DRAFT

INTEGRATED
FEASIBILITY REPORT
AND
ENVIRONMENTAL IMPACT STATEMENT

COASTAL STORM DAMAGE REDUCTION

SURF CITY AND NORTH TOPSAIL BEACH

NORTH CAROLINA

AUGUST 2009

US Army Corps of Engineers

Wilmington District

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EXECUTIVE SUMMARY, AUGUST 2009

The purpose of this study is to evaluate coastal storm damage reduction for the Towns of Surf City and North Topsail Beach, NC and develop the most suitable plan of damage reduction for the present and future conditions for a 50-year period of analysis. Topsail Island is on the southeastern North Carolina coast. From south to north the three towns on the island are Topsail Beach, Surf City and North Topsail Beach. The primary study area for this report includes the towns of Surf City and North Topsail Beach and associated nearby borrow sites. This report was authorized by two Transportation and Infrastructure Committee resolutions dated February 16, 2000 and April 11, 2000. A General Reevaluation Report has been completed for the Town of Topsail Beach under a separate authority.

The study team integrated representatives of Federal, State, and local governments, in the effort to identify cost-effective and environmentally- and technically-sound alternatives to reduce damages within the two towns, and to the adjacent shoreline. The process fully integrated the Corps' "Twelve Actions for Change", in all aspects of the study process. The study effort identified a "National Economic Development" (NED) plan, which would maximize net benefits to the nation through reduction of future storm damages. The tentatively recommended plan of action is construction of the NED Plan.

This study discloses that the most practicable plan of damage reduction for the primary study area is a berm and dune project extending along approximately 10 miles of the oceanfront. The southern limit of the project is the boundary between Topsail Beach and Surf City. The northern limit is within North Topsail Beach at the southern edge of the Coastal Barrier Resources System (Topsail Unit, L06).

The principal project purpose is the reduction of damages associated with coastal storm events and beach erosion. In addition, the project will enhance the beach strand available for recreation use and provide habitat for a variety of plants and animals.

The tentatively selected National Economic Development Plan (NED) consists of a sand dune constructed to an elevation of 15 feet above the National Geodetic Vertical Datum (NGVD), fronted by a 50-foot wide beach berm constructed to an elevation of 7 feet above NGVD. The berm and dune project extends along a reach of 52,150 feet. This plan is identified among the other alternatives as "Plan 1550". No Locally Preferred Plan was suggested. The NED Plan is the tentatively recommended plan of improvement. The project plan is shown schematically in Figure i. Details of geographic scope, project features, and source borrow area, are summarized in Table i. At the project ends the cross sections will begin transitions to terminate gradually according to conditions existing at construction.

Figure i. Surf City and North Topsail Beach, Plan view

Table i. Plan Quantities

Dune, topwidth,	25 feet
Dune, elevation, NGVD	15 feet
Dune, landward slope	5H:1V
Dune, seaward slope	10H:1V
Berm, width	50 feet
Berm, elevation, NGVD	7 feet
Berm, seaward slope	15H:1V
Dune and berm fill, length	52,150 feet
North transition section, length (if required)	Variable
South transition section, length (if required)	Variable
Total Length	52,150 feet
Volume, initial, borrow CY	11,500,000
Volume, renourishment, average, borrow, CY	1,639,000
Renourishment interval	4 years
Borrow source	Off shore

The tentatively recommended plan was evaluated using a discount rate of 4.625% at October 2008 price levels. First costs of the project are currently estimated at $118,000,000. Renourishment costs at 4 year intervals are estimated at $17,600,000. Expected annual costs are estimated at $10,900,000. With expected annual benefits estimated at $40,000,000 of which $16,900,000 are coastal storm damage reduction benefits, $20,000,000 are recreation benefits and $3,100,000 are benefits during construction. The project benefit-cost ratio is 3.7 to 1. The baseline cost estimate for construction in FY2015 is $126,000,000. Details of first costs, annual costs, annual and net benefits, and benefit-cost ratios are made at October 2008 levels are shown in Table ii.

