WILMINGTON HARBOR, NORTH CAROLINA, 96 ACT
NEW HANOVER AND BRUNSWICK COUNTIES, NORTH CAROLINA. SUPPLEMENT TO THE FINAL FISH AND WILDLIFE COORDINATION ACT REPORT

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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.

This report is provided under authority of Section 2(b) of the Fish and Wildlife Coordination Act (FWCA) of 1958 (48 Stat. 401, as amended; 16 U.S.C. 661-667d). The FWCA established fish and wildlife conservation as a coequal objective of federally funded or permitted water resources development projects. Consultation during project planning is intended to allow state and federal resource agencies to determine the potential adverse impacts on fish and wildlife resources and develop recommendations to avoid, minimize, and/or compensate for detrimental impacts.

The existing Federal project consists of a channel 40 feet deep and 500 feet wide from the Atlantic Ocean through the ocean bar (Bald Head Shoal and Smith Island Channels) and entrance channels (Bald Head-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.

This report reviews supplemental modifications to the Wilmington Harbor, North Carolina, 96 Act Project proposed since the Service's most recent report on the project, the Cape Fear-Northeast Cape Fear Rivers Comprehensive Study, New Hanover and Brunswick Counties, North Carolina, Final FWCA Report of May 1996. The six proposed modifications are: (1) construction and maintenance of the harbor entrance channel (Bald Head Shoal Channel) along a new alignment through the ocean bar to the northeast; (2) backfilling the abandoned portion of the old ocean bar channel with material unsuitable for beach or littoral zone placement; (3) placement of sand dredged from the ocean bar channel, riverine channels upstream through Reaves Point channel, and/or the larger sandy disposal islands of the lower Cape Fear River on

area beaches or in the littoral zone; (4) placement in the Offshore Dredged Material Disposal Site (ODMDS) of all dredged sediment that does not go to the beaches, the littoral zone, or abandoned channel; (5) establishment of a clear, comprehensive plan for utilization of all types of dredging equipment and disposal alternatives that are appropriate for use in each specific portion of the project; and (6) reduction in the area requiring blasting, number of blasts, and size of each blast, plus elimination of the bubble curtain to protect aquatic resources during blasting.

The proposed modifications would occur in four general ecological communities. These are: (1) the offshore marine areas where a new channel would be constructed and sediments would be disposed; (2) the beaches where sand would be deposited; (3) nearshore marine communities, including hardbottoms, that would be impacted by beach disposal; and, (4) riverine areas where the existing channel would be modified by dredging, blasting, infilling, and the movement of dredged material.

The offshore and nearshore areas in Brunswick and New Hanover Counties are dominated by their underlying geology, with hardbottoms of limestone and sandstone alternately exposed or covered by a thin veneer of sandy or muddy sediments of varying thicknesses. Most of the beaches in the region are barrier islands, some of which are also controlled by their underlying geology. Carolina and Kure Beaches are not on a barrier island, but rather a portion of the mainland that has been separated into an artificial island by the Atlantic Intercoastal Waterway. Rock, peat and mud occasionally outcrop on most of the beaches in the study area. The Cape Fear River estuary supports a variety of fish and wildlife habitats, including spoil islands used by colonial waterbirds, wetlands and aquatic nursery areas.

The major concerns of the Service center on the following potential adverse impacts:

- The new channel alignment may accelerate erosion on nearby beaches by disrupting the existing longshore sediment transport system at the mouth of the Cape Fear River and result in the loss of sea turtle nesting habitat;

- Sediment deposition on area beaches may diminish the habitat quality for nesting sea turtles and adversely affect populations of beach invertebrates;

- Sediment deposition on area beaches may result in turbidity and siltation in nearshore areas that adverse affect important hardbottom habitat;

- The increased extent of overflowing scows or barges carrying sediment may reduce water quality and adversely affect fish and other aquatic organisms as well as estuarine habitats such as primary nursery areas, and;

- The elimination of the bubble curtain around blast areas in the river will kill some fish.

In light of these concerns, the Service proposes the following planning objectives for this project:

1. Construction and maintenance of a new alignment for the harbor entrance channel with a minimum of short- and long-term adverse environmental impacts;

2. Ensure proper timing for beach disposal such that it will not result in significant adverse environmental impacts to marine and estuarine organisms or unique habitats (e. g., hardbottoms).

3. Beach disposal should incorporate design features and construction techniques which would minimize alterations of natural coastal geologic processes and maintain the water quality of the area.

4. All dredging operations and sediment movement procedures should maintain and enhance 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.

5. If the revised procedures used to modify the existing navigation channel in the Cape Fear River, especially blasting, will result in mortality of aquatic organisms, project plans should include specific mitigation measures to ensure that these resources do not suffer a decline in abundance.

Descriptions of natural resources within the study area and the assessment of project impacts are based on previous studies for similar projects, published literature, and personal communications with knowledgeable individuals.

The estuarine and marine fish fauna within the project area is varied. The Cape Fear River and nearby ocean waters are utilized by a diverse group of invertebrates and fish species. The endangered shortnose sturgeon is found within the Cape Fear River estuary. Offshore bottoms provide habitat for coastal demersal fishes. Hardbottoms found off the North Carolina coasts support a rich diversity of invertebrates such as corals, anemones, and sponges which are refuges for fish and other marine life. There are more than 300 species of reef fish along the South Atlantic and some of these species may be expected at hardbottoms off North Carolina.

Hardbottoms with their associated assemblage of benthic flora and fauna can be found throughout the project area. The rock substrate found in these exposed benthic environments provides habitat for many sessile fauna including coral, sponges, algae, sea whips, and anemones. Over 300 species of fish and hundreds of thousands of different invertebrates may be found in hardbottom/reef areas.

Marine mammals occur in offshore and inshore waters of North Carolina. Twenty-nine species of cetaceans have been recorded along the coast of the Carolinas, Virginia, and Maryland. Dredging of the Wilmington Channel in January 1995 encountered several humpback whales. Bottle-nosed dolphins are common in this area.

The West Indian manatee, an endangered species, may move north along the Atlantic Coast and occasionally make their way into the coastal waters of North Carolina. At least five sightings of this endangered species have been documented in the project area since 1952.

All five Atlantic sea turtles may occur in the coastal waters of North Carolina. The presence of sea turtles in nearshore and estuarine waters of North Carolina appears to be seasonal. Sea turtles are present in the offshore water of North Carolina throughout the year and present in inshore waters from April through December. The loggerhead sea turtle is the most common sea turtle along the North Carolina coast. During the twelve-year period of 1988-1999, 3,343 loggerhead nests were reported in the area under consideration for dredge disposal. In addition to the loggerhead nests, 13 green and one Kemp's ridley sea turtle nests have occurred over the same time period in the project area.

Seabeach amaranth habitat exists on the beaches proposed for dredge disposal of sediments. This threatened annual plant prefers overwash areas on accreting barrier island spits. Thousands of individuals have been documented to occur in the project area on an annual basis.

Four pairs of piping plovers nested on Holden Beach near Shallotte Inlet in 1993, one pair in 1997 and one pair in 1998, all just west of the project area. The Service lists the areas of Holden Beach and Long Beach surrounding Lockwood Folly Inlet as actual or potential nesting sites in the 1996 Recovery Plan for this threatened bird.

The Endangered Species Act requires the designation of critical habitat and its constituent elements by the Service, which would include the federally-listed sea turtles, seabeach amaranth, and piping plover. Due to a court order, the designation of critical habitat for overwintering piping plovers is imminent, and available data indicate that such overwintering usage occurs within the project area.

The dredge spoil islands found in the project area provide nesting, foraging and loafing habitat for many species of colonial waterbirds.

The sandy beaches contain a diverse assemblage of invertebrate species that include the coquina clam, mole crab, ghost crab, and polychaete worms. Shorebirds prey on these invertebrates as well as loaf or nest on the beaches.

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 modifications, the original project considered by the Service in the mid-1990s would be implemented.

Each design and construction feature of the original project that was considered for modification has a single change proposed. The single change proposed was adopted as the preferred alternative, or preferred modification.

The selection of each proposed modification was considered separately and the selection criteria varied. The new alignment was selected to reduce cost and to avoid the environmental damage of rock blasting. The backfilling of the abandoned channel was based on both the need for a disposal site and the possibility of creating benthic habitat. The decision to place sediment on area beaches was a response to the desires of local interests. Future sediment disposal at the ODMDS will essential constitute a continuation of present procedures. The expansion of existing dredging methods is an effort to reduce project costs. The elimination of the bubble curtain resulted from test data that indicate this measure to be ineffective in protective aquatic organisms from underwater blast impacts.

The six major project modifications are described in detail in the appendices of this report. In short, the Corps would:

- construct and maintain the harbor entrance channel (Baldhead Shoal Channel) along a new alignment through the ocean bar;
- place sand dredged from the ocean bar channel, riverine channels upstream through Reaves Point channel, and/or the larger sandy disposal islands of the lower Cape Fear River on area beaches or in the littoral zone;
- backfill the abandoned portion of the old ocean bar channel with material unsuitable for beach or littoral zone placement;
- place all dredged sediment that does not go to the beaches, the littoral zone, or abandoned channel in the ODMDS;
- establish a clear, comprehensive plan for utilization of all types of dredging equipment and disposal alternatives that are appropriate for use in each specific portion of the project; and,
- eliminate the bubble curtain that had been proposed as a protective device around underwater blasts in the Cape Fear River.

The environmental impacts of creating a new alignment for the ocean entrance channel would be similar to those associated with offshore dredging for beach nourishment material. The operation would eliminate shallow marine bottoms and create turbidity that could result in harmful sedimentation on nearby habitats. Allowing the abandoned channel to refill with natural inflows of sediment and placing material too fine for beach disposal in the channel may not create benthic habitat similar to that lost in the construction of the new alignment. If finer-grained material fills in this channel, the physical characteristics of the substrate may not be suitable for the organisms that utilize natural marine bottoms in the area. Sediment placement on area beaches may produce a deterioration of nearshore habitat quality due to long-term turbidity from the artificial beach-dune system; a reduction in beach invertebrate populations, reduced sea turtle

nesting success; and disruption of shorebird feeding and roosting. The movement of sediment from existing spoil islands may disrupt colonial waterbird nesting. The expansion of dredging methods may increase turbidity and sedimentation within the Cape Fear River that is harmful to fish and other aquatic organisms.

The comparison of impacts involves essentially the impacts of the project as originally proposed and the impacts of the modifications under consideration. The construction of the entrance channel on a new alignment would impact previously undisturbed ocean bottoms. In general, the Service supports the use of previously disturbed areas rather than the use of new alignments. However, the environmental impacts associated with modifying the existing channel would be substantial if extensive blasting is required.

The original plans would enlarge the existing alignment and the refilling of this channel would not be an issue. If the existing channel is allowed to naturally fill with what is likely to be finer grained material than what occurs locally, the proposed change would produce an overall adverse impact of the marine benthic community. Also, the time to fill in the channel with naturally deposited sediment may take many years, postponing the return of the abandoned channel to more natural conditions. If the abandoned channel is artificially refilled with sediment matching the native grain sizes in adjacent areas, the physical characteristics of the abandoned channel are more likely to resemble current conditions in the undisturbed path of the proposed, new alignment in a shorter period of time.

While beach disposal was under consideration during the mid-1990s, the present proposal includes specific plans to place large quantities of material on project area beaches. Earlier plans suggested that the most cost effective disposal option would be placement in the ODMDS. The use of the ODMDS would have impacted both benthic and pelagic organisms at and near the site, but this area was subject to periodic disposal activities from other projects. The proposed change would produce impacts similar to any beach nourishment project using offshore borrow areas. Such impacts include harm to beach invertebrates, nearshore fishes, organisms on area hardbottoms, shorebirds including the federally threatened piping plover, and sea turtle reproduction. The long-term impacts on beaches such as Bald Head Island could be significant with only a few years between disposals. Such short disposal intervals would leave little time for the recovery of beach invertebrates and may seriously diminish the value of this important sea turtle nesting area by continuous escarpment formation and persistent beach compaction.

There are relatively minor differences between the two alternatives in regard to disposal of sediments in the ODMDS. The original design called for the placement of most of the soft sediment from the seaward portion of the project in the ODMDS. The proposed changes would simply reduce the amount of material by disposing of beach quality sand on project area beaches.

The expansion of the dredging methods would produce some increase in adverse environmental impacts. Such increases may be small, but there would be no increase at all without this project modification. The use of overflow loading of dredges and scows is likely to increase turbidity

and siltation. The use of all dredging techniques in areas that previously allowed only certain methods is likely to adverse impact sensitive natural areas, such as fisheries nursery areas. The areas subject to the adverse impacts of overflow loading would be enlarged. Overall, the Corps indicates that these changes are being proposed in order to save money and not on the basis of any new biological data. The Service concludes that fish and wildlife resources would be better served by the retention of these dredging restrictions.

The impact comparison for elimination of the bubble curtain involves relatively little difference in fish mortality. However, the mortality for which this protective device was originally proposed will occur.

If the NEPA process confirms that the current preferred alternative should be constructed, conservation measures should be used to avoid or minimize direct impacts. Elimination of the offshore benthic community in the sediment removed can be minimized, but this community will be lost in the areas used for the new channel alignment.

Based on pre-project survey data, in-kind mitigation should be provided for the loss of benthic habitat along the new alignment. Such mitigation may be possible along the existing channel that would be abandoned if it is backfilled appropriately by the Corps. Backfilling by the Corps with fill sediment that matches native benthic substrate conditions would maximize recovery and recolonization of benthic flora and fauna. Sediment size, composition and organic content should be matched to maximize mitigation success.

Areas of the new alignment that pass through the ODMDS or offshore shoals may be subject to large movements of sediment that could increase shoaling along the new alignment. Fine grained material deposited in the ODMDS is more likely to be pushed by prevailing currents into the new alignment. An increase in shoaling would lead to increased maintenance dredging and create the turbidity and sedimentation associated with such dredging. Regular surveys of the buffer surrounding the new alignment through the ODMDS would detect bathymetric changes that contribute to shoaling in the new channel. The survey area should be extended along the entire alignment since the channel would also pass through nearshore shoals. Such surveys would identify areas of shifting sediment and could suggest areas where future dumping should be avoided in order to minimize maintenance dredging of the new alignment.

In order to fully assess the impacts to benthic habitat, the Corps should sponsor a long-term monitoring program to evaluate the recolonization of the abandoned channel. Such a program is the only method for determining the actual development of benthic habitat as the channel refills with sediment. If benthic organisms fail to become established in the area, it may be necessary to develop new mitigation measures.

The risk of contamination to fish and wildlife resources in all disposal areas needs to be minimized. All of the sediment data provided thus far for this project (including the disposal islands and new alignment) indicate a significant proportion of fine grain sizes that have a high

probability for contaminant adhesion. A Tier One Assessment, performed in accordance with Inland Testing Manual (ITM) guidelines, should be included in the environmental documents for the project. That assessment should include documentation of the significance of contaminant-related risks, and it should identify the need for any additional assessment. Should any sediments contain toxicants that exceed reasonable screening values for contaminant effects (e.g., EPA Region 4 screening guidelines; NOAA and USGS-BRD derived screening guidelines), appropriate measures should be taken to manage the contaminants.

There is no single month, or even a single season, when all adverse impacts to important fish and wildlife resources could be avoided. From a strictly biological point of view, the least harmful six-month period would probably be the months of October through March. It is very difficult to assign relative importance to the various fish and wildlife resources in the project area. Overall biological activity for beach resources is less during the colder months. The least harmful period for beach disposal would be the four months from December through March. This period would avoid the time when sea turtle nests (both the nesting and incubation periods) may be on area beaches, May 1 to November 15. The months April and November include the period when beach invertebrates such as *Donax* spp., *Emerita* spp. and digger amphipods may be on the beaches in high numbers. Piping plovers may begin nesting activities in March and April. However, the Service believes that it is very important to avoid dredging and subsequent beach disposal when sea turtle nests may be on area beaches. Offshore fisheries would be harmed by dredging during the winter. However, mitigation alternatives may be available to these species and from an overall perspective, the least damaging time for dredging and beach disposal is during the colder months of the year.

Beach nourishment should not result in changes in sand density (compaction), beach shear resistance (hardness), beach moisture content, beach slope, sand color, grain size, shape, and mineral composition. These parameters should be similar to the original beach sand. Any changes could result in adverse impacts on sea turtle nest site selection, digging behavior, clutch viability, and emergence by hatchlings. The beach invertebrate populations that live in burrows also would be impacted adversely by such changes.

The placement of sediment on area beaches should be done in a manner to match the shape and slope of the natural beach. Often beach nourishment results in a steep escarpment between the beach fill area and the natural offshore slope. Such a change in beach profile may cause access problems for nesting sea turtles or obstruct hatchling sea turtles on their way to the ocean. Shorebirds and macrofauna feeding in the swash zone would be impaired by scarps that form at the mean high water line as well. Human recreational use of the beach's intertidal zone may also be hampered. Efforts should be made to ensure that the beach profile after nourishment is a natural, gently sloping beach rather than a layered beach with sharp escarpments. If the nourished beach profile develops high escarpments, they should be leveled to grade into the natural profile. A project conservation measure would be a monitoring program to detect the more apparent abnormalities of the artificial beaches. Such programs could also include measures of biological productivity along the beaches.

Heavy equipment used to level scarps may crush nests over which it passes. Such heavy equipment should be kept off the beaches during the nesting and incubation season, May 1 through November 15. Such equipment should not be used to move sediment placed on the beach during this period either. Limiting the number of heavy vehicles on the beach, perhaps to one regular sized bulldozer, would minimize the potential for crushing invertebrate burrows as well as the spatial extent and degree of compaction of sediments. Dredge pipelines should not be stockpiled on the beach, either, as they impede human and wildlife utilization of the entire beach habitat.

Fish and wildlife resources will benefit from the longest interval possible between placements of sediment on beaches. If the project leads to increased erosion in the deposition areas, the interval between sediment placement will gradually decrease over time. Extended time periods allow beach invertebrates to recover and minimize the turbidity and siltation associated with the movement and disposal of sediment. The ability for invertebrates to return to the sediment placement area is also influenced by the length of the project. Since surviving populations on the edges of the placement area may supply the colonists for the placement area and dispersal may be limited, the shorter the placement area, the greater the opportunity for adjacent populations to reach the entire length of new beach.

