Brunswick County. 1993. Brunswick County, North Carolina Land Use Plan. Prepared by Glen Harbeck Associates, Wilmington, NC for the Brunswick County Planning Board.

Buell, J.W. 1992. Fish entrainment monitoring of the Western-Pacific dredge R. W. Lofgren during operations outside the preferred work period. Buell and Associates. 38 pp. + appendices.

Burton, W.H., S.B. Weisberg, and P. Jacobson. 1992. Entrainment effects of maintenance hydraulic dredging in the Delaware River estuary on striped bass ichthyoplankton. Report to the Delaware Basin Fish and Wildlife Management Cooperative, West Trenton, New Jersey. 33pp.

Camfield, F.E., R.E.L. Ray and J.W. Eckert. 1980. The possible impact of vessel wakes on bank erosion. Final Report. Prepared for US Coast Guard.

Carolina Power and Light Company (CP&L). 1980. Brunswick Steam Electric Plant, Cape Fear Studies: Interpretive Report. Carolina Power and Light Company, Raleigh, N.C.

Carolina Power and Light Company (CP&L). 1994. Brunswick Steam Electric Plant, Cape Fear Studies: Interpretive Report. Carolina Power and Light Company, Raleigh, N.C.

Carpenter, E.J. 1971. Annual phytoplankton cycle of the Cape Fear River Estuary, North Carolina. Chesapeake Science 12:95-104.

Carriker, M.R., LaSalle, M.W., Mann, R., and Pritchard, D.W. 1986. Entrainment of Oyster Larvae by Hydraulic Cutterhead Dredging Operations: Workshop Conclusions and Recommendations. American Malacological Bulletin, Special Edition No. 3. pp5-10. Chavance, P., C. Flores-Coto, and Sanchez-Iturbe, A. 1984. Early Life History and Adult Biomass of Sea Bream in the Terminos Lagoon, Southern Gulf of Mexico. Transactions of the American Fisheries Society 113:166-177.

Coe, Joffre L., H. Trawick Ward, Martha Graham, Liane Navey, and S. Homes Hogue. 1980. Archaeological and Paleo-Osteological Investigations at the Cold Morning Site, New Hanover County, North Carolina. Prepared by the Research Laboratories of Anthropology, University of North Carolina, Chapel Hill.

Copeland, B.J., R.G. Hodson, and R.J. Monroe. 1979. Larvae and Post Larvae in the Cape Fear Estuary, North Carolina During Operation of the Brunswick Steam Electric Plant, 1974-1978. Report 79-3 to the Carolina Power and Light Company, Raleigh, N.C.

Cushing, D.H. 1988. The study of stock and recruitment. In: Fish population dynamics (Second Edition). Edited by J.A. Gulland. John Wiley and Sons Ltd.

Das, M.M. 1969. Relative effect of waves generated by large ships and small boats in restricted waterways. Hydraulic Engineering Laboratory, College of Engineering, University of California, Berkeley.

Department of the Army, Waterways Experiment Station. 1984. Shore Protection Manual, Coastal Engineering Research Center.

Dew, C. B. and J. H. Hecht. 1994. Recruitment, Growth, Mortality, and Biomass Production of Larval and Early Juvenile Atlantic Tomcod in the Hudson River Estuary. Transactions of the American Fisheries Society. Volume 123. September 1994. Number 5. pp.681-702.

Domenico, S.N. 1982a. Acoustic wave propagation in air-bubble curtains in water-Part II: Field experiments. Geophysics 47:354-375.

Domenico, S.N. 1982b. Acoustic wave propagation in air-bubble curtains in water-Part I: History and theory. Geophysics 47:345-353.

Duff, James A., and Diana M. Lange. 1980. Town Creek Magnetometer Survey, Brunswick County, North Carolina. Report prepared by the North Carolina Division of Archives and History, Raleigh.

EA Engineering, Science and Technology, Inc. 1991. Lower Cape Fear Water Quality and Fisheries Literature Review, Volume 1, Final Report. Prepared for Wilmington Industrial Development, Inc. Wimington, North Carolina. EA Report No. 11747.

Envirosphere Company. 1987. Military Ocean Terminal, Sunny Point, North Carolina, Historic Preservation Plan. Report prepared for the Wilmington District Corps of Engineers by Enviroshpere Co., Lyndhurst, New Jersey.

Fonvielle, Chris Eugene, Jr. 1987. To Forge A Thunderbolt: The Wilmington Campaign, February, 1865. Unpublished M.A. Thesis, East Carolina University, Greenville, North Carolina.

Gaspin, J.B. 1975. Experimental investigations of the effects of underwater explosions on swimbladder fish, I: 1973 Chesapeake Bay tests. NSWC/WOL TR 75-58.

Gaspin, J.B., M.L. Wiley, and G.B. Peters. 1976. Experimental investigations of the effects of underwater explosions on swimbladder fish, II: 1975. Chesapeake Bay tests. NSWC/WOL TR 76-61.

Giese, G.L., H.B. Wilder, and G.C. Porter. 1979. Hydrology of Major Estuaries. and Sounds of North Carolina, US Geological Survey, Water Resources Investigation 79-46.

Hackney, C.T. and G.F. Yelverton. 1990. Effects of Human Activities and Sea Level Rise on Wetland Ecosystems in the Cape Fear River Estuary, North Carolina, USA. In: Wetland Ecology and Management: Case Studies, pp 55-61. D.F. Whigham, R.E. Good and J. Kivet eds. Kluwer Academic Publishers, Netherlands.

Hall, Wesley K. 1979. A Cultural Resource Survey of Selected Portions of the Military Ocean Terminal at Sunny Point, North Carolina. Report prepared by Coastal Zone Resources Division, Ocean Data Systems, Inc., Wilmington, North Carolina.

Hargrove, Thomas H. 1984. Archaeological Test Excavations at Reaves Point, Military Ocean Terminal, Sunny Point, North Carolina. Report prepared by Archaeological Research Consultants, Inc., Chapel Hill, North Carolina.

Hargrove, Thomas H., Gordon P. Watts, Jr., and Bill Reaves. 1985. Terrestrial and Manne Archaeological Survey of the Proposed Castle Street Boat Ramp on the Cape Fear River, Wilmington, New Hanover County, North Carolina. Report prepared by Archaeological Research Consultants, Inc., Chapel Hill, North Carolina.

Hackney, T.H. and S.G. Brady. 1996. Evaluation of Habitat Requirements of the Greenfield Ramshorn in Town Creek North Carolina and a Search for Other Populations. Report prepared for Wilmington District Corps of Engineers by the Dept. of Biological Sciences, UNC-W, Wilmington, NC.

Hayes, D.F., G.L. Raymond, and T.N. McLellan. 1984. Sediment Resuspension from Dredging Activities, in Dredging and Dredged Material Disposal. R.L. Montgomery and J.W. Leach, eds. Proceedings of the Conference - Dredging '84. November 14-16, 1984.

Hignett, H. J. 1984. The Current State of the Art of Rock Cutting and Dredging. Miscel. Paper GL-84-17. Published by the US Army Corps of Engineers Waterways Experiment Station.

Hirsch, N.D., L.H. DiSalvo, and R. Peddicord. 1978. Effects of Dredging and Disposal on Aquatic Organisms. Technical Report DS-78-5. US Army Engineer Waterways Experiment Station, August 1978.

Hodson, R.G. 1979. Utilization of Marsh Habitats as Primary Nursery Areas by Young Fish and Shrimp, Cape Fear Estuary, North Carolina. Report 79-5 to the Carolina Power and Light Company, Raleigh, N.C..

Ippen, A.T. (ed.). 1966. Estuary and Coastline Hydrodynamics, McGraw Hill Book Company, New York, NY.

Jackson, Claude V., III. 1995. A Maritime History and Survey of the Cape Fear - Northeast Cape Fear Rivers, Wilmington Harbor, North Carolina, Volume 1, Maritime History. North Carolina Division of Archives and History Underwater Archaeology Unit, Kure Beach.

Jones, Edmunds & Associates, Inc. 1979. Grain Size Analysis, Bioassays, and Bioaccumulation Potential Assessment - Access Channels and Anchorage Basins, Military Ocean Terminal - Sunny Point, North Carolina.

Keevin, T.M., G.L. Hempen, L.G. Nico, and D.J. Schaeffer. 1995. The use of an air bubble curtain to reduce fish mortality resulting from underwater explosions. Unpublished Draft Report. 20pp.

Kimmel, Richard. 1987a. Historic Properties Assessment of the Proposed Cape Fear River Channels Passing Lane. Manuscript on file, US Army Corps of Engineers, Wilmington.

Kimmel, Richard. 1987b. Summary of Magnetic Survey, Wilmington Harbor/Northeast Cape Fear River. Manuscript on file, US Army Corps of Engineers, Wilmington.

Klein, Joel I. 1987. Military Ocean Terminal Sunny Point, North Carolina: Historic Preservation Plan. Report prepared by Envirosphere Co., Lyndhurst, New Jersey.

Kray, C.J. 1973. Design of Ship Channels and Maneuvering Areas, Journal of the Waterways, Harbors and Coastal Engineering Division, Proceedings of the American Society of Civil Engineers, Vol. 99, No. WW 1.

Lautier, Jeff C. 1996. Wilmington Harbor Groundwater Study, Draft Final Report. N.C. Department of Environment, Health, and Natural Resources, Division of Water Resources.

Lautzenheiser, Loretta. 1995. Archaeological Survey, Proposed Treated Wastewater Holdings Ponds, Federal Paper Board Riegelwood Operations, Riegelwood, Columbus County, North Carolina. Coastal Carolina Research, Tarboro, North Carolina.

Law Engineering Testing Company. 1978. Bottom Sediment and Water Sampling and Analysis, Wilmington Harbor Anchorage Basin, Geo-Environmental Services Division.

Law Engineering Testing Company. 1979. Benthos on the Wilmington Harbor Ocean Bar, North Carolina, Geo-Environmental Services Division.

Lawler, Matusky & Skelly Engineers. 1975. Aquatic Ecology Studies, Cape Fear River Estuary, North Carolina, September 1972 to August 1973. Appendix A of Environmental Impact Assessment of Alternatives for the Maintenance of Wilmington Harbor North Carolina. Report for the US Army Corps of Engineers, Wilmington District.

Lawrence, Richard W. 1985. Underwater Archaeological Sites in the Wilmington Historical District. Addendum to the National Register of Historic Places Nomination - Inventory Form, Wilmington Historical District. Manuscript on file North Carolina Division of Archives and History, Raleigh.

Lawrence, Richard W. 1988. Field Inspection of the Walker Barge, 0068CFR. Manuscript on file, North Carolina Division of Archives and History, Underwater Archaeology Unit, Kure Beach.

LeGrand, H. E. 1984. Groundwater and its Contamination in North Carolina with Reference to Waste Management. Available from Geo. Science Resources, Burlington, North Carolina.

Linton, T.L., N. Hall, D. LaBomascus and A. M. Landry. 1985. The effects of seismic sounds on marine organisms: an annotated bibilography and literature review. Texas A&M University-Sea Grant Report No. TAMU-SG-86-604, College Station, Texas. 67 pages.

Loftfield, Thomas C. 1988. Prehistoric Oystermen of the Central North Carolina Coast. In *Sea and Land - Cultural and Biological Adaptations in the Southern Coastal Plain*. Edited by James L. Peacock and James C. Sabella, pp. 106-121. The University of Georgia Press, Athens.

Loftfield, Thomas C. 1990. Ossuary Interments and Algonquian Expansion on the North Carolina Coast. *Southeastern Archaeology* 9(2);116-123.

Loftfield, Thomas C. 1991. The Caribbean Influence in Early Colonial North Carolina. Paper presented at the 1991 Society for Historical Archaeology, Conference on Historical and Underwater Archaeology, Richmond, Virginia.

Lunz, J., D. Clarke, and T. Fredette. 1984. Seasonal restrictions on bucket dredging operations. In: Dredging and Dredged Material Disposal, Proceeding of the Conference, Dredging 1984. ASCE. Montgomery and Leach, editors.

MacNair, C. and G. Banks. 1986. Prediction of Flow Fields Near the Suction of a Cutterhead Dredge. American Malacological Bull. Spec. Ed. No. 3, October 1986. pp. 37-40.

Mathis, Mark A. 1993. Broad Reach: A Unique Site or the Truth About What We've Missed? In *Site Destruction in Georgia and the Carolinas*, edited by David G. Anderson and Virginia Horak. Readings in Archaeological Resource Protection Series No. 2. US Department of the interior, National Park Service, Atlanta.

McLellan, T. N, R. N. Havis, D. F. Hayes and G. L. Raymond. 1989. Field Studies of Sediment Resuspension Characteristics of Selected Dredges. Technical Report HL-89-9, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Moser, M. L. and S. W. Ross. 1993. Distribution and Movements of Shortnose Sturgeon (*Acipenser brevirostrum*) and Other Anadromous Fishes of the Lower Cape Fear River, North Carolina. Final Report to the US Army Corps of Engineers, Wilmington District, May 1993. 112 pp.

Moser, M.L. and S.W. Ross. 1994. Effects of Changing Current Regime and River Discharge on the Estuarine Phase of Anadromous Fish Migration. Offprint from Changes in Fluxes in Estuaries.

Moser, M.L. and S.W. Ross. 1995. Habitat Use and Movements of Shortnose and Atlantic Sturgeons in the Lower Cape Fear River, North Carolina. Transactions of the American Fisheries Society 124:225-234, 1995. American Fisheries Society.

Munday, D.R., G.L. Ennis, D.G. Wright, D.C. Jeffries, E.R. Mcgreer, and J.S. Mathers. 1986. Development and evaluation of a model to predict effects of buried underwater blasting charges on fish populations in shallow water areas. Canadian Technical Report of Fisheries and Aquatic Sciences. 1418:x + 49 pp.

National Waterways Study. 1981. Traffic Forecasting Methodology.

Needham, R.N. 1982. Breeding Birds of a Southern River Swamp Forest. M.S. Thesis, University of North Carolina, Wilmington, Wilmington, 66p.

Nichols, P. and E. Louder. 1970. Upstream passage of anadromous fish through navigation locks and use of stream for spawning habitat, Cape Fear River, North Carolina, 1962-1966. US Fish and Wildlife Service, Circ. 252.

North Carolina Department of Environment, Health and Natural Resources. 1990a. Division of Environmental Management. Administrative Code 15 NCAC 2B .0200 - Classification and Water Quality Standards Applicable to Surface Waters of North Carolina.

North Carolina Department of Environment, Health and Natural Resources. 1990b. Division of Marine Fisheries. Prohibited Area Map, Cape Fear Area. Areas B-1, B-2, B-3, B-4 and A-3.

North Carolina Department of Human Resources. 1988. Division of Health Services. Risk Evaluation of Malathion Used for Mosquito Control. Memo to Nolan Newton, Vector Control Branch from Environmental Epidemiology Branch.

North Carolina Department of Natural Resources and Community Development. 1989. Division of Environmental Management. Administrative Code 15 NCAC 2B .0311 - Classification and Water Quality Standards Assigned to the Waters of the Cape Fear River Basin.

North Carolina Division of Marine Fisheries. 1995. Computer Listing of the 1994 Commercial Landing Statistics for the Cape Fear River, North Carolina.

O'Keeffe, D.J. and G.A. Young. 1984. Handbook on the environmental effects of underwater explosions. Naval Surface Weapons Center. NSWC TR 83-240.

Ocean Surveys, Inc. 1981. Cultural Resource Magnetic Survey, Northeast Cape Fear River, Wilmington, North Carolina. Report prepared for Atlantic Resources, Inc. by Ocean Surveys, Inc., Old Saybrook, Connecticut. Manuscript on file, North Carolina Division of Archives and History, Raleigh.

Overton, Glenn C., Richard W. Lawrence, and Claude V. Jackson, III. 1995. A Maritime History and Survey of the Cape Fear - Northeast Cape Fear Rivers, Wilmington Harbor, North Carolina, Volume 2, Cultural Survey. North Carolina Division of Archives and History Underwater Archaeology Unit, Kure Beach.

Palermo, M., J. Homziak, and A. Teeter. 1988. Evaluation of Clamshell Dredging and Barge Overflow, Military Ocean Terminal, Sunny Point, N.C. US Army Corps of Engineers Waterway Experiment Station, Vicksburg, MS, for US Army Engineer District, Wilmington, NC. In Preparation.

Payne, Ted M. and Ann Brown. 1983. Cultural Resources Survey: Reaves Point, Proposed Disposal Area 5 and Disposal Area 2 Project Areas, Military Ocean Terminal, Sunny Point, North Carolina. Report on file, US Army Corps of Engineers, Wilmington.

Payonk, P., M. Palermo, A. Teeter. 1988. Clamshell Dredging and Overflow Monitoring, Military Ocean Terminal, Sunny Point, N.C. in: Proceedings of the American Water Resources Association Symposium on Coastal Water Resources. W. Lyke and T. Hoban eds. May 1988. pp. 95-108.

Peddicord, R.K. and V.A. McFarland. 1978. Effects of Suspended Dredged Material on Aquatic Animals. Technical Report D-78-21. US Army Engineer Waterways Experiment Station, July 1978.

Pezeshki, S. R. and J. L. Chambers. 1986. Effect of soil salinity on stomatal conductance and photosynthesis of green ash (*Fraxinus pennsylvanica*). Canadian Journal Forest Resources 15:371.

Pezeshki, S. R., R. D. Delaune and W. H. Patrick, Jr. 1987a. Response of bald cypress (*Taxodium distichum L. var. distichum*) to increases in flooding salinity in Louisiana's Mississippi River deltaic plain. Wetlands 7(1):1-10.

Pezeshki, S. R., R. D. Delaune and W. H. Patrick, Jr. 1987b. Response of freshwater marsh species, Panicum hemitomon, to increased salinity levels. Freshwater Biology 16:569.

Phelps, David Sutton. 1976. An Archaeological Survey of the Lower Cape Fear Regional Water Supply System Project Area. *Archaeological Impact Studies No. 9.* Archaeological Research Laboratory, East Carolina University, Greenville, North Carolina.

Phelps, David Sutton. 1983. Archaeology of the North Carolina Coast and Coastal Plain: Problems and Hypotheses. In *The Prehistory of North Carolina: An Archaeological Symposium.* Mark A. Mathis and Jeffrey J. Crow, eds., pp. 1-51. North Carolina Division of Archives and History, Raleigh.

Pleasants, James A., Jr. 1977. A Brief Survey of Archival References Relating to Known Wrecks and Shipping Channel History from Wilmington to the Ocean Bar, 1624 - 1925. Manuscript on file, North Carolina Division of Archives and History, Raleigh.

Posey, M.H., T. D. Alphin, and C. M. Powell. 1996. Epibenthic Fauna in Shallow and Channel Habitats of the Lower Cape Fear River-May and October 1995 Sampling. Draft Final Report. Prepared for the Wilmington District Corps of Engineers by the Dept. of Biological Sciences, UNC-W, Wilmington, NC.

Preist, W.I. 1981. The Effects of Dredging Impacts on Water Quality and Estuarine Organisms: A Literature Review. in: A Study of Dredging Effects in Hampton Roads, VA, Final Contract Report for US Army Corps of Engineers, Norfolk District by the Virginia Institute of Marine Science, Walter I. Preist, III ed. March 1981. SRAMSOE No. 247.

Purcell, B.H. 1981. Effects of BTI on Aedes taeniorhynchus and some non-target organisms in the salt marsh.

Purvis, C. 1976. Nursery area survey of Northern Pamlico Sound and tributaries. N.C. Division of Marine Fisheries. Prepared for US National Marine fisheries Service.

Ragland, B.C., et al. 1987. Water Resources Data, North Carolina, Water Year 1987, US Geological Survey Water-Data Report NC-87-1, Raleigh, NC.

Rasmussen, B. 1967. The effects of underwater explosions on marine life. Bergen, Norway. 17 pp.

Ray, G.L. 1996. Benthic Characterization of the Wilmington Harbor and Cape Fear Estuary-March 1996. US Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

Raymond, G.L. 1984. Techniques to Reduce the Sediment Resuspension Caused by Dredging. Miscellaneous Paper HL-84-3. US Army Engineer Waterways Experiment Station, September 1984.

Reaves, William. 1988. History of Wilmington and the Lower Cape Fear. Lecture series. Cape Fear Community College, Wilmington, NC.

Research Triangle Institute. 1983. Contributions of State Ports to the North Carolina Economy.

Ross, S.W., F.C. Rohde, and D.G. Lindquist. 1988. Endangered, Threatened, and Rare Fauna of North Carolina. Part II. A Re-evaluation of the Marine and Estuarine Fishes. Occasional Papers of the North Carolina Biological Survey 1988-7, 20pp.

Rozas, L.P. 1982. Utilization of Oligohaline Intertidal Rivulets by Fishes and Macrofaunal Crustaceans in the Cape Fear River Estuary, North Carolina. M.S. Thesis, University of North Carolina at Wilmington, Wilmington, 74p.

Rozas, L.P. and C.T. Hackney. 1984. Use of Oligohaline Marshes by fishes and Macrofaunal Crustaceans in North Carolina. Estauries 7(3): 213-224.

Rubenstein, Paul D. 1982. An Archaeological Reconnaissance of the Ethyl-Dow Chemical Bromine Extraction Plant New Hanover County, North Carolina. Manuscript on file, US Army Corps of Engineers, Savannah.

Sacchi, Richard R., Terry H. Erlandson, Diana Lange, Richard Lawrence, David Moore, and Gordon Watts. 1980. An Archaeological Survey and Evaluation at Fort Fisher State Historic Site and Vicinity. Report prepared by the North Carolina Division of Archives and History, Raleigh.

Saltus, Allen R. 1982. Cultural Resources Survey of a Portion of the Northeast Cape Fear River and Report on the Test Excavation to Evaluate the Steamship SPRAY. Report prepared by Archeological Research and Survey for Atlantic Salvesen. Manuscript on file, North Carolina Division of Archives and History, Raleigh.

Schwartz, F.J., W.T. Hogarth, and M.P. Weinstein. 1981. Marine and Freshwater Fishes of the Cape Fear Estuary, North Carolina and Their Distribution in Relation to Environmental Factors. Brimleyana No. 7:17-37. July 1981.

Schwartz, F.J. 1995. Florida Manatees, *Trichechus manatus* (Sirenia: Trichechidae), in North Carolina 1919-1994. Brimleyana No. 22:53-60. June 1995.

Schwartz, F.J. 1996. Personal Communication. January 19,1996.

Sebastien, R.J. and R.A. Brust. 1981. An Evaluation of Two Formulations of *Bacillus thuringiensis var. israelensis* for Larval Mosquito Control in Sod-lined Simulated Pools. Mosquito News 41:508-511.

Settle, L.R. and J.D. Fuss. 1995. A summary of the larval ichthyofauna in the Cape Fear River estuary. Final Report submitted to the US Army Corps of Engineers, Wilmington District. 64 pp.

Smith, Hardy J. 1987. Estimating the Mechanical Dredgeability of Rock. Rock Mechanics: Proceedings of the 28th Symposium, University of Arizona. Edited by I.W. Farmer, J.J.K. Demen, C.S. Desai, C.E. Glass & S.P. Neuman, University of Arizona, Tuson. pp 945-952.

Snavely, Alan N. and Diana C. Gorin. 1974. Archaeological Reconnaissance of Carolina Beach and Vicinity, New Hanover County, North Carolina. Report prepared for the North Carolina Division of Archives and History, Raleigh.

South, Stanley A. 1977. *Method and Theory in Historical Archaeology*. Academic Press, New York.

Sprunt, James. 1896. *Tales and Traditions of the Lower Cape Fear, 1661- 1896*. Reprinted 1975 by The Reprint Co., Spartanburg, South Carolina.

Stern, E.M. and W.B. Stickle. 1978. Effect of Turbidity and Suspended Material in Aquatic Environments: Literature Review. Technical Report D-78-21. US Army Engineer Waterways Experiment Station, June 1978.

Stine, Linda F., Margaret L. Stephenson, Lesley M. Drucker, and Susan H. Jackson. 1990. Archaeological Inventory Survey and National Register Evaluations: Military Ocean Terminal, Sunny Point, New Hanover County, North Carolina. Report prepared by Carolina Archaeological Services, Columbia, South Carolina.

Strange, J.F. 1963. The attentuating effects of a bubble screen on underwater shock. Miscellaneous Paper No. 2-553. US Army Engineer Waterways Experiment Station (WES), Vicksburg, Mississippi.

Struhsaker, P. 1969. Demersal Fish Resources: Composition, Distribution, and Commercial Potential of the Continental Shelf Stocks of the Southeastern United States. US Fish and Wildlife Service, Fish. Ind. Res. 4:261-300.

TEG International, LTD. 1975. Environmental Impact Assessment of Alternatives for The Maintenance of Wilmington Harbor, North Carolina.

Tidewater Atlantic Research, Inc. 1995. Underwater Archaeological Assessment of Eight Magnetic Anomaly Locations within the Wilmington Harbor Channel Widening Project Area Below Wilmington, North Carolina.

US Army Corps of Engineers, Wilmington District. 1967. Carolina Beach and Vicinity, Area South of Carolina Beach, North Carolina, Design Memorandum.

US Army Corps of Engineers, Wilmington District. 1971. Fort Fisher and Vicinity, North Carolina - Survey Report of Beach Erosion Control.

US Army Corps of Engineers, Wilmington District. 1976. Cape Fear River Bottom Sample, Unpublished analysis of bottom samples.

US Army Corps of Engineers, Wilmington District. 1977. Final Environmental Statement-Maintenance of Wilmington Harbor, North Carolina.

US Army Corps of Engineers, Wilmington District. 1979. Feasibility Report, Wilmington Harbor, Northeast Cape Fear River, Wilmington, North Carolina.

US Army Corps of Engineers, Wilmington District. 1979. Grain Size Analysis, Bioassays, and Bioaccumulation Potential Assessment, Access Channels and Anchorage Basins, Military Ocean Terminal Sunny Point, N.C. Unpublished Data Provided by Jones, Edmunds, and Associates, Inc. Under Contract to the Wilmington District.

US Army Corps of Engineers, Wilmington District. 1980. Grain Size Analysis, Bioassays, and Bioaccumulation Potential Assessment - Smith Island and Baldhead Shoal Channels, Wilmington Harbor, North Carolina.

US Army Corps of Engineers, Wilmington District. 1980. Grain Size Analysis, Bioassays, and Bioaccumulation Potential Assessment, Smith Island and Baldhead Shoal Channels, Wilmington Harbor, N.C. Unpublished Data Provided by Jones, Edmunds, and Associates, Inc. Under Contract to the Wilmington District.

US Army Corps of Engineers, Wilmington District. 1982. Environmental Assessment, for Restoration of the Cape Fear River Pelican Islands, New Hanover and Brunswick Counties, North Carolina.

US Army Corps of Engineers, Wilmington District. 1986a. Grain Size Analysis, Chemical Analysis, Bioassay, and Bioaccumulation Potential Analyses for Keg Island Channel Sediments. Unpublished Data, September 1986.

US Army Corps of Engineers, Wilmington District. 1986b. Maintenance Dredging with Clamshell Dredge and Ocean Dumping, Keg Island to Snow Marsh Channels, Wilmington Harbor, North Carolina. Environmental Assessment. November 1986.

US Army Corps of Engineers, Wilmington District. 1988. Wilmington Harbor - Northeast Cape Fear River, General Design Memorandum, Wilmington District, Wilmington, NC.

US Army Corps of Engineers, Wilmington District. 1989. Final EIS - Long-Term Maintenance of Wilmington Harbor, NC, Wilmington District, Wilmington, NC.

US Army Corps of Engineers, Wilmington District. 1989. Wilmington Harbor-Baldhead Island, Wilmington, N.C. Reconnaissance Report, Section 111, PL 90-483. January 1989.

US Army Corps of Engineers, Wilmington District. 1990. Final Supplement to the Final Environmental Impact Statement, Wilmington Harbor-Northeast Cape Fear River, North Carolina.

US Army Corps of Engineers, Wilmington District. 1991. Reconnaissance Report on Improvement of Navigation, Cape Fear River-Northeast Cape Fear Rivers, Comprehensive Study, Wilmington Harbor, Wilmington, North Carolina.

US Army Corps of Engineers, Wilmington District. 1994. Interim Feasibility Report and Final Environmental Impact Statement on Improvement of Navigation, Wilmington Harbor Channel Widening, Wilmington, North Carolina.

US Army Corps of Engineers, Wilmington District. 1994. Environmental Assessment, Beneficial Use of Dredged Material, Wilmington Harbor Offshore Fisheries Enhancement Structure, Wilmington Harbor Ocean Bar Channel Deepening, Wilmington, North Carolina.

US Army Corps of Engineers, Wilmington District. 1996a. April 9, 1996 letter from C.E. Shuford, Jr. P.E, Acting Chief, Engineering and Planning Division, with enclosures regarding additional surface water model results and preliminary groundwater model results.

US Army Corps of Engineers, Wilmington District. 1996b. Management recommendations for Eagle Island Confined Disposal Facility, mosquito surveillance and control, Brunswick and New Hanover Counties, Prepared by Brunswick County, New Hanover County, the State of North Carolina, and the US Army Corps of Engineers.

US Army Corps of Engineers. 1983. Hydraulic Design of Deep-Draft Navigation Projects, EM 1110-2-1613, Washington, DC.

US Army Engineer, Waterway Experiment Station. 1974. Containment Area Facility Concepts for Dredged Material Separation, Drying, and Rehandling, W. W. Mallory and M. A. Newrocki; Hittman Associates, Inc., Dredged Material Research Program. Contract Report D-74-6.

US Environmental Protection Agency. 1983. Final Environmental Impact Statement, Savannah, Georgia; Charleston, South Carolina; and Wilmington, North Carolina, Ocean Dredged Material Disposal Site Designation. October 1983.

US Environmental Protection Agency. 1989. Biological and Chemical Assessment of Sediments from Proposed Dredge Sites in the Military Ocean Terminal, Sunny Point, N.C. Environmental Research Laboratory, Gulf Breeze, Florida.

US Environmental Protection Agency. 1990. Studies with Sediment from the Proposed Wilmington Harbor Passing Lane, N.C., and Representative Marine Organisms. Environmental Research Laboratory, Gulf Breeze, Florida.

Van Dolah, R.F., R.M. Martore, A.E. Lynch, P.H. Wendt, M.V. Levisen, D.J. Whitaker, and W.D. Anderson. 1994. Environmental evaluation of the Folly Beach project. Final report, US Army Corps of Engineers, Charleston District and the South Carolina Department of Natural Resources, Marine Resources Division.

Walburg, C.H. and P.R. Nichols. 1967. Biology and Management of the American Shad and Status of the Fisheries, Atlantic Coast of the United States. 1960. US Fish and Wildlife Service, Spec. Sci. Rpt. Fish. No. 550 p35-38.

Ward, J.A., M.R. Pinza, M.E. Barrows, and J.Q. Word. Ecological Evaluation of Proposed Dredged Material From Wilmington Harbor and Military Ocean Terminal, Sunny Point, North Carolina. May 1993. Prepared for the US Army Corps of Engineers - North Carolina District Under a Related Services Agreement with the US Department of Energy Contract DE-AC06-76RLO 1830 by Battelle, Pacific Northwest Laboratory, Richland, Washington 99352.

Watts, Gordon P., Jr. 1975. Magnetometer Survey of the Brunswick Town Waterfront: Report of Activities of the 1975 Field School in Underwater Archaeology. North Carolina Division of Archives and History, Underwater Archaeology Unit, Kure Beach.

Watts, Gordon P., Jr. 1988. Archaeological Reconnaissance of the Wilmington Harbor/Northeast Cape Fear River. Final report prepared for the Wilmington District Corps of Engineers by Tidewater Atlantic Research, NC, Washington, N.C.

Watts, Gordon P., Jr. 1990a. An Underwater Archaeological Investigation of the Hilton Wreck, Wilmington, North Carolina. Report prepared by Tidewater Atlantic Research, Inc., Washington, North Carolina.

Watts, Gordon P., Jr. 1990b. A Report on Magnetic and Acoustic Targets Identified by Remote Sensing Investigation of Six Turns and Proposed Passing Lanes in the Shipping Channels of the Cape Fear River Below Wilmington, North Carolina. Tidewater Atlantic Research, Inc., Washington, North Carolina.

Watts, Gordon P., Jr. 1993. A Submerged Cultural Resource Survey of Baldhead Shoal Channel, Vicinity of Wilmington North Carolina. Report prepared for the Wilmington District Corps of Engineers by Tidewater Atlantic Research, Washington, N.C.

Watts, Gordon P., Jr. 1994. A Remote Sensing Survey and Diver Investigation at Wilmington Harbor Offshore Fishery Enhancement Structure, Vicinity of Wilmington, North Carolina. Report prepared for the Wilmington District Corps of Engineers by Tidewater Atlantic Research, Washington, N.C.

Watts, Gordon P., Jr. 1995a. Underwater Archaeological Assessment of Eight Magnetic Anomaly Locations within the Wilmington Harbor Channel Widening Project Area Below Wilmington, North Carolina. Final report prepared for the Wilmington District Corps of Engineers by Tidewater Atlantic Research, Washington, N.C.

Watts, Gordon P., Jr. 1995b. Underwater Archaeological Assessment of Four Target Locations at Smith Island Channel, Wilmington Harbor, North Carolina. Final report prepared for the Wilmington District Corps of Engineers by Tidewater Atlantic Research, Washington, N.C.

Weinstein, M.P. 1979. Shallow marsh habitats as primary nurseries for fish and shellfish, Cape Fear River, North Carolina. Fisheries Bulletin 77(2)339-357.

Weinstein, M.P., S.L. Weiss, R.G. Hodson, and L.P. Gerry. 1980. Retention of Three Species of Postlarval Fishes in an Intensively Flushed Tidal Estuary, Cape Fear River, North Carolina. Fisheries Bull. 78(2)419-436.

Welch, J.M. and B.B. Parker. Circulation and Hydrodynamics of the Lower Cape Fear River, North Carolina, National Oceanic and Atmospheric Weinstein, M.P. 1979. Shallow Marsh Habitats as Primary Nurseries for Fish and Shellfish, Cape Fear River, North Carolina. Fisheries Bull. 77(2)339-357.

Wilde-Ramsing, M. 1984. Archaeological survey and testing on prehistoric shell midden sites in New Hanover County, North Carolina. Unpublished MA thesis. Catholic University, Washington, D.C.

Wilde-Ramsing, Mark. 1995. Presentation to the 1995 North Carolina Maritime History Workshop, Beaufort.

Wilmington - New Hanover County Land Use Update. 1993. Policies for Growth and Development. Prepared by the New Hanover County Planning Department. 63pp.

Woodward-Clyde Consultants. 1980. Aquatic and Terrestrial Ecology. Prepared for Brunswick Energy Company.

Wright, D.G. 1982. A discussion paper on the effects of explosives on fish and marine mammals in the waters of the Northwest Territories. Can. Tech. Rep. Fish. Aquat. Sci. 1052: v + 16 pp.

Young, G.A. 1991. Concise method for predicting the effects of underwater explosions on marine life. Naval Surface Warfare Center. NAVSWC MP 91-220. 22pp.

ATTACHMENT A

COMMENT/RESPONSES
ON THE
DRAFT ENVIRONMENTAL IMPACT STATEMENT

CAPE FEAR-NORTHEAST CAPE FEAR RIVERS
COMPREHENSIVE STUDY
NORTH CAROLINA

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I. INTRODUCTION.

This attachment includes all comments on the Draft EIS, and responses by the U. S. Army Corps of Engineers, (USACE) Wilmington District. The first portion of this attachment includes the appropriate USACE responses to the written comments. The second portion of this attachment contains comments received in writing. These comments are listed in the following order: Federal, State and local agencies; and the public.

Each agency or public entity was numbered and identified by the usual acronym or abbreviation. Individual comments within each letter have been given a numeric identification. Thus, the comment letter from the US Environmental Protection Agency is designated II.4. USEPA (i.e., Section II, letter number 4, from the US Environmental Protection Agency). A letter with more than one comment will bear designations like 1, 2, and so on. These numeric designations correspond to the responses that follow each letter.

In order to reduce repetition, responses will be made once to a comment and a particular issue. If the issue appears again, in another letter, the reader will be referred to the initial comment. In many instances, our response to a comment is indicated as "noted." Noted means that the comment was evaluated and it will be considered in making the final design of the proposed action.

II. FEDERAL AGENCIES

The following Federal Agencies responded to the Draft Environmental Impact Statement (EIS) for the Cape Fear-Northeast Cape Fear Rivers, Comprehensive Study, Wilmington, North Carolina, dated January 1996:

1. US Department of Housing and Urban Development, Southeast/Caribbean, Environmental Division. Letter dated March 1, 1996, from Mr. Thomas A. Ficht, Supervisory Environmental Officer. (USDHUD)

2. US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office. Letter dated March 15, 1996, from Mr. Andreas Mager, Jr., Assistant Regional Director, Habitat Conservation Division. (NMFS)

3. US Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Survey. Letter dated March 26, 1996, from Captain Lewis A. Lapine, Director, National Ocean Survey. (NOS)

4. US Environmental Protection Agency, Region IV. Letter dated April 5, 1996 from Mr. Heinz J. Mueller, Chief, Environmental Policy Section, Federal Activities Branch. (USEPA)

5. US Environmental Protection Agency, Region IV. Letter dated April 2, 1996 from Mr. Heinz J. Mueller, Chief, Environmental Policy Section, Federal Activities Branch. (USEPA)

6. US Department of the Interior, Office of the Secretary, Office of Environmental Policy and Compliance. Letter dated March 29, 1996 from Mr. James H. Lee, Regional Environmental Officer Director. (USDOI)

RESPONSES TO THE FEDERAL AGENCIES COMMENT LETTERS

II.1. USDHUD

1. Noted.

II.2. NMFS

1. Section 5.02 of the Draft EIS discussed at length the potential impacts of the proposed project on larval and juvenile fishery resources in the Cape Fear River Estuary.

2. Noted.

3. Disagree. The USACE has considered the impacts of blasting on larval life forms and juvenile fish. Please review Section 5.02 in the Draft and Final EIS. Blasting impacts on these larval life forms were not considered significant for the following reasons: a) the daily blast(s) will take up less than 0.00462 percent (less than 5 one-thousands of 1 percent) of the day, b) about 0.06 percent (6 one-hundredths of 1 percent) of the larvae in the ship channel will be affected by an individual blast, c) the daily mean average density of larvae in the Cape Fear River is 1902/1000 cubic meters (CP&L, 1994), and d) natural larval mortalities may approach 99 percent (Dew and Hacked, 1994). Moreover, the USACE has decided to implement the following protective measures in order to minimize impacts:

a. Each hole will be stemmed and a delay will be installed per hole, and a bubble curtain and/or physical barrier will be placed completely around the blast area (about 35,000 square feet).

b. Dredging and blasting will be conducted during the NCDMF dredging window (August 1 through January 31), whenever possible.

4. See response to paragraph 3, above.

5. A staged approach is not warranted because impacts to fishery resources are not considered significant (paragraph 3 above), and a staged approach will significantly increase cost.

6. Noted

7. Additional information has been received on the model since the publication of the Draft EIS. The results were used to augment Section 5.02 of the Final EIS.

8. As indicated in Section 5.02, "The contractor will be required to monitor the reduction in the pressure wave for each blast and report the results of each blast to the Corps of Engineers to assure that 95 percent or greater reduction is met." The USACE has stated in this section that even if the 35,000-square-foot blast area was multiplied by a factor of ten (i.e., approximately 8 acres within the blast area), only 0.6 percent (6/10 of one percent) of the larvae in the ship channel will be affected by a blast. Moreover, there are a number of islands located between the ship channel and the primary nursery areas in the Cape Fear River. These islands will act as physical barriers and will absorb all

of the resultant blast pressure wave.

9. We agree. The St. Louis District (SLD) model does not and can not be used to assess the impacts of fish smaller than 0.125 pound. The SLD model lower limit is for a 0.125 pound fish, it does not go any smaller. Neither Tables 6 nor 7 in the Draft EIS can be expanded to include the fish weights outlined in your comment. The SLD model assumes that anything within the 35,000-square-foot blast area will be impacted, whether the fish are at the top or bottom of the water column. As indicated in Section 5.02, "Studies have shown that the degree of impact experienced by fish as a result of explosions is determined by several factors including physical characteristics of the fish, the weight of the explosive charge, and the distance of the fish from the charge. Swimbladder fish have been found to be more susceptible to damage from shock waves than non-swimbladder fish (most common estuarine fish except flounders have swimbladders), and smaller fish are more susceptible to damage than larger fish of the same species (Wright, 1982). Larval fish are less sensitive to the effects of shock waves than eggs or than post-larval fish in which the swimbladder has developed (Rasmussen, 1967; as cited in Wright, 1982). The damaging effects on marine life increase in relation (but not in direct proportion) to increasing the weight of the explosive charge. The shock wave from an underwater explosion diminishes over distance at a rate proportional to the cube root of the weight of the explosive charge. Therefore, the peak pressure generated by an 8-pound charge at a specific distance is only about twice the peak pressure of a 1-pound charge at the same distance (2 is the cube root of 8). Thus, doubling the weight of an explosive charge does not double the impact to marine life (Young, 1991). Also, the further an animal is located from an explosive charge, the greater will be its chances of survival."

The USACE did not use the SLD model to assess impacts to larval and juvenile fishes. Please review our response to paragraph 3, above.

10. See response to paragraph 9, above.

11. Whether they are at the surface or the bottom, all larval and juvenile fishes within the 35,000-square-foot blast area will be impacted. As indicated in paragraph 3, above, these impacts are not considered significant.

12. Noted.

13. We disagree. The proposed pre and post monitoring plan will not address the need to assess the impacts to larval and juvenile fishes, since those impacts are not significant. Additionally, the USACE is using all available mitigative techniques to reduce the blasting impacts to the Cape Fear River estuary (i.e., stemming each hole, placing a delay per hole, installing a bubble curtain and/or a physical barrier around the blast area, and working within the NCDMF window (August 1 through January 31)). However, we will continue to work with representatives of NMFS, USEPA, USFWS, NCDEM, NCDCM, NCDMF, and NCWRC to **finalize the pre- and post blast monitoring plan.**

II.3. NOS

1. Project construction is scheduled to begin in FY 2001, accordingly there is still adequate time to assess any possible impacts of the project on NOAA monuments. Two construction activities could have an impact on the NOAA monuments, namely, rock blasting and material disposal. At this time, we are reasonably sure where most of the blasting is likely to occur; however, additional

subsurface investigations will be conducted during the next phase of the project development which will further refine our estimates of where blasting will be required. Once all of the blasting information is developed, an assessment can be made of possible monument disturbance that could result from this activity. With respect to material disposal, we are presently planning to dispose of the new work material in the same manner as presently used to maintain the existing harbor project. Therefore, disposal activities should not adversely affect the NOAA monuments. If the disposal plan changes during the next phase of the project development, the information provided by NOAA on monument location will be used to determine if any monuments will be disturbed.

2. Since monument disturbance is not considered likely, costs to replace damaged or destroyed monuments are not included in the project cost estimate.

3. We agree that post completion surveys will be required. However, the document does not discuss 11 inshore disposal areas. The proposed action will dispose of dredged material either in one upland disposal site, Eagle Island, or in the EPA designated Ocean Dredged Material Disposal Site (ODMDS). Most of the excavated rock will be placed in the existing Wilmington Offshore Fisheries Enhancement Structure (WOFES).

4. Agreed.

5. See response to paragraph 1, II.2. NMFS.

6. See response to paragraph 2, II.2. NMFS.

7. See response to paragraph 3, II.2. NMFS.

8. See response to paragraph 4, II.2. NMFS.

9. Based on the numerical model results performed by the Waterways Experiment Station (WES), tides and currents are likely to change in the Cape Fear and Northeast Cape Fear Rivers as a result of the harbor deepening project. The degree of change is uncertain, but, according to the WES numerical model, the average tide range could increase by 4 inches depending on location within the rivers. There could also be some shift in the tide phasing and currents. Therefore, NOAA's concerns are legitimate.

10. Noted.

11. Additional model results indicate that the average tidal range will increase about 4 inches in the Wilmington area, and under normal conditions the salinity conditions in the river will be essentially unchanged. These results are indicated in Section 5.01 of the final EIS. The salinity conditions indicated in Section 5.01 of the Draft EIS were changes associated with about a 10 year low flow. The model did not predict tidal current changes.

12. Noted.

13. See response to 14. below.

14. While there may be a need to revise the tide prediction tables, the revisions should not occur until the deepening project is complete and tides in the river have had a chance to adjust to the

new channel conditions. In this regard, NOAA has maintained a tide gage at the USACE Engineer Yard for a considerable length of time. It would seem possible to evaluate the changes, if any, at this gage site to determine if significant tide changes did occur as a result of the deepening project. If significant changes do occur, then a tide gauging program should be established to redefine the tidal components in the system. This activity should be a joint effort between the USACE and NOAA. In any event, revision of the tide and tidal current tables will require a considerable amount of time, and during the interim, mariners will have to make their own adjustments based on experience.

15. Installation of NOAA's Physical Oceanographic Real-Time System (PORTS) for the Cape Fear-Northeast Cape Fear River project would primarily benefit the port users. Therefore, any decision regarding the use of PORTS in Wilmington Harbor would have to be made by and funded by non-Federal interest.

16. See response to 14, above.

17. See response to paragraph 5, II.2. NMFS.

18. See response to paragraph 6, II.2. NMFS.

19. See response to paragraph 7, II.2. NMFS.

20. See response to paragraph 8, II.2. NMFS.

21. See response to paragraph 9, II.2. NMFS.

22. See response to paragraph 10, II.2. NMFS.

23. See response to paragraph 11, II.2. NMFS.

24. See response to paragraph 12, II.2. NMFS.

25. See response to paragraph 13, II.2. NMFS.

II.4. USEPA

1. Noted.

2. The 2,800 acres of habitat referenced in this comment is not a part of the proposed project. The project the 2,800 acres of habitat is associated with is described in: US Army Corps of Engineers, Wilmington District. 1990. Final Supplement to the Final Environmental Impact Statement, Wilmington Harbor-Northeast Cape Fear River, North Carolina.

3. See response to paragraph 2, above.

4. Noted, but see response to paragraph 2, above.

5. Response to EPA's letter of April 2, 1996 concerning blasting impacts for the Wilmington Harbor Channel Widening are provided in part II.5. USEPA, below.

6. The project will impact less than 0.2 acres of marsh. We proposed to mitigate for this loss as indicated in Section 5.06 and Attachment D of the Final EIS. Using dredged material for creation of marsh habitat is feasible and has been performed in many areas in the US. However, dredged material adjacent to Eagle Island and many of the islands downstream is dominated by silt. Such dredged material is not conducive to the creation of marsh.

7. See response to paragraph 6, above.

8. Noted.

9. The number of vessel trips will probably not change appreciably. With the deeper draft project constructed, vessels will not be light-loaded and ,thus, will carry more tonnage per vessel trip. Therefore, the number of vessels calling on Wilmington will not be greater to transport the same or a reasonable increase in tonnage, and the likelihood for accidents should not change appreciably. The US Coast Guard as well as the insurance companies of the ship owners have provisions to cover these concerns.

10. As indicated in Section 3.10 of the Draft EIS, the volume of dredged material in Table 4 is about 10 percent greater than existing maintenance volumes. The maintenance and new work dredging will be performed at the same time in order to reduce mobilization costs for the dredges.

11. See response to paragraph 10, above. The movement of sediments from the ODMDS is not anticipated to adversely impact the WOFES. Therefore, continued placement of the dredged material in the ODMDS should not be a problem.

12. The ocean channel prism will widen due to increased depth. The ocean channel will also be lengthened. This increased depth, width and length is anticipated to increase sedimentation by about 10 percent.

13. Agreed. See Section 3.07 of the Final EIS.

14. Agreed.

15. Turbidity will be controlled to the extent practicable. Except for bucket and barge dredging, no dredging or blasting will be conducted in the river during the NCDMF dredging window (August 1 to January 31) to the maximum extent practicable. Bucket and barge dredging will not be conducted within 100 yards of a primary nursery area. Even then, the tidal currents are parallel to the primary nursery areas (PNA) which should preclude most of any turbidity plume from entering the PNA .

16. The monitoring plan has not been finalized, but will be until fully coordinated with all concerned agencies. The blast turbidity plume can not be contained, but no blasting will be conducted during the NCDMF dredging window (August 1 to January 31). The tidal currents are parallel to the PNA which should preclude most of any turbidity plume from entering the PNA .

17. Additional discussion on the no-action alternative will be added to the Final EIS.

18. Sublethal effects are hard to determine and or model accurately. Therefore, bubble curtains, single delays per hole, stemming each hole, seasonal restrictions, and observers are to be

used to reduce potential impacts to the maximum extent feasible.

19. Gill nets have been used effectively in the Cape Fear River, with minimum impact to the shortnose sturgeon (Moser and Ross, 1993).

20. Additional information has been added to the cumulative impact section since supplemental information has been developed on the groundwater and surface water models. However, the cumulative impacts of the proposed project are still not considered significant. Therefore, the detail you requested is not warranted.

21. The discussion in Sections 5.01 and 5.04 of the EIS indicates the impacts of bucket and barge dredging.

22. Noise is not indicated to be a significant problem as indicated in Section 5.15 of the EIS.

II.5. USEPA

1. Noted.

2. We will continue to work with representatives of the USEPA, NMFS, NCWRC, NCDMF, NCDCM, and NCDEM in order to finalize the monitoring plan.

3. Noted. The USACE is aware of this matter and has discussed these conditions with the USEPA staff.

4. This office is working very closely with Mr. Doug Johnson and will abide by the findings of the proposed Site Management and Monitoring Plan (SMMP) for the Wilmington Harbor. It is noted that the SMMP will be used for subsequent concurrence under Section 103 of Marine Protection, Research, and Sanctuaries Act (MPRSA).

5. Noted. As indicated in Section 3.06, "Normal industry procedure requires that the contractor perform limited onsite blasting tests and adjust the final (blasting) plan to actual site conditions, ..." The USACE believes that blasting is required to remove the non-dredgeable rock. During the limited onsite blasting tests, we will test the effectiveness of the bubble curtain and/or physical barrier. The contractor could set up a series of hydrophones within and without the blast area to measure the effectiveness of the bubble curtain and/or physical barrier.

6. Noted.

7. Noted.

II.6. USDOI

General Comments:

1. Noted. We always give a thorough consideration of the environment during planning in order to avoid and minimize impacts.

2. Noted.

3. Agreed.

4. As detailed below and in the EIS, the Corps will take all appropriate measures to minimize adverse impacts to all resources including fisheries, sea turtles, and marine mammals.

5. There is no evidence of contaminated sediments in the harbor. As indicated in Sections 4.02 and 5.16 of the EIS, the dredged material for ocean disposal have been previously evaluated (Ward et al, 1993). These site-specific test results indicate that the maintenance sediments meet the testing criteria of the EPA Ocean Dumping Regulations and Criteria and are, therefore, acceptable for transportation for ocean dumping under Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972, as amended. USEPA, Region IV, concurred with this determination by letter dated December 21, 1993. Based on these results, the new work material should also be acceptable for ocean disposal. The dredged material to be placed in CDF's was evaluated using Section 404(b)(1) guidelines (40 CFR 230), which implement environmental protection provisions of the Clean Water Act. These evaluations consider potential contaminants and potential migration pathways of contaminants to the environment when evaluating dredging and dredged material disposal alternatives. The Ocean Dumping Regulations and Section 404(b)(1) guidelines result in an equivalent level of environmental protection as will occur under a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or Resource Conservation and Recovery Act (RCRA) investigation. Based on appropriate dredged material evaluations, there is no reason to believe that the material within the Wilmington Harbor project is contaminated. There is no reason to believe that contaminants will be mobilized in the environment as a result of the dredging, blasting, and dredged material disposal.

6. See response to comment 5, above. As indicated in Section 4.02 of the EIS, appropriate testing of the new work material for disposal in the Wilmington ODMDS will be performed prior to construction.

7. Eagle Island is the only proposed upland disposal area that is planned to be used for construction of the project. No colonial waterbirds nest on this disposal island. We have historically renourished two colonial waterbird nesting islands in the lower Cape Fear River. As indicated in Section 3.07 of the EIS, this option will be considered as a management measure and will be coordinated with natural resource agencies prior to any disposal.

8. The potential impacts of the proposed dredging methods are fully discussed in Sections 5.01, 5.02 and 5.03 of the EIS. Since this will be the first operation where bucket and barge operations do not have seasonal restrictions, trained observers will be on board for the first year of construction to watch for listed species and record any species taken by the dredging operation. If a manatee is observed within 100 yards of dredging operations, all operations will cease until the manatee has left the area. As indicated in Attachment C, during blasting trained observers will watch for species of concern and delay blasting until the species has left the area.

Manatees are rare visitors to the Cape Fear River Region. From 1952 to 1994, there have been only 7 known observations in the Cape Fear System (Schwartz, 1995). One of these manatees was dead (1986) but no data were gathered on the cause of death (Schwartz, 1996). Three additional live manatees have been sited in Wilmington Harbor since the Schwartz publication. One was sited near Southport in the Fall of 1995, and two (probably a calf and its mother) were sited near

Wilmington in the Spring of 1996. Except for the 1996 siting, each siting in the Cape Fear Region has been of a single manatee. During the most frequent period of observations (1993-1996), there was one observation per year except for the 1996 siting. All dredging locations are in the existing ship channel, 38 feet deep or greater, where no possible food source exists. Thus, any manatee that may come close to a dredge will be a transient. Dredging, commercial, and recreational traffic have existed in the Wilmington Harbor Channel for decades with no known injury or mortality attributed to dredging activities. Therefore, we do not believe that standard manatee conditions (such as idle speeds, and signs) should be enforced in Wilmington Harbor. However, as indicated above for bucket and barge dredging, if a manatee is observed within 100 yards of any dredging operation, all operations will cease until the manatee has left the area. Any observations of or injuries to manatees will be reported to the USFWS.

9. As indicated in Appendix G of Volume II of the report, our data indicates that blasting will be required.

10. The District proposes to blast within the August 1 through January 31 dredging window proposed by the NCDMF. An observer program for endangered and threatened species, as well as marine mammals (including manatees and dolphins) will be instituted. This observer program will ensure that these species are not present within the blast impact zone or adjacent areas (Attachment C of the EIS).

Due to the infrequent observations of manatees in the harbor (see response 8, above), and low frequency of occurrence of sea turtles in the upper estuary (where blasting is to occur), reducing the blasting period to 4 months is not warranted. In addition, the full 6-month window for blasting each of the 3 construction years is needed to accomplish the anticipated number of blasts. Even with this 18-month period multiple drilling platforms and crews will be required.

11. Agreed.

12. Agreed.

13. See Table 7 of the EIS for fish. Normal industry procedure requires that the contractor perform limited onsite blasting tests and adjust the final (blasting) plan to actual site conditions. During the limited onsite blasting tests, the effectiveness of the bubble curtain and/or physical barrier will be tested. As indicated in Section 5.02 and Attachment C, the contractor will be required to reduce the pressure wave created by the blast by ≥95 percent. This could be done by setting up a series of hydrophones within and without the blast area to measure the effectiveness of the bubble curtain and/or physical barrier. An appropriate pre-blast monitoring area will be coordinated with all concerned agencies; however, with the use of bubble curtains that must contain ≥95 percent of the pressure wave, the area of impact should be much smaller than that indicated in Table 7 of the EIS (34.5, acres, 656-foot radius) for LD 1 percent (0.125 pound fish). If there is no take of listed species or other significant resources within the first series of blasts (e.g., 30), we propose to reduce the monitoring zone to the immediate vicinity of the bubble curtains (e.g., 300-foot radius from the bubble curtain).

14. See response to 13, above.

15. An appropriate monitoring plan will be coordinated with all interested agencies. The preliminary plan is included in Attachment C.

16. Agreed. See response to 15, above.

17. Agreed. See response to 15, above.

18. Agreed.

19. Noted.

20. Agreed.

21. Agreed. An additional mitigation option is discussed in Attachment D of the Final EIS.

22. See response 23, below.

23. The full text of the 1996 Corps memorandum regarding increased ship draft and potential for shoreline erosion has been included in Section 5.05 of the Final EIS.

24. See response 25, below.

25. There is no direct relationship between the proposed modifications to the navigation channel and the existing long shore sediment transport system associated with the beaches adjacent to the mouth of the Cape Fear River. In other words, the channel is so deep now that dredging 4 feet deeper will trap no more sand than the current deep channel.

26. The preliminary results of the groundwater model were presented at the April 18, 1996 agency meeting in Wilmington, North Carolina. The results are summarized in Section 5.01 of the Final EIS. These results do not indicate any significant changes in water levels or chloride concentrations.

27. See response 26, above. Additional model results will be fully coordinated.

28. Noted. Additional model results are provided in Section 5.01 of the Final EIS.

29. The surface water salt water intrusion modeling effort will be completed and a report prepared. The report will be provided to all interested groups for review and comment.

30. As indicated in response 28, additional model results are provided in Section 5.01 of the Final EIS. The isohalines presented are surface values, because surface concentrations are most likely to affect vegetated areas. However, other depth values could also be presented. The results of a more average flow indicate salt water moves further downstream versus low flows and that the base and project isohalines are closer together. Higher flows will push salt water further downstream and cause the base and project isohalines to be even closer together. We do not anticipate the proposed project to cause significant reduction in oxygen concentration in deeper waters.

31. We agree that a monitoring program is needed. As indicated in Section 5.01 of the Final EIS, we realize there is some uncertainty in the surface saltwater intrusion model results. Therefore, we commit to a pre-and post-monitoring effort in the potentially affected area. This monitoring could include changes in tide levels, soil pore water chemistry and vegetation on selected plots, and other appropriate items. Details of this monitoring effort will be developed in coordination with all known

interested parties. Results will also be coordinated with all known interested parties to determine if impacts different than those anticipated have occurred.

32. Noted.

33. The number of vessel trips will probably not increase appreciably. With the deeper draft project constructed, vessels will not be light-loaded and thus will carry more tonnage per vessel trip. Therefore, the number of vessels calling on Wilmington will not be greater to transport the same or a reasonable increase in tonnage, and the likelihood for accidents should not change appreciably. The Corps' Federal authority does not cover your areas of concern. The US Coast Guard as well as the insurance companies of the ship owners have provisions to cover these concerns.

34. See response 33, above.

35. Noted. See responses to 36-39, below.

36. Sections 5.01 and 5.11 of the EIS adequately addresses the potential cumulative impacts of the proposed projects in Wilmington Harbor. The 4.7 acres of estuarine bottom mentioned will not be eliminated, it will only be converted from slightly less than 10 feet deep to slightly more than 10 feet deep.

37. The incremental increase in large boat wakes of 1 percent is not considered significant. This 1 percent increase will be lost in the "noise" of numerous recreational craft using the harbor and wind generated waves. The number of vessel trips will probably not change appreciably. With the deeper draft project constructed, vessels will not be light-loaded and thus will carry more tonnage per vessel trip. Therefore, the number of vessels calling on Wilmington will not be greater to transport the same or a reasonable increase in tonnage.

38. Additional model results indicate that under normal conditions the salinity conditions in the river will be essentially unchanged. These results are indicated in Section 5.01 of the Final EIS. Also as indicated in Section 5.01 of the Final EIS, we realize there is some uncertainty in the surface saltwater intrusion model results. Therefore, we commit to a pre- and post-monitoring effort in the potentially affected area. This monitoring could include changes in tide levels, soil pore water chemistry and vegetation on selected plots, and other appropriate items. Details of this monitoring effort will be developed in coordination with all known interested parties. Results will also be coordinated with all known interested parties to determine if impacts different than those anticipated have occurred.

39. See responses 26 for groundwater, 25 for longshore transport and 33 for shipping accidents, above.

40. Noted.

41. Agreed. The potential for this alternative disposal method is discussed in Section 3.07 of the EIS.

42. Agreed. As indicated in Section 3.07 of the EIS, renourishing the colonial waterbird nesting islands is a disposal alternative being considered. Renourishing of this islands has occurred with past maintenance actions and will be evaluated for all construction and maintenance actions.

43. Agreed. Construction of the WOFES is discussed in Section 3.06 of the EIS. The construction of the WOFES will be coordinated with all appropriate agencies. None of the rock proposed for disposal in the WOFES will contain contaminated material.

44. The 2,800-acre tract was not proposed to mitigate direct impacts of the proposed Wilmington Harbor - Northeast Cape Fear River project. Therefore, this tract is considered a "separable" element. The current Corps of Engineers policy is that this tract remains "unscheduled".

45. Noted.

46. Noted.

47. Noted.

48. Noted. See response 1, above.

49. Noted. See response 13, above.

50. These issues have been addressed in several responses, above.

51. These issues have been addressed in several responses, above.

52. Noted.

III. STATE AND LOCAL AGENCIES

The following State and local agencies responded to the Draft EIS for the Wilmington Harbor Channel Widening, New Hanover and Brunswick Counties, North Carolina, dated February 1996:

1. North Carolina State Clearinghouse, Department of Administration. Memorandum dated April 10, 1996 from Mrs. Chrys Baggett, Director, with the following comments:

a. N.C. Department of Environment, Health and Natural Resources, Legislative and Intergovernmental Affairs. Memorandum dated April 10, 1996 from Ms. Melba McGee, Project Review Coordinator. (NCLI)

b. N.C. Department of Environment, Health and Natural Resources, Division of Environmental Management. Memorandum dated April 2, 1996, from Mr. Greg Price. (NCDEM)

c. N.C. Wildlife Resources Commission. Memorandum dated March 22, 1996, from Mr. Bennett Wynne. (NCWRC)

d. N.C. Department of Environment, Health and Natural Resources, Division of Coastal Management. Memorandum dated March 8, 1996, from Mr. Steve Benton. (NCDCM)

e. N.C. Department of Cultural Resources, Division of Archives and History. Letter dated March 27, 1996, from David Brook, Deputy State Historic Preservation Officer. (NCDCR)

2. N.C. Department of Environment, Health and Natural Resources, Division of Coastal Management. Memorandum dated April 24, 1996, from Mr. Steve Benton. (NCDCM)

3. N.C. Department of Cultural Resources, Division of Archives and History. Memorandum dated May 1, 1996, from David Brook, Deputy State Historic Preservation Officer. (NCDCR)

RESPONSE TO THE STATE AND LOCAL AGENCIES COMMENTS

III.1.a. NCLI

Noted.

III.1.b. NCDEM

1. Noted.

2. We clearly prefer that the work be accomplished by dredging only. However, numerous factors affect the dredgeability of rock, and the analysis in Appendix G, Volume II of the report indicates that blasting will be required. We will attempt to ensure that no more rock is blasted than is realistically required, and we will employ seasonal restrictions and mitigative measures, such as stemming each hole, inserting a delay within each hole, and constructing an air/bubble curtain and/or a physical barrier around the 35,000-square-foot blast area.

3. The USACE is working and will continue to work with NMFS, USFWS, NCDMF, NCDCM, and the NCDEM in resolving these issues regarding blasting impacts and toward the development of a blast monitoring plan. As indicated in Abstract to the Draft EIS, Local interests, represented by the North Carolina State Ports Authority, North Carolina Division of Water Resources, the Cape Fear River Pilots Association, and other shipping interests have requested that the USACE study the deepening of the Wilmington Harbor Ship Channel. The State of North Carolina is the cost sharing partner with the USACE on this project and will share in all project costs.

4. Noted.

5. Noted.

III.1.c. NCWRC

1. Noted.

2. Noted.

3. No colonial water birds nest on the disposal islands we are considering to use for mitigation.

4. Large vessels that are currently light-loaded will be fully loaded with the proposed project in place. However, since the under the hull clearance will remain about the same, vessel speeds are not anticipated to increase as a result of the proposed project. Additional discussion on this issue has been added to Section 5.05 of the Final EIS.

5. As indicated in response 4 above, vessel speeds are not anticipated to increase as a result of the proposed project and the number of vessel trips will probably not increase appreciably. With the deeper draft project constructed, vessels will not be light-loaded and, thus, will carry more tonnage per vessel trip. Therefore, the number of vessels calling on Wilmington will not be greater to

transport the same or a reasonable increase in tonnage, and the likelihood for accidents should not change appreciably. The US Coast Guard as well as the insurance companies of the ship owners have provisions to cover potential spill concerns.

6. Normal industry procedure requires that the contractor perform limited onsite blasting tests and adjust the final (blasting) plan to actual site conditions. During the limited onsite blasting tests, the effectiveness of the bubble curtain and/or physical barrier will be tested. As indicated in Section 5.02 and Attachment C of the EIS, the contractor will be required to reduce the pressure wave created by the blast by ≥95 percent. This could be done by setting up a series of hydrophones within and without the blast area to measure the effectiveness of the bubble curtain and/or physical barrier. An appropriate monitoring area will be coordinated with all concerned agencies; however, with the use of bubble curtains that must contain ≥95 percent of the pressure wave, the area of impact should be much smaller than that indicated in Table 7 of the EIS (34.5, acres, 656-foot radius) for LD 1 percent (0.125 pound fish). If there is no take of listed species or other significant resources within the first series of blasts (e.g., 30), we propose to reduce the monitoring zone to the immediate vicinity of the bubble curtains (e.g., 300-foot radius from the bubble curtain).

7. See Attachment C of the EIS.

8. Additional modeling results are included in Section 5.01 of the Final EIS. The ramshorn snail is discussed in Section 5.02 of the Final EIS.

9. The vicinity of Wilmington will experience the greatest change in tidal range which is estimated to average about 4 inches. This will mean about a 2 inch higher high tide and 2 inches lower low tide. This change should not appreciably change navigability of tidal creeks. As indicated in Section 5.01 of the Final EIS, we realize there is some uncertainty in the surface saltwater intrusion model results. Therefore, we commit to a pre-and post monitoring effort in the potentially affected area. This monitoring could include changes in tide levels, soil pore water chemistry and vegetation on selected plots, and other appropriate items. Details of this monitoring effort will be developed in coordination with all known interested parties. Results will also be coordinated with all known interested parties to determine if impacts different than those anticipated have occurred.

10. noted.