Table ii. Economic Analysis, in thousands. October 2008 levels, 4.625% interest rate

Item	Amount
Total First Cost	$118,415,000
Interest During Construction	$10,318,000
Total Investment Cost	$128,733,000
Renourishment, first event	$10,120,000
Renourishment, events 2 to 12, every 4 years	$17,557,000
Present Value, TIC & Renourishments.	$200,984,000
Annual Costs	
Interest and Amortization	$10,378,000
Monitoring	$508,000
OMRR&R	$52,000
Total	$10,938,000
Average Annual Benefits	
CSDR Benefits (incl. $1,398,000 BDC)	$18,293,000
Net Benefits (CSDR only)	$7,355,000
BCR (CSDR only)	1.7 to 1
Recreation Benefits (incl. $1,664,000 BDC)	$21,664,000
Total Benefits (all)	$39,957,000
Net Benefits (all)	$29,019,000
BCR (all)	3.7 to 1

Based on the recommendation of use of public funds for the reduction of damages along this shoreline, the Sponsors will provide public access and parking in accordance with Corps of Engineers guidelines, at intervals of no more than a half mile, throughout Surf City and the reach of North Topsail Beach benefitted by the cost-shared project.

The tentatively identified National Economic Development Plan (NED) of improvement is considered to be environmentally acceptable. However, piping plover were documented to feed along the primary study area. This species is most common as a winter resident of the State and frequently uses the surf zone. The project may affect piping plover foraging distribution on the beach since beach food resources may be affected by beachfill operations. The green sea turtle, loggerhead sea turtle, Kemp's ridley sea turtle, and leatherback sea turtle are known to nest in North Carolina and could nest in the project area. For this reason, they could be affected by initial project construction and periodic nourishment. These sea turtles occur in offshore waters and may also be affected by hopper dredges. Initial construction and periodic nourishment activities will be timed, to the extent practicable, to avoid the sea turtle nesting season and avoid hopper dredging during months when water temperatures are warm and turtles may be present. The project combined Feasibility Report and Environmental Impact

Statement will include a biological assessment of project impacts as Appendix I. The U.S. Fish and Wildlife Service and the National Marine Fisheries Service will review this biological assessment pursuant to Section 7 of the Endangered Species Act of 1973. The requirements of Section 404(r) of Public Law 92-500, as amended, have been met. The Town of North Topsail Beach is developing a non-Federal coastal storm damage reduction project for the parts of town that lie within the Coastal Barrier Resources System (Topsail Unit, L06). There is no conflict between the Federal and non-Federal project, either on the shoreline or in the borrow areas. In the event that the non-Federal project is not in place when the Federal project begins, then the northern 2,000 feet of the dune and berm will be replaced with a transition section.

Agency Technical Review (ATR) was conducted in accordance with the Corps' "Peer Review of Decision Documents" process, has been reviewed by Corps staff outside the originating office, conducted by a regional and national team of experts in the field, and coordinated by the National Planning Center of Expertise in Coastal Storm Damage Reduction, North Atlantic Division, U.S. Army Corps of Engineers. Comments and responses will accompany the report to the Assistant Secretary of the Army for Civil Works (ASA(CW)) and the Office of Management and Budget (OMB). Documentation of ATR certification will accompany the final report.

An Independent External Peer Review (IEPR) will be conducted following with the ATR. The IEPR will be conducted by a non-USACE national team of experts in the field, and coordinated by the National Planning Center of Expertise in Coastal Storm Damage Reduction, North Atlantic Division, U.S. Army Corps of Engineers. Comments and responses will accompany the report to the Assistant Secretary of the Army for Civil Works (ASA(CW)) and the Office of Management and Budget (OMB). Documentation of IEPR certification will accompany the final report.