Conservation measures to benefit reproduction by colonial waterbirds are primarily related to avoiding disturbances of the birds during the sensitive breeding season. While sand removal from a nesting site is an extreme example, measures must also consider more subtle disturbances such as the noise, fumes, lights, and movements associated with dredging. The activities associated with dredging cause stress and excessive flight responses among breeding birds. Dredging activities near nest sites can ultimately cause the birds to abandon nests. Therefore, dredging activities and sand removal from breeding areas should not occur at or near nesting sites of colonial waterbirds during the breeding season of April 1 through October 31.

Expanding the dredging methods would increase the risk to adversely impact Federally-listed aquatic resources. Impacts to sea turtles would be minimized by restricting the operation of hopper dredges during periods when sea turtles are most abundant in waters of the project area. Monitoring should be conducted during dredging for the presence of other Federally-listed species such as whales and the West Indian manatee, and appropriate conservation measures taken if such species are identified.

The elimination of the protective curtain requires a reconsideration of conservation measures for blasting. 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 Service believes that blasting during August and September could harm and/or kill manatees and sea turtles. 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.

The Corps should provide contractual opportunities to local universities to conduct aquatic resource surveys before, during and after the project construction period in order to document and gather important data on valuable fish and wildlife resources such as the shortnose sturgeon and impacts to their populations and distributions. This data should be made available to the Service, NMFS and all interested parties in order to better define dredging windows, types of dredges allowed, and impacts of dredging on aquatic resources.

To mitigate for fish losses due to blasting the Service proposes the Corps either provide structural fish passage for anadromous fish, including sturgeon, at Lock and Dams 1, 2 and 3 in addition to the fish locking sequence that is currently employed and fund a graduate student (Master of Science) to examine the effectiveness of the structures, or remove those structures. Existing structures and operations do not pass sturgeon and could be improved for other species. The Coastal Program of the Service will work with the Corps to provide technical assistance. Dams along the Cape Fear River are a significant impediment to certain fish reaching historical spawning areas. Reproduction would be enhanced if areas upstream from these dams were accessible to the fish. In the Cape Fear River 99 miles of mainstem and a very large mileage of tributary streams (likely over 1,500 miles) exist between Lock and Dam 2 and Buck Horn Dam (next dam upstream).

All of the previous conservation measures and recommendations made by the Service relating to project features that have remained unchanged, such as those related to saltwater intrusion, post-blasting monitoring for killed and injured organisms, and potential increased erosion of riparian shorelines from increased ship wakes, are still valid and should be supplemented by the following recommendations on these project modifications.

1) A Tier One Assessment according to the Inland Testing Manual (ITM) adopted by the Corps and the EPA in 1998 be conducted on all sediments in the project, and such documentation be included in the environmental documents. Sediments to be assessed include those from any disposal islands proposed for pumpout for either beach or offshore disposal. Should any sediments contain contaminants or toxins that exceed EPA standards, appropriate measures should be taken to manage the contaminants.

2) The Corps should address the issue of existing and proposed Essential Fish Habitats (EFH) in the new channel alignment and immediate surrounding areas. If any existing or proposed EFH are located in the new alignment construction area or offshore disposal areas, the Corps should coordinate with the NMFS to take the appropriate conservation measures.

3) Loss of benthic habitat with the creation of a new channel should be mitigated in-kind with backfilling the abandoned channel with identical or very similar substrate grain size, composition and geomorphology as adjacent benthic substrates.

4) The 2500' designated buffer surrounding the channel where it passes through the existing ODMDS should be regularly surveyed for bathymetric changes in order to monitor increased shoaling rates of the channel, which would lead to increased maintenance needs. Additional surveys should be conducted along a similar 2500' corridor for the entire new channel alignment, seaward of station 50+00, in order to monitor for shoaling from other adjacent sediment bodies. Multi-beam or the Corps' SHOALS surveys would yield more accurate bathymetry data than a few scattered soundings and increase spatial resolution and coverage.

5) Sediments used to backfill the abandoned navigational channel should match the native grain size, mineral composition and organic content in order to better mimic the native habitat.

6) Backfilling of the abandoned channel should approximate the natural bathymetric contours and geomorphology of the surrounding areas. Deviation from the natural conditions could prevent or delay re-colonization of the newly filled area by benthic organisms.

7) The backfilled channel should be monitored regularly with both bathymetric surveys (preferably multi-beam or SHOALS) and benthic organism surveys to establish recolonization rates and success or failure. Bathymetric surveys would generate data on changes to the former channel due to altered current or wave patterns, which could suspend portions of the fill and remove it from the channel. Any measured impacts over the life of the project should be mitigated through coordination with the Service, NMFS and other relevant agencies.

8) No disposal of dredge materials should take place on beaches or the littoral zone during the sea turtle nesting and incubation season of May 1 to November 15, which roughly coincides with shorebird nesting and beach invertebrate spawning and recruitment seasons.

9) Fill placement should not create a pronounced hill or mound of sand that could create an obstacle or scarp to wildlife and human resources utilizing the beach.

10) Heavy equipment used to manipulate fill sediments placed on the beach should be kept to a minimum, perhaps only one regular size bulldozer on any given beach at any given time. Night work should use the minimum amount of light necessary (which may require shielding) or low pressure sodium lighting during project construction. Extensive lengths of pipeline should not be stored on or run along the beach, but placed behind the primary dune or dune scarp with perpendicular sections crossing to the beach as close to the immediate disposal area as possible. Heavy equipment (e.g., contractor sheds, trucks, bulldozers, extra pipeline, surveying equipment) should not be stored on the beach at night during the sea turtle nesting and hatching season.

11) Sediments disposed on the beaches or adjacent littoral zones should be *at least* 90% sand, match native grain size ranges and mineral composition, contain as little organic matter as possible and be free of contaminants exceeding safe levels. Monitoring and sampling should be conducted daily of the dredge spoil material placed the day before on all project beaches for grain size distribution and total organic content (TOC) in order to ensure only beach suitable

material is disposed of on the beaches. TOC levels should be measured for each mile of beach within two months prior to dredge spoil disposal for comparison purposes. Reports summarizing the sampling should be provided to the Service on a weekly basis throughout the beach disposal period, and the Service shall be notified within 48 hours of the discharge of any dredge spoil that is not beach suitable (i.e., less than 90% sand size sediments).

12) Beach fill should be monitored for compaction, escarpment formation, and subaerial and subaqueous profiles on a regular basis (perhaps quarterly and after every storm) in order to determine the longevity of the material's placement. Immediately after completion of sand disposal on beaches and prior to sea turtle nesting seasons, monitoring shall be conducted to determine if escarpments are present and escarpments shall be leveled as required to reduce the likelihood of impacting sea turtle nesting and hatching activities.

13) Nearshore turbidity levels should be measured with a Turbidimeter on a daily basis during beach disposal work, with direct sampling of both the nearshore turbidity plume and adjacent ambient waters within 250 feet of the discharge pipe. Turbidity levels should not exceed the state saltwater standard of 25 NTUs or naturally elevated ambient conditions. A weekly report should be submitted to the Service and other relevant government agencies of measured turbidity levels, and a review should be conducted at 3 months on sampling protocols.

14) If the Corps chooses to proceed with beach disposal during the summer months, the next NEPA document should outline in detail how the proposed delineation of reaches of beach with less than ideal sea turtle habitat will occur, what data will be incorporated into such delineations, and the order of spoil disposals in such reaches. Prior to the actual time of disposal, Corps staff should meet with relevant Service and NCWRC staff on-site with relevant maps to review those reaches where impacts to nesting sea turtles may be minimized so that high density nesting reaches are avoided during the nesting season. Data from the 2000 nesting season, with new locational data from Global Positioning System (GPS) coordinates, should be incorporated into any delineations as it will further aid demarcation of areas where adverse impacts of summer disposal may be minimized.

15) Beaches scheduled to receive maintenance materials (i.e., Bald Head Island and Caswell Beach) should be monitored long-term for increased erosion rates, decreased biological productivity and cumulative impacts to fish and wildlife resources, especially Federally-listed species such as sea turtles, piping plovers, and seabeach amaranth. Monitoring plans should be developed in coordination with the Service, NMFS and North Carolina Wildlife Resources Commission (NCWRC). Any measured impacts over the lifespan of the project and its maintenance should be mitigated through coordination with the Service, NMFS and other relevant agencies.

16) Hopper dredges should not be used during the summer sea turtle nesting season or spring and fall migration periods when species numbers in inland waters are high.

17) Observers should be present on all hopper dredges to monitor for incidental takes of sea turtles year-round. All takes should be documented and reported to the Service and NMFS, and appropriate conservation measures coordinated in the event of excess takes.

18) Dredging activities should not occur adjacent to disposal islands during the colonial waterbird nesting season of April 1 to October 31 in order to minimize disturbance to such nests. Activities should be minimized from disturbing colonial waterbirds with potential noise, lights and fumes at all times of the year. Potential screening/blocking or other appropriate conservation measures should be coordinated with the North Carolina Colonial Waterbird Management Committee and other relevant agencies.

19) Spoil islands should not be pumped out or re-filled during the colonial waterbird nesting season to minimize disturbances to nesting habitat and existing nests. Surveys for nesting activities of least terns and other birds should be conducted to prevent such disturbances.

20) All dredging activities should comply with existing agreements with the National Marine Fisheries Service and the U.S. Fish and Wildlife Service as to timing and types of allowable dredges. The 1995 Biological Opinion and Incidental Take Statement issued by NMFS to the Corps (and any updates) should be fully complied with in particular.

21) The Service recommends mitigation for the loss of fish (including sturgeon) associated with the blasting of rock during the project. The Service proposes the Corps either provide structural fish passage at Lock and Dams 1, 2 and 3 in addition to the fish locking sequence that is currently employed for anadromous fish and fund a graduate student (Master of Science) to examine the effectiveness of the structures, or remove these structures. The blast-induced fish mortality should be treated as a fish kill with known cause; dead and dying fish should be collected, counted, measured (length) and identified to species so that appropriate mitigation and restoration can be calculated. Small fish that may be quickly ingested by predators should have their size and numbers estimated.

22) All blasting should avoid times of spawning or known important juvenile stages of fish in the project area.

23) The Corps should provide contractual opportunities to local universities to conduct aquatic resource surveys before, during and after the project construction period in order to document and gather important data on valuable fish and wildlife resources such as the shortnose sturgeon and impacts to their populations and distributions. This data should be made available to the Service, NMFS and all interested parties.

The Wilmington Harbor, North Carolina, 96 Act Project Modifications 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 modifications 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 the 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 elimination of the bubble curtain in the proposed modifications fails to meet the Service's concerns regarding containing blast impacts. Mitigation for the loss of fish and other aquatic resources should be provided. The Service recommends improved fish passage at Lock and Dams 1, 2 and 3, or the removal of these structures. Our Coastal Program is willing to coordinate such mitigation activities. Monitoring of the effectiveness of this mitigation could be provided through funding of a Master's student at a local university.

The Service is more concerned about the long-term, secondary impacts of the proposed project modifications. This report has detailed concerns about potential indirect impacts from each of the six modifications. The Service realizes that these impacts may be difficult to predict with a high degree of accuracy. However, the Service is concerned that several of the Corps' efforts to evaluate these impacts have not been completed. There are currently only minimal or no evaluations of the potential impacts to the longshore transport system that influences area beaches, turbidity and siltation effects on nearshore hardbottoms or estuarine nursery areas, contaminants contained within the dredged sediments, suitability of all of the dredge spoil scheduled for beach disposal, cumulative impacts to beach invertebrate populations, and alterations to local water circulation and wave patterns resulting from the new channel alignment, backfilling of the old channel, and filling the existing ODMDS to full capacity. 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 proposed expansion of dredging methods generates a set of direct and indirect impacts that would adversely affect fish and wildlife resources throughout the project area. Increased turbidity and siltation with overflowing scows could smother important estuarine benthic habitat and nursery areas, suffocate fish and alter the nutrient and oxygen levels of local waters. The year-round use of dredges, some of which have been documented to take Federally-listed species such as sea turtles, would breach previously arranged agreements the Corps has with resource

agencies. The Service cannot support the expansion of dredging methods proposed in this set of project modifications.

The Service believes that some of the proposed project modifications offer opportunities for the enhancement of fish and wildlife resources within the project area. Such measures include: (1) the use of 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 sediment which is free of contaminants, of the appropriate grain size, and properly placed in the littoral zone near the mouth of the Cape Fear River to support area beaches; and (3) the use of sediment which is contaminant-free and properly placed to fill the abandoned navigational channel to restore a more natural benthic habitat. 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 modifications are compatible with the long-term viability of marine, estuarine, and freshwater ecosystems in the project area and the many fish and wildlife resources which they support.

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SECTION 1. INTRODUCTION

Authority

This report is provided under authority of Section 2(b) of the Fish and Wildlife Coordination Act (FWCA) of 1958 (48 Stat. 401, as amended; 16 U.S.C. 661-667d). This Act established two important federal policies which are: (1) fish and wildlife resources are valuable to the nation; and, (2) the development of water resources is potentially damaging to these resources. In light of these principles, the FWCA mandates that:

> ". . . wildlife conservation shall receive equal consideration and be coordinated with other factors of water-resource development programs through effectual and harmonious planning, development, maintenance, and coordination of wildlife conservation and rehabilitation."

The FWCA essentially established fish and wildlife conservation as a coequal purpose or objective of federally funded or permitted water resources development projects.

In order to fully incorporate the conservation of fish and wildlife resources in the planning of water resources development, the FWCA mandates that federal agencies consult with the U. S. Fish and Wildlife Service (Service) and the state agency with the responsibility for fish and wildlife resources in the project area. The state agency with this responsibility is the North Carolina Wildlife Resources Commission (NCWRC).

Consultation during project planning is intended to allow state and federal resource agencies to determine the potential adverse impacts on fish and wildlife resources and develop recommendations to avoid, minimize, and/or compensate for detrimental impacts. Therefore, this report will:

1. Describe the fish and wildlife resources at risk in the project area;

2. Evaluate the potential adverse impacts, both direct and indirect, on these resources;

3. Develop recommendations to avoid, minimize, or compensate for any unavoidable, adverse environmental impacts; and,

4. Present an overall summary of findings and the position of the Service on the project.

This draft report will be submitted to the North Carolina Wildlife Resources Commission for their review and comments. The report, when finalized, will include a letter of concurrence from the NCWRC and will constitute the formal report of the Service under Section 2(b) of the FWCA.

Subject of This Report

Wilmington Harbor is a 37-mile-long Federal navigation project located in southeastern North Carolina along the Cape Fear and Northeast Cape Fear Rivers. It connects deep water of the Atlantic Ocean with the Port of Wilmington. Congressionally-authorized improvements scheduled to start in April 2000 will include deepening the navigation channel by 4 feet and widening portions of the project. Three environmental impact statements (EIS) have been prepared recently for Improvements in Wilmington Harbor, NC. The first was the Final Supplement to the Final EIS Wilmington Harbor-Northeast Cape Fear River (U. S. Army Corps of Engineers [hereafter USACOE] 1990). This project involved widening the Fourth East Jetty Channel to the West 100 feet and deepening the ship channel to 38 feet from the Cape Fear Memorial (CFM) Bridge to 750 feet above the Hilton Railroad Bridge. The second was the Final Supplement I to the Final EIS Wilmington Harbor Channel Widening (USACOE 1996a). This project involved the widening of five turns and bends by 75 to 200 feet, and widening by 200 feet the navigation channel in the lower harbor over a 6.2 mile distance to provide a passing lane. The third was the Final EIS Cape Fear-Northeast Cape Fear Rivers Comprehensive Study (USACOE 1996d). The project primarily involved deepening the harbor by 4 feet from the Memorial Bridge downstream with some deepening upstream of the Hilton Railroad Bridge. All three of these projects were combined by Congress in 1996 and subsequently called the Wilmington Harbor 96 Act.

The Wilmington District, U. S. Army Corps of Engineers (Corps) has contacted the Service regarding several major modifications to the overall project (Table 1). These modifications include a new alignment for the most seaward portion of the navigation channel, new disposal location for dredged material, the relaxation of certain dredging restrictions, and the elimination of a bubble curtain procedure originally proposed to reduce mortality of aquatic organisms during blasting. The subject of this report will be the modifications that have been proposed since the Service's 1996 FWCA Report (U. S. Fish and Wildlife Service [hereafter USFWS] 1996a) .

Scope

The scope of the overall project has been expanded by the proposed changes. The original project included the existing navigation channel, certain existing confined disposal facilities, and the offshore Ocean Dredged Material Disposal Site (ODMDS). The proposed changes have added the beaches of Brunswick County (Bald Head Island, Caswell, Yaupon, Long, and Holden) and the southern beaches of New Hanover County (Carolina and Kure). The proposed new alignment for the ocean bar channel would dredge the ocean floor that is, in part, undisturbed.

Table 1. Major changes in design features and construction techniques that are considered in this report.

Original Project Feature	Current/Revised Project Feature	#
Deepen the existing harbor entrance channel.	Construction and maintenance of the harbor entrance channel (Bald Head Shoal Channel) along a new alignment through the ocean bar	1
	Backfilling of the abandoned portion of the old ocean bar channel with material unsuitable for beach or littoral zone placement	2
Disposal of soft sediment from the lower part of the project area in the Ocean Dredged Material Disposal Site (ODMDS)	Placement of sand dredged from the ocean bar channel, riverine channels upstream through Reaves Point channel, and/or the larger sandy disposal islands of the lower Cape Fear River on area beaches or in the littoral zone	3
	Placement in the ODMDS of all dredged sediment that does not go to the beaches, the littoral zone, or abandoned channel	4
Approved dredging methods that placed restrictions on areas where overflow of scows was allowed and areas that could receive certain types of sediment.	Establishment of a clear, comprehensive plan for utilization of all types of dredging equipment and disposal alternatives that are appropriate for use in each specific portion of the project.	5
A bubble curtain and/or a physical barrier would be placed completely around the blast area.	Reduction in area requiring blasting, number of blasts, size of each blast. Bubble curtain eliminated.	6

Prior Studies and Reports

Three environmental impact statements (EIS) have been prepared recently for Improvements in Wilmington Harbor, NC. The first was the Final Supplement to the Final EIS Wilmington Harbor-Northeast Cape Fear River (USACOE 1990). This project involved widening the Fourth East Jetty Channel to the West 100 feet and deepening the ship channel to 38 feet from the Cape Fear Memorial (CFM) Bridge to 750 feet above the Hilton Railroad Bridge. The second was the Final Supplement I to the Final EIS Wilmington Harbor Channel Widening (USACOE 1996a). This project involved the widening of five turns and bends by 75 to 200 feet, and widening by 200 feet the navigation channel in the lower harbor over a 6.2 mile distance to provide a passing lane. The third was the Final EIS Cape Fear-Northeast Cape Fear Rivers Comprehensive Study (USACOE 1996d).