11. Agreed. See response 3, above.

12. See response 4, above.

13. See response 5, above.

14. Agreed. See response 6, above.

15. See response 7, above. All monitoring plans will be fully coordinated with all interested agencies.

16. Agreed. See responses 8 and 9, above.

III.1.d. NCDCM

Noted.

III.1.e NCDCR

1. Noted.

2. Noted.

3. Noted.

III.2 NCDCM

1. Noted.

2. The Draft and Final Feasibility Report discuss the beneficial uses of dredge material under the topic of Alternative Disposal Locations.

3. Noted.

4. We have responded to the Wildlife Resources Commission's comments in III.1.c, above.

5. Additional modeling results are discussed in detail in Sections 5.01 and 5.04 of the Final EIS. In addition, Sections 5.01 and 5.13 of the Final EIS indicate the pre- and post monitoring efforts planned related to potential model uncertainties. We agree there are some unknowns related to this project as there are with any project, but we are making a concerted effort to minimize these unknowns through extensive modeling efforts and pre- and post construction monitoring efforts.

6. Changes related to "...harbor activities back to the beginning" will be impossible to quantify since no baseline had been established. Changes could include an increase in tide range, movement of saltwater upstream, and change of freshwater systems to brackish systems. These changes probably also increased estuarine nursery areas and overall production of the Cape Fear River Estuary. It will be impossible to say whether overall these changes were good, bad or offset. However, as indicated in Section 5.06 and Attachment D of the Final EIS, we will address the actions related to the proposed project.

The 2,800-acre tract was not proposed to mitigate direct impacts of the proposed Wilmington Harbor - Northeast Cape Fear River project. Therefore, this tract is considered a "separable" element. The current Corps of Engineers policy is that this tract remains "unscheduled".

7. Noted.

III.3 NCDCR

1. Noted

2. Noted.

3. This change has been made to Section 5.08 of the Final EIS.

4. See response 3, above.

5. Noted.

6. Noted.

IV. PUBLIC COMMENT LETTERS

The US Army Corps of Engineers, Wilmington District did not receive any comment letters from the public responding to the Draft Environmental Impact Statement.

V. COPIES OF COMMENTS RECEIVED ON THE DRAFT EIS

U.S. DEPARTMENT OF H[illegible]G AND URBAN DEVELOPMENT
SOUTHEAST/ CARIBBEAN
Environmental Division
Richard B. Russell Federal Building
75 Spring Street, S.W.
Atlanta, Georgia 30303-3388

March 1, 1996

Mr. Mr. Frank Yelverton
Environmental Resources Division
Department of the Army
Wilmington District, Corps of Engineers
Post Office Box 1890
Wilmington, North Carolina 28402-1890

Dear Mr. Yelverton:

This letter is in reference to the Draft Feasibility Report and Environmental Impact Statement On Improvement of Navigation: Cape Fear - Northeast Cape Fear Rivers Comprehensive Study; Volume I and Volume II; Wilmington, North Carolina dated January, 1996.

Our review indicates that due to the nature and location of your proposed project, there will be no significant impact to any current HUD projects. Therefore, we have no objections to, or comment on this proposal.

Thank you for the opportunity to review and comment on this project. If you have questions on this comment please contact Linda Poythress, Environmental Protection Specialist at 404-331-3167.

Sincerely,

Thomas A. Ficht

Thomas A. Ficht,
Supervisory Environmental
Officer
Southeast/Caribbean

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
9721 Executive Center Drive N.
St. Petersburg, Florida 33702

March 15, 1996

Colonel Robert J. Sperberg
District Engineer, Wilmington District
Department of the Army, Corps of Engineers
P. O. Box 1890
Wilmington, North Carolina 28402-1890

Dear Colonel Sperberg:

The National Marine Fisheries Service (NMFS) has reviewed the Draft Feasibility Report and Draft Environmental Impact Statement (DEIS), Improvement of Navigation, Cape Fear-Northeast Cape Fear Rivers Comprehensive Study, North Carolina, Volumes I and II, dated January 1996. The recommended plan includes the deepening of about 35 miles of navigation channel and harbor by four feet and widening of two turning basins and channels near Wilmington.

General Comments

The NMFS is concerned that the DEIS does not adequately address the potential adverse impacts of the proposed project on larval and juvenile fishery resources that use the Cape Fear River. This project, as proposed, includes the possibility of some 558 blasts covering 82.7 acres of channel bottom to remove non-dredgeable rock between Keg Island Channel and the Memorial Bridge. Rock blasting will only be used if other dredging methods are unsuccessful.

The preliminary blasting plan as described in the DEIS reflects industry standards for underwater blasting. It incorporates measures to reduce adverse impacts on fisheries and protected species including: monitoring, seasonal restrictions, stemming of blast holes, delays in blasting charges, and the use of protective barriers around the blast area. The DEIS concludes that the implementation of these measures will result in an insignificant impact to fishery resources. We disagree with this conclusion.

We are concerned that the studies cited in the DEIS as a basis for the impact assessment do not consider impacts to the smaller size classes of fishes using the Cape Fear River estuary. Ocean-spawned larval fish are recruited into the river where they develop into adults in estuarine nursery areas.[1] This process of larval recruitment is essential for the continued production of important commercial and recreational fisheries.[2] Some larval estuarine-dependent fish are present in the river throughout the year.[3] Studies in the DEIS only address impacts on juveniles 0.125 pound or larger. However, at any given time, the area proposed for blasting could be populated with larvae that range in size from 0.01 to 0.00001 pound.[4] Accordingly, no consideration is given to very small fish or the interspecific differences in sensitivity of these organisms.

4 We agree with the conclusion in the DEIS that, assuming the presence of an air bladder, the smaller the fish the greater the likelihood of adverse impacts. However, we are unaware of studies that address the impacts of blasting on larval fish in the 0.01 to 0.00001 pound range. Therefore, we disagree with the conclusion that the impacts on recruiting larvae are ". . . not considered significant", and that, ". . . monitoring the impacts on recruiting larvae is not needed."

Specific Comments

3.00 ALTERNATIVES
3.01 Alternative Plans

5 Page EIS-8, paragraph 1. This section of the document addresses Plans 1, 2 (the recommended plan) and 3, which involve additional deepening of the navigation channel by two, four, and six feet, respectively. We recommend that further consideration be given to Plan 1 because it involves less blasting and minimizes adverse impacts to larval fishery resources. A staged approach to dredging and blasting would allow additional opportunities to evaluate impacts on fisheries. If impacts were negligible as predicted in the DEIS, then additional work to construct the National Economic Development Plan (Plan 2) could be pursued.

4.00 AFFECTED ENVIRONMENT
4.11 Threatened and Endangered Species

6 Page EIS-26, paragraph 7. Our Protected Species Management Branch is reviewing the Biological Assessment independently and their assessment will be provided separately.

---

[1]Douglas, P.A. and R.H. Stroud: Editors, 1971. A Symposium of the Biological Significance of Estuaries, Sponsored by the SFI, Washington, D.C. 154 p.

[2]Hoss, D.E. and G.W. Thayer. 1993. The importance of habitat to the early life history of estuarine dependent fishes. Amer. Fish. Soc. Sym. 14: 147-158. 11pp.

[3]Settle, L.R. and J.D. Fuss. 1995. A summary of the larval ichthyofauna in the Cape Fear River estuary. Final Report submitted to the U.S. Army, COE, Wilmington District. 64pp.

[4]Peters, David. 1996. Personal communication. NMFS, SEFSC, Beaufort Laboratory, Beaufort, NC.

5.00 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION
5.01 Water Quality Saltwater Intrusion and Hydrology

7 Page EIS-32, paragraph 4. This paragraph describes the use of a three-dimensional surface water model to address saltwater intrusion and changes in hydrology that may result from construction of the proposed project. Its focus is on potential changes in salinity and associated vegetation in the upper reaches of the project area. It does not, however, consider how the predicted changes in salinity and water level could affect the use of these areas by fishery resources. A section should be added to the DEIS at "5.02 Aquatic Resources" to address the potential impacts of changes in salinity and water level on the utilization of adjacent wetlands by fishery resources.

5.02 Aquatic Resources
Nekton and Benthos
Blasting Impacts

8 Page EIS-36, paragraph 5. An assessment of blasting impacts on early life stages, including larval, post-larval and juvenile forms, is a major concern in the Cape Fear River which serves as a spawning area, a migratory pathway of larvae, and a nursery area. We do not agree with the assessment in this section that the predicted impact on larval fish, will be minimized by the use of bubble curtains which may or may not provide the predicted 98 percent reduction in blast pressure. While a 98 percent reduction in peak pressure may be achieved, it would be more appropriate to use an average reduction and to give some indication of the variability in pressure reduction. For example, the factors that are likely to cause variability in percent reduction and how much variability they will cause should be discussed. We recommend that this section be revised to include a more detailed description of the variability in bubble screen effectiveness in reducing impacts to larval fish.

9 Page EIS-38, paragraph 2. We disagree that the use of the Saint Louis District (SLD) model, which uses studies of the impacts of blasting on freshwater fish larger than 0.125 pound, is adequate for an assessment of the impacts of blasting on larval and juvenile fishes in the Cape Fear River. For example, Table 5, which was generated using the model, should be expanded to include the following sizes: 0.01, 0.001, 0.0001, and 0.00001 pounds. This additional information will allow a better assessment of the model and its applicability to predicting the mortality rates on earlier life stages of fish. Likewise, the application of the SLD model for predicting lethal distance should be described in more detail. For example, how much does the lethal distance change with a fishes proximity to the surface or bottom? Also, what assumptions have been made about the relationship between fish size and the susceptibility to blast damage? Special attention should be placed on documenting the primary data sources which detail blasting impacts on the larval life stages of fishes.

10 Page EIS-39, Table 6. This table should be modified in accordance with our recommendations concerning Table 5, above.

Larval life forms

11 Page EIS-40, paragraph 2. This section should be expanded to indicate the magnitude of interspecific differences in larval and juvenile fishes' sensitivity to blasting. Data concerning these differences between species is necessary in determining the impacts on fishery resources. This is especially true when commercially and recreationally important species are involved as is the case of the Cape Fear River.

ATTACHMENT B

BIOLOGICAL ASSESSMENT UNDER THE ENDANGERED SPECIES ACT OF 1973, AS AMENDED

12 Page EIS-77. See our comments on Page EIS-26, paragraph 7.

ATTACHMENT C

PRELIMINARY PRE- AND POST-BLAST IMPACT MONITORING PLAN

13 Page EIS-96. The monitoring plan described in this section does not address the need to assess project impacts on larval and juvenile fishes. For reasons outlined above, we believe that the determination that these impacts will be insignificant is flawed. Accordingly, pre- and post-blasting monitoring of larval and juvenile fish would provide some quantification of impact and, thereby, support or refute the DEIS's conclusions on this matter.

Sincerely,

Andreas Mager, Jr.
Assistant Regional Director
Habitat Conservation Division

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
National Geodetic Survey
Silver Spring, Maryland 20910-3282

MAR 2 6 1996

MEMORANDUM FOR: Donna Wieting
Acting Director, Ecology and Conservation Office

FROM: Captain Lewis A. Lapine, NOAA
Director, National Geodetic Survey

SUBJECT: DEIS-9602-05--Cape Fear-Northeast Cape Fear Rivers

The subject statement has been reviewed within the areas of the National Geodetic Survey's (NGS) responsibility and expertise and in terms of the impact of the proposed actions on NGS activities and projects.

All available geodetic control information about horizontal and
vertical geodetic control monuments in the subject area is on
1 the attached diskettes. This information should be reviewed for
identifying the location and designation of any geodetic control
monuments that may be affected by the proposed project.

If there are any planned activities which will disturb or destroy
these monuments, NGS requires not less than 90 days' notification
in advance of such activities in order to plan for their
2 relocation. NGS recommends that funding for this project include
the cost of any relocation(s) required.

For further information about these monuments, please contact John Spencer; SSMC3, NOAA, N/NGS; 1315 East West Highway; Silver Spring, Maryland 20910; telephone: 301-713-3169; fax: 301-713-4175.

With regard to the U.S. coastal zone in this area, the deepening
of the channel along the proposed subject project will involve
rock blasting and thus require detailed post completion surveys
3 to verify the removal of the rock and accurately determine the
controlling depths in each section. Eleven inshore sites along
the project have been proposed for disposal of dredged material;
the exact sites have not been identified.

NOAA requests U.S. Army Corps of Engineers blueprints of this
project upon completion so that these controlling depths can be
4 accurately revised and the hydrography shown in the areas
designated as disposal sites for the dredged material can be
revised on future editions of affected NOS nautical charts. The
text of U.S. Coast Pilot 4 referencing Wilmington Harbor and Cape
Fear River will also have to be amended upon completion of the
project. Please provide copies of any surveys within this
project to: Howard Danley, NOAA, Office of Coast Survey, N/CS28,
1315 East West Highway, Silver Spring, Maryland 20910.

Attachments

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA)

COMMENTS ON

DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)

FOR

CAPE FEAR-NORTHEAST CAPE FEAR RIVERS STUDY,

NEW HANOVER AND BRUNSWICK COUNTIES,

NORTH CAROLINA

General Comments - Fisheries

5 NOAA is concerned that the DEIS does not adequately address the potential adverse impacts of the proposed project on larval and juvenile fishery resources that use the Cape Fear River. This project, as proposed, includes the possibility of some 558 blasts covering 82.7 acres of channel bottom to remove non-dredgeable rock between Keg Island Channel and the Memorial Bridge. Rock blasting will only be used if other dredging methods are unsuccessful.

6 The preliminary blasting plan as described in the DEIS reflects industry standards for underwater blasting. It incorporates measures to reduce adverse impacts on fisheries and protected species including: monitoring, seasonal restrictions, stemming of blast holes, delays in blasting charges, and the use of protective barriers around the blast area. The DEIS concludes that the implementation of these measures will result in an insignificant impact to fishery resources. We disagree with this conclusion.

7 We are concerned that the studies cited in the DEIS as a basis for the impact assessment do not consider impacts to the smaller size classes of fishes using the Cape Fear River estuary. Ocean-spawned larval fish are recruited into the river where they develop into adults in estuarine nursery areas. This process of larval recruitment is essential for the continued production of important commercial and recreational fisheries. Some larval estuarine-dependent fish are present in the river throughout the year. Studies in the DEIS only address impacts on juveniles 0.125 pound or larger. However, at any given time, the area proposed for blasting could be populated with larvae that range in size from 0.01 to 0.00001 pound. Accordingly, no consideration is given to very small fish or the interspecific differences in sensitivity of these organisms.

We agree with the conclusion in the DEIS that, assuming the presence of an air bladder, the smaller the fish the greater the likelihood of adverse impacts. However, we are unaware of studies that address the impacts of blasting on larval fish in
8 the 0.01 to 0.00001 pound range. Therefore, we disagree with the conclusion that the impacts on recruiting larvae are ". . . not considered significant", and that monitoring the impacts on recruiting larvae is not needed."

General Comments - Tidal Current Predictions

NOAA has a strong concern that the dredging of the main navigation channel will seriously alter the tidal characteristics
9 of the Cape Fear River estuary and thus render NOS's tide and tidal current predictions less useful.

At present, NOS's internal quality control shows that for Wilmington NC, 90% of high tide predictions are with 0.5 foot of observed, and 90% of times of high tide are within 0.5 hours of
10 observed. NOS's tidal current predictions at locations in the Cape Fear River have generated no complaints from mariners about their accuracy.

The USACE numerical circulation modeling study has determined that, on average, there would be a 0.5 foot increase in the tide range at Wilmington NC (Vol. I, p. EIS-32) due to the proposed
11 deepening. There will also be a decrease in salinity of about 2 to 3 ppt in the upper river. The extent of changes in tidal currents has not been determined by the model.

In the past, NOS has received complaints about changes in currents, and the loss of accuracy of NOS's tidal current predictions, after the deepening of navigation channels, especially in Chesapeake Bay. Since we expect similar changes in the Cape Fear River if deepening occurs, NOS will officially notify mariners that "tidal current predictions for this
12 region should be considered questionable at best and potentially dangerous to rely on. Tide predictions will also be affected but to a lessor degree". Notification would appear in the Notice to Mariners, the Coast Pilot, in a note on currents in the next publication of the relevant nautical chart, and as a note in the NOS Tidal Current Tables.

Accurate tide predictions would save shippers a significant amount of money. Using the figures in the cost-benefit analysis, at an operational cost in transit of $1,000 per hour (Vol II,
13 p.F-35) and approximately 800 ships per year (Vol. II, p. F17), saving even 1 hour by timing departure to coincide with high tide would save $800,000 per year.

Therefore, we recommend that funding be provided as part of the
dredging project to re-survey the Cape Fear River water levels
14 and currents to assure the continuing accuracy of tide and tidal
current predictions and to provide maximum benefit to maritime
commerce.

An alternative would be for the project to fund a Cape Fear River
federal/local partnership that would design, install, and
maintain a Physical Oceanographic Real-Time System (PORTS)
patterned after other NOAA PORTS installations. Maximum economic
15 benefit from the deepened channels could be realized from the
real-time water level data. The centralized data acquisition and
dissemination system would provide water levels, currents, and
other oceanographic and meteorological data for the Cape Fear
River maritime community in a variety of user-friendly forms.

We further recommend that the circulation modeling study be
extensively described in the final EIS, including model
description, probable errors, and accuracy of predictions.
16 Changes in tide ranges and currents in all parts of
estuary need to be defined and explained.

Specific Comments

3.00 ALTERNATIVES

3.01 Alternative Plans

Page EIS-8, paragraph 1. This section of the document addresses
Plans 1,2 (the recommended plan) and 3, which involve additional
deepening of the navigation channel by two, four, and six
feet, respectively. We recommend that further consideration be
given to Plan 1 because it involves less blasting and minimizes
17 adverse impacts to larval fishery resources. A staged
approach to dredging and blasting would allow additional
opportunities to evaluate impacts on fisheries. If impacts were
negligible as predicted in the DEIS, then additional work to
construct the National Economic Development Plan (Plan 2) could
be pursued.

4.00 AFFECTED ENVIRONMENT

4.11 Threatened and Endangered Species

Page EIS-26, paragraph 7. Our Protected Species Management Branch
18 is reviewing the Biological Assessment independently and their
assessment will be provided separately.

5.00 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION

5.01 Water Quality Saltwater Intrusion and Hydrology

19 Page EIS-32, paragraph 4. This paragraph describes the use of a

three-dimensional surface water model to address saltwater intrusion and changes in hydrology that may result from construction of the proposed project. Its focus is on potential changes in salinity and associated vegetation in the upper reaches of the project area. It does not, however, consider how the predicted changes in salinity and water level could affect the use of these areas by fishery resources. A section should be added to the DEIS at "5.02 Aquatic Resources" to address the potential impacts of changes in salinity and water level on the utilization of adjacent wetlands by fishery resources.

5.02 Aquatic Resources

Nekton and Benthos

Blasting Impacts

Page EIS-36, paragraph 5. An assessment of blasting impacts on
early life stages, including larval, post-larval and juvenile
forms, is a major concern in the Cape Fear River which serves as
a spawning area, a migratory pathway of larvae, and a nursery
area. We do not agree with the assessment in this section that
the predicted impact on larval fish will be minimized by the use
of bubble curtains which may or may not provide the predicted 98
20 percent reduction in blast pressure. While a 98 percent
reduction in peak pressure may be achieved, it would be more
appropriate to use an average reduction and to give some
indication of the variability in pressure reduction. For
example, the factors that are likely to cause variability in
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be discussed. We recommend that this section be revised to
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blasting on freshwater fish larger than 0.125 pound, is
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and juvenile fishes in the Cape Fear River. For example, Table
5, which was generated using the model, should be expanded to
include the following sizes: 0.01, 0.001, 0.0001, and 0.00001
21 pounds. This additional information will allow a better
assessment of the model and its applicability to predicting the
mortality rates on earlier life stages of fish. Likewise, the
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should be described in more detail. For example, how much does
the lethal distance change with a fish's proximity to the surface
or bottom? Also, what assumptions have been made about the
relationship between fish size and the susceptibility to blast
damage? Special attention should be placed on documenting the
primary data sources which detail blasting impacts on the larval
life stages of fishes.

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Larval life forms

23 Page EIS-40, paragraph 2. This section should be expanded to indicate the magnitude of interspecific differences in larval and juvenile fishes' sensitivity to blasting. Data concerning these differences between species is necessary in determining the impacts on fishery resources. This is especially true when commercially and recreationally important species are involved as is the case of the Cape Fear River.

ATTACHMENT B

BIOLOGICAL ASSESSMENT UNDER THE ENDANGERED SPECIES ACT OF 1973, AS AMENDED

24 Page EIS-77. See our comments on Page EIS-26, paragraph 7.

ATTACHMENT C

PRELIMINARY PRE- AND POST-BLAST IMPACT MONITORING PLAN

25 Page EIS-96. The monitoring plan described in this section does not address the need to assess project impacts on larval and juvenile fishes. For reasons outlined above, we believe that the determination that these impacts will be insignificant is flawed. Accordingly, pre- and post-blasting monitoring of larval and juvenile fish would provide some quantification of impact and, thereby, support or refute the DEIS's conclusions on this matter.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
345 COURTLAND STREET, N.E.
ATLANTA, GEORGIA 30365

APR 25 1995

Lieutenant Colonel Thomas C. Suermann
District Engineer
Wilmington District, Corps of Engineers
P.O. Box 1890
Wilmington, NC 28402-1890

Attn: Mr. Frank Yelverton, Environmental Resources Branch

Subject: Draft Environmental Impact Statement (DEIS), Wilmington Harbor-Northeast Cape Fear River, New Hanover and Brunswick Counties, North Carolina

Dear Sir:

Pursuant to Section 309 of the Clean Air Act and Section 102 (2)(C) of the National Environmental Policy Act, EPA, Region 4 has reviewed the subject document which evaluates the consequences of upgrading the navigational capability of the harbor complex.

The preferred alternative would improve shipping access by dredging the harbor four (4) feet deeper from the ocean bar through the Memorial Bridge while the channel from Hilton Railroad Bridge to the turning basin would be excavated nine (9)
1 feet deeper. The total volume of material excavated approximates 13 million cubic yards (MCY), viz., 9.5 MCY of unconsolidated sediments and 3.5 MCY of rock material. Given current technologies and the indurate nature of the material involved, about .5 MCY of the latter will require blasting to remove.

Region 4's involvement with this project extends back to its initial planning and design almost 20 years ago. As a result of interagency coordination, 2,800 acres of various biologically important habitats were incorporated into the plan and eventually
2 became an integral part of the Congressionally authorized project. In a practical sense these lands would have compensated for the unavoidable future losses occasioned by development along and within the river corridor as well as federal actions occurring prior to NEPA which were not mitigated.

The manner in which these holdings would be geographically
3 arrayed relative to this development would serve to buffer the

adverse effects on the natural environment. Unfortunately, a decision was made to interpret these lands as a separable fish and wildlife enhancement measure. Moreover, acquisition of these lands has been deferred and classified as unscheduled. Given the present fiscal constraints, we are concerned whether funding will ever be made available to purchase these properties.

EPA's disappointment with this decision has been repeatedly communicated in its comments on NEPA documentation for the various elements of the Wilmington facility. As the result of
4 coordination meetings/site inspections conducted by Wilmington District technical staff members together with extended dialogue with Division Corps personnel we understand, but do not necessarily agree with the logic used to reach this conclusion.

While the project has an extensive scope, its overall adverse impacts do not appear to be directly linked to its size. For example, from the trawling data obtained during the Wilmington Harbor study it appears that the slopes of a deepened channel will continue to serve as habitat for a number of commercially important species. Hence, the long-term
5 consequences of the proposed excavation may be more closely correlated to the effects of blasting on the estuarine biota. Equally important will be restricting explosive use to periods with the least species richness. A monitoring plan will be instituted to determine the actual outcome of this dredging method. Our specific comments/concerns about the use of explosives to excavate those channel alignments underlain with rock are similar to those expressed to the proposed Wilmington Harbor Channel Widening and will not be repeated.

Excavated material will be placed in Eagle Island. It is estimated that a small amount of mixed tidal marsh there will impacted on this action; however, mitigation for this loss can
6 easily be accomplished on several formerly used disposal islands in the vicinity. For example, some of the shoreline and marsh along Eagle Island and down river disposal areas are eroding and could be reconstituted to their "historic" dimensions using dredged material.

It is our opinion that the use of dredged material in this fashion is acceptable unless it were demonstrated that this shallow bottom habitat is an important limiting factor in overall system functioning. This should not be construed as an endorsement of this technique as an acceptable means to routinely
7 dispose of dredged material, but in selected, thoughtfully considered instances it can mitigate significant environmental losses to acceptable levels. In a related matter we strongly support the Wilmington District's decision to use wetlands reestablished in this fashion to retard erosion at its intra-

river disposal sites and believe that the use of wetland vegetation to arrest erosional processes should be expanded wherever applicable.

On the basis of our review a rating of EC-2 has been assigned to this proposed action. That is, we have environmental concerns about the potential adverse impacts associated with use of explosives to excavate portions of the enlarged channel. The additional information gathered by the proposed monitoring plan
8 should serve to ascertain the actual environmental costs of using this dredging method. As soon as the results of these studies are available for review/comment, distribution should be made to the involved parties.

Thank you for the opportunity to comment. If we can be of further assistance, Dr. Gerald Miller (404-347-3555 VM 6853) will serve as initial point of contact.

Sincerely yours,

Heinz J. Mueller, Chief
Environmental Policy Section
Federal Activities Branch

Attachment: Specific Comments

SPECIFIC COMMENTS

o Page 8 - Along with the economic benefits associated with
deepening Cape Fear Harbor there are a number of environmental
costs, e.g., vessel cargoes (petroleum, chemical and fertilizers)
with significant, long-term environmental consequences if
spilled. When such cargoes are increased per carrier tonnage and
possibly per number of carriers, any change in the potential for
9 spillage (both accidental or incidental) should be ascertained.
We understand that this is a Coast Guard responsibility
regulatory-wise, but believe the NEPA process can serve as a
impetus for the Port Authority to routinely update its "HazMat"
plan.

o Page 37 - Table 15 has a footnote which indicates that dredged
material volumes are only for the project improvements, i.e.,
they do not include maintenance volumes. Table 3 of the DEIS
(pg. EIS-16) lists projected maintenance dredging volumes;
however, these are estimated volumes for the new plan (COE
10 recommended Plan 2) and not the present volumes (assuming
maintenance dredging is needed). Maintenance dredging volumes
required now should also be noted and documented in the EIS,
especially if the maintenance dredging and new work dredging are
combined.

As a point of information, will the project area (channel
and turnarounds) first be maintenance dredged and then dredged
for improvements (new work)? Ordinarily, maintenance material is
kept separate from the new work dredged material since their
respective disposal could be different. However, this may not be
an operative concern is this instance. There is, nonetheless, a
11 matter of discussion regarding the rocks which are anticipated
for disposal near the ODMDS. Since this material is anticipated
to provide new habitat which will be quickly colonized, it may be
deemed a resource worthy of protection. Therefore, some
consideration about disposal of the rock adjacent to the ODMDS
may be warranted to avoid any future controversy.

o Page 42 - A 10% additional increase in the volume of
maintenance dredging is anticipated for the ocean reaches once
they are deepened compared to existing maintenance dredging. We
12 assume that this variation is due to the greater sediment
movement offshore as opposed to the interior reaches, but this
was not specifically indicated.

o Page 43 - Notwithstanding costs, the use of good quality sand
for beach nourishment needs to remain under consideration. Since
13 beaches will, in fact, be nourished, it is important to conserve
this resource and limit the number of sites being perturbed in

its acquisition.

o Page 43 - The EPA designated Wilmington ODMDS is mentioned. The sentence stating that "the site encompasses 2.3 square miles, and has been designated by the Environmental Protection Agency as
14 an approved site for dredged material disposal," would be improved to read:

> "The site encompasses 2.3 square miles, and has been designated by the U.S. Environmental Protection Agency as an approved site for suitable dredged material disposal."

o Page 45 - Turbidity from dredging is often difficult to control. This notwithstanding, extra care should be taken for work done proximate to nursery areas where post-larval
15 development takes place. While turbidity will dissipate with time, its impacts can be important to developing biota for even brief periods during this critical phase.

o Page 46 - It is unclear as to how the blast "danger zone" would be monitored for sea turtles and cetaceans before each submarine explosion. We understand that approved observers will be used, but exactly what will they do and the success of the
16 noted methods in previous, similar operations is not specified. Will it be possible/necessary to contain the blast turbidity plume? Is plume modeling/monitoring needed and has any modeling been done similar to the COE's barge dredge overflow monitoring?

DRAFT EIS:

o Page EIS-17 - The No-Action Alternative is mentioned in Section 3.12. However, the discussion primarily focuses on the adverse economic consequences if the harbor were not deepened. Since this is an element of the Corps' decision-making process, the FEIS should also mention the obvious, viz.. that additional
17 environmental impacts would not be incurred if there were no project. We suggest a summary of those impacts that would be avoided, e.g., increased turbidity, potential loss of estuarine nursery areas, contaminant resuspension, blasting, disposal of more dredged material, increase in potential spillage of hazardous cargoes, etc..

o Page EIS-37 - There is a legitimate focus on survival versus death of marine organisms within a blast impact zone. However, sublethal effects of blasting could also be important as/if they
18 ultimately become lethal. If the modeling used to determine the size of the blast zone impact area for various lethalities could be manipulated to estimate sublethal effects, the results should be noted in the final document.

o Page EIS-43 - Gill net surveys will be conducted to determine
19 the number of the endangered shortnosed sturgeon which could potentially be affected by blasting. Our staff's experience with

gill net sampling suggests that there could be some significant "take" involved in using this procedure. We recommend that the state and federal wildlife agencies be consulted again to verify that this is the best method to determine potential presence of the sturgeon.

Cumulative Impacts section could be improved with a table of
20 representative species "scored" against the various perturbations associated with this proposal.

o Page EIS-46 - The recommendation made by the state to dredge from August 1 to January 31 has been accepted. However, there is an exigent clause which would allow excavation outside this time
21 window if deemed necessary. Since bucket and barge dredging is exempt, we assume that this techniques is not viewed as damaging. The reasons for this assumption should be detailed.

o Page EIS-48 - Noise was not addressed in the Environmental Consequences Section. We suggest that as a minimum the final
22 document commit that the contractor will maintain his equipment in terms of manufacturers' specifications in terms of mufflers and other source reduction means.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
345 COURTLAND STREET, N.E.
ATLANTA, GEORGIA 30365

APR 2— 1995

Colonel Robert J. Sperberg
District Engineer
Wilmington District, Corps of Engineers
P.O. Box 1890
Wilmington, NC 28402-1890

Attn: Mr. Hugh Heine
Environmental Resources Branch

Subject: Draft Supplement to the Environmental Impact Statement (EIS) for Wilmington Harbor Channel Widener, New Hanover and Brunswick Counties, NC

Dear Colonel Sperberg:

Pursuant to Section 309 of the Clean Air Act and Section 102
(2)(C) of the National Environmental Policy Act, EPA, Region 4
has reviewed the subject document which focuses on the specific
consequences of using explosives to excavate non-dredgeable rock
within Turns 2, 3, and 4 (Keg Island to Lower Brunswick Channels)
of the Wilmington Harbor Channel. After blasting, this rock
1 (approximately 70,000 cubic yards) could be removed by a pipeline
dredge and/or bucket and barge. Disposal of this material would
be to the originally noted upland island sites, offshore disposal
site, and/or at the offshore fishery enhancement structure.
Alternative disposal areas for dredged material which were not
discussed in the final EIS are also presented and assessed.

The overall blasting effects on the estuarine environment
are evaluated using information from pertinent literature and
empirical observations; a monitoring plan will be conducted to
2 determine how closely anticipated effects mesh with actual
impacts. Further coordination will be necessary to determine
exactly where the components of the subject material will
ultimately be discarded.

As our Coastal Regulatory Unit has previously indicated to
your staff, the large volume of material being generated by the
various upgrades to the Wilmington facility will require careful
planning. There has already been some concern that material from
3 the offshore site (ODMDS) has migrated back into the Baldhead
Shoal Channel. Additionally, local shrimpers have noted that
wood debris, disposed in the ODMDS, has moved into adjacent
fishing areas creating problems.

4 The Site Management and Monitoring Plan (SMMP) being jointly developed by the Wilmington District and our Coastal Unit should provide some answers to germane issues attendant to harbor upgrades. Moreover, the SMMP will serve as the basis for subsequent concurrence under Section 103 of Marine Protection, Research, and Sanctuaries Act (MPRSA). Mr. Doug Johnson (404-347-1740) will serve as initial point of contact regarding MPRSA matters.

5 EPA has very limited practical experience with the use of explosives to fracture rock. Therefore, we were pleased that some preliminary work for the proposed channel enlargement will be done to gauge production potential of this technique together with its environmental ramifications. When the results of these initial studies are completed, additional dialogue with state and federal wildlife agencies will be undertaken to determine the effectiveness of mitigative measures (bubble curtains, warning charges, stemming)

6 On the basis of our review a rating of EC-2 has been assigned to this proposed action. That is, we have environmental concerns about the potential adverse impacts associated with the use of explosives to excavate portions of the enlarged channel. We look forward to examining the additional information which will be collected to determine the actual impacts of this dredging technique. The need for this information is especially compelling since it appears likely that blasting will become more common as channel depths attempt to keep pace with the larger shipping fleet.

7 Thank you for the opportunity to comment. If we can be of further assistance, Dr. Gerald Miller (404-347-3555 VM 6853) will serve as initial point of contact.

Sincerely yours,

Heinz Mueller

Heinz J. Mueller, Chief
Environmental Policy Section
Federal Activities Branch

United States Department of the Interior

OFFICE OF THE SECRETARY
OFFICE OF ENVIRONMENTAL POLICY AND COMPLIANCE
Richard B. Russell Federal Building
75 Spring Street, S.W.
Atlanta, Georgia 30303

March 29, 1996

ER-96/114

Colonel Robert J. Sperburg
Wilmington District Engineer
U.S. Army Corps of Engineers
Post Office Box 1890
Wilmington, North Carolina 28402-1890

Dear Colonel Sperburg:

The Department of the Interior has reviewed the Draft Feasibility Report and the Draft Environmental Impact Statement (DEIS) for the Cape Fear-Northeast Cape Fear Rivers Comprehensive Study, NC, as requested.

The general and specific comments of the Department are enclosed. We request that you consider these comments in preparing a final Environmental Impact Statement for this project.

If you have questions regarding fish and wildlife resources, please contact Jon Andrew, Regional Environmental Coordinator, with the Fish and Wildlife Service in Atlanta at 404/679-7123; or John Hefner of the Service's Raleigh Field Office at 919/856-4520. If you have questions related to hydrology, please contact James F. Devine, U. S. Geological Survey, at 703/648-4423.

Thank you for the opportunity to review this document.

Sincerely,

James H. Lee

James H. Lee
Regional Environmental Officer

Enclosure

U.S. Department of the Interior
Review of Draft Environmental Impact Statement (DEIS),
for the Improvement of the Cape Fear-Northeast Cape Fear River
Comprehensive Study

GENERAL COMMENTS

The large construction effort needed to accomplish the preferred alternative has the potential to create significant direct, indirect, and/or cumulative adverse, environmental impacts. Some of these impacts could significantly alter the diverse ecosystems of the lower Cape Fear River watershed. In addition to adverse impacts, there are opportunities for the proposed project to produce some beneficial environmental impacts. The major concerns
1 of the Department involve potential, direct and indirect harm to marine and estuarine food chains, degradation of fisheries resources, loss of tidal freshwater habitats, loss of shallow water estuarine areas, loss of sea turtle nesting habitat, and the direct mortality of Federally-threatened and endangered species during construction. However, the Department believes that a thorough consideration of the environment during planning can avoid many of the most severe impacts and minimize others.

Impacts resulting from the implementation of the preferred alternative may be direct, indirect, or cumulative in nature. The
2 following comments outline the specific impacts and recommend actions to avoid or minimize the impacts of project construction. Furthermore, potential beneficial impacts are discussed along with recommendations for their implementation.

SPECIFIC COMMENTS

Direct Impacts

Injury or death due to increased turbidity during construction

Data in the DEIS indicate that approximately 9,401,000 cy of soft
3 sediment would be removed during construction (p. EIS-11). This dredging may cause injury or death to aquatic organisms due to increased turbidity and sedimentation. While the increased turbidity cannot be completely eliminated, the Corps should use all available construction techniques to avoid or minimize the creation of excessive turbidity during dredging operations.

Injury or death due to offshore dumping of dredge material

Data included in Table 2 of the DEIS (p. EIS-10) indicate that approximately 8,500,000 cy of dredged material, including 900,000
4 cy of rock, would be dumped at the two offshore disposal sites. Such dumping could result in injury or death to marine organisms. The Corps should plan construction in a manner which will avoid or minimize adverse impacts to fisheries resources, sea turtles, and

marine mammals due to the offshore disposal of dredge material. These plans should incorporate all reasonable technology which would detect species of concern in the immediate disposal area and procedures to delay disposal, if necessary.

Contaminants in dredge material

If material removed during construction contains toxic substances,
dredging and disposal could produce adverse impacts in the river
5 and at the disposal site. Dredging of contaminated sediment would
immediately release harmful compounds into the water column.
Disposal of contaminated sediment would introduce these substances
into the disposal sites.

It is stated in the DEIS (p. EIS-18) that prior testing of sediment
removed during maintenance indicated that the material was suitable
for ocean dumping. The DEIS extrapolates these results to reach
the conclusion that ". . . new work material should also be
acceptable for ocean disposal." However, the DEIS also states that
new work material will be tested in accordance with Section 103 of
the Marine Protection, Research, and Sanctuaries Act of 1972. The
6 Department supports such testing and recommends a comprehensive,
toxicological testing program with sampling from all regions to be
deepened. The Corps should have sufficient bioassay and
bioaccumulation data from sediment of representative areas
throughout the project area to insure that the project will not
produce a significant toxicological risk to organisms at the
dredging site, any offshore disposal areas, or any inland disposal
areas. The Corps should develop plans for the special handling and
disposal of contaminated sediment.

Nesting habitat for colonial waterbirds

Sediment from the upper part of the project will be placed in
existing upland confined disposal facilities (p. EIS-11). The
Corps is also considering the use of dredge material to renourish
colonial waterbird nesting islands. The Department supports the
use of dredge material which is free of contaminants and has the
7 proper physical characteristics to enhance colonial waterbird
habitat. However, the improper disposal of sediment at inland
sites may result in the loss of nesting habitat for colonial
waterbirds. The placement of sediment with undesirable physical
characteristics, the creation of an unsuitable topography, or
placement during ongoing nesting activities will adversely affect
nesting. The Department recommends that the Corps consult with
representatives of the National Audubon Society and the North
Carolina Wildlife Resources Commission to insure that inland dredge
disposal does not harm nesting by colonial waterbirds.

Loss of benthic and nektonic organisms

The Department is concerned that this large dredging operation will
directly impact both benthic and nektonic organisms in the project
area. All benthic invertebrate infauna within the sediment removed
will be lost. Removal of rock using a cutterhead dredge will
result in mortality of benthic organisms, plankton, and nekton
unable to escape the dredge. Hydraulic pipeline dredges could
entrain significant numbers of larval shrimp, oysters, and fish.
8 Therefore, the Department recommends that the Corps use all
feasible design features and construction techniques to minimize
direct harm or loss of animals during the removal of soft sediment.
The Corps should educate all construction personnel on the times of
potential presence of manatees, sea turtles, whales and other
marine mammals. Personnel should be instructed to watch for all
protected species during the periods of likely occurrence and to
cease operations if these species are seen in the immediate
vicinity of construction activities. Special work conditions to
protect manatees should be strictly enforced during the most likely
period of manatee presence, June through September.

Mortality of aquatic organisms due to blasting

It is indicated in the DEIS (p. EIS-31) that 558 blasts may be
required. Blasting may result in the mortality of invertebrates,
fish, sea turtles, and marine mammals. The lethal range of the
shock waves produced by underwater explosions will vary among
different groups of organisms. Furthermore, the lethal range will
9 depend on the type of explosives used and the methods of blasting.
In order to minimize the adverse, environmental impacts of blasting
the Department recommends that project contracts state clearly that
blasting will not be authorized until data are supplied to the
Corps which verify that rock cannot be removed with a cutterhead
dredge.

If blasting is required, the Corps should insure that all blasting
is limited to the time of year with the lowest biological activity.
Current plans to protect fisheries resources limit blasting to the
six-month period from August 1 through January 31. The Department
10 supports this effort to protect fish in the project area. However,
the Department is very concerned about possible mortality among
manatees which are most common in the area from June through
September and sea turtles which are most abundant in the lower Cape
Fear from April through September. Therefore, the Department
recommends that blasting be limited to the four-month period from
October 1 through January 31 of any year.

The type of explosives used and the blast plan selected should be
11 those which can be expected to produce the least harm to aquatic
organisms. The Department supports the use of stemming and delays
between each charge. The Department has recommended that delays in
the range of 0.9 to 1.0 second be used to further minimize adverse

shock waves. The Corps noted (p. EIS-54) that such delays for a frame of 80 charges could result in early blasts disrupting later blasts. The Department understands this problem and recommends the use of the longest delays which are consistent with efficient removal of rock. Since low velocity explosives produce shock waves with lower peak pressure, explosives with the lowest velocity consistent with achieving project goals should be used.

The Corps should develop pre-blast procedures which include:

1. a determination of significant species, including all
12 Federally-listed species, which may occur in the project area at
the time of proposed blasting and which the Corps is committed to
protecting;

2. the determination, based on the best available data and models,
13 of the radius for a danger zone in which very low mortality, such
as 1% (LD_1), would be produced by the effective weight of the
explosion for each species or group of similar species;

3. the determination of an adequate buffer, or safety zone to
14 surround the danger zone in order to provide additional protection
for Federally-listed species;

15 4. a surveillance plan to detect the significant species within
their respective danger or safety zones;

16 5. procedures, such as detonation of a small pre-blast, which may
cause significant species to leave the blasting area; and,

17 6. an effective procedure to halt blasting if significant species
are detected within their danger or safety zones.

A comprehensive, post-blast monitoring plan should be developed and
implemented in order to determine the number of organisms killed by
blasting. This plan should be developed in coordination with the
18 Fish and Wildlife Service (Service), the North Carolina Division of
Marine Fisheries, and the National Marine Fisheries Service. The
plan should include surveying the blast area by boat, counting all
dead or injured organisms seen, and identifying these animals to
the most detailed taxonomic level possible.

Indirect Impacts

The Department is concerned that a project of this magnitude may
produce indirect, or secondary, impacts. Indirect impacts would be
19 separated in time and space from the actual time of construction
and the immediate project area. However, indirect, adverse
environmental impacts are potentially more harmful to the lower
Cape Fear River ecosystem than direct impacts. The Department has

identified six potential indirect impacts of the proposed projects. These impacts and our recommendations for minimizing their effects are given below.

Loss of shallow estuarine areas

The DEIS states (p. EIS-42) that 13.2 acres of shallow estuarine
bottom will be dredged to a depth greater than 10 feet and 0.2
acres of mixed tidal marsh would also be deepened due to the
creation of channel side slopes. These areas have been designated
primarily as nursery areas by the North Carolina Division of Marine
20 Fisheries. These areas permit initial, post-larval development and
are considered area of high biological activity. Any permanent loss
of primary nursery area would diminish the productivity of
estuarine and marine ecosystems. The primary productivity of
shallow estuarine areas forms the base for many important food
chains on which fish and wildlife resources depend.

The Department has recommended that the Corps provide compensatory
mitigation for the loss of all shallow water wetlands. Attachment
D to the DEIS contains a mitigation analysis and a preliminary
mitigation plan. The plan calls for the restoration of shallow
estuarine habitat at one or more existing disposal areas in the
21 lower Cape Fear River area at a ratio of 2-to-1. The mitigation
effort would be concurrent with or prior to project construction.
At this time mitigation planning appears adequate. However, the
Department recommends that the Corps continue to develop specific
plans for the location, scheduling, specific goals, success
criteria, and a monitoring program.

Erosion of riverine shorelines and marshes

The Department is concerned that an indirect impact could be
increased erosion of riverine shorelines due to the wakes produced
by larger ships using the deeper channel. The DEIS notes (p. EIS-
26) that the shoreline and marsh along Eagle Island and other
disposal areas are eroding due to wind, waves, and boat wakes.
Larger ships displace greater amounts of water than smaller ships.
The greater displacement of water may result in greater wave action
22 along the riparian shoreline as ships move through the ship
channel. Larger waves impacting the riparian shoreline will stir
the sediment and could lead to increased shoreline erosion. Any
shoreline erosion would produce a loss of riparian habitat and
adversely affect those organisms which depend on that habitat. An
increase in shoreline erosion could also lead to demands for
construction to stabilize the shoreline. This construction could
also be detrimental to organism in the area.

23 The DEIS (p. EIS-43) states that the Corps has determined that the
project will not increase riverine shoreline and marsh erosion.
This finding is supported by a Corps memorandum which indicates
that ships using the four feet of additional draft in the channel

would increase wake height by one percent. The Corps also projects that the number of vessel trips will not increase appreciably. The Department is pleased that the Corps has addressed this issue. However, we request that the Final EIS present details for this determination and fully consider the issue of the impacts of greater ship displacement on riverine shoreline and marsh erosion.

Disruption of the longshore transport system

The Department is concerned that deepening the ship channel at the
mouth of the Cape Fear River may disrupt the longshore transport
24 system of sediment which influences the deposition and removal of
sand on beaches adjacent to the river mouth. The enlarged channel
could trap and retain more sand. Furthermore, the offshore
disposal of sand during construction and future maintenance would
remove sand from the longshore system.

The DEIS does not address the issue of longshore transport system
disruption. However, a response to the Service's concern (p. EIS-
57) states that there is no direct relationship between the
proposed channel deepening and this system. The Department remains
25 concerned that the proposed project may have a long-term, indirect
impact on the sediment budgets along the coast, and recommends that
the Corps fully assess the potential impacts of the proposed
project on the existing movement of sediment within and adjacent to
the mouth of the Cape Fear River.

Saltwater intrusion into groundwater

A 1991 planning document by the Corps raised the issue that
dredging to greater depths in the ship channel could increase
encroachment of saltwater into groundwater supplies. The
Department is also concerned that increased intrusion could occur
due to a breach in a confining layer separating fresh and saltwater
26 or to increasing withdrawals which alter the present hydrostatic
head which currently produces a net inflow of freshwater into the
Cape Fear River. If groundwater supplies are rendered salty as an
indirect impact of this project, the Department is concerned that
projects to replace freshwater supplies would include the damming
of streams or increased withdrawals from existing surface water
sources. These projects would adversely affect fish and wildlife
resources.

The Corps responded to these concerns in the DEIS (p. EIS-57). The
North Carolina Division of Water Resources plans to model potential
project impacts up to the year 2020, if practical. This modeling
effort will seek to determine a worst case scenario for project
27 impacts. However, the Corps notes that the environmental issues
associated with efforts to replace existing freshwater supplies is
beyond the scope of the present investigation. The Department is
pleased that the Corps is addressing this issue. However, the
Department recommends that the results of this modeling effort be

considered in the final environmental documentation. If there are indications that the project could produce such intrusion, the Corps should address the environmental issues associated with the creation of replacement freshwater supplies. Lastly, because there is much uncertainty in future projections of pumping, the ground water model should be used to determine under what conditions there might be a reversal of lateral gradients, resulting in Cape Fear River becoming a recharge rather than a discharge zone.

Saltwater intrusion into surface water

The Department is concerned that the project may increase the tidal
amplitude moving into the Cape Fear River and thereby allow
saltwater to intrude farther upstream. Such increased intrusion
would result in the conversion of freshwater wetlands into
28 oligohaline marsh and other salt tolerant communities. Past
studies in the region have indicated that estuarine vegetation has
changed due to increased tidal flooding and increased salinities.
Any change in estuarine plant communities would impact fish and
wildlife resources.

The Corps has addressed this potentially serious indirect impact by
sponsoring modeling studies on post-construction salinity levels.
Preliminary modeling results (p. EIS-32) indicate that the project
may actually cause surface isohalines to move downstream rather
than upstream. The Department supports the Corps' efforts to
29 anticipate salinity changes in surface water. However, the Corps
should release a written report on the saltwater intrusion model
which contains a detailed description of field data used in the
model and data collection procedures. This report should also
include all major assumptions and mathematical relationships used
in the model. This report should be made available to all State
and Federal resource agencies for both internal review and
submission to independent experts for evaluation.

It should be noted that the surface water modeling results appear
unusual, in that several dimensionless numbers predict that
saltwater intrusion will increase if the channel depth is
increased, in contrast to the results presented. It is also
unclear whether the presented isohalines are depth-averaged values
30 or surface values. Furthermore, in addition to evaluating the
effects of channel deepening on the location of isohalines, changes
in density stratification should be addressed for both the high and
low-flood conditions. The EIS should also include an analysis of
whether stratification will be increased, leading to less oxygen
transfer to deeper waters of the channel, thereby placing the
aquatic resources of the channel under stress.

In the absence of sufficient data to predict the actual effect of
31 the project on the intrusion of saltwater into surface water, the
Corps should develop a long-term program to monitor actual changes

in both salinity and riparian vegetation. Permanent sampling stations should be established for sampling water, vegetation, and animal communities. The Corps should also develop a general plan for remedial action in the event that a significant increase in saltwater intrusions occurs.

Accidents involving larger ships

The Department is concerned that the project may increase the risk of larger spills into the lower Cape Fear River. The primary purpose of the project is to allow larger ships to use the channel. The five largest commodities among the waterborne commerce of
32 Wilmington Harbor in the 1987-1988 period were, in descending order, petroleum products, industrial chemicals, asphalt and tar, pulp and paper products, and fertilizer. The current channel is used by 15,000-ton liquid gas tankers to carry ammonia fertilizer. A massive spill of ammonia or any hazardous substance would result in extensive environmental damage.

To minimize this risk the Department recommends that the operation and maintenance plan of the proposed project includes: (1) enforceable measures (e. g., speed limits and traffic levels) to minimize the risk of shipping accidents; (2) a permanent, fully
33 funded emergency response plan based on the types of cargo which will be carried in the ship channel; and, (3) specific provisions to insure that the owners of all ships using the Port of Wilmington have the financial resources to pay for any environmental cleanup for which they may be found liable.

The Corps responded to the Department's preliminary recommendations by stating that these issues were beyond its Federal authority (p. EIS-58). While the Corps may not have the authority to compel the North Carolina State Ports Authority to adopt specific measures, the Department believes that the environmental harm caused by an
34 accident involving a large ship which enters the channel as a direct result of the proposed deepening is an indirect impact which should be addressed. Therefore, the Department recommends that the Corps present information on the present status of the three items mentioned above and evaluate their adequacy for the ship traffic which would occur as a result of this project. If the measures are not adequate, the Department recommends the Corps request the State sponsor to modify the measures to address Department and other State and Federal review agency concerns.

Cumulative Impacts

The Department is concerned that the proposed project may produce cumulative impacts. A cumulative impact is the impact on the
35 environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal)

or person undertakes such other actions. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time. In regard to the present project, the Department believes that each of the six indirect impacts noted above may, when considered with similar projects within the lower Cape Fear River watershed, produce cumulative impacts which diminish the quality and quantity of fish and wildlife habitat. The major communities which could be impacted are estuarine and freshwater tidal ecosystems.

The Department recommends that the Corps assess past, current, and
anticipated construction projects in lower Cape Fear River
watershed which have had, are having, and/or will have adverse
environmental impacts on estuarine and freshwater tidal ecosystems.
This assessment should determine whether the proposed project would
contribute to a decline in either the areal extent or functioning
36 of estuarine and tidal freshwater ecosystems. For instance, the
Corps does not propose to compensate for the loss of 4.7 acres of
shallow estuarine bottoms which are not designated as primary
nursery area (pp. EIS-98/99). The Corps should not consider the
loss of this habitat as an isolated event, but evaluate this
incremental loss in light of past and anticipated future losses of
similar habitat in order to determine the cumulative impact of the
damage to this biological community.

As noted above, the DEIS states that wakes of post-construction
ship traffic should not increase shoreline and marsh erosion (p.
EIS-43). Wake heights are predicted to increase by only one
percent. From a perspective of cumulative impact analysis, the
37 Corps should not consider this small increase in erosion potential
in isolation. The baseline should not be the current erosion
produced by ships in the channel. The cumulative erosion potential
of the project should be the existing impacts of ship wakes added
to the incremental increase of this project.

Similarly, it is stated in the EIS (p. EIS-21) that major changes
have occurred in the salinity regime of the Cape Fear River as a
result, in part, of past navigation projects. While current
computer simulations suggest that the proposed project will not
38 result in greater saltwater intrusion, any change in salinity
should be considered in light of past projects of a similar nature.
However, the cumulative impact of the proposed project on salt
water intrusion will be existing intrusion resulting from past
modifications to the ship channel in addition to any incremental
increase which would be produced.

39 Similar analyses should be performed for impacts associated with
saltwater intrusion into ground water, the disruption of the
longshore transport system, and potential shipping accidents.

Beneficial Impacts

The proposed project may produce beneficial environmental impacts.
40 The Department recommends that the Corps consider these measures to enhance the fish and wildlife resources of the lower Cape Fear River.

Use of dredge material to maintain sea turtle nesting habitat

The Department believes that beach quality sand should be retained in the nearshore environment in order to enhance nesting habitat
41 for sea turtles. However, any efforts to use dredge material from the project for local beaches should insure that the material is free of contaminants and disposed of in a manner and at a time which will not adversely affect Federally-listed species and/or other important fish and wildlife resources.

Sediment to provide nesting habitat for colonial waterbirds

Sediment removed from the ship channel which has suitable texture and is free of contaminants should be used to create nesting habitat for colonial waterbirds. Existing dredge disposal islands
42 which are developing dense ground vegetation are becoming unsuitable for those species which require open areas for nesting. Therefore, the Department recommends the Corps consider proper placement and grading of sediment from the proposed project in order to restore the habitat value of these existing, artificial islands.

Rock to create offshore, artificial reef

Rock removed during construction could be used to create artificial reefs which benefit marine fish. While currently proposed blasting may result in rock rubble which is too small for reef creation, the Corps should monitor the size and other characteristics of the
43 rubble produced in this project. If suitable material is produced by the project, the Corps should consider the use of this material for the creation of artificial reef. This effort should be coordinated with the National Marine Fisheries Service, the Service's South Atlantic Fisheries Resource Coordination Office, and the North Carolina Division of Marine Fisheries. Only material which is of appropriate size and is free of contaminants should be used for artificial reef creation.

Acquisition of conservation lands

The study phase of the Wilmington Harbor-Northeast Cape Fear River
44 Project was authorized in 1967. The original project proposal contained a provision to acquire, either in fee simple or through conservation easements, 2,800 acres along the Northeast Cape Fear River. The area under consideration consisted of wetlands, bluffs, and buffer strips along the river. The area was a separate fish

and wildlife enhancement feature of the authorized project, and it was to be used for conservation purposes. However, this project element became "unscheduled" because of guidance from the Office of the Chief of Engineers which gave funding priority to " . . . components of the project that have high priority benefits. . .". The Service noted in 1988 that without protection these relatively undeveloped areas would be subject to "imminent threat due to commercial development, timber harvest and other uses." The Service has stated that we do not believe the conservation proposal is a wholly "enhancement" feature. The conservation lands may be considered, in part, as compensation for past, ongoing or anticipated habitat losses associated with harbor development in the lower Cape Fear River. Therefore, the Department recommends that the Corps make every effort to "reschedule" and pursue the acquisition of the 2,800-acre tract of conservation lands along the Northeast Cape Fear River.

SECTION 7 COMMENTS

The DEIS (p. EIS-43) and the Biological Assessment (Attachment B) state that the proposed project may affect the Federally-endangered West Indian manatee (*Trichechus manatus*, the Federally-threatened loggerhead sea turtle (*Caretta caretta*) the Federally-threatened green sea turtle *(Chelonia mydas)* the Federally-endangered Kemp's ridley sea turtle *(Lepidochelys kempi)*, and the Federally-endangered shortnose sturgeon. The Service has reviewed the BA and
45 concurs that the project, as currently planned, may adversely
affect the species mentioned above. Since the proposed project will not affect sea turtles during nesting on land, sea turtles, as well as the shortnose sturgeon, are under the jurisdiction of the National Marine Fisheries Service (NMFS). The NMFS should be contacted regarding your Section 7 responsibilities for these species. The manatee is under the jurisdiction of the Service.

Since the manatee is present in North Carolina waters, blasting and, to a lesser extent, dredging are the principal threats. While manatees are not abundant in North Carolina, the Service believes that the best way to minimize harm to this species is to completely
46 avoid potentially harmful activities when they may be present.
Current project plans call for blasting in the ship channel from August 1 through January 31. Project plans also include comprehensive pre- and post-blast monitoring plans (Attachment C in the DEIS). While the Service supports the measures in these plans, we believe even the most well designed pre-blast monitoring and exclusion procedures may not be completely effective.

Based on the Corps' determination that the project may adversely
47 affect the manatee, formal consultation with the Corps has been
initiated. Section 7 allows the Service up to 90 days to conclude formal consultation with the Corps and an additional 45 days to prepare our biological opinion (unless we mutually agree to an

extension). Therefore, the Service expects to provide the Corps with our biological opinion before July 10, 1996.

SUMMARY COMMENTS

The Cape Fear-Northeast Cape Fear Rivers Comprehensive Project will result in significant alterations in the diverse ecosystems of the lower Cape Fear River watershed. The planning process to date has adequately documented the economic justification for the proposed
48 modifications, the range of alternatives considered, and the selection of a preferred alternative. The large construction effort needed to accomplish the preferred alternative for the present project has the potential to create significant direct, indirect, and cumulative adverse, environmental impacts. However, the Department believes that a thorough consideration of the environment during planning can avoid many of the most severe impacts and minimize others.

With the exception of blasting, the Department believes that most direct impacts associated with construction will be relatively minor and short-term. Blasting impacts could produce significant mortality, and impacts should be avoided or minimized by a
49 comprehensive program to restrict the use of blasting, the use of seasonal restrictions on blasting, the proper selection of equipment and blasting procedures, monitoring programs, and programs to contain blast impacts and halt blasting if important resources are detected within scientifically-based, predetermined danger/safety zones.

The Department is more concerned about the long-term, secondary impacts of the proposed project. We have discussed concerns about six, potential, indirect impacts. The Department realizes that these impacts may be difficult to predict with a high degree of accuracy. However, the Department is concerned that the Corps' effort to evaluate some of these impacts have not been completed.
50 Efforts to evaluate saltwater intrusions into both surface water and groundwater have not been completed. There are no current evaluations of the potential impacts to the longshore transport system, which influences area beaches, and of the risk of accidents in the enlarged channel. The Department strongly recommends that the Corps fully evaluate all potential, indirect impacts which may be produced by the project, develop long-term monitoring programs where major uncertainties exist, and plan remediation measures for a "worst-case" scenario of each potential impact.

The Department believes that the proposed project offers several
51 opportunities for the enhancement of fish and wildlife resources in the project area. Such measures include: (1) the use of soft sediment which is free of contaminants and properly placed and graded on existing disposal islands to benefit nesting by colonial waterbirds; (2) the use of soft sediment which is free or

contaminants and properly placed in the littoral zone near the mouth of the Cape Fear River to support area beaches; (3) the use of rock which is contaminant-free and properly placed to create an off shore, artificial reef to enhance fisheries resources; and, (4) the acquisition of freshwater wetlands, as originally proposed in the Wilmington Harbor-Northeast Cape Fear River Project, for the enhancement of fish and wildlife resources in the project area. The Department strongly recommends that the Corps fully consider each of these measures.

The Service has provided recommendations which, in our opinion, will: (1) eliminate, or minimize, most short-term, direct impacts; (2) generate information on potential indirect impacts which are now poorly understood; (3) define those elements of the environment which are susceptible to long-term degradation and which require
52 monitoring and contingency planning for possible remedial actions; and, (4) identify actions which could benefit the natural resources of the project area. If the Corps implements each of these recommendations, the Department believes that the proposed project is compatible with the long-term viability of marine, estuarine, and freshwater ecosystems in the project area and the many important fish and wildlife resources which they support.

FM208

NORTH CAROLINA STATE CLEARINGHOUSE
DEPARTMENT OF ADMINISTRATION
116 WEST JONES STREET
RALEIGH NORTH CAROLINA 27603-8003

04-10-96

INTERGOVERNMENTAL REVIEW COMMENTS

MAILED TO:

ARMY CORPS OF ENGINEERS
FRANK YELVERTON
P.O. BOX 1890
WILMINGTON, NC 28402-1890

FROM:

MRS. CHRYS BAGGETT
DIRECTOR
N C STATE CLEARINGHOUSE

PROJECT DESCRIPTION:

DRAFT FEASIBILITY REPORT/DRAFT EIS - CAPE FEAR-NORTHEAST CAPE FEAR RIVERS STUDY, PROPOSED PLAN TO DEEPEN WILMINGTON HARBOR

SAI NO 96E00000533 PROGRAM TITLE - DRAFT FEAS REPORT/DEIS

THE ABOVE PROJECT HAS BEEN SUBMITTED TO THE NORTH CAROLINA INTERGOVERNMENTAL REVIEW PROCESS. AS A RESULT OF THE REVIEW THE FOLLOWING IS SUBMITTED: ( ) NO COMMENTS WERE RECEIVED

(X) COMMENTS ATTACHED

SHOULD YOU HAVE ANY QUESTIONS, PLEASE CALL THIS OFFICE (919) 733-7232.

C.C. REGION O

State of North Carolina
Department of Environment,
Health and Natural Resources
Legislative & Intergovernmental Affairs

James B. Hunt, Jr., Governor
Jonathan B. Howes, Secretary
Henry M. Lancaster II, Director

DEHNR

MEMORANDUM

TO: Chrys Baggett
State Clearinghouse

FROM: Melba McGee
Environmental Review Coordinator

RE: Cape Fear - Northeast Cape Fear Rivers Comprehensive Study, Brunswick County

DATE: April 10, 1996

The Department of Environment, Health, and Natural Resources has reviewed the subject proposal. This department ask that careful consideration be given to the attached suggestions provided by the N.C. Wildlife Resources Commission and the Division of Environmental Management.

Thank you for the opportunity to respond.

attachments

RECEIVED

APR 1 [illegible]

N.C. STATE CLEARINGHOUSE

State of North Carolina
Department of Environment,
Health and Natural Resources
Division of Environmental Management

James B. Hunt, Jr., Governor
Jonathan B. Howes, Secretary
A. Preston Howard, Jr., P.E., Director

DEHNR

April 2, 1996

MEMORANDUM

To: Melba McGee

Through: John Dorney

From: Greg Price

Subject: Cape Fear - Northeast Cape Fear Rivers Comprehensive Study
Brunswick County
EHNR #96-0533, DEM WQ #11191

1 The subject document has been reviewed by this office. The Division of Environmental Management is responsible for the issuance of the Section 401 Water Quality Certification for activities which may impact waters of the State including wetlands. The following comments are offered in response to the EIS.

2 1. The DEM prefers the alternative of using a rock cutterhead dredge rather than the use of explosives for the removal of nondredgeable rock. However, the DEM accepts the blasting plan if blasting is deemed unavoidable.

3 2. If blasting is still required, the Corps must comply to condition #3 of the 401 certification (WQC #2971) issued for the Wilmington Harbor Channel Widening project on February 9, 1995. Condition #3 states that written DEM approval for blasting is required after consultation with other state and federal agencies. Any fish or other aquatic organisms killed during blasting must be replaced at a cost to be determined by these agencies.

4 The COE is reminded that endorsement of an EIS by DEM would not preclude the denial of a 401 Certification upon application if wetland impacts have not been avoided and minimized to the maximum extent practicable.

5 Questions regarding the 401 Certification should be directed to Greg Price (733-1786) in DEM's Water Quality Environmental Sciences Branch.

cc: Monica Swihart
Wilmington DEM Regional Office

North Carolina Wildlife Resources Commission

512 N. Salisbury Street, Raleigh, North Carolina 27604-1188, 919-733-3391
Charles R. Fullwood, Executive Director

MEMORANDUM

TO: Melba McGee
Office of Legislative & Intergovernmental Affairs

FROM: Bennett Wynne BW
Habitat Conservation Program

DATE: March 22, 1996

SUBJECT: US Army Corps of Engineers Draft Feasibility Report and Environmental Impact Statement on Improvement of Navigation; Cape Fear-Northeast Cape Fear Rivers Comprehensive Study, Project No. 96-0533, New Hanover County, North Carolina.

1 The Wildlife Resources Commission has completed a review of the project and associated impacts on wildlife and fishery resources. Our comments are provided in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et. seq.).

2 The Corps of Engineers proposes to deepen most of Wilmington Habor's 35 miles of channel by 4 ft. and widen 2 turning basins and channel near Wilmington. A variety of dredging techniques, including blasting with explosives would be used to complete the project. Environmental impacts and commitments have been addressed quite comprehensively in the Draft Environmental Impact Statement (DEIS). However, we do have a number of concerns.

3 **Mitigation** - Restoration of spoil disposal areas to wetland and shallow water habitats as mitigation for the loss of these resources could result in loss of high quality colonial nesting bird islands.

4 **Marsh Erosion** - The DEIS contends shoreline marsh erosion should not increase since a 4 ft. increase in vessel draft would only elevate wake heights about 1% (p.EIS-43). This does not take into account increased vessel speeds made possible by channel deepening (this project) and widening (separate, concurrent project). Neither is the distance from channel to marsh shoreline addressed. We have yet to be convinced that larger and likely faster vessels will not accelerate marsh erosion, especially in areas where the channel comes closest to marsh shorelines, resulting in additional loss of wetland habitat.

5 **Spill Potential** - Larger vessels carrying bigger loads at a greater average speed would have the potential for increasing the severity of a hazardous material spill should an accident occur. Direct adverse impacts to fish and wildlife resources would be expected to accompany such an event.

6 **Blasting** - Overeliance on the effectiveness of an air bubble curtain blast mitigation measure that has been untested in the Cape Fear estuary could result in a pre-blast observer underestimating the area he/she should cover. Animals within the actual lethal range of the blast could be missed during pre-blast observation.