In analyzing potential measures, the study team considered, in all cases where technically sound and environmentally feasible, both structural and non-structural measures. Non-structural measures, such as removal and relocation, were found to be of greater cost than benefits, and therefore, were not recommended for the purposes of storm damage reduction. However, the recommendations of the study team that accompany all structural recommendations for dune and berm construction is that of continued and vigilant attention to the need for pro-active hurricane and coastal storm threat education, coastal storm and hurricane warning and evacuation planning procedures, floodplain management, and other non-structural activities directed at both damage reduction and preservation of life and safety, and are thus, provided as recommended actions, although many do not fall within current Corps implementation authorities.

The analyses and design of the recommendations contained in this report comply with the National Environmental Policy Act (NEPA). A separate Environmental Impact Statement (EIS) will not be provided, as the draft document is a fully-integrated report that complies with both NEPA requirements and the Corps (and Federal) water resources planning process and its requirements. The report complies with all applicable environmental statutes.

The draft report fully discusses areas of risk, uncertainty, and consequences, where that information is appropriate, and describes them with sufficient detail that decisions can be made with knowledge of the degree of reliability of the estimated benefits and costs and of the effectiveness of alternative plans. All recommendations made in the report are capable of being adaptively managed, should that capability be needed, as renourishment may be needed more often or less often, depending on the occurrence of large storms and accompanying erosion.

It should be noted that the Administration's position on funding support for coastal storm damage reduction projects is as follows: "The Office of Management and Budget advises that while the Water Resources Development Act of 1999 (WRDA 99) changed the cost-sharing formula for the long-term sand renourishment component of certain future shore protection projects, these changes did not go far enough considering the long-term cost of most of these projects. Further, because WRDA 99 delayed the effect of the change in cost sharing for up to a decade or more, it did not address current constraints on Federal spending. The Administration intends to work with Congress to address these problems. However, until these issues are satisfactorily resolved, the Administration will not support authorization of new shore protection projects that involve significant long-term Federal investments beyond the initial construction of these projects, and will give new shore protection projects that are already authorized low priority for funding." As stated above, the Administration has expressed concern about significant long-term Federal investments associated with coastal storm damage reduction projects. Clearly, substantial long-term Federal investments would be required to implement the current project proposal. The Administration's projections of future inflation are 1.8% percent annually. Based on these data, the total inflation adjusted (fully funded) project costs are estimated to be $552,000,000 over the 50-year period of Federal participation for the tentatively recommended plan of improvement. The Federal share of the fully funded project costs is currently estimated at $293,000,000. The non-Federal share of the fully funded costs is currently estimated at $259,000,000. Given the Administration's declared budgetary concerns, potential long-term costs associated with the proposed project may be vital to decision making. As previously indicated, the total project benefit-cost ratio is 3.7, which means that for every dollar spent for the project there are 3 dollars and 70 cents realized in National Economic Development (NED) benefits from the project.

Recommendations

Hurricane Risk Education

Numerous people die each year as a result of hurricanes, primarily due to the failure to evacuate to an area of safety. Any loss of life is tragic, and any number of those deaths may have been prevented. Even one death prevented is sufficient reason to improve our methods of educating the public on hurricane and storm threats, and to ensure that all is done to warn all those residents or visitors to the coastline of North Carolina as to the dual hazards of wind and surge/waves. It is particularly vital to inform the public as to the potential for hurricane occurrence, particularly within the dangerous hurricane season, so they pay continued attention to media reports on weather. Education needs to include articulation of effects related to the potential magnitude of the threat, the urgency to heed potential calls to evacuate, and providing the means by which to make wise choices on evacuation methods and route (see recommendations given below under "Hurricane Evacuation Planning"). The following are suggested guidelines for implementation by State and local government, in the interests of good education on hurricane storm threats:

- Provide good science and information to the residents and visitors to coastal North Carolina, so they can understand the nature of the threat, and its possibility of happening at any time within the hurricane season. This information should be provided in both written form, and as an initial "page" on televisions provided in visitor's housing, and also in a variety of venues, including:
    - Posting and televised education in supermarkets, libraries, and public buildings;
    - Teacher-provided, posted and televised education in schools and at public meetings and gatherings, at intervals not to exceed 1 year;
    - Publically-posted and visitor-housing-posted information on evacuation routes, and procedures, on publicly-accessible websites, updated regularly (minimum 1 yr.).