The expansion of the Wilmington Harbor navigation Channel has been the subject of prior reports by the Service. The overall changes to the Wilmington Harbor Navigation Channel were originally considered as a separate project for review under the FWCA. These reports include:

U.S. Fish and Wildlife Service. 1988a. Planning Aid Report - Wilmington Harbor Passing Lane. Raleigh Field Office, Raleigh, NC. 20 pp.

_____. 1988b. Planning Aid Report - Wilmington Bends and Turns. Raleigh Field Office, Raleigh, NC. 29 pp.

_____. 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. 36 pp.

_____. 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. 71 pp.

_____. 1993b. Draft Fish and Wildlife Coordination Act Report. Wilmington Channel Widening Project. Raleigh Field Office, Raleigh, NC. 57 pp.

_____. 1993c (August). 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.

_____. 1996a (May). Final Fish and Wildlife Coordination Act Report. Cape Fear - Northeast Cape Fear Rivers Comprehensive Study, New Hanover and Brunswick Counties, North Carolina. Raleigh Field Office, Raleigh, NC. 86 pp. + Appendices.

_____. 1996b (May). Supplement I to the Final Fish and Wildlife Coordination Act Report. Wilmington Harbor Channel Widening Project. Raleigh Field Office, Raleigh, NC. 36 pp. + Appendices.

The placement of sand on beaches of both New Hanover and Brunswick Counties, whether as a specific, long-term beach nourishment project or as dredge disposal have also been considered in the past. Service reports addressing sand placement on Brunswick County beaches were prepared for the Ocean Isle Beach Project, which was separated from the larger project for the entire county. These reports include:

_____. 1993e (July). Final Fish and Wildlife Coordination Act Report. Area South of Carolina Beach. Raleigh Field Office, Raleigh, NC. 45 pp.

_____. 1995 (August). Ocean Isle Beach - Beach Erosion control and Hurricane Wave Protection Project. Draft Fish and Wildlife Coordination Act Report. Raleigh Field Office, Raleigh, NC. 40 pp.

SECTION 2. STUDY AREA DESCRIPTION

The proposed modifications would occur in four general ecological communities. These are: (1) the offshore marine areas where a new channel would be constructed; (2) the beaches where sand would be deposited; (3) nearshore marine communities, including hardbottoms, that would be impacted by beach disposal; and, (4) riverine areas where the existing channel would be modified by dredging, blasting, infilling, and the movement of dredged material. The description of the general project area and the major communities have been presented in earlier FWCA Reports prepared by the Service, environmental documents prepared by the Corps, and private individuals, including academics. This supplemental report will limit the study area description to key references from the sources given below.

Offshore Marine Areas

The area of the ocean bar has been described (USFWS 1993a, USFWS 1993c). Salinities around the mouth of the Cape Fear River are generally greater than 10 parts per thousand (ppt) during spring, and they increase to about 32 ppt by fall (Schwartz et al. 1979). The channel is underlain by bedrock. Limestones of either the Eocene Castle Hayne type or the Cretaceous Pee Dee Formation lie at the top of the rock. The precise thickness and extent of these rock types is unknown under the channel. The thickness of the rock types and their hardness may vary considerably across short distances. In some areas the Castle Hayne limestone may be cemented and in other sections it may be softer and more friable (Bill Hoffman, North Carolina Geological Survey, personal communication, August, 1992). The upper layer of the Pee Dee Formation limestone is generally harder than the Castle Hayne Formation (USACOE 1991). Rock from both the Castle Hayne limestone and the Pee Dee Formation has required blasting in other portions of the Cape Fear River.

Hardbottoms are areas with exposed limestone, phosphate, and other sedimentary rock which make up the North Carolina continental shelf. These areas, which may be called "rocky ridges" (Burgess 1993), differ from the more common areas covered by soft sediment. The ocean waters off Cape Fear contain a high number of hardbottom habitats (U.S. Minerals Management Service [hereafter USMMS] 1990). However, due to the small size and patchy distribution of hardbottoms, vibracore borings may not indicate their presence unless the cores are taken very close together (Bob Dickson, National Marine Fisheries Service, Beaufort laboratory, personal communication, July 1992).

Hardbottoms represent one of the most valuable biological communities in the project area. Frankenberg (1997, pp. 191-192) states that these “hardground” habitats:

> “. . . support a community of algae, soft and encrusted coral, sea anemones, sea whips, and recreational important finfish. These rocky outcrops are oases of sea floor life that support a northern extension of the snapper-grouper complex of fish as well as habitat for predators like mackerel and bluefish.”

Beaches

While the beaches of New Hanover and Brunswick Counties share some attributes, each beach in the project area has a unique history. The beaches of Brunswick County have been described in great detail (USACOE 1973b). More recent descriptions are provided by Pilkey et al. (1998, pp. 191-202). The beaches of New Hanover County have also been described in association with previous beach nourishment projects (USFWS 1993e). The general shoreline of Brunswick County has been described (Frankenberg 1997, pp. 207-218; Pilkey et al. 1998, pp. 191-202). The history and current conditions of the southern beaches of New Hanover County, Carolina and Kure, are discussed by Pilkey et al. (1998, pp. 187-191) and Frankenberg (1997 pp. 183-194).

Nearshore Marine Areas

The nearshore marine communities have been described in association with both completed and proposed beach nourishment projects. The area near Kure Beach in New Hanover County has been described in associated with the beach nourishment for the Area South of Carolina Beach Project (USFWS 1993e). Cleary (1999) characterizes the nearshore marine environment offshore of Oak Island as containing undulating hardbottoms, low relief scarps, ripple scour depressions and sandy and muddy surficial deposits of various thicknesses.

Riverine Areas

The portion of the project area within the Cape Fear River has been described in association with the Cape Fear Comprehensive Study (USFWS 1996a) and the Wilmington Harbor Channel Widening Project (USFWS 1996b). An excellent summary of the riverine areas has been provided by the Corps (USACOE 1984).

SECTION 3. FISH AND WILDLIFE SERVICE CONCERNS AND PLANNING OBJECTIVES

The involvement of the Service in this planning process is in response to a Congressional mandate through the FWCA 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.

General Fish and Wildlife Service Concerns

The Service is concerned that creation of a new ocean entrance channel will eliminate habitat for benthic organisms and adversely affect other habitats in the vicinity of the new channel. While allowing the old channel to fill in may re-create some of the habitat values, there are no assurances that sediments filling the old channel will have the same physical characteristics of the area along the proposed alignment. The new channel may also create adverse impacts by altering the existing flow of sand along the coast.

The Service is concerned that beach disposal of dredged material may adversely affect fish and wildlife resources on the beach and nearshore zone. The scheduling of sediment disposal would influence the extent of impact on beach invertebrates, nesting sea turtles, foraging shorebirds, and nearshore fisheries. The more extensive use of overflowing barges to transport sediment poses new concerns for water quality in the lower Cape Fear River.

Specific Fish and Wildlife Service Concerns

The Service has the following concerns:

- The new channel alignment may accelerate erosion on nearby beaches by disrupting the existing longshore sediment transport system at the mouth of the Cape Fear River and result in the loss of sea turtle nesting habitat;

- Sediment deposition on area beaches may diminish the habitat quality for nesting sea turtles and adversely affect populations of beach invertebrates;

- Sediment deposition on area beaches may result in turbidity and siltation in nearshore areas that adverse affect important hardbottom habitat;

- The increased extent of overflowing scows or barges carrying sediment may reduce water quality and adversely affect fish and other aquatic organisms as well as estuarine habitats such as primary nursery areas, and;

- The elimination of the bubble curtain around blast areas in the river will kill some fish.

Planning Objectives

Careful planning and a conscientious balancing of economic considerations with environmental concerns can produce projects with minimal, short- and long-term environmental impacts. The Service proposes the following planning objectives:

1. Construction and maintenance of a new alignment for the harbor entrance channel with a minimum of short- and long-term adverse environmental impacts;

2. Ensure proper timing for beach disposal such that it will not result in significant adverse environmental impacts to marine and estuarine organisms or unique habitats (e. g., hardbottoms).

3. Beach disposal should incorporate design features and construction techniques which would minimize alterations of natural coastal geologic processes and maintain the water quality of the area.

4. All dredging operations and sediment movement procedures should maintain and enhance 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.

5. If the revised procedures used to modify the existing navigation channel in the Cape Fear River, especially blasting, will result in mortality of aquatic organisms, project plans should include specific mitigation measures to ensure that these resources do not suffer a decline in abundance.

In accordance with the FWCA, as amended, these planning objectives should be given full and equal consideration with the economic benefits expected from the project.

SECTION 4. EVALUATION METHODS

Descriptions of natural resources present within the study area and the preliminary assessment of the environmental impacts of the proposed project modifications are based on previous studies for similar projects, published literature, and personal communications with knowledgeable individuals. 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.

Nomenclature in this report follows Tiner (1993) for coastal 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 follow the original publication. If the Service is aware of a widely accepted synonym for the common name, that synonym is given in brackets. If the Service is aware of a change in the scientific name of a given species, the revised nomenclature is included in brackets following the published name.

SECTION 5. EXISTING FISH AND WILDLIFE RESOURCES

Information on the fish and wildlife resources was complied by the Service for the area of the Cape Fear Comprehensive Study (USFWS 1996a) and the prior study on deepening the ocean bar (USFWS 1993c). Resources associated with beach placement of sediments were discussed for the Area South of Carolina Beach (USFWS 1993e) in New Hanover County and Ocean Isle Beach in Brunswick County (USFWS 1995). The material below will be a brief summary of information from previous reports.

Marine Habitats

Trawling surveys conducted as part of a study concerning the effects on aquatic resources of the Carolina Power and Light nuclear power plant in Southport demonstrate that the Cape Fear River and nearby ocean waters are utilized by a diverse group of invertebrates and fish species (Schwartz et al. 1979). The most abundant invertebrate species were arthropods, such as the blue crab (*Callinectus sapidus*), the lesser blue crab (*Callinectus similis*), mantis shrimp (*Squilla empusa*), penaed shrimp (*Penaeus aztecus*, *P.duorarum, P. setiferus*), and grass shrimp *(Palaemonetes* sp.); echinoderms, such as the common sea star (*Asterias forbesi*) and sand dollar (*Mellita quinquiesperforata*); jellyfish (Scyphozoa) and other cnidarians; comb jellies (Ctneophora); and various mollusks such as oysters (*Crassostrea virginica*), Atlantic brief squid (*Lolliguncula brevis*), conchs and whelks (Melongenidae), and mud snails (Nassariidae). Many other invertebrate species were found in smaller numbers.

Huntsman (1994) discusses coastal demersal fishes, species that live on the bottom. This group includes Atlantic croaker, spot, southern flounder, summer flounder, and weakfish.

Hardbottom Marine Communities

Localized areas not covered by unconsolidated sediments, where the ocean floor consists of hard rock, are known as hardbottoms. Hardbottoms are found along the continental shelf off the North Carolina coasts. Hardbottoms are also called "live-bottoms" because they support a rich diversity of invertebrates such as corals, anemones, and sponges which are refuges for fish and other marine life. While hardbottoms are most abundant in southern portions of North Carolina, they are located along the entire coast (USMMS 1990). Data from the Southeast Monitoring and Assessment Program (SEAMAP) indicate that hardbottoms are located in or near the proposed borrow areas (SEAMAP 1998). Cleary (1999) provides data that hardbottoms are present immediately offshore of the beach disposal areas along Oak Island.

Hardbottoms can provide very important habitat for fish and invertebrate species. According to Burgess (1993):

> "Some of these rocky hardbottoms are veritable oases covered with algal meadows, sponges, soft whip corals, tropical fishes and territorial and predatory

> animals. These habitats provide shelter and food to sustain valuable commercial and recreational fish such as groupers and snappers, worth millions of dollars to the state's economy. More than 300 species of fish and hundreds of thousands of invertebrates call these reefs home."

In addition to simple, flat, rocky bottoms, areas with high relief such as underwater channels and cliffs, also provide valuable habitat. Areas of "high-relief scarps" create the most productive of hardbottom habitats (Burgess 1993). Rocks which break off these scarps collect as underwater rubble mounds that provide many nooks and crannies that serve as important hiding places for reef fishes and invertebrates such as the arrow crab (*Stenorhynchus seticornis*) and spiny lobster (*Panulirus argus*). Seaweeds such as brown sargassum (*Saragassum* spp.) and green calcareous algae attach to the rock surfaces.

Van Dolah and Knott (1984) sampled the benthos offshore the South Carolina coast, including some hardbottoms. They found 167 species representing nine major taxa. McCrary and Taylor (1986) studied benthic macrofauna assemblages offshore of Fort Fisher, North Carolina. Their grab samples were taken from between approximately 0.5 to 2 miles offshore. They found many polychaete species, isopods, amphipods, decapods, molluscs, echinoderms, many nematodes, and a few Amphioxus (*Brachiostoma caribaeum*) in the benthic samples. In reference to one of their sampling locations located approximately 0.5 mile offshore, they state that it was obvious that a hardbottom was in the vicinity, although hard substrate was not found in the sediment samples of the site. They found 33 individuals of Chrysopetidae, a family which is predominately associated with coral or other hard substrates.

The benthos inhabiting potential offshore borrow areas serve as food for commercially important species and are essential in marine food chains. For example, adult spot (*Leiostomus zanthurus*) are benthic feeders, primarily eating polychaetes and benthic copepods. Atlantic croaker (*Micropogonias undulatus*) are also bottom feeders, preying on polychaetes and bivalves. Pink (*Penaeus duorarum*) and white (*P. setiferus*) shrimp also prefer benthos.

Huntsman (1994) states that there are more than 300 species of reef fish along the South Atlantic. These are species that might be expected at hardbottoms off North Carolina. Some species within this group are gray triggerfish (*Balistes capriscus*), scamp (*Mycteroperca phenax*), speckled hind (*Epinephelus drummondhayi*), vermilion snapper (*Rhomboplites aurorubens*), white grunt (*Haemulon plumieri*), snowy grouper (*Epinephelus niveatus*), red porgy (*Pagrus pagrus*), red snapper (*Lutjanus campechanus*), and warsaw grouper (*Epinephelus nigritus*). Some of these are extremely overfished (Huntsman 1994).

Beach and Nearshore Habitats

Nearshore

The nearshore zone typically extends out to about 30 feet of water, including the surf zone where waves break (Leatherman 1988). Knott et al. (1983) found 205 benthic macroinvertebrate species in water depths from 1 to 5 meters in South Carolina.

Many fish species are found within the surf zone and some species occur in both offshore and nearshore waters. Huntsman (1994) writes that coastal pelagic species, those living in the nearshore water column, include Atlantic menhaden, Spanish mackerel, King mackerel (*Scomberomorus cavalla*), bluefish, and little tunny (*Euthynnus alletteratus*). Other fishes that may occur in this area are the summer flounder, Atlantic croaker, spot, weakfish, red drum, cobia (*Rachycentron canadum*), black sea bass, spiny dogfish, northern sea robin, and pompano (*Trachinotus carolinus*).

Hackney et al. (1996. p. 52) state that "Apparently, many surf zone fishes not only exhibit ontogenetic changes in diet, but also shift diets in relation to prey availability. . . Such opportunism has great advantages in a variable environment like the surf zone. The ability to modify feeding could also mitigate impacts from beach renourishment."

There are two species of small coastal sharks, the dogfish and spiny dogfish known to occur in the project area (Huntsman 1994).

Beach

Sandy or silty sand beaches support many species of fat, soft-bodied, white, burrowing amphipods in many genera of the family Haustoriidae (Phylum Arthropoda) (Ruppert and Fox 1988, p. 346). High energy, intertidal beaches in the southeastern United States may have 20-30 invertebrate species (Ruppert and Fox 1988, p. 346). Knott et al. (1983) identified 25 Polychaeta, 25 Amphipoda, 13 Pelecypoda, 4 Decapoda, 2 Gastropoda, 5 Isopoda, 3 Echinodermata, 5 Cumacea and six other taxa in the intertidal zones near Murrells Inlet, South Carolina. Invertebrates commonly found on sandy beaches include the beach digger (*Haustorius canadensis*), various polychaete worms (e.g., *Scolelepis squamata*), ghost crab (*Ocypode quadrata*), ghost shrimp (*Callianasa* sp.), the mole crab (*Emerita talpoida*) and coquina clam (*Donax* sp.). The swash zone is dominated by the mole crab and coquina clam.

Shorebirds such as the sanderling (*Crocethia alba*), black-bellied plover (*Squatarola squatarola*), Wilson's plover (*Charadrius wilsonia*), willet (*Catoptrophorus semipalmatus*), ruddy turnstone (*Arenaria interpres*), greater yellowleg (*Tringa melanoleuca*), lesser yellowleg (*Tringa flavipes*), marbled godwit (*Limosa fedoa*), American oystercatcher (*Haematopus palliatus*), laughing gull (*Larus atricilla*), herring gull (*Larus argentatus*), and great black-

backed gull (*Larus marinus*) forage on the algae and invertebrates of beaches in the project area.

Estuarine Waters of the Cape Fear River

The lower Cape Fear River estuary is one of the most important colonial waterbird nesting locations in North Carolina. 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). 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 thicket vegetation which has 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). North and South Pelican Islands and Ferry Slip Island 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, such that nesting by colonial waterbirds was diminishing, and a large number of nests laid 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).