7 **Post-Blast Evaluation** - We found no description of or plans for a post-blast evaluation in the DEIS. Without such an evaluation, animal mortalities cannot be quantified and accurately assessed. This information must be collected and documented in order to determine the effectiveness of blast mitigation measures.

8 **Salinity Intrusion** - The extent to which salinity may intrude into ground and surface waters is a huge unknown at this point in time. Potential impacts range from changes in wetland characteristics to extinction of the Greenfield Ramshorn Snail to reduced water supply for human consumption. Impacts would be expected to become more acute over the life of the project as development proliferates along the estuary.

9 **Tidal Amplitude** Increased tidal amplitude expected to result from the project may decrease navigability of small tidal creeks during low tide. Riparian wetlands may also migrate upgradient, affecting what were previously uplands.

10 Based on these concerns, we find the project consistent with our *Policies and Guidelines for Conservation of*

Wetlands and Aquatic Habitats only under the following conditions:

11 1. Spoil disposal areas to be used as wetland and shallow water mitigation sites must not be areas currently utilized by colonial nesting birds.

12 2. Marsh erosion potential is more thoroughly addressed. If marsh erosion is accelerated by the project, this wetland loss must be fully mitigated.

13 3. Emergency response resources are capable of handling potentially larger spills of hazardous materials.

4. For the initial month of blasting, pre blast
14 observation for detection of animals in the blast area will be done as though air bubble curtains are not being used. If after a month it has been demonstrated that mortalities outside the bubble curtain are insignificant, pre-blast observation can be limited to the area enclosed by the bubble curtain.

5. Post-blast evaluations, including quantification of
15 species and sizes of animals killed or injured, are conducted for the initial month of blasting. Animals should be collected from the surface and the bottom, within and outside the bubble curtain.

6. Ground and surface water models predict that
16 salinity intrusion will not occur over the life of the project, or if it is predicted to occur, the intrusion can and will be fully mitigated. Monitoring of ground and surface water as well as wetland vegetation would be needed post project to verify model predictions.

Thank you for the opportunity to comment on this project. If you need to discuss these comments or need additional assistance, please call me at (919) 522-9736.

cc: William Wescott, Coastal Hab. Con. Coordinator
s:\boatfish\habcon\coast\d2 (wlhrb2.doc)

State of North Carolina
Department of Environment, Health and Natural Resources
Division of Coastal Management

James B. Hunt, Jr., Governor
Jonathan B. Howes, Secretary
Roger N. Schecter, Director

DEHNR

MEMORANDUM

TO: Melba McGee, NC Division of Policy and Development
FROM: Steve Benton, NC Division of Coastal Management

SUBJECT: Review of SCH # 96-0593 **DATE:** 3/8/96

✓ **A Copy of All Comments Received by the SCH is Requested** ___ **Reviewer Comments Attached**

Review Comments:

___ This document is being reviewed for consistency with the NC Coastal Management Program pursuant to federal law and/or NC Executive Order 15. Agency comments received by SCH are needed to develop the State's consistency position.
Project Review Number (if different from above) __________.
A Consistency position will be developed based on our review on or before __________.

___ A Consistency Determination document ___is, or ___may be required for this project. Applicant should contact Steve Benton or Caroline Bellis in Raleigh, phone # (919) 733-2293, for information on the proper document format and applicable state guidelines and local land use plan policies.

✓ Proposal is in draft form, a consistency response is inappropriate. A Consistency Determination should be included in the final document.

___ A Consistency Determination document (pursuant to federal law and/or NC Executive Order 15) is not required.
___ A consistency response has already been issued.
Project No. __________. Date issued __________.
___ Proposal involves < 20 Acres or a structure < 60,000 Sq. Feet and no AEC's or Land Use Plan Problems.
___ Proposal is not in the Coastal Area and will have no significant impacts on any land or water use or natural resource of the Coastal Area.

___ A CAMA Permit ___is, or ___may be required for all or part of this project proposal. Applicant should contact __________ in __________, phone # __________, for information.

___ A CAMA Permit ___ has already been issued, or ___ is currently being reviewed under separate circulation.
Permit No. __________. Date issued __________.

* Other (~~see attached~~). DOCUMENT BEING REVIEWED AS DCM PROJECT DCM96-18. COMMENTS RECEIVED WILL BE FORWARDED UPON RECEIPT

State of North Carolina Consistency Position:

___ The proposal is consistent with the NC Coastal Management Program provided that all conditions are adhered to and that all state authorization and/or permit requirements are met prior to implementation of the project.

___ The proposal is inconsistent with the NC Coastal Management Program.

___ Other (see attached)

North Carolina Department of Cultural Resources

James B. Hunt Jr., Governor
Betty Ray McCain, Secretary

Division of Archives and History
Jeffrey J. Crow, Director

March 27, 1996

Colonel Robert J. Sperberg
District Engineer
U.S. Army Corps of Engineers
Wilmington District
P.O. Box 1890
Wilmington, NC 28402-1890

Re: Feasibility report on improvement of navigation, Cape Fear River, Wilmington vicinity, New Hanover and Brunswick Counties, 96-E-0000-0533, ER 96-8445

Dear Colonel Sperberg:

We have received information concerning the above project from the State Clearinghouse.

Jeff Adolphsen, restoration specialist with our office, spoke with Richard Kimmel, Army
Corps of Engineers archaeologist, in regard to our concern about the blasting effect on the
historic structures in Wilmington. Mr. Kimmel stated the blast models indicate no historic
1 structures should be affected by the blasting. In addition, the actual planned blasts will not
be as powerful as the blast model. Based upon this information, we have determined the
blasting will have no effect upon the historic structures in the surrounding area.

There are no known archaeological sites within the proposed project area. Based on our
present knowledge of the area, it is unlikely that any archaeological resources which may
2 be eligible for inclusion in the National Register of Historic Places will be affected by the
project construction. We, therefore, recommend that no archaeological investigation be
conducted in connection with this project.

The above comments are made pursuant to Section 106 of the National Historic
3 Preservation Act and the Advisory Council on Historic Preservation's Regulations for
Compliance with Section 106 codified at 36 CFR Part 800.

Thank you for your cooperation and consideration. If you have questions concerning the above comment, please contact Renee Gledhill-Earley, environmental review coordinator, at 919/733-4763.

Sincerely,

David Brook/w

David Brook
Deputy State Historic Preservation Officer

DB:slw

cc: State Clearinghouse
Steve Benton, Division of Coastal Management
Richard Kimmel, Army Corps of Engineers
Wilmington Historic District Commission

State of North Carolina
Department of Environment,
Health and Natural Resources
Division of Coastal Management

James B. Hunt, Jr., Governor
Jonathan B. Howes, Secretary
Roger N. Schecter, Director

DEHNR

April 24, 1996

Mr. Frank Yelverton
U.S. Army Corps of Engineers
Wilmington District
P.O. Box 1890
Wilmington, NC 28402-1890

REFERENCE: DCM96-18: Draft Feasibility Report and EIS on Improvement of Navigation, Cape Fear-Northeast Cape Fear Rivers Comprehensive Study

Dear Mr. Yelverton:

The North Carolina Division of Coastal Management has reviewed the referenced document, in two volumes dated January 1996. The Corps of Engineers proposes to deepen approximately 38 miles of the channel, widen portions of the channel, and extend two anchorage/turning basins within
1 the Wilmington Harbor Navigation Project. Approximately 12,825,586 cubic yards of material would be removed by new dredging. Of this amount, approximately 3,423,777 cubic yards are rock. It is anticipated that 564,000 cubic yards of the rock will require removal by blasting. The proposal is in draft form. Our consistency position will be provided upon completion of our review of the Final EIS.

The Division of Coastal Management is concerned with how the alternatives for disposal of dredged materials from this project are addressed in the document. As you are aware, it is state policy that where practicable, dredged material of suitable quality shall be placed within the littoral system (15A NC Administrative Code Subchapter M). The NC General Assembly recently enacted an amendment to the North Carolina Dredge and Fill Law that requires that beach quality material be
2 placed on downdrift beaches, or, if placed elsewhere, an equivalent amount from another source shall be placed on downdrift beaches. Disposal alternatives that do provide the beneficial use of dredged material are discussed in the EIS (EIS-14). However, these alternatives do not appear to have been carried over to the Feasibility Report, where there is no consideration given to alternatives other than disposal offshore or at the upland Eagle Island site (p. 43). The project as described in the Feasibility Report would be considered inconsistent with these rules.

During our review we circulated the document to our network of review
3 agencies. The Division of Environmental Health requested that they be kept
informed of the progress of this and future studies. They commented that they could contribute to the work of these studies, and their involvement could potentially save on costs associated with mosquito control.

The Wildlife Resources Commission expressed concerns regarding several issues related to the proposed project. A copy of comments received from the Wildlife Resources Commission is attached. The Division of Coastal Management shares the concerns of the Wildlife Resources Commission, especially regarding
4 mitigation, marsh erosion, salinity intrusion, and spill potential. Salt water
intrusion appears to be a very significant unresolved issue concerning the increased depths in the river system. It is difficult to accept the model's indications that a fresher system may occur following the project. In addition, the projected 2" rise in the river level may have unanticipated impacts on existing habitats.

Some of the issues raised are not new but rather reflect ongoing concerns related to the continued expansion of the Wilmington Harbor Projects. It would be interesting to see some figures and illustrations depicting how the river has been modified over time. Over the years state and federal agencies have raised the same
5 issues in response to channel improvement projects. The Corps has put a lot of
effort into monitoring and modeling studies over the past few years. But we still do not have enough information to determine what the long term cumulative impacts on coastal resources of the area are. While we understand that the Corps intends to continue their studies and conduct post-project monitoring, we are hesitant to approve additional harbor improvements until there are more knowns and less unknown.

We support the continued consideration and development of innovative mitigation elements as part of the proposed harbor improvements. However, rather than limiting the mitigation to impacts resulting from the incremental enlargement
6 of the harbor, we would prefer a more comprehensive approach which involves
identification and mitigation for impacts resulting from the harbor activities back to the beginning. Some analysis of cumulative, additive impacts has already been done as part of the EIS for the harbor improvements which was completed in 1980. We also encourage a reauthorization of the "enhancement" proposal which involved acquisition of approximately 2,500 acres of adjacent lands as a conservation buffer.

The Division of Coastal Management appreciates the opportunity for continued
7 participation in the planning and review of important projects such as this. If you
have any questions regarding these or the attached comments, please contact me or

Caroline Bellis, Division of Coastal Management, at (919)733-2293. Thank you for your consideration of the North Carolina Coastal Management Program.

Sincerely,

Caroline Bellis

for Stephen B. Benton
Consistency Coordinator

cc: Bob Stroud, Division of Coastal Management, Wilmington
Linda Sewall, Division of Environmental Health
Franklin McBride, Wildlife Resources Commission

North Carolina Department of Cultural Resources

James B. Hunt Jr., Governor
Betty Ray McCain, Secretary

Division of Archives and History
Jeffrey J. Crow, Director

May 1, 1996

RECEIVED
MAY 3 1996
COASTAL MANAGEMENT

MEMORANDUM

TO: Stephen B. Benton, Consistency Coordinator
Division of Coastal Management, DEHNR

FROM: David Brook *David Brook*
Deputy State Historic Preservation Officer

SUBJECT: Draft EIS for Cape Fear-Northeast Cape Fear Rivers Feasibility Study, New Hanover and Brunswick Counties, Project DCM 96-18, ER 96-8445

1 We would like to make the following supplemental comments on the Draft Environmental Impact Statement (DEIS) for the Cape Fear-Northeast Cape Fear Rivers Feasibility Study based on review of this document by our Underwater Archaeology Unit (UAU).

2 The DEIS accurately states that "none of the known or newly discovered shipwreck sites are sufficiently close to the navigation channels to require evaluation during construction of the proposed project." However, the DEIS does not contain the recommendations made by the UAU at the December 13, 1995 agency meeting concerning the need for additional remote sensing survey during the planning, preconstruction engineering, and design (PED) phase of the project. As stated in the Submerged Cultural Resources Survey Report prepared for this project by the UAU:

> 3 A review of the past dredging history of the various ranges of the river indicated that portions of the Lower Swash, Battery Island, Southport, Baldhead-Caswell, and Smith Island ranges near the river's mouth have never been dredged and thus may contain significant, undisturbed cultural resources. It is recommended that a magnetometer survey be conducted of those ranges and that any targets located during the survey be investigated and evaluated.

4 Although the official review period for the DEIS is over, we hope these recommendations can be incorporated into the final EIS for the Cape Fear-Northeast Cape Fear Rivers Feasibility Study.

5 The above comments are made pursuant to Section 106 of the National Historic Preservation Act and the Advisory Council on Historic Preservation's Regulations for Compliance with Section 106 codified at 36 CFR Part 800.

6 Thank you for your cooperation and consideration. If you have questions concerning the above comment, please contact Renee Gledhill-Earley, environmental review coordinator, at 919/733-4763.

DB:slw

ATTACHMENT B

**BIOLOGICAL ASSESSMENT AND BIOLOGICAL OPINION
UNDER THE
ENDANGERED SPECIES ACT OF 1973, AS AMENDED**

FINAL

**ENVIRONMENTAL IMPACT STATEMENT
FOR
CAPE FEAR-NORTHEAST CAPE FEAR RIVERS
FEASIBILITY STUDY
NEW HANOVER AND BRUNSWICK COUNTIES, NORTH CAROLINA**

NOTES:

1) The Biological Assessment (BA) contained in this attachment covers those species under the jurisdiction of the National Marine Fisheries Service (NMFS) and the US Fish and Wildlife Service (USFWS).

2) The Draft Biological Opinion from the USFWS is included in this attachment on page ATTACH. B-20.

3) The BO from NMFS was not been received in time to be printed with this EIS. Coordination is continuing with NMFS and the BO will be available prior to preparation of the Record or Decision (ROD).

BIOLOGICAL ASSESSMENT
FOR
CAPE FEAR-NORTHEAST CAPE FEAR RIVERS
FEASIBILITY STUDY
NEW HANOVER AND BRUNSWICK COUNTIES, NORTH CAROLINA

JUNE 1996

1.00 SUMMARY

Deepening of the existing channel from the ocean bar to the Port of Wilmington is the central feature of the proposed action. Other features included in the proposed action consist of widening two turning basins and extending the deep draft project about 1.6 miles further up the Northeast Cape Fear River (Figure 1). The total length of improvements is approximately 38 miles. The 44-foot deep bar channel and 42-foot deep river channel will be the recommended plan. This project will require removal of about 12,825,000 cubic yards of dredged material of which about 3,423,000 cubic yards are rock. About 601,000 cubic yards of this rock will require blasting for removal. The construction period for the entire project will be about 3 years. The detailed project description is as follows:

The recommended project provides for a navigation channel 44 feet deep and 500 feet wide from the Atlantic Ocean through Baldhead Shoal Channel to Battery Island Channel near Southport, North Carolina. From Lower Swash Channel through the anchorage basin, located at the foot of Castle Street in Wilmington, North Carolina, the channel will be 42 feet deep and 400 feet wide. The five turn wideners and 6.2-mile passing lane (both a part of the Wilmington Harbor Channel Widening Final Environmental Impact Statement (EIS) (USACE, 1994)) will be deepened to 42 feet. The 1,200-foot-wide anchorage basin, which extends from the North Carolina State Ports Authority to the Cape Fear Memorial Bridge near the foot of Castle Street, will be extended to the north about 300 feet. No construction is planned between the Cape Fear Memorial Bridge and 750 feet above the Hilton Railroad Bridge. The existing 25-foot-deep and 200-foot-wide channel from 750 feet above the Hilton Railroad Bridge to the Arcadian Plant will be deepened to 34 feet and widened to 250 feet. The 700-foot-wide turning basin located at the Arcadian Plant will be widened to 800 feet. The recommended project ends at the Arcadian Plant located 1.6 miles above the Hilton Railroad bridge. Channel side slopes from the Baldhead Shoal Channel to Battery Island Channel will be 5H:1V. Side slopes for the remaining project reaches and turning basins will be 3H:1V. In addition to the required project depths, dredging depths associated with all of the project features will include 2 feet of allowable overdepth in non-rock areas and 1 foot of required overdepth plus an additional 2 feet of allowable overdepth in rock areas.

Excavation methods include the use of hydraulic pipeline dredges, bucket and barge dredges, hopper dredges, and blasting. Hydraulic pipeline dredges will be used from about 4 miles south of the State Port (Upper Big Island Channel) to the upstream limit of the Federal Channel with disposal in Eagle Island, an existing upland confined disposal facilities (CDF). Beginning about 4 miles south of the State Port (Lower Big Island Channel) to Southport (Lower Swash Channel), a bucket and barge dredge will be used with disposal in the US Environmental Protection Agency approved Ocean Dredged Material Disposal Site (ODMDS). From Southport (Battery Island Channel) thru Smith Island Channel a hopper dredge will be used with disposal in the ODMDS. In Baldhead Shoal Channel, the rock substrate and sediment will be excavated by a rock cutterhead dredge and pumped to a barge. The rock will be used to complete the Wilmington Offshore Fisheries Enhancement Structure (WOFES) and the sediment placed in the ODMDS. In the river from Lower Big Island Channel downstream, in areas requiring rock blasting, the rock will be removed following blasting with a bucket and barge dredge and placed on the WOFES. Rock requiring dredging or blasting at or upstream of Upper Big Island Channel will be removed by pipeline dredge and pumped to Eagle Island. **If pieces are too large to be removed by hydraulic pipeline dredge, they will be removed by bucket and barge and either placed on Eagle Island or in the WOFES.** Blasting and hydraulic pipeline dredging in the river will be restricted to August 1 to January 31. Dredging by bucket and barge in the river, hopper dredge in the lower river, and rock dredge in the ocean will be performed year-round. None of the proposed year-round dredging actions will be contiguous to a primary nursery area.

Benefits which will accrue from the deepening of Wilmington Harbor include reductions in light loading of vessels and vessel delays. Shippers will also be able to use larger, more efficient vessels. The total project costs are $210,264,000, average annual costs are $18,566,000, and average annual benefits are $28,691,000. This results in a benefit-cost ratio about 1.5 ($28,691,000/$18,566,000).

2.00 PRIOR COORDINATION

An updated list of threatened or endangered species was obtained from both the USFWS (Raleigh, North Carolina, Field Office) and the NMFS (Southeast Regional Office) on October 2, 1995.

3.00 ALTERNATIVES

In addition to the **recommended plan, three alternative plans were considered. These alternatives include conditions of depths, some shallower and deeper than the recommended plan (see Section 3.01 of the EIS).** The shallower depth does not meet the local sponsor's needs of sufficient reductions in light loading of vessels and vessel delays, and shippers will not be able to use larger, more efficient vessels. The costs for the deeper project, especially associated with the additional blasting required, prevents this alternative from being cost effective.

The District has reviewed several alternatives to the use of explosives for the removal of nondredgeable rock. **These include a backhoe mounted ripper tooth, a large punch or chisel dropped onto the rock surface to pulverize, a dipper dredge, and a rock cutterhead hydraulic dredge. However, based on the analysis in Appendix G of Volume II, there are no feasible alternatives to blasting in the reaches indicated in Table 1.**

A dipper dredge was used briefly in 1994 on the ocean bar with mixed results. The rock cutterhead dredge can probably be used on the ocean bar. Such a dredge is currently being successfully used to establish the authorized depth on the bar channel of 40 feet mllw. This depth had not been previously established due to the presence of rock. A rock cutterhead dredge probably can also be used in the harbor above the Hilton Railroad Bridge. The rock in the rest of the harbor, Keg Island Channel through the Memorial Bridge, is such that blasting will be necessary (Appendix G of Volume II). Also deepening of the harbor to 38 feet mllw downstream of the Memorial Bridge in the late 1960's and early 1970's required blasting of rock from Keg Island to the vicinity of the Memorial Bridge.

Approximately 601,000 cubic yards of rock will have to be blasted within the reaches from the Keg Island Channel through the Memorial Bridge. The percentage of nondredgeable rock to the total quantity material of dredged for the project is about 4.7 percent (601,000 cubic yards/12,825,000 cubic yards).

The removal of 601,000 cubic yards of nondredgeable rock translates into about 89.3 acres of river bottom that will be affected. This 89.3 acres of river bottom will be removed by dredging (bucket and barge and\or hydraulic dredge) even if no blasting occurs. Rock blasted or dredged from Lower Big Island Channel downstream through Baldhead Shoal channel will be used to finish construction of the WOFES. The total volume of rock (dredged and blasted rock) that could be put on the WOFES is about 2.4 million cubic yards.

The preliminary blast plan includes:

The drilling of holes will be on 8-foot spacing within rows and between each row, 10 holes per row, and 8 rows per frame for a total of 80 holes. Hole diameter will be 4.5 inches and depth will average 11.2 feet. Each hole will be stemmed to a depth of 1 foot. Inserting one delay per hole, charge weight will be 98.5 pounds per hole. Total weight of charges per frame (i.e., 80 holes) will be 7,880 pounds. A bubble curtain and/or a physical barrier will be placed completely around the blast area (about 35,000 square feet).

Construction of Proposed Project Plan

The proposed project (recommended plan) is summarized in Table 1.

Table 1. RECOMMENDED PLAN

Cape Fear - Northeast Cape Fear River Comprehensive

(44' Ocean Bar/42' Interior/1200' wide Anchorage Basin-extended 300' north/34' above Chemserve/800' turning basin)

Reach (Name)	Width/Dim (Ft)	Depths *	Total Vol. (CY)	Rock Volume Total (CY)	Rock Volume Blast (CY)	Num. of Blasts	Disposal (Location)	Dredge Type
Baldhead Shoal 305+00 to 491+00	500'	44 + 1 + 2(1/2	965,990	965,990	0	0	ODMDS	suction
Baldhead Shoal 305+00 - 125+00	500'	44 + 1 + 2(1/2	1,484,090	1,413,527	0	0	ODMDS	suction
Baldhead Shoal 125+00 in	500'	44 + 0 + 2(1/2	579,410	0	0	0	ODMDS	suction
Smith Island	500'	44 + 0 + 2(1/2	119,630	0	0	0	ODMDS	hopper
Baldhead - Caswell	500'	44 + 0 + 2(1/2	57,810	0	0	0	ODMDS	hopper
Southport	500'	44 + 0 + 2(1/2	43,790	0	0	0	ODMDS	hopper
Battery Island	500'	44 + 0 + 2(1/2	45,490	0	0	0	ODMDS	hopper
Lower Swash	400'	42 + 0 + 2(1/2	119,940	0	0	0	ODMDS	clamshell
Snow Marsh	400'	42 + 1 + 2(1/2	392,350	1,367	1,367	1	ODMDS	clamshell
Horseshoe Shoal	400'	42 + 0 + 2(1/2	270,110	0	0	0	ODMDS	clamshell
Reaves Point	400'	42 + 0 + 2(1/2	323,280	0	0	0	ODMDS	clamshell
Lower Midnight	600'	42 + 0 + 2(1/2	626,770	0	0	0	ODMDS	clamshell
Upper Midnight	600'	42 + 0 + 2(1/2	1,087,510	0	0	0	ODMDS	clamshell
Lower Lilliput	600'	42 + 0 + 2(1/2	847,860	0	0	0	ODMDS	clamshell
Upper Lilliput	400'	42 + 1 + 2(1/2	661,050	7,240	7,240	7	ODMDS	clamshell
Keg Island	400'	42 + 1 + 2(1/2	570,300	28,580	28,580	28	ODMDS	clamshell
Lower Big Island	400'	42 + 1 + 2(1/2	334,780	97,747	97,747	97	ODMDS	clamshell
Upper Big Island	400'	42 + 1 + 2(1/2	358,250	182,747	100,321	129	Eagle Is.	suction
Lower Brunswick	400'	42 + 1 + 2(1/2	606,300	26,497	12,871	17	Eagle Is.	suction
Upper Brunswick	400'	42 + 1 + 2(1/2	368,000	4,129	0	0	Eagle Is.	suction
Fourth East Jetty	500'	42 + 1 + 2(1/2	546,690	3,976	0	0	Eagle Is.	suction
Between Channel	550'	42 + 1 + 2(1/2	216,080	24,869	0	0	Eagle Is.	suction
Anchorage Basin - 1200' basin extend 300'	1200	42 + 1 + 2(1/2	1,295,553	622,031	353,177	316	Eagle Is.	suction
750' Chemserve to Arcadian	250'	34 + 1 + 2(1/2	904,553	45,077	0	0	Eagle Is.	suction
(turning basin)	800'	34 + 1 + 2(1/2	-	-	-	0	Eagle Is.	suction
		TOTALS	12,825,586	3,423,777	601,303	595		

Without Project Assumptions:

1. Ocean Bar project constructed.
2. Channel Widening (Turns & Bends / Passing Lane) project constructed.
3. Northeast Cape Fear River project constructed.

Notes:

* The depths shown are project depth + required depth + 1/2 of the allo

4.00 SPECIES CONSIDERED UNDER THIS ASSESSMENT

The following composite list of species to be considered in this assessment was furnished by the USFWS and the NMFS (see prior correspondence, above):

Mammals

Eastern cougar	(*Felis concolor couguar*)	Endangered
West Indian manatee	(*Trichechus manatus*)	Endangered
Finback whale	(*Balaenoptera physalus*)	Endangered
Humpback whale	(*Megaptera novaeangliae*)	Endangered
Right whale	(*Eubaleana glacialis*)	Endangered
Sei whale	(*Balaenoptera borealis*)	Endangered
Sperm whale	(*Physeter catadon*)	Endangered

Birds

Bald eagle	(*Haliaeetus leucocephalus*)	Endangered
Piping plover	(*Charadrius melodus*)	Threatened
Wood Stork	(*Mycteria americana*)	Endangered
Peregrine falcon	(*Falco peregrinus*)	Threatened
Red-cockaded woodpecker	(*Picoides borealis*)	Endangered

Reptiles

Loggerhead sea turtle	(*Caretta caretta*)	Threatened
Kemp's ridley sea turtle	(*Lepidochelys kempii*)	Endangered

Reptiles (continued)

Green sea turtle	(*Chelonia mydas*)	Threatened
Hawksbill sea turtle	(*Eretmochelys imbricata*)	Endangered
Leatherback sea turtle	(*Dermochelys coriacea*)	Endangered

Fish

Shortnose sturgeon	(*Acipenser brevirostrum*)	Endangered

Plants

Cooley's meadowrue	(*Thalictrum cooleyi*)	Endangered
Rough-leafed loosestrife	(*Lysimachia asperulaefolia*)	Endangered
Sea-beach amaranth	(*Amaranthus pumilis*)	Threatened

5.00 ASSESSMENT OF IMPACTS TO LISTED SPECIES

5.01 General Impacts

Dredging and disposal methods associated with the proposed action are similar to current maintenance dredging methods. Therefore, the potential impacts associated with blasting will be emphasized in the impact assessments below.

Explosions in the estuarine environment can injure and/or kill fish, marine mammals (including manatees and bottlenose dolphins), sea turtles, and other marine life. Underwater shock waves from high-velocity explosives have been reported to result in the rupture of the swim bladder and other internal organs of fish, and damage to the lungs, intestines, and the auditory systems of marine mammals. Damage to sea turtles is thought to resemble that observed in mammals, i.e., to lungs, intestines, and auditory systems (O'Keefe and Young, 1984). Marine invertebrates, including clams, oysters, and crabs, have been found to be highly resistant to explosive shock (Gaspin, 1975; Gaspin et al., 1976; as cited in O'Keefe and Young, 1984). Experimental studies have shown that many types of bottom-dwelling invertebrates such as sea anemones, polychaete worms, isopods, and amphipods exhibit no damage from blasting (Gaspin, 1975; Gaspin et al., 1976; as cited in O'Keefe and Young, 1984). Due to the very high resistance of benthic animals to blast impacts, any damage sustained by these populations should be negligible outside the immediate blast vicinity.

Studies have shown that the degree of impact experienced by fish as a result of explosions is determined by several factors, including physical characteristics of the fish, the weight of the explosive charge, and the distance of the fish from the charge. Swim bladder fish have been found to be more susceptible to damage from shock waves than non-swim bladder fish (most common estuarine fish except flounders have swim bladders), and smaller fish are more susceptible to damage than larger fish of the same species (Wright, 1982). Larval fish are less sensitive to the effects of shock waves than eggs or than post-larval fish in which the swim bladder has developed (Rasmussen, 1967; as cited in Wright, 1982). The damaging effects on marine life increase in relation (but not in direct proportion) to increasing the weight of the explosive charge. The shock wave from an underwater explosion diminishes over distance at a rate proportional to the cube root of the weight of the explosive charge. Therefore, the peak pressure generated by an 8-pound charge at a specific distance is only about twice the peak pressure of a 1-pound charge at the same distance; thus, doubling the weight of an explosive charge does not double the impact to marine life (Young, 1991). Also, the further an animal is located from an explosive charge, the greater will be its chances of survival.

Mitigative measures will be employed during underwater blasting in order to reduce potential impacts to estuarine life. These measures include seasonal blasting restrictions, stemming of the holes in which the explosive charges are placed, the use of delays between each charge, and the construction of a physical barrier and/or a bubble/air curtain around the blast zone. Stemming is a procedure in which the top 1 foot, or more, of each hole containing an explosive charge is filled with crushed stone or gravel. This process partially contains the explosive force, increases the amount of work done to surrounding rock, and reduces the impact to the aquatic environment above. The use of delays effectively reduces each detonation into a series of small explosions, and the resulting blast overpressure levels are directly related to the size of the charge in each delay rather than the summation of charges detonated in all holes (Munday et al., 1986). Thus, a large weight of explosive charge can be fired as a series of smaller charges with a major reduction in impacts. Reduction of the number of blasting events required to perform a job can be achieved by drilling the maximum number of holes per day and then firing them as a unit making up one blast (but including the delays mentioned above to prevent cumulative impact from the increased weight of explosive charge). Air/bubble curtains constructed around the blast area are effective in reducing pressures (Strange, 1963). Research has shown that a small fractional volume of air bubbles in water increase the compressibility several orders of magnitude above that in bubble-free water, thereby greatly reducing the velocity and increasing attenuation of acoustic waves (Domenico, 1982a). As a result, bubble curtains have been routinely used by demolition engineers to protect underwater structures from damage by underwater explosive shock waves (Domenico, 1982b). Physical barriers will also include any solid barrier that contains or reduces the explosive pressure wave. Cofferdams or a sheet wall suspended from a barge would be examples of physical barriers.

Because of the harmful impacts of blasting on estuarine life, much research has focused on the development of models to predict the lethal distances of underwater explosions. Knowledge concerning potential lethal distances is useful in assessing potential adverse impacts on estuarine life and in establishing preventive measures. Models have been developed that are based upon various methodologies, but the impulse strength model appears to be the best at predicting lethal and safe ranges under various sets of conditions and assumptions (Wright, 1982). The St. Louis District (SLD), Corps of Engineers has developed a computer mathematical model, based upon the impulse strength method, to predict the kill radius for swim bladder fish from explosions that are buried in holes drilled in a rock substrate. This model takes into account (1) the effects of different explosive charge weights, (2) the greater susceptibility of smaller fish to blast damage, (3) the constraining effects of stemming on the overall explosive impact, and (4) the impact reduction achieved by employing delays. This model was used to predict the potential impact zone associated with blasting for this project.

Results from the SLD model (stemming the top 1 foot of holes and inserting delays after each row), using 2-ounce swim bladder fish as a worst-case example, show that the blast created by the general blast plan will kill about 50 percent of the fish at a distance of 1,610 feet (lethal distance 50 percent, or LD50) and about 1 percent of the fish at a distance of 2,780 feet (lethal distance 1 percent, or LD1). The circular areas enclosed by these two distances are 196 and 573 acres, respectively. Larger fish are more resistant to blasting impacts, and 1-pound fish will experience an LD50 of about 899 feet and an LD1 of about 1,550 feet. Fish of 12-pound size will experience an LD50 of about 446 feet and an LD1 of about 768 feet. These distances and their associated acreage appear in Table 2.

TABLE 2

BLASTING IMPACTS ESTIMATED FOR A GENERAL UNDERWATER BLASTING PLAN (STEMMING THE TOP 1 FOOT OF HOLES AND INSERTING DELAYS AFTER ROWS)

Fish Weight In Lbs.	LD50 Feet	Acres for LD50	LD1 Feet	Acres for LD1
0.125	1,610	196	2,780	573
1.000	899	63	1,550	181
12.000	446	17	768	47

Results from the SLD model (stemming the top 1 foot of holes and inserting delays at each hole), using 2-ounce swim bladder fish as a worst-case example, show that the blast created by the general blast plan will kill about 50 percent of the fish at a distance of 381 feet (lethal distance 50 percent, or LD50) and about 1 percent of the fish at a distance of 656 feet (lethal distance 1 percent, or LD1). The circular areas enclosed by these two distances are 12.5 and 34.5 acres, respectively. Larger fish are more resistant to blasting impacts, and 1-pound fish will experience an LD50 of about 213 feet and an LD1 of about 364 feet. Fish of 12-pound size will experience an LD50 of about 105 feet and an LD1 of about 180 feet. These distances and their associated acreage appear in Table 3.

TABLE 3
BLASTING IMPACTS ESTIMATED FOR A GENERAL UNDERWATER BLASTING PLAN
(STEMMING THE TOP 1 FOOT OF HOLES AND INSERTING A DELAY AT EACH HOLE)

Fish Weight In Lbs.	LD50 Feet	Acres for LD50	LD1	Acres for LD1 Feet
0.125	381	12.5	656	34.5
1.000	213	4.5	364	11.5
12.000	105	1.4	180	3.4

It is evident from the SLD model that stemming and inserting delays (a minimum of 25 milliseconds) on each hole reduces the size of the blast impact zone for the worst-case scenario, (i.e., LD1 for a 2-ounce swim bladder fish) by approximately 94 percent (from 573 acres to 34.5 acres). In addition to requiring the contractor to stem and insert a delay in each hole, the Wilmington District will require the contractor to construct a physical barrier and/or bubble/air curtain around the blast zone. Using such a barrier, the blast zone impact area (LD1) for a 2-ounce swim bladder fish may be further reduced from 34.5 acres to about 0.8-acre (35,000 square feet).

5.02 Species Accounts

5.02.1 Eastern Cougar, Bald Eagle, Piping Plover, Wood Stork, Peregrine Falcon, Red-Cockaded Woodpecker, Cooley's Meadowrue, Rough-Leaved Loosestrife, and Seabeach Amaranth

These species are all terrestrial and, if present in the project area, should be unaffected by construction or continued maintenance of the project using blasting and dredging. None of the CDF's being considered for use as disposal areas or mitigation sites offer suitable habitat for these species. For these reasons, it has been determined that construction and maintenance of the proposed project is not likely to effect any of these species.

5.02.2 West Indian Manatee

a. **Status** - Endangered

b. **Occurrence in Immediate Project Vicinity** - The coast of North Carolina is within the summer range of the manatee. Historically, the species is known from as far north as New Jersey. All of the presently designated critical habitat for the species is located in Florida.

Manatees are rare visitors to the Cape Fear River Region. From 1952 to 1994, there have been only 7 known observations in Cape Fear System (Schwartz, 1995). One of these manatees was dead (1986) but no data were gathered on the cause of death (Schwartz, 1996). **Three additional live manatee have been sited in Wilmington Harbor since the Schwartz publication. One was sited near Southport in the Fall of 1995, and two (probably a calf and its mother) were sited near Wilmington in the Spring of 1996. Except for the Spring of 1996, each siting in the Cape Fear Region has been of a single manatee. During the most frequent period of observations (1993-1996), there was one observation per year except for the 1996 siting.** Numbers of manatees using the region are not known but are presumed to be very low. More research is needed to determine the status of the species in North Carolina and identify areas (containing food and freshwater supplies) which are critical for supporting summer populations.

c. **Current Threats to Continued Use of the Area** - Current threats to this species in the Cape Fear River can not be clearly assessed due to our lack of knowledge regarding its population, seasonality, distribution, and the habitat components in the river that may be critical for its continued occupation of the area. Cold winter water temperatures will probably keep the species from overwintering in the project area, except in the vicinity of the warm-water discharge from Carolina Power and Light's nuclear power plant (Clark, 1987).

d. **Project Impacts**

(1) **Habitat** - Impacts to estuarine and nearshore ocean habitat of the area should be minor and should be similar to those already occurring under the existing maintenance of Wilmington Harbor. The effect of these impacts on the value of the area to the manatee are unknown. With the current state of knowledge on the habitat requirements for the manatee in North Carolina, it is impossible to determine the magnitude of such impacts.

(2) **Food Supply** - Foods which are used by the manatee in North Carolina are unknown. In Florida, their diet consists primarily of vascular plants. Project construction and maintenance will involve minimal change to the physical habitat of the estuary and overall estuarine and nearshore productivity should remain high throughout the project area. Therefore, potential food sources for the manatee should be unaffected.

(3) **Relationship to Critical Periods in Life Cycle** - The manatee is considered to be a summer resident of the North Carolina coast. Construction and maintenance of the proposed project should have little effect on the manatee since its habitat and food supply will not be significantly impacted.

(4) **Affect Determination** - While records for the manatee within the Cape Fear River are spotty with a maximum of one individual observed per year, they do indicate that the species most frequently occurs in the system during the summer and fall - the time period (August 1 through January 31) when construction, and blasting, are most likely to occur. If any manatees were in the vicinity of blasting, they could be adversely impacted by pressure waves. For this reason, it has been determined that the project may adversely impact the species.

In order to minimize any potential impacts from rock blasting, pre-blast monitoring is proposed. Pre-blast monitoring will include, at a minimum, deployment of NMFS-approved observers to assure that no marine mammals (primarily manatees and bottlenose dolphins) are present in the vicinity of any blast. Should listed species be observed, blasting will be delayed. After blasting, observers will also examine the area to determine if incidental take of any marine mammals, including manatees and bottlenose dolphins resulted from a blast. Through implementation of such protective measures, it is believed that potential impacts to the manatee can be minimized.

5.02.3 Finback Whale, Humpback Whale, Right Whale, Sei Whale, and Sperm Whale

a. Status - Endangered

b. Occurrence in Immediate Project Vicinity. These species all occur infrequently in the ocean off the coast of North Carolina. Their occurrence in the State's waters is usually associated with spring or fall migrations. Due to their restriction to oceanic environments, the only aspects of the proposed construction and maintenance dredging of the harbor which might result in an encounter with these species will be the disposal of dredged material in the ocean disposal area, and operation of the hopper dredge in Baldhead Shoal Channel.

These species were all assessed by the EPA in its environmental impact statement (USEPA, 1983) for designation of ODMDS at Savannah, Georgia; Charleston, South Carolina; and Wilmington, North Carolina. That assessment determined that use of the Wilmington ODMDS will not have any effect on these species and the NMFS has concurred with that determination (52 FR 127, page 25009).

c. Current Threats to Continued Use of the Project Area. None.

d. Project Impacts.

(1) Habitat - None.

(2) Food Supply - Productivity of the nearshore ocean will not be diminished by the proposed dredging; therefore, the food supply of these species should be unaffected.

(3) Relationship to Critical Periods in Life Cycle - The presence of a dredged material disposal barge or hopper dredge in the nearshore ocean waters should pose no more of a threat to migrating whales than normal commercial ship traffic. However in order to maximize protection of the right and humpback whales, 100 percent daytime whale observer coverage will be from December 1 through March 31.

(4) Affect Determination - Since existing habitat conditions and food supplies will be maintained and whale observer coverage will be implemented, it has been determined that the continued maintenance of the harbor will not affect the above listed species of whales.

5.02.4 Hawksbill and Leatherback Sea Turtles

a. Status - Endangered

b. Occurrence in Immediate Project Vicinity. Neither of these species is known to nest regularly along the North Carolina coast. In North Carolina, the leatherback and hawksbill are known only from oceanic waters and are considered to be residents of North Carolina waters only from the spring through the fall (Lee and Palmer, 1981). This finding is supported by a survey sponsored by the NMFS which found no sea turtles in estuarine areas north of Florida in the winter months (Richardson and Hillestad, 1979). Based on these findings, neither species should occur in the project area.

c. Affect Determination. Since these species do not occur in vicinity of the proposed project, it has been determined that the proposed harbor improvements are not likely to affect them.

5.02.5 Green, Loggerhead, and Kemp's Ridley Sea Turtles

a. Status - Green and loggerhead, Threatened, Kemp's Ridley Endangered

b. Occurrence in Immediate Project Vicinity. All of these species have been noted to nest in North Carolina but the loggerhead sea turtle is by far the most common nesting species. In addition to nesting use, all of these species occasionally enter into the lower Cape Fear River estuary to feed. There are no known records of sea turtles in the river within the area proposed for blasting; however, there are no known barriers to prevent their entry into, or use of, this region. It is presumed that their scarcity in this area is a reflection of the lower salinity and different food availability in the area.

c. Current Threats to Continued Use of the Area. The primary threats facing these species worldwide are the same ones facing it in the project area. Of these threats, the most serious seem to be loss of breeding females through accidental drownings by shrimpers (Crouse, et al., 1987) and human encroachment on traditional nesting beaches. Other threats to the loggerhead include excessive natural predation in some areas, utilization of eggs as food by humans, and excavation of dredged material with a hopper dredge. With the exception of hopper dredges, none of the dredge plants proposed for use in the construction or maintenance of this project are known to take sea turtles.

d. Project Impacts.

(1) Habitat - Most of the dredged material will be placed either in the approved ODMDS or in diked disposal areas. Neither activity will impact the nesting areas in the region. Any sand placed on the beaches of Baldhead Island, will comply with the protective measures that are a part of this Section 933 action.

(2) Food Supply - The principal food sources of these species are crustaceans, mollusks, other invertebrates, fish, and plant material (Schwartz, 1977). Dredging will temporarily remove some of these resources from the channel bottom and blasting will impact the fishes within the immediate blasting area. Impacts on river foraging habitat will be minor as dredging and blasting will only affect a limited portion of the estuary. Most of this area is currently experiencing periodic maintenance dredging. Therefore, the project should not significantly affect the food supply of the species.

(3) **Relationship to Critical Periods in Life Cycle** - All blasting operations will occur between August 1 and January 31. During the late summer season, these species could be present within the river system. Should they venture into the upper reaches of the river, they could be within the area subjected to the pressure wave from blasting, currently estimated to be less than an acre (see discussion of blasting impacts above).

In order to minimize potential impacts to sea turtles from rock blasting, pre-blast monitoring is currently proposed for use. Pre-blast monitoring will include, at a minimum, deployment of NMFS-approved observers to assure that no sea turtles are present in the vicinity of any blast. Use of trawling prior to blasting was considered but is considered to be impractical to implement due to the presence of detonation cords, bubble curtain equipment, existing snags, and other construction activity within the impact area. Should sea turtles be observed, blasting will be delayed. After blasting, observers will also examine the area to determine if incidental take resulted from a blast. Post-blast trawling is not practical in the area due to the presence of snags. However, attempts will be made to deploy a channel net down current of each of the first several blasts in attempt to verify the effectiveness of the bubble curtains. Through implementation of such protective measures, it is believed that potential impacts to sea turtles can be minimized.

In addition to potential blasting impacts, hopper dredges are known to take turtles and on rare occasions have taken turtles in Wilmington Harbor. However, to minimize potential take, the actions required in the August 25, 1995 NMFS Biological Opinion will be implemented. These actions include: rigid draghead deflectors and 100 percent observer monitoring from April 1 through November 30.

(4) **Affect Determination** - While it is unlikely that sea turtles will be present in the vicinity of the blasting area, there are no known barriers to prevent their accessing the area. Because of this possibility, observers will be stationed to monitor sea turtle use of the area and delay blasting, if needed. While this measure represents the best available option, there is still the possibility that submerged sea turtles will go undetected within the area impacted by the blast. In addition with precautions taken with hopper dredges, turtles may still be taken. For these reasons, it has been determined that the project may adversely affect the species.

5.02.6 Shortnose Sturgeon

a. **Status** - Endangered

b. **Occurrence in Immediate Project Vicinity.** This species ranges along the Atlantic seaboard from the Saint John River in New Brunswick, Canada, to the Saint Johns River, Florida. The distribution of the shortnose sturgeon in the Cape Fear River basin is not completely documented.

It is apparent from historical accounts that this species was once fairly abundant throughout the State's waters, including the project area. However, in the recent past, this species was thought to be probably extirpated from North Carolina (Schwartz et al., 1977). During the winter of 1986/87, the capture of about 12 to 15 shortnose sturgeon from the Brunswick River was reported by a shad fisherman. One specimen was turned over to the NCDMF for verification and was subsequently placed in the fish collection of the North Carolina State Museum of Natural Science. All other specimens were returned to the Brunswick River. In response to the information that shortnose sturgeon were in the Cape Fear basin, the NCDMF immediately passed a special regulation prohibiting the taking of sturgeon less than 3 feet in length from all parts of the Brunswick, Cape Fear, Black, and Northeast Cape Fear Rivers. It has been reported that about 12 to 15 shortnose sturgeon were captured and released by a shad fisherman in the Brunswick River again in the winter of 1987/88. In 1991, the prohibition on sturgeon take was extended statewide and covers all sturgeons of any size.

Recently, studies of the shortnose sturgeon population in the Cape Fear River system have been conducted by Moser and Ross (1993). This work consisted of a fishery-independent gillnet survey and sonic tracking study, conducted from May 1990 to September 1992, to establish the distribution and movement patterns of shortnose sturgeon and other anadromous fishes in the Cape Fear River estuary. Intensive gillnet sampling (893 days) took place within the study area, but only seven shortnose sturgeon were captured, three of the seven were recaptured. Results from this study indicate that dredging and blasting operations in the inner Wilmington Harbor should be limited to the period from August to November to reduce the risks of disrupting spawning migrations of shortnose sturgeon and other anadromous fishes. No juvenile shortnose sturgeon have been caught in the Cape Fear River basin, which may mean that this species may not be spawning successfully here (Moser and Ross, 1995).

Historically, the shortnose sturgeon probably spawned in the mainstem of the Cape Fear River well upstream of the project area, possibly as far up as Smiley Falls near Lillington. Moser and Ross (1993) postulated that current upstream migrations may be blocked by Lock and Dam No. 1 because the fish arrive too early in the season to benefit from the locking procedures designed to aid anadromous fish passage (March 20 - May 1). Indeed, blocked migration was noted during their study; however, during the frequent spring flooding events migrating adults may be able to pass over the low-head dam and continue upstream.

Moser and Ross (1993) observed that shortnose sturgeon appeared to be most active in the night and early morning. When migrating, this species stayed in mid-channel in the upper to middle portion of the water column. During periods of daytime holding, the shortnose sturgeon preferred deep holes.

All of the general life history information which follows is extracted from Dadswell, et al. (1984), except where noted. The species is known to use three distinct portions of river systems: (1) non-tidal freshwater areas for spawning and occasional overwintering; (2) tidal areas in the vicinity of the fresh/saltwater mixing zone, year-round as juveniles and during the summer months as adults; and (3) high salinity estuarine areas (15 parts per thousand (ppt) salinity or greater) as adults during the winter. Variation from this general scheme does exist, however, due to the wide range of habitats available in the major river systems along the Atlantic seaboard. One population, in Holyoke Pool, Connecticut, is totally landlocked.

Upstream spawning migrations by adults are known to begin when water temperatures are approximately 8 to 9 degrees Celsius. In the Cape Fear system, Moser and Ross (1993) detected the onset of spawning migrations in January. Spawning subsequently takes place at temperatures of 9 to 12 degrees Celsius. Spawning temperatures usually occur in February and March in the project area but can occur as early as January or persist into May. The species spawns above the influence upstream of the project area) and to river mile 50 on the Northeast Cape Fear River (about 60 miles above the project area). In the Cape Fear River basin, suitable spawning habitat probably also occurs in the Black River, a tributary to the Cape Fear River about 16 miles upstream of the junction of the Northeast Cape Fear River and the Cape Fear River. The availability of spawning habitat on the main stem of the Cape Fear River may be reduced due to the blockages imposed by the locks and dams on the river.

Post-spawning adults and juvenile young-of-the-year move downstream to tidal areas and concentrate at, or just upstream of, the salt front during the summer months (June through August). This summer concentration zone in Winyah Bay estuary (South Carolina) corresponds to the area with a salinity of 0.5 to 1.0 ppt. Here the juveniles spend the next 2 to 8 years of life, moving up and down stream with the movements of the salt wedge until they reach a size of approximately 45 centimeters. The Cape Fear River estuary is well mixed with no distinct salt wedge. Salinity throughout the project area is highly variable and dependent on freshwater inflow, but can range from near 0 ppt in the vicinity of Wilmington to near 35 ppt in the ocean.

Based on available data, it is impossible to predict when the salinity in the project area will be within the 0.5-1.0 ppt range. However, it is expected that conditions suitable for the concentration of juvenile shortnose sturgeon and the summer concentration of adults exist periodically within the vicinity of Wilmington. As water temperatures begin to cool, adults will be expected to leave the summer concentration zone and move to the lower estuary where salinities typically exceed 15 ppt. This will be expected to occur in September in the project area. Some adults, however, may move back upstream to the spawning grounds in September, remaining there until after the spawning season. Although spawning does not occur within the project area, adult shortnose sturgeon (coming from wintering areas within or downstream of the project area) may pass through the project area from January to April to reach their spawning areas.

c. Current Threats to Continued Use of the Area. Pollution, blockage of traditional spawning grounds, and over fishing are generally considered to be the principal causes of the decline of this species. The prohibition on taking any sturgeon in North Carolina should help to protect the species from commercial and recreational fishing pressure.

d. Project Impacts.

(1) Habitat - Spawning habitat for the shortnose sturgeon should lie well outside of the project area and should not be affected by this project. Habitat conditions suitable for juveniles and adults could occur within the project area. Juvenile shortnose sturgeon are known to occupy deep water portions (greater than 27 feet) of rivers. Juveniles will therefore be expected to occur within the river channel while within the project area. Adults are found in shallow to deep water (6 to 30 feet) and will be expected to occupy the river channel during the day and the shallower areas adjacent to the channel during the night.

The proposed project will deepen about 13.2 acres to greater than 10 feet mllw. The rest of the project will be essentially deepening current channel bottoms. Due to the apparent preference by the species for deep water habitat, this will not be considered an adverse effect. Potential habitat within the project area will be temporarily disturbed during project construction and maintenance. However, as deep water areas are already disturbed by maintenance dredging and no increase in the frequency of maintenance is proposed, construction and future maintenance will essentially maintain the status quo.

Deepening the channel could alter the location of the salt wedge and thus habitat locations of the sturgeon. When the results of the additional saltwater intrusion model runs are available, an assessment will be made regarding this potential impact.

(2) __Food Supply__ - The shortnose sturgeon is a bottom feeder, consuming various invertebrates and occasionally plant material. Adult foraging activities normally occur at night in shallow water areas adjacent to the deep water areas occupied during the day. Juveniles are not known to leave deep water areas and are expected to feed there.

All estuarine bottoms dredged as a part of project construction and maintenance will suffer temporary declines in benthic fauna populations in comparison to adjacent undisturbed areas. Existing channel bottoms will continue to be dredged at the same frequency as under existing conditions and will be expected to continue to support benthic populations similar to the existing populations.

Because most of the available shallow water feeding areas adjacent to the channel will not be affected by the project and channel benthic populations should continue to have their existing levels of production, it is believed that the food supply of the shortnose sturgeon will remain essentially at current levels after project construction.

(3) __Relationship to Critical Periods in Life Cycle__ - Because of the mobility of adult and juvenile shortnose sturgeon, they should be able to avoid the dredging equipment; therefore, direct mortality as a result of dredging is not likely to be frequent. However during, November 1995, a sturgeon (species undetermined) was captured by a bucket and barge operation in the lower Cape Fear River. Blasting will occur between August 1 and January 31. According to Moser (1995, pers. comm.) shortnose sturgeon will be most likely to be in the area of blasting during the months of January through March. Therefore, it is considered possible that adults and juveniles could occur in the project area during blasting. Any fish within the potential lethal zone of the blast could be killed.

In order to minimize potential impacts to shortnose sturgeon from rock blasting, pre-blast monitoring is proposed. Pre-blast monitoring will include, at a minimum, use of a gillnet survey to capture and relocate shortnose sturgeon to a holding area outside of the impact area (probably in the Brunswick River). Use of trawling prior to blasting was considered but was determined to be impractical to implement due to the presence of detonation cords, bubble curtain or physical barrier equipment, existing snags, and other construction activity within the impact area. After blasting, observers will examine the blast area, and shoreline areas up and downstream of the blasting area, to determine if incidental take of shortnose sturgeon resulted from a blast. Post-blast trawling is not practical in the area due to the presence of snags. However, attempts will be made to deploy a channel net down current of each of the first several blasts in attempt to verify the effectiveness of the bubble curtains. Several days may be necessary for dead fish to surface so it will not be possible to determine which blasting event actually caused any detected mortality. In addition, some mortality may never be detected because fish may be hidden in marsh grasses at high tides or because of scavenging by crabs, fish, etc. Through implementation of the above outlined protective measures, it is believed that potential impacts to the shortnose sturgeon from blasting will be minimized to the maximum extent practicable.

In order to determine the potential taking of shortnose sturgeon and other species by bucket and barge operations, observers will be on board the bucket and barge during for the first full year of construction. The maximum extent feasible, the observers will record all species captured along with length and weight and any circumstances will might have led to the species capture.

(4) **Affect Determination** - Analysis of the life history of the shortnose sturgeon and the physical character of the Cape Fear River estuary indicate that the project area may be used by the species. Project construction and maintenance will not result in significant habitat modification and feeding areas will not be significantly affected. Spawning occurs outside of the project area, but adult and juvenile shortnose sturgeon could be present in the project area during construction and maintenance. Since the shortnose sturgeon which occupy the project area are mobile, they should generally be able to avoid areas being disturbed by dredging. Any shortnose sturgeon in the potential lethal zone of any given explosion may be lost. In spite of the impact minimization plan described above, impacts to the species could still occur; therefore, it has been determined that the project may adversely affect the species.

6.00 COMMITMENTS TO REDUCE IMPACTS TO LISTED SPECIES

The following list is a summary of environmental commitments related to the construction and maintenance of the proposed project. These commitments address agreements with agencies, mitigation measures, and construction practices.

- A pre- and post blast monitoring program will implemented for the project (Attachment C). Pre-blast monitoring will include, at a minimum, deployment of NMFS-approved observers to assure that no sea turtles, marine mammals (primarily manatees and bottlenose dolphins) are present in the vicinity of any blast. In addition, gillnet surveys will be performed in order to remove shortnose sturgeons from the impact area. Any captured shortnose sturgeon will be relocated to a holding area well removed from the blast site. Should listed species be observed, blasting will be delayed. After blasting, observers will also examine the area to determine if incidental take of any listed species resulted from a blast. Through implementation of such protective measures, it is believed that potential impacts to listed species can be minimized.

- Stemming each hole, a delay per hole, and a bubble curtain and/or a physical barrier will be placed completely around the blast area (about 35,000 square feet).

- Hydraulic pipeline dredging (during construction and maintenance) and blasting will be conducted during the NCDMF dredging window (August 1 through January 31) to the maximum extent practicable.

- Hopper Dredging activities will comply with the turtle deflecting draghead and whale protective measures.

- In order to determine the potential taking of shortnose sturgeon and other species by bucket and barge operations, observers will be on board the bucket and barge during for the first full year of construction. To the maximum extent feasible, the observers will record all species captured along with length and weight and any unusual circumstances that might have led to the species capture. If a manatee is observed within 100 yards of dredging operations, all operations will cease until the manatee has left the area. Any observations of or injuries to manatees will be reported to the USFWS.

- After blasting, observers will also examine the area to determine if incidental take of listed species resulted from a blast. Through implementation of such protective measures, it is believed that potential impacts to listed species can be minimized.

7.00 SUMMARY AFFECT DETERMINATION

It has been determined that the project, as currently proposed, may adversely affect the manatee, green sea turtle, loggerhead sea turtle, Kemp's ridley sea turtle, and shortnose sturgeon.

8.00 LITERATURE CITED

Clark, M. K. 1987. West Indian Manatee. Pages 18-21 in: Endangered, threatened and rare fauna of North Carolina Part I. A re-evaluation of the mammals (M. K. Clark, editor). Occasional Papers of the North Carolina Biological Survey 1987-3.

Crouse, Deborah T., L. B. Crowder, and H. Caswell. 1987. A staged-based population model for loggerhead sea turtles and implications for conservation. Ecology 68(5):1412-1423.

Dadswell, M. J., B. D. Taubert, T. S. Squiers, D. Marchette, and J. Buckley. 1984. Synopsis of biological data on shortnose sturgeon, *Acipenser brevirostrum* LeSeur 1818. National Oceanic and Atmospheric Administration Technical Report NMFS 14, Washington, DC.

Domenico, S.N. 1982a. Acoustic wave propagation in air-bubble curtains in water Part II: Field experiments. Geophysics 47:354-375.

Domenico, S.N. 1982b. Acoustic wave propagation in air-bubble curtains in water Part I: History and theory. Geophysics 47:345-353.

Gaspin, J.B. 1975. Experimental investigations of the effects of underwater explosions on swim bladder fish, I: 1973 Chesapeake Bay tests. NSWC/WOL TR 75-58.

Gaspin, J.B., M.L. Wiley, and G B. Peters. 1976. Experimental investigations of the effects of underwater explosions on swim bladder fish, II: 1975 Chesapeake Bay tests. NSWC/WOL TR 76-61.

Lee, D. S. and W. M. Palmer. 1981. Records of leatherback turtles, *Dermochelys coriacea* (Linnaeus), and other marine turtles in North Carolina waters. Brimleyana 5:95-106.

Moser, M. L. and S. W. Ross. 1993. Distribution and Movements of Shortnose Sturgeon (*Acipenser brevirostrum*) and Other Anadromous Fishes of the Lower Cape Fear River, North Carolina. Final Report to the US Army Corps of Engineers, Wilmington District, May 1993. 112 pp.

Moser, M.L. and S.W. Ross. 1995. Habitat Use and Movements of Shortnose and Atlantic Sturgeons in the Lower Cape Fear River, North Carolina. Transactions of the American Fisheries Society 124:225-234, 1995.

Munday, D.R., G.L. Ennis, D.G. Wright, D.C. Jeffries, E.R. Mcgreer, and J.S. Mathers. 1986.

Development and evaluation of a model to predict effects of buried underwater blasting charges on fish populations in shallow water areas. Canadian Technical Report of Fisheries and Aquatic Sciences. 1418:x + 49 pp.

O'Keeffe, D.J. and G.A. Young. 1984. Handbook on the environmental effects of underwater explosions. Naval Surface Weapons Center. NSWC TR 83-240.

Rasmussen, B. 1967. The effects of underwater explosions on marine life. Bergen, Norway. 17 pp.

Richardson, J. I., and H. O. Hillestad. 1979. Survey for wintering marine turtles in South Carolina and Georgia. National Marine Fisheries Service, Miami. 39 pages + i-iii and maps. Strange, J.F. 1963.

Schwartz, F.J. 1977. Modern sea turtles, in Endangered and Threatened Plants and Animals of North Carolina. Editors J.E. Cooper et. al. North Carolina State Museum of Natural History, Raleigh, North Carolina. pp 303-308.

Schwartz, F.J. 1995. Florida Manatees, *Trichechus manatus* (Sirenia: Trichechidae), in North Carolina 1919-1994. Brimleyana No. 22:53-60. June 1995.

Schwartz, F.J. 1996. Personal Communication. January 19,1996.

Smith, Hardy J. 1987. Estimating the Mechanical Dredgeability of Rock. Rock Mechanics: Proceedings of the 28th Symposium, University of Arizona. Edited by I.W. Farmer, J.J.K. Demen, C.S. Desai, C.E. Glass & S.P. Neuman, University of Arizona, Tucson. pp 945-952.

Strange, J.F. 1963. The attenuating effects of a bubble screen on underwater shock. Miscellaneous Paper No. 2-553. US Army Engineer Waterways Experiment Station (WES), Vicksburg, Mississippi.

US Army Corps of Engineers, Wilmington District. 1994. Interim Feasibility Report and Final Environmental Impact Statement on Improvement of Navigation, Wilmington Harbor Channel Widening, Wilmington, North Carolina.

US Environmental Protection Agency. 1983. Final Environmental Impact Statement, Savannah, Georgia; Charleston, South Carolina; and Wilmington, North Carolina, Ocean Dredged Material Disposal Site Designation. October 1983.

Wright, D.G. 1982. A discussion paper on the effects of explosives on fish and marine mammals in the waters of the Northwest Territories. Can. Tech. Rep. Fish. Aquat. Sci. 1052: v + 16 pp.

Young, G.A. 1991. Concise method for predicting the effects of underwater explosions on marine life. Naval Surface Warfare Center. NAVSWC MP 91-220. 22pp.

DRAFT BIOLOGICAL OPINION
FROM THE
US FISH AND WILDLIFE SERVICE

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Raleigh Field Office
Post Office Box 33726
Raleigh, North Carolina 27636-3726

May 17 ,1996

Mr. C.E. Shuford, Jr.
Acting Chief, Engineering and Planning Division
Corps of Engineers
P.O. Box 1890
Wilmington, North Carolina 28402-1890
Attn: Frank Yelverton (CFC) & Hugh Heine (WHCW)

Dear Mr. Shuford:

Enclosed for your information are copies of the draft Biological Opinions for the proposed Wilmington Harbor Channel Widening project and the proposed Cape Fear-Northeast Cape Fear Rivers project. These are provided to you so you may be fully aware of our current position on review of the proposed activities. Be advised that the Service's manatee recovery coordinator has not yet reviewed these drafts.

If you have any questions regarding the draft opinions, please contact Howard Hall at 919/856-4520 ext. 27.

Sincerely,

TAugspurger

Tom Augspurger
Acting Field Supervisor

May 17, 1996

Colonel Robert J. Sperberg
District Engineer
U.S. Army Corps of Engineers
P.O. Box 1890
Wilmington, North Carolina 28402-1890

Dear Colonel Sperberg:

The U.S. Fish and Wildlife Service (Service) has reviewed the Biological Assessment (BA) for the Cape Fear-Northeast Cape Fear Rivers Study, Brunswick and New Hanover Counties, North Carolina. Your January 31, 1996 request for formal consultation was received on February 16, 1996. This document represents the Service's biological opinion on the effects of that action on the West Indian manatee (*Trichechus manatus*) in accordance with section 7 of the Endangered Species Act of 1973 (ESA), as amended, (16 U.S.C. 1531 *et seq.*).

Consultation History

The Cape Fear-Northeast Cape Fear Rivers Project, which is referred to as the Cape Fear Comprehensive (CFC) Project, is one of three projects on which the Service has consulted, both informally and formally, with the Wilmington District, U. S. Army Corps of Engineers (Corps) since 1991, due to the potential requirement of blasting in the Wilmington ship channel. The

Service began working with the Corps on the CFC project in 1991. However, early project descriptions did not include a definite requirement for blasting to remove rock. The May 1991 Reconnaissance Report on the project states that data will be collected in order to separate dredgeable from nondredgeable rock (U. S. Army Corps of Engineers 1991). On October 26, 1992, the Service provided the Corps with scoping comments which noted that blasting could kill fish, sea turtles, marine mammals, and other species near the blast.

The second project was the Wilmington Harbor Ocean Bar Channel Project to deepen the most seaward portion of the ship channel to its authorized depth of 40 feet plus allowable and required overdepths. On June 7, 1993, the Corps provided the Service with a BA on the Ocean Bar Project. The BA determined that blasting associated with the project may affect the manatee. The Corps proposed several measures to protect Federally-listed species. These measures included stemming of charges, delays between charges, and observers on either boat or airplane platform for two hours prior to and one hour after each detonation. The Service issued a biological opinion for the Ocean Bar Channel on August 9, 1993. The Service found that the project was not likely to jeopardize the continued existence of the manatee.

During 1993, the Service issued both Draft and Final Fish and Wildlife Coordination Act Reports on a third project involving modifications to the ship channel. This project, the Wilmington Harbor Channel Widening (WHCW) Project, involved the construction of a 6.2 mile passing lane and the enlargement of five turns in the ship channel. However, these reports did not address impacts related to blasting since the Corps' plans at that time did not include the need to remove nondredgeable rock.

On October 5, 1994, the Department of the Army published a Notice of Intent to prepare a Draft Environmental Impact Statement (EIS) for the CFC project. This notice stated that one of the significant issues to be analyzed was blasting impacts on marine mammals and other organisms.

On June 9, 1995, the Corps informed the Service that a supplemental EIS would be prepared for the WHCW project to address the impacts associated with the removal of nondredgeable rock, primarily through blasting. A supplemental EIS was necessitated by geotechnical data from hydrographic surveys which indicated that the top of rock at sites of proposed construction of Turns 2, 3, and 4 was above -41 feet mean lower low water (mllw). The authorized depth of the current channel is-38 feet mllw with 2 feet of allowable overdepth. Corps regulations specify that ship channels over hard material must have one foot of required overdepth in addition to allowable overdepth. Therefore, new construction would require a depth of -41 feet mllw which is likely to require the removal of rock.

On August 23, 1995, a Service biologist toured the CFC and WHCW project areas with personnel of the Corps and State and Federal natural resource agencies. At this time the Service expressed concerns about possible harm to manatees during construction in the warmer months of the year.

On September 22, 1995, the Service issued a Draft Fish and Wildlife Coordination Act Report on the use of blasting for the WHCW Project. The Service recommended that the Corps should: (1) use blasting only as a last resort; (2) use equipment and a blast plan which would produce the least harm to aquatic organisms; (3) calculate a safety zone for the most important organisms which could occur in the project site; (4) develop pre-blast procedures which would include surveillance of the safety zone and means to halt blasting if Federally-listed species were within their safety zone; (5) limit blasting to the period from October 1 through January 31; and, (6) develop a post-blast monitoring plan to assess the animals killed by blasting.

On December 13, 1995, a Service biologist attended a meeting on the CFC project with the Corps and State and Federal natural resource personnel. The Service reiterated our concerns about the adverse impacts of blasting on manatees during the warmer months.