There is nothing humanly possible to maintain the lives and safety of coastal North Carolina residents and visitors, if they do not have sufficient warning, and if they then do not use that knowledge to evacuate in a timely manner.

Education of hurricane risks is an on-going effort of multiple agencies and educational institutions, and not a funded program under existing Corps authorities. Updating of websites containing evacuation routes and procedures should be done under existing programs implemented by the state and local governments.

Hurricane and Storm Warning

Residents and visitors to the coast of North Carolina need to recognize that they live in, or visit, a high-hazard area. Although certain times of the year pose less risk than others, each year's hurricane season provides a strong possibility of hurricane impact somewhere along the coast of North Carolina. All residents and visitors need to be made aware of

the current hurricane threat, but first meteorological conditions must be evaluated, and any threat must be assessed and characterized by experts with the National Oceanic and Atmospheric Administration's National Weather Service, and that interpretation passed to national and local media for dissemination. Continued support of NOAA's program, and the following supportive activities is critical to an adequate warning process:

- On-going efforts to upgrade the existing system of NOAA buoys, transmission capabilities, and advanced warning measures that provide data on the location and nature of weather conditions.
- Efforts directed at the interpretation of that data and its dissemination to the media and public, through the National Weather Service.
- Public appreciation for the need to be aware at all times of, and the need to listen to weather reports and advice given on various media. Television weather reports, radio, and the internet all provide excellent up-to-date information on weather conditions, and the development of threatening situations. Simply living in or visiting the barrier islands of North Carolina should be sufficient to create a consistent and on-going process of being exceptionally aware of the weather, and its potential consequences.
- The vital importance of heeding the advice of experts. One should know what needs to be done in the event of an approaching storm. Family members should conduct evacuation drills, keep needed phone numbers and travel supplies on hand, and be prepared to leave on short notice. One should be aware of evacuation routes, keeping a full tank of gas during the hurricane season, and having a plan for where one should go, how to maintain contact with other family members, and where one will re-locate temporarily, particularly if this turns out to be longer than expected.

Hurricane Evacuation Planning Upgrading

The critical need for adequate evacuation planning was borne out by Hurricanes Bertha, Fran, and Floyd, of the late 1990s, and brought even more to the forefront by the monumental impacts of Hurricane Katrina in 2005. An evacuation plan is an essential component of a comprehensive plan for ensuring the safety of residents of, and visitors, to the coast of North Carolina. The preservation of life is the single most important goal and objective of the recommendations. Joint Federal Emergency Management Agency (FEMA)/ NOAA/Corps/State of North Carolina studies of evacuation routes and populations along the coastline has provided a tremendous amount of value to-date in aiding local government, individual and family readiness, in the face of approaching events. Support for this program is a critical element of the recommendations for the Towns of Surf City and North Topsail Beach, in support of its residents and visitors. The following are important recommendations in support of efforts to support Hurricane Evacuation Planning:

- There is still much that can be done to update this on-going effort, and to provide new, and more widely-disseminated data and tools for evacuation planning by the State and the Towns of Surf City and North Topsail Beach, and also for use by individuals and families in their preparation for an impending event.

- Evacuation route signage is an important part of a successful evacuation campaign. Maintenance of hurricane evacuation route signage is viewed as a vital link in ensuring the safety of residents and visitors alike.
- The provision of additional signage illustrating surge height achieved during past events would be an added and continual link to on-going education efforts. This could take the form of signs placed in locations in which there is significant traffic, such as major thoroughfares, where pedestrians walk, and particularly in those highest hazard zones based on elevation/depth data.

Evacuation Planning is an on-going effort of multiple agencies, including the Corps of Engineers, but its implementation is not a funded program under existing Corps authorities. Updating of websites containing evacuation routes and procedures should be periodically updated under existing programs implemented by the State of North Carolina.