Benthic communities of the Cape Fear River estuary 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.

Nekton is a collective term for 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 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 (Table 2). Invertebrates species included groups such as squid,

Table 2. 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

mantis shrimp, mud crabs (Family Xanthidae), and species such as blue crab (*Callinectes sapidus*) and white shrimp (*Penasus setiferus*). Moser (1991) 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.

Federally Protected Species

The proposed modifications would affect areas used by federally protected species. These species include the cetaceans, shortnose sturgeon (*Acipenser brevirostrum*), five species of sea turtles, the West Indian manatee (*Trichechus manatus*), the piping plover (*Charadrius melodus*) and seabeach amaranth (*Amaranthus pumilus*). The level of occurrence and distribution of these species were discussed in the Final FWCA Report for the Cape Fear Comprehensive Project (USFWS 1996a).

Cetaceans

Marine mammals occur in offshore and inshore waters of North Carolina. Twenty-nine species of cetaceans 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 continental 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. Bottle-nose dolphins are commonly observed in the estuarine waters between Bald Head Island and Southport.

The August 1995 Biological Opinion of NMFS under the Endangered Species Act Section 7 consultation for hopper dredging of channels and beach nourishment activities in the southeastern United States describes three days of dredging in the Wilmington Channel that encountered humpback whales:

> 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 the whale, and two other humpbacks nearby, approached within 100 yards, including one passing 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. (NMFS 1995, p. 17)

This data documents the presence of Federally-listed cetaceans within the project area.

Shortnose Sturgeon

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 (Rohde 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).

West Indian Manatee

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 in the lower Cape Fear River during 1972; one near the Carolina Power and Light Plant on the Cape Fear River in August 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.

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 sea turtle is rare in North Carolina waters. Leatherbacks are seen regularly in low numbers in the nearshore waters of the state during northern migrations in May and June. Both species are Federally-listed as endangered. Survey data (Table 3 in USFWS 1996a) in the Cape Fear River from 1980 to 1991 included 7 leatherbacks among 157 total sea turtles (David Webster, University of North Carolina, Wilmington, personal communication, 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). The North Carolina Wildlife Resources Commission (NCWRC) reports that 888 sea turtle strandings were found in Brunswick and New Hanover Counties from 1980-1999 (Table 3). NCWRC also reports that 137 sea turtles were found within or near the CP&L Brunswick County Nuclear Power Plant intake canal between 1995 and 1999 (Table 4) (Ruth

Boettcher, Sea Turtle Coordinator, N.C. Wildlife Resources Commission, personal communication, February 6, 2000).

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 (David Webster, University of North Carolina, Wilmington, personal communication, June 1994) (Table 3 in USFWS 1996a). 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.

Available data indicate that three species of sea turtles nest on beaches that may be used for sediment disposal during this project. Table 5 gives data on recorded nests for the loggerhead sea turtle and green sea turtle. Among the six beaches considered 3,343 loggerhead nests were recorded from 1988 through 1999. The ocean beaches at Bald Head Island are the most highly used beaches for loggerhead nesting in North Carolina. Over 70 nests are recorded each year and 182 nests occurred in 1990.

Nesting by the federally threatened green sea turtle is much less than for the loggerhead with only 13 nests were recorded during these 12 years. This species normally nests in Florida and the Carribean.

On June 17, 1992 a Kemp's ridley sea turtle (*Lepidochelys kempi*), a federally endangered species, nested on Long Beach. This positive identification is the first record of the species nesting in North Carolina. However, two other descriptions of sea turtles nesting in North Carolina during the 1992 season fit the description of the Kemp's ridley turtles (Therese Conant, Sea Turtle Coordinator, N.C. Wildlife Resources Commission, personal communication, August, 1992). Current nesting distribution is along the northwestern shore of the Gulf of Mexico from the Mexican state of Veracruz to North Padre Island, Texas, with the vast majority of activity occurring in Mexico.

Piping Plover

The piping plover (*Charadrius melodus*) is federally-listed as threatened. The species generally breeds north of the project area. However, there are limited data indicating nesting in southeastern North Carolina. Data collected by the NCWRC during 1993 found that 4 pairs of piping plovers nested on Holden Beach near Shallotte Inlet, just west of the project area (Tom Henson, NCWRC, 1993, personal communication to Janice Nicholls; USFWS 1996). The Service's 1996 recovery plan includes both Holden Beach and Long Beach near Lockwood Folly Inlet as actual or potential nesting sites (USFWS 1996). Johannsen and Allen (1999) report one

Table 3. Number of ocean beach (ocean) and inshore sea turtle strandings (by species) reported in Brunswick and New Hanover Counties, NC, from 1980-1999 (all years combined). Data from NCWRC.

	NEW HANOVER		BRUNSWICK		
SPECIES	**OCEAN**	**INSHORE**	**OCEAN**	**INSHORE**	**TOTAL**
Loggerhead	84	31	525	96	**736**
Green	2	5	19	7	**33**
Kemp's ridley	1	2	65	15	**83**
Leatherback	6	1	23	6	**36**
TOTAL	**93**	**39**	**632**	**124**	**888**

Table 4. Number of sea turtles, by year and species, found entrained inside CP&L's Brunswick County Nuclear Power Plant intake canal or impinged on river side of the diversion structure located at the junction of the canal and the Cape Fear River, 1995-1999.

SPECIES*	1995	1996	1997**	1998	1999	TOTAL
Loggerhead	16	49	10	10	17	102
Green	7	4	0	2	0	13
Kemp's ridley	1	5	6	5	5	22
TOTAL	**24**	**58**	**16**	**17**	**22**	**137**

* No sightings of leatherbacks.

** A blocker panel was installed on the riverside of the intake canal's diversion structure, which helped to reduce the number of subsequent turtles entrained in the canal. However, it has since been discovered that turtles can still enter the canal via the marsh adjacent to the diversion structure during extreme high tides.

Table 5. Recorded nests of the loggerhead sea turtle and green sea turtles from 1988 through 1999 on beaches that may be used for sediment disposal during the enlargement and maintenance of the Wilmington Ship Channel. Source: North Carolina Wildlife Resources Commission.

Year	Beach					Total
	Carolina and Kure	Bald Head Island [a]	Caswell	Long [b]	Holden [c]	
1988		112			7	119
1989	1	108	28	41	12	190
1990	11	182	81	62	58	394
1991	20	181	70	94	42	407
1992	1	136	68	56	54	315
1993	0	71	19	27	43	160
1994	10	120	100	103	35	368
1995	5	88	35	49	39	216
1996	7	99	70	95	45	316
1997	18	75	50	47	21	211
1998	12	88	46	61	71	278
1999	19	107	86	105	52	369
Total	104	1,367	653	740	479	3,343

[a] During this period, 9 green sea turtle nest were recorded on Bald Head Island

[b] During this period, 2 green sea turtles nests were recorded on Long Beach

[c] During this period, 2 green sea turtle nests were recorded on Holden Beach

piping plover nest at the west end of Holden Beach in 1997 and another in 1998. Birds were also observed in the early 1998 breeding season along Long Beach (Johannsen and Allen 1999). Piping plovers are regularly seen resting and foraging on the beaches during migration and in the winter. In the winter, the birds prefer expansive sand or mudflats for feeding and areas near sandy beaches for roosting. Table 6 lists the known winter sightings of piping plovers in the project area.

The Endangered Species Act requires the designation of critical habitat and its constituent elements by the Service, which would include the federally-listed coastal species found in North Carolina. Due to a court order, the designation of critical habitat for overwintering piping plovers is imminent, and available data indicate that such overwintering usage occurs within the project area.

The species' decline is attributed to increased development and recreational activities on beaches. Vehicular and foot traffic on beaches can directly crush eggs and chicks or indirectly lower productivity by disrupting territory establishment and breeding behavior. Increased development of beach areas has also resulted in an increase in the number of predators, such as gulls and raccoons, on piping plover chicks and eggs.

Seabeach Amaranth

The beach disposal component of the modifications requires the addition of the threatened seabeach amaranth (*Amaranthus pumilus*). Seabeach amaranth is an annual plant which grows on barrier islands primarily on overwash flats on accreting spits. However, it can sometimes be found on middle portions of islands on upper strands of non-eroding beaches. Seabeach amaranth is a dune building pioneer species and is usually found high on the beach in front of the foredune.

This plant has been extirpated from 75 percent of its historical range and North Carolina is considered seabeach amaranth's present stronghold (Weakley and Bucher 1992). Corps survey data from 1992 to 1996 indicate varying numbers of seabeach amaranth individuals on potential project beaches (Table 7).

Seabeach amaranth plants germinate between April and July and mortality of seedlings can be very high. Flowering begins as soon as the plant is large enough, possibly as early as June. Seed production begins in July or August and usually reaches a peak in September, but continues until the death of the plant. Seed dispersal occurs primarily by wind but tides may also play a role in spread of the seeds. Beach disposal activities will bury these annual plants, resulting in their mortality, and the depth of the disposal material will be such that germination of the seeds the following season may not occur. On the other hand, beach disposal/nourishment projects may benefit the species by providing additional suitable habitat. Beach disposal/nourishment may be compatible with seabeach amaranth provided the timing of beach disposal is appropriate, the material placed on the beach is compatible with the natural sand, and special precautions are

adopted to protect seabeach amaranth. Further studies are needed to determine the best methods of beach disposal in seabeach amaranth habitat (Weakley and Bucher 1992).

The shortnose sturgeon, whales, and sea turtles in the water 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. The address is:

National Marine Fisheries Service
U.S. Department of Commerce
9450 Koger Boulevard
Duval Building
St. Petersburg, Florida 33702

Table 6. Sightings of wintering piping plovers in New Hanover and Brunswick Counties.

Area	Number of Wintering Piping Plovers[a]						
	1987	1989	1990	1991	1996	1997	1998
Wrightsville Beach	**2**	**3**	**0**	**0**	**0**	**--**	**--**
Masonboro Island	**--[b]**	**--**	**1**	**0**	**0**	**--**	**1**
Carolina Beach	**3**	**3**	**1**	**0**	**--**	**--**	**--**
Fort Fisher	**0**	**0**	**0**	**0**	**1**	**--**	**0**
Bald Head Island	**1**	**4**	**--**	**0**	**0**	**--**	**--**
Fort Caswell	**--**	**--**	**--**	**0**	**0**	**--**	**--**
Long Beach	**3**	**1**	**1**	**0**	**0**	**--**	**--**
East Holden Beach	**0**	**--**	**0**	**0**	**0**	**0**	**0**

[a] Source: North Carolina Wildlife Resources Commission (NCWRC)
[b] Dashed line indicates data are not available to the NCWRC

Table 7. Seabeach amaranth Corps survey data for the project area.

	Number of Individuals				
Community	**1992**	**1993**	**1994**	**1995**	**1996**
Holden Beach	21	52	239	59	99
Long Beach	3148	6103	4409	4628	1983
Bald Head Island	1	26	2	1	37
Fort Fisher	0	0	0	0	0
Carolina and Kure Beaches	9	35	103	579	93

SECTION 6. FUTURE FISH AND WILDLIFE RESOURCES WITHOUT PROPOSED MODIFICATIONS

This section presents the opinion of the Service on the condition of fish and wildlife resources in the project area which could be reasonably anticipated if a proposed modification was not implemented. These conditions would essentially represent the future condition of these resources after they had reacted to the impacts of the original, unmodified project plan.

New Alignment for Ocean Entrance Channel

Without this project modification, the original channel would be lengthened and deepened. If, as expected, modification of the existing channel requires blasting, fish and wildlife resources would be adversely affected by keeping the original design. If the destruction of hardbottoms with corals and other unique marine organisms is avoided by using the new alignment, the habitat values of the offshore ecosystem would be enhanced by the proposed modification. However, creating the new alignment is expected to impact a total of 707 acres as opposed to a total of 657 acres for modifying the existing channel (Table 8). In this respect, the future without this modification would have an additional 50 acres of relatively undisturbed marine bottoms. On balance, the preservation of offshore hardbottoms is very important. If there are exposed hardbottoms along the existing alignment, the future abundance of some fish and wildlife resources is likely to diminish if a new alignment is not used.

Backfilling Abandoned Channel

If the new alignment is not used, the area of the old channel would be deepened and lengthened. The area would be subjected to periodic dredging. With the use of a new alignment this area would be allowed to refill with sediment from the Cape Fear River and the addition of fine material from the new channel. While the extent to which the refilling of this channel would recreate the natural areas lost along the new alignment is uncertain, it is likely that the refilling would have positive impacts on the habitat characteristics of the area. Therefore, without this proposed project modification, the future of fish and wildlife resources in the area of the existing channel would be adversely affected.

Disposal on Beaches of Brunswick and New Hanover Counties

Without these proposed modifications, the beaches and nearshore areas would not be subjected to the placement of dredge spoil material. The invertebrate beach fauna would not be subject to burial and the offshore, aquatic organisms would not be subject to the turbidity and siltation that beach disposal would produce. While the Service understands that the Corps is planning a long-term nourishment project for the Brunswick County Beaches and the beaches of New Hanover County are part of ongoing beach nourishment projects, the addition of the sediment from this project will create adverse impacts and fish and wildlife resources would be adversely affected.

Table 8. Area (in acres) that would be impacted (both bottoms and side slopes) by both the original plan to lengthen and deepen the existing ocean entrance channel and the modified plan to construct the channel partially on new alignment. Source: Wilmington District, U. S. Army Corps of Engineers, Wilmington, North Carolina.

Options for Enlarged Ocean Entrance Channel	Area in Acres (Including Bottom and Side Slopes)				
	Existing Disturbed Area				
	Channel Already Disturbed	ODMDS Path	Channel in Both Align.	New Impacts in Channel	Total
Plan 1 - Use Existing Alignment					
Existing 5.8 mi. Channel	372	0	0	0	372
Deepen Existing Channel		0	0	55	55
3.5 mi. Extension		0	0	230	230
Total for 9.3 mi. Channel	372	0	0	285	657
Plan 2- Create new alignment					
Construct 6.7 mi. Channel		121	147	439	707
Area planned for restoration by backfilling	224				

Disposal at ODMDS

The future without these options is likely to be very similar to the original project plan that called for considerably more disposal at this site. The Service (1996a) noted that 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. The modifications under consideration would shift a portion of the sediment intended for this area to the beaches of New Hanover and Brunswick Counties.

Overfilling Barges

Without the proposed expansion of dredging options barges would not be overfilled. In this regard the turbidity and siltation associated with the overall project would be less. Overall, the future of fish and wildlife resources would be enhanced by a continuation of the prohibition on overfilling of sediment barges.

Expansion of Dredging Methods

Without the proposed expansion of dredging methods, aquatic organisms would still be exposed to some turbidity and siltation during the enlargement of the navigation channel. However, the generally tighter restrictions on the overflowing of barges and seasonal restrictions would minimize the impacts associated with construction. The Service noted (1996a) that 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.

Elimination of Bubble Curtain

Data from tests of the bubble curtain during blasts in the Cape Fear River (Appendix C) indicate that this procedure adds little, if any, protection to aquatic organisms, particularly fish. Therefore, the future of fisheries resources would not change appreciably by the absence of the bubble curtain. However, the Service noted (1996a) that 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. The fact that the bubble curtain adds almost no protection does not eliminate the fact that aquatic organisms will be killed or injured by the blasting.

SECTION 7. ALTERNATIVES CONSIDERED

The alternatives under consideration are essentially those of the original project (USACOE 1996d) and the proposed modifications. These are briefly summarized in this section.

New Alignment for Ocean Entrance Channel

There are two options for the alignment of the ocean entrance channel to the Wilmington Harbor navigation Channel. Either the existing channel would be enlarged and lengthened or a new alignment selected. Figure 1 in Appendix D shows the two channel alignments.

Backfilling Abandoned Channel

If the new alignment is chosen as the preferred alternative, the old channel will be abandoned and filled with sediment. The only alternative to this project modification is to not abandon the old channel, but to enlarge and lengthen it.

Disposal on Beaches of Brunswick and New Hanover Counties

The original disposal plan for the various types of sediment that required disposal was based on the characteristics of the material. The project would generate three broad types of material: (1) rock; (2) soft sediment with greater than 90% sand; and, (3) soft sediment that is 90% or less sand. The proposed modifications do not involve the disposal of rock. All of the materials would be disposed of at the ODMDS or on existing disposal islands.

There are now two options for disposing of the materials suitable for beach disposal on the beaches of Brunswick and New Hanover Counties. The first option is to place all of the beach suitable material on Bald Head Island and the eastern end of Oak Island (up to the Sea Turtle Restoration Project area) (Appendix D, Figure 2). The other option is to dispose of the sand on Bald Head Island, all of Oak Island except the Sea Turtle Restoration Project area, and Holden Beach. Which option is chosen appears to depend upon whether the local communities can use the Section 933 cost-sharing program. Maintenance dredging disposal plans are the same for either alternative, with the sand being deposited on Bald Head Island and Caswell Beach at a 2:1 ratio.

If the first option is chosen to use just Bald Head Island and the east end of Oak Island, a larger quantity of sand will be deposited on those beaches. The alternative to distribute the sand equally amongst Bald Head, all of Oak Island and Holden Beach would reduce the amount of sand any given beach receives but increase the cost of the project (Appendix D, Table 3). The alteration to the width of the beaches post-disposal would be less with the Sec. 933 alternative to spread the estimated 5.6 mcy of material across all the aforementioned communities; the first option would create wider beaches than the second. The second option would widen a higher number of beaches, however.

The only other project option is to not dispose of any sediments on the beach, but deposit them all at the ODMDS. The existing ODMDS does not have enough remaining capacity to hold all of the project's sediments when combined with maintenance dredging at MOTSU, however (Appendix D). If the beach quality sediments were disposed of at the ODMDS, the project would be delayed at least a year while a new ODMDS capable of handling all of the dredge spoil was established.

Disposal at ODMDS

There are no alternatives provided for this aspect of the project.

Expansion of Dredging Methods

There are no alternatives provided for this aspect of the project modifications.

Elimination of Bubble Curtain

The bubble curtain was initially proposed as a mitigation measure for the expected fish mortality resulting from the rock blasting included in the project (USACOE 1996a). No alternative mitigation measures to replace the elimination of this one have been provided.