On January 17, 1996, the Service sent the Corps preliminary recommendations for the CFC project. The Service recommended that blasting be limited to the period from October 1 through January 31 in order to protect the manatee; other marine mammals, such as the bottle-nosed dolphin (*Tursiops truncatus*); sea turtles, such as loggerhead sea turtle (*Caretta caretta*), green sea turtle (*Chelonia mydas*), and Kemp's ridley sea turtle (*Lepidochelys kempi*); and anadromous fish, such as the shortnose sturgeon (*Acipenser brevirostrum*). Our recommendations also included a comprehensive list of measures to minimize harm to manatees and other species in the project area.

On January 31, 1996, the Corps issued the Draft EIS for the CFC project along with their BA. This assessment determined that the project may affect the manatee. In the Draft EIS the Corps responded to the Service's preliminary recommendations on blasting. The Draft EIS states that blasting would be conducted from August 1 through January 31 over the approximately three years of construction. Blast procedures would include drilling holes for charges, stemming each hole, using delays between each charge, and surrounding each blast with an air/bubble curtain. The Corps proposed to work with the Service and other resource agencies to develop pre- and post-blast monitoring plans. With regard to the establishment of a manatee specific danger zone, the Corps indicated that monitoring zones would be based on calculations for the one percent lethal zone (LD$_1$), the zone in which one percent of individuals would be projected to be killed, for a two-ounce fish with a swimbladder. The Corps expressed the opinion that blasting techniques combined with the use of a bubble/air curtain and/or physical barrier could reduce the LD_1 zone down to approximately the 35,000 square feet (0.8 acre) enclosed by the bubble curtain/barrier. These measures, in conjunction with an observer program (which would halt blasting if sea turtles or marine mammals were in the project area), were considered by the Corps to be adequate protection for manatees.

On February 16, 1996, the Corps issued the Draft Supplement I to the Final EIS for the WHCW project. This document stated that blasting, if required, would follow the same procedures as those to be used in the CFC project.

On February 23, 1996, the Service released a Draft Fish and Wildlife Coordination Act Report on the CFC project. While it was acknowledged that the Corps' blast plan, the use of a bubble curtain, and pre-blast procedures would contribute to manatee protection, the Service repeated recommendations that the best way to minimize harm would be to avoid blasting during the months when manatees are most likely to occur in the project area. The Service also recommended that the Corps calculate manatee-specific danger and safety zones and develop surveillance procedures for manatees within the calculated safety zone.

BIOLOGICAL OPINION

Description of proposed action

Wilmington Harbor is a Federal navigation project of approximately 35 miles located along the Cape Fear and Northeast Cape Fear Rivers in southeastern North Carolina. The North Carolina Division of Water Resources, North Carolina State Ports Authority, the Cape Fear River Pilots Association, and other shipping interests in the harbor have requested that the U.S. Army Corps of Engineers study the deepening of the Wilmington Harbor Ship Channel. Measures to accomplish this were determined to be economically feasible and in the Federal interest.

The recommended plan for the CFC Project includes dredging most of the harbor 4 feet deeper with some widening of two turning basins and the channel near Wilmington. Recommended dredging methods include hydraulic pipeline, bucket and barge, hopper, and rock cutterhead dredge. Hydraulic pipeline dredges will be used from about 4 miles south of the State Port (Upper Big Island Channel) to the upstream limit of the Federal Channel with dredged material disposal in an existing upland confined disposal facility (CDF). Beginning about 4 miles south of the State Port (Lower Big Island Channel) to Southport (Lower Swash Channel), a bucket and barge dredge will be used with disposal in the U.S. Environmental Protection Agency approved Ocean Dredged Material

Disposal Site (ODMDS). From Southport (Battery Island Channel) to the Smith Island Channel, a hopper dredge will be used with disposal in the ODMDS. From the ocean bar offshore (Baldhead Shoal Channel), the rock substrate will be excavated by a rock cutterhead dredge with disposal to complete the Wilmington Offshore Fisheries Enhancement Structure (WOFES). Silty and sandy sediments will be placed in the ODMDS. Certain areas of rock in the river may require blasting for removal. Such rock from Lower Big Island Channel downstream will be removed following blasting with a bucket and barge dredge and placed on the WOFES. Rock requiring dredging or blasting at or upstream of Upper Big Island Channel, will be removed by pipeline dredge and pumped to a CDF.

This proposed action would result in the excavation of 12,825,586 cubic yards of dredged material of which 3,423,777 cubic yards are rock (about 2.4 million cubic yards would be placed in the WOFES). Approximately 564,000 cubic yards may require blasting. The Corps estimates that 558 blasts may be required. The estimated construction period would be 3 years.

Blasting, if required, would be done by detonating a frame of individual charges. Each frame would consist of 8 rows with 10 charges per row, for a total of 80 charges. Each frame would be constructed by drilling holes into the rock and inserting 98.5 pounds of explosives into each hole. The total amount of explosives in each frame would be 7,880 pounds. There would be 8-foot spacing within rows and between each row. Each hole would be 4.5 inches in diameter and 11.2 feet deep. The top one foot, or more, or each hole would be filled with crushed stone or gravel, a procedure known as stemming. A firing delay of at least 25 milliseconds would be required between each hole.

The present blast plan states that blasting would be confined to the period from August 1 through January 31. This period is based on recommendations by the North Carolina Division of Marine Fisheries for the protection of fisheries resources. The Corps will institute both pre- and post-blast monitoring programs. Each blast would be surrounded by a bubble curtain and/or a physical barrier. This measure is designed to absorb harmful shock waves from the blast and would include an area of approximately 35,000 square feet (0.8 acre).

Status of the Species

The West Indian manatee, also known as the Florida manatee, is a Federally-listed endangered mammal. Although the manatee's principle stronghold in the United States is Florida, it occasionally makes its way into the coastal waters of North Carolina (Webster et al. 1985). Generally, manatees remain in the coastal waters of the Florida peninsula during the winter and disperse during the summer months, some moving north along the

Atlantic Coast to North Carolina. A small number of individuals may travel as far north as New Jersey (Odell 1982). In the fall wandering manatees return to their core range in Florida. Observations of manatees from within the Cape Fear River and surrounding waters are generally reported every year during the summer months. The number of sightings is usually low, but they do occur within the Cape Fear River on a regular basis during the warmer months of the year (David Webster, University of North Carolina at Wilmington, personal communication, May, 1993, and Mary Clark, North Carolina Museum of Natural History, personal communication, May, 1993).

In addition to protection under the ESA, the species is listed as endangered in North Carolina under the State Endangered Species Act (G.S. 113-331 to 113-337). Additional Federal protection is provided under the Marine Mammal Protection Act of 1972.

The fact that manatees spend much of their time submerged in shallow water is a factor in the ability to observe these animals. Scholander et al. (1941) reported manatee dives of up to 24 minutes. The length of time between breaths usually ranges from four minutes while resting to 30 seconds during strenuous activity (Hartman 1979).

While manatees have no natural predators, they are subject to a number of natural mortality factors. During unusually cold winters, when water temperatures drop below 60°F, manatees become sluggish, stop eating, and eventually die. Periodic red tide blooms have been associated with manatee deaths. Toxins produced by red tide algae accumulate in sea squirts which adhere to seagrasses. This poison is ingested incidentally by feeding manatees.

Current status of species

Early reports suggest that thousands of manatees once lived in Florida. By the early 18th century, some concerns were raised about the need to protect manatees from hunting. However, significant hunting pressure continued until the late 1930s and early 1940s. Manatee numbers probably reached a low around the early 1940s (Rose 1985).

O'Shea and Ludlow (1992) report that no estimates are available for the total number of manatees throughout the species range due to a lack of appropriate census methods. The species has been reduced or extirpated in many regions of former occurrence. However, the Service considers the species to have declined severely from several thousand individuals in the 1700's and early 1800's to as few as a thousand in the mid-1970's (Hartman 1974). Aerial surveys throughout the species' range in 1992 counted 1,856 individuals. A survey during February 1996 revealed that the minimum manatee population in the United States was 2,639 (U. S. Fish and Wildlife Service [hereafter USFWS] 1996). The manatee is generally considered a regular, but infrequent, resident of North Carolina's coastal waters. Clark (1987) states that the species appears to be only an occasional, seasonal visitor to the State. She notes, however, that the North Carolina State Museum regularly receives reports of manatees in the coastal rivers of North Carolina and suggests that the occurrence of the species in the state should not be considered exceptional. Her account postulates that there is no justification for discounting the importance of local habitats to the species, and that the present paucity of data on manatees in North Carolina results from lack of attention and the special problems associated with the study of marine mammals.

Schwartz (1995) summarized data on the sighting of 68 manatees from 59 locations in North Carolina from 1919-1994. This report indicates that manatees are now known to frequent nearly all North Carolina ocean and inland waters. Recent sightings have been subadults or young about 1.8 to 2.4 meters (5.9 to 7.9 feet) in length. The species has been recorded from 11 coastal counties. There have been nine documented sightings in New Hanover County, one of the two counties in which the Wilmington Ship Channel is located. Sightings have occurred during nine months of the year with the highest number of sightings (14) in September followed by eight sightings in both August and October.

This report states that a manatee was sighted in the Northeast Cape Fear River, north of Wilmington in Pender County on July 11, 1993. Although these sightings may suggest that more young manatees are expanding their range into North Carolina, it could be an artifact of an increased public awareness of the species rather than a real population increase.

There are no data to predict the number of manatees which may be in the action area at any given time. The Service considers the species to be a possible resident of the action area during the warmer months of the year, primarily from May through the end of October. It is possible for manatees to be present in the project area at the time of a blast under the proposed work window. As it might be expected for a wide-ranging, highly mobile species which has been Federally-listed as endangered for almost 30 years, occurrences outside the core range are likely to be few and sporadic.

Reasons for current status and current threats

The present plight of the manatee is the result high mortality in association with a relatively low reproductive rate. Manatee population trends are poorly known, but deaths have increased steadily from 1976 to 1991 (USFWS 1993). The primary threat to the continued existence of the species is the aggregate mortality directly caused by human activities. The species is also harmed by the loss habitat due to coastal development, particularly the loss of seagrass beds.

The most significant mortality among manatees result directly or indirectly from human activities. Human activities are responsible for about half of annual manatee mortality for which a cause can be established (Rose 1985). Boats may run over manatees that are submerged below the surface. Encounters with boats may either kill the manatee on impact or cause injury as propeller blades cut into the skin. Mortality from collisions with watercraft have increased from 21% of all deaths in the 1976-1980 period to 29% of all deaths in the 1986-1991 period. Comparison of the same two periods indicate that deaths of dependent calves have increased from 14% to 24% of all deaths. Canal locks and flood gates of water control structures may crush or drown manatees. Discarded fishing line may cause death or injury through accidental ingestion which blocks the digestive tract or by becoming tightly wound around flippers which may cause serious infection or amputation. Harassment by divers, fishermen, or boaters can interrupt feeding and mating activity. Human activities during winter may drive manatees into cooler water where they are more susceptible to disease and cold stress.

Manatee habitat in Florida has been and continues to be greatly altered by residential and commercial development (Packard and

Wetterqvist 1986). Dredge and fill activities may destroy areas of aquatic vegetation. Water pollution poses a threat to aquatic plants. Aquatic weed control programs also pose a threat to their source of food.

Effects of the action

The principal threat to the manatee from the proposed project is direct injury or death due to the shock wave produced by underwater explosions. Manatee deaths due to explosives have been reported. In 1943, the use of explosives to widen the Miami River in Florida killed at least 100 manatees (Moore 1951). O'Keeffe and Young (1984) cite studies which indicate that underwater blasting may injure marine mammals in two ways. The primary cause of injury is the creation of hemorrhaging in and around the lungs. The other way is the excitation of radial oscillations of small gas bubbles which are normally present in the intestines. Presumably, the degree of harm is directly proportional to tissue damage produced by the shock wave of the blast. Smaller animals are considered to be more susceptible to harm from underwater shock waves than larger animals (Young 1991). Therefore, all considerations for a safety zone for the species should be based on preventing harm to manatee calves. Underwater detonations could cause hearing loss or damage to manatees in the vicinity of the concussion. Although dredging activities are not likely to affect the species, collisions with hopper dredges or other vessels could potentially occur, resulting in death or injury to manatees.

Aside from direct mortality to manatees, indirect impacts are also possible. If manatees are injured during their summer residence in North Carolina, they may not be able to successfully return to their winter range and may die as a result of cold weather. To a much lesser extent, blasting may force manatees which are outside the zone of injury to alter their feeding, resting, and migratory behavior. It is possible that blasting during the late summer and early fall could cause manatees upstream from the blast area to delay their movement downstream and thereby prevent their timely return to wintering areas. Any factor causing delays in fall migrations could ultimately lead to manatees deaths if they succumb to cold temperatures. In addition, hearing loss or other injuries could reduce the ability of individual mantees to detect and avoid boat and ship collisions, resulting in their loss from the population. Although the proposed channel modifications may result in a larger number and increased size of vessels utilizing the Cape Fear shipping channel, this increase is not anticipated to significantly impact the manatee. An analysis of watercraft-related mortalities in Florida indicated that small- to medium-sized watercraft are responsible for the majority of manatee deaths (Wright et al., 1995).

Cumulative effects

Cumulative effects include the effects of future State, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA. Based on information provide in the BA, the Service does not believe that the proposed project will produce cumulative, adverse impacts on the manatee.

Conclusion

After reviewing the current status of the manatee, the environmental baseline for the action area, and the effects of the proposed work, it is the Service's biological opinion that the Cape Fear-Northeast Cape Fear Rivers Comprehensive Project, as proposed, is not likely to jeopardize the continued existence of the manatee. No critical habitat has been designated for this species in North Carolina, therefore, none will be affected.

INCIDENTAL TAKE

Sections 4(d) and 9 of ESA, as amended, prohibit taking (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect,

or attempt to engage in any such conduct) of listed species of fish or wildlife without a special exemption. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is any take of listed animal species that results from, but is not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or the applicant. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered a prohibited taking provided that such taking is in compliance with any terms and conditions of an incidental take statement.

The Service is not including an incidental take authorization for marine mammals at this time because the regulations required for incidental take of marine mammals in this specific area or for this activity have not been issued under Section 101(a)(5) of the Marine Mammal Protection Act and/or its 1994 Amendments. In addition, the Service has reviewed the biological information relevant to the proposed action, including the Corps' monitoring plan and measures to reduce shock wave impacts from blasting. No incidental take of manatees is anticipated to occur as a result of blasting or collisions with dredges or project related vessels.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The Service recommends the following conservation measures for the CFC project:

1. Blasting should only be used in the event that rock cannot be removed by any other practical means.

2. While the Service approves of the proposed procedures to contain and minimize blasting impacts, the Service believes that the best way to protect manatees is to avoid blasting during the time of year when these animals are most likely to be in the project area. As the Service noted in our Biological Opinion on the deepening of the Ocean Bar Channel, manatees are most likely to be present from May through October.

3. **If blasting occurs between May through October of any year, the contractor should select equipment and implement blasting procedures which minimize the impacts of blasting on manatees and other aquatic organisms. The contractor should use low velocity explosives to reduce peak pressure levels, stem all holes, use the longest possible delays between charges, and use a bubble curtain or physical barrier to contain shock waves. The project description given in the BA states that these measures will be included in the contract. The Service strongly supports these protective measures.**

Regarding the use of delays, Munday et al. (1986) note that blasting caps are available in a series which can produce delays ranging from 25 milliseconds to 1,125 milliseconds. They also state that a single detonation can be effectively reduced to a series of small blasts by using such caps. They indicate that all caps for a single detonation can be initiated simultaneously, and that different burn times within each cap would produce delays between explosions. This procedure would eliminate the concerns of the Corps regarding the chance that early blasts could interrupt the initiation of later explosions. The Service believes that delays between charges in the range of 0.9 to 1.0 second would be the most effective in preventing possible overlap, and additive impact, of shock waves from separate

blasts.

All blasts should be scheduled during daylight hours and during period of slack tide to allow for optimal surveillance conditions. Blasting should not occur if weather conditions are not suitable for observing manatees, such as during rain or fog.

4. The Corps should calculate a safety zone around each blast from which manatees must be excluded in order to prevent any injury. The area should be composed of a danger zone, in which injury to manatees is possible, and a buffer zone, an area from which manatees could easily enter the danger zone. The combined area of the danger zone and the buffer zone would constitute the safety zone.

The BA indicates that the bubble curtain is expected to reduce shock waves by 95 percent or more. Until the exact extent of bubble curtain efficacy is established in the project area, the Service recommends that the danger zone be based on published calculations which assume only the burial of charges, stemming, and time delays. If actual field monitoring data for this project indicate that the bubble curtain reduces the shock wave, the danger zone may be reduced to the area within the bubble curtain, currently estimated at 0.8 acre, plus a calculated radius based on the shock wave penetrating the bubble curtain.

However, even with a highly effective bubble curtain, the Service would recommend that a buffer zone surround the bubble curtain.

Several formulas have been developed to calculate the distance from a blast at which no significant injury occurs to an individual of a given weight. As an example, Goertner (1982) calculated the maximum horizontal distance for slight injuries by a 12-pound underwater explosion to a manatee calf of 70 pounds to be 450 feet. This calculation is based on a charge in a bolehole at a depth of 40 feet with or without time delays. The conditions used for this published calculation resemble the proposed blasting. It is possible to factor in the increased weight of a charge in the CFC project, 98.5 pounds. The Draft EIS notes that the peak pressure of a larger charge at a given distance changes by the cube root of the weight multiplier for the larger charge. The weight multiplier in this case is 8.2 (98.5 lbs/12 lbs), and the distance required to avoid injury would change by a factor of 2.0 ($\sqrt[3]{8}=2$). Therefore, the calculated distance needed to prevent slight injuries to a manatee calf in the vicinity of a buried 98.5 lbs charge would be 900 feet (2 x 450 feet).

The Corps should carefully consider the proper weight of explosives used in danger zone calculations. As currently planned, each detonation would consist of 80 separate charges of

98.5 pounds. This procedure would result in a total detonation of 7,880 pounds of explosives. With a minimum delay of 25 milliseconds between each blast, the 80 explosions will occur in two seconds. The Service believes that shock waves from 80 separate explosions may be additive in some instances. Therefore, the "effective" weight of the detonation may be more than a single 98.5 pound charge. The Service recommends that the Corps present a written justification for any weight of explosive used in calculating the danger zone for manatees.

As an added precaution, the Service recommends that a buffer area be established around the perimeter of the calculated danger zone. The purpose of this buffer zone is to allow time to halt blasting before a manatee moving toward the blast area enters the danger zone. In the case of the manatee, a buffer zone extending 300 feet from the danger zone is considered sufficient (Bob Turner, Manatee Coordinator, USFWS, Jacksonville, Florida, personal communication, February 1996).

A land mass, such as a dredge disposal island, should block the shock wave. If a land mass is within the safety zone, surveillance may terminate at the land mass and would not be necessary within the area behind the mass.

5. For any blast between May 1 and October 1, the Corps should institute a manatee surveillance program within the calculated safety zone around each blast. Pre-blast surveillance personnel should, at a minimum, consist of a surveillance coordinator, one aerial team, and one boat team. Additional boat teams may be required depending on the calculated size of the safety zone around the blast. The surveillance coordinator should determine whether weather conditions are suitable for an acceptable survey of the blast area. If the surveillance coordinator determines that weather conditions are not suitable for a proper survey, blasting should be postponed under proper surveys can be undertaken. Aerial survey should begin at least one hour before detonation. Boat survey may include all daylight hours on the day of the blast, but should begin at least two hours before detonation.

Each surveillance team should have a minimum of two members. At least one member of each team should have experience in observing/spotting manatees. Members without previous experience should be trained in observing/spotting manatees. The surveillance program should have an adequate number of "substitute" observers who are available for work in place of any member that becomes unavailable. Each team should have two-way radio communications with the surveillance coordinator on a frequency dedicated to the surveillance. All surveillance personnel should be equipped with polarized sunglasses, binoculars, a red flag for a backup visual communication system, a log book for recording sightings, and a map for recording the location of manatees sighted.

All observers should maintain communications with the blasting contractor. If a manatee is seen within the safety zone, this fact will be immediately reported to the blasting contractor and detonation will be halted. Detonation will not occur until the safety zone is completely clear of manatees. Manatees will be allowed to leave the safety zone on their own volition and will not be herded or harassed away from the safety zone. If subsequent searches fail to locate the manatee seen in the safety zone, and movement out of the safety zone cannot be assured, the blast event will not resume until 30 minutes after the initial sighting.

Surveys for manatees may coincide with surveys for marine mammals required by the National Marine Fisheries Service provided the area surveyed includes the entire safety zone calculated for the manatee. The Corps is encouraged to determine whether telemetry data from radio-collared manatees are available for use in establishing the presence of manatees in the project area.

6. After detonation, an aerial and/or boat survey of the entire

safety zone should continue for at least one-half hour. If a dead or injured manatee is seen by the aerial surveillance team, they should contact ground personnel and direct them to the site. If no dead or injured manatees are seen and no additional, pre-blast surveillance is required, the aerial survey team may leave the project area. However, this team should remain available to monitor an injured manatee which may be detected at a later time. The boat surveillance team may continue surveillance work downstream from the blast site in order to search for dead or injured manatees outside the safety zone.

If a dead or injured manatee is sighted after blasting, the surveillance coordinator should contact the Service's Raleigh Field Office at 919-856-4520, the Service's Law Enforcement Officer at 919-856-4786, and David Allen of the North Carolina Wildlife Resources Agency at 919-224-1288. The surveillance team or construction contractor should have the capability to recover dead manatees and track injured manatees. The team should record basic biological data from dead manatee, such as sex, age class, and length, and have the capability of short-term storage of a carcass. The surveillance coordinator should contact the North Carolina Marine Mammal Stranding Network (Paul Barrington, Director, North Carolina Aquarium at Fort Fisher, ph. 910-458-8258). This network can initiate the post-mortem examination of any marine mammal carcass.

If a dead manatee is recovered within three miles up or downstream from a detonation site within 72 hours of a detonation without clear indications that the cause of death was unrelated to blasting, blasting should cease until a post-mortem examination can either confirm or reject blasting as a cause of death. Similarly, if any injured manatee is reported within this same area within 72 hours of a detonation, blasting should cease until the cause of injury can be determined.

7. If blasting associated with this project results in the death or injury of a manatee, all blasting should cease and the Corps should reinitiate formal consultation.

8. At least two months prior to the initiation of blasting during a given year, the Corps should submit a complete manatee surveillance plan to the Service. The plan should contain the names of the coordinator, primary observers, and substitute observers along with their qualifications and experience in manatee surveillance. The plan should describe the equipment to be used in the surveillance. The plan should describe the data used in the calculation of the manatee safety zone (including data on the effectiveness of the bubble curtain, if available) and the procedures to be used to detect manatees in this zone. The plan should outline the communication procedures to be used in pre-blast

surveillance. The plan should outline the procedures for dealing with the occurrence of dead or injured manatees. The plan should contain sample maps and log sheets which will be used to record manatee sightings.

9. At least one month before the initiation of blasting, the Corps should hold a meeting to discuss all measures to be used to prevent harm to Federally-listed species. This meeting should include representatives of the construction contractor, the Service, the NMFS, the North Carolina Wildlife Resources Commission, and other interested parties, such as the U. S. Coast Guard. All personnel will be informed about the possible presence of manatees in the area, and that civil or criminal penalties can result from harassment, injury, and/or death of a listed species. The construction contractor will present the protocol and logistics for blasting. The manatee surveillance coordinator will outline the equipment and procedures to be used in the surveillance program. Any unresolved issues regarding coordination between the contractor and the manatee surveillance program should be clearly established during this meeting. The Corps should release a written summary of agreements developed during the meeting, including any changes to the plans released prior to the meting, to all attendants prior to the initiation of blasting.

10. Within one month after the end of the manatee season, May through September, the Corps should issue a written report on construction progress made during the season and a full assessment of blasting impacts on Federally-listed species and other fish and wildlife resources. This report should address any problems encountered within or between the blasting operation and the manatee surveillance program. The report may recommend ways to eliminate any problems of the past season and propose changes to the blasting and surveillance plans for the next manatee season.

11. If hopper dredges are used during May through October, at least two qualified observers should be aboard the dredges to locate any manatees in the area. The vessel captain should be made aware of any manatees in the area and they should be avoided by reducing the speed of the vessel or by changing the course of the vessel.

12. The Service is concerned that blasting on an almost daily basis in the Cape Fear River from August 1 through the end of January could prevent manatees which moved upstream of the blasting area during early and mid-summer from returning downstream on their fall migration southward. This potential problem would be most likely to occur during blasting to enlarge and deepen the turning basin near Wilmington where the Northeast Cape Fear River is

approximately 1,000 feet wide. Manatees may be reluctant to move downstream in the face of the blasting disturbances. Therefore, the Service recommends that if there are no continuous breaks in blasting of at least two days during the months of September and October, the Corps should conduct aerial surveys for manatees. If manatees are located upstream from the blast sites after October 15, the Corps should contact the Service regarding procedures to ensure that these manatees can safely return to the ocean.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION - CLOSING STATEMENT

This concludes formal consultation on the actions outlined in the request. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3)

the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, in this case the death or injury of any manatee, the operations causing such injury must cease pending reinitiation.

If you have any questions regarding this opinion, please contact Howard Hall at 919-856-4520, ext. 27.

Sincerely,

John M. Hefner
Field Supervisor

FWS/R4:HHall:5/17/96:WP:A:BO_CFC.596

Literature Cited

Clark, M. K. 1987. *Trichechus manatus* Linnaeus, West Indian (Florida) Manatee. pp. 18-21 in M. K. Clark (ed.) Endangered, Threatened, and Rare Fauna of North Carolina Part I. A re-evaluation of the mammals. Occasional Papers of the North Carolina Biological Survey. No. 1987-3. North Carolina State Museum of Natural Sciences. Raleigh, NC.

Hartman, D. S. 1974. Distribution, status, and conservation of the manatee in the United States. Natl. Tech. Inf. Ser., PB81-140725, Springfield, Virginia. 246 pp.

Hartman, D. S. 1979. Ecology and behavior of the manatee (*Trichechus manatus*) in Florida. The American Society of Mammalogists, Special Publication No. 5. 153pp.

Goertner, J. F. 1982. Prediction of underwater explosion safe ranges for sea mammals. Naval Surface Weapons Center, NSWC TR 82-188. Silver Springs, Maryland. 25 pp.

Moore, J. C. 1951. The range of the Florida manatee. Quart. J. of the Florida Academy of Science. 14:1-19.

Munday, D.R., G.L. Ennis, D.G. Wright, D.C. Jeffries, E.R. Mcgreer, and J.S. Mathers. 1986. Development and evaluation of a model to predict effects of buried underwater blasting charges on fish populations in shallow water areas. Canadian Technical Report of Fisheries and Aquatic Sciences. 1418:x + 49 pp.

Odell, D. K. 1982. West Indian Manatee. pp. 828-837 in J. A. Chapman and G. A. Feldhamer (eds.) Wild Mammals of North America. The Johns Hopkins University Press. Baltimore, Maryland. 1147pp.

O'Keeffe, D.J. and G.A. Young. 1984. Handbook on the environmental effects of underwater explosions. Naval Surface Weapons Center. NSWC TR 83-240.

O'Shea, T. J. and M. E. Ludlow. 1992. Florida manatee. pp. 190-200. In S. R. Humphrey (ed.). Rare and Endangered Biota of Florida, Volume I. Mammals. University of Florida Press. Gainesville. 392 pp.

Packard, J. M. and O. F. Wetterqvist. 1986. Evaluation of manatee habitat systems on the northwestern Florida coast. Coastal Zone Manage. J. 14:279-310.

Rose, P. M. 1985. The West Indian manatee. pp. 541-546. in R. L. Silvestro (ed.). Audubon Wildlife Report 1985. The National Audubon Society. New York, New York. 671pp.

Scholander, P. F. and L. Irving. 1941. Experimental investigations of the respiration and diving of the Florida manatee. J. of Cellular and Comparative Physiology 17(2):169-911.

Schwartz, F. J. 1995. Florida manatees, *Trichechus manatus* (Sirenia: Trichechidae), in North Carolina 1919-1994. Brimleyana 22: 53-60.

U.S. Army Corps of Engineers. 1991. Reconnaissance Report on Improvements to navigation, Cape Fear - Northeast Cape Fear Rivers, Comprehensive Study. Volume II - Supporting Documentation. Wilmington District, U.S. Army Corps of Engineers, Wilmington, NC. Appendices A-G.

U. S. Fish and Wildlife Service. 1993. West Indian Manatee, _Trichechus_ _manatus_ [Linnaeus]. Endangered and threatened Species of the Southeastern United States [The Red Book]. U. S. Fish and Wildlife Service, Atlanta, Georgia. 6pp.

__________. 1996. Record number of endangered manatees succumb to unknown ailment. News release #96-17, March 28, 1996. U. S. Fish and Wildlife Service, Atlanta, Georgia. 1p.

Webster, W.D., J.F. Parnell, W.C. Biggs, Jr. 1985. Mammals of the Carolinas, Virginia, and Maryland. The University of North Carolina Press, Chapel Hill. 255pp.

Wright, S. D., B. B. Ackerman, R. K. Bonde, C. A. Beck, and D. J. Banowetz. 1995. Analysis of watercraft-related mortalities in Florida, 1979-1991. Pages 259-268 in T. J. O'Shea, B. B. Ackerman, and H. F. Percival, eds. Population Biology of the Florida manatee. National Biological Service Information and Technology Report 1.

Young, G. A. 1991. Concise methods for predicting the effects of underwater explosions on marine life. NAVSWC MP 91-220. Naval Surface Warfare Center. 22pp.

ATTACHMENT C

PRELIMINARY PRE- AND POST BLAST IMPACT MONITORING PLAN
FINAL ENVIRONMENTAL IMPACT STATEMENT
FOR
CAPE FEAR-NORTHEAST CAPE FEAR RIVERS
FEASIBILITY STUDY
NEW HANOVER AND BRUNSWICK COUNTIES, NORTH CAROLINA

Endangered and threatened species which could be present in waters of the area during project construction include the West Indian manatee, green sea turtle, Kemp's ridley sea turtle, loggerhead sea turtle, and shortnose sturgeon. Evaluation of the potential effects of the proposed action on these species and their habitats will be included in biological assessments which are being prepared and which will be coordinated with the National Marine Fisheries Service (NMFS) and the US Fish and Wildlife Service (USFWS), pursuant to Section 7 of the Endangered Species Act of 1973, as amended. This coordination will be completed prior to the initiation of the proposed construction.

In order to assure that endangered and/or threatened species will not be adversely affected by rock blasting, if it is required for project completion, any protective agreements reached through this ongoing coordination will be incorporated into the contract for the proposed work.

At this time we believe that pre-blast monitoring, use of bubble curtains, and seasonal restrictions will be the most effective measures to minimize potential impacts to listed species. Anticipated protective measures will include, at a minimum:

1. During pre-blast monitoring, NMFS approved observers will be used to assure that no sea turtles or marine mammals (including manatees and bottlenose dolphins) are present in the vicinity of the blast. Should listed species or marine mammals be observed, blasting will be delayed. **Normal industry procedure requires that the contractor perform limited onsite blasting tests and adjust the final (blasting) plan to actual site conditions. During the limited onsite blasting tests, the effectiveness of the bubble curtain and/or physical barrier will be tested. As indicated in Section 5.02, the contractor will be required to reduce the pressure wave created by the blast by ≥95 percent. This could be done by setting up a series of hydrophones within and without the blast area to measure the effectiveness of the bubble curtain and/or physical barrier. An appropriate pre-blast monitoring area will be coordinated with all concerned agencies; however, with the use of bubble curtains that must contain ≥95 percent of the pressure wave, the area of impact should be much smaller than that indicated in Table 7 of the EIS (34.5, acres, 656-foot radius) for LD 1 percent (0.125 pound fish). If there is no take of listed species or other significant resources within the first series of blasts (e.g., 30), we propose to reduce the monitoring zone to the immediate vicinity of the bubble curtains (e.g., 300-foot radius from the bubble curtain).**
2. A gillnet survey will be used to capture and relocate shortnose sturgeon to holding areas outside of the impact areas.
3. Hydraulic pipeline dredging in the river (during construction and maintenance) and blasting will be conducted during the North Carolina Division of Marine Fisheries (NCDMF) dredging window (August 1 to January 31) to the maximum extent practicable.
4. After blasting, observers will also examine the area to determine if incidental take of listed species resulted from a blast. Post-blast trawling is not practical in the area due to the presence of snags. However, attempts will be made to deploy a channel net down current of each of the first 30 blasts in attempt to verify the effectiveness of the bubble curtains.
5. The potential use of small 'scare' charges detonated within 1 minute prior to each blast will be investigated.

Through implementation of such protective measures, it is believed that potential impacts to listed species can be minimized. In addition to the shortnose sturgeon (*Acipenser brevirostrum*) caught during the aforementioned pre-blast gillnet surveys, data will be collected regarding species and size of other fish. Observers will inspect the blast impact area and the area immediately down current for fish mortality after each blast. Post-blast observations will be documented.

ATTACHMENT D

MITIGATION ANALYSIS

FINAL ENVIRONMENTAL IMPACT STATEMENT FOR CAPE FEAR-NORTHEAST CAPE FEAR RIVERS FEASIBILITY STUDY NEW HANOVER AND BRUNSWICK COUNTIES, NORTH CAROLINA

1.00 INTRODUCTION

Deepening of the existing channel from the ocean bar to the Port of Wilmington is the central feature of the proposed action. Other features included in the proposed action consist of widening one turning basin and channel and extension of the anchorage basin near Wilmington (Figure 1). The total length of improvements is approximately 37 miles. Three alternative depths were considered for the ocean bar channel (42, 44, and 46 feet plus over depth) and generally three alternative depths for the river channels (40, 42, and 44 feet plus over depth). The 44-foot bar channel and 42 foot river channel is the recommended plan. This project would require removal of about 12,825,000 cubic yards of dredged material of which about 3,423,000 cubic yards are rock. About 601,000 cubic yards of this rock would require blasting for removal. The construction period for the entire project would be about 3 years.

The study area includes the Cape Fear and Northeast Cape Fear Rivers at and above Wilmington, the estuary below Wilmington, and the nearshore ocean water including the Wilmington Harbor ODMDS.

Activities potentially impacting fish and wildlife resources include dredging of benthic resources; blasting impacts on aquatic primary nursery areas, anadromous fish, sea turtles, and marine mammals; potential increased salinity especially in upstream areas; and loss of wetlands and primary nursery area due to deepening and widening the project.

As described in the project EIS, many of these impacts will be minimized by project timing and construction techniques. Salinity changes are expected to be insignificant. Any excavated material that is predominantly rock from Lower Big Island Channel downstream, will be used to finish construction of the Wilmington Offshore Fisheries Enhancement Structure (WOFES). The estimated volume of rock to be placed in the WOFES is about 2.4 million cubic yards.

Mitigation is proposed to compensate for loss of primary nursery habitat. Due to the proposed dredging activities, approximately 13.4 acres of primary nursery (designated by the NC Division of Marine Fisheries) will be excavated to a depth greater than 10 feet mean lower low water (mllw). This impact area includes about 13.2 acres of shallow estuarine bottom and about 0.2 acres of mixed tidal marsh located upstream of mouth of the Brunswick River.

No mitigation is proposed for non primary nursery areas. About 4.7 acres of shallow estuarine bottom (non primary nursery less than 10 feet deep downstream of the mouth of the Brunswick River) will be excavated to a depth greater than 10 feet mllw. Benthic recolonization of these areas is expected with no significant long-term loss of functional value.

Dominant plant species of the mixed fringe marshes which would be lost due to project construction are saltmarsh cordgrass (Spartina alterniflora) and giant cordgrass (Spartina cynosuroides). Plant species found inland of the fringe, and which may also be lost to dredging include narrow-leaf cattail (Typha angustifolia), soft-stem bulrush (Scirpus validus), wild rice (Zizania aquatica), common reed (Phragmites australis), and umbrella sedge (Cyperus strigosus).

These marshes and adjacent shallow estuarine bottom provide food and cover for fish and wildlife resources including waterfowl, contribute to wave and erosion protection, and help control sedimentation. Primary nursery areas are defined as those areas in the estuary that provide habitat for post-larval development of fin fishes. Primary nursery area status is applied to all those aquatic habitats in the estuarine system upstream of the mouth of the Brunswick River, outside of the main navigation channel. This area provides important nursery habitat for larval young of such species as Atlantic menhaden (Brevoortia tyranus), Atlantic croaker (Micropogon undulatus), spot (Leiostomus xanthurus), star drum (Stellifer lanceolatus), penaeid shrimp, mullet (Mugil spp.), and weakfish (Cynoscion regalis).

2.00 FUNCTIONAL ANALYSIS OF PROJECT IMPACTS

A qualitative functional analysis of relative estuarine values within the project impact area (with and without the proposed project) is shown on Table 1, Project Impacts. This analysis was based on evidence gained during the field surveys, literature review, and collaboration with State and Federal resource agencies. Although estuarine habitats next to the harbor and channels in the vicinity of the City of Wilmington have been somewhat degraded as a result of existing navigation, port related activities and commercial and industrial development, these habitats still provide important functional values. Estuarine functions considered to have a moderate to high relative importance in the mitigation analysis include fish spawning and nursery, wildlife (including waterfowl) feeding and cover, wave and erosion protection, water quality and esthetic value.

Table 1. Project Impacts

RELATIVE ESTUARINE VALUES

Project Name:	Cape Fear - Northeast Cape Fear Rivers
Wetland Type:	Primary Nursery
Location:	Project Impact Area
Evaluator:	Corps of Engineers -Wilmington

#	Estuarine Functions	Relative Import. 0-5	Existing Condition Rating	Existing Condition Weighted
1	Flood Conveyence	0	0	0
2	Waves and Erosion	4	4	16
3	Flood Storage	0	0	0
4	Sediment Control	4	4	16
5	Fish Habitat			
	a. Spawning	5	4	20
	b. Nursery	5	5	25
6	Shellfish Habitat	0	0	0
7	Waterfowl Habitat			
	a. Nesting	0	0	0
	b. Feeding	4	3	12
	c. Cover	4	3	12
8	Wildlife Habitat			
	a. Nesting/Breeding	4	3	12
	b. Feeding	5	3	15
	c. Cover	5	3	15
9	Recreation	3	4	12
10	Water Supply	0	0	0
11	Food Production	0	0	0
12	Timber Production	0	0	0
13	Historical Values	0	0	0
14	Education & Research	0	0	0
15	Aesthetic Values	4	4	16
16	Water Quality	5	4	20
	Total	52		191
	Wetland Value =			3.7

Primary Nursery	Existing Condition			With Project	
	Wetland Val.	Ac.*	HUs	Ac.	HUs
Includes open water and marsh habitats	3.7	13.4	49.6	0.0	0.0

Impact Acres	Habitat Units (HUs)	Mitigation Goal HUs
-13.4	-49.6	49.6

NOTES: Relative Wetland Values: High =5, Moderate=3, Low=1, No Value =0
Relative Importance: High =5, Moderate=3, Low = 1, Not Applicable =0
Habitat Units (HUs)
* Impact area includes 13.2 acres of open water and .2 acres of mixed marsh

As shown at the bottom of Table 1, 13.4 acres of a primary nursery habitat within the project impact area had a Relative Value of 3.7 under the existing (without project) condition, with a possible range of 0 (no value) to 5 (high value). This provides 49.6 Habitat Units (HUs), based on a modified Habitat Evaluation Procedure (HEP) where Habitat Units = Relative Value X Area. Although the impact area would continue to provide some of the same functional values, it would no longer be located outside of the main navigation channel and none (0 acres) of the subject 13.4 acres would continue have primary nursery status. This provides no (0) Habitat Units under the with project condition.

3.00 MITIGATION GOALS AND OBJECTIVES

The mitigation objective for the project is to provide adequate and fair replacement for the loss of existing shallow primary nursery area and marsh resources that will be converted to deep channel bottom as a result of project construction and maintenance, i.e., 100 percent replacement of lost estuarine function. **Our mitigation goal is 49.6 Habitat Units (see table 1)** . In order for the mitigation to effectively offset impacts to the affected estuarine system it must be located within that system. For that reason, mitigation sites which are adjacent to, or near, the impacted habitats are considered to be the most desirable.

The functional aspects of the converted habitats include fish spawning and nursery, wildlife (including waterfowl) feeding and cover, wave and erosion protection and esthetic value. Site specific design goals and site restrictions will be developed in coordination with regulatory agencies prior to site construction.

4.00 MITIGATION ALTERNATIVES

Options available for mitigation generally fall into one of four categories: restoration, creation, enhancement and preservation. **As a result of the considerations described below, restoration or a combination restoration/preservation plan are considered the only feasible mitigation alternatives for this project.**

Restoration. Restoration consists of taking sites which have been previously destroyed, i.e., lost the ability to perform a desired function, and restoring that function. In the project area, the most common origin of such sites is where wetland areas have been filled for development or where they have been filled to receive dredged material from harbor maintenance. Developed areas are not available for **mitigation in the project area**; however, numerous dredged material disposal sites exist **which have potential for development as restoration sites.**

Creation. Creation consists of establishing a function on a site which has not previously occurred in that location. Examples would be grading down natural high ground or filling in deep water areas to make shallow water habitats or marsh. This mitigation option is essentially unworkable in the project area for two reasons: First, natural high ground located adjacent to the river is either already developed or is being reserved for future development, making the real estate costs excessive. Second, deep water portions of the river are used by navigation interests and represent valuable habitat for the shortnose sturgeon (Acipenser brevirostrum), a federally listed endangered species. It is unlikely that either navigation interests or fisheries management interests would find this alternative acceptable.

Enhancement. Enhancement consists of upgrading the functions and/or improving the habitat values of a desirable habitat. This could be by intensive management such as construction of impoundments for waterfowl. An examination of the functions and values performed by the habitats to be impacted by the project indicates that there are no opportunities available within the project area where the outcome of a given enhancement measure could be reliably predicted. This is due principally to a general lack of understanding about how primary nursery areas function. Without a clear idea about how the various attributes (chemical, physical, and biological) interrelate, it is impossible to predict the outcome of a given action with any certainty.

Preservation. Preservation consists of the acquisition and subsequent protection of habitats which are being threatened by ongoing land-use practices. Currently, most natural resource management agencies have a skeptical view of preservation, principally because the certainty of the habitat loss to be offset by acquisition may be unknown (i.e., the site selected for mitigation through preservation may be unimpacted by other developments for many years while the need for mitigation is immediate).

Although the Draft EIS identified no opportunities for preservation, an opportunity for Prevention of Degradation (POD) to primary nursery by preservation of adjacent wetland and upland habitats was identified during the public review period. POD is a term coined by the US Fish and Wildlife Service to describe a proactive concept where high quality habitats at known risk to future degradation are identified. These risks are removed to preclude future habitat losses thus improving the long-term habitat value of the site. Preliminary coordination with resource agencies regarding POD indicates that this alternative may be acceptable when risks are well founded, the habitat values protected are like those impacted (inkind), and when this method is used in combination with a restoration or creation plan.

5.00 SITE SELECTION AND EVALUATION

The mitigation objective can be most effectively achieved when the mitigation measures are implemented in the same environmental regime in which the project related adverse impacts are occurring; therefore, it was determined that mitigation actions should take place within the general vicinity of the authorized project improvements.

Restoration. Seven sites (Table 2) located in the general vicinity of the project were considered for potential habitat restoration. All of these sites are disposal areas that have been used at different times during the history of the harbor.

Table 2. Approximate acreage of potential mitigation sites associated with the Cape Fear-Northeast Cape Fear Rivers Project.

Site	Acres	Dredged Material
Disposal Site No.9	9 Acres	Yes
Disposal Site No.10	36 Acres	Yes
Disposal Site No.11	28 Acres	Yes
Disposal Site No.12	31 Acres	Yes
Disposal Site No.13	30 Acres	Yes
Disposal Site No.14	10 Acres	Yes
Disposal Site No.19	12 Acres	Yes

All of the areas shown on Table 2 are river islands or occur in tidal wetlands located adjacent to designated primary nursery and the impact area. It is expected that equally suitable replacement habitat could be restored on any of these sites.

Since all of these sites are considered to have equal mitigation potential, construction cost was the primary factor considered in site selection. Given the limited availability of suitable land in the project area and the high costs of high ground adjacent to a deep water ship channel, minimizing real estate costs was a primary consideration. Other factors that would affect construction cost include site elevation and proximity to the Eagle Island dredged material disposal area (dredging costs), cultural resources potential (additional mitigation/data recovery costs), potential for hazardous and toxic waste (potential clean-up costs), accessibility (need for temporary roads or dredged access channels), and size of the site (need for multiple mobilizations). Costs for grading to achieve proper contours and for planting appropriate vegetation cover are expected to be the same at all the potential sites.

Proximity to Disposal Areas and Topography. Sites within 2 miles of Eagle Island disposal area were considered high priority since those located beyond 2 miles would require disposal on the same site and generally have double the land requirement. **Two sites, Islands 13 and 14, are available within 2 miles of the disposal area. Sites located beyond 2 miles were dropped from further evaluation. Mitigation would preclude future use of these islands site for dredged material disposal; however, Islands 13 and 14 are not proposed as disposal sites for long-term project maintenance.**

Restoration of wetland habitat on a previously filled area will require excavation and disposal of significant quantities of dredged material. The quantity of material to be removed is directly proportional to the average elevation of fill over the proposed development area. Therefore, sites with lower elevation (less fill) are preferred. Uplands on Islands 13 and 14 have an average elevation of about 10 to 16 feet. These elevations would not preclude the use of these areas for restoration.

Size. The size of the available site is an important consideration. A single site which can accommodate all mitigation requirements is the most desirable for ease of construction and monitoring; however, multiple sites would be acceptable if increased equipment mobilization cost do not become prohibitive. **Site 13 is large enough to accommodate the total 27 acre mitigation requirement for the restoration plan and is therefore the proposed site for that alternative. The use of this site would minimize acquisition cost (1 tract) and equipment mobilization cost. Site 14 is too small to accommodate the entire restoration alternative but is located closer to the disposal area and has high potential for restoration. The use of Island 14 for restoration may be considered in combination with POD at Tonys and Lagoon Creeks (see POD below).**

Environmental Impact. Construction of the mitigation feature can also carry environmental costs associated with site access impacts and loss of interspersed wetlands, wildlife habitat, etc. It is important that these costs be minimized during the site selection process. **Sites 13 and 14 contain limited areas of good quality terrestrial and wetland habitat. Protection of these areas will be considered when developing the final restoration plan.**

Potential for Cultural Resources. Sites were evaluated for potential cultural resources based on their location in relation to State identified Cultural Resource Priority Areas. Using sites within a priority area would require cultural resources surveys and extensive coordination with Federal, state and local government. Due to the additional time and cost likely to be incurred for coordination and potential mitigation of cultural resources impacts, sites within nonpriority areas are preferred. **Sites 13 or 14 are not located in a Cultural Resources Priority Area and have low potential to contain important cultural resources.**

Presence of Hazardous, Toxic or Radioactive Waste (HTRW). Due to evaluation and remediation costs which would be associated with using a site containing HTRW, any area which has a high probability of containing such features **will not be used for restoration. Sites 13 or 14 do not have a high probability of containing HTRW.**

Cost of Acquisition. Cost of acquiring a site to construct mitigation is a major consideration. High ground areas adjacent to a deep-water navigation channel are expensive and, within this group of lands, those with the **greatest** development potential (size and accessibility) are the most expensive. **Sites 13 and 14 are remote and have limited development potential and similar per-acre costs.**

Accessibility. Sites which are readily accessible to deep water are preferred since these sites would not require extensive access channels and are therefore expected to have lower construction costs and, less environmental impact. **Sites 13 and 14 are easily accessible at high tide by a shallow draft vessel; however, if a dredge is used a small pilot channel may be needed to access the site from the river channel.**

POD. Two primary nursery areas were identified for potential protection by POD. These sites were selected because they are located near the project impact area, and their primary nursery function is at immediate risk to degradation. The area surrounding the PNA's at risk have a relatively small water shed comprised mostly of swamp allowing control of the drainage area with a moderate land acquisition requirement. They are (1) the Northeast Cape Fear River segment from about Cowpen Landing extending south to include the headwaters of Lagoon Creek and (2) the Northeast Cape Fear River Segment from the southern limit of Area 1, extending South to the Pender County line. Area 1 includes the entire drainage of Tonys Creek and Lagoon Creeks and contains about 29 acres of primary nursery including tidal creek habitat and the disarticulated shoreline of the Northeast Cape Fear River within about 50 feet of the swamp forest. Primary nursery in Area 2 does not include tidal creek habitat and is limited to 4 acres of Northeast Cape Fear River shoreline.

Adjacent wetlands and riparian uplands associated with both of these sites are mostly undeveloped and include; marsh, wooded swamp, and longleaf pine forest with limited residential and commercial development. Area 1 includes about 700 acres of mature swamp forest and about 100 acres of upland which is mostly (longleaf pine forest) with limited residential and commercial development. Area 2 includes about 100 acres of swamp forest and about 30 acres of upland pine forest.

Extensive clear cutting is ongoing in the Cape Fear and Black River swamps and in nearby longleaf pine forests. Essentially all swamp forest acres in the potential POD site are owned by a lumber company. Most of the potential POD upland forest is owned by a lumber company or local industries with the remaining lands being in private ownership. The upland portion of the site has high residential or commercial development potential. New home construction is evident in the area. There are good roads to the site and boat access at Cowpen Landing. The potential POD site is located near Wilmington, North Carolina (one of the fastest growing towns in the US) in Pender County (fastest growing county in North Carolina). The site is also within 5 miles of the proposed I-40/U.S. 421 connector which is expected to stimulate development in the area.

In addition to protection of primary nursery, the plan would preserve unique environmental features found on the site including red-cockaded woodpecker habitat, virgin cypress trees, Atlantic white cedar, and longleaf pine forest. These attributes are significant but do not relate to the aquatic habitat proposed for protection and were not considered in the functional analysis.

6.00 FUNCTIONAL EVALUATION OF MITIGATION REQUIREMENTS

Restoration. A qualitative evaluation of relative functional values in the proposed restoration area is shown on Table 3. This evaluation assumes that replacement habitats to be restored will take 10 years to fully achieve the values associated with habitats to be impacted as they will be established on presently non-aquatic substrates and will, initially, have minimal species diversity. This analysis recognizes the need for recovery, or maturation, of such newly restored systems before they will fully function as well as the original habitats impacted by the project, and indicates that 27.6 acres of this habitat would be needed to replace the 49.6 HUs (13.4 acres) lost due to project construction. This equates to about a 2 to 1 mitigation ratio. Such a ratio is supported by the draft Memorandum of Agreement Between the Environmental Protection Agency and the Department of the Army Concerning the Determination of Mitigation Under the Clean Water Act Section 404(b) Guidelines (dated 13 July 1992) which suggests that, for restoration efforts, a 2 to 1 ratio should serve as a guide.

POD. An evaluation of the relative functional values of the two previously described potential POD sites was also made (see tables 4 and 5). Based on existing land ownership and observed development activities in adjacent and nearby areas as described above, It is expected that swamp forest clearcutting and residential and industrial development of uplands adjacent to the primary nursery to be protected will occur within the next 5 years of the construction date without POD. Habitat values within the primary nursery would be reduced due to loss of stream shading, runoff, and degraded water quality. With POD, riparian habitats are protected and existing high quality primary nursery is maintained over the analysis period. This evaluation (Table 4) indicates that POD to 55.1 acres of Primary Nursery including tidal creek (Tonys Creek and Lagoon Creek) and Northeast Cape Fear River shoreline would be required to replace the total mitigation goal (49.6 HUs for 13.4 acres PN lost). POD on 70.9 acres of NE Cape Fear River Shoreline is required to replace 49.6 HUs (see Table 5). Table 6 summarizes project impacts, mitigation goal and acreage requirements for the three mitigation alternatives.

7.00 INCREMENTAL COST ANALYSIS

An incremental cost analysis is shown on table 7. This compares costs for alternative means of mitigation. The costs shown for POD are preliminary and subject to change; however, the relative comparison is expected to be valid. It is expected that the most cost effective mitigation alternative is POD to primary nursery at Tonys and Lagoon Creeks. The least cost effect plan is POD to NE Cape Fear River shoreline. This is primarily due to the relatively large land acquisition compared to a small area of primary nursery to be enhanced . The cost per HU for restoration of primary nursery at dredged disposal islands of the Cape Fear River falls between the cost of the other alternatives.

Table 3. Restoration Site

RELATIVE ESTUARINE VALUES

Project Name:	Cape Fear - Northeast Cape Fear Rivers
Wetland Type:	Primary Nursery
Location:	Dredged Disposal Island 13 or 14.
Evaluator:	Corps of Engineers -Wilmington

#	Estuarine Functions	Relative Import. 0-5	Existing Condition Year 0 Rating	Existing Condition Year 0 Weighted	Year 5 Rating	Year 5 Weighted	Year 10 Rating	Year 10 Weighted
1	Flood Conveyence	0	0	0	0	0	0	0
2	Waves and Erosion	4	0	0	3	12	4	16
3	Flood Storage	0	0	0	0	0	0	0
4	Sediment Control	4	0	0	3	12	4	16
5	Fish Habitat							
	a. Spawning	5	0	0	1	5	4	20
	b. Nursery	5	0	0	2	10	5	25
6	Shellfish Habitat	0	0	0	0	0	0	0
7	Waterfowl Habitat							
	a. Nesting	0	0	0	0	0	0	0
	b. Feeding	4	0	0	1	4	3	12
	c. Cover	4	0	0	2	8	3	12
8	Wildlife Habitat					0		0
	a. Nesting/Breeding	4	0	0	1	4	3	12
	b. Feeding	5	0	0	1	5	3	15
	c. Cover	5	0	0	2	10	3	15
9	Recreation	3	0	0	1	3	4	12
10	Water Supply	0	0	0	0	0	0	0
11	Food Production	0	0	0	0	0	0	0
12	Timber Production	0	0	0	0	0	0	0
13	Historical Values	0	0	0	0	0	0	0
14	Education & Research	0	0	0	0	0	0	0
15	Aesthetic Values	4	0	0	2	8	4	16
16	Water Quality	5	0	0	2	10	4	20
	Total	52		0		91		181
	Wetland Value =			0.0		1.8		3.7

Mitigation Plan	Habitat Units /Acre* Year 0	Habitat Units /Acre* Year 5	Habitat Units /Acre* Year 10	Ave. Ann. HUs	Mitigation Goal	Acres Needed	Acres Available
Restore PN at Disposal Islands 13 or 14	0.0	1.8	3.7	1.8	49.6	27.6	27.6

NOTES: Relative Wetland Values: High =5, Moderate=3, Low=1, No Value =0
Relative Importance: High =5, Moderate=3, Low = 1, Not Applicable =0
*Habitat Units (HUs)

Table 4. Tony & Lagoon Creeks

RELATIVE ESTUARINE VALUES

Project Name:	Cape Fear - Northeast Cape Fear Rivers
Wetland Type:	Primary Nursery
Location:	Tonys and Lagoon Creeks without POD
Evaluator:	Corps of Engineers -Wilmington

#	Estuarine Functions	Relative Import. 0-5	Existing Condition Year 0 Rating	Existing Condition Year 0 Weighted	Year 5 Rating	Year 5 Weighted	Year 10 Rating	Year 10 Weighted
1	Flood Conveyence	0	0	0	0	0	0	0
2	Waves and Erosion	4	3	12	3	12	3	12
3	Flood Storage	0	0	0	0	0	0	0
4	Sediment Control	4	5	20	3	12	4	16
5	Fish Habitat							
	a. Spawning	5	5	25	3	15	4	20
	b. Nursery	5	4	20	3	15	5	25
6	Shellfish Habitat	0	0	0	0	0	0	0
7	Waterfowl Habitat							
	a. Nesting	0	0	0	0	0	0	0
	b. Feeding	4	4	16	3	12	3	12
	c. Cover	4	5	20	3	12	3	12
8	Wildlife Habitat					0		0
	a. Nesting/Breeding	4	3	12	2	8	3	12
	b. Feeding	5	5	25	4	20	4	20
	c. Cover	5	5	25	3	15	4	20
9	Recreation	3	5	15	3	9	4	12
10	Water Supply	0	0	0	0	0	0	0
11	Food Production	0	0	0	0	0	0	0
12	Timber Production	0	0	0	0	0	0	0
13	Historical Values	0	0	0	0	0	0	0
14	Education & Research	0	0	0	0	0	0	0
15	Aesthetic Values	4	5	20	3	12	4	16
16	Water Quality	5	5	25	3	15	4	20
	Total	52		235		157		197
	Without POD Wetland Value =		4.5		3.0		3.8	
	With POD Wetland Value =		4.5		4.5		4.5	
	Net Habitat Value		0.0		1.5		0.7	

Mitigation Plan Enhance PN by POD	Net Habitat Units/ Ac. Year 0	Year 5	Year 10	Ave. Ann. HUs/Ac.	Mitigation Goal	Acres Needed	Acres Available
Tonys & Lagoon Cks	0.0	1.5	0.7	0.9	49.6	55.1	29.1

NOTES: Relative Wetland Values: High =5, Moderate=3, Low=1, No Value =0
Relative Importance: High =5, Moderate=3, Low = 1, Not Applicable =0
Net Habitat Units (HUs)/Ac. reflect the diference between With and Without POD
The value for the with POD condition assumes that environmental functions are maintained

Table 5. NE Cape Fear River

RELATIVE ESTUARINE VALUES

Project Name: Cape Fear - Northeast Cape Fear Rivers
Wetland Type: Primary Nursery
Location: NECF River, Lagoon Ck to Pender Co. Line, Without POD
Evaluator: Corps of Engineers -Wilmington

#	Estuarine Functions	Relative Import. 0-5	Existing Condition Year 0 Rating	Existing Condition Year 0 Weighted	Year 5 Rating	Year 5 Weighted	Year 10 Rating	Year 10 Weighted
1	Flood Conveyence	0	0	0	0	0	0	0
2	Waves and Erosion	4	5	20	3	12	4	16
3	Flood Storage	0	0	0	0	0	0	0
4	Sediment Control	4	4	16	3	12	4	16
5	Fish Habitat							
	a. Spawning	5	3	15	2	10	2	10
	b. Nursery	5	5	25	3	15	3	15
6	Shellfish Habitat	0	0	0	0	0	0	0
7	Waterfowl Habitat							
	a. Nesting	0	0	0	0	0	0	0
	b. Feeding	4	3	12	3	12	3	12
	c. Cover	4	3	12	2	8	3	12
8	Wildlife Habitat		0		0	0	0	0
	a. Nesting/Breeding	4	3	12	2	8	3	12
	b. Feeding	5	3	15	2	10	4	20
	c. Cover	5	3	15	2	10	3	15
9	Recreation	3	2	6	1	3	2	6
10	Water Supply	0	0	0	0	0	0	0
11	Food Production	0	0	0	0	0	0	0
12	Timber Production	0	0	0	0	0	0	0
13	Historical Values	0	0	0	0	0	0	0
14	Education & Research	0	0	0	0	0	0	0
15	Aesthetic Values	4	4	16	2	8	3	12
16	Water Quality	5	4	20	3	15	2	10
	Total	52		184		123		156
	Wetland Value =		3.5		2.4		3.0	
	With POD Wetland Value =		3.5		3.5		3.5	
	Net Value		0.0		1.1		0.5	

Mitigation Plan Enhance PN by POD	Net Habitat Units /Acre* Year 0	Year 5	Year 10	Ave. Ann. HUs	Mitigation Goal	Acres Needed	Acres Available
Lagoon to Pender Co.	0.0	1.1	0.5	0.7	49.6	70.9	4.0

NOTES: Relative Wetland Values: High =5, Moderate=3, Low=1, No Value =0
Relative Importance: High =5, Moderate=3, Low = 1, Not Applicable =0
*Habitat Units (HUs) Reflect the diference between the With POD and Without POD condition
The value for the with POD condition assumes that environmental functions are maintained

Table 6. Summary

PROJECT IMPACTS AND MITIGATION GOAL - ACRES & HABITAT UNITS

Primary Nursery	Existing Condition			With Project		Net Loss		Goal
	Rel. Value	Acres Present	Habitat Units	Acres Present	Habitat Units	Acres	Habitat Units	Habitat Units
Shallow water and Marsh	3.7	13.4	49.6	0.0	0.0	-13.4	-49.6	49.6

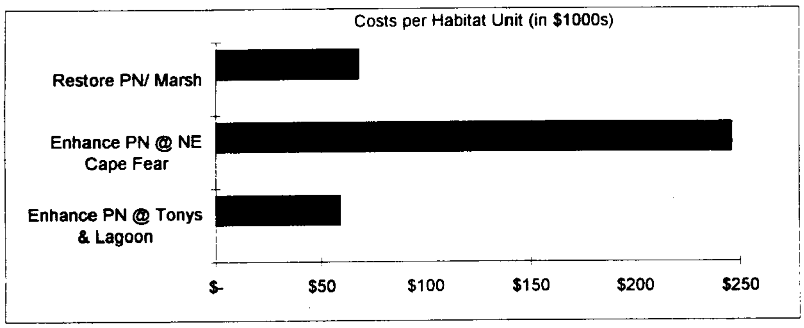
MITIGATION ACRES REQUIRED

Mitigation Plans	Habitat Units /Acre @ Given Interval			Av. An. HUs/Acre		Mit. Goal		Acres Needed	Acres Available
	Yr. 0	Yr. 5	Yr. 10						
Enhance Primary Nursery by POD Tonys & Lagoon Cks	0.0	1.5	0.7	0.9	HUs	49.6	HUs	55.1	29.1
Enhance Primary Nursery by POD @ NE Cape Fear River Pender Co Line to Lagoon Ck	0.0	1.1	0.5	0.7	HUs	49.6	HUs	70.9	4.0
Restore Primary Nursery / Marsh at Disposal Island	0.0	1.8	3.7	1.8	HUs	49.6	HUs	27.6	27.6

Notes: The mitigation goal of 49.6 HUs remains the same for all alternatives, acreage requirements increase or decraese depending the habitat value (Av. Ann. HUs/Ac.) provided by a given plan.

Table 7. Incremental Analysis

Mitigation Plans	MITIGATION COST (in Thousands) Const. Cost	Monitor	Acres Avail	HUs	Total Cost	Cost/ HU
Enhance PN @ Tonys & Lagoon	$1,519	$ 15	29.1	26	$ 1,534	$ 59
Enhance PN @ NE Cape Fear	$ 476	$ 15	3.4	2	$ 491	$ 246
Restore PN/ Marsh	$3,300	$ 100	27.6	50	$ 3,400	$ 68



8.00 PROPOSED PLAN

The proposed mitigation plan (Table 8) includes a combination of restoration and POD to primary nursery habitats including tidal marsh and shallow estuarine bottom. POD includes the purchase of swamp and upland buffer or obtaining conservation easements as appropriate to change future land use from forestry and development to conservation. Presently cleared areas would be allowed to revegetate. All lands acquired would be transferred to an appropriate agency or land trust for management.

As shown on table 8 only about 29 acres of primary nursery is available at the Tonys and Lagoon Creeks site. POD in this area will provide 26.0 HUs. The remaining 23.6 HUs will be replaced by restoration of 13 acres of primary nursery by construction of an estuarine creek and marsh complex at Islands 13 or 14. Preliminary evaluation indicates that a combined plan is the most cost-effective means of mitigation for this project and is, therefore, our proposed plan. However, if detailed evaluation shows POD to be economically infeasible or if it is found to be unacceptable to regulatory agencies, our original proposal (restoration of about 27 acres of primary nursery) will be implemented.

This action is expected to compensate for shallow estuarine bottom and tidal marsh lost due to construction and maintenance of the Cape Fear - Northeast Cape Fear Rivers Project. The areas to be protected by POD and/or restored would be very similar to adjacent habitats and would possess most of the same sets of values and ecological functions. It is proposed that the general configuration of the restoration site would be an estuarine creek and marsh complex with the proportion of marsh to open water habitat determined during site design to maximize the habitat potential. Development of hard structure (oyster reef or rock) in selected intertidal and subtidal areas of the restoration site is proposed.

The land acquisition for POD and/or construction of the restoration site will occur concurrent with or prior to construction of navigation improvements. The ultimate degree of success of the restoration would be assessed by regular monitoring over a proposed 3 year period. Monitoring of POD lands would be limited to periodic compliance inspections. Transfer of restoration lands to an appropriate land trust or management agency would be made after monitoring indicates that success criteria are met. POD lands would be available for transfer upon acquisition.

Table 8. Proposed Plan

PROPOSED MITIGATION PLAN

Mitigation Method	Habitat Units	Acres
Enhance Primary Nursery by POD Tonys & Lagoon Cks	26.0	29.1
Restore Primary Nursery / Marsh at Disposal Island	23.6	13.1
Total	49.6	42.2

ATTACHMENT E

US FISH AND WILDLIFE SERVICE - FINAL COORDINATION ACT REPORT

FINAL ENVIRONMENTAL IMPACT STATEMENT
FOR
CAPE FEAR-NORTHEAST CAPE FEAR RIVERS
FEASIBILITY STUDY
NEW HANOVER AND BRUNSWICK COUNTIES, NORTH CAROLINA

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Raleigh Field Office
Post Office Box 33726
Raleigh, North Carolina 27636-3726

May 17, 1996

Colonel Robert J. Sperberg
District Engineer
U.S. Army Corps of Engineers
P.O. Box 1890
Wilmington, North Carolina 28402-1890

Dear Colonel Sperberg:

This constitutes the Final Fish and Wildlife Coordination Act (FWCA) Report of the U.S. Fish and Wildlife Service (Service) for the Cape Fear - Northeast Cape Fear River Comprehensive Project, New Hanover and Brunswick Counties, North Carolina. This report identifies fish and wildlife resources located in the project area and the potential impacts of the Corps' recommended project on these resources. This report constitutes the Service's report in accordance with Section 2(b) of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 - 667d) and is provided in accordance with our Transfer Funding Agreement and Scope of Work.