Floodplain Management

Management of the floodplain is a non-Federal responsibility, yet is considered a key component of all plans for coastal storm damage reduction. The Towns of Surf City and North Topsail Beach participate in the National Flood Insurance Program, which requires the Towns to engage in active and responsible floodplain management. Within the Towns of Surf City, property owners have 2,148 flood insurance policies comprised of nearly $480 million insurance in force. North Topsail Beach property owners possess 1,384 flood insurance policies providing approximately $240 million insurance in force. Since so much of the Towns of Surf City and North Topsail Beach are within a recognized floodplain, the Towns continue to engage in activities that reduce threats to existing and potential future development, including structure setbacks, building code and construction monitoring, and flood zone management. The Towns are encouraged to continue to update building codes, and encourage strong pursuit of activities such as first-floor elevation and building code upgrading, in the effort to reduce the potential for future structural and content damage.

Building Codes

The Towns of Surf City and North Topsail Beach have adopted the International Building Code (IBC) to guide the design and construction of residential and commercial structures in the study area. In order to assure that the latest design and construction techniques are being used that apply to hurricane-resistant construction, all future construction is encouraged to follow the latest version of the IBC (2007) and ensure enforcement of the codes through diligent building permit processing and on-site inspections of construction. Annual training classes on the use and enforcement of the new IBC should be encouraged. In addition, the Towns of Surf City and North Topsail Beach should consider adopting the document "FEMA 550 Guidelines for Elevating Residential Structures on the Gulf Coast" as a part of their updated building codes for construction, due to the possibility of surge inundation associated with hurricane events.

Long-term Critical Infrastructure and Services Upgrading

The upgrading of critical infrastructure and services, such as Fire and Police services, is considered a vital recommendation in the reduction of threats to lives and property. The need to bring these services up to immediate restoration in the wake of a hurricane is of vital importance to the community. The methodical upgrading of the Towns' Fire and Police services facilities as past of their Capital Improvement Programs will provide long-term savings in capital outlay, and potentially save lives and residential and commercial property damage. This program may be instituted under a modified Capital Improvement Program, where structures reaching the end of their economic life are successively replaced by upgraded structures, locating vital communications and power supplies above the elevation of a Maximum Probable Surge event, and capable of surviving the ravages of wind and/or surge, as funds become available.

Upgrading or replacement of services is primarily a local charge, implemented through Capital Improvement Plans, with funding from a variety of Federal, State, and local resources, and will take many years to accomplish, due to the varying age and condition of each facility.

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DRAFT
FEASIBILITY REPORT
AND ENVIRONMENTAL IMPACT STATEMENT

COASTAL STORM DAMAGE REDUCTION

SURF CITY AND NORTH TOPSAIL BEACH

NORTH CAROLINA

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1. STUDY OVERVIEW

This General Reevaluation Report presents the results of studies to reexamine the feasibility of Federal coastal storm damage risk reduction for the Towns of Surf City and North Topsail Beach, which are located on Topsail Island. The third of three towns on the island, Topsail Beach, comprises the southern 5 miles of the island. Topsail Island lies in Pender and Onslow Counties, North Carolina as indicated in Figure 1.1, Location and Vicinity Map. The Towns of Surf City and North Topsail Beach are the project sponsors. The study has evaluated alternative plans for protecting the commercial and residential structures and infrastructure of Surf City and North Topsail Beach. The study has resulted in a recommendation to construct a berm and dune project with continuing renourishment. The scale and costs of the project have been optimized to produce the maximum net economic benefits, or National Economic Development (NED) Plan, as directed by Federal planning guidelines.