SECTION 8. SELECTION OF THE PREFERRED MODIFICATIONS

The Service (USFWS 1996a) discussed the selection of the preferred alternative for which modifications have been proposed. The Corps provided the Service with information used in selecting the current preferred alternative.

New Alignment for Ocean Entrance Channel

The Corps decision to propose a new alignment for the ocean bar channel was based upon an assessment of problems with the existing channel. These problems are:

1. Deepening the channel along its present alignment would require the removal of extremely hard rock;

2. Rock removal would require extensive blasting and would be very slow and expensive;

3. Present 5.8-mile channel would be extended 3.5 miles seaward to a new total length of 9.3 miles; and,

4. Seaward channel extension would pass through a substantial amount of live coral and other ecologically valuable, live hard bottoms.

The proposed new channel alignment addresses these problems and the advantages are summarized as:

1. Avoid the need for rock blasting and its associated environmental impacts;

2. Avoid coral/live hard bottom in the path of extending the existing alignment;

3. Shorten distance to natural deep water to about 6.7 miles rather than 9.3 miles on the existing alignment;

4. Save about $40 million in construction costs by avoiding the need for rock removal;

5. Reduce channel construction time;

6. Avoid 1 extra foot of overdepth that would be required when the channel bottom is rock;

7. Route the channel over deeper rock so that future deepening, if necessary, would require less blasting.

Backfilling Abandoned Channel

The advantage of this option is stated in Appendix B. This option is expected to benefit the commercial fishing industry because trawling activities could likely be resumed along the old channel alignment.

Disposal on Beaches of Brunswick and New Hanover Counties

The decision to move beach quality material dredged during the expansion of the navigation channel to area beaches was apparent based on requests from local interests. The Corps states (Appendices B and D) that beach-quality sand dredged during construction and maintenance of the new ocean bar channel will be made available for placement on area beaches, to the extent feasible. Planning for the placement of this sand is being coordinated through the Brunswick County Consortium, which represents the interests of Bald Head Island, Caswell Beach, Oak Island (Yaupon Beach and Long Beach), and Holden Beach in acquiring as much sand as possible from the Wilmington Harbor project (Appendix D). These communities are currently working with Federal and State governments to obtain funding assistance for sand placement, possibly through the authority of Section 933 of the Water Resources Development Act of 1986. Section 933 authorizes 50 percent Federal sharing of the extra costs of using sand dredged from Federal navigation improvements and maintenance for beach nourishment. Sand placed through the use of this authority must provide benefits at least equal to the cost of placement, but future nourishment of the beach is not a project requirement; that is, the beach does not become a Federal shore protection project with a continuing maintenance obligation.

Excavation of the new channel between the Lower Swash Range and the Bald Head Shoal Range is expected to generate 14.8 million cubic yards (mcy) of sediment, with roughly 5.6 mcy of that material suitable for beach disposal. Dredging segments of the channel between Snows Marsh Range and Reaves Point Range is estimated to contain another 1.3 mcy of beach quality material. The former would be disposed of on Brunswick County beaches, while the latter will be added to another 1.3 mcy of beach quality sand pumped out of disposal islands 3 and 4 and placed on Kure, Carolina or Fort Fisher Beaches in New Hanover County, and/or Bald Head Island or Caswell Beach in Brunswick County (Appendix D). Including maintenance dredging at MOTSU, 21 mcy of sediment is expected to require disposal before the end of 2001. The existing ODMDS can only contain roughly 17.8 mcy more before reaching full capacity, however. So disposing of the estimated 5.6 mcy of the sediment on nearby beaches prevents the project from exceeding the full capacity of the existing ODMDS.

Placement of sand on the Brunswick County beaches was preliminarily designed to begin at mean high water (elevation +2.5 ft mllw) and to extend seaward during construction. It is anticipated that natural forces will immediately reduce this beach width by 17% after a period of about two to six months. Shoreline erosion rates are expected to be the same or slightly higher than the rates before the fill placement. During placement deposited sand was preliminarily designed not to exceed elevation +8.0 feet. A preliminary design beach profile is shown at true

scale in (Appendix B, Figure 4) and exaggerated scale in (Appendix B, Figure 5). The Sand Management Plan in Appendix D does not provide any fill dimensions, so it does not confirm or revise the preliminary placement designs in Appendix B. Table 9 lists the beach fill characteristics that are known about the two design alternatives.

Should the beach communities not be in a position to accept any or all of the sand generated by construction of the Wilmington Harbor improvements, the excess sand would be placed in the littoral system, to the maximum extent practicable, so as to retain it within the active coastal sand system.

Disposal at ODMDS

This design feature is part of the original project proposal. The Wilmington ODMDS will be available for disposal of any harbor sediments that are not suitable for beach or littoral zone placement (due to > 10 percent silts and clays). In addition, if neither beaches nor littoral zone placement can accommodate all the sand generated by the harbor improvements and maintenance, any remainder may go to the Wilmington ODMDS. Once the ODMDS reaches its full capacity with an additional 17.8 million cubic yards of sediment, a new ODMDS approximately 5 miles seaward of the existing ODMDS is intended to be the disposal site for project and maintenance sediments unsuitable for beach disposal. The existing ODMDS is expected to reach full capacity before the end of 2001, and a new ODMDS currently is being developed with the Environmental Protection Agency (EPA).

Expansion of Dredging Methods

The proposal of this project modification was apparently driven by the desire to reduce project costs. Dredging methods currently approved for use in various sections of Wilmington Harbor include hydraulic pipeline, hopper, and bucket dredges with scow. Overflowing of hopper dredges and scows to achieve economic loading has also been approved for some portions of the harbor, and has been conditionally approved for additional portions subject to monitoring the overflow plume. Approved disposal sites include the ODMDS, confined disposal facilities (CDFs) on islands along the river, and the Eagle Island CDF located near river mile 25. The same dredging methods and disposal sites are planned for future use. However, it is proposed that all dredging methods be allowed throughout the Wilmington Harbor project from its upstream end (mile 31) downstream to and including the ocean bar channel (Baldhead Shoal Channel), providing that their use is consistent with appropriate environmental protection measures, including those imposed to safeguard water quality, fish and wildlife, and endangered and threatened species. It is also proposed that the various types of dredging equipment be allowed to operate by methods that achieve greater economic efficiency (such as overflowing hopper dredges and scows to achieve economic loading) so long as these methods do not violate regulatory restrictions and conditions. Furthermore, it is proposed that placement of dredged material from any portion of the harbor may be at any approved dredged material disposal site, so long as this is in accordance with Section 404 of the Clean Water Act or Section 103 of the

Table 9. Beach disposal plans for each of the communities proposed for fill placement (Appendix D). Note that Option 1 plans for disposal on just Bald Head and the east end of Oak Island are denoted by "A" and Option 2 with Sec. 933 distribution of sediments are denoted by "B". The last column lists the adjusted beach width with an expected retention rate of 83% following reworking of the sediments over a few to several months. Erosion is expected to continue at similar or slightly higher rates.

Community	Fill Length (ft)	Fill Volume (cy/ft)	Estimated Volume (cy)	Estimated Initial Beach Width (ft)	Estimated Width after Adjustment (ft)
Bald Head – South Beach, west end	A: 2,000 B: 2,000	A: 120 B: 62	A: 240,000 B: 125,000	A: 180 B: 100	A: 90 to 100 B: 50
Bald Head – South Beach, east end	A: 12,000 B: 12,000	A: 175 B: 62	A: 2,100,000 B: 750,000	A: 270 B: 100	A: 130 to 140 B: 50
Bald Head – West Beach	A: 2,000 B: 2,000	A: 120 B: 62	A: 240,000 B: 125,000	A: 180 B: 100	A: 90 to 100 B: 50
Oak Island – East	A: 25,000 B: 25,000	A: 90 B: 62	A: 2,220,000 B: 1,550,000	A: 140 to 150 B: 100	A: 70 B: 50
Oak Island – West	B: 25,600	B: 62	B: 1,590,000	B: 100	B: 50
Holden Beach	B: 10,600	B: 62	B: 660,000	B: 100	B: 50

Marine Protection, Research, and Sanctuaries Act as appropriate. Dredging methods already approved and those proposed for approval for all the channel segments of Wilmington Harbor are shown in Appendix B, Figure 6.

Elimination of Bubble Curtain

The decision to eliminate the protective bubble curtain around blasts in the Cape Fear River was based on tests that demonstrated that the procedure provided little, if any, protection. In light of the dubious benefits and high costs of this procedure, the bubble curtain was dropped (Appendix C).

SECTION 9. DESCRIPTION OF THE PREFERRED MODIFICATIONS

The Corps has indicated a number of changes to the original project design. These changes have been supplied to the Service. A description of five of the six proposed changes which constitute the preferred alternative considered by this report are given in Section 1.04 of Appendix B. These changes are:

1. New Alignment for Ocean Entrance Channel
2. Backfilling Abandoned Channel
3. Disposal on Beaches of Brunswick and New Hanover Counties
4. Disposal at ODMDS
5. Expansion of Dredging Methods

The preferred alternative for changes in blasting procedures, primarily the elimination of the protective bubble curtain, is given in Appendix C. The Sand Management Plan with detailed descriptions of the beach disposal and maintenance dredging plans is provided in Appendix D.

SECTION 10. IMPACTS OF THE PREFERRED MODIFICATIONS

A discussion of environmental impact of any construction project can be divided into two broad categories: direct and indirect impacts. Direct impacts refer to those consequences of a given action which occur at generally the same time as the action and in the immediate vicinity of the action. While the proposed modifications may be considered as a one time event, there would be indirect project impacts. In this case indirect impacts would be those that occurred at a distance from the actual work. However, in some cases there may be impacts that occur after the actual construction operation that may also be considered as indirect impacts. For instance, perpetual disposal of sediments from channel maintenance on to the beaches of Bald Head Island and Caswell Beach will create indirect and cumulative impacts to their beaches and nearshore systems.

New Alignment for Ocean Entrance Channel

The environmental impacts of creating a new alignment for the ocean entrance channel would be similar to those associated with offshore dredging for beach nourishment material. The operation would create both direct and indirect impacts.

Offshore dredging will kill the plants and animals within the sand removed from borrow sites. The National Research Council (1995, p. 118) states that "The primary biological effect of dredging borrow sites is the removal of benthic assemblages inhabiting the surficial substrate." Every acre of new channel outside of the existing ODMDS is the loss of an acre of relatively undisturbed benthic habitat, for up to 707 acres.

The preferred alternative would increase turbidity during the dredging of sand at the offshore borrow sites. Silt and clay particles within the borrow material would become suspended by the dredge. The increased turbidity would be harmful to planktonic invertebrates, fish, and marine mammals. The suspended sediment would reduce light penetration beyond the actual area dredged and reduce primary production.

While increased turbidity *per se* is harmful, a closely related event, increased offshore sedimentation, also produces adverse impacts. The suspended particles are carried away from the actual dredging site and eventually settle to the bottom, creating sedimentation. The settling of suspended particles is also referred to as siltation. Bush et al (1996, p. 83) state their belief that the dredging of sand off Boca Raton, Florida, for a new beach released mud that was responsible for killing coral heads more than 20 miles to the north. Hardbottom areas indicated by SEAMAP data (SEAMAP 1998) and Cleary (1999) could be destroyed by sedimentation. It is difficult to forecast the exact magnitude and areal extent of sedimentation produced by dredging. However, sediment with certain characteristics, e.g., high silt and clay content, could flow along currents and cover hardbottom areas many miles from the dredging site with a damaging layer of sediment.

Another indirect impact from the new channel alignment may be increased erosion rates on the shorelines of Bald Head Island and Oak Island, with the former closer to the new channel than the old. The Base New Work Disposal Plan (Appendix D) takes this into account and decreases the volumes of material placed on West Beach and the west end of South Beach along Bald Head Island in order to reduce the speed at which the disposal material re-enters the new channel via longshore transport. Artificially increased erosion rates would accelerate the regression of the islands with rising sea level and alter the geologic fate of the islands. The channel would serve as a sediment sink for longshore transport of littoral sediment from both Bald Head Island and Caswell Beach (Appendix D). As sediment is removed from the comparatively natural longshore system, adjacent shorelines would erode faster, possibly become overwash dominated and thus alter the existing coastal ecosystem to a more dynamic one.

Backfilling Abandoned Channel

Allowing the abandoned channel to refill with natural inflows of sediment and placing material too fine or unsuitable for beach disposal in the channel may not create benthic habitat similar to that lost in the construction of the new alignment. A beach nourishment project that removes sand from offshore borrow areas may permanently alter the physical characteristics of the areas and impact the benthic flora and fauna adapted to existing conditions. The long-term physical alterations produced by sand removal from marine habitats have not been well documented (National Research Council [hereafter NRC] 1995, p. 118). The majority of follow up studies from offshore borrow sites have shown decreases in the mean grain size, including, in some cases, increases in the percentage of silts and clays in the borrow site (NRC 1995, p. 118). Offshore holes may fill with finer grain material (NRC 1995, p. 118). The finer material or other significant alterations in the physical characteristics of the substrate may not be suitable for the organisms that formerly occupied bottom sediment of the borrow area.

Backfilling the channel will dramatically alter the bathymetry of the seafloor in this area. While returning the channel to its previous water depths, any deviation from the surrounding seafloor bathymetric contours or geomorphology may prevent the area from returning to its native habitat pre-navigational channel. Overfilling or underfilling the channel may alter water circulation pathways, wave patterns, and resulting passive fish and wildlife distributions. Underfilling may also create stagnant areas where deep pools persist relative to adjacent geomorphology.

Disposal on Beaches of Brunswick and New Hanover Counties

The placement of sediment on beaches, whether as a formal beach nourishment project or merely a disposal operation, produces a host of both direct and long-term indirect impacts.

There may be a deterioration of nearshore habitat quality due to long-term turbidity from the artificial beach-dune system. Bush et al. (1996, p. 83) state that “Streams of turbid water from the surf zone of Miami Beach are still responsible for killing coral heads 14 years after the beach was emplaced.” Goldberg (1985) gives an example of a Florida nourishment project which

resulted in damage to a nearby rocky environment 50 to 60 meters offshore. Material placed on the beach during a nourishment project quickly eroded off the beach and covered nearshore rocks. Seven years after the project, the rocks were still covered in fine sand and silt, and turbidity of the nearshore area remained high.

When a beach is nourished, large volumes of sand are placed within the supralittoral and intertidal zones. Beach invertebrate populations are eliminated or greatly reduced. As noted, the direct, adverse impacts may be dramatic, but longer-term, indirect impacts related to altered beach characteristics and recruitment of a recovery population may have the greater impact on fish and wildlife resources that depend on beach invertebrates as a food source. Sand placement disturbs the indigenous biota inhabiting the subaerial habitats, which in turn affects the foraging patterns of the species that feed on those organisms (NRC 1995, p. 108). Dean (1999, p. 118-119) describes the artificial beach in Miami, Florida, as a quiet area without natural life.

Reilly and Bellis (1978) state that species of beach infauna recruited from pelagic larval stocks, such as mole crabs and coquina clams, will recover if nourishment activity ends before larval recruitment begins in the spring. In the spring, recruitment begins with juveniles and adults approaching the beach. In the Bogue Banks project, nourishment extended from December until June, a time that included the March recruitment period of coquina clams. No increase in coquina clams occurred until July 29, approximately two months after cessation of nourishment, and populations failed to reach pre-nourishment numbers found during the winter. At the control site, coquina clams also decreased during the winter as they moved offshore. However, during March, numbers at the control site increased to high levels. This study indicated that adult coquina clams were probably killed in their offshore wintering environment, and beach nourishment effects, most likely high turbidity, prevented normal pelagic larvae recruitment. The individuals that eventually arrived were post metamorphic adults likely to have diffused from adjacent beaches via littoral drift.

Peterson et al. (2000) documented invertebrate populations following dredge spoil disposal from Bogue Sound placed on the beaches of Bogue Banks to be reduced by 86-99% (compared to control beaches) 5 to 10 weeks following fill placement. The authors conclude that "Failure of *Emerita* and *Donax* to recover from nourishment by mid summer when they serve as a primary prey base for important surf fishes, ghost crabs, and some shorebirds may be a consequence of the poor match in grain size and high shell content of source sediments and/or extension of the project too far into the warm season" (Peterson et al. 2000, p. 2).

Donoghue (1999) found the timing of beach fill placement, the time interval between fill placement episodes, the size and type of fill, and the compatibility of the fill material to the native sediments to be critical to the short- and long-term impacts to beach invertebrate populations. Fill placement during the invertebrate reproduction or recruitment periods in early spring and early fall depressed the populations of mole crabs and coquina clams for several months to years; ghost crab populations were similarly decreased as a result of fill placement on the beaches at Pea Island. The alterations to the geomorphology and sediment characteristics of

the study beaches appear to be more controlling factors on invertebrate recovery periods than direct burial or mortality.

Technical data available to the Service indicate that weathered limestone gravel, mud and clay will be placed in some percentages on the beaches in the dredge spoil. These percentages will vary depending on the mixing of the materials with other spoil sediments. Locally these percentages might be very significant, and in patches they may compose almost 100% of the spoil material. Limestone gravel, mud and clay do not naturally occur as part of the unconsolidated sediments that make up the project beaches, and introduction of these non-native materials will have significant impacts on the natural sandy beach strand ecosystem.

Significant quantities of limestone gravel on disposal beaches will decrease the internal stability of the beach sediments, potentially compromising the ability of beach invertebrates to maintain burrows. Data on the grain sizes of the sand found in the areas to be dredged for beach disposal indicate that on average the spoil material will be significantly coarser, or larger, than the native beach sands. Coarser sand grains, especially those with high shell content, can have the same impact as gravel on invertebrate burrows. Both gravel and coarser sand will reduce the aeolian (wind) transport of sediments on the disposal beaches, which will decrease the amount of sediment supplied to local dunes and potentially destabilize them. The slope and shape of the beach may also be altered by larger grain sizes, which would in turn impact the wave and tidal energies reaching different portions of the disposal beaches. Modified hydrodynamic and morphologic characteristics of the beaches will redistribute ecological characteristics and possibly render the beaches unsuitable for a lengthy time period, delaying recovery of fish and wildlife resources.