The draft of this report was issued by the Service on February 23, 1996. The draft was sent to State and Federal resource agencies for their review and comments. These agencies included: the National Marine Fisheries Service, the U. S. Environmental Protection Agency, the Service's Southeast Fisheries Resource Coordination Office, the Service's Southeast Regional Office, the North Carolina Wildlife Resources Commission (NCWRC), the North Carolina Division of Coastal Management, the North Carolina Division of Marine Fisheries, the North Carolina Division of Environmental Management, the North Carolina Division of Water Resources, and the North Carolina Natural Heritage Program. All comments received from these agencies were considered in the preparation of this final report. A copy of the letter of concurrence from the NCWRC is enclosed.

This un-bound version is supplied to you in the interest of expediting delivery of the final report. We will provide a bound copy next week when the report is returned from printing.

The Service appreciates this opportunity to provide this report. If you have any questions or comments on this report, please contact Howard Hall at 919-856-4520, ext. 27.

Sincerely,

Tom Auspurger
Acting Field Supervisor

FILE COPY

North Carolina Wildlife Resources Commission

512 N. Salisbury Street, Raleigh, North Carolina 27604-1188, 919-733-3391
Charles R. Fullwood, Executive Director

MEMORANDUM

TO: Cherry Green, Acting Supervisor
U.S. Fish and Wildlife Service

FROM: Franklin T. McBride, Manager
Habitat Conservation Program

DATE: March 29, 1996

SUBJECT: Comments on Draft Fish and Wildlife Coordination Act Report for the Cape Fear-Northeast Cape Fear Rivers Comprehensive Study. Brunswick and New Hanover Counties, North Carolina.

Staff biologists with the North Carolina Wildlife Resources Commission have reviewed the subject Fish and Wildlife Coordination Act Report and are familiar with habitat values associated with the proposed project area Our comments are provided in accordance with provisions the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et. seq.).

We concur with the findings as presented in the Draft Fish and Wildlife Coordination Act Report for the Cape Fear-Northeast Cape Fear Rivers Comprehensive Study.

Thank you for the opportunity to review and comment on this project. If you have any questions, please contact me at (919) 528-9886.

CAPE FEAR-NORTHEAST CAPE FEAR RIVERS

COMPREHENSIVE STUDY, NEW HANOVER AND BRUNSWICK

COUNTIES, NORTH CAROLINA

FINAL FISH AND WILDLIFE COORDINATION ACT REPORT

Prepared by
Howard F. Hall

Under the Supervision of
John M. Hefner
Supervisor

Released by
U. S. Fish and Wildlife Service, Raleigh Field Office
Raleigh, North Carolina

May 1996

EXECUTIVE SUMMARY

Wilmington Harbor is a Federal navigation project which extends from the Atlantic Ocean up the Cape Fear River to points above the City of Wilmington on both the Cape Fear and Northeast Cape Fear Rivers. The State of North Carolina operates a port facility in Wilmington. Local interests expressed concern that existing channel depths are not adequate for ships calling at the port. Current channel depths require some shippers to light-load vessels and wait for tidal advantage to enter the port. Due to these depth constraints, shipping costs are increasing. In order to address these issues, the Committee on Public Works and Transportation, U. S. House of Representatives, authorized a study to investigate the feasibility of improving Wilmington Harbor on September 8, 1988. In response to this authorization, the Wilmington District, U. S. Army Corps of Engineers (Corps) undertook studies on modifications to the navigation project.

The involvement of the Service in this study is in response to a Congressional mandate through the Fish and Wildlife Coordination Act (FWCA), amended (48 Stat. 40; 16 U.S.C. 661 - 667d) which directs that the conservation of fish and wildlife resources shall receive full and equal consideration and be coordinated with other features of Federal projects. This Fish and Wildlife Coordination Act Report is provided under authority of Section 2(b) of the FWCA. This report identifies fish and wildlife resources located in the project area, the potential effect of the proposed project on these resources, and provides recommendations to avoid and/or minimize adverse impacts. This report should be considered in the Corps' planning process. This report constitutes the formal report of the Service under Section 2(b) of that Act. In addition to fulfilling responsibility under the Fish and Wildlife Coordination Act, this report also fulfills the Service's responsibility in accordance with Section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531-1543).

The existing Federal project consists of a channel 40 feet deep and 500 feet wide from the Atlantic Ocean through the ocean bar (Baldhead Shoal and Smith Island Channels) and entrance channels (Baldhead-Caswell, Southport, and Battery Island Channels). However, the authorized depth has not been achieved in the ocean bar channel due to dredging inaccuracies and rock obstructions. In the main river channel from Lower Swash Channel to the Cape Fear Memorial Bridge in Wilmington the authorized channel is 38 feet deep and 400-feet-wide. From the Cape Fear Memorial Bridge to the Hilton Railroad Bridge over the Northeast Cape Fear River the authorized channel is 32 feet deep and 400 feet wide. From the Hilton Railroad Bridge to a point 1.7 miles up the Northeast Cape Fear the authorized channel is 25 feet deep and 200 feet wide.

The Corps identified the principal navigation problem at the Port of Wilmington to be inadequate depths across the ocean bar and in the river channel to Wilmington. Benefits which would accrue from the deepening of Wilmington Harbor include reductions in light-loading of vessels and vessel delays. The Corps' 1991 Reconnaissance Report proposed channel modifications for three sections of the shipping channel. From the ocean bar to the State Port depths of 40, 42, and 44 feet were considered, with additional depth across the ocean bar and entrance channels. From the Cape Fear Memorial Bridge to the Hilton Railroad Bridge a 40-foot channel was the only alternative considered. From the Hilton Railroad Bridge upstream to the limits of the Federal navigation project on the Northeast Cape Fear River depths of 30, 35, and 38 feet were considered.

Since the May 1991 Reconnaissance Report project alternatives were modified. Project alternatives in the Preliminary Environmental Impact Statement released in January 1996 include three design alternatives for three sections of the ship channel. For all dredging alternatives, proposed depths would include 2 feet of allowable overdepth in non-rock areas and 1 foot of required overdepth plus an additional 2 feet of allowable overdepth in rock areas. All alternatives would widen the turning basin at the upper end of the project near Arcadian from 700 to 800 feet. The 1200-foot wide Anchorage Basin adjacent to the State Port would be extended north 300 feet. All alternatives assume that the project features associated with the Wilmington Harbor-Northeast Cape Fear River Project and the Wilmington Harbor Channel Widening Project will be constructed. The total length of the project would be approximately 35 miles. The construction period for the entire project would be about 3 years.

The three sections considered in the Preliminary EIS are: (1) from the ocean bar and entrance channels to the upstream end of Battery Island Channel; (2) from Lower Swash Channel to approximately the Cape Fear Memorial Bridge; and, (3) from the Chemserve facility to the Arcadian Plant. Current plans omit changes from the Cape Fear Memorial Bridge to the Chemserve facility just north of the Hilton Railroad Bridge.

The first designs alternative (Plan 1) presented in the Preliminary EIS would dredge the channel 2 feet deeper from the ocean bar through the Memorial Bridge inclusive (40 to 42 feet from Baldhead Shoal to Battery Island Channel and 38 to 40 feet from Lower Swash through the Memorial Bridge). From 750 feet above the Hilton Railroad Bridge to the turning basin at the upper end of the project at Arcadian, the channel would be deepened by 5 feet (25 to 30 feet). The total volume of excavated material associated with this project is about 6,154,136 cubic yards including about 1,687,000 cubic yards of rock. About 187,000 cubic yards of this rock will require blasting

The second alternative (Plan 2) would dredge the channel 4 feet deeper from the ocean bar through the Memorial Bridge inclusive (40 to 44 feet from Baldhead Shoal to Battery Island Channel and 38 to 42 feet from Lower Swash through the Memorial Bridge). From 750 feet above the Hilton Railroad Bridge to the turning basin at the upper end of the project at Arcadian, the channel would be deepened by 9 feet (25 to 34 feet). The total volume of excavated material associated with this project is about 12,825,000 cubic yards including about 3,423,000 cubic yards of rock. About 564,000 cubic yards of this rock will require blasting.

The third alternative (Plan 3) would dredge the channel 6 feet deeper from the ocean bar through the Memorial Bridge inclusive (40 to 46 feet from Baldhead Shoal to Battery Island Channel and 38 to 44 feet from Lower Swash through the Memorial Bridge). From 750 feet above the Hilton Railroad Bridge to the turning basin at the upper end of the project at Arcadian, the channel would be deepened by 9 feet (25 to 34 feet). The total volume of excavated material associated with this project is about 21,723,000 cubic yards including about 6,485,000 cubic yards of rock. About 5,786,000 cubic yards would require blasting.

The build alternatives and the no-action alternative were evaluated with the understanding that each incremental increase in channel depth would allow larger, more efficient ships to enter the Port of Wilmington. The Corps determined that Plan 2 would maximize net economic benefits. Accordingly, this plan is designated the National Economic Development (NED) Plan. Under current Federal planning policy, the NED plan will be recommended for implementation unless there are overriding considerations which favor recommendation of another plan. Environmental impacts associated with a shallower depth (Plan 1) would be less than those associated with the NED plan, but the Corps has determined that the lesser impacts of Plan 1 are not sufficient to justify recommendation of this plan instead of the NED Plan. Therefore, the NED Plan, Plan 2, has been recommended for implementation.

Excavation methods include the use of hydraulic pipeline dredges, bucket and barge dredges, and hopper dredges. Sediment removed in the northern areas would be placed the existing, upland confined disposal facility (CDF) on Eagle island. Sediment removed in the southern areas would be placed at the Ocean Dredged Material Disposal Site (ODMDS). Dredging by bucket and barge in the river, hopper dredging in the lower river and ocean, and rock dredging in the ocean would be conducted throughout the year.

The Preliminary EIS proposed several options to the disposal plan outlined above. These options are placement in: (1) the littoral zone off Brunswick County Beaches or Baldhead Island; (2) islands used for nesting by colonial waterbirds; and/or, (3) the estuary to create wetlands. These options will be investigated in Preliminary Engineering and Design Studies.

Wherever possible, rock would be removed by a cutterhead dredge. In areas where the rock is too hard for conventional dredging, the project would require blasting. The Corps predicts that blasting would be required in portions of the area from Keg Island Channel upstream to the Cape Fear Memorial Bridge. Plan 2 may require 558 blasts to remove 564,000 cubic yards of rock.

The preliminary blast plan developed by the Corps reflects industry standards for underwater blasting. Blasting would be conducted with charges arranged in frames. A bubble curtain and/or a physical barrier would be placed completely around the blast area. From Upper Big Island Channel to the upstream limit of the project, rock debris from both dredging and blasting would be removed by pipeline dredge and pumped to Eagle Island. Downstream from Lower Big Island Channel, rock debris would be removed with a bucket and barge dredge and deposited in the Wilmington Offshore Fisheries Enhancement Structure, an artificial reef project. Blasting and hydraulic pipeline dredging in the river would be restricted to the period from August 1 to January 31.

The preferred alternative would excavate approximately 13.2 acres of primary nursery area to a depth greater than 10 feet mean low water (mlw). Approximately 0.2 acre of mixed tidal marsh would be excavated. The proposed mitigation plan for the loss of primary nursery and marsh areas calls for restoration at a 2:1 ratio, or the restoration of about 27 acres of estuarine/marsh habitat.

The study area, or action area, of the proposed project is defined as the areas in the Atlantic Ocean which may be used for dredge material disposal, northward through the mouth of the Cape Fear River, up the Cape Fear River past the City of Wilmington, to points on the Cape Fear and Northeast Cape Fear Rivers and their tributaries which are currently influenced by ocean-derived salt water or could be affected by an increase in salinity due to the proposed project.

The proposed project is located within the Atlantic Coastal Plain physiograghic province. Groundwater is contained in surficial sand, the Waccamaw/Bear Bluff aquifer, and the Castle Hayne aquifer. The Cape Fear River Estuary has relatively free access to the ocean which results in a significant tidal range. The sediment types in the harbor generally consist of silt, sandy silt, and silty sand with some clays and peat. Shallow areas along the river may have estuarine marshes or forested wetlands. Some areas within the project area have been designated as primary nursery areas.

The major concerns of the Service center on potential adverse impacts to marine and estuarine food chains, degradation of fisheries resources, loss of tidal freshwater habitats, loss of shallow water estuarine area, loss of sea turtle nesting habitat, and the direct mortality of Federally-threatened and endangered species during construction. In light of these concerns, the Service proposes the following planning objectives for this project:

1. To maintain and enhance, where possible, existing water quality within the project area and adjacent waters of the Cape Fear and Northeast Cape Fear Rivers, including designated primary and secondary nursery areas.

2. To maintain and enhance, where possible, the quality and quantity of all existing marine, estuarine, and freshwater communities in the project area.

3. To assess the cumulative impacts of all past, ongoing, and reasonably foreseeable future channel modifications from a perspective of mitigating any adverse environmental impacts to such valuable fish and wildlife habitats as forested wetlands, emergent wetlands, shallow estuarine waters, and tidal flats.

The area for the proposed navigation improvement project will involve a variety of habitat types, but predominantly consists of open water and estuarine, unconsolidated, subtidal bottoms. Other habitat types in the project area include: (1) estuarine, intertidal, emergent wetlands; (2) estuarine, intertidal, unconsolidated mud flats; and, (3) estuarine, forested wetlands. Freshwater wetland habitats include emergent marshes, scrub-shrub areas, and forests. Habitat is also provided by upland islands formed by the disposal of dredged material.

The project areas support a diverse assemblage of terrestrial and aquatic invertebrates. Fisheries resources include resident, anadromous, and catadromous species. The project area provides important habitat for many species of amphibians, reptiles, birds, mammals. Several Federally-protected species are known to occur in the project area including the shortnose sturgeon, West Indian manatee, sea turtles, and marine mammals.

Future abundance, quality, and diversity of the study area's fish and wildlife resources will be largely determined by management activities of Federal, State, County, and local regulatory agencies within the study area and within the larger area of the Cape Fear River watershed. In the absence of the proposed project routine dredging of the existing channel would continue. While such work would create short-term decline in water quality, the long-term adverse impacts would be relatively minor.

The potential, adverse, environmental impacts of the preferred alternative may be either direct, indirect (secondary), and cumulative adverse impacts. In addition to adverse impacts, there are opportunities for the proposed project to produce some beneficial environmental impacts.

Potential, direct impacts include: (1) injury or death due to increased turbidity and sedimentation during dredging; (2) injury or death to marine organisms due to dumping at the offshore disposal site; (3) loss of nesting habitat due to improper disposal at inland sites; (4) release of toxic substances during dredging; (5) the placement of contaminated sediment in both offshore and inland disposal area; (6) direct mortality of aquatic organisms during routine dredging; and, (7) direct mortality during blasting.

Potential, indirect impacts include: (1) loss of biological productivity due to losses in shallow water habitat; (2) increased erosion of riverine shoreline due to larger wakes from larger ships; (3) increased beach erosion due to disruption of the longshore transport system for sand; (4) salt water intrusion into groundwater supplies; (5) increased salt water intrusion into surface freshwater ecosystems; and, (6) direct mortality and habitat degradation due to accidents involving larger ships.

Potential cumulative impacts include long-term decline of the quality and/or quantity of fish and wildlife habitat in the region. The Service is concerned about the cumulative nature of the six indirect impacts when each is considered on a statewide basis.

Potential beneficial impacts include: (1) the use of contaminant-free sediment to maintain sea turtle nesting habitat on area beaches; (2) the use of sediment to provide nesting habitat for colonial nesting waterbirds; (3) the use of suitable rock to create offshore, artificial reefs; and (4) the acquisition of conservation lands which were originally approved as part of construction associated with the Wilmington Harbor Project.

Many of the direct adverse impacts of the proposed project cannot be completely avoided. While many of these direct impacts may have significant, short-term detrimental effects on the fish and wildlife resources, indirect, long-term impacts are potentially the most harmful. In general the most serious impacts include the permanent loss of important habitats and the start of a long-term decline in habitat quality. Therefore, the conservation measures should focus on ways: (1) to minimize short-term, direct impacts; (2) avoid long-term loss and degradation of habitat; and, (3) promote those actions which will benefit fish and wildlife resources.

The increased turbidity associated with the removal of soft sediment cannot be completely avoided. However, it is possible to ensure that dredging does not introduce toxic substances into the aquatic environmental. A comprehensive, toxicological testing program from a sample of all regions of project area would determine the safety of dredge material for offshore or upland disposal. The Corps should employ any available technology which allow disposal crews to detect the presence of marine mammals at the offshore disposal site in order to avoid harm to the species during offshore disposal. Inland disposal of material should be conducted at a time and in a manner which does not harm nesting colonial waterbirds. The Service believes that routine dredging is compatible with the presence of manatees, if certain precautions are implemented. The Service's manatee coordinator has prepared a list of standard conditions for work in areas where manatees may be present. These conditions should be employed to minimize potential harm to manatees.

The Service believes that a comprehensive blasting program which incorporates multiple layers of protection can significantly minimize harm to the aquatic resources in the project area. The major elements of the blast plan should include:

1. Specific procedures to ensure that blasting is used only as a last resort to remove nondredgeable rock;

2. If blasting is required, it should be limited to a specific time of year which minimizes risk to whales, dolphins, manatees, sea turtles, and important fisheries resources;

3. Within the designated blasting period, the selection of explosives and blasting techniques, such as stemming holes and delays between individual charges, should be used to minimize the production of harmful shock waves;

4. Pre- and post-blast monitoring plans should be implemented;

5. The Corps should use all practical methods, such as the use of small, pre-blast detonations, to induce important, mobile aquatic organisms to leave the blast area; and,

6. The Corps should also employ additional techniques, such as bubble curtains and physical barriers, to contain blasting impacts to the smallest possible area.

In order to avoid the permanent loss of valuable estuarine habitat, the Corps should provide in-kind compensation in the immediate vicinity of the areas lost. Compensation could be in the form of either restoring a degraded wetland or the creation of a wetland area. If compensation is required, the Corps should develop a comprehensive mitigation plan which describes all aspects of the mitigation effort.

In order to avoid long-term damage to riparian habitats, the Corps should make a thorough assessment of the affects which traffic by larger ships would have of the riparian area of the lower Cape Fear and Northeast Cape Fear Rivers. Part of this assessment should be proposals to rectify any loss in the quantity and quality of riparian habitats which are produced by this project.

In order to avoid long-term degradation of sea turtle nesting habitat, the Corps should make a thorough assessment of project impacts on the longshore transport system and the indirect impacts on beaches adjacent to the mouth of the Cape Fear River. Part of this assessment should be proposals to rectify any loss of beach area which are produced by this project.

In the absence of the Corps' final assessment of potential impacts to groundwater supplies, the Service believes that the most important fish and wildlife conservation measure pertaining to groundwater supplies is the completion of the Wilmington Harbor Groundwater Study. The Service hopes that this report will be truly comprehensive and look beyond existing conditions by fully evaluating such factors as increased withdrawal from existing supplies as development continues in the project area. The Corps' Summary of Benefits and Costs used a 50-year period of analysis. Therefore, the Service would expect the Corps to use all available data and best projection techniques to predict salinity levels in regional aquifers during the period of 2045-2050. The Service would also expect this report to address the measures which would be taken to supply freshwater to area homes and businesses in event that optimistic model predictions proved incorrect.

Major fish and wildlife conservation measures regarding saltwater intrusion into surface water ecosystems are: (1) completion of computer simulations for salinities changes in the project area; (2) issuance of a written report on the computer model which could be reviewed by State and Federal resource agencies as well outside experts; (3) the development of a post-construction monitoring plan to fully assess the actual long-term impacts of the project on salt water intrusion; and (4) the development of a mitigation plan which would compensate for any freshwater wetlands which are lost as a result of salinity caused by the project.

The conservation measures regarding the risk of accidental spills involve an adequate emergency response infrastructure and an assurance that companies which use the enlarged channel are financially prepared to clean up any spill for which they are judged to be liable.

The primary fish and wildlife conservation measure in regard to the cumulative impacts of the project would be an assessment of project impacts in the context of all alterations which are currently affecting North Carolina's estuarine ecosystems as well as additional alterations which can be reasonably expected to impact these ecosystems in the foreseeable future.

The proposed project presents opportunities to create beneficial impacts. The placement of beach quality sand in the littoral zone of Brunswick County could serve to reduce the loss of beaches which are used as sea turtle nesting sites. The proper disposal of soft sediment on existing disposal islands could enhance nesting habitat for colonial waterbirds. As a fisheries enhancement measure, dredged rock may be used to create artificial reefs which benefit marine fish species. While currently proposed blasting may result in rock rubble which is to small for reef creation, the Corps should monitor the size and other characteristics of the rubble produced in this project. If suitable material is produced by the project, the Corps should evaluate the use of this material for artificial reef creation in close cooperation with the NMFS or the North Carolina Division of Marine Fisheries.

The Service continues to believe that the fish and wildlife resources of the lower Cape Fear River watershed would benefit from the acquisition of the 2,800 acre conservation area that was authorized in 1967. The Service has stated that without protection these relatively undeveloped areas would be subject to "imminent threat due to commercial development, timber harvest and other uses." The wetlands along the Northeast Cape Fear River function to control floods, increase water quality, provide recreational opportunities, and support the valuable fish and wildlife resources of the area.

The Service recommends that the following fish and wildlife conservation measures be incorporated into the planning process of the proposed project.

In order to avoid or minimize direct, adverse impacts resulting from the proposed project the Service recommends that:

1. The Corps should use all available construction techniques to avoid or minimize the creation of excessive turbidity during dredging operations.

2. The Corps should have sufficient bioassay and bioaccumulation data from sediment of representative areas throughout the project area to ensure that the project will not produce a significant toxicological risk to organisms at the dredging site, any offshore disposal areas, or any inland disposal areas. The Corps should develop plans for the special handling and disposal of contaminated sediment, if such sediment must be dredged.

3. The Corps should plan construction in a manner which will avoid or minimize adverse impacts to fisheries resources, sea turtles, and marine mammals due to the offshore disposal of dredge material. These plans should incorporate all reasonable technology which would detect species of concern in the immediate disposal area and procedures to delay disposal, if necessary.

4. The Corps should not dispose of dredge material in inland disposal sites in a manner which would be harmful to nesting by colonial waterbirds.

5. The Corps should use all feasible design features and construction techniques to minimize direct harm or death to animals during routine dredging of soft sediment. Dredging personnel should watch for sea turtles and manatees during all periods of warm weather and cease operations if these species are seen in the immediate vicinity of construction activities. The standard manatee conditions should be strictly enforced during the most likely period of manatee presence, June through September.

6. Project contracts should state clearly that blasting will not be authorized until data are supplied to the Corps which verify that rock cannot be removed with a cutterhead dredge. If it is determined that blasting is required, the following procedures should be implemented:

    a. All blasting should be limited to the time of year with the lowest biological activity. Current plans to protect fisheries resources limit blasting to the six-month period from August 1 through January 31. The Service supports this effort to protect fish in the project area. However, the Service is very concerned about possible mortality among manatees which are most common in the area from June through September. The Service is also concerned about harm to sea turtles which are most abundant in the lower Cape Fear from April through September. Therefore, the Service recommends that blasting be limited to the four-month period from October 1 through January 31 of any year, a period of 123 days. With proper planning, the Service believes that the estimated 558 blasts over a period of three years could be accomplished within an annual, four-month blasting period. This procedure would allow a total of 12 months for blasting over the proposed three year construction period. Sufficient personnel would allow for multiple blasts during a single day within the blast period.

    b. The type of explosives used and the blast plan selected should be those which can be expected to produce the least harm to aquatic organisms. The Service supports the use of stemming and delays between each charge. The Service recommends that delays in the range of 0.9 to 1.0 second to be used to further minimize adverse shock waves. Since low velocity explosives produce shock waves with lower peak pressure, explosives with the lowest velocity consistent with achieving project goals should be used.

c. The Corps should develop pre-blast procedures which fully utilize existing biological data on species likely to be present near the blast site and the danger or safety zones for these species. Pre-blast procedures should include: 1) a determination of significant species, including all Federally-listed species, which may occur in the project area during blasting and the Corps is committed to protecting from any blasting impacts; (2) a method to calculate a danger zone for the designated significant species; (3) the determination of an adequate buffer zone to add to the calculated danger zone in order to create a larger safety zone; (4) a surveillance plan to detect the significant species within their respective safety zones; (5) procedures, such as detonation of small pre-blast, which may cause significant species to leave the blasting area; and, (6) an effective procedure to halt blasting if significant species are detected within their safety zone. The Corps should specifically address blasting impacts on early life stages of fish in the project area.

d. A comprehensive post-blasting monitoring plan should be developed and implemented so that the number of organisms by species killed by the blasts can be determined. The monitoring plan should be developed in coordination with the Service, the North Carolina Division of Marine Fisheries, and the National Marine Fisheries Service. The plan should involve surveying the blast impact area by boat and counting and identifying dead or injured organisms which float to the surface. Although all dead organisms may not float to the surface immediately, this method should give an indication of the extent of the impacts to finfish and other organisms. Part of post-blast monitoring should include sampling of the river bottom. These data should be complied in an annual report and supplied to State and Federal resource agencies.

e. The Service supports the use of bubble curtains and/or physical barrier to exclude animals and absorb shock waves. However, in the absence of specific data on the protective value of these devices for the species of concern and the conditions present in the Cape Fear River, these protective devices should be used in conjunction with other protective measures, particularly a careful consideration of limiting blasting to the time of year with low biological activity. During early blasts, the safety zone to be surveyed should not assume any protective value for the bubble curtain. If field data should show that shock waves are contained by the curtain, the surveillance zone may be reduced.

f. In addition to the protective measures recommended above, if blasting will occur during a time of year when species protected by either the Endangered Species Act or the Marine Mammal Protection Act may be in the project area, the Corps should use the best available data and models to calculate danger and safety zones for these species. The radius of this danger zone could be based on a calculated radius at which very low mortality, such as 1% (LD_1), would be produced. The radii of danger zones for Federally-listed species should be increased by an appropriate buffer area to create a safety zone. All protective measures for Federally-listed species should be based upon the larger, safety zone.

g. Based on data regarding the species which may be present in the project area during blasting and calculations on the size of danger and safety zones, project plans should include measures to exclude species of concern from the blast zone. The Service developed a "manatee watch plan" to protect manatees at a Florida construction site which required blasting (Appendix C) which may serve as a model for the proposed project if blasting is scheduled during the period, June through September, when manatees are most likely to be in the Cape Fear River.

In order to avoid or minimize indirect, adverse impacts resulting from the proposed project the Service recommends that:

7. The Corps should ensure that the project does not result in a permanent loss of primary nursery areas. These highly productive, shallow water areas contain organisms which form the base for important estuarine food chains. Construction for the project should either avoid these areas or in-kind compensatory mitigation should be provided in the immediate vicinity of the areas lost. If compensation is required, the Corps should develop a comprehensive mitigation plan which describes the functions and values of the areas lost, the manner in which these functions and values will be

replaced, details for restoring or creating the mitigation site, success criteria for various time periods of the mitigation effort, and the long-term plan for the protection of the mitigation area. If shallow water wetlands are created from spoil disposal islands, the Corps should ensure that there is no loss of nesting habitat for colonial waterbirds.

8. The Corps should fully assess the potential for an increase in erosion along riparian area in the project area which will be subject to the impacts of wakes from larger ships. If this assessment indicates that shoreline erosion is likely to increase as a long-term impact of the project, the Corps should present a plan to mitigate this damage and ensure the continued existence of the important biological communities in these areas.

9. The Corps should fully assess the potential impacts of the proposed project on the longshore sediment transport system. This assessment should either present evidence that the proposed project will not adversely affect beaches on either side of the mouth of the Cape Fear River or present a plan to mitigate the consequences of the project on area beaches. The Corps should consider the feasibility of placing all beach quality sand within the littoral zone of the project area.

10. The Corps should complete the planned assessment of potential impacts of the project on groundwater resources in the lower Cape Fear River watershed. This assessment should look beyond current conditions in which pressure within the aquifer seems sufficient to exclude saltwater and consider the consequences of increased groundwater withdrawals which will result from increased development in the area. In particular, the assessment should give an evaluation of groundwater conditions for 50 years after project construction, a time period used to calculate the economic benefits of channel modifications. This assessment should consider a "worst-case" scenario and evaluate the impacts associated with constructing facilities to replace water which was previously withdrawn from aquifers and possible sources of freshwater which would replace existing groundwater resources. All costs associated with replacing existing groundwater resources should be completely evaluated in the benefit-cost analysis of the project.

11. The Corps should complete the current modeling effort on the potential for increased saltwater intrusion as a result of the proposed channel modifications. On the completion of this effort, the Corps should release a written report on the saltwater intrusion model which contains a detailed description of field data which were used in the model and

data collection procedures. This report should also include all major assumptions and mathematical relationships which were used in the model. This report should be made available to all State and Federal resource agencies for both internal review and submission to independent experts for evaluation.

In the absence of sufficient data to predict the actual effect of the project on the intrusion of saltwater into surface water, the Corps should develop a long-term program to monitor actual changes in both salinity and riparian vegetation. Permanent sampling stations should be established for sampling water, vegetation, and animal communities. The Corps should also develop a general plan for remedial action in the event that a significant increase in saltwater intrusions occurs.

12. The Corps should ensure that the operation and maintenance plan of the proposed project includes: (1) enforceable measures to minimize the risk of shipping accidents; (2) a permanent, fully funded emergency response plan based on the types of cargo which will be carried in the ship channel; and, (3) specific provisions to ensure that the owners of all ships using the Port of Wilmington have the financial resources to pay for any environmental cleanup for which they may be found liable.

The Service makes the following recommendations to minimize the potential cumulative effects of the proposed project:

13. The Corps should assess past, current, and anticipated construction projects in North Carolina which have had, are having, and/or will have adverse, environmental impacts on estuarine ecosystems in order to ensure that the proposed project will not contribute to a State-wide decline in either the areal extent or functions of these ecosystems.

14. The Corps should assess past, current, and anticipated construction projects in North Carolina which have had, are having, and/or will have adverse, environmental impacts on freshwater, tidal ecosystems in order to ensure that the proposed project will not contribute to a State-wide decline in either the areal extent or functions of these ecosystems.

The Service recommends the following actions to benefit and enhance the fish and wildlife resources in the project area:

15. The Corps should assess the feasibility of disposing of beach quality sand in a manner and at a location which would benefit nesting habitat for sea turtles.

16. If material removed during project construction is suitable for disposal on colonial waterbird nesting islands in the

lower Cape Fear River, the Corps should place this material, as needed for habitat improvement, on colonial waterbird nesting islands in the area, as they have done in the past. The Corps, in accordance with the 1988 Cooperative Agreement to implement the State-wide Colonial Waterbird Management Plan, should continue to coordinate such activities with the North Carolina Colonial Waterbird Management Committee to develop a plan for the beneficial disposal of this material.

17. The Corps should implement the current proposal for using rock removed from the channel for artificial reef creation in close cooperation with the National Marine Fisheries Service or the North Carolina Division of Marine Fisheries. However, only material which is of appropriate size and is free of contaminants should be used for artificial reef creation.

18. The Corps should make every effort to "reschedule" and pursue the acquisition of the 2,800-acre tract of conservation lands along the Northeast Cape Fear River. This acquisition was an original element in the Wilmington Harbor-Northeast Cape Fear River Project, but this effort to preserve important wetlands and river bluffs along the lower Northeast Cape Fear River was subsequently designated as "unscheduled."

The large construction effort needed to accomplish the preferred alternative has the potential to create significant direct, indirect, and/or cumulative adverse, environmental impacts. Some of these impacts could significantly alter the diverse ecosystems of the lower Cape Fear River watershed. However, the Service believes that a thorough consideration of the environment during planning can avoid many of the most severe impacts and minimize others.

If all sediment removed is free of contaminants and all recommended precautions are employed during blasting, the Service believes that most direct impacts associated with construction will be short-term and rectified in time. Blasting impacts may be avoided or minimized by a comprehensive program to restrict the use of blasting, the use of seasonal restrictions on blasting, the proper selection of equipment and blasting procedures, monitoring programs, and programs to contain blast impacts and halt blasting if important resources are detected within scientifically-based, predetermined danger/safety zones.

The Service is more concerned about the long-term, secondary impacts of the proposed project. These concerns are based, in part, on the fact that several of the Corps' efforts to evaluate these impacts have not been completed. Efforts to evaluate saltwater intrusions into surface water and groundwater have not been completed. There are no current evaluations on the potential impacts to riparian shorelines, the longshore transport system which influences area beaches, and the risk of accidents in the enlarged channel. The Service strongly recommends that the Corps fully evaluate all potential, indirect impacts which may be produced by the project, develop long-term monitoring programs where major uncertainties exist, and plan remediation measures for a "worst-case" scenario of each potential impact.

In summary, the Service has provided recommendations which, in our opinion, will: (1) eliminate, or minimize, most short-term, direct impacts; (2) generate information on potential indirect impacts which are now poorly understood; (3) define those elements of the environment which are susceptible to long-term degradation and which require monitoring and contingency planning for possible remedial actions; and, (4) designate actions which could benefit the natural resources of the project area. If the Corps implements each of these recommendations, the Service believes that the proposed project is compatible with the long-term viability of marine, estuarine, and freshwater ecosystems in the project area and the many important fish and wildlife resources which they support.

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INTRODUCTION

Purpose, Scope, and Authority

Wilmington Harbor is a Federal navigation project located along the Cape Fear and Northeast Cape Fear Rivers in southeastern North Carolina. The Federal navigation project extends from the Cape Fear River Ocean Bar to a point 1.7 miles above Hilton Railroad Bridge on the Northeast Cape Fear River (Figure 1). The total length of the Wilmington Harbor project is approximately 35 miles. Depths and widths have been increased incrementally in the ship channel for over 100 years. However, existing channel depths are not adequate for the fleet now calling at the Port of Wilmington. As a result, shippers are required to light-load vessels and wait for tidal advantage to enter the port. Due to these depth constraints, shipping costs are increasing.

In order to address these issues, the Committee on Public Works and Transportation, U. S. House of Representatives, authorized a study to investigate the feasibility of improving Wilmington Harbor on September 8, 1988. In response to this authorization, the Wilmington District, U. S. Army Corps of Engineers (Corps) undertook studies on improvements to the harbor.

This Fish and Wildlife Coordination Act (FWCA) Report is provided under authority of Section 2(b) of the Fish and Wildlife Coordination Act, as amended (48 Stat. 40; 16 U.S.C. 661 - 667d) and should be considered in the Corps' planning process for this project. This report constitutes the formal report of the U. S. Fish and Wildlife Service (Service) under Section 2(b) of that Act. In addition to fulfilling our responsibility under the Fish and Wildlife Coordination Act, this report also fulfills the Service's responsibility in accordance with Section 7 of the Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. 1531-1543).

The purpose of this report is to describe the fish and wildlife resources within the study area, assess the potential impacts to these resources, discuss fish and wildlife resource problems and conservation opportunities, and recommend measures to conserve fish and wildlife resources.

Prior Studies

For many years the Service has reviewed and commented on projects which altered the Wilmington ship channel in order to accommodate larger vessels and expedite ship traffic from the Atlantic Ocean to the various port facilities along the Cape Fear River. The Service has also provided fish and wildlife conservation recommendations on the routine maintenance of the ship channel and projects related to the disposal of dredge material. The most significant recent projects will be given in this section

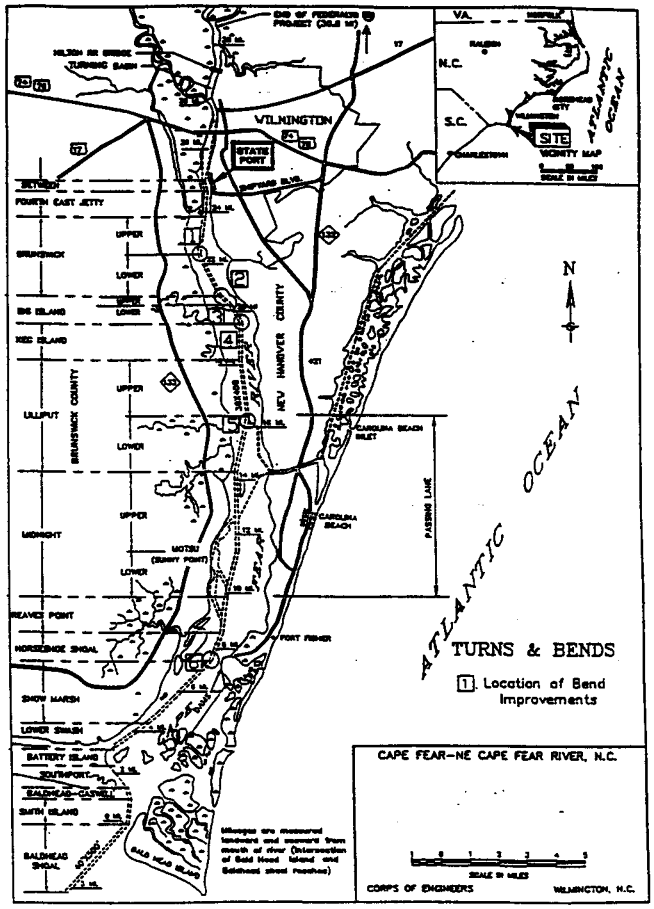

Figure 1. General location of the proposed project for the Improvement of Navigation, Cape Fear-Northeast Cape Fear River Comprehensive Study, Brunswick and New Hanover Counties, North Carolina. The figure gives the name of individual channels within the Wilmington Harbor Ship Channel and shows the location of the proposed passing lane and numbered turns, some of which will be widened as part of separate project on channel modification. Source: Wilmington District, U. S. Army Corps of Engineers.

and the reports cited and the citations they contain may be examined for more detailed data.

Offshore Disposal Area - Some dredge material from the current project would be deposited offshore in either the Wilmington Offshore Dredged Material Disposal Site (ODMDS) or the Wilmington Offshore Fisheries Enhancement Structure (WOFES) (Figure 2). The Wilmington ODMDS has been approved for dredged material disposal (U. S. Environmental Protection Agency 1983). The Corps has released an Environmental Assessment (EA)(U. S. Army Corps of Engineers [hereafter USACOE] 1994b) and Finding of No Significant Impact (USACOE 1994c) for the WOFES.

Wilmington Harbor-Ocean Bar Project - A project related to ship traffic in the Wilmington ship channel involved work on the Ocean Bar Channel beyond the mouth of the Cape Fear River. The Ocean Bar Channel consists of two smaller reaches designated as the Bald Head Shoal Channel and the Smith Island Channel (Figure 1).

Between 1968 and 1973, the Ocean Bar Channel was widened and deepened. Although a depth of 40 feet was authorized, unanticipated rock was encountered which prevented deepening beyond 38.5 feet. An inaccurate tide gage led the Corps to believe the channel was actually 40 feet deep. When the tide gage was replaced in 1991, the actual depth was determined to be 38.5 feet. Due to rapid shoaling in the area, the current depth of 38.5 feet was available only 50 percent of the year, and approximately 1 foot less was available during the rest of the year. Vessels require approximately 2 feet more clearance in the Ocean Bar Channel than in the river channels due to wave action. The North Carolina State Port Authority and vessel pilots requested a deeper Ocean Bar Channel in order to avoid rock outcrops and improved the overall efficiency of navigation through Wilmington Harbor.

The Corps issued a Final Reevaluation Report for the Wilmington Harbor Ocean Bar Channel Deepening Project which concluded that the improvements were economically feasible and could be implemented without additional Congressional authorization (USACOE 1991c). The Corps later released several descriptions of the project (USACOE 1993b, 1993c). The Corps prepared an EA for the project (USACOE 1993d). The Service issued Draft and Final FWCA Reports on channel deepening in the Ocean Bar Channel (USFWS 1993a, 1993c).

This project is presently under construction. Project plans call for deepening the channel to its authorized depth of 40 feet plus 2 feet of allowable overdepth to account for dredging inconsistencies and an additional 1 foot of overdepth in areas underlain by rock. Thus, the channel will be deepened to a maximum depth of 42 feet in areas of soft sediment bottoms and a maximum of 43 feet in areas where rock is present.

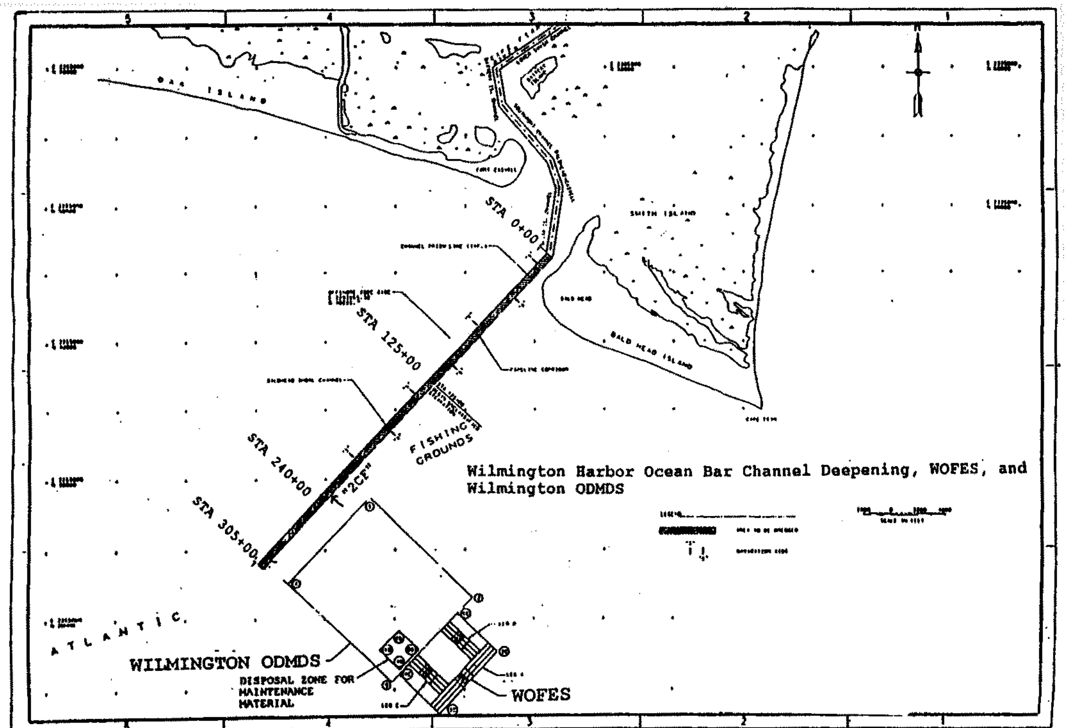

Figure 2. Location of the Wilmington Offshore Dredged Material Disposal Site (ODMDS) and the adjoining Wilmington Offshore Fisheries Enhancement Structure (WOFES). The Wilmington ODMDS is a proposed disposal site for soft sediment, and the WOFES is a proposed disposal site for dredged rock. Source: Wilmington District, U. S. Army Corps of Engineers.

Wilmington Channel Widening Project. This project was originally considered as two separate actions. These actions were the Wilmington Harbor Turns and Bends Project which involved the widening of six channel turns and bends (USACOE 1989a, USACOE 1990a, USFWS 1988b, USFWS 1989, and USFWS 1991) and the Wilmington Harbor Passing Lane Project which involved the creation of a passing lane about midway between the mouth of the Cape Fear River and the Port of Wilmington (USACOE 1988, USFWS 1988a, USFWS 1990a, USFWS 1990b).

Subsequent to these early planning efforts, the Corps consolidated the Passing Lane Project and the Turns and Bends Project into a single project designated as the Wilmington Harbor Channel Widening Project (hereafter referred to as the Channel Widening Project). The Corps prepared a Preliminary Draft EIS for this work (USACOE 1992). The Service issued a Draft FWCA Report on this project (USFWS 1993b) and the Corps released a Draft Interim Feasibility Report and Environmental Impact Statement (EIS) (USACOE 1993e). The Service issued a Final FWCA Report on the Channel Widening Project (USFWS 1993d), and the Corps released the Final Interim Feasibility Report and EIS (USACOE 1994a). In early 1995, geotechnical studies revealed that this construction might require blasting to remove nondredgeable rock. Based on this potential aspect of project construction the Service issued a supplement to the Final FWCA Report (USFWS 1995).

MOTSU - The Military Ocean Terminal, Sunny Point (MOTSU) is a military port facility designed and constructed specifically for the safe, efficient shipment of explosives, munitions, ordnance, and related material. MOTSU is located on the west bank of the Cape Fear River, approximately 10 miles upstream from the river's mouth. In response to the military transportation requirements associated with Operation Desert Storm (1990-1991), the Army requested the deepening and widening of certain channels and basins within the port.

The Corps issued an EA and Finding of No Significant Impact for the emergency construction (USACOE 1991a). However, military operations in the Persian Gulf ended before the project was implemented. The Corps prepared a Final EIS for the project (USACOE 1994d).

Wilmington Harbor-Northeast Cape Fear Project - The Wilmington Harbor-Northeast Cape Fear River project involves channel modifications in the upper reaches of Wilmington Harbor. The major features of this project are:

1. Widening the Fourth East Jetty Channel by 100 feet to the west at the existing project depth of 38 feet for a distance of 8,000 feet.

2. Deepening the navigation channel from the project depth of 32 feet to 38 feet at a width of 400 feet between the Cape Fear Memorial Bridge and the NC 133 Highway Bridge.

3. Widening the turning basin just upstream from the mouth of the Northeast Cape Fear River by 50 feet on the west side at a project depth of 38 feet.

4. Deepening the navigation channel from a project depth of 32 feet to 38 feet at a width of 300 feet from the NC 133 Bridge to the Hilton Railroad Bridge, located 2,600 feet upstream, and deepening the navigation channel from a project depth of 25 feet to 38 feet at a width of 200 feet from the Hilton Railroad Bridge to a point approximately 750 feet upstream.

This project has been the subject of two National Environmental Policy Act (NEPA) review processes. Initial project planning was addressed in a Final EIS (USACOE 1979). The Service issued a Final FWCA Report for the project (USFWS 1988c). A Final Supplement to the Final EIS was released (USACOE 1990b).

One element of the authorized project was the acquisition of 2,800 acres of conservation lands along the Northeast Cape Fear River upstream from the project limits. However, this aspect of the project became "unscheduled", still authorized but not funded. The project was later modified and alternative mitigation proposals were developed to compensate for direct wetland and primary nursery area losses. These project modifications and a new mitigation proposal were addressed in the Environmental Assessment and Finding of No Significant Impact regarding project modifications and the mitigation plan (USACOE 1993a).

Present study - The present project is part of a General Investigation Study started in 1990. The Corps has released a Reconnaissance Report (USACOE 1991b). On June 25, 1991, the Service provided the Corps with a "Summary Letter of Concerns", and on October 26, 1992 provided additional scoping comments to the Corps.

Coordination

Comments on the draft FWCA report released in February 1996 were solicited from the U. S. Environmental Protection Agency, National Marine Fisheries Service (NMFS), the Service's Fishery Resources office, the Service's Southeast Regional Office, the North Carolina Wildlife Resources Commission, the North Carolina Division of Marine Fisheries, the North Carolina Division of Environmental Management, the North Carolina Division of Coastal Management, and the North Carolina Natural Heritage Program. Comments from these agencies have been considered in the preparation of this report.

STUDY AREA DESCRIPTION

The proposed project includes a variety of distinct areas from the offshore disposal area to oligohaline waters and wetlands above Wilmington. For the purposes of this report, the study area, or action area, of the proposed project is defined as the areas in the Atlantic Ocean which may be used for dredge material disposal, northward through the mouth of the Cape Fear River, up the Cape Fear River past the City of Wilmington, to points on the Cape Fear and Northeast Cape Fear Rivers and their tributaries which are currently influenced by ocean-derived saltwater or could be affected by an increase in salinity due to the proposed project.

This section will present a broad overview of the entire project area and address the significant features of each major area, starting from the marine environment at the southern project limit and moving north to the project limit.

General Project Area

Excellent descriptions of the general project area have been given by the Corps (USACOE 1984, USACOE 1991b). The proposed project is located within the Atlantic Coast Plain physiograghic province. The coastal plain in southeastern North Carolina is relatively flat, with a gentle slope east and southeast toward the Atlantic Ocean. The coastal plain is dissected by meandering streams which have broad, swampy flood plains and low escarpments bordering the river valleys. River flood plains vary in width from slightly less than a mile to over two miles in the project area. The flood plain is low and commonly marshy, with several areas of tidal flats. A layer of distinctly organic soil, underlain by a thick sequence of mostly sandy material, underlies the floodplain. Sand is generally exposed on river bottoms in the project area. This sandy material varies in age from late Cretaceous to Holocene. The highland area just west of the flood plain consists of a series of ancient sand dunes varying in elevation from 35 to 75 feet above mean low water (mlw). To the east of the Northeast Cape Fear River flood plain, the highland area is a flat, sandy plain with an average elevation of about 25 to 50 feet mlw. These sand dunes are probably of Pleistocene age.

Groundwater - General groundwater resources have been described by the Corps (USACOE 1994d). There are three groundwater scurces in the Wilmington Harbor/New Hanover County area. At the top is the water table aquifer of the surficial sand. Below the surficial sand is the aquitard, Canepatch formation. Below the Canepatch is the aquifer of the Waccamaw and Bear Bluff, i.e., marine sands. The aquifer below the Waccamaw and Bear Bluff is the Castle Hayne limestone. There is an undetermined amount of connection between the Waccamaw/Bear Bluff and the Castle Hayne aquifers. Most domestic water wells are set in the surficial sands. The second most used aquifer for water supply is the Castle Hayne limestone.

Locally, vertical groundwater movement may occur downward through the surficial sand, the discontinuous aquitard, and the marine sand aquifer to the Castle Hayne limestone. Regionally, the horizontal groundwater movement is eastward with some southeastern movement. The resultant groundwater movement picture is that of movement to the coast, upward movement, and lateral movement. There are no large artesian springs, for the most part, due to confining clays and silts.

Offshore Marine Environment

The area beyond the mouth of the Cape Fear River may be used for disposal of dredge material. Two areas which have been previously designated as disposal areas may be used. These areas are the Wilmington Offshore Dredged Material Disposal Site (ODMDS) and the adjacent Wilmington Offshore Fisheries Enhancement Structure (WOFES) (Figure 2). Approximately 1,000,000 cubic yards (cy) of dredged material from the Wilmington Harbor ship channel and 1,000,000 cy of material from the MOTSU are presently dumped in the Wilmington ODMDS each year (USACOE 1994b). The Wilmington ODMDS has an area of approximately 2.3 square nautical miles. Depths within the Wilmington ODMDS range from 28 to 46 feet below mean lower low water (mllw). Charted depths in the WOFES range from 39 to 46 feet below mllw.

In the review of past projects, the Service has expressed concern about the adverse impacts which result when dredge material is dumped on or near marine bottoms with exposed rock substrate, or hardbottoms. This situation would obviously not occur in the Wilmington ODMDS. The Corps has stated that "Rock substrates have not been detected in the WOFES project area", and that bottom sediment ranges from coarse sands and shells to silty sands (USACOE 1994b).

Cape Fear Estuary

Hydrology - The Cape Fear River Estuary is a typical drowned river valley, characterized by tidally-driven currents, high turbidity, and vertical salinity stratification (Moser and Ross 1993). The river has relatively free access to the ocean which results in a significant tidal range. An average tidal range of about one foot extends as far north as Lock and Dam #1 on the Cape Fear River, approximately 65 miles from the mouth of the river. The average tidal range in the estuary below Wilmington is about four feet. Regular reversals of flow occur with each tide, except during periods of high freshwater inflow. The average freshwater inflow to the Cape Fear River Estuary is about

9,600 cubic feet per second (cfs)(USACOE 1996a). The average discharge at the mouth of the Cape Fear River Estuary is about 11,000 cfs (USACOE 1994a).

The Cape Fear River may be classified under some flow conditions as a partially-mixed estuary (Ragland et al. 1987). There exists a definite salinity gradient with depth, although turbulence within the river does not allow the formation of a distinct saltwater wedge. In the area of the MOTSU, the estuary may have bottom salinities ranging from one-half to three times greater than surface salinities. The salinity of the estuary is constantly changing due to many factors including tidal action, freshwater inflow, and wind, so that for any location within the river the salinity might range from a few parts per thousand (ppt) to almost normal ocean salinity (35 ppt). Salinity gradients with depth are not likely within shallow water areas of the river next to the maintained channels due to mixing.

Water Quality - The State of North Carolina has placed the lower Cape Fear River estuary into two water classifications (USACOE 1994a). The Cape Fear River from the mouth of the Northeast Cape Fear River south to a line across the river between Snows Marsh and Federal Point is classified as "SC". This designation means that these waters are suitable for fishing, fish and wildlife propagation, secondary recreation, and other uses requiring water of lower quality. From this line south to the Atlantic Ocean, the waters are classified as "SA", except for a segment west of the river channel that is classified as "SC". "SA" waters are suitable for all uses of "SC" waters plus shellfishing for market purposes and primary contact recreation. Waters north of the line and west of the channel between Snows Marsh and Southport are closed to shellfishing.

Bottom Sediments - The Corps presented data on the sediment characteristics of the Cape Fear in association with the Channel Widening Project (USACOE 1994a). The sediment types in the harbor generally consist of silt, sandy silt, and silty sandy with some clays and peat. These alluvial deposits are interbedded, generally unconsolidated, and relatively soft. The subsurface sediments are generally silty sand. Limestone and sandstone are the underlying bedrock in the harbor channel (USACOE 1994a).

Wetlands - The estuarine marshes in the project area have been described by the Corps (USACOE 1990b). These areas which are referred to as "mixed brackish marsh fringe", are dominated by such plant species are saltmarsh cordgrass (*Spartina alterniflora*), black needlerush (*Juncus romerianus*), giant cordgrass (*Spartina cynosuroides*), and giant reed (*Phragmites australis*). The fringe marsh along the shoreline of Eagle Island near Wilmington was reported to contain saltmarsh cordgrass, giant cordgrass, giant reed, three square (*Scirpus americanus*), and narrow-leaved cattail (*Typha angustifolia*) (USACOE 1991b). Black willow (*Salix nigra*) and bald cypress (*Taxodium distichum*) are sparsely scattered in these fringe marshes.

The forested wetlands in the project area have been described (USACOE 1984). These areas, which the Corps' report designates as "swamp forests", are either regularly flooded due to tidal fluctuations or semipermanently flooded. The wetland communities along the river are described as productive, diverse, and beautiful. The riparian areas, tributary streams, and other areas of long-standing water are dominated by bald cypress, pond cypress (*T. ascendens*), black gum (*Nyssa sylvatica* var. *biflora*). Trees in other forested wetlands include chestnut oak (*Quercus montana*), water hickory (*Carya aquatica*), red maple (*Acer rubrum*), water ash [probably green ash (*Fraxinus pennsylvanica*)], sweetgum (*Liquidambar styraciflua*), sycamore (*Platanus occidentalis*), and water oak (*Quercus nigra*). The Corps' 1984 report states that there are about 8,000 acres of swamp forest attendant to the Northeast Cape Fear River estuary, and that 1,740 acres (22%) of the total lies between river mile 3 and 8, as measured upstream from the confluence with the Cape Fear River (USACOE 1984). The majority of swamp forests in New Hanover County are located along the Northeast Cape Fear River.

Primary Nursery Areas - The North Carolina Division of Marine Fisheries has the authority under 15 NCAC 3B.1405 to designate primary nursery area within coastal waters . A primary nursery area is an estuarine area where fish may undergo initial post-larval development. Data presented to the Service by the Corps on December 13, 1995 indicate that the Cape Fear River from the lower boundary of Upper Lilliput Channel to the mouth of the Brunswick River is a primary nursery except for the ship channel and 300 yards on either side of the channel. From the mouth of the Brunswick River to the north end of the project the entire river is primary nursery area except the ship channel.

Wilmington Ship Channel and Harbor

The Wilmington Harbor is a Federal navigation project which extends from the Atlantic Ocean up the Cape Fear River to points above the City of Wilmington on both the Cape Fear and Northeast Cape Fear Rivers. The overall length of the project is approximately 30.8 miles. The harbor consists of a number of channels or reaches, each connected by a turn or bend. A bend is generally defined as a connector between two channels which meet at an angle of less than 20 degrees, and a turn connects two channels which meet at an angle greater than 20 degrees. The harbor has 27 reaches. Some of these are fairly long, such as Upper Midnight Channel which is approximately 2.5 miles long. Other channels are much shorter, such as Upper Big Island Channel which is only 2,700 feet long. The are 47 piers, wharves, docks, and mooring dolphins at the harbor (USACOE 1994a).

The existing Federal project consists of a channel 40 feet deep and 500 feet wide from the Atlantic Ocean through the ocean bar (Baldhead Shoal and Smith Island Channels) and entrance channels (Baldhead-Caswell, Southport, and Battery Island Channels). However, the authorized depth has not been achieved in the ocean bar channel due to dredging inaccuracies and rock obstructions. The main river channel from Lower Swash Channel to the Cape Fear Memorial Bridge in Wilmington has an authorized channel which is 38 feet deep and 400 feet wide. From the Cape Fear Memorial Bridge to the Hilton Railroad Bridge over the Northeast Cape Fear River the authorized channel is 32 feet deep and 400 feet wide. From the Hilton Railroad Bridge to a point 1.7 miles up the Northeast Cape Fear the authorized channel is 25 feet deep and 200 feet wide.

FISH AND WILDLIFE SERVICE CONCERNS AND PLANNING OBJECTIVES

Fish and Wildlife Service Concerns

The involvement of the Service in this study is in response to a Congressional mandate through the Fish and Wildlife Coordination Act (*op.* cited) which directs that the conservation of fish and wildlife resources shall receive full and equal consideration and be coordinated with other features of Federal projects.

Fish, wildlife, and their habitats are valuable public resources which are conserved and managed for the people by State and Federal governments. If proposed land or water developments may reduce or eliminate the public benefits that are provided by such natural resources, then State and Federal resources agencies have a responsibility to recommend means and measures to mitigate such losses. In the interest of serving the public, it is the policy of the Service to seek to mitigate losses of fish, wildlife, and their habitats and to provide information and recommendations that fully support the Nation's needs for fish and wildlife resource conservation as well as sound economic and social development through balanced, multiple use of the Nation's natural resources.

The major concerns of the Service about the proposed project are:

1. The impoverishment of marine and estuarine food chains by reducing invertebrate populations through direct mortality, permanent elimination of habitat, and an increased risk of accidents due to greater traffic by larger ships;

2. The degradation of important fisheries resources through direct mortality, reduced food resources, permanent loss of nursery habitat, and an increased risk of accidents due to greater traffic by larger ships;

3. The loss of important tidal freshwater wetlands and the

freshwater species they contain by increasing the upstream limit of significant saltwater intrusion;

4. The permanent loss of important shallow water, estuarine areas and the organisms they contain thought direct removal for channel enlargement or their degradation due to increased erosion from the wakes of, and the increased risk of accidents involving, larger ships;

5. The loss of sea turtle nesting habitat due to accelerated erosion of beaches near the mouth of the Cape Fear River caused by the enlarged channel disrupting the longshore sediment transport system; and,

6. The direct mortality of Federally-endangered and threatened species, if project design and construction features do not contain adequate safeguards for their protection.

Planning Objectives

The Service proposes the following planning objectives for this project:

1. To maintain and enhance, where possible, existing water quality within the project area and adjacent waters of the Cape Fear and Northeast Cape Fear Rivers, including designated primary and secondary nursery areas.

2. To maintain and enhance, where possible, the quality and quantity of all existing marine, estuarine, and freshwater communities in the project area.

3. To assess the cumulative impacts of all past, ongoing, and reasonably foreseeable future channel modifications from a perspective of mitigating any adverse environmental impacts to such valuable fish and wildlife habitats as forested wetlands, emergent wetlands, shallow estuarine waters, and tidal flats.

In accordance with the Fish and Wildlife Coordination Act, as amended, these planning objectives should be given full and equal consideration with other features of the Cape Fear - Northeast Cape Fear Rivers Project.

EVALUATION METHODS

Descriptions of natural resources present within the study area and the preliminary assessment of the proposed project's potential impacts are based on previous studies for similar projects, published literature, and personal communications with other Service biologists, academic biologists, and planners. Published reports and studies were examined to determine their relevance to the proposed project. Material which described potential environmental impacts of similar projects and methods of reducing these impacts are incorporated by reference in this report.

A Service biologist attended an interagency scoping meeting on August 28, 1991 to discuss the potential environmental impacts of the project. A Service biologist attended an interagency meeting on the Corps' saltwater intrusion model on August 22, 1995 and an interagency meeting on the project on December 13, 1995.

A Service biologist visited the project area with other State and Federal resource agency personnel and Corps planners on August 23, 1995 and November 8, 1995. The former visit consisted of travel by boat from the Cape Fear Memorial Bridge to a dredge operating at the ocean bar. The latter visit was an inspection of a bucket and barge dredge working the ship channels leading to the MOTSU.

Nomenclature in this report follows Radford et al. (1968) for plants; Rohde et al. (1994) for freshwater fish; Robins and Ray (1986) for marine fish; Martof et al. (1980) for amphibians and reptiles; Potter et al. (1980) for birds, and Webster et al. (1985) for mammals.

Both common and scientific names from cited literature will follow the original publication. If the Service is aware of a widely accepted synonym for the common name, that synonym will be given in brackets. If the Service is aware of a change in the scientific name of a given species, the revised nomenclature will be included in brackets following the published name.

EXISTING FISH AND WILDLIFE RESOURCES

The area for the proposed channel modifications will involve a variety of habitat types, but predominantly consists of open water and estuarine, unconsolidated, subtidal bottoms. Other habitat types in the project area include: (1) estuarine, intertidal, emergent wetlands; (2) estuarine, intertidal, unconsolidated mud flats; and, (3) estuarine, forested wetlands. Freshwater wetland habitats include emergent marshes, scrub-shrub areas, and forests. Habitat is also provided by upland islands formed by the past disposal of dredged material.

These habitats support a diverse flora and fauna which directly or indirectly support many fish and wildlife species. In general, the Cape Fear River Estuary, including the adjacent Atlantic Ocean, is characterized by a few species that occur very abundantly and others that occur only incidentally (Carolina Power & Light 1980). The existing fish and wildlife resources along with other taxonomic groups which serve to support these resources are discussed below.

Invertebrates

This report will not address all invertebrates in the proposed project area. However, this section will discuss selected invertebrates which may form the base for important food chains and/or have a special status at either the State or Federal level.

Terrestrial - The rare skipper (*Problema bulenta*), a butterfly, has been found characteristically in estuarine marshes such as those which occur near Wilmington (Opler and Krizek 1984). Literature on this species indicates that it has been collected from the old Eagles Island Causeway opposite Market Street on the west side of the Cape Fear River (Harris 1972). The species is a candidate for listing under the ESA, and data available to the Service indicate that it may occur in both New Hanover and Brunswick Counties.

Wetlands - The Greenfield rams-horn (*Helisoma eucosmium*), a rare freshwater snail, was found recently in Town Creek, a tributary of the Cape Fear River in Brunswick County. When this population was discovered in 1993, the species had not been seen for 86 years. The Corps is currently funding additional field work to determine the areas occupied by the species.

Benthos - Benthos is a collective term for those aquatic organisms which live in close association with the bottom or substrate of a given water body. The animals in this diverse community may be divided into the benthic infauna, those species which burrow into the bottom, and the epibenthic fauna which live on the surface of the bottom.

Benthic communities of the Cape Fear River Estuary in the MOTSU area vary in species composition and density (Birkhead et al. 1979; Lawler, Matusky and Skelly Engineers [hereafter LMS] 1975). Approximately 40 benthic taxa were collected in the MOTSU area during the above-cited studies. The benthic community structure was found to be highly dependent on substrate type and salinity regime. Densities of benthic organisms in the Cape Fear River Estuary ranged from 30 organisms/square meter (m^2) on sandy substrate to 500 organisms/m^2 on mud substrate in the Atlantic Ocean (Birkhead et al. 1979). Near the MOTSU, LMS (1975) observed mean densities of 160 organisms/m^2, 110 organisms/m^2, and 55 organisms/m^2 in the Wilmington Harbor navigation channel, west of the channel, and areas east of the channel, respectively.

Birkhead et al. (1979) reported the capitellid polychaete, *Heteromastus filaformis*; the mud snail, *Ilyanassa obsoleta*, the spionid polychaete, *Paraprionospio pinnata*; and the bivalve mollusk, *Mulinia lateralis* as widely occurring dominants of the Cape Fear River Estuary in the vicinity of the MOTSU.

H. filaformis was especially abundant, with densities averaging approximately 14 individuals/m^2. Average density of *Mulinia lateralis* was as high as 8 individuals/m^2. Other benthic organisms that were collected frequently by Birkhead et al. (1979) included the spionid polychaete, *Spiophanes bombyx* and the bivalve mollusc, *Macoma plenax*, as well as unidentified amphipods and mysids. LMS (1975) reported that the abundant organisms collected from stations in the Wilmington Harbor navigation channel adjacent to the MOTSU included gammaridean amphipods; oligochaetes; the bivalve mollusc, *Modiolus demissus*; the capitellid polychaete, *Capitella capitata*; the arabellid polychaete, *Drilonereis longa*; and the mysid, *Neomysis americana*. Other abundant organisms were the bivalve mollusc, *Macoma balthica*; the polychaetes, *Streblospio benedicti*; *Paraprionospio pinnata*, and *Scolecolepides viridis*. Abundant organisms west of the Wilmington Harbor navigation channel at the MOTSU included the polychaetes, *Capitella capitata* and *Scolecolepides viridis*, and unidentified oligochaetes and amphipods.

Posey (1993) sampled the Cape Fear River estuarine benthic infaunal communities from two sites, one site in the MOTSU area near the proposed, center basin widener and the other, termed the Carolina Beach site, on the east side of the Wilmington Harbor navigation channel. At each site, 40 core samples were taken in August 1992 and 20 core samples were taken in March 1993. These data indicated that the infaunal community of the MOTSU and Carolina Beach sites are dominated by typical estuarine infauna, predominantly polychaetes.