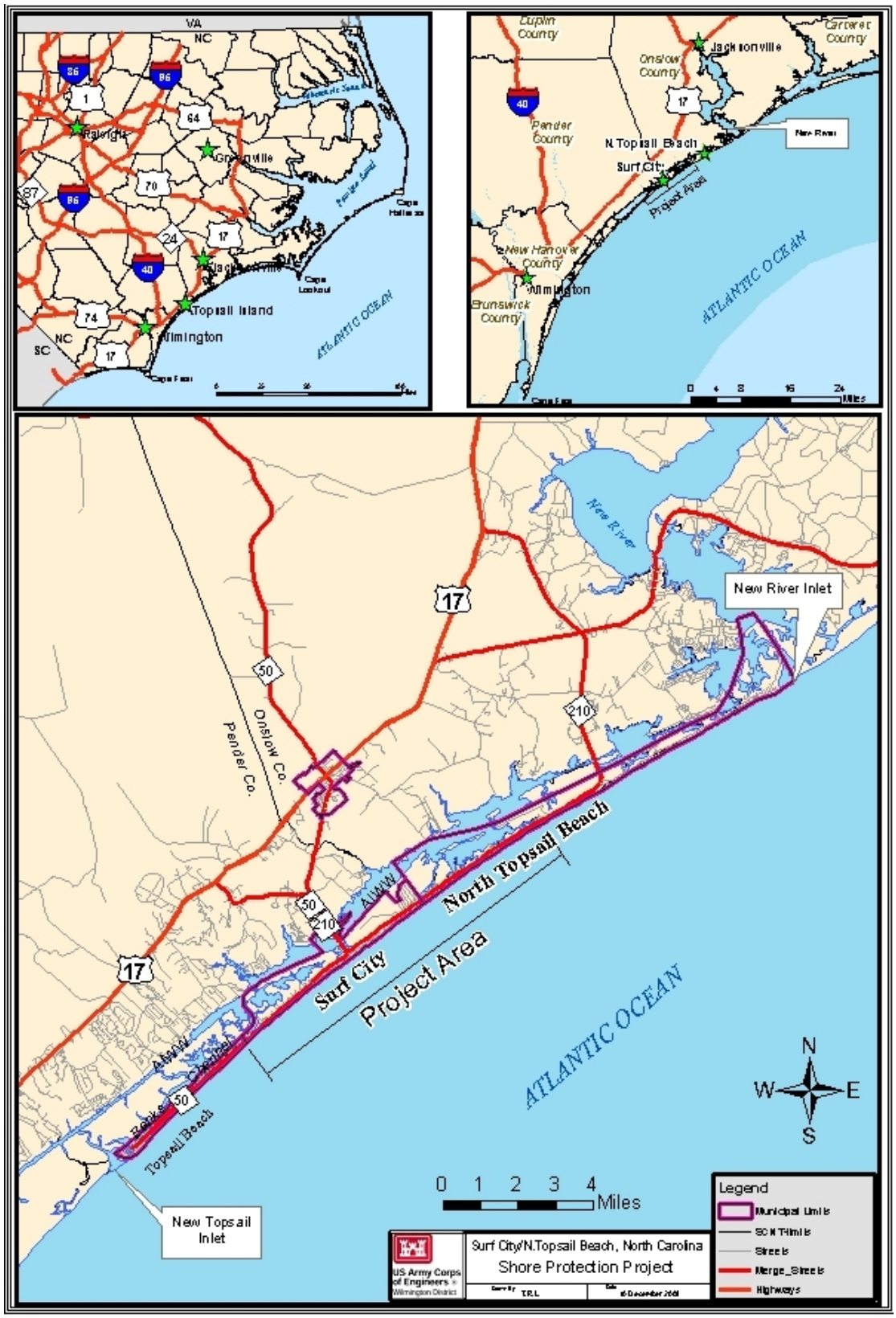

Figure 1.1 Location and Vicinity Map. Left inset, NC coast. Right inset, region.

1.01 Study Authority

There were 4 congressional resolutions leading up to initiation of this project. The most applicable text is underlined.