As heavy equipment compacts and breaks up any weathered limestone gravel present in the spoil deposits, pieces of rock of varying sizes will be ground into the sandy beach. Depending on the mineralogical composition of the limestone, freshwater from rain or runoff may dissolve the carbonate material and literally cement the underlying beach sediments together. Wildlife that live within these sediments will be adversely impacted by any such cementation and entire populations may be decimated for a long time period.

Large proportions of fine-grained material such as mud and clay within the spoil will increase turbidity in nearshore waters both from dewatering of the spoil material and during the reworking of the spoil over time. These fine grains are also quite cohesive and will bind the beach sediments together, thereby cementing and compacting the beach substrate. Increased cohesion of the sediments may also increase the likelihood of the formation and persistence of resistant escarpments on the beaches. Mud and clay are also a darker color than the natural quartz sand found on the project beaches. Significant organic materials may also be contained within these fine sediments. Mud (or clay) balls of varying sizes may also be scattered across beaches where dredging has penetrated mud or clay strata. All of these altered physical characteristics may compromise the viability of sea turtle nests, foraging habitat for shorebirds and surf fishes, and distribution and abundances of invertebrates.

Sand flowing onto the lower portion of the beach during the nourishment operation can increase the beach height in the intertidal zone from several centimeters to more than a meter (NRC 1995, p. 109). This significant change in the character of the intertidal zone can affect habitat suitability and feeding by beach invertebrates beyond the immediate impact of sediment placement.

Thus we are concerned about the impacts of the beach disposal of dredge sediments, both in the short-term and long-term, to the beach invertebrate populations. These populations are a key facet of the coastal food web, and therefore decreased species abundances would reduce the prey base for shorebirds, surf fishes and beach macrofauna. Perpetual beach fill placement of maintenance dredging materials has the potential cumulative impact of permanently depressing beach invertebrate populations, especially at Bald Head Island where two-thirds of the maintenance materials will be deposited.

Bottom habitats in the nearshore surf zone often support a diverse array of biota that are directly or indirectly affected by beach nourishment operations (NRC 1995, p. 112-113). This community may be affected by burial of the bottom habitats, increased sedimentation, changes in nearshore bathymetry and associated wave action, and elevated turbidity.

Dr. William Cleary of the University of North Carolina at Wilmington has studied the movement of sand off recently renourished beaches in New Hanover County, Wrightsville Beach and Carolina Beach. He found that there are many more hardbottom areas in the nearshore zone within 1 or 2 miles of shore than was previously thought and the distribution of rock is very patchy. In some locations, 5 to 6 feet of sand covers the rock at times (Dr. William Cleary, University of North Carolina at Wilmington, personal communication, July 1992). More recently Cleary (1999) found the hardbottom rock outcrops offshore Oak Island to be covered by less than an inch to perhaps six feet of sediment.

Such thin veneers of sediment may be frequently reworked and moved with waves and currents, continually shifting the position of exposed hardbottom habitats. Any increase of sediment to this dynamic system has the potential of reducing the distribution and exposure of hardbottom habitats. The Service is concerned that the perpetual channel maintenance with beach disposal may have cumulative impacts to the hardbottom ecosystem as millions of cubic yards of sediment are introduced to the nearshore system on a regular basis either from turbidity and siltation or from potentially increased erosion rates on adjacent beaches.

Studies have documented only limited or short-term alterations in abundance, diversity, and species composition of nearshore infaunal communities sampled off new beaches (NRC 1995, p. 115). However, several of these studies had inadequate sampling designs that may have precluded detection of significant alterations in the populations or community parameters measured (Nelson 1991, 1993). The NRC (1995, p. 115) concluded that " . . . efforts should be directed toward obtaining a better understanding of functional changes in the trophic contribution

of benthic assemblages to the fish and crustaceans species that rely on the benthos as a major food resource."

Disposal at ODMDS

Open ocean disposal of dredge spoil sediments can have several impacts. The actual dumping of the spoil from the dredge or barge involves three aspects: convective descent of the material, dynamic collapse and the outward spreading of density currents along the seafloor. The finer portions of the spoil will be suspended in the water column, generating areas of increased turbidity as the sediments settle to the bottom. The heavier particles will sink straight to the seafloor. And lastly, layers of dense, turbid mixtures of suspended sediment will be carried away from the disposal area along the ocean floor. These density currents can range up to several meters thick and spread significant distances rather quickly (Drapeau et al. 1999). Current speed and dimensions will decrease with distance from the drop zone and time.

Increased turbidity levels have several potential impacts to fish and wildlife resources. Higher suspended sediment loads decrease light penetration in the water column, reducing biological productivity for a short period of time. If there is a high organic content in the dredge spoil, oxygen levels may become depressed and nutrient levels in the water altered. Fish gills may be clogged by high sediment loads in the water as well. Finally, siltation of the suspended sediments has the indirect impact of burying sessile benthic organisms that are unable to relocate out of the pathway of settling sediments; many of these organisms are filter-feeders, and high suspended sediment loads in the water may suppress their ability to feed.

The dredged sediment that is dumped at the ODMDS will bury any benthic flora and fauna present on the existing seafloor. Any organisms such as fish, mammals or sea turtles present in the water column between the dredge or barge and the ODMDS seafloor may not be able to escape the collapsing material and could be suffocated, killed, maimed or buried alive. These impacts could occur every single time a dredge or barge dumps its load and would be possible for the life of the project or use of the ODMDS. Creation of a new ODMDS would eliminate a completely new and comparatively undisturbed area of seafloor and accompanying benthic habitat. The existing ODMDS has been continually disturbed with maintenance dredging disposal from the existing navigational channel and nearby MOTSU; thus the benthic habitat is perhaps not as mature or well developed as would naturally occur. Usage of a new ODMDS site, therefore, would increase the initial impacts from disposal of project sediments offshore.

The spreading density currents radiating from the ODMDS will enlarge the zone of potential impacts beyond the area immediately surrounding the dredge or barge. Again the utility of a new ODMDS will also enlarge the zone of potential impacts, in this case to a relatively undisturbed section of seafloor. Burial and potential suffocation of benthic flora and fauna would extend for as far as any density currents spread around both ODMDS sites. If any contaminants are contained within the dredge spoil, the density currents would spread their distribution over a large, uncontained area. While any such contaminants should be diluted as

they spread, the repeated usage of the existing and new ODMDS with maintenance dredging could allow for cumulative impacts as contaminants accumulate. Fish and wildlife resources exposed to such contaminants could become affected in the long term.

Dredging the new alignment and disposal of fine-grained material may diminish the habitat values of the Wilmington Offshore Fisheries Enhancement Structure (WOFES), a disposal area for rock removed from the ship channel. The WOFES is located adjacent to the southeastern edge of the ODMDS and covers approximately 165 acres. It was designed to enhance attributes and features that would provide habitat and attract fish (USACOE 1994). The structure was designed to contain a mixture of rock (basketball sized to golf ball sized) and finer grained material to provide habitat complexity and structural stability. This effort sought to replace the low relief, sandy substrate bottom with a rock material substrate having high vertical relief. To the extent that dredging the new channel through the ODMDS and the disposal fine-grained material in the ODMDS produces sediment that moves to the southeast and settles on the WOFES, the intended habitat values of the area would be diminished. Areas of exposed rock could be covered by sediment and the desirable areas of high vertical relief decreased.

Burial of nearby hardbottoms by dredge and fill activities has been shown to reduce the abundance of fish species and individuals in Florida (Lindeman and Snyder 1999). Lindeman and Snyder (1999) state that "Because of behavioral and morphological constraints on flight responses, high mortalities are probably unavoidable for many cryptic [fish] species, newly settled life stages, or other site-associated taxa subjected to direct habitat burial" (p. 520). Nearshore, shallow hardbottoms were found to carry a large number of newly settled stages, and therefore Lindeman and Snyder (1999) conclude that burial as a result of dredge and fill activities may have amplified impacts if conducted just prior to peak larval recruitment, which is in spring and summer in their study area. Thus we are concerned that the timing of open ocean disposal of dredge sediments from this project may be a critical factor in the magnitude and frequency of impacts to adjacent hardbottoms.

Finally there are long-term, relatively permanent alterations to the offshore environment by using an ODMDS for dredge spoil. The bathymetry will be changed, with decreasing water depths as usage of the sites continues. The existing ODMDS at full capacity will have a water depth of 26 feet below mean lower low water. The adjacent natural bathymetry ranges from 34 to 45 feet water depth. This platform of soft sediments could alter water circulation patterns, which could redistribute pelagic larvae, eggs and nutrient patterns and pathways. Waves and currents, especially during storms, could refract or divert around this mound of material. Some of the soft sediments could be resuspended during storms, renewing turbidity and siltation impacts on adjacent fish and wildlife resources. Creation of a new ODMDS could create a similar situation at its location. Over time, the cumulative impacts of these actions would create a permanent alteration to the natural benthic environment by modifying its bathymetry.

Expansion of Dredging Methods

There are several proposed expansions of dredge types and windows of use in this project. When sediments are suitable for beach disposal, hopper dredges are proposed for year-round usage for dredging and disposal of sediments on the beaches or nearshore littoral zones. Hydraulic pipeline dredges are proposed for similar usage and timing. Bucket and barge or scow dredges are not proposed for beach or littoral zone disposal, but are proposed for year-round disposal in diked disposal sites. All of this year-round dredge and disposal activity is also proposed to allow overflowing scows for economic loading.

For sediments that are not suitable for beach or littoral zone disposal, overflowing scows are proposed for hydraulic pipeline, hopper, and bucket and barge dredges, with disposal on disposal islands, the ODMDS, and diked disposal sites. Overflowing scows carrying rock materials are proposed for disposal by hydraulic pipeline as well as bucket and barge dredges at the WOFES or ODMDS.

Beach or littoral zone placement of dredge materials during the spring, summer and fall months may affect nesting sea turtles, foraging and nesting shorebirds including the piping plover, and the reproduction and recruitment of beach invertebrates. Sea turtle nests may be on North Carolina beaches from May 1 to November 15. Shorebirds have a similar nesting season, with additional foraging and loafing usage during spring and fall migrations. Beach invertebrate populations generally have a bimodal population distribution with both early spring and early fall spawning and recruitment periods, the former in April and May and the latter in August and September (Donoghue 1999).

Active beach fill placement during the spring, summer and early fall months would thus alter the habitat used by all of these organisms, especially given the realistic probability of non-beach suitable dredge spoil materials being placed on the beaches. Nests could be buried by dredge material. Alterations to the grain size, color and composition could create unsuitable habitat for sea turtle nesting and beach invertebrate colonization and recovery. The greater the deviation from the natural grain characteristics present on the disposal beaches, the greater the potential impacts to all organisms using or living on the beaches. Deposition of disposal material during recruitment or nesting seasons could increase recovery times for invertebrate populations and reduce the abundance of sea turtle and shorebird nests or success of existing nests.

Physical alterations to the beach plan and profile would also impact sea turtles, shorebirds and beach invertebrates. If a tall berm is created at the existing high tide line, that berm will create an obstacle for emerging nesting sea turtles. Beach cusps that may be present initially would be eliminated by the fill, and these swash features seem to be preferable to beach invertebrates (Donoghue 1999). Any increase in topographical elevation in the intertidal zone, especially by a berm or mound of sand extending up to +8.0 feet, would have a high probability of forming a scarp as waves and tides reworked the fill sediment. Such scarps would be barriers to sea turtles trying to reach dry beach for nesting and could also impede the foraging patterns of shorebirds

who feed on swash zone invertebrates. Over time the sediments would be reworked and the likelihood of persistent scarps decreases.

The mechanics of pumping out the dredge materials onto the beach would generate other direct and indirect impacts to coastal fish and wildlife. Pipelines, either from a hopper pumpout or a hydraulic dredge, would be laid on the beach and in the nearshore waters. Such pipelines would create a physical barrier for not only wildlife resources but people utilizing the beach as well. Pipelines running parallel to the shoreline would impede sea turtle access to nesting habitat. Macrofauna such as ghost crabs would also have difficulty reaching foraging areas in or near the intertidal zone. The slurry being pumped out of the pipeline would require dewatering and heavy equipment to adjust the fill dimensions. As the slurry that is 80% or more fluid dewaters, sediment plumes will extend off of the beach. Juvenile surf fishes could be impacted with respiratory stress or trauma that is either lethal or sublethal. Filter-feeding molluscs in the immediate nearshore area could also be suffocated or traumatized. The heavy equipment on the beach used to move the fill could compact the sediments, destroy existing invertebrate burrows and run over nests of sea turtles or shorebirds. Compaction of the sediments could render them unsuitable for sea turtle nesting, burrow excavation and invertebrate recolonization.

Thus if beach disposal was to occur during the winter months when the beaches are less utilized by sea turtles, shorebirds and invertebrates, the impacts would be less. Sediments would have a longer period of time to be reworked across the beach profile. Impacts to fish and wildlife resources would be minimized by limiting beach disposal activities to winter only.

Similarly, hopper dredges have been known to incidentally take sea turtles present in the water column near the dredging activities. The number of sea turtles and other aquatic species killed or fatally wounded by such activities would logically increase with the increased abundance of these species in the water. The Service is concerned that use of hopper dredges year-round would have the additional impact of increased takes of federally listed resources as populations increase during spring and fall migration periods as well as the summer foraging and nesting season. Limiting hopper dredging activity to the winter season would minimize the potential number of takes of these species.

Colonial waterbird nesting season extends from May 1 to October 31. Disturbances to disposal islands utilized by these birds during their nesting season could increase abandonment of nests and lead to decreased reproduction success rates. Active pumpout of these islands to Kure or Carolina Beach, as well as additional disposal on them, would destroy any nests present during the nesting season. Noise and any potential fumes accompanying dredging activities adjacent to disposal islands may discourage usage of the islands for nesting. Night-time dredging activities with lights could further disrupt colonial waterbirds not only nesting on disposal islands, but those resting or foraging on the islands.

Overflowing scows throughout the project area would increase the areas impacted by sediment plumes and elevated turbidity levels. Areas that would otherwise be undisturbed by the project

could become affected. Primary nursery areas and submerged aquatic vegetation (SAV) could be sensitive to reduced light penetration, increased siltation and changes in dissolved oxygen or nutrient levels. Repeated overflowing of scows in localized areas could generate cumulative impacts and alterations to the benthic environment.

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. 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 estimated 26 month project period would extend increased impacts from expanded dredging methods through two seasons of nesting, spawning and recruitment for all fish and wildlife resources in the project area. As a result, this lengthy time period could hinder the recovery of any affected flora and fauna in the second season by perpetuating the impacts through another biological cycle. The cumulative impacts of depressed biological productivity for two years are unknown but could be significant. Preventing disturbing activities during periods of high biological productivity would minimize this risk of significant cumulative impacts to fish and wildlife resources.

Elimination of Bubble Curtain

Underwater 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 a high pressure shock wave (usually expressed in pounds per square inch) for 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 l991).

Testing indicates that the highest mortality rates appear to occur within 140 feet of the blasts planned for this project (Appendix C). Delayed mortality of impacted fish that survive within this zone or present outside of the zone is not known. Cumulative impacts to fish exposed to several blasts (at varying distances) over the course of the project is also not known.

SECTION 11. COMPARISON OF IMPACTS

Current planning for the Wilmington Ship Channel involves two broad options. The Corps could retain the plans of the mid-1990s or adopt the design and construction changes which have been developed since the earlier project description. Environmental impacts would differ among these two options and this section considers those differences.

New Alignment for Ocean Entrance Channel

The construction of the entrance channel on a new alignment would impact previously undisturbed ocean bottoms. In general, the Service supports the use of previously disturbed areas rather than the use of new alignments. However, the environmental impacts associated with modifying the existing channel would be substantial if extensive blasting is required. Therefore, a comparison of impacts comes down to the dredging of the new alignment or the blasting required to enlarge the existing alignment.

Backfilling Abandoned Channel

The original plans would enlarge the existing alignment and the refilling of this channel would not be an issue. The key issue is that the undisturbed habitat (generally areas outside the ODMDS) along the new alignment would be replaced by the habitat that eventually occurs along the existing channel. If the existing channel is allowed to naturally fill with what is likely to be finer grained material than what occurs locally, the proposed change would produce an overall adverse impact of the marine benthic community. The abandoned channel would have significantly finer grained material than natural benthic bottoms and could be unsuitable habitat for some organisms. Also, the time to fill in the channel with naturally deposited sediment may take many years, postponing the return of the abandoned channel to more natural conditions. If the abandoned channel is artificially refilled with sediment matching the native grain sizes in adjacent areas, the physical characteristics of the abandoned channel are more likely to resemble current conditions in the undisturbed path of the proposed, new alignment.

Disposal on Beaches of Brunswick and New Hanover Counties

While beach disposal was under consideration during the mid-1990s, the present proposal includes specific plans to place large quantities of material on project area beaches. Earlier plans suggested that the most cost effective disposal option would be placement in the ODMDS. The use of the ODMDS would have impacted both benthic and pelagic organisms at and near the site, but this area was subject to periodic disposal activities from other projects. The proposed change would produce impacts similar to any beach nourishment project using offshore borrow areas. Such impacts include harm to beach invertebrates, nearshore fishes, organisms on area hardbottoms, shorebirds including the federally threatened piping plover, and sea turtle reproduction. These impacts could be even larger than other nourishment projects due to the realistic probability that the dredge spoil will contain significant portions of weathered limestone

gravel, mud and/or clay, all of which are not native to these beaches. The long-term impacts on beaches such as Bald Head Island could be significant with only a few years between disposals. Such short disposal intervals would leave little time for the recovery of beach invertebrates and may seriously diminish the value of this important sea turtle nesting area by continuous escarpment formation and persistent beach compaction.

The two options for beach disposal, whether it is limited to Bald Head Island and the east end of Oak Island or includes the west end of Oak Island and Holden Beach as well, have slightly different impacts. If all of the estimated 5.6 mcy of material is placed on Bald Head and the east end of Oak Island, the magnitude of the beach disposal will be greater. But placement of the material equally over all four placement reaches would extend the impacts of beach fill over a much larger spatial area; the magnitude of the fill would be reduced, though.