In the summer of 1992, the numerically dominant taxa at the MOTSU were the polychaetes, *Mediomastus californiensis* and *Capitella capitata* (Posey 1993). These two species comprised almost 75% of the fauna collected at that site. *Mediomastus* and *Capitella* are closely related worms that are generally considered burrowing, non-selective deposit feeders. They are often characteristic of disturbed or organically enriched locations. Important subdominant species at the MOTSU were oligochaetes and the gastropod, *Nassarius obsoletus* which together comprised about 10% of the MOTSU fauna collected. The numerically dominant fauna at the Carolina Beach site were *Mediomastus californiensis* and *Websterinereis* sp., polychaete worms, which together comprised 66% of the fauna collected. Important subdominants included *Heteromastus filiformis*, *Neanthes succinea*, nemerteans, and the clam, *Macoma* sp. These four subdominant taxa comprised 22% of the fauna collected at the Carolina Beach site. The Carolina Beach subdominants ranged from non-selective deposit feeders, such as *H. filiformis*, and predators, such as *N. succinea*, to surface feeders/facultative suspension feeders, such as *Macoma* sp.). Thus, the MOTSU and Carolina Beach sites were dominated by functionally similar organisms (burrowing deposit feeders such as *Mediomastus*, *Heteromastus*, and *Capitella*), but the Carolina Beach site contained a more diverse set of subdominant species with diverse feeding strategies. However, the Shannon Index (H'), a diversity index, was similar between the two sites at 0.673 and 0.766 for the MOTSU and Carolina Beach site, respectively.

In the spring of 1993, benthic infauna at the MOTSU was dominated by the tube dwelling polychaete, *Spio* sp. and *Mediomastus californiensis* (Posey 1993). The Carolina beach site was dominated by a mix of infauna including *Spio* sp., *M. californiensis*, and *Macoma* sp. Important subdominants at the MOTSU site were *Macoma* sp., *Streblospio* sp., and an amphipod species. Important subdominants at the Carolina Beach site were *Websterinereis* sp., *Heteromastus* sp., and *Gammarus* sp. For the spring 1993 samples, the Shannon Index (H') was similar between the two sites at 0.673 and 0.766 for MOTSU and Carolina Beach site, respectively.

In summary, Posey (1993) compared benthic fauna from an area proposed for new dredging work at the MOTSU and a reference site on the Carolina Beach side of the river channel. The two sites were qualitatively similar in benthic fauna though quantitative differences between the two sites existed. Posey concluded that the MOTSU site is not dominated by a particularly rich benthic community nor is there evidence that it is unique in its composition or characteristics. Temporal variability and the identity of dominant taxa at the MOTSU site indicate a community currently subject to periodic disturbance, dominated by rapid colonizing species, and which is likely to be resilient to many types of disturbance.

Shellfish beds are also present in the Cape Fear River estuary, primarily south of Snows Marsh, which is approximately 1.5 miles north of MOTSU, (Woodward-Clyde Consultants, 1980). All significant beds are in shallow water east of the Wilmington Harbor Federal navigation channel. The dominant species are the American [eastern] oyster (*Crassostrea virginica*) and the hard-shelled clam, or quahogs (*Mercenaria mercenaria*). In the area south of Federal Point, which is just south of the MOTSU on the east bank of the Cape Fear River, both species are harvested for sale and personal consumption.

In 1995 the epibenthic fauna of the lower Cape Fear River Estuary was sampled (Posey et al. 1995). Twenty-six higher taxa, including zoeal and megalopal stages for anomuran/brachyuran crabs, were recognized. However, most of the taxa were relatively rare, with only 7 groups comprising 3% of the non-mysid fauna. The community was strongly dominated by mysids, with anomuran/brachyuran larvae, carid shrimp, and gammarid amphipods as less common co-dominants. Only mysids exhibited strong distributional differences along a depth gradient, with over 50 times greater abundance in deep channel areas compared to shallow sites. Sediment type was the variable most commonly related to distributional patterns. Crabs were most common over sand substrate.

Nekton - Nekton is a collective term for all aquatic organisms which are not moved passively by currents or gravity, but are able to control their location by active movement. Sampling of the nekton with an otter trawl in the MOTSU basins was performed in September 1976 by the U.S. Army Environmental Hygiene Agency (1977). Data from the MOTSU basin samples were reported simply as species collected without estimates of abundance (Appendix A). Invertebrates species included groups such as squid, mantis shrimp, mud crabs (Family Xanthidae), and species such as blue crab (*Callinectes sapidus*), and white shrimp (*Penasus setiferus*). Moser (1991, cited in USACOE 1994d) conducted a one-time gill and trammel net survey of the Carolina Beach Borrow Site, across the Cape Fear River form the MOTSU. The only nektonic invertebrate collected was the blue crab.

General Fish

Fish in the Cape Fear River Estuary are dominated by species residing in the estuary as larvae or juveniles and using the estuary as nursery or feeding habitat, but spawning offshore in the Atlantic Ocean (Birkhead et al. 1979). Abundant species in the "nursery use" category include Atlantic menhaden (*Brevoortia tyrannus*), Atlantic croaker (*Micropogon undulatus*), spot (*Leiostomus xanthurus*), star drum (*Stellifer lanceolatus*), mullet (*Mugil* spp.), and weakfish (*Cynoscion regalis*). Species that are estuarine endemics, or permanent residents, are also abundant. Species in this group include bay anchovies (*Anchoa mitchilli*), killifishes (*Fundulus* spp.), and silversides (*Menidia* spp.) (Weinstein 1979). Anadromous species, such as blueback herring (*Alosa aestivalis*), American shad (*Alosa sapidissima*) hickory shad (*Alosa mediocris*), alewife (*Alosa pseudoharengus*) striped bass (*Morone saxatilis*), and Atlantic sturgeon (*Acipenser oxyrhynchus*), use the Cape Fear River estuary as a transportation route to upper river spawning and nursery areas (Walburg and Nichols 1967; Nichols and Louder 1970). Anadromous fish use is highest from mid-winter to mid-spring. The catadromous American eel (*Anguilla rostrata*) is widely distributed in the Cape Fear River Estuary (Schwartz et al. 1981). Fish data from the MOTSU basin were reported simply as species collected without estimates of abundance (Appendix A).

Moser (1991, as cited in USACOE 1994d) conducted a one-time gill and trammel net survey of the Carolina Beach Borrow site (CBBS), and species collected included Atlantic menhaden, striped mullet (*Mugil cephalus*), spot, ladyfish (*Elops saurus*), and threadfin shad (*Dorosoma petenense*), and grey trout (sic) [probably, weakfish (*Cynoscion regalis*)].

General Reptiles and Amphibians

Reptiles and amphibians are not common residents of open estuarine waters. Dardeau et al. (1992) do not discuss these groups in their summary of the vertebrate fauna of southeastern estuaries. However, freshwater tidal wetlands have a rich diversity of reptiles and amphibians. Among the many species which may be found in bottomland hardwood forest and cypress swamps are the lesser siren (*Siren intermedia*), southern dusky salamander (*Desmognathus* auriculatus), marbled salamander (*Ambystoma opacum*), green frog (*Rana clamitans*), Brimley's chorus frog (*Pseudacris brimleyi*), eastern mud turtle (*Kinosternon subrubrum*), black swamp snake (*Seminatrix pygaea*), redbelly watersnake (*Nerodia erythrogaster*), and cottonmouth (*Agkistrodon piscivorous*) (Sharitz and Mitsch 1993; Martof et al. 1980). American alligators (*Alligator mississippiensis*) are known to occur in the Cape Fear River and surrounding habitats. Alligator tracks have been observed on dredge disposal islands along the Cape Fear River, and a few alligators inhabit Bald Head Island.

General Birds

The wetlands in the project area provide important habitat for many birds. The Corps provided a list of birds which may occur in the swamp forests, freshwater marshes, and uplands areas along the Northeast Cape Fear River (USACOE 1984). Some of the species mentioned in this report which may use wetlands in the project area include the anhinga (*Anhinga anhinga*), great blue heron (*Ardea herodias*), yellow-crowned night heron (*Nyctanassa violacea*), belted kingfisher (*Megaceryle alcyon*), pileated woodpecker (*Dryocopus pileatus*), great horned owl (*Bubo virginianus*), long-billed marsh wren (*Cistothorus palustris*), prothonotary warblers (*Protonotaria citrea*), and wood duck (*Aix sponsa*).

The lower Cape Fear River estuary is one of the most important colonial waterbird nesting locations in North Carolina. Battery Island, located to the northwest of Bald Head Island is a natural, estuarine island owned and managed by the National Audubon Society. The island contains dense maritime shrub thickets which have supported a mixed-species nesting rookery since at least 1928. It is used by glossy ibis (*Plegadis falcinellus*), white ibis (*Eudocimus albus*), cattle egret (*Bubulcus ibis*), little blue herons (*Egretta caeurlea*), and other waders. Battery Island contains two separate colonies - the north colony and the south colony. Collectively, they form the largest wading bird nesting population in North Carolina (Parnell and Shields 1990).

Dredged material islands within and adjacent to the project area serve as nesting habitat for approximately 14 colonial waterbird species (Dr. James Parnell, University of North Carolina at

Wilmington, pers. comm., 1989). North and South Pelican Islands and Ferry Slip Island are closest to the study site and are used by brown pelicans (*Pelecanus occidentalis*), royal terns (*Sterna maxima*), and laughing gulls (*Larus atricilla*). Black skimmers (*Rynchops niger*), common terns (*Sterna hirundo*) and gull-billed terns (*Sterna nilotica*) also nest on Ferry Slip Island. South Pelican Island and Ferry Slip Island support nearly one half of the State's brown pelican breeding population (Parnell and Shields 1990).

Ferry Slip Island and South Pelican Island have experienced severe erosion in the past. This erosion diminished nesting by colonial waterbirds and many nests were destroyed. In the winter of 1992, the Corps disposed of material on Ferry Slip and South Pelican Islands, increasing the nesting value of these islands. It is likely that these islands will require additional disposal material in future years (Dr. James Parnell, University of North Carolina at Wilmington, personal communication, March, 1993).

The Cape Fear River estuary is utilized by waterfowl for resting and feeding. The Service's mid-winter waterfowl surveys of the Lower Cape Fear River from 1982 through 1987 reported 14 species of waterfowl using this area.

General Mammals

While many parts of the project area do not contain terrestrial mammals, the riparian areas in the northern part of the project area and wetlands farther upstream which may be indirectly impacted by the project do have a mammalian fauna. The Corps reported on the terrestrial mammals which are known to occur in the Wilmington Harbor-Northeast Cape Fear River area (USACOE 1984). Wetland species included the river otter (*Lutra canadensis*), opossum (*Didelphis virginiana*), raccoon (*Procyon lotor*), mink (*Mustela vison*), marsh rabbit (*Sylvilagus palustris*), white-tailed deer (*Odocoileus virginianus*), bobcat (*Lynx rufus*), and black bear (*Urus americanus*).

Federally Protected Species

The action area of the proposed project would include open water, wetlands, and riparian uplands in both New Hanover and Brunswick Counties, North Carolina. The action area would also include marine environments off the coast of North Carolina. The Service has prepared lists of the Federally-listed species which have been reported in each North Carolina county. The most recent revision of these county lists was done on April 19, 1995. A consolidated list of the Federally-endangered and -threatened species is given in Table 1. Former candidate species are given in Table 2. Marine mammals are protected by the Marine Mammal Protection Act (MMPA) of 1972 (16 USCA 1361 *et seq.*). Provisions of the MMPA are implemented by the NMFS.

Table 1. Federally-endangered (E) and -threatened (T) species, along with those species which are candidates for listing, which have been reported from New Hanover and Brunswick Counties, North Carolina. The list includes data available as of April 19, 1995.

	Status
Mammal	
Eastern cougar (*Felis concolor cougar*)	E
West Indian manatee (*Trichechus manatus*)	E
Bird	
Bald eagle (*Haliaeetus leucocephalus*)	T
Peregrine falcon (*Falco peregrinus*)	E
Piping plover (*Charadrius melodus*)	T
Red-cockaded woodpecker (*Picoides borealis*)	E
Wood stork (*Mycteria americana*)	E
Fish	
Shortnose sturgeon (*Acipenser brevirostrum*)	E
Reptile	
Green sea turtle (*Chelonia mydas*)	T
Kemp's Ridley sea turtle (*Lepidochelys kempi*)	E
Leatherback sea turtle (*Dermochelys coriacea*)	E
Loggerhead sea turtle (*Caretta caretta*)	T
Plant	
Cooley's meadowrue (*Thalictrum cooleyi*)	E
Rough-leaved loosestrife (*Lysimachia asperulaefolia*)	E
Seabeach amaranth (*Amaranthus pumilus*)	T

Sea turtles when "in the water" and the shortnose sturgeon are under the jurisdiction of the NMFS. This agency should be contacted concerning your agency's responsibilities under Section 7 of the Endangered species Act. Their address is:

National Marine Fisheries Service
U.S. Department of commerce
9450 Koger Boulevard
Duval Building
St. Petersburg, Florida 33702

Table 2. Former candidates for listing under the Endangered Species Act of 1973 which have been reported from New Hanover and Brunswick Counties, North Carolina. The Service no longer considers those species which were designated as C2 to be candidate species. The Service remains concerned about the species formerly designated as C2 and is working with Federal and State agencies, private conservation groups, and the scientific community to develop data sharing arrangements and continues to assess the status of these species. Source: U. S. Fish and Wildlife Service, Asheville, North Carolina.

Species	Former Status
Bird	
Bachman's sparrow (*Aimopila aestivalis*)	C2
Henslow's sparrow (*Ammodramus henslowii*)	C2
Reptile	
Mimic glass lizard (*Ophisarus mimicus*)	C2
Amphibian	
Carolina crawfish frog (*Rana areolata capito*)	C2
Fish	
Carolina pygmy sunfish (*Elassoma boehlkei*)	C2
Molluscs	
Cape Fear three tooth (*Tridopsis soelneri*)	C2
Greenfield ramshorn snail (*Taphius eucosmius eucosmius*)	C2
Magnificent ramshorn snail (*Planorbella magnifica*)*	C2
Waccamaw spike (*Elliptio waccamawensis*)	C2
Insect	
Pyxie moth (*Agrotis buchholzi*)	C2
Rare skipper (*Problema bulenta*)	C2
Plant	
A beaksedge (*Rhycoospora decurrens*)	C2
Awned meadowbeauty (*Rhexia aristosa*)	C2
Carolina asphodel (*Tofieldia glabra*)	C2
Carolina bogmint (*Macbridea caroliniana*)	C2
Carolina goldenrod (*Solidago pulchra*)	C2
Carolina grass-of-parnassus (*Parnassia caroliniana*)	C2
Carolina spleenwort (Asplenium heteroresiliens)*	C2

Table 2 (continued).

Chapman's sedge (*Carex chapmanii*)	**C2**
Dune blue curls (*Trichostema* sp.)	**C2**
Dwarf burhead (*Echinodorus parvulus*)	**C2**
Harper's fringe rush (*Fimbristylis perpusilla*)	**C2**
Honeycomb head (*Balduina atropurpurea*)	**C2**
Loose watermilfoil (*Myriophyllum laxum*)	**C2**
Pineland plantain (*Plantago sparsiflora*)	**C2**
Pondspice (*Litsea aestivalis*)	**C2**
Pickering's morning glory (Stylisma pickeringii var. pickeringii)*	**C2**
Sandhills milkvetch (*Astragalus michauxii*)*	**C2**
Savanna campylopus (*Campylopus carolinae*)*	**C2**
Savanna leadplant (*Amorpha georgiana confusa*)	**C2**
Savanna cowbane (*Oxypolis ternata*)	**C2**
Smooth bog-asphodel (*Tofieldia glabra*)	**C2**
Spring-flowering goldenrod (*Solidago verna*)	**C2**
Sun-facing coneflower (*Rudbeckia heliopsidis*)	**C2**
Thorne's beaked-rush (*Ryhnchospora thornei*)	**C2**
Venus flytrap (*Dionaea muscipula*)	**C2**
Wireleaf dropseed (*Sporobolus teretifolius*)	**C2**
White wicky (*Kalmia cuneata*)	**C2**

*Indicates no specimen in at least 20 years from these counties.

The proposed project is located in areas used by some of these Federally-listed species. A discussion of those species which are most likely to be affected by the proposed project, based on current information, is given below.

Cetaceans - Marine mammals occur in offshore and inshore waters of North Carolina. Twenty-nine species of cetaeans have been recorded along the coast of the Carolinas, Virginia, and Maryland (Webster et al. 1985). Some species occur only in deeper offshore waters beyond the project limits, but other species could occur within the project area. The Federally-endangered right whale (*Balaena glacialis*) and humpback whale (*Megaptera novaeangliae*) are spring and fall migrants off of North Carolina. Both species may be found in nearshore waters, and the right whale appears to prefer shallow waters. The long-finned pilot whale (*Globicephala melaena*) and short-finned pilot whale (*G. macrorhynchus*) are primarily oceanic, but frequently move inshore when food resources are more plentiful there (Webster et al. 1985). The sperm whale (*Physeter macrocephalus*), dwarf sperm whale (*Kogia simus*), and pygmy sperm whale (*K. breviceps*) inhabit the offshore waters of North Carolina. While the sperm whales favor the deeper water off the continential shelf, they may use shallow waters to calve or in times of sickness (Webster et al. 1985). The sperm whale is a year round resident of the shelf edge and pelagic waters off North Carolina. This species probably moves farther offshore during the winter.

Bottle-nosed dolphins (*Tursiops truncatus*) and harbor porpoises (*Phocoena phocoena*) utilize nearshore waters including bays, estuarine creeks, and sounds. They are the most common cetaceans in the area. Bottlenose dolphins are commonly observed in the estuarine waters between Bald Head Island and Southport.

Shortnose sturgeon (*Acipenser brevirostrum*) - Current data indicate that this Federally-endangered fish is found within the Cape Fear River estuary. Dr. Mary Moser and Dr. Steve Ross of the Center for Marine Science Research at the University of North Carolina at Wilmington, studied the shortnose sturgeon in the Cape Fear River from May 1990 until September 1992 (Moser and Ross 1993). During this period, they caught over 100 Atlantic sturgeons and 9 shortnose sturgeons. Thus, the number of shortnose sturgeons within the estuary appears to be very low. The species' distribution within the Cape Fear River has been documented to extend as far up the river as Lock and Dam #1. Whether shortnose sturgeons occur beyond that point is unknown (Dr. Mary Moser, University of North Carolina at Wilmington, personal communication, April 1993).

Both sturgeons are bottom dwellers and prefer deep waters and a soft substrate (Rohde et al. 1994). During spawning these species require freshwater areas with a fast flow and a rough bottom (Rodhe et al. 1994). Moser indicated that sturgeon seemed to use the main channel of the river and tend to associate with deep holes. Atlantic sturgeon associate with the deepest parts of the river during the warmest times of the year, and they show a considerable amount of fidelity to deep holes (Dr. Mary Moser, personal communication, April 1993).

Sea Turtles - All five Atlantic sea turtles may occur in the coastal waters of North Carolina (Epperly et al. 1995). These species are the loggerhead sea turtle (*Caretta caretta*), the green sea turtle (*Chelonia mydas*), Kemp's ridley sea turtle (*Lepidochelys kempi*), the hawksbill sea turtle (*Eretmochelys imbricata*), and the leatherback sea turtle (*Dermochelys coriacea*).

The hawksbill and leatherback are not common in North Carolina waters. Both species are Federally-listed as endangered. However, survey data (Table 3) in the Cape Fear River from 1980 to 1991 included 7 leatherbacks among 157 total sea turtles (personal communication, David Webster, University of North Carolina, Wilmington, June 1994). Epperly et al. (1995) report the capture of a single leatherback in Pamlico Sound during the 1989-1992 period. A hawksbill was found within the Cape Fear River at the Carolina Power and Light plant near Southport (Sherry Epperly, NMFS, personal communication, April 1993). Epperly et al. (1995) reference State data for the capture of a single hawksbill in Pamlico Sound during the 1989-1992 period.

The Federally-endangered Kemp's ridley sea turtle, the Federally-threatened loggerhead, and Federally-threatened green sea turtle occur within the Cape Fear River estuary, primarily during the warmer months. Among 157 sea turtles reported in the Cape Fear River from 1980 to 1991, there were 135 loggerheads, 11 Kemp's ridleys, and 3 greens (N. L. Grogan and W. D. Webster, University of North Carolina, Wilmington, personal communication, June 1994).

Preliminary analysis of sea turtle sightings and strandings within North Carolina indicate that the Cape Fear River may provide important developmental habitat for green sea turtles (Crouse 1985). From 1989 through 1992, 9 sea turtles were observed in the Cape Fear River by recreational fisherman as reported by the Marine Recreational Fisherman Statistics Survey (Epperly et al. 1995). The NMFS also provided the Service with data which indicate that between 1980 and 1991 approximately 43 loggerheads, 2 greens, 2 leatherbacks, and 2 Kemp's ridleys were reported as stranded within the Cape Fear River area. Although NMFS states that these data are preliminary, they give an indication of the relative abundance of the various species of sea turtles found in the Cape Fear River (National Marine Fisheries Service [hereafter NMFS] 1993).

Table 3. Seasonal distribution of reported occurrences of the loggerhead sea turtle (*Caretta caretta*), green sea turtle (*Chelonia mydas*), Kemp's ridley sea turtle (*Lepidochelys kempi*), and leatherback sea turtle (*Dermochelys coriacea*) in the Cape Fear River (upper table) and on Bald Head Island and Oak Island (lower table) which flank the mouth of the Cape Fear River, 1980-1991. Source: N. L. Grogan and W. D. Webster, University of North Carolina, Wilmington, personal communication, June 1994.

Species compostition and seasonality in sea turtles that have been reported in the Cape Fear River from 1980-1991.

SPECIES	MONTH												TOTAL
	J	F	M	A	M	J	J	A	S	O	N	D	
Caretta	3	0	1	6	21	55	23	14	5	2	4	1	135
Lepidochelys	0	0	0	0	4	2	2	2	1	0	0	0	11
Dermochelys	0	0	0	1	6	0	0	0	0	0	0	0	7
Chelonia	0	0	0	0	2	0	0	0	0	0	0	1	3
TOTAL	3	0	1	7	33	57	25	16	6	2	4	2	157

Species compostition and seasonality in sea turtles that have been reported from Oak and Bald Head islands from 1980-1991.

SPECIES	MONTH												TOTAL
	J	F	M	A	M	J	J	A	S	O	N	D	
Caretta	0	0	0	4	46	18	39	23	16	7	3	1	157
Lepidochelys	0	0	0	0	0	0	0	0	0	0	0	0	0
Dermochelys	0	0	0	0	2	1	0	0	0	0	0	0	3
Chelonia	0	0	0	0	1	0	0	0	0	0	0	0	1
TOTAL	0	0	0	4	49	19	39	23	16	7	3	1	161

The presence of sea turtles in nearshore and estuarine waters of North Carolina appears to be seasonal. Epperly et al. (1995) reported that sea turtles were present in the offshore water of North Carolina throughout the year and were present in inshore waters from April through December. Seasonal data on sea turtles in the Cape Fear River and from Bald Head and Oak Islands which flank the mouth of the Cape Fear River were collected by Grogan and Webster (personal communication, David Webster, University of North Carolina, Wilmington, June 1994)(Table 3). These data show that sea turtles were found in the Cape Fear River during every month except February. The months with the highest occurrences were April through September. These six months account for 144 (91.7%) of the 157 reports.

West Indian manatee (*Trichechus manatus*) - This species, also known as the Florida manatee, is a Federally-listed endangered mammal. Although the manatee's principle stronghold in the United States is Florida, it occasionally makes its way into the coastal waters of North Carolina (Webster et al. 1985). Generally, manatees remain in the coastal waters of the Florida peninsula during the winter and disperse during the summer months, some moving north along the Atlantic Coast to North Carolina. Observations of manatees from within the Cape Fear River and surrounding waters are generally reported every year during the summer months. The number of sightings is usually low, but they do occur within the Cape Fear River on a regular basis during the warmer months of the year (David Webster, University of North Carolina at Wilmington, personal communication, May, 1993, and Mary Clark, North Carolina Museum of Natural History, personal communication, May, 1993).

Schwartz (1995) summarized manatee sightings in North Carolina from 1919 through 1994. This report provides information on the occurrence of 68 manatees from 59 sites and notes that the species is known to frequent nearly all North Carolina ocean and inland waters. Recorded sightings in the vicinity of the project area include one individual near Southport in 1952; one near the Carolina Power and Light Plant on the Cape Fear River; one in the lower Cape Fear River during 1976; one in the Cape Fear River near Marker 50 in March 1986; and one at the south end of the State Port at Wilmington in July 1994.

FUTURE FISH AND WILDLIFE RESOURCES WITHOUT PROJECT

It is necessary to distinguish between changes in the fish and wildlife resources which are likely occur without the project and those expected to occur if the project is completed. Therefore, this section will discuss the future condition of fish and wildlife resources in the project area which could be reasonably anticipated in the absence of the proposed project. This discussion will be based primarily on changes which have occurred in the recent past and the factors for these changes which are expected to extend into the future.

Future abundance, quality, and diversity of the study area's fish and wildlife resources will be largely determined by management activities of Federal, State, County, and local regulatory agencies within the study area and within the larger area of the Cape Fear River watershed. Anticipated generic actions which might be expected and which often adversely affect fish and wildlife resources include: conversion of wetlands to agricultural and plantation pine lands; conversion of wetlands to uplands; conversion of permeable riparian lands to nonpermeable land which increases the rate and volume of freshwater run-off; and the introduction of pollutants through numerous sources, including such nonpoint sources as urban run-off, agricultural run-off, and septic tank failure.

Benthic Organisms and Habitat

The proposed project will result in the direct loss of benthic infauna and epibenthic fauna. Areas for which deepened has been proposed outside the existing channel would not be significantly impacted in the absence of this project. The proposed project would result in the permanent loss of benthic habitat which may, however, be replaced by a successful mitigation program. Without the proposed project there is not likely to be any major loss of benthic habitat.

Decline in Water Quality

Periodic maintenance dredging of the existing ship channel will continue to cause short-term, adverse impacts to benthic organisms in the proposed project area. Dredging for both maintenance and new construction temporarily increases turbidity by increasing the amount of suspended solids. These conditions may result in mortality of aquatic larva and post-larval fish. Sessile and slow-moving benthic and epibenthic species will be lost along the path of the dredge, and minor turbidity and siltation could cause physiological stress for some species. Without the proposed project, the routine, maintenance dredging of the exiting ship channel would continue to periodically increase turbidity. However, the adverse impacts associated with maintenance dredging are likely to be less than those which would be produced by the proposed major construction.

Long-term maintenance dredging of the present Wilmington Harbor channel will necessitate the use of existing dredged material disposal sites within the Cape Fear River basin, including dredged material disposal islands located within the project study area. The rate of water outflow from confined disposal facilities can be controlled by adjustable spillways; therefore, without the proposed project any increase in turbidity in the estuary due to dredged material disposal should be minimal.

Increased development in the Cape Fear River watershed may lead to some declines in water quality due to increased erosion and nonpoint source runoff from agricultural areas and extensive paved areas. Future development in the watershed will result in further habitat losses and, although the State is attempting to regulate nonpoint source discharges, the concurrent increases in the volume and rate of surface runoff are expected to result in further declines in water quality and thereby reduce the quality of fish and wildlife. The degree to which fish and wildlife resources will be adversely affected by any future decline in overall water quality cannot be precisely predicted.

Fish and wildlife resources could be indirectly affected by saltwater intrusion into groundwater supplies. However, the degree to which salt water intrusion would increase, if at all, in the absence of the proposed project, cannot be predicted.

Loss of Estuarine Wetlands

The Service hopes that existing State and Federal laws will serve to prevent the future loss of estuarine wetlands. However, the use of general permits may allow some small losses to occur without the requirement for compensatory mitigation. Therefore, some permanent losses continue to occur despite existing regulations. The cumulative effects of many development projects, both and large and small, may, in time, reduce both the quality and quantity of these very valuable communities. However, a precise assessment of any future decline in the quality and quantity of these areas cannot be made at this time.

Conversion of Freshwater, Tidal Wetlands

Freshwater, tidal wetlands face the same long-term threats as estuarine wetlands from development and declines in water quality. In addition, sea level rise, erosion, severe coastal storms, and other Wilmington Harbor channel modifications may cause an increase in the saltwater penetration above Wilmington. The present estimate of sea level rise along the North Carolina coast is one foot per 100 years (Pilkey et al 1980). The combined effects of these factors will contribute to the conversion of existing, freshwater, tidal wetlands into oligohaline, tidal wetlands. The rate and long-term extent of this conversion are not known. Further studies of impacts from channel activities are essential to a better knowledge and understanding of ecosystem changes in the area and a clearer picture of how man's perturbations affect ecosystem changes.

Shoreline Erosion due to Ship Traffic

While the role which present ship traffic plays in any shoreline erosion has not been precisely quantified, the contribution of wake action to the loss of estuarine and tidal, freshwater

wetlands would be expect to remain the same without the proposed project.

Beach Erosion due to Loss of Sediment and Disruption of the Longshore Transport System

Sea turtles are expected to continue to use the waters of the study area for feeding and the beaches for nesting. Both Bald Head and Oak Islands are used for sea turtle nesting. Erosion continues to be a problem on these islands. Any significant loss of beach on these islands would adversely impact sea turtle reproduction. The longshore transport system carries sediment along the coast and both deposits and removes beach sand. The enlarged channel may trap sand moving along the coast. Any removal of sand from the longshore transport system resulting from the enlargement of the present ship channel would not occur in the absence of the project. Without the proposed project current erosion rates and current beach usage by sea turtles would be expected to remain basically unchanged.

Nesting Habitat for Colonial Waterbirds

Several species of colonial waterbirds in North Carolina are highly dependent on the existing dredged material disposal islands. Dredge disposal islands in the area may continue to support nesting populations of colonial waterbirds as long as management of the islands continues, including disposal of dredged material when needed. Significant changes in use of the dredged disposal islands by colonial waterbirds will occur unless appropriate management activities are implemented. Without an effective means to exclude predators, some disposal islands may cease to be useful to colonial waterbirds. Pioneer species such as the royal tern (*Sterna maxima*) and sandwich tern (*Sterna sandvicensis*) often nest on recently disturbed dredged material islands with little to no vegetation, a habitat type that is in relatively short supply in North Carolina. In the absence of periodic dredged material disposal or substrate manipulation to establish early successional vegetation, the use of some disposal islands by these pioneer species is expected to decline. Over time the increased vegetation will prevent any breeding by colonial waterbirds which require open areas for nesting. Therefore, to the extent that dredge material from the proposed project would be used to create nesting habitat for colonial waterbirds, there may be a decline in nesting habitat without the proposed project.

Habitat for Waterfowl

Without the proposed project waterfowl populations within the project study area are not expected to change significantly in the near future. However, it is expected that implementation of the North American Waterfowl Management Plan will increase waterfowl populations in North America, and this may result in an increase in the number of waterfowl utilizing the project area. Waterfowl usage of the project may be adversely affected by changes in water quality and any reduction in productivity within estuarine and freshwater, tidal wetlands.

ALTERNATIVES CONSIDERED

Problems with Existing Facilities

The Corps identified the principal navigation problem at the Port of Wilmington to be inadequate depths across the ocean bar and in the river channel to Wilmington. Economic benefits which would accrue from the deepening of Wilmington Harbor include reductions in light-loading of vessels and vessel delays. Shippers would also be able to use larger, more efficient vessels.

In 1991 the main channel from the ocean bar to the State Port at Wilmington along with the anchorage basin, or turning basin, upriver from the port had a depth of 38 feet (Figure 3). However, 40 feet is the minimum depth considered to be compatible with a "Panamax vessel", the largest vessel capable of passing through the Panama Canal, and other large vessels utilizing Wilmington Harbor. Even with a 40-foot river channel, many vessels would still require tidal advantage to enter or leave the port.

The existing channel from the Cape Fear Memorial Bridge to the Hilton Railroad Bridge (Figure 4) in 1991 was 32-feet-deep. This depth was considered inadequate by local interests, and these interests requested that this channel have a depth greater than 38 feet to accommodate the bulk carriers using this reach of the river.

The northern section of the existing project extends from the Hilton Railroad Bridge to the end of the Federal navigation project at mile 30.8 (Figure 5). The shipping channel in this reach in 1991 was 25-feet-deep and 200-feet-wide. The Wilmington Harbor-Northeast Cape Fear River Project will only extend the 38-foot channel for 750 feet upstream from the Hilton Bridge, and from this point the channel would remain unchanged. Local interests have stated that other users would benefit from an extension of the 38-foot depth upstream.

Design Alternatives Presented in the 1991 Reconnaissance Report

The Reconnaissance Report proposed channel modifications for three sections of the shipping channel (USACOE 1991b). Three different plans, designated A-C, were proposed (Table 4). Reach 1 included the existing 38-foot-deep channel from the ocean bar to the State Port. This reach also included the anchorage basin, or turning basin, upriver from the State Port. In order to

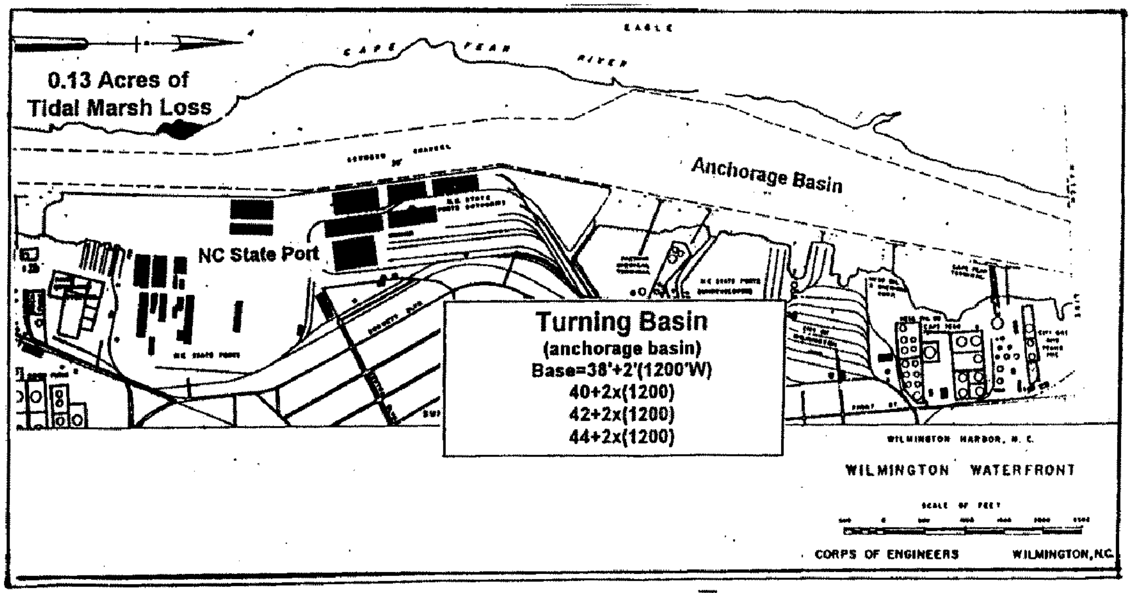

Figure 3. Portion of the Wilmington Ship Channel in the vicinity of the State Port. Dimensions for the turning basin are given as depth plus overdepth with width (W) in parentheses. All dimensions are in feet. Base dimensions are for conditions after the completion of the Wilmington Harbor-Northeast Cape Fear River Project. The three dimensions below the base data are alternatives considered for the Cape Fear-Northeast Cape Fear Rivers Project. Source: Wilmington District, U. S. Army Corps of Engineers, December 1995.

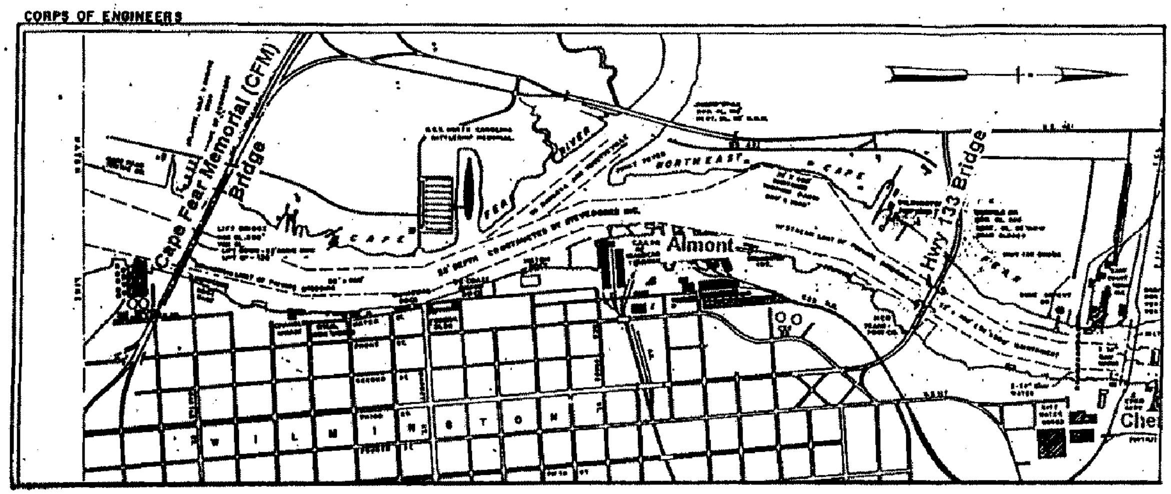

Figure 4. Portion of the Wilmington Ship Channel from the Cape Fear Memorial Bridge (far left) to the Hilton Railroad Bridge (far right). This reach will be modified as part of the Wilmington Harbor-Northeast Cape Fear River Project. The reach was originally considered for modification as part of the Cape Fear-Northeast Cape Fear Rivers Project, but is not currently included in the project. Source: Wilmington District, U. S. Army Corps of Engineers, December 1995.

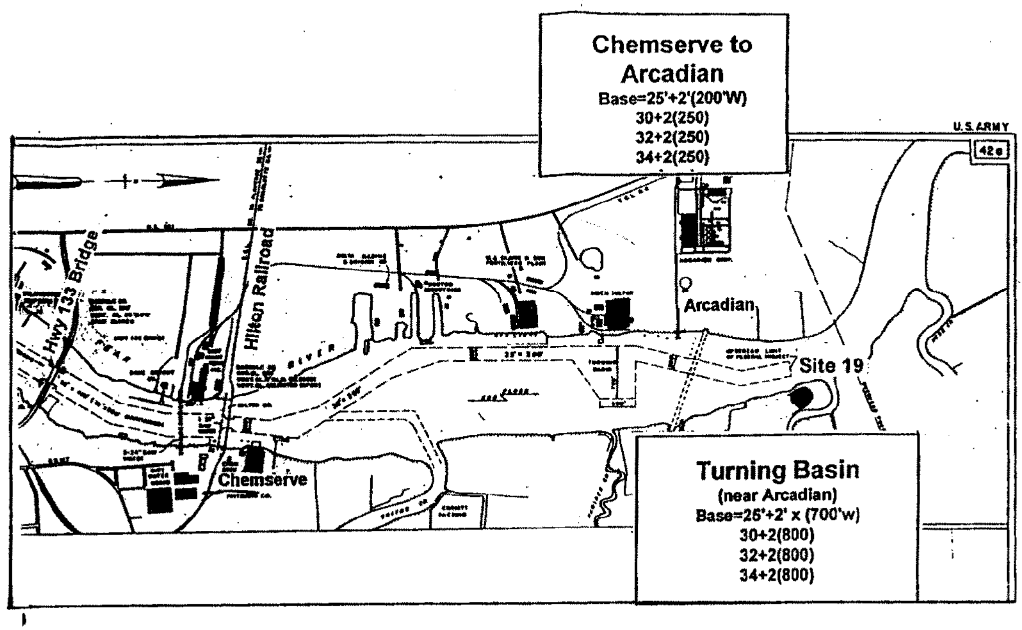

Figure 5. The northern reach of the Wilmington Harbor Project from the Highway 133 Bridge to the Arcadian Plant (former W. R. Grace). Dimension for the channel and the turning basin are given as depth plus overdepth with width (W) in parentheses. All dimensions are in feet. Base dimensions are the exisitng condition. The three sets of dimension below the base data are alternatives considered for the Cape Fear-Northeast Cape Fear Rivers Project. Source: Wilmington District, U. S. Army Corps of Engineers, December 1995.

Table 4. Existing conditions and alternatives proposed for the depth (D) and width (W) for the three reaches of the Wilmington Harbor Ship Channel. Source: Wilmington District, U. S. Army Corps of Engineer (1991d).

	Dimensions (in feet)							
	Reach 1[a]				Reach 2[b]		Reach 3[c]	
	Ocean Bar &Entrance		River Channel					
Plan	D	W	D	W	D	W	D	W
Existing	40	500	38	400	38	300	25	200
A	42	500	40	400	40	300	30	300
B	44	600	42	400	40	300	35	300
C	46	800	44	400	40	300	38	300

a Reach 1 extends from the ocean bar channel to the Cape Fear Memorial Bridge.

b Reach 2 extends from the Cape Fear Memorial Bridge to the Hilton Railroad Bridge.

C Reach 3 extends from the Hilton Railroad Bridge to the upstream project limit.

accommodate larger vessels in the main channel, depths of 40, 42, and 44 feet were considered, with two feet of additional depth across the ocean bar and entrance channels. While channel widths would remain the same for the 40-foot alternative, a wider ocean bar channel would be provided with the 42- and 44-foot alternatives.

Reach 2 extended from the Cape Fear Memorial Bridge to the Hilton Railroad Bridge. This reach includes the confluence of the Cape Fear and Northeast Cape Fear Rivers. Deepening of this reach from its authorized depth of 32 feet to 38 feet was authorized as part of the Wilmington Harbor-Northeast Cape Fear River Project. As stated, local interests requested that the depth of this reach be extended beyond 38 feet to accommodate bulk carriers using the reach. A depth of 40 feet for the reach between the Cape Fear Memorial Bridge and the Hilton Railroad Bridge was considered adequate. Therefore, a 40-foot channel was the only alternative considered for this Reach 2 (USACOE 1991b).

Reach 3 extended from the Hilton Railroad Bridge upstream to the limits of the Federal navigation project on the Northeast Cape Fear River. In 1991 the authorized channel beyond Hilton Bridge to the anchorage basin in front of the Arcadian Nitrex facility (former W. R. Grace) was 25-feet-deep and 200-feet-wide. Acadian Nitrex currently uses small liquid gas tankers to bring in ammonia fertilizer from the Caribbean. Draft limits require even a 15,000-ton tanker to be light-loaded for the voyage. The Wilmington Harbor-Northeast Cape Fear River Project will deepen the channel to 38 feet up to the Hilton Bridge and extend this depth upstream for 750 feet. However, this extension would not reach the last user who would benefit from a 38-foot-deep channel. Alternative depths of 30, 35, and 38 feet for the channel up to Acadian Nitrex were considered. Along with each additional depth, consideration was given to widening the channel to 300 feet and widening the turning basin opposite the Acadia facility by 100 feet.

Design Alternatives Presented in the Preliminary EIS

Subsequent to the May 1991 Reconnaissance Report, several changes were made in design alternatives for project. These revised projects plans were presented in the Preliminary EIS (USACOE 1996a). The 6.2-mile-long Passing Lane is no longer a part of this study but is included in the Wilmington Harbor Channel Widening Project for which the Corps has released a Final EIS (USACOE 1994a). The channels in the Northeast Cape Fear River (the area designated as Reach 3) that were to be widened by 100 feet have been reduced to a width of 50 feet.

Other changes involve modifications to the reaches, designated as 1, 2, and 3, given in the 1991 Reconnaissance Report. The Corps now considers the overall project in three general sections which differ from the three sections proposed in 1991 (Table 5). The first section of the proposed project now includes only the ocean bar and entrance channels, to the upstream end of Battery Island Channel (Figure 1). The second section now extends from Lower Swash Channel to approximately the Cape Fear Memorial Bridge. Revised plans omit changes in the ship channel from the Cape Fear Memorial Bridge to the Chemserve facility just north of the Hilton Railroad Bridge (Figures 4 and 5). The third, and final, section of the project plan extends from the Chemserve facility to the Arcadian Plant (Figure 5). The total length of the project would be approximately 35 miles.

Revised planning considered three basic harbor deepening plans in addition to the no-action alternative (USACOE 1996a). For all dredging alternatives, dredging depths would include 2 feet of allowable overdepth in non-rock areas and 1 foot of required overdepth plus an additional 2 feet of allowable overdepth in rock areas. The additional depth is needed to compensate for dredging inaccuracies and to allow the project to remain at project depth between maintenance events. Channel slopes would be five horizontal to one vertical (5H:1V) for the area of Baldhead Shoal through Battery Island Channel, inclusive, and 3H:1V for the rest of the project.

The first alternative (Plan 1) would involve dredging the harbor 2 feet deeper from the ocean bar through the Memorial Bridge, inclusive. Channel depth would change from 40 feet to 42 feet from Baldhead Shoal to Battery Island Channel and from 38 feet to 40 feet from Lower Swash through the Memorial Bridge. From 750 feet above the Hilton Railroad Bridge to the turning basin at the upper end of the project at Arcadian, the channel would be deepened by 5 feet (25 to 30 feet). The total volume of excavated material associated with this project is about 6,154,136 cubic yards including about 1,687,000 cubic yards of rock. About 187,000 cubic yards of this rock will require blasting.

Alternative two (Plan 2) would involve dredging the harbor 4 feet deeper from the ocean bar through the Memorial Bridge, inclusive. Channel depths would change from 40 feet to 44 feet from Baldhead Shoal to Battery Island Channel and from 38 feet to 42 feet from Lower Swash through the Memorial Bridge. From 750 feet above the Hilton Railroad Bridge to the turning basin at the upper end of the project at Arcadian, the channel would be deepened by 9 feet (25 to 34 feet). The total volume of excavated material associated with this project is about 12,825,000 cubic yards including about 3,423,000 cubic yards of rock. About 564,000 cubic yards of this rock will require blasting.

The third alternative (Plan 3) would involve dredging the harbor 6 feet deeper from the ocean bar through the Memorial Bridge inclusive (40 to 46 feet from Baldhead Shoal to Battery Island

Table 5. Basic design features and construction techniques for the Cape Fear-Northeast Cape Fear Rivers Comprehensive Project, New Hanover and Brunswick Counties, North Carolina. Source: Wilmington District, U. S. Army Corps of Engineers (1996a).

Reach (Name)	Width/Dim (Ft)	Depths	Total Vol. (CY)	Rock Volume Total (CY)	Rock Volume Blast (CY)	Num. of Blasts	Disposal (Location)	Dredge Type
Baldhead Shoal 305+00 to 491+00	500'	44 + 1 + 2(1/2)	965,990	965,990	0	0	ODMDS	suction
Baldhead Shoal 305+00 - 125+00	500'	44 + 1 + 2(1/2)	1,484,090	1,413,527	0	0	ODMDS	suction
Baldhead Shoal 125+00 In	500'	44 + 0 + 2(1/2)	579,410	0	0	0	ODMDS	suction
Smith Island	500'	44 + 0 + 2(1/2)	119,630	0	0	0	ODMDS	hopper
Baldhead - Caswell	500'	44 + 0 + 2(1/2)	57,810	0	0	0	ODMDS	hopper
Souhport	500'	44 + 0 + 2(1/2)	43,790	0	0	0	ODMDS	hopper
Battery Island	500'	44 + 0 + 2(1/2)	45,490	0	0	0	ODMDS	hopper
Lower Swash	400'	42 + 0 + 2(1/2)	119,940	0	0	0	ODMDS	clamshell
Snow Marsh	400'	42 + 1 + 2(1/2)	392,350	1,367	0	0	ODMDS	clamshell
Horseshoe Shoal	400'	42 + 0 + 2(1/2)	270,110	0	0	0	ODMDS	clamshell
Reaves Point	400'	42 + 0 + 2(1/2)	323,280	0	0	0	ODMDS	clamshell
Lower Midnight	600'	42 + 0 + 2(1/2)	626,770	0	0	0	ODMDS	clamshell
Upper Midnight	600'	42 + 0 + 2(1/2)	1,087,510	0	0	0	ODMDS	clamshell
Lower Lilliput	600'	42 + 0 + 2(1/2)	847,860	0	0	0	ODMDS	clamshell
Upper Lilliput	400'	42 + 1 + 2(1/2)	661,050	7,240	0	0	ODMDS	clamshell
Keg Island	400'	42 + 1 + 2(1/2)	570,300	26,580	21,242	21	ODMDS	clamshell
Lower Big Island	400'	42 + 1 + 2(1/2)	334,780	97,747	78,500	75	ODMDS	clamshell
Upper Big Island	400'	42 + 1 + 2(1/2)	358,250	182,747	100,321	129	Eagle Is.	suction
Lower Brunswick	400'	42 + 1 + 2(1/2)	606,300	26,497	12,871	17	Eagle Is.	suction
Upper Brunswick	400'	42 + 1 + 2(1/2)	368,000	4,129	0	0	Eagle Is.	suction
Fourth East Jetty	500'	42 + 1 + 2(1/2)	546,690	3,976	0	0	Eagle Is.	suction
Between Channel	550'	42 + 1 + 2(1/2)	216,080	24,869	0	0	Eagle Is.	suction
Anchorage Basin - 1200' basin extend 300'	1200	42 + 1 + 2(1/2)	1,295,553	622,031	353,177	316	Eagle Is.	suction
750' Chemserve to Arcadian	250'	34 + 1 + 2(1/2)	904,553	45,077	0	0	Eagle Is.	suction
(turning basin)	800'	34 + 1 + 2(1/2)	-	-	-	0	Eagle Is.	suction
		TOTALS	12,825,586	3,423,777	564,111	558		

Channel and 38 to 44 feet from Lower Swash through the Memorial Bridge). From 750 feet above the Hilton Railroad Bridge to the turning basin at the upper end of the project at Arcadian, the channel would be deepened by 9 feet (25 to 34 feet). The total volume of excavated material associated with this project is about 21,723,000 cubic yards including about 6,485,000 cubic yards of rock. About 5,786,000 cubic yards would require blasting.

Alternatives for Dredging and Disposal of Dredged Material

Excavation methods include hydraulic pipeline dredges, bucket and barge dredges, hopper dredges, and blasting. Several alternative disposal plans are under consideration, including beneficial uses of dredged material.

One method would be the use of hydraulic pipeline dredges from about 4 miles south of the State Port (Upper Big Island Channel) to the upstream limit of the Federal Channel with disposal on Eagle Island, an existing, upland, confined disposal facilities (CDF). Beginning about 4 miles south of the State Port (Lower Big Island Channel) to Southport (Lower Swash Channel), a bucket and barge dredge would be used with disposal in the U.S. Environmental Protection Agency approved Ocean Dredged Material Disposal Site (ODMDS). From Southport (Battery Island Channel) to the Smith Island Channel, a hopper dredge will be used with disposal in the ODMDS. On the Baldhead Shoal Channel, rock substrate would be excavated by a rock cutter head dredge with disposal used to complete the Wilmington Offshore Fisheries Enhancement Structure (WOFES, Figure 2). The non-rock material from Baldhead Shoal Channel would be placed in the ODMDS.

Two proposals would use dredge material to renourish local beaches. These proposals will be investigated during the Preliminary Engineering and Design Studies (PED). If either one of these proposals is determined to be feasible (considering environmental and economic costs) during PED studies, they will be discussed in a supplement to the EIS.

The first proposal would utilize a 30-inch hydraulic pipeline dredge to construct the project from the Bald Head Shoal Channel to Battery Island Channel and pump the sandy material to the beaches at Bald Head or Oak Islands. The pipeline dredge would continue to construct the project between Lower Swash and Reaves Point Channel and pump the sandy material directly to either Fort Fisher or Kure Beach. The exact location of these pumpouts would depend on the need and the willingness of the local communities to cost share in any added costs associated with this disposal method. Similar alternatives will be considered for maintenance.

The second renourishment proposal would utilize a hopper dredge to construct the deepening project and the maintenance from the

Bald Head Shoal Channel extension through Battery Island Channel and deposit the sandy material in the littoral zone off either Brunswick County Beaches or Bald Head Island. The long-term maintenance study for Wilmington Harbor (USACOE 1989b) found the area off Long Beach to be the most feasible area in Brunswick County due to the fact that the barges can get relatively close to the beach. Consideration is now being given to depositing maintenance dredging material from the existing project off of Bald Head Island. If this proposed existing maintenance action is approved, suitable material removed during the construction of the project could also be placed there. A bucket and barge system could dredge from Lower Swash Channel through Reaves Point Channel and deposit the sandy material in the same littoral zone. Similar alternatives will be considered for maintenance.

If the costs of either beach nourishment alternatives exceeds the costs for ocean disposal, cost sharing partners will be required for these alternatives.

Soft dredged material could be used to renourish nesting islands of colonial waterbird. This alternative would dispose of dredged material in potential nesting areas. This alternative will be considered by the Corps as a management measure and will be coordinated with natural resource management agencies prior to deposition.

Soft dredged material could be used for wetlands creation. This alternative would Dispose of dredged material into the estuary to create wetlands. This alternative would require alteration of productive estuarine bottom, and was not determined to be desirable.

Alternatives for Rock Removal

For the removal of rock, several alternatives were considered. The Corps reviewed several alternatives to the use of explosives for the removal of nondredgeable rock. The Caterpillar Company has designed a backhoe-mounted ripper tooth. This has been used as a mechanical pretreatment alternative to blasting at Port Everglades, Florida (Smith 1987). In another type of mechanical pretreatment used at Port Everglades, the contractor dropped a large punch or chisel (53,000 lbs) onto the rock surface to pulverize it (Smith 1987). A dipper dredge and rock cutterhead hydraulic dredges have also been used to remove rock without the use of explosives.

A dipper dredge was used briefly in 1994 on the ocean bar with mixed results. The use of a rock cutterhead dredge can probably be used in the harbor on the ocean bar. Such a dredge is currently being successfully used to establish the authorized depth of 40 feet msl on the bar channel. This depth had not been previously established due to the presence of rock. A rock cutterhead dredge probably can also be used in the harbor above the Hilton Railroad Bridge. The rock hardness in the rest of the harbor, Keg Island Channel through the Memorial Bridge, is such that blasting will probably have to be performed. Unconfined compressive strengths of core samples from this area indicate that rock strength may exceed 4,300 pounds per square inch (psi). H.J. Hignett, in a report entitled "The Current State of the Art of Rock Cutting and Dredging," Miscellaneous Paper GL-84-17, September 1984, published by the U.S. Army Corps of Engineers Waterways Experiment Station, suggests, as a guideline, that rock greater than 4,300 psi unconfined compressive strength may not be efficiently removed by a rock cutterhead dredge. Also deepening of the harbor to 38 feet mean sea level downstream of the Memorial Bridge in the late 1960's and early 1970's required blasting of rock from Keg Island to the vicinity of the Memorial Bridge.

Approximately 564,000 cubic yards of nondredgeable rock may have to be blasted within the project limits between the Keg Island Channel and the Memorial Bridge (Table 5). The percentage of nondredgeable rock to the total quantity dredged for the 42 foot project is about 4.4 percent (564,000 cubic yards/12,825,000 cubic yards).

The removal of 564,000 cubic yards of nondredgeable rock translates to about 82.7 acres of river bottom that will be affected, most of which is in the existing channel. This 82.7 acres of river bottom would be removed by dredging (bucket and barge and\or hydraulic dredge) even if no blasting occurs. If rock is blasted in the Lower Big Island and Keg Island Channels (total of about 98,000 cubic yards), it will be removed by bucket and barge dredge and placed on the WOFES. Rock blasted upstream of Lower Big Island Channel will be removed by hydraulic pipeline dredge and pumped to Eagle Island.

SELECTION OF THE PREFERRED ALTERNATIVE

All alternatives were evaluated in order to identify the plan which ". . . maximized net economic benefits" (USACOE 1996a). While the Preliminary EIS does not specifically mention the elimination of the no-action alternative (USACOE 1996a), the assumption may be made that the economic benefits of the status quo were less than those of the three plans for modification.

The three build alternatives were evaluated with an understanding that each incremental increase in channel depth would allow larger, more efficient ships to enter the Port of Wilmington. The evaluation also considered that as channel depths of the various reaches increased, the time spent waiting for tidal advantage and the need for light-loading would be reduced.

Consideration of the selected alternative also assumed that all work on related changes to the Wilmington Harbor Project would be implemented. These projects include the Wilmington Harbor Ocean Bar Project, the Wilmington Harbor Channel Widening Project, and the Wilmington Harbor-Northeast Cape Fear River Project.

The Corps determined that Plan 2 would maximize net economic benefits. Accordingly, this plan is designated the National Economic Development (NED) Plan. Under current Federal planning policy, the NED plan will be recommended for implementation unless there are overriding considerations which favor the recommendation of another plan. Environmental impacts associated with a shallower depth (Plan 1) would be less than those associated with the NED plan, but the Corps has determined that the lesser impacts of Plan 1 are not sufficient to justify recommendation of this plan instead of the NED Plan. Therefore, the NED Plan, Plan 2, has been recommended for implementation.

The Preferred Design Alternative

Deepening of the existing channel from the ocean bar to the Port of Wilmington is the central feature of the proposed action. The total length of channel modifications is approximately 35 miles. As noted, Plan 2 would increase depths of the existing ship channel by approximately 4 feet. This project would require removal of about 12,825,000 cubic yards of dredged material of which about 3,424,000 cubic yards are rock. About 564,000 cubic yards of this rock would require blasting for removal. The construction period for the entire project would be about 3 years.

The Corps' preferred alternative provides for a navigation channel 44-feet-deep and 500-feet-wide from the Atlantic Ocean through Baldhead Shoal Channel to the upper end of Battery Island Channel near the Town of Southport (Figure 1, Table 5). From the lower end of Lower Swash Channel through the anchorage basin, located at the foot of Castle Street in Wilmington, the proposed channel would be 42-feet-deep and 400-feet-wide, except at the passing lane which would 600-feet-wide. The five turn wideners and 6.2-mile passing lane, major elements of the Wilmington Harbor Channel Widening Project (USACOE 1994a), would be deepened to 42 feet. The 1,200-foot-wide anchorage basin, which extends from the North Carolina State Ports Authority to the Cape Fear Memorial Bridge near the foot of Castle Street, would be widened to the north about 300 feet. The project would not involve work between the Memorial Bridge and 750 feet upstream from the Hilton Railroad Bridge. From the Chemserve Facility (750 feet above the Hilton Railroad Bridge) to the Arcadian Plant, the existing 25-foot-deep by 200-foot-wide channel would be deepened to 34 feet and widened to 250 feet. The 700-foot-wide turning basin located at the Arcadian Plant would be widened to 800 feet. The recommended project ends at the Arcadian Plant located 1.6 miles above the Hilton Railroad bridge.

Channel side slopes from the Baldhead Shoal Channel to Battery Island Channel would be 5H:1V. Side slopes for the remaining project reaches and turning basins would be 3H:1V. In addition to the required project depths, dredging depths associated with all of the project features would include 2 feet of allowable overdepth in nonrock areas and 1 foot of required overdepth plus an additional 2 feet of allowable overdepth in rock areas.

Dredging and Disposal of Soft Sediment

Excavation methods include the use of hydraulic pipeline dredges, bucket and barge dredges, and hopper dredges. Hydraulic pipeline dredges would be used from about 4 miles south of the State Port, the vicinity of Upper Big Island Channel, to the upstream limit of the Federal Channel with disposal in an existing, upland confined disposal facility (CDF) on Eagle Island. From the vicinity of Lower Big Island Channel southward to Southport, the vicinity of Lower Swash Channel, a bucket and barge dredge would be used with disposal in the US Environmental Protection Agency approved Ocean Dredged Material Disposal Site (ODMDS). From Southport, the vicinity of Battery Island Channel, to the ocean bar channel, the vicinity of Smith Island Channel, a hopper dredge would be used with disposal in the ODMDS. Dredging by bucket and barge in the river, hopper dredging in the lower river and ocean, and rock dredging in the ocean would be conducted throughout the year.

The Corps has proposed several options to the disposal plan outlined above. These options include a plan to place sandy material in the littoral zone off Brunswick County Beaches or Baldhead Island, placement on islands used by colonial waterbirds, and/or placement in the estuary to create wetlands. These options will be investigated in Preliminary Engineering and Design Studies.

Dredging and Disposal of Rock and Preliminary Blast Plan

Wherever possible, rock would be removed by a cutterhead dredge. In areas where the rock is too hard for conventional dredging, the project would require blasting. The Corps predicts that blasting would be required in portions of the area from Keg Island Channel upstream to the Cape Fear Memorial Bridge (Table 5). Current information indicates that 564,000 cubic yards of rock will require blasting for removal. Project plans currently estimate that 558 blasts would be required. The number of actual blast days has not been determined. The area requiring blasting would be approximately 82.7 acres with all of this area in the existing channel bottom.

The preliminary blast plan developed by the Corps reflects industry standards for underwater blasting. This preliminary blast plan balances the issues of the cost-effective production of rock removal and minimizing the impacts of blasting on the estuarine environment. Normal industry procedure requires the contractor to perform limited onsite blasting tests and adjust the final plan to actual site conditions. Therefore, some plan modifications may occur.

Blasting would be conducted with charges arranged in frames. Each frame would consist of 8 rows with 10 holes per row, for a total of 80 charges per frame. Holes would be on 8-foot spacing between each charge in a row and 8 feet between rows. Each hole would be 4.5 inches in diameter. Stemming (filling the top of the holes with angular rock) would be 1 foot. Inserting one delay per hole, charge weight would be 98.5 pounds per hole. Total weight of charges per frame (i.e., 80 holes) would be 7,880 pounds. A bubble curtain and/or a physical barrier would be placed completely around the blast area. The area enclosed by the bubble curtain would be approximately 35,000 square feet which includes a safety set-back of the curtain of about 40 feet from the nearest blast hole.

From Upper Big Island Channel to the upstream limit of the project, rock debris from both dredging and blasting would be removed by pipeline dredge and pumped to Eagle Island. Downstream from Lower Big Island Channel, rock debris produced by blasting would be removed with a bucket and barge dredge and deposited in the WOFES. The estimated volume of rock that would be placed in the WOFES is 2,400,000 cubic yards. Blasting and hydraulic pipeline dredging in the river would be restricted to the period from August 1 to January 31.

Blasting impacts on fish, sea turtles, and aquatic mammals would be reduced, to the extent feasible, by placing rock in each hole over the charge (stemming), single delays per charge, and other protective methods such as bubble curtains or physical barriers. Additional measures which would be used to protect threatened and endangered species include observers on dredges and turtle deflector heads on hopper dredges. The Corps will investigate the use of small "scare" charges which would be detonated one minute to each blast. The purpose of these small pre-blast detonations would be to frighten aquatic animals away from the blast site. However, different species may reaction differently to these detonations. These small explosions sometimes frighten shad and herring from the site, but may attract predators to the site.

The Corps has proposed a preliminary pre- and post-blast impact monitoring plan. The pre-blast monitoring program would be used to minimize adverse impacts on Federally endangered or threatened species. The Corps anticipates that protective measures would include, at a minimum, pre-blast monitoring, with dedicated NMFS-approved observers to assure that no sea turtles or marine mammals (including bottlenose dolphins) are present in the vicinity of any blast and use of a gillnet survey to capture and relocate shortnose sturgeon to holding areas outside of the impact areas (Moser and Ross, 1993). Should listed species be observed, blasting would be delayed, if possible. After blasting, observers would also examine the area to determine if incidental take of listed species resulted from a blast. Through implementation of such protective measures, it is believed that potential impacts on listed species can be minimized.

For fish species other than the shortnose sturgeon data will be collected regarding species and size of fish caught during the aforementioned pre-blast gillnet surveys for shortnose sturgeon. Observers will inspect the blast impact area and the area immediately down current for fish mortality after each blast. Post-blast observations will be documented.

The Corps plans to coordinate the final pre- and post-blast monitoring plans with the NMFS, the Service, the North Carolina Division of Marine Fisheries, and North Carolina Water Resources Commission.

Maintenance Dredging Requirements

The channel modifications included in the selected plan will be maintained in conjunction with maintenance of the overall Wilmington Harbor project. Maintenance dredging will continue to be conducted at the same frequency, generally every 1 to 5-years depending on the channel. Dredging methods and disposal locations described above will be used for maintenance. Average annual maintenance dredging requirements for the selected plan and alternatives would essentially be the same.

Proposed Compensation for Unavoidable Wetland Losses

The proposed dredging activities would excavate approximately 13.2 acres of estuarine bottom which have been designated as primary nursery areas (PNA) by the North Carolina Division of Marine Fisheries. The shallow water areas would be excavated to a depth greater than 10 feet mean low water. The project would also excavate approximately 0.2 acre of mixed tidal marsh. Therefore, approximately 13.4 acres of PNA would be lost due to project construction. These losses would all occur upstream from the mouth of the Brunswick River. Additionally, 4.7 acres of non-primary nursery area would be excavated to a depth greater than 10 feet mlw. The non-primary nursery area is all downstream of the mouth of the Brunswick River.

The proposed mitigation plan for the loss of primary nursery and marsh areas calls for restoration at a 2:1 ratio, or the restoration of about 27 acres of estuarine/marsh habitat. No mitigation is proposed for the non-primary nursery areas excavated. Mitigation sites under consideration are existing disposal areas in the Cape Fear River. The Corps is also considering a mitigation plan which would combine restoration, at a minimum ratio of 1:1, with the preservation of valuable riparian areas at a much higher ratio.

POTENTIAL IMPACTS OF THE PREFERRED ALTERNATIVE

The potential, adverse, environmental impacts of the preferred alternative may be divided into three broad categories. These categories are direct, indirect or secondary, and cumulative adverse impacts. In addition to adverse impacts, the proposed project may produce some beneficial environmental impacts. A consideration of potential impacts in each category is given below.

Direct Impacts

Direct, adverse, environmental impacts are defined as those conditions which are caused by any action undertaken to accomplish the proposed project and occur at the same time, or very soon after, and place as the action.

Impacts Associated with Offshore Disposal - The dumping of dredged material in either the ODMDS or the WOFES could cause direct injury or death to fish, sea turtles, or marine mammals which are in the path of the released sediment. While these organisms are mobile, the release of an entire barge filled with soft sediment or a rock-soft sediment mix could result in material striking those organisms which are directly beneath the barge.