- Resolution adopted 24 June 1970 by the United States Senate

  Resolved by the Committee on Public Works of the United States Senate, that the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act, approved June 13, 1902, be, and is hereby, requested to review the reports of the Chief of Engineers on the Inland Waterway from Beaufort to Jacksonville, N.C., and New River to Jacksonville, published as House Document Numbered 421, Eightieth Congress, on Bogue Inlet to Moore Inlet, North Carolina, published as House Document Numbered 480, Eightyninth Congress, and other pertinent reports with a view to determining whether any modification of the existing project is advisable at the present time, particularly for the stabilization and deepening of New River Inlet.

- Resolution adopted 2 December 1970 by the United States House of Representatives

  Resolved by the Committee on Public Works of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors is hereby requested to review the reports of the Chief of Engineers on the Intracoastal waterway from Beaufort, North Carolina, to the Cape Fear River, published as House Document Numbered 450, 69th Congress, on the Inland Waterway from Beaufort to Jacksonville, North Carolina, and New River to Jacksonville, published as House Document Numbered 421, 80th Congress, on Bogue Inlet to Moore Inlet, North Carolina, published as House Document 480, 89th Congress, and other pertinent reports with a view to determining whether any modification of the existing project is advisable at the present time, particularly for the stabilization and deepening of New River Inlet and Bogue Inlet.

- Resolution adopted 23 June 1971 by the United States House of Representatives

  Resolved by the Committee on Public Works of the House of Representatives, United States, that, in accordance with Section 110 of the River and Harbor Act of 1962, the Secretary of the Army is hereby requested to direct the Chief of Engineers to make a survey of the shores of West Onslow Beach, Onslow County, North Carolina, and such adjacent shores as may be necessary in the interest of beach erosion control, hurricane protection, and related purposes.

- Resolution adopted 14 November 1979 by the United States House of Representatives

  Resolved by the Committee on Public Works and Transportation of the House of Representatives, United States, that, in accordance with Section 110 of the River and Harbor Act of 1962, the Secretary of the Army is hereby requested to direct

the Chief of Engineers to make a survey of Topsail Beach and Surf City, North Carolina, and adjacent beaches and inlets, in the interest of beach erosion control, hurricane protection, and related purposes.

The 4 study resolutions between 1970 and 1979 were combined and used to initiate studies separated by function and location. Studies for navigation improvement at Bogue Inlet were combined with other congressional authorities related to Bogue Banks. Navigation needs at New River Inlet were later investigated under the Chief of Engineers Section 107 Continuing Authority program. The remaining study resolutions, pertaining to West Onslow Beach (North Topsail Beach), New River Inlet, Topsail Beach, and Surf City, were combined in 1980 at the direction of the Chief of Engineers, and designated the "West Onslow Beach and New River Inlet, North Carolina" general investigation study. This study was therefore a coastal storm damage reduction study and did not include navigation.

The study area originally included all of Topsail Island, including the towns of Topsail Beach and Surf City, the community of West Onslow Beach, the community of New Topsail Shores, and New River Inlet. In 1990 West Onslow Beach and New Topsail Shores were incorporated as the town of North Topsail Beach. The recommended plan, authorized in 1992, consisted of a beachfill for the southern portion of Topsail Beach. Storm damage reduction was not found economically feasible for the rest of the island at that time.

Following a series of hurricanes that damaged Topsail Island between 1996 and 1999 interest in a coastal storm damage reduction project was renewed. The current feasibility study is in response to the 2 following resolutions adopted February 16, 2000, and April 11, 2000 respectively:

- Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That the Secretary of the Army is requested to review the report of the Chief of Engineers on West Onslow Beach and New River Inlet, North Carolina, published as House Document 393, 102nd Congress, 2nd Session, dated September 23, 1992, and other pertinent reports, to determine whether any modifications of the recommendations contained therein are advisable at the present time in the interest of shore protection and related purposes for Surf City, North Carolina.

- Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That the Secretary of the Army is requested to review the report of the Chief of Engineers on West Onslow Beach and New River Inlet, North Carolina, published as House Document 393, 102nd Congress, 2nd Session, dated September 23, 1992, and other pertinent reports, to determine whether any modifications of the recommendations contained therein are advisable at the present time in the interest of shore protection and related purposes for North Topsail Beach, North Carolina.