Disposal at ODMDS

There are relatively minor differences between the two alternatives in regard to this project feature. The original design called for the placement of most of the soft sediment from the seaward portion of the project in the ODMDS. The proposed changes would reduce the amount of material by disposing of beach quality sand on project area beaches.

Expansion of Dredging Methods

Proposed modifications to dredging methods include the elimination of areas where certain techniques are forbidden, the use of overflowing for hopper dredges and scows, and the expanded use of dredged material disposal sites. The Corps' proposals are generally accompanied by vague statements that the changes must be consistent with appropriate environmental protection measures. This may mean that the changes would adhere to the strict letter of environmental regulations, but extend beyond measures that previous agreements have indicated were beneficial for fish and wildlife resources. The driving force for the proposals appears to be efforts to reduce project costs.

The Service believes that dredging restrictions that the Corps seeks to eliminate for this project were developed on the basis of sound biology. The elimination of these restrictions would produce some increase in adverse environmental impacts. Such increases may be small. The use of overflow loading of dredges and scows is likely to increase turbidity and siltation. The use of all dredging techniques in areas that previously allowed only certain methods is likely to adverse impact sensitive natural areas, such as fisheries nursery areas. The areas subject to the adverse impacts of overflow loading would be enlarged. However, without comprehensive monitoring such impacts would not be determined.

Overall, the Corps indicates that these changes are being proposed in order to save money and not on the basis of any new biological data. While the environmental impacts of these changes could be relatively small, the magnitude of such impacts are likely to remain unknown. The

Service concludes that fish and wildlife resources would be better served by the retention of these dredging restrictions.

Elimination of Bubble Curtain

Based on data acquired by the Corps during test blasts with the bubble curtain, the elimination of the bubble curtain is not likely to produce any significant increase in mortality of aquatic organisms near the blast site. However, the failure of the curtain to reduce mortality does not negate the fact that some mortality will occur near the blast. The bubble curtain was proposed as a mitigation measure and it has now been shown to be ineffective. To some extent the elimination of this mitigation would be offset by a reduction in the number of total blasts and a decrease in the area requiring blasting. However, the Service believes that blasting will adversely affect aquatic organisms, especially fish, in the Cape Fear River, and that some form of compensatory mitigation should be provided.

SECTION 12. CONSERVATION MEASURES

Fish and wildlife conservation measures include: 1) mitigation; and 2) enhancement. Mitigation, as defined by the Council of Environmental Quality and adopted by the Service in its Mitigation Policy (Federal Register 46[15] 1656-1662, January 23, 1981) 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 project; and 5) compensating for the impact by replacing or providing substitute resources or environments. This five-action sequence should be viewed as the proper order for formulating mitigation measures.

An issue that is not limited to one of the listed six project modifications, but is relevant to the entire project, is the potential for adverse impacts from contaminants within the dredged sediments. All fish and wildlife resources would benefit by avoiding the introduction of toxic substances into the aquatic and upland habitats of the project area. Certain harmful substances may be contained in the bottom sediments along the new channel alignment and material in existing dredge spoil disposal sites. It is important that toxic substances in toxic amounts are not introduced into the beaches and nearshore ecosystems of the project area.

Wilmington Channel is a major point of entry along the East Coast of the U.S., and as such has seen a great deal of vessel traffic from all over the world. Ballast exchange by freighters that have traveled all over the world could introduce unknown biological and chemical contaminants to the Cape Fear River in the project area. Transfer of petrochemicals, tar, turpentine, and other industrial materials exposes the project area to potential contamination. Various industries along the banks of the Cape Fear River are known to use and discharge toxicants; the Cape Fear basin includes many known or suspected hazardous waste sites. Hog waste lagoon and municipal sewage spills in the Cape Fear watershed in recent years have largely unknown long-term contamination impacts downstream. The Service is concerned that the number and diversity of known point-source and non-point source pollution inputs to this system may result in contaminants-related issues with any dredge spoil in this project excavated from the Cape Fear River or disposal islands.

In 1998 the EPA and the Corps adopted a new Inland Testing Manual (ITM) as a guideline for contaminants testing and evaluation for dredging inland waters, including disposal on dredge spoil islands. The ITM provides a four-tier assessment process for contaminants testing, and the Tier One Assessment is basically a documentation procedure that searches known literature, studies and tests for the project area. Based upon the results of this review, new analysis of sediments may be conducted or determined unnecessary. Either way, the Tier One Assessment documents the decision-making process.

The Service recommends that the Corps conduct a Tier One Assessment for sediments in this project, particularly those in the spoil islands scheduled for pumpout. This conservation measure would minimize the risk of contamination to fish and wildlife resources in all disposal areas. All of the sediment data provided thus far for this project indicate a significant proportion of fine grain sizes that have a high probability for contaminant adhesion; organic material has also been found in many of the offshore samples adjacent to the new alignment. A Tier One Assessment, performed in accordance with ITM guidelines, should be included in the environmental documents for the project. That assessment should include documentation of the significance of contaminant-related risks, and it should identify the need for any additional assessment. Should any sediments contain toxicants that exceed reasonable screening values for contaminant effects (e.g., EPA Region 4 screening guidelines; NOAA and USGS-BRD derived screening guidelines), appropriate measures should be taken to manage the contaminants.

New Alignment for Ocean Entrance Channel

The annual work schedule for creating the new channel will have a profound effect on the environmental impacts of the project. This is due to the fact that a significant proportion of the material taken from the new channel would be carried directly to the beaches for disposal. The timing of beach disposal is critical to the severity of several environmental impacts. These impacts are: (1) mortality of beach invertebrates; (2) reduced sea turtle nesting success; (3) disturbance of shorebirds foraging and nesting; and, (4) disturbance of offshore marine mammals.

Overall biological activity for these resources is less during the colder months. From a strictly biological point of view, the least harmful period for beach disposal would be the four months from December through March. This period would avoid the time when sea turtle nests (both the nesting and incubation periods) may be on area beaches, May 1 to November 15. The months April and November include the period when beach invertebrates such as *Donax* spp., *Emerita* spp. and digger amphipods may be on the beaches in high numbers. Piping plovers may begin nesting activities in March and April. However, the Service believes that it is very important to avoid dredging and subsequent beach disposal when sea turtle nests may be on area beaches.

No studies concerning the effects of dredging sand for borrow material or channel creation off the North Carolina coast have been conducted. Therefore, impacts associated with offshore sand mining are unknown, and mitigation requirements are difficult to predict. Hurme and Pullen (1988) recommend pre-project, baseline surveys in all potential borrow sites. This requirement is also appropriate for the creation of a new channel. Offshore monitoring is needed in order to determine the effects channel creation has on marine communities in and adjacent to the new alignment. Special attention should be given to identifying hardbottoms and to monitoring the effects on hardbottom habitats which may be near proposed borrow areas. Stender et al. (1991) and Maier et al. (1991) used side scan sonar and underwater television cameras to identify live bottom sites near potential offshore sand borrow sites in South Carolina. The purpose of these

surveys would be to avoid important benthic resources such as Essential Fish Habitats, clam beds or active spawning areas.

Based on pre-project survey data, in-kind mitigation should be provided for the loss of benthic habitat along the new alignment. Such mitigation may be possible along the existing channel that would be abandoned if it is backfilled appropriately by the Corps. Natural processes would fill in much of the abandoned channel, but that process would take years and may never fully approximate the natural benthic environment. Backfilling by the Corps with fill sediment that matches native benthic substrate conditions would minimize recovery and recolonization periods of benthic flora and fauna. Sediment size, composition and organic content should be matched to maximize mitigation success.

Areas of the new alignment that pass through the ODMDS or offshore shoals may be subject to large movements of sediment that could increase shoaling along the new alignment. Fine grained material deposited in the ODMDS is more likely to be pushed by prevailing currents into the new alignment. An increase in shoaling would lead to increased maintenance dredging and create the turbidity and sedimentation associated with such dredging. Regular surveys of the buffer surrounding the new alignment through the ODMDS would detect bathymetric changes that contribute to shoaling in the new channel. The survey area should be extended to incorporate the entire new alignment seaward of station 50+00 where it passes through or closely to shoals. Such surveys would identify areas of shifting sediment and could suggest areas where future dumping should be avoided in order to minimize maintenance dredging of the new alignment.

Backfilling Abandoned Channel

Offshore shoals and underwater ridges are desirable habitats for many species of fish. Hurme and Pullen (1988) write that " . . . little is known about the potential effects of modifying the general offshore bathymetry on fisheries." Just as the physical characteristics of the material placed in the abandoned channel are important in reestablished natural habitat values, the contours of both the channel and surrounding areas will be important. The Corps should seek to recreate the natural bathymetric contours and geomorphology of undisturbed ocean bottoms.

Certain construction techniques can minimize long-term harm to offshore organisms. The ability of a benthic community to repopulate a borrow area is influenced by the similarity of sediment surrounding the area, the new sediment-water interface, and possible changes in water quality (Hurme and Pullen 1988). If the abandoned channel is refilled with only finer-grained material, the area will not replace existing benthic habitat lost by the construction of the new channel. In order to minimize the permanent loss of benthic habitat, the Corps should attempt to refill the abandoned channel with material of similar grain size, mineral composition, and organic content.

In order to fully assess the impacts to benthic habitat, the Corps should sponsor a long-term monitoring program to evaluate the recolonization of the abandoned channel. Such a program is

the only method for determining the actual development of benthic habitat as the channel refills with sediment. If benthic organisms fail to become established in the area, it may be necessary to develop new mitigation measures.

Disposal on Beaches of Brunswick and New Hanover Counties

The placement of sediment on area beaches should be done in a manner to match the shape and slope of the natural beach. Often beach nourishment results in a steep escarpment between the beach fill area and the natural offshore slope. Such a change in beach profile may cause access problems for nesting sea turtles or obstruct hatchling sea turtles on their way to the ocean. Shorebirds and macrofauna feeding in the swash zone would be impaired by scarps that form at the mean high water line. Human recreational use of the beach's intertidal zone may also be hampered.

Efforts should be made to ensure that the beach profile after nourishment is a natural, gently sloping beach rather than a layered beach with sharp escarpments. If the nourished beach profile develops high escarpments, they should be leveled to grade into the natural profile. Immediately after completion of sand bypassing on beaches and prior to the sea turtle nesting seasons, monitoring shall be conducted to determine if escarpments are present and escarpments shall be leveled as required to reduce the likelihood of impacting sea turtle nesting and hatching activities. Escarpments may be created during the nesting and incubation season that require the use of heavy equipment to grade. However, the use of bulldozers or other heavy equipment on the beach are harmful to existing nests. The use of heavy machinery can cause sand compaction on nourished beaches (Nelson et al. 1987, Nelson and Dickerson 1988a). Heavy equipment may crush nests over which it passes. Such heavy equipment should be kept off the beaches during the nesting and incubation season, May 1 through November 15.

Just as heavy equipment to level escarpments should not be used during the sea turtle nesting and incubation period, such equipment should not be used to move sediment placed on the beach during this period. Limiting the number of heavy vehicles on the beach, perhaps to one regular sized bulldozer, would minimize the potential for crushing invertebrate burrows and the spatial extent and degree of compaction of sediments. Dredge pipelines should not be stockpiled on the beach, either, as they impede human and wildlife utilization of the entire beach habitat.

Beach nourishment should not result in changes in sand density (compaction), beach shear resistance (hardness), beach moisture content, beach slope, sand color, sediment grain size, sand grain shape, and sand grain mineral content. These parameters should be similar to the original beach sand, and available data indicates that not all of the spoil material will meet these suitability comparisons. Any changes could result in adverse impacts on sea turtle nest site selection, digging behavior, clutch viability, and emergence by hatchlings (Nelson and Dickerson 1987, Nelson 1988). The beach invertebrate populations that live in burrows also would be impacted adversely by such changes.

Monitoring and sampling should be conducted daily of the dredge spoil material placed the day before on all project beaches for grain size distribution and total organic content (TOC) in order to ensure only beach suitable material is disposed of on the beaches. TOC levels should be measured for ambient conditions and comparison. Reports summarizing the sampling should be prepared and the Service should be notified immediately of the discharge of any dredge spoil that is not beach suitable (i.e., less than 90% sand size sediments) so that proper enforcement and restoration procedures may be implemented.

These impacts can be minimized by using sand similar to the native beach material and by tilling the beach after nourishment if the sand becomes compacted. The level of beach compaction can be assessed by measuring sand compaction using a cone penetrometer. Tilling of a nourished beach may reduce sand compaction to levels comparable to unnourished beaches. A pilot study by Nelson and Dickerson (1988b) showed that a tilled nourished beach will remain uncompacted for up to 1 year. Therefore, the Service advocates multi-year beach compaction monitoring and, if necessary, tilling to ensure that project impacts on sea turtles are minimized. Service policy calls for beaches to be tilled if compaction levels exceed 500 pounds per square inch (psi), and we recommend pulling a root rake with tines at least 42 inches long and less than 36 inches apart pulled through the sand of compacted beaches.

To provide the most suitable sediment for nesting sea turtles, the color of the nourished sediments must resemble the natural beach sand in the area. A change in sediment color on a beach could change the natural incubation temperatures of nests in an area, which, in turn, could alter natural sex ratios. Natural reworking of sediments and bleaching from exposure to the sun would help to lighten dark nourishment sediments; however, the timeframe for sediment mixing and bleaching to occur could be critical to a successful sea turtle nesting season. Bleaching would also be limited to surficial sediments exposed to sunlight.

Surveys have shown that extensive hardbottoms exist immediately offshore of project beaches, and turbidity caused by the dredging and spoil placement portions of this project may create significant adverse impacts to the fish and wildlife resources found on or near hardbottoms. Nearshore turbidity levels should be measured on a daily basis during beach disposal work, with direct sampling of both the nearshore turbidity plume and adjacent ambient waters. Turbidity levels should not exceed the state saltwater standard of 25 NTUs or naturally elevated ambient conditions. A weekly report should be submitted to the Service and other relevant government agencies of measured turbidity levels in order to provide data on the measured impacts of dredge spoil slurry dewatering and the winnowing of fine sediments from recent spoil placement.

Fish and wildlife resources will benefit from the longest interval possible between placements of sediment on beaches. If the project leads to increased erosion in the deposition areas, the interval between sediment placement will gradually decrease over time. Extended time periods allow beach invertebrates to recover and minimize the turbidity and siltation associated with the movement and disposal of sediment. Species which annually move offshore and then return to the beaches in the spring, e.g., mole crabs and coquina clams, are much more likely to recolonize

a nourished beach at the first recruitment period after sand placement. Hackney et al. (1996, p. 109) conclude that accomplishing renourishment before larval recruitment will ensure rapid recovery of these species. However, more sedentary species, such as digger amphipods of the genus *Haustorius*, have much slower rates of recolonization. In the North Carolina beach nourishment study of Reilly and Bellis (1978, p. 67), the authors concluded that the life history and behavior of *H. canadensis* did ". . . not favor its return to the nourished area quickly." The point of these concerns is that shorter intervals between new sediment placements may reach the point where a given species never returns to the placement area.

The ability for invertebrates to return to the sediment placement area is also influenced by the length of the project. Since surviving populations on the edges of the placement area may supply the colonists for the placement area and dispersal may be limited, the shorter the placement area, the greater the opportunity for adjacent populations to reach the entire length of new beach. In this regard, a series of small projects spaced over several years may be more beneficial to beach invertebrates than a single large project which covers many miles of beach. Such a procedure would allow beach invertebrates to colonize the impacted zone from nearby, unaffected beaches.

Several aspects of beach disposal can lead to greater erosion in the area. These aspects include an altered offshore and nearshore bathymetry that can produce increased wave energy striking the beach, altered wave patterns, and a steeper beach profile that also allowed greater wave energy to strike the beach. These factors, either together or especially in combination, can increase the removal of the new sediment. The Service's concern about increased sediment removal stems from the fact that such removal would decrease the time between sediment additions. More frequent sediment additions increase all the direct impacts of dredging and sediment placement.

Another reason for concerns about increased erosion rates is the shoreline development that is likely to follow early sediment placements. Early placements are likely to create an atmosphere of protection from coastal storms, and greater development of more expensive structures occurs over the years. If such development does occur and the erosion rate of the beaches increases, demands for more damaging shoreline protection measures, e.g, rock sea walls and groin fields such as the one on Bald Head Island, are likely.

Therefore, a major conservation measure would be a thorough assessment of the erosion rates on beaches that would receive sediment. This assessment would be essentially a measure of the longevity of the artificial beach and the program must be a long-term commitment. If the erosion rate increases, a condition that leads to a decrease in beach longevity, the Corps will need to consider a broader array of measures to protect loss of fish and wildlife habitat.

Artificial beaches may have both dramatic, short-term abnormalities as well as subtle and long-term changes that adversely affect fish and wildlife resources. In the former category, erosional "hot spots" and the formation of escarpments are detrimental to successful sea turtle nesting. Escarpments may form rapidly during storms. A project conservation measure would be a

monitoring program to detect the more apparent abnormalities of the artificial beaches. Such programs could also include measures of biological productivity along the beaches.

The project should provide procedures for detecting and removing escarpments along project area beaches. Immediately after completion of sand bypassing on beaches and prior to the sea turtle nesting seasons, monitoring should be conducted to determine if escarpments are present and escarpments should be leveled as required to reduce the likelihood of impacting sea turtle nesting and hatching activities. As noted, the use of heavy equipment on the nesting beaches during the nesting and incubation period may be counterproductive since nests could be harmed or destroyed. Therefore, the Service prefers that work to control escarpments be completed immediately prior to May 1, the start of the nesting season, and that only minor, non-mechanical work be conducted on the beaches during the actual nesting and incubation period. Some leveling and contouring is also appropriate at the time the beach is created.

Project plans should also include a monitoring program for the federally threatened seabeach amaranth plants and piping plover. Survey data would serve three functions. These functions are: (1) provide data to the Service for assessing the current status of the species and developing recovery procedures; (2) provide baseline population data for use in assessing species recovery in the project area after nourishment; and, (3) provide information to the Plant Conservation Program of the North Carolina Department of Agriculture which would assess the feasibility of relocating plants and the NCWRC in migratory usage of North Carolina's beaches by threatened birds.