Impacts Associated with Inland Disposal - The disposal of clean dredge material in upland, confined disposal facilities has the potential to either harm or help the nesting of colonial waterbirds. The proper design and construction of disposal sites can be very beneficial to avian species which have lost much of their former nesting habitat to coastal development. Conversely, poorly designed disposal facilities or facilities which are not maintained can eliminate areas which have been very productive in the past.

Impacts Associated with Contaminants in Soft Sediment - Sediment in or near the present shipping channel may contain hazardous or toxic substances. Sections of the northern project area are near existing docking facilities, and over the years any material which leaked or spilled from ships could have accumulated in the nearby sediment. If the sediments contain toxic material, the project could release this material into the water column during dredging. If contaminated material was placed in the ODMDS, the offshore organisms could be adversely affected. If the material was placed on an inland, confined disposal facility, the species using this area, including colonial waterbirds, could be adversely affected.

Impacts Associated with Increased Turbidity - Blasting and dredging will result in increased turbidity in the immediate vicinity of the blast or dredging operation. Turbidity levels will depend on the amount of fine particles in the material being removed. Suspended particles may block the gills and/or food filters of larval fish and invertebrates, including shrimp and anadromous fish. High levels of suspended solids may result in physiological stress to both benthic and nektonic species.

The Wilmington District conducted a field study of clamshell dredging and barge overflow at the MOTSU in 1987. The sediment dredged was maintenance material which predominantly consisted of silts and clays with fine sand. Dredging produced visible plumes of turbid water. Clamshell bucket dredging operations are cyclic, and turbidity plumes result from bottom impact, loss from the bucket during ascent from the bottom, and bucket spillage and overflow. The plumes formed a series of patches which tended to spread and merge as they were advected downstream. The plumes were not visible to observers in boats at distances greater than 1,000 feet down-current. Approximately 600 water samples were taken around the dredge. Only four samples (0.7%) produced turbidity measurements which exceeded 25 nephelometer turbidity units (NTUs). All values greater than 25 NTUs were from bottom samples and ranged from 27 to 33 NTUs. In addition to station samples, worst-case, or point of disturbance, samples were taken approximately 10 feet from the dredge and the overflow point. Maximum turbidities among these samples were 72 NTUs at the surface and 150 NTUs at a depth of 30 feet. The amount of total suspended solids (TSS) at these positions were 327 milligrams/liter (mg/l) and 739 mg/l, respectively.

The 1987 study also made eight complete samples of the vertical distribution of suspended material concentrations within the turbid plume created by the dredge. These values were depth averaged. The depth averaged value of TSS was found to be 65 mg/l above background. Based on this concentration, the apparent sediment release rate from the clamshell operation was estimated to be 2,459 gram per second (g/sec). However, actual sediment release rates from the clamshell operation were probably on the order of 100,000 g/sec. The apparent sediment release rates were only 2-4 percent of the probable total sediment release rate. Most of the sediment released by dredging did not enter far-field suspension. Based on these data, turbidity may produce some short-term, localized adverse impacts on certain aquatic organisms.

Direct Mortality to Aquatic Organisms due to Dredging of Soft Sediment - All benthic invertebrate infauna within the sediment removed will be lost. Removal of rock using a cutterhead dredge will result in mortality of benthic organisms, plankton, and nekton unable to escape the dredge. Larvae are particularly vulnerable because many are flowing freely with the currents and are unable to avoid dredging operations. Although some adults would also be impacted by dredging, many nektonic invertebrates and vertebrates may be able to avoid dredging areas.

The impacts of hydraulic entrainment have been the subject of concern for more than a decade. Studies have been conducted nationwide to assess these impacts on early life stages of marine resources such as larval oyster (Carriker et al., 1986), post-larval brown shrimp (Van Dolah et al., 1994), striped bass eggs and larvae (Burton et al., 1992), juvenile salmonid fishes (Buell 1992), and Dungeness crabs (Armstrong et al., 1982). These studies indicate that the primary organisms subject to entrainment by hydraulic dredges are bottom-dwelling fish and shellfish. The significance of impacts due to entrainment depends on the species present; the number of organisms entrained; the relationship of the number entrained to local, regional, and total population numbers; and the natural mortality rate for the various life stages of a species.

As part of the assessment of dredging impacts, the Corps has calculated the proportion of water which a dredge could intercept during a day (USACOE 1996a). A hydraulic dredge with a discharge pipe no larger than 30 inches in diameter would be capable of transporting about 40,000 cubic yards of sediment per day. This sediment would be pumped as a slurry containing about 15 percent sediment by volume. Based on these conditions, the volume of water discharged during a 24-hour period would be approximately 226,700 cubic yards, or 6,120,900 cubic feet. At the calculated rate, the hydraulic dredge would discharge approximately 70 cubic feet per second (cfs) throughout a 24-hour day. The average daily freshwater inflow of the Cape Fear River is approximately 9,700 cfs in the vicinity of Turns 2, 3, and 4 (Figure 1). Between Fort Caswell and Bald Head Island, the average discharge over a tidal cycle is about 200,000 cfs (Carolina Power and Light 1979). Therefore the amount of water intercepted by an operating dredge, 70 cfs, would constitute approximately 0.7% (70/9,700) of the average flow in the vicinity of the turns indicated.

One interpretation of the calculations given above is that a single hydraulic dredge would have no significant, adverse impacts on nektonic organisms in the Cape Fear River. However, this interpretation is based on an assumption that these organisms are randomly distributed in time and space. The assumption of a random time distribution is especially questionable. The reproductive strategy of some aquatic organisms is based on the production of a large number of offspring during a relatively brief period of time. In these cases, the annual production of larvae would not be uniformly distributed throughout the year, but highly concentrated in a relatively brief period. The adverse impacts on these species due to larval entrainment could be quite high. Furthermore, the assumption of low impacts does not fully consider the very high natural mortality among the developing forms of many aquatic species. In those cases where a delicate balance exists between the number of offspring and the natural mortality among various juvenile stages, any additional mortality factors could reduce recruitment into the adult, reproductive population.

Direct Mortality to Aquatic Organisms Due to Blasting - Blasting may result in the mortality of invertebrates, fish, sea turtles, and marine mammals. The lethal range of the shock waves produced by underwater explosions will vary among different groups of organisms. Furthermore, the lethal range will depend on the type of explosives used and the methods of blasting. The greater the distance between an animal and the explosion, the lower any adverse impacts of the blast.

Linton et al. (1985) summarize past studies on the effects of blasting on marine organisms. These studies indicate that different species and different life stages of the same species react differently to shock pressures. Eggs, larvae, juveniles, and adult organisms with air bladders tend to be most susceptible to explosives. Damage is directly proportional to the pressure produced by the explosion and the time over which it is produced. For example, a high velocity explosive produces high pressure shock wave, usually expressed as pounds per square inch (psi), over a short duration while a low velocity explosive produces a lower pressure shock wave over a longer time period.

Water is a good transmitter of shock waves (Du Pont Company 1980). The damaging effects on aquatic organisms increase in relation, but not in direct proportion, to increasing the weight of the explosive charge. The shock wave from an underwater explosion diminishes over distance at a rate proportional to the cube root of the weight of the explosive charge. Therefore, the peak pressure generated by an 8-pound charge at a given distance is only about twice the peak pressure of a one pound charge at the same distance ($\sqrt[3]{8} = 2$). Thus, doubling the weight of an explosive charge does not double the impact to aquatic life (Young, 1991).

Marine invertebrates such as clams, oysters, and crabs, have been found to be highly resistant to explosive shock (Gaspin, 1975; Gaspin et al., 1976; as cited in O'Keefe and Young, 1984). Experimental studies have shown that many types of bottom-dwelling invertebrates such as sea anemones, polychaete worms, isopods, and amphipods exhibit no damage from blasting (Gaspin, 1975; Gaspin et al., 1976; as cited in O'Keefe and Young, 1984). Due to the high resistance of benthic invertebrates to blast impacts, any damage sustained by these populations should be negligible outside the immediate blast vicinity.

Studies have shown that the degree of impact experienced by fish as a result of explosions is determined by several factors, including physical characteristics of the fish, the weight of the explosive charge, and the distance of the fish from the explosion. Swimbladder fish have been found to be more susceptible to damage from shock waves than nonswimbladder fish.

The rapid rise and fall in pressure causes swim bladders to rupture because they do not have time to adjust. Underwater shock waves from high-velocity explosives have been reported to result in the rupture of the swimbladder and other internal organs of fish. Most common, estuarine fish, except flounders, have swimbladders.

Smaller fish are more susceptible to damage from shock waves than larger fish of the same species (Wright, 1982). Larval fish are less sensitive to the effects of shock waves than eggs or post-larval fish in which the swimbladder has developed (Rasmussen, 1967; as cited in Wright, 1982).

Linton et al. (1985) state that generally, high velocity explosions producing a peak pressure of 40 psi will kill some fish within a certain radius of the explosion and those producing a peak pressure above 70 psi will kill all fish within a certain radius of the blast site. However, with low velocity explosives, such as black powder, pressure rises and falls slower and fish may withstand pressures over 70 psi.

Some data on the impacts of underwater explosions on sea turtles have come from the removal of offshore petroleum platforms (National Research Council 1990). In 1986 ten petroleum structures were removed in the nearshore area of the upper Texas Gulf coast. During the period of this work, 51 sea turtles, primarily Kemp's ridleys, were found dead on beaches of the area. Shrimping which can cause turtle mortality was at a seasonal low, and some circumstantial evidence suggested that at least some of the strandings were due to the underwater explosions used to remove the petroleum structures.

It has been difficult to document a cause-and-effect relationship between turtle mortality and the use of explosions to remove offshore structures because no dead animals have been recovered at the removal site. This lack of evidence for direct mortality may be due to the fact that freshly killed turtles sink and drift a long way before putrefaction causes them to float to the surface (National Research Council 1990). However, damage to sea turtles is thought to resemble that observed in mammals with injury to lungs, intestines, and auditory systems (O'Keeffe and Young, 1984).

Manatees may be killed or injured by underwater blasts depending on their distance from the blast site. The injuries sustained by manatees near underwater blasts are likely to be similar to those of humans, e.g., damage to lungs, intestines, and auditory systems.

Indirect or Secondary Impacts

An indirect effect is defined as a consequence of an action or groups of actions undertaken to complete a project which occurs later in time and/or at some distance from the actual action. An indirect effect which produces a permanent alteration or degradation of a given habitat may be more serious than a direct effect which produces severe, but short-term, impacts. Since indirect impacts are separated in time and/or space from their causative factors, a precise cause-and-effect relationship between the action and the impact may be questioned. However, the Service is concerned that the proposed project may produce indirect impacts. Our concerns on specific, indirect impacts are given below.

Loss of Biological Productivity in Estuarine and Marine Ecosystems - The project would result in the loss of approximately 13.4 acres of wetlands used as primary nursery areas for juvenile finfish and beneficial for other aquatic organisms. Compensatory mitigation may not completely replace the functions of these areas. Any permanent loss of primary nursery area would diminish the productivity of estuarine and marine ecosystems. The primary productivity of shallow estuarine areas forms the base for many important foods chains on which fish and wildlife resources depend. The permanent loss of primary nursery areas would be detrimental to estuarine fish and wildlife resources.

Increased Erosion of Riverine Shoreline due to Larger Wakes from Larger Ships - The primary purpose of the proposed project is to allow larger ships to move up the Cape Fear River. Larger ships displace greater amounts of water than smaller ships. This greater displacement of water may result in greater wave action along the riparian shoreline as ships move up and down the ship channel. Larger waves impacting the riparian shoreline will stir the sediment and could lead to increased shoreline erosion. Any shoreline erosion would produce a loss of riparian habitat and adversely affect those organisms which depend on that habitat. An increase in shoreline erosion could also lead to demands for construction to stabilize the shoreline. This construction could also be detrimental to organisms in the area.

Increased Erosion due to Disruption of Longshore Transport System - An increased depth of the Wilmington Ship Channel may result in additional erosion along beaches of the adjacent barrier islands. Bald Head Island and Oak Island are east and west of the mouth of the Cape Fear River, respectively. Both islands are subject to the loss of beach area when sand losses are not balanced by sand deposition. Bald Head Island has been experiencing serious erosion especially along its southern beach for two decades. As requested by the Village of Bald Head Island, the Corps completed a Reconnaissance Report in 1989 on Bald Head Island which determined that there was no direct relationship between the dredging of the Wilmington Harbor Ocean Bar Channel and the severe erosion occurring on Bald Head Island (USACOE 1989c).

However, dredging of navigation channels with offshore disposal has been linked to erosion of adjacent shorelines. The removal of material from Oregon Inlet with deposition offshore has been directly linked to the erosion of adjacent Pea Island. If a natural sand bypassing process is interrupted, erosion may accelerate on nearby beaches. The relationship between interruption and erosion is almost direct; with each cubic yard of sediment loss, there is an equivalent amount of erosion (Dolan et al. 1991).

The enlarged shipping channel will trap sediments moving through littoral transport along the coast. This trapping of sand will disrupt the longshore sediment transport system, and may result in a reduction of sand which is available for deposition on adjacent beaches.

In addition to the trapping of sand, the longshore transport system also could be disrupted by the loss of a large quantity of material. If the material removed from the channel during initial construction and maintenance dredging is deposited offshore, outside of the littoral system, this material will be lost from the system. These impacts are very difficult to predict, especially without a detailed understanding of the sediment budget in the immediate area.

Saltwater Intrusion into Groundwater - Dredging to increased depths on the Cape Fear River has the potential to increase saltwater intrusion into the aquifers and increase salinity in ground water. The Corps' Reconnaissance Report assessed this potential problem by stating (USACOE 1991b):

> "The current withdrawals of ground water is thought to be a small part of the available supply although the water availability varies. The aquifers are susceptible to salt-water encroachment because of the aquifer containing salty-water underlying the Peedee sandstone and because of the bordering Atlantic Ocean and brackish Cape Fear River. The volume and hydrostatic head of the fresh water maintain the position of the interface between salty and fresh water. Therefore, a substantial reduction in rainfall or changes in ground-water conditions caused by withdrawal of water by overpumping, swamp drainage, or dredging which reduces the fresh water hydrostatic head, may cause an encroachment of saltwater (Bain 1970)."

At the present time the Corps is supporting a Wilmington Harbor Groundwater Study. The second phase of this is currently underway and will involve a three dimensional, finite groundwater model called FEMWATER. The objectives of this phase are to determine: (1) if deepening the channel would cause changes in water levels in the aquifer system; (2) if salt water encroachment would occur due to upward movement of an underlaying freshwater/salt water interface; and if salt water encroachment would occur from the river due to changes in a recharge/discharge relationship between the river and the aquifer system. The basic outline of this study and preliminary data were presented to resource agency personnel at a meeting on April 18, 1996.

In the absence of definitive data, the Service must consider the possibility of increased salinity in groundwater supplies. Increased salinity could result from the creation of breaks in confining layers within the groundwater system due to dredging. Furthermore, increased development in the project area and the resulting increased withdrawals from existing groundwater supplies could reduce current pressure within aquifers and, over time, reverse the current flow of freshwater into the river.

If freshwater wells near the Cape Fear River became unusable because of increased salinity, local residents and businesses would be forced to obtain freshwater elsewhere. This effort could require the construction of an extensive system of water supply pipes. Such a construction effort would be detrimental to the fish and wildlife resources in the area. Furthermore, freshwater could be withdrawn from surface water supplies including the Cape Fear River. There would probably be increased requests to dam freshwater streams in the area. Such damming would be very detrimental to aquatic resources in the area, particular anadromous fish. Any significant reduction in freshwater flow into the lower Cape Fear River could increase the potential for greater saltwater intrusion in the river and its tributaries.

Increase in Saltwater Intrusion in Surface Water - Deepening the Wilmington Ship Channel may increase the tidal amplitude moving into the Cape Fear River and increase saltwater intrusion farther upstream. This may result in the additional conversion of forested wetlands into oligohaline marsh and other salt tolerant communities. Such impacts are difficult to attribute to particular channel modifications, and the extent of such habitat conversions is especially difficult to predict. Any conversion of freshwater, forested wetlands into oligohaline or salt marsh will benefit fauna adapted to increased salinity and adversely affect species depending on freshwater wetlands. An upstream extension of saltwater would increase the ranges of marine fish and invertebrates, such as pink shrimp, farther upstream and prevent the movement of freshwater species downstream. The Corps noted that minor salinity changes in the Northeast Cape Fear

River may cause slight changes in the species composition of benthic invertebrates and fish (USACOE 1991b).

Over the past 100 years, the deepening and widening of the Cape Fear River channel has been implicated in the 53 centimeter (20.9 inches) increase in tidal range and the 26.5 centimeter (10.4 inches) increase in high tide above previous levels at Wilmington. Except in the headwaters of tidal creeks that receive significant freshwater flow, much of the forested wetlands within the middle reaches of the estuary, where salinities range from 5 to 18 parts per thousand (ppt), have been converted to brackish marsh dominated by black needlerush and Olney bulrush *(Scirpus olneyi)* (Hackney and Yelverton 1990). In the tidal swamps of the upper estuary, where salinities range from 0.5 to 5 ppt, estuarine vegetation has changed due to increased tidal flooding and increased salinities (Hackney and Yelverton 1990).

The Corps cited a brief study by the State of North Carolina performed during 1987 on the problem of recent (approximately 1982-1987) tree mortality in riparian areas along the lower Northeast Cape Fear River (USACOE 1994a). That study concluded that tree death in this area was attributable to high levels of salinity in the river. Site inspections by the Corps during January and May, 1988 found that tree mortality was evident throughout the lower Northeast Cape Fear River estuary. Salinity stress was noted on Smith Creek to a point approximately 1.5 miles upstream from the Southern Coastline Railroad (SCLRR) bridge (Figure 1).

The potential for a change in the magnitude of saltwater intrusion resulting from the proposed project was modeled. Preliminary results were presented at a meeting in Wilmington, North Carolina on August 22, 1995. Initial results indicated that during low flow conditions deepening may slightly decrease salinities.

Based on comments made during the initial presentation of the model, additional model runs were made. These model runs considered changes in saltwater intrusion resulting from past channel deepenings. The results of these simulations were presented to resource agency personnel and other interested parties on April 18, 1996a. These additions tests also indicated that the proposed deepening would decrease salt water intrusion in the Cape Fear and Northeast Cape Fear Rivers.

Direct Mortality and Habitat Degradation due to Accidents Involving Larger Ships - The proposed project is likely to result in increased traffic by larger ships. This result would increase the potential for environmental damage in the event of an accident. The 1991 Reconnaissance Report states that the five largest commodities among the waterborne commerce of Wilmington

Harbor in the 1987-1988 period were, in descending order, petroleum products, industrial chemicals, asphalt and tar, pulp and paper products, and fertilizer (USACOE 1991b). This report also states that the current channel is used by 15,000-ton liquid gas tankers to carry ammonia fertilizer (USACOE 1991b). A massive spill of ammonia or any hazardous substance could result in extensive environmental damage.

Cumulative Impacts

Cumulative adverse, environmental impacts may be defined as those conditions which result when the impact of a single, localized project is considered in the context of all other similar impacts to the same resource within a larger area. The precise definition of the given resource and the exact extent of the area to be included must be defined for each evaluation. However, it is possible to present a relevant example. If the annual loss of acres of tidal, freshwater, forested wetlands in North Carolina was exactly equal to the acres being created through compensatory mitigation or natural succession, the State would have no net loss of this valuable resource. The proposed project may cause the loss of this community due to increased saltwater intrusion. While the actual number of acres lost as a result of the present project may be small, a consideration of the State-wide status of this community might show that this single project altered the balance from a stable number of acres to a net loss. In this hypothetical example, the cumulative impact of a single channel enlargement project would be significant.

Theoretically, each of the direct and indirect, adverse impacts addressed above could be assessed from a perspective of its contribution to the cumulative nature of that impact within North Carolina. However, the Service's primary concerns about cumulative impacts involve the reduction in the quantity and quality of fish and wildlife habitat. While the direct mortality associated with a particular project may be disturbing, particularly with regard to Federally-listed species, in many cases these losses of fish and wildlife resources can be restored in time if the quantity and quality of the habitat have been maintained.

In considering the proposed project, the Service is concerned about the cumulative nature of the six indirect impacts. There is a distinct possibility that the loss of shallow water wetlands, the increase in riparian erosion, the increase in beach erosion, and the construction needed to replace existing groundwater supplies could, when considered with similar impacts on a state-wide basis, lead to an overall loss in the quantity of fish and wildlife habitat. Similarly, there is a distinct possibility that accidental spills from large cargo ships, the increased salinity in areas which are now freshwater communities, and the diversion of surface freshwater to replace lost groundwater supplies could, when considered with similar impacts on a state-wide basis, lead to an overall reduction in the quality of fish and wildlife habitat.

Potential Beneficial Impacts

Use of Soft Sediment to Provide Nesting Habitat for Colonial Nesting Waterbirds - Sediment removed from the ship channel which has suitable texture and is free of contaminants could be used to create nesting habitat for colonial birds. Existing dredge material islands which are developing dense ground vegetation are becoming unsuitable for those species which require open areas for nesting. The proper placement and grading of sediment from the proposed project could restore the habitat value of these existing, artificial islands.

Use of Dredged Rock to Create an Artificial Offshore Reef - A potentially positive use of the rock after removal from the channel would be to use it for the creation of artificial reef habitat. An artificial reef created with natural rock would provide substrate for marine organisms to attach and grow, provide excellent foraging habitat, and serve as a refuge for fish and other organisms. However, the material deposited for this structure must contain rocks of the appropriate size, be free of contaminants, and not have a significant amount of fine sediment.

FISH AND WILDLIFE CONSERVATION MEASURES

Fish and wildlife conservation measures as specified in the Fish and Wildlife Coordination Act consist of "...means and measures that should be adopted to prevent the loss of or damage to such wildlife resources (mitigation), as well as to provide concurrently for the development and improvement of such resources (enhancement)." Mitigation, as defined by the Council on Environmental Quality and adopted by the Service in its Mitigation Policy, includes:

1. avoiding the impact altogether by not taking a certain action or parts of an action;

2. minimizing impacts by limiting the degree or magnitude of the action and its implementation;

3. rectifying the impact by repairing, rehabilitating, or restoring the affected environment;

4. reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and,

5. compensating for the impact by replacing or providing substitute resources or environments.

These five actions should be viewed as the proper sequence for formulating conservation measures.

Enhancement measures are those which result in a net increase in resource values under the with-project condition compared to the without-project condition. For any given type, kind, or category of resource being evaluated, there must be compensation (i.e., full replacement) for all project-associated losses before any enhancement of that given resource can occur.

Many of the direct, adverse impacts of the proposed project cannot be completely avoided. While many of these direct impacts may have a significant, short-term detrimental effects on the fish and wildlife resources of the project area, the most harmful aspects of the proposed project are likely to be the permanent loss of important habitats and the start of a long-term decline in habitat quality. Therefore, the conservation measures for this project should focus on ways to minimize short-term direct impacts, avoid long-term loss and degradation of habitat, and promote those actions which will benefit fish and wildlife resources.

Dredging and Disposal of Soft Sediment

The increased turbidity associated with the removal of soft sediment cannot be completely avoided. However, it is possible to ensure that dredging does not introduce toxic substances into the aquatic environmental. The 1991 Reconnaissance Report states that bioassay/bioaccumulation tests have not been under taken north of Keg Island Channel (USACOE 1991b). However, the report states that sediment was collected from Keg Island in July 1986 for bioassay and bioaccumulation analysis. These tests indicated that this sediment was safe for offshore disposal. A comprehensive toxicological testing program from a sample of all regions of project area would determine the safety of dredge material for offshore or upland disposal.

The Corps proposed routine dredging by bucket and barge and hydraulic pipeline equipment on a year round basis. This will mean that operations will occur during periods when manatees are most likely to be in the project area. The Service believes that such dredging is compatible with the presence of manatees if certain precautions are implemented. The Service's manatee coordinator has prepared a list of standard conditions for work in areas where manatees may be present (Appendix B). Those conditions which are applicable to the proposed project should be employed to minimize potential harm to this Federally-endangered species.

Soft sediment will be placed in either the Wilmington ODMDS or in an upland confined disposal facility. Disposal offshore presents a risk of direct harm to marine mammals, sea turtles, and important fisheries resources. The Corps should employ any available technology which allows disposal crews to detect the presence of these organisms in the immediate dump site. If possible, sonar devices should be used to detect the presence of marine mammals. In conjunction with detection devices, a procedure should be established to halt disposal if species in the groups mentioned above are in the immediate vicinity of the disposal operation.

The disposal of soft sediment does present an opportunity to add beach quality sand to the longshore transport system near the mouth of the Cape Fear River. The placement of beach quality sand in the littoral zone of Brunswick County could serve to reduce the loss of beaches which are used as sea turtle nesting sites. Disposal of soft sediment also presents an opportunity to enhance nesting habitat for colonial waterbirds. The proper placement and grading of sediment of the proper texture on established upland confined disposal facilities would create nesting habitat for these species. Sediment disposal on a confined disposal facility should present little direct harm to estuarine resources if the flow of turbid water back into the estuary is carefully controlled.

Blasting and Disposal of Rock

The impacts of blasting in a dredging operations add significantly to the adverse effects produced by the routine removal of soft sediment. The Service believes that a comprehensive blasting program which incorporates multiple layers of protection can significant minimize harm to the aquatic resources in the project area. The major elements of the blast plan should include:

1. Specific procedures to ensure that blasting is used only as a last resort to remove nondredgeable rock;

2. If blasting is required, it should be limited to a specific time of year which minimizes risk to whales, dolphins, manatees, sea turtles, and important fisheries resources;

3. Within the designated blasting period, the selection of explosives and blasting techniques, such as stemming holes and delays between individual charges, should be used to minimize the production of harmful shock waves;

4. Pre- and post-blast monitoring plans should be implemented;

5. The Corps should use all practical methods, such as the use of small, pre-blast detonations, to induce important, mobile aquatic organisms to leave the blast area; and,

6. The Corps should also employ additional techniques, such as bubble curtains and physical barriers, to contain blasting impacts to the smallest possible area.

The major elements of these six protective measures are given below:

As an initial step in avoiding the adverse impacts of blasting, the Corps should ensure that blasting is only used as a final resort. The Corps should develop definite criteria for the use of blasting and ensure that the contractor understands and abides by these measures.

As part of the planning process the Corps should also determine an annual time frame for blasting. While we are pleased with the many design features and construction techniques which the Corps is proposing to minimize adverse impacts, the Service believes that even the combined benefits of these measures have margins of error which could allow significant harm and/or death to organisms in the project area. Therefore, the Service recommends that blasting should be restricted to the time of year of lowest biological activity. However, finding a suitable time period for blasting will be difficult because the critical time periods for whales, manatees, sea turtles, larval fish, and adult fish do not coincide.

The current "window" for blasting in the lower Cape Fear River is the six-month period from August 1 through January 31. This schedule is based primarily on concerns for fisheries resources, including the Federally-endangered shortnose sturgeon. The Service supports the use of this schedule. However, the Service has determined that the Federally-endangered manatee is most likely to occur in the project area during the period between June 1 and September 30. While sea turtles may occur in the estuary during all months of the year, they are most abundant from April through September (Table 3). Therefore, the Service believes that blasting during August and September could harm and/or kill manatees and sea turtles, and therefore we believe that blasting should be limited to the four-month period from October 1 through January 31.

Even within the four-month blast period recommended above important fisheries resources and sea turtles, may be present in the project area. Therefore, the selection of the proper type of explosives is a major factor in the potential impacts on aquatic organisms. One important characteristic of the charge is velocity. Velocity refers to the speed at which a detonation wave travels through a column of an explosion (Du Pont 1980).

High velocity explosives rapidly produce a high pressure spike of relatively short duration. On the other hand, low velocity explosives rise relatively slowly to a lower maximum pressure. The sudden pressure wave produced by high velocity explosives can be harmful to aquatic organisms, especially to organisms with air-filled cavities, such as swimbladders in fish and lungs in mammals. These factors should influence the selection of explosives for the proposed project.

After the selection of the explosives, the procedures used in setting explosives can have an important influence on the impacts of the blast. The drilling of blast holes and the stemming of the charges can minimize adverse impacts. The amount of explosives detonated at one time also plays an important role. The Corps should seek to minimize the size of each blast.

The use of delays with blasts composed of multiple charges can minimize impacts. A single blast sends out a shock wave which can harm or kill aquatic organisms. When multiple charges are denoted, there is a potential for shock waves to overlap. As with water waves, the overlap of two peaks are additive and doubles the force of the wave and, thus, the impact to organisms in the path of the wave. The use of delays is intended to minimize the overlap of radiating shock waves and thereby reduce impacts on nearby organisms in the water. The current plan states that blast delays of a 25 millisecond (0.025 second) minimum will be employed. The Service believes that longer delays would be more appropriate. The Service is aware that explosives used to remove offshore petroleum platforms use delays of approximately 0.9 to 1.0 seconds. Therefore, the Corps should carefully consider this aspect of the blast plan and ensure that the timing of delays will provide the maximum advantage to organisms near the blast.

The Corps should use biological data on the important resources which may be in the blast area to develop a pre-blast exclusion and monitoring plan. The purposes of this plan are threefold. First, the plan should attempt to exclude important species from the blast zone. Second, the plan should outline procedures for determining the presence of important species within the danger or safety radii of the pending blast. Finally, the plan should clearly outline the procedures for halting blasting when important species, especially Federally-listed species, are within the danger or safety radii of the blast.

The Service considers data on the organisms killed during blasting to be important. These data, if carefully collected and analyzed, can lead to improved procedures for future projects. The Corps has proposed a preliminary post-blast monitoring plan. The Corps should expand on this preliminary plan, and develop a comprehensive program to assess the extent of those organisms killed during blasting.

The Service's Jacksonville Office produced a Manatee Watch Program for use when blasting is required in areas where manatees may be present. This program is given in Appendix C and should serve as a model for procedures to be employed if blasting in the lower Cape Fear must occur during the season when the species is likely to be present.

The Corps has proposed the use of a bubble curtain around the blast site to reduce the impact area of the blast. Bubble curtains are walls of bubbles rising from the bubble manifold which is supplied with compressed air. The manifold is placed on the bottom of the water body. Bubble manifolds are typically constructed of parallel pipes with small holes drilled along their length. Water current of tides may deflect the wall of bubbles produced, but the wall may remain intact and functional. Curtains of air or bubbles are either required or recommended as a mitigation measure in Alaska, New Jersey, Oregon, Washington State, and the Canadian Provinces of Alberta and Ontario (Keevin et al. 1995). Air bubbles in water substantially increase the compressibility of water. This greater compressibility reduces the peak pressure wave of a blast (Domenico 1982a, 1982b, Strange 1963). A review of the existing literature indicates that air/bubble curtains may reduce the overall peak pressure wave by 85-98 percent (Alberta Fisheries Habitat Protection Guidelines 1987, Domenico 1982b, Keevin et al. 1995, Strange 1963). Air/bubble curtains have been successfully used to protect underwater structures from underwater explosions (Domenico 1982a, Keevin and Hempen, unpublished data). Air/bubble curtains were used effectively during the explosive demolition of Lock and Dam 26 on the Mississippi River where freshwater flows range from 300,000 to 400,000 cubic feet per second (cfs)(Keevin and Hempen, unpublished data). The average discharge at the mouth of the Cape Fear River Estuary is about 11,000 cfs (USACOE 1994a).

Physical barriers include any solid barrier that contains or reduces the pressure wave of a blast. The Connecticut Department of Environmental Protection required the State's Department of Transportation to use a cofferdam system in order to use explosives to remove bridge piers and abutments in the Connecticut River. These restrictions were imposed to protect the Federally-endangered shortnose sturgeon which inhabits the river. A partially dewatered, double wall cofferdam was used to remove these structures. Monitors indicated that 1,050 pounds of explosives produced a maximum pressure of 37 psi in the water column outside of the coffer dam. No shortnose sturgeons or any commercially important fish species were impacted during this blasting.

If the Corps is forced to conduct blasting during any time whe.. Federally-listed species or any group of important aquatic resources may be present in the blast area, a comprehensive program of protective measures must be implemented to prevent harm or mortality to these species. This program should be submitted to State and Federal resource agencies for their review and concurrence.

An initial step in developing this program will be to use all available data to determine a radius at which significant mortality or serious injury will occur to the major groups of organisms which may be in the blast area. This radius should be designated as the danger zone for that particular species or group of closely related species.

Due to the harmful impacts of blasting on aquatic organisms, much research has focused on the development of models and formulas to predict the lethal distances of underwater explosions. Knowledge concerning potential lethal distances is useful in assessing potential, adverse impacts on estuarine life and in establishing preventive measures.

The Service's Jacksonville Field Office in Florida has used the following formula to estimate the danger zone from underwater explosions for manatees (Appendix C):

$$r = 260 \sqrt[3]{W}$$

where r = radius of the danger zone in feet, and w = weight of the explosive charge (tetryl or TNT) in pounds. This formula was derived from an equation in the National Oceanic Diving Manual which provides guidance for diver safety (Jim Valade, Biologist, U.S. Fish and Wildlife Service, Jacksonville Field Office, personal communication, July 1993).

On Sept. 22, 1995 the Service provided recommendations to the Corps on the Wilmington Harbor-Channel Widening Project (USFWS 1995). For that project the Corps proposed the use of 98.5 pounds of explosives for each charge with each blast consisting of 80 charges set in 8 rows with 10 charges per row. Based on this formula given above, the danger zone for a single proposed charge would have a radius of 1,200.7 feet, or an area of approximately 104 acres. The danger zone for a single row of 10 charges, a total of 985 pounds of explosives, would have a radius of 2,587 feet, or an area of approximately 483 acres.

As an added precaution, the Service's Jacksonville Field Office recommended that a buffer area be established around the perimeter of the calculated danger zone. The purpose of this buffer zone would be to allow time to halt blasting before an animal entered the danger zone. The area defined by both the danger zone and the buffer area would constitute the safety zone. In the case of the manatee, a buffer area of 300 feet around the danger zone was considered sufficient. If a manatee is sighted within the safety zone, blasting operations should be halted.

The Naval Surface Warfare Center developed models for determining the lethal range of underwater explosions on several mammals: a 20-foot whale, an adult porpoise, a porpoise calf, and a human being (Young 1991). The adult porpoise would be similar in size to an adult manatee, and calculations for the adult porpoise indicate an approximate safety zone for manatees. For an adult porpoise, the lethal radius (in feet) = (weight of charge)$^{0.28}$ x 434. The lethal radius for a single charge, 98.5 pounds of explosive would be 1,568.9 feet and the resulting, circular danger area would be approximately 177.5 acres. The lethal radius for a single row of 10 charges, 985 pounds of explosives would be 2,989.8 feet and the resulting, circular danger area would be 644.7 acres.

Goertner (1982) calculated the maximum horizontal distance for slight injuries by a 12-pound underwater explosion to a manatee calf of 70 pounds to be 450 feet. This calculation is based on a charge in a bolehole at a depth of 40 feet with or without time delays. The conditions used for this published calculation resemble the proposed blasting. It is possible to factor in the increased weight of a charge in the CFC project, 98.5 pounds. The Corps has stated that the peak pressure of a larger charge at a given distance changes by the cube root of the weigh multiplier for the larger charge (USACOE 1996b). The weight multiplier in this case is 8.2 (98.5 lbs/12 lbs), and the distance required to avoid injury would change by a factor of 2.0 ($\sqrt[3]{8}=2$). Therefore, the calculated distance needed to prevent slight injuries to a manatee calf in the vicinity of a buried 98.5 lbs charge would be 900 feet (2 x 450 feet).

While the exact amount of explosives to factor into these equations will be determined by the blast plan to be developed later, these preliminary calculations indicate that the required safety zone for manatees will be quite large. Even considering a single, proposed charge (98.5 pounds) within a field of 80 charges, the dangerous or lethal zone for a marine mammal such as a porpoise or manatee could range from 100 to 200 acres. Furthermore, the area required to prevent significant harm would need to be larger.

Other models have been developed to determine safety zones for fish. These models are based upon various methodologies, but the impulse strength model appears to be the best at predicting lethal and safe ranges under various sets of conditions and assumptions (Wright, 1982). The Corps' St. Louis District (SLD) developed a computer mathematical model, based upon the impulse strength method, to predict the kill radius for swimbladder fish from explosions that are buried in holes drilled in rock substrate. This model takes into account the effects of different explosive charge weights, the greater susceptibility of smaller fish to blast damage, the constraining effects of stemming on the overall explosive impact, and the impact reduction achieved by employing delays.

Results from the SLD model with stemming the top one foot of holes and inserting delays after each row are given in Appendix D. These data show that smaller fish are more susceptible to blasting impacts. The shock wave created by the general blast plan would kill about 50 percent of the fish with a swimbladder and weighing 0.125 pound at a distance of 1,610 feet (lethal distance for 50 percent of fish, or LD_{50}) and about 1 percent of these fish at a distance of 2,780 feet (lethal distance for 1 percent of fish, or LD_1). The circular areas enclosed by these two distances are 196 and 573 acres, respectively. Larger fish are more resistant to blasting impacts, and fish weighing one pound would experience an LD_{50} of about 899 feet and an LD_1 of about 1,550 feet. Fish of 12-pound size would experience an LD_{50} radius of about 446 feet and an LD_1 radius of about 768 feet. These distances and the resulting areas are given in Appendix E.

The SLD model predicts that stemming and inserting delays (a minimum of 25 milliseconds) on each hole reduces the size of the blast impact zone. Data for radii and areas of impact under these conditions are given in Appendix E. Under these conditions, the LD_1 area for a 2-ounce fish with a swimbladder is reduced from 573 acres to 34.5 acres, a reduction of approximately 94 percent.

The Wilmington District has used the SLD models to determine impact zones for fish in the Cape Fear River. The Corps plans to require the contractor to stem and insert a delay in each hole and to construct a physical barrier (i.e., a bubble/air curtain or any solid sheet wall suspended from barges) around the blast zone. The use of such a physical barrier may reduce the LD_1 area for a 2-ounce swimbladder fish from 34.5 acres to about 0.8 acre (35,000 square feet).

This report has outlined some of the available procedures for determining the danger zone for species of special concern, especially for the manatee. However, this planning effort should also address the major groups of fish species, the sea turtles, and other mammal marines, such as whales and dolphins.

In order to ensure the complete safety of Federally-listed species the danger zone must be enlarged. In protecting manatee the Service has increased the radius of the danger zone by 300 feet (Appendix C). The area produced by this additional factor may be referred to as the safety zone.

Once the danger zone has been determined and an appropriate buffer area is added to establish a larger safety zone, monitoring procedures must be established. While the procedures used to protect manatees may serve to protect other species, plans should be developed for other protected species and major groups of fisheries resources in cooperation with the NMFS and the North Carolina Division of Marine Fisheries.

The offshore disposal of rock presents the same potential harm to marine mammals, sea turtles, and important fisheries resources as the disposal of soft sediment. Similar procedures should be used to minimize the risk of direct harm to these species at the disposal site.

As a fisheries enhancement measure, hard substrate may be used to create artificial reefs which benefit marine fish species. While currently proposed blasting may result in rock rubble which is too small for reef creation, the Corps should monitor the size and other characteristics of the rubble produced in this project. If suitable material is produced by the project, the Corps should evaluate the use of this material for artificial reef creation in close cooperation with the NMFS or the North Carolina Division of Marine Fisheries. Only material which is of appropriate size and is free of contaminants should be used for artificial reef creation.

The National Fishing Enhancement Act of 1984 (NFEA) established a national policy to promote and facilitate responsible and effective efforts to establish artificial reefs. The NFEA mandated the preparation of a National Artificial Reef Plan (NMFS 1985) and gave the Corps regulatory authority for artificial reef construction. The WOFES which the Corps has developed is consistent with national artificial reef standards and policies. North Carolina has released a master plan for an artificial reef program (North Carolina Division of Marine Fisheries 1988). The Corps stated that the WOFES is also consistent with the North Carolina artificial reef master plan to the maximum extent practical (USACOE 1994b).

Loss of Shallow-Water Wetlands/Primary Nursery Areas

The proposed project would result in the conversion of 13.2 acres of shallow water to areas of deeper water. These areas have been designed as primary nursery area for estuarine organisms. In order to avoid the permanent loss of this valuable habitat, the Corps should provide in-kind compensation in the immediate vicinity of the areas lost. Compensation should be in the form of either restoring or enhancing a degraded wetland. The Corps may also incorporate elements of preservation as part of an overall mitigation effort. Any compensation through preservation should be directed at wetlands of high quality which are clearly threatened by degradation. If compensation is required, the Corps should develop a comprehensive mitigation plan which describes all aspects of the mitigation effort. The overall goal of the mitigation effort should be no net loss of wetland functions and values.

Increased Erosion of Riverine Shoreline

The increased wakes from larger ships using the enlarged ship channel could adversely affect riparian areas within the project area by increasing erosion and disrupting nektonic organisms. However, the precise extent to which increased wakes would damage these areas is not known. Therefore, the major fish and wildlife conservation measure for this potential impact is a thorough assessment of the affects which traffic by larger ships would have of the riparian area of the lower Cape Fear and Northeast Cape Fear Rivers. Part of this assessment should be proposals to rectify any loss in the quantity and quality of riparian habitats which are produced by this project.

Increased Beach Erosion due to Disruption of Longshore Transport System

The proposed project may disrupt the longshore transport system which carries sand along the coastline of Brunswick County. A significant disruption in this system could accelerate the loss of beaches which are used as nest sites by sea turtles. This potential impact has not been fully evaluated by the Corps. Therefore, the major fish and wildlife conservation measure for this potential impact is a thorough assessment of direct project impacts on the longshore transport system and the indirect impacts on beaches adjacent to the mouth of the Cape Fear River. Part of this assessment should be proposals to rectify any loss of beach area which are produced by this project.

Saltwater Intrusion into Groundwater

The Corps' Reconnaissance Report states that the Corps should examine available data in order to determine the amount of saltwater encroachment that would occur as a result of the river deepening (USACOE 1991b). This effort concluded that the most recent data, complied in 1970, were not sufficiently current to make an accurate determination. The Corps determined that New Hanover County had grown so much from the early 1970s to the early 1990s that an updated study of groundwater resources was needed. The Reconnaissance Report proposed that a detailed groundwater analysis be conducted. The Corps has undertaken modeling efforts to estimate potential impacts on groundwater supplies. While final results are not available, preliminary findings of the Wilmington Harbor Groundwater Study indicate that the aquifers primarily exhibit a discharge into the Cape Fear River along the length of the shipping channel as evidence by the higher elevations of water level contours relative to the elevations of the surface of the river.

In the absence of the Corps' final assessment of potential impacts to groundwater supplies, the Service believes that the most important fish and wildlife conservation measure pertaining to groundwater supplies is the completion of the Wilmington Harbor Groundwater Study. The Service hopes that this report will be truly comprehensive and look beyond existing conditions by fully evaluating such factors as increased withdrawal from existing supplies as development continues in the project area. The Corps' Summary of Benefits and Costs used a 50-year period of analysis. Therefore, the Service would expect the Corps to use all available data and best projection techniques to predict salinity levels in regional aquifers during the period of 2045-2050. The Service would also expect this report to address the measures taken to supply freshwater to area homes and businesses in the event that optimistic model predictions are proved incorrect.

Increased Saltwater Intrusion into Surface Water

Saltwater intrusion has increased in the Cape Fear Estuary as a result of rising sea level and past changes to navigation facilities (Hackney and Yelverton 1990). These factors have resulted in an increased tidal amplitude which allows ocean derived salinity to encroach farther upstream. The Corps acknowledges that there is concern that additional deepening and widening of the ship channel may permit greater penetration of saline water into areas that were previously fresh (USACOE 1991b). It is extremely difficult to accurately predict the effect of a particular channel modification project on saltwater intrusion. In response to these uncertainties the Corps has undertaken a comprehensive modeling effort which included the collection of field data and the development of a complex, three-dimensional model of the project area. The primary purpose of this model is not to predict the exact magnitude of salinity changes, but the direction of salinity changes, that is whether a given isohaline will move upstream, downstream, or remain essentially unchanged. Preliminary results of these efforts indicate that the proposed modifications to the existing ship channel will increase the tidal amplitude of the system. This increase in tidal amplitude will lead to increased mixing of fresh and saltwater. The increased mixing will lead to an actual reduction in saltwater intrusion.

Results from the saltwater intrusion model were presented on August 22, 1995 and April 18, 1996. However, the Corps has not supplied the Service with a written report on the model along with the assumptions and mathematical relationships which form the basis of the model. Therefore, the major fish and wildlife conservation measure regarding this potential impact is the completion of ongoing computer simulations and the release of a written report describing the model, the assumptions used, and the mathematical relationships among important variables.

The Service believes that the major fish and wildlife conservation measures regarding this potential, adverse impact are: (1) completion of computer simulations for salinity changes in the project area; (2) issuance of a written report on the computer model which could be reviewed by State and Federal resource agencies as well outside experts; (3) the development of a post-construction monitoring plan to fully assess the actual long-term impacts of the project on saltwater intrusion; and (4) the development of a mitigation plan which would compensate for any freshwater wetlands which are loss as a result of salinity caused by the project.

Increased Risk for Accidents Involving Larger Ships

The primary purpose of the proposed project is to allow larger ships to move up the Wilmington Ship Channel to the State Port and beyond. The Service believes that even the most stringent safety procedures cannot completely eliminate the risk of accidents. Any accident in the Wilmington Ship Channel carries the risk of spilling cargo into the Cape Fear Estuary, and creating access for larger ships means that larger spills must be considered. Even spills of cargo which is essentially non-hazardous can produce short-term adverse environmental impacts. Spills of hazardous or toxic material would have devastating short-term, and perhaps long-term, impacts on the estuarine ecosystem.

The primary fish and wildlife conservation measures regarding the risk of accidental spills involve an adequate emergency response infrastructure and an assurance that companies which use the enlarged channel are financially prepared to clean up any spill for which they are judged to be responsible.

Cumulative Impacts

The Service remains concerned that adverse environmental impacts of a single project are viewed in relative isolation from similar impacts over a wider geographical area. In the case of the proposed project, the Service believes that the geographical area of concern should be the State of North Carolina. While many of the impacts associated with the proposed project cannot be precisely defined, the Service has stated six major areas of concern in this report. In brief, these concerns are: (1) impoverishment of marine and estuarine food chains; (2) degradation of fisheries resources; (3) the loss of tidal freshwater wetlands; (4) the loss of shallow-water estuarine areas; (5) the loss of beach areas used for sea turtle nesting; and, (6) the direct mortality of Federally-listed species. The primary fish and wildlife conservation measure in regard to the cumulative impacts of the project would be an assessment of project impacts in the context of all alterations which are currently affecting North Carolina's estuarine ecosystems as well as additional alterations which can be reasonably expected to impact these ecosystems in the foreseeable future.

Acquisition of Conservation Lands

The study phase of the Wilmington Harbor-Northeast Cape River Project was authorized in 1967. The original project proposal contained a provision to acquire, either in fee simple or through conservation easements, 2,800 acres along the Northeast Cape River. The area under consideration consisted of wetlands, bluffs, and buffer strips along the river. The area was a separate fish and wildlife enhancement feature of the authorized project and it was to be used for conservation purposes. The Service's Draft FWCA noted that subsequent plans for this project eliminated the acquisition for these conservation lands (USFWS 1988c). This project element became "unscheduled" because of guidance from the Office of the Chief of Engineers which gave funding priority to " . . . components of the project that have high priority benefits. . ."

As the Service noted in our Draft FWCA, without protection these relatively undeveloped areas would be subject to "imminent threat due to commercial development, timber harvest and other uses" (USFWS 1988c). The current body of data on the functions and value of wetlands indicates that riparian, forested wetlands perform provide many benefits to society. The wetlands along the Northeast Cape Fear River function to control floods, increase water quality, provide recreational opportunities, and support the valuable fish and wildlife resources of the area. Therefore, the Service reiterates the position that the acquisition of conservation lands in the vicinity of the various Wilmington Harbor projects would be a highly significant fish and wildlife enhancement measure.

The Service has stated that we do not believe the conservation proposal is a wholly "enhancement" feature with no association to compensation for any past, ongoing or anticipated habitat losses associated with harbor development in the project area (USFWS 1988c). The validity of viewing acquisition of the conservation lands as a project feature and not merely as an enhancement is best documented in the Corps's Final Environmental Impact Statement (USACE 1979) which states:

> "The scope of nationally significant resource values contributed by the critical ecological zone is so broad as to involve many different Federal authorities for the conservation of environmental quality. It is for this basic reason that the planning function of the Corps of Engineers is appropriately applied to these needs and plan implementation authority is recommended to the U.S. Congress. The critical character of this need is directly and clearly associated with past, and projected future, incremental losses of environmental quality in the regional estuarine ecosystem. This perspective is an essential factor in deciding the

worthiness of future authorizations to continue navigation improvement in the estuary without environmental conservation action. From 1829 to 1965, 13 Federal navigation improvements were completed, each without apparent consideration of ecological effects. A total of 3,050 acres of marsh and swamp has been lost to upland or deep open water by such development and a much greater loss has occurred from other sources. Neither the plans nor authorizing acts contained specific measures to offset losses of estuarine resources. Of equal importance, the great cumulative losses which threatened the quality of the regional estuary were apparently not understood by the public, their elected representatives, or the implementing agencies. Indeed, prudent men using the state of ecological knowledge and art of that time could not have perceived the magnitude of the ecosystems influenced or the value of such areas to the region and Nation. The seriousness of continued losses is now understood and appreciated by water and related land resource managers. The new navigation improvements recommended herein constitute another step in the continued economic growth of the area related to Wilmington Harbor. They also provide stimulus for continued incremental changes to regional environmental quality. Accordingly, features are included in the recommended plan which address the maintenance of environmental quality, as well as fostering the economic growth of the region."

Based on the considerations stated above, the Service continues to believe that the fish and wildlife resources of the lower Cape Fear River watershed would benefit from the acquisition of these conservation lands.

RECOMMENDATIONS

The Service recommends that the following fish and wildlife conservation measures be incorporated into the planning process of the proposed project.

In order to avoid or minimize direct, adverse impacts resulting from the proposed project the Service recommends that:

1. The Corps should use all available construction techniques to avoid or minimize the creation of excessive turbidity during dredging operations.

2. The Corps should have sufficient bioassay and bioaccumulation data from sediment of representative areas throughout the project area to ensure that the project will not produce a significant toxicological risk to organisms at

the dredging site, any offshore disposal areas, or any inland disposal areas. The Corps should develop plans for the special handling and disposal of contaminated sediment, if such sediment must be dredged.

3. The Corps should plan construction in a manner which will avoid or minimize adverse impacts to fisheries resources, sea turtles, and marine mammals due to the offshore disposal of dredge material. These plans should incorporate all reasonable technology which would detect species of concern in the immediate disposal area and procedures to delay disposal, if necessary.

4. The Corps should not dispose of dredge material in inland disposal sites in a manner which would be harmful to nesting by colonial waterbirds.

5. The Corps should use all feasible design features and construction techniques to minimize direct harm or death to animals during routine dredging of soft sediment. Dredging personnel should watch for sea turtles and manatees during all periods of warm weather and cease operations if these species are seen in the immediate vicinity of construction activities. The standard manatee conditions should be strictly enforced during the most likely period of manatee presence, June thought September.

6. Project contracts should state clearly that blasting will not be authorized until data are supplied to the Corps which verify that rock cannot be removed with a cutterhead dredge. If it is determined that blasting is required, the following procedures should be implemented:

   a. All blasting should be limited to the time of year with the lowest biological activity. Current plans to protect fisheries resources limit blasting to the six-month period from August 1 through January 31. The Service supports this effort to protect fish in the project area. However, the Service is very concerned about possible mortality among manatees which are most common in the area from June through September. The Service is also concerned about harm to sea turtles which are most abundant in the lower Cape Fear from April through September. Therefore, the Service recommends that blasting be limited to the four-month period from October 1 through January 31 of any year, a period of 123 days. With proper planning, the Service believes that the estimated 558 blasts over a period of three years could be accomplished within an annual, four-month blasting period. This procedure would allow a total of 12 months for blasting over the proposed three year construction period. Sufficient personnel would allow for multiple blasts during a single day within the blast period.

b. The type of explosive used and the blast plan selected should be those which can be expected to produce the least harm to aquatic organisms. The Service supports the use of stemming and delays between each charge. The Service recommends that delays in the range of 0.9 to 1.0 second to be used to further minimize adverse shock waves. Since low velocity explosives produce shock waves with lower peak pressure, explosives with the lowest velocity consistent with achieving project goals should be used.

c. The Corps should develop pre-blast procedures which fully utilize existing biological data on species likely to be present near the blast site and the danger or safety zones for these species. Pre-blast procedures should include: (1) a determination of significant species, including all Federally-listed species, which may occur in the project area during blasting and the Corps is committed to protecting from any blasting impacts; (2) a method to calculate a danger zone for the designated significant species; (3) the determination of an adequate buffer zone to add to the calculated danger zone in order to create a larger safety zone; (4) a surveillance plan to detect the significant species within their respective safety zones; (5) procedures, such as detonation of small pre-blast, which may cause significant species to leave the blasting area; and, (6) an effective procedure to halt blasting if significant species are detected within their safety zone. The Corps should specifically address blasting impacts on early life stages of fish in the project area.

d. A comprehensive post-blasting monitoring plan should be developed and implemented so that the number of organisms by species killed by the blasts can be determined. The monitoring plan should be developed in coordination with the Service, the North Carolina Division of Marine Fisheries, and the NMFS. The plan should involve surveying the blast impact area by boat and counting and identifying dead or injured organisms which float to the surface. Although all dead organisms may not float to the surface immediately, this method should give an indication of the extent of the impacts to finfish and other organisms. Part of post-blast monitoring should include sampling of the river bottom. These data should be complied in an annual report and supplied to State and Federal resource agencies.

e. The Service supports the use of bubble curtains and/or physical barriers to exclude animals and absorb shock waves. However, in the absence of specific data on the protective value of these devices for the species of concern and the conditions present in the Cape Fear River, these protective devices should be used in conjunction with other protective measures, particularly a careful consideration of limiting blasting to the time of year with low biological activity. During early blasts, the safety zone to be surveyed should not assume any protective value for the bubble curtain. If field data should show that shock waves are contained by the curtain, the surveillance zone may be reduced.

f. In addition to the protective measures recommended above, if blasting will occur during a time of year when species protected by either the Endangered Species Act or the Marine Mammal Protection Act may be in the project area, the Corps should use the best available data and models to calculate danger and safety zones for these species. The radius of this danger zone could be based on a calculated radius at which very low mortality, such as 1% (LD_1), would be produced. The radii of danger zones for Federally-listed species should be increased by an appropriate buffer area to create a safety zone. All protective measures for Federally-listed species should be based upon the larger, safety zone.

g. Based on data regarding the species which may be present in the project area during blasting and calculations on the size of danger and safety zones, project plans should include measures to exclude species of concern from the blast zone. The Service developed a "manatee watch plan" to protect manatees at a Florida construction site which required blasting (Appendix C) which may serve as a model for the proposed project if blasting is scheduled during the period, June through September, when manatees are most likely to be in the Cape Fear River.

In order to avoid or minimize indirect, adverse impacts resulting from the proposed project the Service recommends that:

7. The Corps should ensure that the project does not result in a permanent loss of primary nursery areas. These highly productive, shallow water areas contain organisms which form the base for important estuarine food chains. Construction for the project should either avoid these areas or in-kind compensatory mitigation should be provided in the immediate

vicinity of the areas lost. If compensation is required, the Corps should develop a comprehensive mitigation plan which describes the functions and values of the areas lost, the manner in which these functions and values will be replaced, details for restoring or creating the mitigation site, success criteria for various time periods of the mitigation effort, and the long-term plan for the protection of the mitigation area. If shallow water wetlands are created from spoil disposal islands, the Corps should ensure that there is no loss of nesting habitat for colonial waterbirds.

8. The Corps should fully assess the potential for an increase in erosion along riparian area in the project area which will be subject to the impacts of wakes from larger ships. If this assessment indicates that shoreline erosion is likely to increase as a long-term impact of the project, the Corps should present a plan to mitigate this damage and ensure the continued existence of the important biological communities in these areas.

9. The Corps should fully assess the potential impacts of the proposed project on the longshore sediment transport system. This assessment should either present evidence that the proposed project will not adversely affect beaches on either side of the mouth of the Cape Fear River or present a plan to mitigate the consequences of the project on area beaches. The Corps should consider the feasibility of placing all beach quality sand within the littoral zone of the project area.

10. The Corps should complete the planned assessment of potential impacts of the project on groundwater resources in the lower Cape Fear River watershed. This assessment should look beyond current conditions in which pressure within the aquifer seems sufficient to exclude saltwater and consider the consequences of increased groundwater withdrawals which will result from increased development in the area. In particular, the assessment should give an evaluation of groundwater conditions at 50 years after project construction, a time period used to calculate the economic benefits of channel modifications. This assessment should consider a "worst-case" scenario and evaluate the impacts associated with constructing facilities to replace water which was previously withdrawn from aquifers and possible sources of freshwater which would replace existing groundwater resources. All costs associated with replacing existing groundwater resources should be completely evaluated in the benefit-cost analysis of the project.

11. The Corps should complete the current modeling effort on the potential for increased saltwater intrusion as a result of the proposed channel modifications. On the completion of this effort, the Corps should release a written report on the saltwater intrusion model which contains a detailed description of field data which were used in the model and data collection procedures. This report should also include all major assumptions and mathematical relationships which were used in the model. This report should be made available to all State and Federal resource agencies for both internal review and submission to independent experts for evaluation.

In the absence of sufficient data to predict the actual effect of the project on the intrusion of saltwater into surface water, the Corps should develop a long-term program to monitor actual changes in both salinity and riparian vegetation. Permanent sampling stations should be established for sampling water, vegetation, and animal communities. The Corps should also develop a general plan for remedial action in the event that a significant increase in saltwater intrusions occurs.

12. The Corps should ensure that the operation and maintenance plan of the proposed project includes: (1) enforceable measures to minimize the risk of shipping accidents; (2) a permanent, fully funded emergency response plan based on the types of cargo which will be carried in the ship channel; and, (3) specific provisions to ensure that the owners of all ships using the Port of Wilmington have the financial resources to pay for any environmental cleanup for which they may be found liable.

The Service makes the following recommendations to minimize the potential cumulative effects of the proposed project:

13. The Corps should assess past, current, and anticipated construction projects in North Carolina which have had, are having, and/or will have adverse, environmental impacts on estuarine ecosystems in order to ensure that the proposed project will not contribute to a State-wide decline in either the areal extent or functions of these ecosystems.

14. The Corps should assess past, current, and anticipated construction projects in North Carolina which have had, are having, and/or will have adverse, environmental impacts on freshwater, tidal ecosystems in order to ensure that the proposed project will not contribute to a State-wide decline in either the areal extent or functions of these ecosystems.

The Service recommends the following actions to benefit and enhance the fish and wildlife resources in the project area:

15. The Corps should assess the feasibility of disposing of beach quality sand in a manner and at a location which would benefit nesting habitat for sea turtles.

16. If material removed during project construction is suitable for disposal on colonial waterbird nesting islands in the lower Cape Fear River, the Corps should place this material, as needed for habitat improvement, on colonial waterbird nesting islands in the area, as they have done in the past. The Corps, in accordance with the 1988 Cooperative Agreement to implement the State-wide Colonial Waterbird Management Plan, should continue to coordinate such activities with the North Carolina Colonial Waterbird Management Committee to develop a plan for the beneficial disposal of this material.

17. The Corps should implement the current proposal for using rock removed from the channel for artificial reef creation in close cooperation with the NMFS or the North Carolina Division of Marine Fisheries. However, only material which is of appropriate size and is free of contaminants should be used for artificial reef creation.

18. The Corps should make every effort to "reschedule" and pursue the acquisition of the 2,800-acre tract of conservation lands along the Northeast Cape Fear River. This acquisition was an original element in the Wilmington Harbor-Northeast Cape Fear River Project, but this effort to preserve important wetlands and river bluffs along the lower Northeast Cape Fear River was subsequently designated as "unscheduled."

SUMMARY OF FINDINGS AND SERVICE POSITION

The Cape Fear-Northeast Cape Fear Rivers Comprehensive Project may result in significant alterations in the diverse ecosystems of the lower Cape Fear River watershed. The planning process to date has adequately documented the economic justification for the proposed modifications, the range of alternatives considered, and the selection of a preferred alternative.

In the past the Service has expressed concern about the environmental impacts of other projects to modify the Wilmington Harbor Ship Channel. The large construction effort needed to accomplish the preferred alternative for the present project has the potential to create significant direct, indirect, and cumulative adverse, environmental impacts. However, the Service believes that a thorough consideration of the environment during planning can avoid many of the most severe impacts and minimize others.

With the exception of impacts associated with blasting, the Service believes that most direct impacts associated with construction will be short-term and rectified in time. However, blasting in the ship channel has the potential to produce significant harm to important fisheries resources and Federally protected species. These impacts may be avoided or minimized by a comprehensive program to restrict the use of blasting, the use of seasonal restrictions on blasting, the proper selection of equipment and blasting procedures, monitoring programs, and programs to contain blast impacts and halt blasting if important resources are detected within scientifically-based, predetermined danger/safety zones.

The Service is more concerned about the long-term, secondary impacts of the proposed project. This report has detailed concerns about six, potential, indirect impacts. The Service realizes that these impacts may be difficult to predict with a high degree of accuracy. However, Service is concerned that several of the Corps' efforts to evaluate these impacts have not been completed. Some information on saltwater intrusions into surface water and groundwater have been presented, but detailed, written reports have not been released. There are no current evaluations on the potential impacts to riparian shorelines, the longshore transport system which influences area beaches, and the risk of accidents in the enlarged channel. The Service strongly recommends that the Corps fully evaluate all potential, indirect impacts which may be produced by the project, develop long-term monitoring programs where major uncertainties exist, and plan remedial measures for a "worst-case" scenario of each potential impact.

The Service believes that the proposed project offers several opportunities for the enhancement of fish and wildlife resources in the project area. Such measures include: (1) the use of soft sediment which is free of contaminants and properly placed and graded on existing disposal islands to benefit nesting by colonial waterbirds; (2) the use of soft sediment which is free or contaminants and properly placed in the littoral zone near the mouth of the Cape Fear River to support area beaches; (3) the use of rock which is contaminant-free and properly placed to create an offshore, artificial reef to enhance fisheries resources; and, (4) the acquisition of freshwater wetlands, as originally proposed in the Wilmington Harbor-Northeast Cape Fear River Project, for the enhancement of fish and wildlife resources in the project area. The Service strongly recommends that the Corps fully consider each of these measures.

In summary, the Service has provided recommendations which, in our opinion, will: (1) eliminate, or minimize, most short-term, direct impacts; (2) generate information on potential indirect impacts which are now poorly understood; (3) define those elements of the environment which are susceptible to long-term degradation and which require monitoring and contingency planning for possible remedial actions; and, (4) designate actions which could benefit the natural resources of the project area. If the Corps implements each of these recommendations, the Service believes that the proposed project is compatible with the long-term viability of marine, estuarine, and freshwater ecosystems in the project area and the many important fish and wildlife resources which they support.

LITERATURE CITED

Alberta's Fisheries Habitat Protection Guideline. 1987.Guideline No. 15. 5pp.

Armstrong, D. A., B. C. Stevens, and J. C. Hoeman. 1982. Distribution and abundance of Dungeness crab and *Crangon* shrimp and dredging related mortality of invertebrates and fish in Gray's Harbor, Washington. Report No. DA-80-86. Washington Department of Fisheries and Seattle District, U. S. Army corps of Engineers.

Bain, G. L. 1970. Geology and ground-water resources of New Hanover County, North Carolina. Ground Water Bulletin No. 17. North Carolina Department of Water and Air Resources, Division of Ground Water. Raleigh, North Carolina.

Birkhead, W.A., F.J. Copeland, and R.G. Hodson. 1979. Ecological monitoring in the lower Cape Fear estuary, 1971-1976. Report 79-1 to the Carolina Power and Light Company. Raleigh, North Carolina.

Buell, J. W. 1992. Fish entrainment monitoring of the Western-Pacific dredge R. W. Lofgren during operations outside the preferred work period. Buell and Associates. 38pp. + Appendices.

Burton, W. H., S. B. Weisberg, and P. Jacobson. 1992.Entrainment effects of maintenance hydraulic dredging in the Delaware River estuary on striped bass ichthyoplankton. Report to the Delaware Basin Fish and Wildlife Management Cooperative, West Trenton, New Jersey. 33pp.

Carolina Power and Light. 1979. Brunswick Steam Electric Plant, Cape Fear Studies: Volume 1 (July 1979). Carolina Power and Light Company. Raleigh, North Carolina.

Carriker, M. R., M. W. LaSalle, R. Mann, and D. W. Pritcher. 1986. Entrainment of oyster larvae by hydraulic cutterhead dredging operations: workshop conclusions and recommendations. American Malacological Bulletin, special Edition No. 3. pp71-74.

Crouse, D.T. 1985. Biology and conservation of sea turtles in North Carolina. Ph.D. Dissertation. University of Wisconsin, Madison, Wisconsin. 212pp.

Dardeau, M. R., R. F. Modlin, W. W. Schroeder, and J. P. Stout. 1992. Estuaries. pp. 615-722. in Courtney T. Hackney et al., (eds.) Biodiversity of the Southeastern United States: Aquatic Communities. John Wiley and Sons. New York. 779pp.

Dolan, R., D. Aubrey, R. Dean, D. Inman, J. Miller, and J. Teal. 1991. Review of the Corps of Engineers Plan for the Stabilization of Oregon Inlet, North Carolina. Report to the Department of the Interior. Contract No. 14-16-0004-91-070. 66pp. + Appendices.

Domenico, S. N. 1982a. Acoustic wave propagation in air-bubble curtains in water-Part II. Field experiments. Geophysics 47:354-375.

__________. 1982b. Acoustic wave propagation in air-bubble curtains in water-Part I. History and theory. Geophysics 47:345-353.

Du Pont Company. 1980. Blasters' Handbook. E. I. du Pont deNemours & Co. (Inc.). Wilmington, Delaware. 494 pp.