Disposal at ODMDS

The proposed project modifications would result in less dumping at the ODMDS. Some material that would have been directed to this site would be placed on area beaches. Therefore, the Service has no specific conservation measures regarding this project modification.

Expansion of Dredging Methods

Conservation measures to benefit reproduction by colonial waterbirds are primarily related to avoiding disturbances of the birds during the sensitive breeding season. While sand removal from a nesting site is an extreme example, measures must also consider more subtle disturbances such as the noise, fumes, lights, and movements associated with dredging. The activities associated with dredging cause stress and excessive flight responses among breeding birds. Dredging activities near nest sites can ultimately cause the birds to abandon nests. Therefore, dredging activities and sand removal from breeding areas should not occur at or near nesting sites of colonial waterbirds during the breeding season of April 1 through October 31.

Impacts to sea turtles would be minimized by restricting the operation of hopper dredges during periods when sea turtles are most abundant in waters of the project area. As noted in this report, the highest concentration of sea turtles in the water of the project area occur during the warmer

months of April through September. This period is similar to the actual nesting period of sea turtles. Therefore, harm to both turtles in the water and on the beach would be minimized by restricting hopper dredging to the colder months of October through March.

Accurate data is needed to assess the impacts of hopper dredging on sea turtles. A significant conservation measure for these protected species would be trained observers on all hopper dredges to count the number of turtles killed during dredging. Data on dredging impacts to sea turtles would be useful in refining seasonal restrictions on dredging and in implementing equipment modifications to protect sea turtles.

The Service would like to support the conservation recommendations of the National Marine Fisheries Service concerning hopper dredging and beach nourishment activities in the southeastern United States (NMFS 1995). The following conservation measures and recommendations are especially relevant to this project:

1. "...precautions that reduce the likelihood of dredge collisions with endangered whales include: aerial surveys conducted in right whale critical habitat during the breeding season, the adoption by dredge operators of necessary precautions when whales are sighted, and reduction in dredge speed during evening hours or days of limited visibility when whales have been spotted within the previous 24 hours." (NMFS 1995, p. 17);

2. "NMFS, based on the recommendations of Griffen (1974), has recommended water column sediment load deposition rates of no more than 200 mg/cm^2/day, averaged over a seven day period to protect coral reefs and hard bottom communities, rather than use of only state standards." (NMFS 1995, p. 19);

3. "...the COE should reinitiate consultation for any project in which more than one turtle is taken in any day, or once five or more turtles are taken. The Southeast Region, NMFS, will cooperate with the COE in the review of such incidents to determine the need for developing further mitigation measures or to terminate the remaining activity." (NMFS 1995, p. 20);

4. "One hundred percent inflow screening is required, and 100 percent overflow screening is recommended when sea turtle observers are required on hopper dredges in areas and seasons in which sea turtles may be present... . If conditions disallow 100 percent inflow screening, inflow screening can be reduced but 100 percent overflow screening is required, and an explanation must be included in the preliminary dredging report..." (NMFS 1995, p. 21). 100% of the screened material must be observed by on-board observers (NMFS 1995, p. 23);

5. "The sea turtle deflecting draghead is required for all hopper dredging during the months that turtles may be present, unless a waiver is granted by the COE SAD in consultation with NMFS." (NMFS 1995, p. 21);

6. "Beach observers cannot be used in place of shipboard observers for hopper dredging of borrow areas unless the COE can demonstrate that the volume of sand deposited on beaches will not preclude observation and identification of turtles or turtle parts." (NMFS 1995, p. 22);

7. "To prevent the impingement of sea turtles within the water column, every effort should be made to keep the dredge pumps disengaged when the dragheads are not firmly on the bottom." (NMFS 1995, p. 22)

8. "An annual report (based on either calendar or fiscal year) must be submitted to NMFS summarizing hopper dredging projects, document sea turtle and sturgeon incidental takes, and whale sightings." (NMFS 1995, p. 22);

9. "NMFS requires monitoring by endangered species observers with at-sea large whale identification experience to conduct daytime observations for whales between December 1 and March 31, when humpback and right whales occur in the vicinity of channels and borrow areas, north of Cape Canaveral. ... During daylight hours, the dredge operator must take necessary precautions to avoid whales. During evening hours or when there is limited visibility due to fog or sea states of greater than Beaufort 3, the dredge must slow down to 5 knots or less when transiting between areas if whales have been spotted within 15 nm of the vessel's path within the previous 24 hours." (NMFS 1995, p. 22);

10. "North of the St. Johns River, in Florida, endangered species observers on hopper dredges within nearshore and riverine areas must also monitor for shortnose sturgeon impingements." (NMFS 1995, p. 22); and,

11. 100% observer monitoring by endangered species observers with at-sea sea turtle identification experience is required to conduct daytime observations for sea turtles between April 1 and November 30 (NMFS 1995, p. 23).

Elimination of Bubble Curtain

The Service provided conservation measures related to blasting in the Cape Fear River in the FWCA Report for the original project (USFWS 1996a). Those measures were based on the planned use of the bubble curtain to mitigate the underwater shock waves from each explosion. The elimination of the protective curtain requires a reconsideration of conservation measures for blasting.

First, the annual timing of blasting is an important conservation measure. 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.

The Service believes that blasting during August and September could harm and/or kill manatees and sea turtles. 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.

Some fish are likely to be killed by blasts within the Cape Fear River. The blast-induced fish mortality should be treated as a fish kill with known cause; dead and dying fish should be collected, counted, measured (length) and identified to species so that appropriate mitigation and restoration can be calculated. Small fish that may be quickly ingested by predators should have their size and numbers estimated. The exact extent of fish mortality may never be known fully, but the lack of hard data should not eliminate the need to compensate for these losses in some manner.

The Corps should provide contractual opportunities to local universities to conduct aquatic resource surveys before, during and after the project construction period in order to document and gather important data on valuable fish and wildlife resources such as the shortnose sturgeon and impacts to their populations and distributions. This data should be made available to the Service, NMFS and all interested parties in order to better define dredging windows, types of dredges allowed, and impacts of dredging on aquatic resources.

Dams along the Cape Fear River are a significant impediment to certain fish reaching historical spawning areas. Reproduction would be enhanced if areas upstream from these dams were accessible to the fish. In the Cape Fear River 99 miles of mainstem and a very large mileage of tributary streams (likely over 1,500 miles) exist between Lock and Dam 2 and Buck Horn Dam (next dam upstream). The Service would like to work with the Corps to provide some form of structural fish passage at Lock and Dams 1, 2 and 3 additional to the fish locking that is currently being accomplished, such as passage options discussed on the April 27, 2000, field site visit to Lock and Dam 1 during the Wilmington Fish Passage Workshop of April 25-27, 2000. To mitigate for fish losses due to blasting the Service proposes the Corps either provide structural fish passage for anadromous fish, including sturgeon, at Lock and Dams 1, 2 and 3 in addition to the fish locking sequence that is currently employed and fund a graduate student (Master of Science) to examine the effectiveness of the structures, or remove those structures. Existing structures and operations do not pass sturgeon and could be improved for other species. The Coastal Program of the Service will work with the Corps to provide technical assistance.

SECTION 13. RECOMMENDATIONS

In accordance with the FWCA, the Service offers the recommendations in this section in order to avoid, minimize, and mitigate adverse impacts on fish and wildlife resources. These brief recommendations are the culmination of all the information presented and analyzed in the preceding sections of this report. These recommendations should not be considered without a thorough understanding of the entire report, specifically the conservation measures presented in Section 12.

All of the previous conservation measures and recommendations made by the Service relating to project features that have remained unchanged, such as those related to saltwater intrusion, post-blasting monitoring for killed and injured organisms, and potential increased erosion of riparian shorelines from increased ship wakes, are still valid and should be supplemented by the following recommendations on these project modifications.

1) A Tier One Assessment according to the Inland Testing Manual (ITM) adopted by the Corps and the EPA in 1998 be conducted on all sediments in the project, and such documentation be included in the environmental documents. Sediments to be assessed include those from any disposal islands proposed for pumpout for either beach or offshore disposal. Should any sediments contain contaminants or toxins that exceed EPA standards, appropriate measures should be taken to manage the contaminants.

New Alignment for Ocean Entrance Channel

2) The Corps should address the issue of existing and proposed Essential Fish Habitats (EFH) in the new channel alignment and immediate surrounding areas. If any existing or proposed EFH are located in the new alignment construction area or offshore disposal areas, the Corps should coordinate with the NMFS to take the appropriate conservation measures.

3) Loss of benthic habitat with the creation of a new channel should be mitigated in-kind with backfilling the abandoned channel with identical or very similar substrate grain size, composition and geomorphology as adjacent benthic substrates.

4) The 2500' designated buffer surrounding the channel where it passes through the existing ODMDS should be regularly surveyed for bathymetric changes in order to monitor increased shoaling rates of the channel, which would lead to increased maintenance needs. Additional surveys should be conducted along a similar 2500' corridor for the entire new channel alignment, seaward of station 50+00, in order to monitor for shoaling from other adjacent sediment bodies. Multi-beam or the Corps SHOALS surveys would yield more accurate bathymetry data than a few scattered soundings and increase spatial resolution and coverage.

Backfilling Abandoned Channel

5) Sediments used to backfill the abandoned navigational channel should match the native grain size, mineral composition and organic content in order to better mimic the native habitat.

6) Backfilling of the abandoned channel should approximate the natural bathymetric contours and geomorphology of the surrounding areas. Deviation from the natural conditions could prevent or delay re-colonization of the newly filled area by benthic organisms.

7) The backfilled channel should be monitored regularly with both bathymetric surveys (preferably multi-beam or SHOALS) and benthic organism surveys to establish recolonization rates and success or failure. Bathymetric surveys would generate data on changes to the former channel due to altered current or wave patterns, which could suspend portions of the fill and remove it from the channel. Any measured impacts over the life of the project should be mitigated through coordination with the Service, NMFS and other relevant agencies.

Disposal on Beaches of Brunswick and New Hanover Counties

8) No disposal of dredge materials should take place on beaches or the littoral zone during the sea turtle nesting and incubation season of May 1 to November 15, which roughly coincides with shorebird nesting and beach invertebrate spawning and recruitment seasons.

9) Fill placement should not create a pronounced hill or mound of sand that could create an obstacle or scarp to wildlife and human resources utilizing the beach.

10) Heavy equipment used to manipulate fill sediments placed on the beach should be kept to a minimum, perhaps only one regular size bulldozer on any given beach at any given time. Night work should use the minimum amount of light necessary (which may require shielding) or low pressure sodium lighting during project construction. Extensive lengths of pipeline should not be stored on or run along the beach, but placed behind the primary dune or dune scarp with perpendicular sections crossing to the beach as close to the immediate disposal area as possible. Heavy equipment (e.g., contractor sheds, trucks, bulldozers, extra pipeline, surveying equipment) should not be stored on the beach at night during the sea turtle nesting and hatching season.

11) Sediments disposed on the beaches or adjacent littoral zones should be *at least* 90% sand, match native grain size ranges and mineral composition, contain as little organic matter as possible and be free of contaminants exceeding safe levels. Monitoring and sampling should be conducted daily of the dredge spoil material placed the day before on all project beaches for grain size distribution and total organic content (TOC) in order to ensure only beach suitable material is disposed of on the beaches. TOC levels should be measured for each mile of beach within two months prior to dredge spoil disposal for comparison purposes. Reports summarizing the sampling should be provided to the Service on a weekly basis throughout the beach disposal

period, and the Service shall be notified within 48 hours of the discharge of any dredge spoil that is not beach suitable (i.e., less than 90% sand size sediments).

12) Beach fill should be monitored for compaction, escarpment formation, and subaerial and subaqueous profiles on a regular basis (perhaps quarterly and after every storm) in order to determine the longevity of the material's placement. Immediately after completion of sand disposal on beaches and prior to sea turtle nesting seasons, monitoring shall be conducted to determine if escarpments are present and escarpments shall be leveled as required to reduce the likelihood of impacting sea turtle nesting and hatching activities.

13) Nearshore turbidity levels should be measured with a Turbidimeter on a daily basis during beach disposal work, with direct sampling of both the nearshore turbidity plume and adjacent ambient waters within 250 feet of the discharge pipe. Turbidity levels should not exceed the state saltwater standard of 25 NTUs or naturally elevated ambient conditions. A weekly report should be submitted to the Service and other relevant government agencies of measured turbidity levels, and a review should be conducted at 3 months on sampling protocols.

14) If the Corps chooses to proceed with beach disposal during the summer months, the next NEPA document should outline in detail how the proposed delineation of reaches of beach with less than ideal sea turtle habitat will occur, what data will be incorporated into such delineations, and the order of spoil disposals in such reaches. Prior to the actual time of disposal, Corps staff should meet with relevant Service and NCWRC staff on-site with relevant maps to review those reaches where impacts to nesting sea turtles may be minimized so that high density nesting reaches are avoided during the nesting season. Data from the 2000 nesting season, with new locational data from Global Positioning System (GPS) coordinates, should be incorporated into any delineations as it will further aid demarcation of areas where adverse impacts of summer disposal may be minimized.

15) Beaches scheduled to receive maintenance materials (i.e., Bald Head Island and Caswell Beach) should be monitored long-term for increased erosion rates, decreased biological productivity and cumulative impacts to fish and wildlife resources, especially Federally-listed species such as sea turtles, piping plovers, and seabeach amaranth. Monitoring plans should be developed in coordination with the Service, NMFS and North Carolina Wildlife Resources Commission (NCWRC). Any measured impacts over the lifespan of the project and its maintenance should be mitigated through coordination with the Service, NMFS and other relevant agencies.

Expansion of Dredging Methods

16) Hopper dredges should not be used during the summer sea turtle nesting season or spring and fall migration periods when species numbers in inland waters are high.

17) Observers should be present on all hopper dredges to monitor for incidental takes of sea turtles year-round. All takes should be documented and reported to the Service and NMFS, and appropriate conservation measures coordinated in the event of excess takes.

18) Dredging activities should not occur adjacent to disposal islands during the colonial waterbird nesting season of April 1 to October 31 in order to minimize disturbance to such nests. Activities should be minimized from disturbing colonial waterbirds with potential noise, lights and fumes at all times of the year. Potential screening/blocking or other appropriate conservation measures should be coordinated with the North Carolina Colonial Waterbird Management Committee and other relevant agencies.

19) Spoil islands should not be pumped out or re-filled during the colonial waterbird nesting season to minimize disturbances to nesting habitat and existing nests. Surveys for nesting activities of least terns and other birds should be conducted to prevent such disturbances.

20) All dredging activities should comply with existing agreements with the National Marine Fisheries Service and the U.S. Fish and Wildlife Service as to timing and types of allowable dredges. The 1995 Biological Opinion and Incidental Take Statement issued by NMFS to the Corps (and any updates) should be fully complied with in particular.

Elimination of Bubble Curtain

21) The Service recommends mitigation for the loss of fish (including sturgeon) associated with the blasting of rock during the project. The Service proposes the Corps either provide structural fish passage at Lock and Dams 1, 2 and 3 in addition to the fish locking sequence that is currently employed for anadromous fish and fund a graduate student (Master of Science) to examine the effectiveness of the structures, or remove these structures. The blast-induced fish mortality should be treated as a fish kill with known cause; dead and dying fish should be collected, counted, measured (length) and identified to species so that appropriate mitigation and restoration can be calculated. Small fish that may be quickly ingested by predators should have their size and numbers estimated.

22) All blasting should avoid times of spawning or known important juvenile stages of fish in the project area.

23) The Corps should provide contractual opportunities to local universities to conduct aquatic resource surveys before, during and after the project construction period in order to document and gather important data on valuable fish and wildlife resources such as the shortnose sturgeon and impacts to their populations and distributions. This data should be made available to the Service, NMFS and all interested parties.

SECTION 14. SUMMARY AND POSITION OF SERVICE

The Wilmington Harbor, North Carolina, 96 Act Project Modifications 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 modifications 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 the 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 elimination of the bubble curtain in the proposed modifications fails to meet the Service's concerns regarding containing blast impacts. Mitigation for the loss of fish and other aquatic resources should be provided. The Service recommends improved fish passage at Lock and Dams 1, 2 and 3, or the removal of these structures. Our Coastal Program is willing to coordinate such mitigation activities. Monitoring of the effectiveness of this mitigation could be provided through funding of a Master's student at a local university.

The Service is more concerned about the long-term, secondary impacts of the proposed project modifications. This report has detailed concerns about potential indirect impacts from each of the six modifications. The Service realizes that these impacts may be difficult to predict with a high degree of accuracy. However, the Service is concerned that several of the Corps' efforts to evaluate these impacts have not been completed. There are currently only minimal or no evaluations of the potential impacts to the longshore transport system that influences area beaches, turbidity and siltation effects on nearshore hardbottoms or estuarine nursery areas, contaminants contained within the dredged sediments, suitability of the dredge spoil material for beach disposal, cumulative impacts to beach invertebrate populations, and alterations to local water circulation and wave patterns resulting from the new channel alignment, backfilling of the old channel, and filling the existing ODMDS to full capacity. 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 proposed expansion of dredging methods generates a set of direct and indirect impacts that would adversely affect fish and wildlife resources throughout the project area. Increased turbidity and siltation with overflowing scows could smother important estuarine benthic habitat and nursery areas, suffocate fish and alter the nutrient and oxygen levels of local waters. The year-round use of dredges, some of which have been documented to take Federally-listed species such as sea turtles, would breach previously arranged agreements the Corps has with resource agencies. The Service cannot support the expansion of dredging methods proposed in this set of project modifications.

The Service believes that some of the proposed project modifications offer opportunities for the enhancement of fish and wildlife resources within the project area. Such measures include: (1) the use of 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 sediment which is free of contaminants, of the appropriate grain size, and properly placed in the littoral zone near the mouth of the Cape Fear River to support area beaches; and (3) the use of sediment which is contaminant-free and properly placed to fill the abandoned navigational channel to restore a more natural benthic habitat. 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 modifications are compatible with the long-term viability of marine, estuarine, and freshwater ecosystems in the project area and the many fish and wildlife resources which they support.

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APPENDICES