Epperly, S. P., J. Braun, and V. Veishlow. 1995. Sea turtles in North Carolina waters. Conservation Biology. 9:384-394.

Gaspin, J.B. 1975. Experimental investigations of the effects of underwater explosions on swimbladder fish, I: 1973 Chesapeake Bay tests. NSWC/WOL TR 75-58.

__________, M.L. Wiley, and G.B. Peters. 1976. Experimental investigations of the effects of underwater explosions on swimbladder fish, II: 1975 Chesapeake Bay tests. NSWC/WOL TR 76-61.

Goertner, J. F. 1982. Prediction of underwater explosion safe ranges for sea mammals. Naval Surface Weapons Center, NSWC TR 82-188. Silver Springs, Maryland. 25 pp.

Hackney, C.T. and G.F. Yelverton. 1990. Effects of human activities and sea level rise on wetland ecosystems in the Cape Fear River Estuary, North Carolina, USA. Pp 55-61 *In* D.F. Whigham, R.E. Good, and J. Kvet (eds). Wetland Ecology and Management: Case Studies. Kluwer Academic Publishers, the Netherlands.

Harris, L. 1972. Butterflies of Georgia. University of Oklahoma Press. Stillwater. 326pp.

Keevin, T. M., G. L. Hempen, L. G. Nico, and D. J. Schasffer. 1995. The use of an air bubble curtain to reduce fish mortality resulting from underwater explosions. Unpublished draft report. 20pp.

Lawler, Matusky and Skelly Engineers. 1975. Aquatic Ecology Studies, Cape Fear River Estuary, North Carolina, September 1972 to August 1975. Report prepared for the Wilmington District, U. S. Army Corps of Engineers.

Linton, T.L., N. Hall, D. Labomascus, and A. Landry. 1985. The Effects of Seismic Sounds on Marine Organisms: an Annotated Bibliography and Literature Review. Texas A & M University, Galveston, Texas. 67 pp.

Martof, B.S., W.M. Palmer, J.R. Bailey, and J.R. Harrison. 1980. Amphibians and Reptiles of the Carolinas and Virginia. The University of North Carolina Press. Chapel Hill, North Carolina. 264pp.

Moser, M. L. 1991. Sampling of nekton in the Carolina Beach Borrow Site. North Carolina Cooperative Fishery Unit. North Carolina State University. Personal communication to the Wilmington District, U. S. Army Corps of Engineers.

__________ and S. W. Ross. 1993. Distribution and movement of shortnose sturgeon (Acipenser brevirostrum) and other anadromous fishes of the lower Cape Fear River, North Carolina. Final Report to the U. S. Army Corps of Engineers Wilmington District. 112 pp.

National Marine Fisheries Service. 1985. National Artificial Reef Plan. NOAA Technical Memorandum, NMFS OF-6, 39pp.

__________. 1993. Marine Recreational Fisherman Statistics Survey Data. National Marine Fisheries Service, Southeastern Fisheries Science Center, Beaufort, North Carolina.

National Research Council. 1990. Decline of the Sea Turtles - Causes and Prevention. National Academy Press. Washington, D.C. 259 pp.

Nichols, P. R. and E. D. Louder. 1970. Upstream passage of anadromous fish through navigation locks and use of the stream for spawning and nursery habitat, Cape Fear River, North Carolina, 1962-66. U. S. Fish and Wildlife Service. Circ. 352.

North Carolina Division of Marine Fisheries. 1988. The North Carolina Artificial Reef Master Plan. North Carolina Department of Natural Resources and Community Development. Special Scientific Report No. 47.

O'Keeffe, D.J. and G.A. Young. 1984. Handbook on the environmental effects of underwater explosions. Naval Surface Weapons Center. NSWC TR 83-240.

Opler, P. A. and G. O. Krizek. 1984. Butterflies East of the Great Plains. Johns Hopkins University Press. 294pp.

Parnell, J.F. and M.A. Shields. 1990. Management of North Carolina's Colonial Waterbirds. National Oceanic and Atmospheric Administration. UNC Seagrant Publication Number UNC-SG-90-03. 169 pp.

Pilkey, O.H., Jr., W.J. Neal, O.H. Pilkey, Sr., and S.R. Riggs. 1980. From Currituck to Calabash - Living with North Carolina's Barrier Island. Duke University Press. Durham, NC. 244 pp.

Posey, M. H. 1993. Benthic communities in the area of the proposed MOTSU channel widening project. Final Report to the Wilmington District, U. S. Army Corps of Engineers. Wilmington, NC.

__________, C. M. Powell, and T. D. Alphin. 1995. Epibenthic fauna in shallow and channel habitats of the lower Cape Fear River. Preliminary Report submitted to the Wilmington District, U. S. Army Corps of Engineers. Wilmington, NC. 5pp. + Tables and Figures.

Potter, E.F., J.F. Parnell, and R.P. Teulings. 1980. Birds of the Carolinas. The University of North Carolina Press. 408 pp.

Radford, A.E., H.E. Ahles and C.R. Bell. 1968. Manual of the Vascular Flora of the Carolinas. University of the North Carolina Press, Chapel Hill, North Carolina. 1183 pp.

Ragland, B. C. et al. 1987. Water Resources Data, North Carolina, Water Year 1987, U. S. Geological Survey Water-Data Report, NC-87-1, Raleigh, North Carolina.

Rasmussen, B. 1967. The effects of underwater explosions on marine life. Bergen, Norway. 17 pp.

Robins, C. R. and G. C. Ray. 1986. A Field Guide to Atlantic Coast Fishes. The Peterson Field Guide Series. Houghton Mifflin Company, New York. 354pp.

Rohde, F.C., R.G. Arndt, D.G. Linquist, J.F. Parnell, 1994. Freshwater Fishes of the Carolinas, Virginia, Maryland, and Delaware. The University of North Carolina Press. Chapel Hill. 222pp.

Schwartz, F. J. 1995. Florida manatees, *Trichechus manatus* (Sirenia: Trichechidae), in North Carolina 1919-1994. Brimleyana 22: 53-60.

__________ , W. T. Hogarth, and M. P. Weinstein. 1981. Marine and freshwater fishes of the Cape Fear Estuary, North Carolina and their distribution in relation to environmental factors. Brimleyana. 7:17-37.

Sharitz, R. R. and W. J. Mitsch. 1993. Southern floodplain forests. pp. 311-372. in Martin, W. H. et al. (eds.). Biodiversity of the Southeastern United States: Lowland Terrestrial Communities. John Wiley and Sons, Inc., New York. 502pp.

Smith, H. J. 1987. Estimating the mechanical dredgeability of rock. pp. 945-952. In: I. W. Farmer, J. J. K. Demen, C. S. Desai, C. E. Glass, and S. P. Neuman (eds.). Rock Mechanics: Proceedings of the 28th Symposium. University of Arizona. Tuson.

Strange, J. F. 1963. The attenuating effect of a bubble screen on underwater shock. Miscellaneous Paper No. 2-553. U. S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi.

U.S. Army Corps of Engineers. 1979. Final Environmental Impact Statement. Wilmington Harbor - Northeast Cape Fear River. Wilmington District, Corps of Engineers, Wilmington, NC. 101pp.

__________. 1984. Wilmington Harbor - Northeast Cape Fear River, North Carolina. Communication from the Assistant Secretary of the Army (Civil Works). U. S. Government Printing Office. Washington, D. C. 746pp.

__________. 1988. Draft Reconnaissance Report. Wilmington Harbor Passing Lane. Wilmington District, Corps of Engineers, Wilmington, NC. 149 pp.

__________. 1989a. Reconnaissance Level Study, Wilmington Harbor- Turns and Bends. Wilmington District, Corps of Engineers, Wilmington, NC. 37 pp + App.

__________. 1989b. Final Environmental Impact Statement for Long-Term Maintenance of Wilmington Harbor, North Carolina. Wilmington District, U.S. Army Corps of Engineers, Wilmington, NC. 100 pp + App.

__________. 1989c. Reconnaissance Report. Wilmington Harbor-Bald Head Island. Wilmington District, U.S. Army Corps of Engineers, Wilmington, NC.

__________. 1990a. Draft Feasibility Study, Wilmington Harbor Turns and Bends. Wilmington District, Corps of Engineers, Wilmington, NC. 14 pp + App.

__________. 1990b. Final Supplement to the Final Environmental Impact Statement. Wilmington Harbor - Northeast Cape Fear River. Wilmington District, Corps of Engineers, Wilmington NC. 106 pp + App.

__________. 1991a. Emergency Improvements to Navigation Basins and Entrance Channels, Military Ocean Terminal, Sunny Point North Carolina. Wilmington District, U.S. Army Corps of Engineers, Wilmington, NC.

__________. 1991b. Reconnaissance Report on Improvements to Navigation, Cape Fear - Northeast Cape Fear Rivers, Comprehensive Study. Volume II - Supporting Documentation. Wilmington District, U.S. Army Corps of Engineers, Wilmington, NC. Appendices A-G.

__________. 1991c. Final Reevaluation Report - Wilmington Harbor Ocean Bar Channel Deepening. Wilmington District, U.S. Army Corps of Engineers, Wilmington, North Carolina. 2: pp + App.

__________. 1992. Preliminary Draft Environmental Impact Statement - Wilmington Harbor Channel Widening. Wilmington District, U. S. Army Corps of Engineers, Wilmington, North Carolina. 143 pp.

__________. 1993a. Environmental Assessment and Finding of No Significant Impact (EA/FONSI) - Project Modification and Mitigation Plan Wilmington Harbor - Northeast Cape Fear River, New Hanover and Brunswick Counties, North Carolina. Wilmington District, Wilmington, North Carolina. 19pp.

__________. 1993b. Draft Project Description, Wilmington Harbor Ocean Bar. Wilmington District, U.S. Army Corps of Engineers, Wilmington, N.C. 1 p.

__________. 1993c. Draft Project Description, Wilmington Harbor Ocean Bar, May, 1993. Wilmington District, U.S. Army Corps of Engineers, Wilmington, N.C. 4 pp.

__________. 1993d. Environmental Assessment and Finding of No Significant Impact, Ocean Bar Channel Deepening, Wilmington Harbor, N. C. Wilmington District, U.S. Army Corps of Engineers, Wilmington, N.C.

__________. 1993e. Draft - Interim Feasibility Report and Environmental Impact Statement on Improvements of Navigation. Wilmington Harbor Channel Widening, Wilmington, North Carolina. Wilmington Corps District, Wilmington, North Carolina. 53 pp. + 87 pp. (EIS) + Appendices.

__________. 1994a. Final - Interim Feasibility Report and Environmental Impact Statement on Improvements of Navigation, Wilmington Harbor Channel Widening, Wilmington, North Carolina. Wilmington Corps District, Wilmington, North Carolina. 56 pp. + 170 pp. (EIS) + Appendices.

__________. 1994b. Environmental Assessment, Beneficial Use of Dredged Material, Wilmington Offshore Fisheries Enhancement Structure, Wilmington Harbor Ocean Bar, Channel Deepening, Wilmington, NC. Wilmington Corps District, Wilmington, North Carolina. 29pp.

__________. 1994c. Finding of No Significant Impact, Beneficial Use of Dredged Material, Wilmington Offshore Fisheries Enhancement Structure, Wilmington Harbor Ocean Bar, Channel Deepening, Wilmington, NC. Wilmington Corps District, Wilmington, North Carolina. 12pp. + Attachment.

__________. 1994d. Final Environmental Impact Statement, Improvements to Navigation Basins and Entrance Channels, Military Ocean Terminal, Sunny Point, North Carolina. Wilmington District, U.S. Army Corps of Engineers, Wilmington, NC. 58pp.+ Appendices.

__________. 1996a. Preliminary Environmental Impact Statement. Cape Fear-Northeast Cape Fear Rivers Feasibility Study. New Hanover and Brunswick Counties, North Carolina. Wilmington District, U.S. Army Corps of Engineers, Wilmington, NC. 117pp.

__________. 1996b. Draft Environmental Impact Statement. Cape Fear-Northeast Cape Fear Rivers Feasibility Study. New Hanover and Brunswick Counties, North Carolina. Wilmington District, U.S. Army Corps of Engineers, Wilmington, NC. v + 121pp.

U. S. Army Environmental Hygiene Agency. 1977. Environmental Assessment, Sunny Point Military Ocean Terminal, July 1976 - May 1977.

U. S. Environmental Protection Agency. 1983. Final Environmental Impact Statement (FEIS). Savannah, GA, Charleston, SC, and Wilmington, NC, Ocean Dredged Material Disposal Sites Designation.

U.S. Fish and Wildlife Service. 1988a. Planning Aid Report - Wilmington Harbor Passing Lane. Raleigh Field Office, Raleigh, NC. 20pp.

__________. 1988b. Planning Aid Report - Wilmington Bends and Turns. Raleigh Field Office, Raleigh, NC. 29pp.

__________. 1988c. Final Fish and Wildlife Coordination Act Report. Wilmington Harbor - Northeast Cape Fear River. Raleigh Field Office, Raleigh, NC. 24 pp + App.

__________. 1989. Planning Aid Report. Wilmington Harbor Bends and Turns Feasibility Level Study. Raleigh Field Office, Raleigh, NC. 31 pp.

__________. 1990a. Planning Aid Report - Wilmington Harbor Passing Lane, Feasibility Level Study. Raleigh Field Office, Raleigh, NC. 36pp.

__________. 1990b. Draft Fish and Wildlife Coordination Act Report. Wilmington Harbor Passing Lane. Raleigh Field Office, Raleigh, NC. 51 pp.

__________. 1991. Draft Fish and Wildlife Coordination Act Report. Wilmington Harbor Turns and Bends. Raleigh Field Office, Raleigh, NC. 55 pp.

__________. 1993a. Draft Fish and Wildlife Coordination Act Report. Wilmington Harbor Ocean Bar Channel Deepening. Raleigh Field Office, Raleigh, NC. 71pp.

__________. 1993b. Draft Fish and Wildlife Coordination Act Report. Wilmington Channel Widening Project. Raleigh Field Office, Raleigh, NC. 57pp.

__________. 1993c. Final Fish and Wildlife Coordination Act Report. Wilmington Harbor Ocean Bar Channel Deepening. Raleigh Field Office, Raleigh, NC. 39 pp.

__________. 1993d. Final Fish and Wildlife Coordination Act Report. Wilmington Channel Widening Project. Raleigh Field Office, Raleigh, NC. 58 pp.

__________. 1995. Draft Supplement I to the Final Environmental Impact Statement. Wilmington Channel Widening Project. Raleigh Field Office, Raleigh, NC. 31pp + Appendices.

Van Dolah, R. F., R. M. Martore, A. E. Lynch, P. H. Wendt, M. V. Levisen, D. J. Whitaker, and W. D. Anderson. 1994. Environmental evaluation pf the Folly Beach project. Final Report to the Charleston District, U. S. Army Corps of Engineers and the South Carolina Department of Natural Resources, Marine Resources Division.

Walberg, C. H. and P. R. Nichols. 1967. Biology and management of the American shad and status of the fisheries, Atlantic coast of the United States, 1960. U. S. Fish and Wildlife Service. Special Science Report. No. 550:35-38.

Webster, W.D., J.F. Parnell, W.C. Biggs, Jr. 1985. Mammals of the Carolinas, Virginia, and Maryland. The University of North Carolina Press, Chapel Hill. 255pp.

Weinstein, M. P. 1979. Shallow marsh habitats as primary nurseries for fish and shellfish, Cape Fear River, North Carolina. Fisheries Bulletin 77(2):339-357.

Woodward-Clyde Consultants. 1980. Aquatic and Terrestrial Ecology. Report Prepared for the Brunswick Energy Company.

Wright, D.G. 1982. A discussion paper on the effects of explosives on fish and marine mammals in the waters of the Northwest Territories. Can. Tech. Rep. Fish. Aquat. Sci. 1052: v + 16 pp.

Young, G.A. 1991. Concise method for predicting the effects of underwater explosions on marine life. Naval Surface Warfare Center. NAVSWC MP 91-220. 22pp.

APPENDICES

APPENDIX A

Nektonic species found at the Military Ocean Terminal, Sunny Point, North Carolina. Sampling was conducted with an otter trawl by the U. S. Army Environmental Hygiene Agency. Source: U. S. Army Environmental Hygiene Agency (1977).

Atlantic menhaden
Gizzard shad
Striped anchovy
Southern kingfish
Bay anchovy
Atlantic croaker
Atlantic silversides
Star drum
Rock sea bass
Southern flounder
Black sea bass
Hogchoker
Bluefish
Blackcheek tonguefish
Atlantic bumper
Squid
Sheepshead
White shrimp
Pinfish
Blue crab
Silver perch
Mantis shrimp
Sand seatrout
Mud crab
Spotted seatrout
Weakfish
Spot

APPENDIX B

STANDARD MANATEE CONSTRUCTION CONDITIONS

Modified from Information Supplied by U. S. Fish and Wildlife Service, Jacksonville, Florida.

1. **The Federal action agency shall instruct all contractors and construction personnel on the potential presence of manatees and the need to avoid collisions with manatees. All construction personnel are responsible for observing water-related activities for the presence of manatees.**

2. **The Corps shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing manatees which are protected under the Marine Mammal Act of 1972 and the Endangered Species Act of 1973.**

3. **All vessels associated with the construction project shall operate at "no wake/idle" speeds at all times while in the construction area and while in water where the draft of the vessel provides less than four feet of clearance from the bottom. All vessels will follow routes of deep water whenever possible.**

4. **If a manatee is seen within 100 yards of the active daily construction/dredging operation or vessel movement, all appropriate precautions shall be implemented to ensure protection of the manatee. These precautions shall include the operation of all moving equipment no closer than 50 feet of a manatee. Operation of any equipment closer than 50 feet to a manatee shall necessitate the immediate shutdown of that equipment. Activities will not resume until the manatee has departed the project area of its own volition.**

5. **An collision with and/or injury to a manatee shall be reported immediately to the North Carolina Wildlife Resources Commission (ph. 919-946-1969) and the manatee coordinator of the U. S. Fish and Wildlife Service in Jacksonville, Florida (ph. 1-904-232-2580)**

APPENDIX C

MANATEE WATCH MEASURES FOR THE DEMOLITION OF THE ACOSTA BRIDGE, JACKSONVILLE, DUVAL COUNTY, FLORIDA

To minimize the potential impacts of the demolition of the Acosta Bridge on manatees, a continuous Manatee Watch Program (MWP) will be established. The following conditions constitute the MWP and should be included as special permit conditions.

1. Seven days prior to the first blast event, the contractor will provide the U.S. Fish and Wildlife Service (USFWS) and Department of Natural Resources (DNR) Office of Protected Species Management a list of the chief and primary observers for the MWP and their qualifications. An outline of the MWP will also be submitted seven days prior to the first blast event. The outline will include time tables for blasting, tide tables for the blasting event indicating slack tides, time table for the MWP (start times for aerial survey and other survey positions, a copy of the MWP log sheet and maps to record manatee sightings.

2. A formal MWP coordination meeting will be held at least two days prior to the first blast event. Attendants will include the chief and primary observers, Federal and State resource agency personnel, and other interested parties, such as the U. S. Coast Guard. All will be informed about the possible presence of manatees in the area, and that civil or criminal penalties can result from harassment, injury and/or death of an endangered species. The construction contractors, demolition subcontractors, and primary observer will present the protocol and logistics of the demolition project and will include time tables for blasting, tide tables for the blasting event indicating slack tides, time table for the MWP (start times for aerial survey and other survey positions), observer positions, a copy of the MWP log sheet and maps to record manatee sightings.

3. The manatee watch will consist of a minimum of six observers, one chief observer and five additional observers. In addition to the observers, there will be one MWP coordinator on site to supervise the watch. Three of the six observers shall have previous experience in observing/spotting manatees and should be documented in the qualifications submitted in Condition 1. One of these observers shall have previous experience and shall be the observer conducting the survey from the helicopter. The four additional observers shall be trained and informed in the methods of surveying and locating manatees.

4. Observers will follow the protocol established for the MWP and will conduct the watch in good faith and to the best of their ability.

5. Each observer will be equipped with a two-way radio that will be dedicated exclusively to the manatee watch. Observers will also be equipped with polarized sunglasses, binoculars, a red flag for a backup visual communication system, and a manatee sighting log with a map to record sightings at the blasting site and vicinity.

6. All blasting events will be scheduled within the period of slack tide to allow for optimum observing conditions. The chief observer will make the decision on the presence of optimum observing conditions to initiate the survey for each blast event.

7. A continuous aerial survey will be conducted by helicopter one hour prior to each blasting event in the vicinity of the blast site. In the event a helicopter is not available, DNR and USFWS will be contacted to determine another suitable method of aerial surveying. The aerial survey will cover the downtown St. Johns River area. The aerial survey route will be designed in conjunction with a DNR manatee specialist. After detonation, the aerial survey crew shall make a complete survey of the danger and buffer zones before landing. The aerial survey crew shall either remain on stand-by in the downtown area or continue surveillance of the river until the end of the watch period in case the need of aerial tracking of an injured manatee arise.

8. The additional primary observers will be located in various positions around the blast site. These positions will be situated to provide maximum visibility of the danger zone and will have unobstructed views underneath the existing bridges. The exact observer locations will be approved by DNR and USFWS prior to each blast. One observer will conduct a sonar starting twenty minutes prior to the blast of a 150-foot radius around pier. The primary observers will begin surveying the area on hour (60 minutes) prior to the blast event and continue observing for one-half hour (30 minutes) after the blast event.

9. Using the formula for an uncontrolled blast of:

$$r = 260 \sqrt[3]{W}$$

where r = radius, w = weight of explosives (TNT equivalent in pounds), the safety zone was determined to be a 900-foot radius, based upon the use of 40 pounds of explosives. The 900-foot radius will be clearly marked with highly visible buoys.

10. All of the observers will be in close communication with blasting subcontractor in order to halt the blast event. The Event will be halted if a manatee(s) is spotted within 300 feet of the perimeter of the danger zone or within the danger zone (900' radius around the blast site). The blasting event will be immediately halted upon the request of the primary observers. The blast will not take place until the animal(s) moves away from the area under its own volition. Manatees must not be herded away or harassed into leaving. If the manatee(s) is not sighted a second time, the event will not resume until 30 minutes after the initial sighting. (If manatees are to be guided out of the danger zone, it will be done through an established protocol developed by the USFWS).

11. Any problems encountered during any of the blasting events will be evaluated by the observers and contractors and logistical solutions will be presented to the USFWS and DNR. Correction to the MWP will be made prior to the next blasting event.

12. If an injured manatee is sighted after the blast event, the Manatee Watch Observers will contact DNR through the Manatee Hotline 1-800-DIAL-FMP (342-5367), and contact the USFWS Jacksonville Office at (904) 791-2580. The Manatee Watch will act according to the situation and maintain contact with the injured or dead manatee.

13. If any injured or dead manatee is rescued/recovered within three miles up or down river from the project site within 72 hours from an underwater blasting event or if the injuries/death of any manatee in the vicinity are documented to be caused by blasting, blasting will be postponed until cause of injury or mortality can be determined by DNR and USFWS. If blasting injuries are substantially documented, all underwater demolition will be suspended and the principle parties will meet to determine a better way to conduct the blasting.

14. Within two weeks (14 days) after completion of all blasting events, the chief observer will submit a report to the USFWS and DNR providing the names of the observers and their positions during the events, number and location of manatees seen and what actions were taken when manatees were seen.

15. If any one of the aforementioned conditions is not met prior to or during the blasting, the chief observer of the MWP will have the authority to terminate the blasting event. Any liability for a violation of the aforementioned protective measures will be assumed by the construction contractor and the DOT.

APPENDIX D

Blasting impacts estimated for a general underwater blasting plan with stemming the top 1 foot of holes and inserting **delays after rows**. Source: Wilmington District, U. S. Army Corps of Engineers.

Fish Weight (lbs)	50% Kill, LD 50		1% Kill, LD 1	
	Radius (feet)	Area (acres)	Radius (feet)	Area (acres)
0.125	1,610	196	2,780	573
1.000	899	63	1,550	181
12.000	446	17	768	47

APPENDIX E

Blasting Impacts Estimated For A General Underwater Blasting Plan (Stemming the top 1 foot of holes and inserting a delay at each hole). Source: Wilmington District, U. S. Army Corps of Engineers.

Fish Weight (lbs)	50% Kill, LD 50		1% Kill, LD 1	
	Radius (feet)	Area (acres)	Radius (feet)	Area (acres)
0.125	381	12.5	656	34.5
1.000	213	4.5	364	11.5
12.000	105	1.4	180	3.4

ATTACHMENT F

CULTURAL RESOURCES

FINAL ENVIRONMENTAL IMPACT STATEMENT
FOR
CAPE FEAR-NORTHEAST CAPE FEAR RIVERS
FEASIBILITY STUDY
NEW HANOVER AND BRUNSWICK COUNTIES, NORTH CAROLINA

The Cape Fear River has a long and active history as one of the earliest and most significant waterways in North Carolina. Although there are few early (10,000-1,000 B.C.) Native American sites along the lower Cape Fear, site frequencies increase after the introduction of agriculture during the three phases of the Woodland Period between 1,000 B.C. and A.D. 1700 (Phelps, 1983:18; Loftfield, 1988:106). The rich subsistence base available along the south coast of North Carolina allowed local populations to maintain permanent village settlement with relative autonomy from other Carolina or Virginia chiefdoms (Loftfield, 1988:115-118). These sites are frequently marked by middens composed of shellfish, fish and animal bone, pottery, and stone tools. Long-term occupations may also contain ossuaries or individual burials (Phelps, 1977; Coe et al., 1980, Baker, 1981b, Hargrove, 1983; Loftfield, 1988, 1990; Wilde-Ramsing, 1984; Mathis, 1993). In New Hanover County, Stine, et al. (1990) have provided survey results with coverage sufficient to allow abstraction of prehistoric site densities to other areas. This study discovered or revisited 33 prehistoric sites occurring over a distance of 7.38 miles of near-shore area (Klein, 1987; Stine, et al., 1990:54). This is about 15.5 percent of the uplands under consideration in the Reconnaissance and Feasibility studies, and we can thus project a total site inventory of over 212 prehistoric sites in lower Cape Fear study area. This figure may be high since the lower portion of New Hanover County may not have been particularly suitable for long-term occupations by large numbers of people since the peninsula narrows and the effects of ocean weather are more pronounced than in northern portions of the project area.

The first European exploration of the Lower Cape Fear may have been undertaken by Lucas Vasquez de Aylion in 1526. Although the coastline had been explored in 1521 by Giovanni de Verrazzano, he is not thought to have entered the Cape Fear. Lucas Vasquez de Aylion may have stopped in the lower Cape Fear to build or repair a vessel damaged or lost to a storm (Angley, 1983:1; Reaves, 1988). The first serious attempt to survey the region with an eye to permanent settlement was made in the fall of 1662 when Englishman William Hilton explored the Cape Fear and Northeast Cape Fear Rivers and made a brief settlement on the Northeast Cape Fear River. Hilton's attempt was followed in 1664 by the establishment of Charles Town near the mouth of Town Creek. This town was founded by John Vassall and a small group of Barbadians and New Englanders but the attempt was poorly organized and did not receive adequate support from either Barbados or England (Angley, 1981:2; Reaves, 1988; Lautzenheiser, et al., 1995:13-14). Although the Charles Town settlement lasted 3 years or less and is generally accounted as a failure, the settlement of the town was accompanied by the development of scattered plantations and farms spreading out for 60 miles along the waterways of the Cape Fear River (Angley, 1983:3). Initial archaeological investigations of the settlement at Town Creek have been undertaken (Loftfield, 1991) but, unfortunately, the results have never appeared in print. More recently, a possible satellite community known as Livingston located in Columbus County has been investigated by Lautzenheiser, et al. (1995).

Longer term and more politically important English settlement was finally undertaken in 1725, when Gēorge Burrington founded a large plantation and town on the west bank of the river. Although never a large town, Brunswick Town survived for 60 years and was an extremely important administrative center for the state's five ports of entry (Angley, 1983:9). This allowed the town to grow and brought attention to the Cape Fear area. By 1733, the town of New Carthage, later to become Wilmington, had been laid out, and in a few decades it would begin to outstrip Brunswick Town as a cultural and maritime center (Reaves, 1988). In 1745, the establishment of Fort Johnston helped assure that the area would remain secure from the Spanish, although at least one Spanish vessel, the *Fortuna*, did manage to get to Brunswick Town in 1748 where it exploded and sank. Although Brunswick Town did not compete successfully with Wilmington, archaeological research conducted there in the 1960's has proven to be very significant in establishing regional trends in artifact analysis and interpretation (South, 1977). Today, Brunswick Town is a North Carolina State Historic Site. Other towns, plantations, and farmsteads also flourished along the river, and by the mid-19th century there were over 140 named landings located along the 115 miles of river between Wilmington and Fayetteville. These landings were regularly visited by pole and steam powered barges and steamships serving farms, mills, and small industrial and commercial centers at and between Smithville (Southport), Navassa, Elizabethtown, Wilmington, and the aforementioned earlier Colonial towns of Brunswick Town and Livingston.

During the years leading up to the Revolution, numerous confrontations took place between the American patriots and British loyalists and troops. Perhaps one of the most significant was the escape of Royal Governor Josiah Martin from his home in New Bern to Fort Johnston. Local patriots had been harassing Fort Johnston for some time, and Martin was eventually forced from Fort Johnston onto the British vessel Cruizer, where he and the Fort commanders could only watch as the fort was razed. Despite this success, the English remained in control of the Cape Fear, conducting sporadic raids on plantations and mills, with Wilmington itself being occupied by the British in October of 1781 (Reaves, 1988). By war's end, Brunswick Town was nearly abandoned and by 1790 the town was deserted. Wilmington was then a thriving maritime center and the fledgling community of Smithville, later to become Southport, was just beginning to grow as a center for river pilotage (Angley, 1983:19-20; Reaves, 1988; Sprunt, 1896:125).

In the 19th century, up to 40 ships per month were visiting Wilmington's Harbor from ports as distant as South America, Germany, Norway, the West Indies, and China, and during the American Civil War, Wilmington was one of the leading ports and shipbuilding centers of the Confederacy (Reaves, 1988). The importance of Wilmington to the Confederacy is reflected in the fortifications used to protect the city and her approaches. Fort Fisher, Fort Holmes, Zekes Island Battery, Camp Wyatt, Fort Hendrick, Fort Campbell, Fort Johnston, Fort Caswell, Battery Buchanan, Fort Anderson, Shaw Battery, Mound Battery, and Battery Lamb were located on the Cape Fear River at and below Wilmington, or faced the ocean and river in Brunswick County, and all were important elements in the coastal defenses. In addition, Camp Lamb and Camp Pender provided training for Confederate troops (Sprunt 1896:131; Reaves, 1988; Jackson, 1995). The defenses at Wilmington were not defeated until late in the war when Fort Fisher finally fell in the largest amphibious assault then known. The Fort was pounded by 57 Union gunboats and attacked by up to 6,000 troops before it eventually surrendered in 1865; Wilmington was occupied by Union troops soon afterward (Angley, 1983:24; Fonvielle, 1987; Reaves, 1988).

After the Civil War, Wilmington's major water courses began to reflect the transition from plantation and agrarian economies to the commercial agriculture and industrial enterprises that would dominate throughout the 20th century. By 1905, channel improvements made the Northeast Cape Fear River navigable for pole boats all the way to Komegays Bridge, 103 miles above the river's mouth (Angley, 1981:14), and ship building, fertilizer and brick factories, shipping terminals, and other capital intensive industries began to replace commercial fishing, hunting, forestry and agriculture as economically dominant businesses. This shift to industrialization is reflected along the banks of the Wilmington waterfront by the remains of numerous shipyards, Liberty Ships, marine railways and dry docks, and the hulks of vessels of virtually every variety. Archaeologically, the importance of the area as a maritime center is shown by the fact that the greater Cape Fear area makes up one of the most chronologically contiguous and typologically complete shipwreck data bases available anywhere in the United States. Thirty-seven historic shipwrecks are listed on the 1985 National Register of Historic Places Registration addendum for the Wilmington Historic District prepared by the North Carolina Division of Archives and History (Pleasants, 1977; Lawrence, 1985). In addition, over 130 shipwrecks are known from the lower Cape Fear - Northeast Cape Fear Rivers vicinity, and nearby upland historic sites include Charles Town, Brunswick Town, Fort Johnston (1750-present), the Robbins Site (1820-1925), Battery Lamb (1865), Fort Anderson (1865), Fort Fisher (1865), and Fort Caswell (1826). An additional 50 lesser known prehistoric and historic sites are also known along the rivers throughout New Hanover and Brunswick County (Snavely and Gorin, 1974; Hall, 1979; Baker, 1981a, 1981b; Rubenstein, 1982; Payne and Brown, 1983; Hargrove, 1984; Wilde-Ramsing, 1984; Hargrove et al., 1985). Today, the majority of these historic places have been lost to neglect, ruin, erosion, and new enterprise. For archaeologists and historians, the initial clue to the location of one of these riverside historic ruins is often the exposed remnants of an historic landing or the frames of an old commercial vessel embedded along the river bank. Less visible are the remains of vessels which sank in open water and which are now embedded in the river bottom.

In order to evaluate the effects of the proposed project on underwater shipwreck sites located adjacent to the channels and basins, a cooperative remote survey and diver investigation was undertaken by the North Carolina Division of Archives and History and the US Army Corps of Engineers, Wilmington District. Portions of these areas had been covered in previous archaeological surveys, including those conducted by the North Carolina Division of Archives and History Underwater Archaeology Unit, and those conducted by the Corps of Engineers in conjunction with the deepening of Cape Fear and Northeast Cape Fear Channels, the widening of Smith Island Channel, the deepening of Baldhead Shoal Channel, and the widening of portions of other Cape Fear River Channels (Lawrence, 1985, 1988; Watts, 1988, 1990a; Wilde-Ramsing, 1995). In addition to these investigations, the Bibliography of North Carolina Underwater Archaeology lists 13 research manuscripts or reports on file for the Cape Fear River, 18 for the vicinity of New Inlet (including off-shore areas), and 19 for the Northeast Cape Fear River (Brooks and Wilde-Ramsing, 1988: 8-10, 17-20). Channels or channel reaches which have received coverage in previous surveys include: Lower and Upper Midnight Channels, Lower Lilliput Channel, five channel turns from the intersection of Lower and Upper Brunswick Channels south to the intersection of Lower and Upper Lilliput Channels, the turn at the intersection of Reaves Point and Lower Midnight Channels, North Carolina Highway 133 Bridge to Hilton Railroad Bridge, channel above the Hilton Railroad Bridge, Sugar Loaf Wreck, the MOTSU basins in the vicinity of the former north channel serving the MOTSU and in the immediate off-shore vicinity of Reaves Point in the vicinity of the south wharf , surveys in the vicinity of Town Creek, survey in the vicinity of the Brunswick Town Harbor (Alford n.d.; Watts, 1975; Duff and Lange, 1980; Ocean Surveys, 1981; Anuskiewicz, 1982, 1983; Saltus, 1982; Hargrove. et al., 1985; Lawrence, 1985; Kimmel, 1987a, 1987b; Watts, 1988, 1990a, 1990b, 1993, 1994, 1995a, 1995b). The comprehensive maritime history and underwater archaeological survey conducted for this Feasibility Study was designed to expand on the results of these surveys by implementing a detailed cartographic inventory of historic sites and place names for use in predicting the loci of cultural activity, a technique sometimes called map projection (Jackson, 1995; Overton, et al., 1995). The map projection was then used to predict locations of shipwreck remains, careening grounds, persistent shoals, and other features which might have influenced the distribution of shipwrecks. Remote sensing and diver investigations of these areas indicate that none of the known or newly discovered shipwreck sites are sufficiently close to navigation channels to require evaluation during construction of the proposed project.

REFERENCES CITED

Alford, Michael B. n.d. A Flat-Bottomed Sailing Craft from the Cape Fear River at Sugar Loaf, Carolina Beach State Park, New Hanover County, North Carolina. Manuscript on file, North Carolina Maritime Museum, Beaufort.

Angley, Wilson. 1981. A Historical Overview of the Northeast Cape Fear River. Manuscript on file, North Carolina Division of Archives and History, Raleigh.

Angley, Wilson. 1983. An Historical Overview of the Sunny Point Terminal Area on the Lower Cape Fear River. Report prepared by the North Carolina Division of Archives and History, Raleigh.

Anuskiewicz, Richard J. 1982. Magnetometer Survey and Cultural Resource Assessment of Selected Magnetic Anomalies, Military Ocean Terminal, Sunny Point, North Carolina. Report on file, U. S. Army Corps of Engineers, Wilmington.

Anuskiewicz, Richard J. 1983. Diver Hands-On Cultural Resource Assessment of Selected Magnetic Anomalies at the North Wharf, Military Ocean Terminal, Sunny Point, North Carolina: A Report of Negative Findings. Report on file, U. S. Army Corps of Engineers, Wilmington.

Baker, Michael. 1981a. An Intensive Archaeological Reconnaissance of Areas Bordering Snows Cut, New Hanover County, North Carolina. Report prepared by Archaeological Research Consultants Inc., Chapel Hill, North Carolina.

Baker, Michael. 1981b. An Intensive Archaeological Reconnaissance of the Carolina Beach Borrow Area, New Hanover County, North Carolina. Report prepared by Archaeological Research Consultants, Inc., Chapel Hill, North Carolina.

Brooks, Barbara Lynn and Mark Wilde-Ramsing. 1988. Bibliography of North Carolina Underwater Archaeology. North Carolina Division of Archives and History, Underwater Archaeology Unit, Kure Beach.

Coe, Joffre L., H. Trawick Ward, Martha Graham, Liane Navey, and S. Homes Hogue. 1980. Archaeological and Paleo-Osteological Investigations at the Cold Morning Site, New Hanover County, North Carolina. Prepared by the Research Laboratories of Anthropology, University of North Carolina, Chapel Hill.

Duff, James A., and Diana M. Lange. 1980. Town Creek Magnetometer Survey, Brunswick County, North Carolina. Report prepared by the North Carolina Division of Archives and History, Raleigh.

Fonvielle, Chris Eugene, Jr. 1987. To Forge A Thunderbolt: The Wilmington Campaign, February, 1865. Unpublished M.A. Thesis, East Carolina University, Greenville, North Carolina.

Hall, Wesley K. 1979. A Cultural Resource Survey of Selected Portions of the Military Ocean Terminal at Sunny Point, North Carolina. Report prepared by Coastal Zone Resources Division, Ocean Data Systems, Inc., Wilmington, North Carolina.

Hargrove, Thomas H. 1984. Archaeological Test Excavations at Reaves Point, Military Ocean

Terminal, Sunny Point, North Carolina. Report prepared by Archaeological Research Consultants, Inc., Chapel Hill, North Carolina.

Hargrove, Thomas H., Gordon P. Watts, Jr., and Bill Reaves. 1985. Terrestrial and Marine Archaeological Survey of the Proposed Castle Street Boat Ramp on the Cape Fear River, Wilmington, New Hanover County, North Carolina. Report prepared by Archaeological Research Consultants, Inc., Chapel Hill, North Carolina.

Jackson, Claude V., III. 1995. A Maritime History and Survey of the Cape Fear - Northeast Cape Fear Rivers, Wilmington Harbor, North Carolina, Volume 1, Maritime History. North Carolina Division of Archives and History Underwater Archaeology Unit, Kure Beach.

Kimmel, Richard. 1987a. Historic Properties Assessment of the Proposed Cape Fear River Channels Passing Lane. Manuscript on file, US Army Corps of Engineers, Wilmington.

Kimmel, Richard. 1987b. Summary of Magnetic Survey, Wilmington Harbor/Northeast Cape Fear River. Manuscript on file, US Army Corps of Engineers, Wilmington.

Lautzenheiser, Loretta. 1995. Archaeological Survey, Proposed Treated Wastewater Holdings Ponds, Federal Paper Board Riegelwood Operations, Riegelwood, Columbus County, North Carolina. Coastal Carolina Research, Tarboro, North Carolina.

Lawrence, Richard W. 1985. Underwater Archaeological Sites in the Wilmington Historical District. Addendum to the National Register of Historic Places Nomination - Inventory Form, Wilmington Historical District. Manuscript on file North Carolina Division of Archives and History, Raleigh.

Lawrence, Richard W. 1988. Field Inspection of the Walker Barge, 0068CFR. Manuscript on file, North Carolina Division of Archives and History, Underwater Archaeology Unit, Kure Beach.

Loftfield, Thomas C. 1988. Prehistoric Oystermen of the Central North Carolina Coast. In *Sea and Land - Cultural and Biological Adaptations in the Southern Coastal Plain.* Edited by James L. Peacock and James C. Sabella, pp. 106-121. The University of Georgia Press, Athens.

Loftfield, Thomas C. 1990. Ossuary Interments and Algonquian Expansion on the North Carolina Coast. *Southeastern Archaeology* 9(2);116-123.

Loftfield, Thomas C. 1991. The Caribbean Influence in Early Colonial North Carolina. Paper presented at the 1991 Society for Historical Archaeology, Conference on Historical and Underwater Archaeology, Richmond, Virginia.

Mathis, Mark A. 1993. Broad Reach: A Unique Site or the Truth About What We've Missed? In *Site Destruction in Georgia and the Carolinas*, edited by David G. Anderson and Virginia Horak. Readings in Archaeological Resource Protection Series No. 2. US Department of the interior, National Park Service, Atlanta.

Ocean Surveys, Inc. 1981. Cultural Resource Magnetic Survey, Northeast Cape Fear River, Wilmington, North Carolina. Report prepared for Atlantic Resources, Inc. by Ocean Surveys, Inc., Old Saybrook, Connecticut. Manuscript on file, North Carolina Division of Archives and History, Raleigh.

Overton, Glenn C., Richard W. Lawrence, and Claude V. Jackson, III. 1995. A Maritime History and Survey of the Cape Fear - Northeast Cape Fear Rivers, Wilmington Harbor, North Carolina, Volume 2, Cultural Survey. North Carolina Division of Archives and History Underwater Archaeology Unit, Kure Beach.

Payne, Ted M. and Ann Brown. 1983. Cultural Resources Survey: Reaves Point, Proposed Disposal Area 5 and Disposal Area 2 Project Areas, Military Ocean Terminal, Sunny Point, North Carolina. Report on file, U. S. Army Corps of Engineers, Wilmington.

Phelps, David Sutton. 1976. An Archaeological Survey of the Lower Cape Fear Regional Water Supply System Project Area. *Archaeological Impact Studies No. 9.* Archaeological Research Laboratory, East Carolina University, Greenville, North Carolina.

Phelps, David Sutton. 1983. Archaeology of the North Carolina Coast and Coastal Plain: Problems and Hypotheses. In *The Prehistory of North Carolina: An Archaeological Symposium.* Mark A. Mathis and Jeffrey J. Crow, eds., pp. 1-51. North Carolina Division of Archives and History, Raleigh.

Pleasants, James A., Jr. 1977. A Brief Survey of Archival References Relating to Known Wrecks and Shipping Channel History from Wilmington to the Ocean Bar, 1624 - 1925. Manuscript on file, North Carolina Division of Archives and History, Raleigh.

Reaves, William. 1988. History of Wilmington and the Lower Cape Fear. Lecture series. Cape Fear Community College, Wilmington, NC.

Rubenstein, Paul D. 1982. An Archaeological Reconnaissance of the Ethyl-Dow Chemical Bromine Extraction Plant New Hanover County, North Carolina. Manuscript on file, US Army Corps of Engineers, Savannah.

Sacchi, Richard R., Terry H. Erlandson, Diana Lange, Richard Lawrence, David Moore, and Gordon Watts. 1980. An Archaeological Survey and Evaluation at Fort Fisher State Historic Site and Vicinity. Report prepared by the North Carolina Division of Archives and History, Raleigh.

Saltus, Allen R. 1982. Cultural Resources Survey of a Portion of the Northeast Cape Fear River and Report on the Test Excavation to Evaluate the Steamship SPRAY. Report prepared by Archeological Research and Survey for Atlantic Salvesen. Manuscript on file, North Carolina Division of Archives and History, Raleigh.

Snavely, Alan N. and Diana C. Gorin. 1974. Archaeological Reconnaissance of Carolina Beach and Vicinity, New Hanover County, North Carolina. Report prepared for the North Carolina Division of Archives and History, Raleigh.

South, Stanley A. 1977. *Method and Theory in Historical Archaeology.* Academic Press, New York.

Sprunt, James. 1896. *Tales and Traditions of the Lower Cape Fear, 1661- 1896.* Reprinted 1975 by The Reprint Co., Spartanburg, South Carolina.

Stine, Linda F., Margaret L. Stephenson, Lesley M. Drucker, and Susan H. Jackson. 1990. Archaeological Inventory Survey and National Register Evaluations: Military Ocean Terminal, Sunny Point, New Hanover County, North Carolina. Report prepared by Carolina Archaeological Services, Columbia, South Carolina.

Watts, Gordon P., Jr. 1975. Magnetometer Survey of the Brunswick Town Waterfront: Report of Activities of the 1975 Field School in Underwater Archaeology. North Carolina Division of Archives and History, Underwater Archaeology Unit, Kure Beach.

Watts, Gordon P., Jr. 1988. Archaeological Reconnaissance of the Wilmington Harbor/Northeast Cape Fear River. Final report prepared for the Wilmington District Corps of Engineers by Tidewater Atlantic Research, nc., Washington, N.C.

Watts, Gordon P., Jr. 1990a. An Underwater Archaeological Investigation of the Hilton Wreck, Wilmington, North Carolina. Report prepared by Tidewater Atlantic Research, Inc., Washington, North Carolina.

Watts, Gordon P., Jr. 1990b. A Report on Magnetic and Acoustic Targets Identified by Remote Sensing Investigation of Six Turns and Proposed Passing Lanes in the Shipping Channels of the Cape Fear River Below Wilmington, North Carolina. Tidewater Atlantic Research, Inc., Washington, North Carolina.

Watts, Gordon P., Jr. 1993. A Submerged Cultural Resource Survey of Baldhead Shoal Channel, Vicinity of Wilmington North Carolina. Report prepared for the Wilmington District Corps of Engineers by Tidewater Atlantic Research, Washington, N.C.

Watts, Gordon P., Jr. 1994. A Remote Sensing Survey and Diver Investigation at Wilmington Harbor Offshore Fishery Enhancement Structure, Vicinity of Wilmington, North Carolina. Report prepared for the Wilmington District Corps of Engineers by Tidewater Atlantic Research, Washington, N.C.

Watts, Gordon P., Jr. 1995a. Underwater Archaeological Assessment of Eight Magnetic Anomaly Locations within the Wilmington Harbor Channel Widening Project Area Below Wilmington, North Carolina. Final report prepared for the Wilmington District Corps of Engineers by Tidewater Atlantic Research, Washington, N.C.

Watts, Gordon P., Jr. 1995b. Underwater Archaeological Assessment of Four Target Locations at Smith Island Channel, Wilmington Harbor, North Carolina. Final report prepared for the Wilmington District Corps of Engineers by Tidewater Atlantic Research, Washington, N.C.

Wilde-Ramsing, M. 1984. Archaeological survey and testing on prehistoric shell midden sites in New Hanover County, North Carolina. Unpublished MA thesis. Catholic University, Washington, D.C.

Wilde-Ramsing, Mark. 1995. Presentation to the 1995 North Carolina Maritime History Workshop, Beaufort.

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APPENDIX A

Pertinent Correspondence

State of North Carolina
Department of Environment,
Health and Natural Resources
Division of Water Resources

James B. Hunt, Jr., Governor
Jonathan B. Howes, Secretary
John N. Morris, Director

DEHNR

May 16, 1996

Colonel Robert J. Sperberg
District Engineer
Wilmington District, Corps of Engineers
Post Office Box 1890
Wilmington, North Carolina 28402-1890

Dear Colonel Sperberg:

The State of North Carolina is pleased to see the completion of the feasibility study for the Cape Fear-Northeast Cape Fear Rivers project. It is urgent to move ahead with the deepening of Wilmington Harbor to accommodate the larger and deeper draft vessels being introduced into service.

The State of North Carolina has reviewed the feasibility report and agrees with its findings and recommendations to deepen Wilmington Harbor from 40 feet to 44 feet through the Ocean Bar Channel, from 38 feet to 42 feet from the Bar Channel to the Cape Fear Memorial Bridge, no modifications from the Memorial Bridge to 750 feet above the Hilton Railroad Bridge, and from 25 feet to 34 feet from just above the Railroad Bridge to the Arcadian Corporation and the associated widenings. The State is also aware of the terms of the Project Cooperation Agreement and is prepared to accept its responsibilities as the non-Federal Sponsor.

The State has committed a total of $2,376,000 to cover the non-Federal costs of the Cape Fear-Northeast Cape Fear Rivers project through Federal fiscal year 1996. According to current cost estimates, additional state funds in the amount of $93,863,000 (including $8,990,000 in LERRD's and $25,190,000 in Associated Costs) for the recommended plan will be required in fiscal years 1997 through 2004 as follows:

Fiscal Year	LERRD's	Associated Costs	Cash	Total Non-Federal Share
1997	$ 200,000	$ 0	$ 330,000	$ 530,000
1998	302,000	526,000	700,000	1,528,000
1999	347,000	1,671,000	1,100,000	3,118,000
2000	2,581,000	1,112,000	370,000	4,063,000
2001	3,570,000	0	17,700,000	21,270,000
2002	1,990,000	4,377,000	17,700,000	24,067,000
2003	0	8,752,000	18,200,000	26,952,000
2004	0	8,752,000	3,583,000	12,335,000
	$8,990,000	$25,190,000	$59,683,000	$93,863,000

The State of North Carolina intends to provide the remaining non-Federal cash and LERRD costs through general fund appropriations by the General Assembly in fiscal years 1997 through 2004, subject to North Carolina's statutory and constitutional procedures for such commitments.

The associated costs are for deepening adjacent to docks and for modification of docks related to the project. These costs will be paid by the North Carolina State Ports Authority and by other owners of facilities at Wilmington Harbor.

The financial plan that the State of North Carolina will follow for the Cape Fear-Northeast Cape Fear Rivers project is the same as our funding method for a number of other Corps of Engineers projects for which the State of North Carolina is the non-Federal Sponsor, or for which it shares project cost with a local government sponsor. The Wilmington Harbor Ocean Bar project now under construction, was funded by this method. In State fiscal year 1994-1995, the General Assembly made appropriations of $10,906,000 for the Wilmington Harbor Ocean Bar project and a total of $22,324,000 for all Corps of Engineers projects requiring matching funds that fiscal year.

The State of North Carolina has statutory authority under the Federal Water Resources Development Law of 1969 (G.S. 143-215.38 et seq.) to make binding commitments to carry out the non-Federal responsibilities for Corps of Engineers projects, including making cash contributions to projects. The State's commitment to the Cape Fear-Northeast Cape Fear Rivers project will be made through signature of the Project Cooperation Agreement, now scheduled for execution in January 1998, following the decision procedures established by this statute.

We have appreciated the opportunity to work closely with the Wilmington District toward the construction of this major improvement to Wilmington Harbor.

Sincerely,

John N. Morris

John N. Morris

APPENDIX B

Local Cooperation

DISTRICT ASSESSMENT OF FINANCIAL CAPABILITY

The following is an assessment of the State of North Carolina's commitment and financial capability to sponsor the Cape Fear - Northeast Cape Fear River Navigation Project. The assessment includes an analysis of the sponsors proposed financing plan and the State's past performance on similar projects.

The attached financial analysis includes the State's proposed plan to finance the project, statement of financial capability and commitment to be the Non-Federal project Sponsor. The State's plan clearly sites the source, authority and capability to provide required project contributions. The analysis shows schedules of Federal and Non-Federal funds required during and after construction. When completed the navigation project will have a depth of less than 45 feet, therefore, the Federal Government will be responsible for all OMRR&R costs. The financial analysis concludes that the State has a reasonable plan for meeting its financial commitment.

In the past year the State has met financial commitments totaling over $2,100,000 for Corps of Engineers' projects. North Carolina's plan to finance the Cape Fear - Northeast Cape Fear project is through the same legislative appropriations process that provided $3,825,000 for the Morehead City Harbor and $10,906,000 for the Wilmington Harbor Ocean Bar Navigation Projects.

Based on the State of North Carolina's commitment to the Cape Fear - Northeast Cape Fear project, its financial capability statement and the District's financial analysis, it is reasonable to expect that ample funds will be made available to meet the required obligations.

17 May 96

Robert J. Sperberg
Colonel, EN
Commanding

FINANCIAL ANALYSIS
CAPE FEAR-NORHTEAST CAPE FEAR RIVER PROJECT

This analysis outlines the steps that the State of North Carolina, as the non-Federal sponsor of the Cape Fear-Northeast Cape Fear River Project, must take to secure the funds needed for construction. Its purpose is to ensure that the State has a reasonable and implementable plan for meeting its financial commitment. It follows the District Engineer's assessment of the sponsor's financial capability and is followed by a letter of financial capability and intent from the State of North Carolina.

Financial Capability and Intent. Contained in this financial analysis is a capsule summary of the State's budget process and an explanation of how the non-Federal funds would be made available at the required time. The North Carolina General Assembly normally does not commit specific legislation for the appropriation of funds for water resources projects. Usually these funds are appropriated through passage of the State's budget by the General Assembly. The availability of State funds for the Cape Fear-Northeast Cape Fear River project, or any other water resources project, depends on appropriation decisions by the General Assembly and on the priority of this project relative to all projects requiring State funds. The General Assembly's budget generally appropriates funds for two-year periods, but does not usually obligate future Assembly's funds beyond this time frame.

State laws require North Carolina to operate on a balanced budget; that is, capital outlays are not to exceed revenues. Furthermore, it is a biennial budget that runs from 1 July to 30 June of the odd numbered years, but the budget is reviewed and adjusted at the end of each even numbered fiscal year to ensure it is on course to balance. Of course, the State is empowered to generate revenue through taxation or issuance of bonds to correct any projected shortfalls.

The Wilmington District Corps of Engineers worked with the North Carolina Department of Environment, Health, and Natural Resources (DEHNR) and State legislators to develop a better method of synchronizing the water resources budget of the State with that of the district's civil works program. The ratification of the following budgetary procedure by the General Assembly in June 1991 was the culmination of this effort. The law, which is now in effect and fully implemented, is summarized below.

(1) Before 1 July in each calendar year, DEHNR prepares a statewide plan for water resources development projects for a period of six years into the future. The plan, called the Water Resources Development Plan, is submitted to the Director of the Budget for review.

(2) The projects are prioritized in the Water Resources Development Plan based on the following criteria: Local interest in the project; the cost of the project to the State; the benefit of the project to the State; and, the environmental impact of the project.

(3) Following the Advisory Budget Commission deliberations on the biennial budget or the revised budget for the second year of the biennium, the Director of the Budget presents the recommended budget to the General Assembly. The budget document transmitted to the General Assembly identifies the water resource projects recommended for funding.

(4) The General Assembly then votes on the recommended budget.

Another important consideration is that the North Carolina General Statutes allow for flexibility in the State budget process in the event of cost overruns. The State can adjust funding for water resource projects and has the capability to carry over these funds. This gives the State significant flexibility to match funds for study or project implementation.

The State understands that if funds in excess of those previously scheduled are needed during construction, the State would provide those funds no later than 30 calendar days from receipt of such notice. The State's budget process allows it to adjust to such a scenario. Where the actual costs of funded projects are different from the estimated costs, DEHNR may adjust the allocations among projects as needed. If any of these projects are delayed and the budgeted State funds cannot be used during a given fiscal year, or they are accomplished at a lower cost, DEHNR may use the resulting funds among other projects or studies as needed. In the event that funds from other projects cannot be transferred due to their high priority, funds could be made available by (1) appealing to the Governor's Emergency Fund (usually set at $10 million each year);or (2) calling the General Assembly into session and passing specific supplemental appropriations bill. This latter approach, though technically legal, is difficult.

In the case of the Cape Fear-Northeast Cape Fear River project, the State has another partner in the North Carolina State Ports Authority (NCSPA). If necessary, NCSPA, which internally generates much of its funds from revenues, will be ready to help the State complete its financial obligations regarding this project. This factor could add greatly to the State's flexibility if it became necessary to quickly secure funds for this particular project. This project is the NCSPA first priority in their harbor deepening needs.

As the largest deep water port in North Carolina, Wilmington Harbor is obviously of vital importance to the economic well being of the State. The value of the State's real estate and improvements at the Port is about $157 million. According to a 1994 Impact Study by the NCSPA, it is expected that the total of the direct, indirect, and induced effects of the Port of Wilmington will represent about 66,000 jobs, annual sales of $9,233 million, $1,614 million in income annually, and $214 million each year in taxes. In addition, the State and the Corps of Engineers have worked together cooperatively for years on the maintenance of Wilmington Harbor, with the State paying for the dredging of the berthing areas and providing diking and disposal sites. This project is rated as one of the highest priorities in the State. It is also noteworthy that the State of North Carolina has not missed a payment on a Federally cost-shared water resources project since 1979 when their budget rules were last changed to comply more closely with Federal procedures.

The financial plan that the State of North Carolina will follow for the Cape Fear-Northeast Cape Fear River Project is the same as our funding method for a number of other Corps of Engineers projects for which the State of North Carolina is the non-federal sponsor, or for which it shares project cost with a local government sponsor. The Wilmington Harbor Ocean Bar Project, now under construction, was funded by this method. In state fiscal year 1994-1995, the General Assembly made appropriations of $10,906,000 for the Wilmington Harbor Ocean Bar Project and a total OF $22,324,000 for all Corps of Engineers projects requiring matching funds that fiscal year.

Financial Plan. The State of North Carolina, as project sponsor, understands that the estimated total fully funded cost for design and construction of this project is $272,000,000. The State further understands that the non-Federal share of this amount is estimated to be $93,863,000 including $59,683,000 cash, $8,990,000 for LERRD's, and $25,190,000 for associated costs. Associated costs include $3,309,000 for utility relocations and $21,881,000 for berthing area improvements. The State also understands its obligation to repay, after construction, 10 percent of the general navigation features less credit for LERRD's, estimated to be $14,800,000. This amount is to be repaid within a period of 30 years following completion of construction. The repayment schedule for future reimbursement is attached. There is no reason to suspect that fulfilling any of the requirements will be a problem for the State.

A detailed schedule of fully funded cost estimates and payments to be made by the State of North Carolina follows:

FEDERAL AND NON-FEDERAL FINANCING
Based on the Fully Funded First Cost Estimate
Oct 1996 Price Levels

Fiscal Year	LERRD's	Associated Costs	Cash	Total Non-Federal Share
1997	$ 200,000	$ 0	330,000	530,000
1998	302,000	526,000	700,000	1,528,000
1999	347,000	1,671,000	1,100,000	3,118,000
2000	2,581,000	1,112,000	370,000	4,063,000
2001	3,570,000	0	17,700,000	21,270,000
2002	1,990,000	4,377,000	17,700,000	24,067,000
2003	0	8,752,000	18,200,000	26,952,000
2004	0	8,752,000	3,583,000	12,335,000
Total	$8,990,000	$25,190,000	$59,683,000	$93,863,000

Table of Repayment Amounts for Navigation Projects
Wilmington Harbor Deepening $14,800,000
Interest rate 6.750%
Number of Years 30

Payment Year	Balance Owed	Payment Amount
1	14,800,000	1,162,868
2	14,636,132	1,162,868
3	14,461,203	1,162,868
4	14,274,466	1,162,868
5	14,075,125	1,162,868
6	13,862,328	1,162,868
7	13,635,167	1,162,868
8	13,392,673	1,162,868
9	13,133,811	1,162,868
10	12,857,475	1,162,868
11	12,562,487	1,162,868
12	12,247,587	1,162,868
13	11,911,431	1,162,868
14	11,552,585	1,162,868
15	11,169,516	1,162,868
16	10,760,591	1,162,868
17	10,324,063	1,162,868
18	9,858,069	1,162,868
19	9,360,621	1,162,868
20	8,829,595	1,162,868
21	8,262,725	1,162,868
22	7,657,591	1,162,868
23	7,011,610	1,162,868
24	6,322,026	1,162,868
25	5,585,895	1,162,868
26	4,800,075	1,162,868
27	3,961,212	1,162,868
28	3,065,726	1,162,868
29	2,109,794	1,162,868
30	1,089,338	1,162,868
Rem Balance	0	

Cape Fear - Northeast Cape Fear River
Federal and Non-Federal Financing
(Full Funded - Oct. 96 Price Level)

Fiscal Year	Project Cost	Non-Federal LEERD's Costs	Non-Federal Associated Costs	Non-Federal Cash	Total Shares Non-Federal	Total Shares Federal
1997	1,530,000	200,000	0	330,000	530,000	1,000,000
1998	3,628,000	302,000	526,000	700,000	1,528,000	2,100,000
1999	6,318,000	347,000	1,671,000	1,100,000	3,118,000	3,200,000
2000	5,300,000	2,581,000	1,112,000	370,000	4,063,000	1,237,000
2001	74,470,000	3,570,000	0	17,700,000	21,270,000	53,200,000
2002	77,167,000	1,990,000	4,377,000	17,700,000	24,067,000	53,100,000
2003	81,552,000	0	8,752,000	18,200,000	26,952,000	54,600,000
2004	22,035,000	0	8,752,000	3,583,000	12,335,000	9,700,000
Totals	272,000,000	8,990,000	25,190,000	59,683,000	93,863,000	178,137,000

Fully Funded Cost Allocation
Jan. 1996 Feasibility Study Cost Estimate (Oct. 96 Price Level)

Item	Total	Non-Federal	Federal
Lands & Damages			
Lands	356,000	356,000	0
Federal PED	104,000	26,000	78,000
Subtotal, Lands & Damages	460,000	382,000	78,000
Associated Costs			
Utility Relocations	3,309,000	3,309,000	0
Berthing Area Improvements	21,881,000	21,881,000	
General Navigation Features			
Channel Improvements	226,363,000	56,851,000	169,512,000
Navigation Aids	137,000	0	137,000
Planning, Engineering, & Design	6,530,000	1,630,000	4,900,000
Construction Management	4,686,000	1,176,000	3,510,000
Disposal Areas	8,634,000	8,634,000	
Subtotal, General Navigation	246,350,000	68,291,000	178,059,000
Future Reimbursement		(14,800,000)	
TOTAL	272,000,000	93,863,000	178,137,000

Note: The Oct 1995 MCACES estimate was price leveled to Oct 96 using OMB factors prior to computing the fully funded total project cost estimate.

State of North Carolina
Department of Environment,
Health and Natural Resources
Division of Water Resources

James B. Hunt, Jr., Governor
Jonathan B. Howes, Secretary
John N. Morris, Director

DEHNR

May 16, 1996

Colonel Robert J. Sperberg
District Engineer
Wilmington District, Corps of Engineers
Post Office Box 1890
Wilmington, North Carolina 28402-1890

Dear Colonel Sperberg:

The State of North Carolina is pleased to see the completion of the feasibility study for the Cape Fear-Northeast Cape Fear Rivers project. It is urgent to move ahead with the deepening of Wilmington Harbor to accommodate the larger and deeper draft vessels being introduced into service.

The State of North Carolina has reviewed the feasibility report and agrees with its findings and recommendations to deepen Wilmington Harbor from 40 feet to 44 feet through the Ocean Bar Channel, from 38 feet to 42 feet from the Bar Channel to the Cape Fear Memorial Bridge, no modifications from the Memorial Bridge to 750 feet above the Hilton Railroad Bridge, and from 25 feet to 34 feet from just above the Railroad Bridge to the Arcadian Corporation and the associated widenings. The State is also aware of the terms of the Project Cooperation Agreement and is prepared to accept its responsibilities as the non-Federal Sponsor.

The State has committed a total of $2,376,000 to cover the non-Federal costs of the Cape Fear-Northeast Cape Fear Rivers project through Federal fiscal year 1996. According to current cost estimates, additional state funds in the amount of $93,863,000 (including $8,990,000 in LERRD's and $25,190,000 in Associated Costs) for the recommended plan will be required in fiscal years 1997 through 2004 as follows:

Fiscal Year	LERRD's	Associated Costs	Cash	Total Non-Federal Share
1997	$ 200,000	$ 0	$ 330,000	$ 530,000
1998	302,000	526,000	700,000	1,528,000
1999	347,000	1,671,000	1,100,000	3,118,000
2000	2,581,000	1,112,000	370,000	4,063,000
2001	3,570,000	0	17,700,000	21,270,000
2002	1,990,000	4,377,000	17,700,000	24,067,000
2003	0	8,752,000	18,200,000	26,952,000
2004	0	8,752,000	3,583,000	12,335,000
	$8,990,000	$25,190,000	$59,683,000	$93,863,000

The State of North Carolina intends to provide the remaining non-Federal cash and LERRD costs through general fund appropriations by the General Assembly in fiscal years 1997 through 2004, subject to North Carolina's statutory and constitutional procedures for such commitments.

The associated costs are for deepening adjacent to docks and for modification of docks related to the project. These costs will be paid by the North Carolina State Ports Authority and by other owners of facilities at Wilmington Harbor.

The financial plan that the State of North Carolina will follow for the Cape Fear-Northeast Cape Fear Rivers project is the same as our funding method for a number of other Corps of Engineers projects for which the State of North Carolina is the non-Federal Sponsor, or for which it shares project cost with a local government sponsor. The Wilmington Harbor Ocean Bar project now under construction, was funded by this method. In State fiscal year 1994-1995, the General Assembly made appropriations of $10,906,000 for the Wilmington Harbor Ocean Bar project and a total of $22,324,000 for all Corps of Engineers projects requiring matching funds that fiscal year.

The State of North Carolina has statutory authority under the Federal Water Resources Development Law of 1969 (G.S. 143-215.38 et seq.) to make binding commitments to carry out the non-Federal responsibilities for Corps of Engineers projects, including making cash contributions to projects. The State's commitment to the Cape Fear-Northeast Cape Fear Rivers project will be made through signature of the Project Cooperation Agreement, now scheduled for execution in January 1998, following the decision procedures established by this statute.

We have appreciated the opportunity to work closely with the Wilmington District toward the construction of this major improvement to Wilmington Harbor.

Sincerely,

John N. Morris

John N. Morris

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