1.02 Study Area

Topsail Island is a 22-mile long and 0.5-mile wide barrier island located approximately 40 miles northeast of Wilmington, North Carolina. Due to the northeast-southwest orientation of the coastline, the island faces the Atlantic Ocean on the southeast. Other waterbodies in the vicinity include New River Inlet immediately to the northeast, Banks Channel and the Atlantic Intracoastal Waterway (AIWW) to the northwest, and New Topsail Inlet at the far southwestern end of the island.

The study area is uniformly developed with few undeveloped lots and a wide range of structures consisting mostly of single-family dwellings, some multi-unit apartment and condominium buildings, about 30 various commercial buildings, and a few hotels. Most of the developable land in the study area is already occupied with structures. Roadway access to the mainland is provided via N.C. Highway 50 to Surf City and then by bridges on N.C. Highway 50/210 at Surf City and N.C. Highway 210 at North Topsail Beach. Public access to the beach is provided by numerous parking areas and dune walkovers.

Over the past 35 years the study area has developed rapidly as a family ocean resort community for outdoor recreation. On summer weekends the population can be in the tens of thousands. In the off-season the population drops to about 2,200 residents. During the summer months a large portion of the homes within the study area are available as summer rentals to vacationers primarily from inland North Carolina and other locations around the Eastern United States. There are 2 fishing piers in the study area.

The sponsors' interest is in developing a plan of protection against storm damages for 17 miles of shoreline extending from the Topsail Beach/Surf City town limits to the northern end of Topsail Island. From the shoreline the study area extends landward approximately 500 feet. Seaward the study area extends from the shoreline approximately 1 mile. The study area also includes offshore borrow areas lying 1 to 6 miles from the shoreline and borrow areas in New River Inlet. For purpose of incremental analysis the shoreline has been divided into study reaches approximately 1,000 feet in length. The study area, including town limits, bodies of water, Coastal Barriers Resources Act (CBRA) zone, and reaches, is shown in Figure 1.1, Location and Vicinity Map.

1.03 Purpose and Need for Action

The purpose and need for coastal storm damage risk reduction is to reduce both storm damages and beach erosion along the ocean shoreline of the study area. There is a wide variety of possible measures that would reduce the impacts of erosion, flooding and waves on commercial and residential structures and infrastructure of the island. Some of these measures would provide incidental environmental and recreational benefits.

1.04 Scope of Study

This study consists of the analysis of measures and plans and to select the plan with the highest net benefits, or determine that no plan of improvement is justified under current planning criteria and policies.

1.05 Study Process

The US Army Corps of Engineers (USACE) studies for water and related land resources follow detailed guidance provided in the Planning Guidance Notebook (Engineer Regulation 1105-2-100). This guidance is based upon the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies that were developed pursuant to Section 103 of the Water Resources Planning Act (P.L. 89-80) and Executive Order 11747, which were approved by the U.S. Water Resources Council in 1982 and by the President in 1983. A defined six-step process is used to identify and respond to problems and opportunities associated with the Federal objective and specific State and local concerns. The process involves an orderly and systematic approach to making evaluations and decisions at each step so that the public and the decision makers can be informed of basic assumptions made, the data and information analyzed, risk and uncertainty, the reasons and rationales used, and the significant implications of each alternative plan. The process concludes with the selection of a recommended plan. Specific aspects of this process are described in more detail in other sections of this document.

1.06 National Objective

The Federal objective of water and related land resources project planning is to contribute to national economic development in a manner consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. If the projected benefits of coastal storm damage reduction measures exceed their estimated costs and are judged environmentally acceptable, their construction as a Federal project would contribute to this objective and be in the Federal interest.

1.07 Prior Studies and Reports

The USACE has conducted a number of prior studies regarding the Topsail Island area and has prepared a number of related engineering, planning, and environmental reports. These studies have addressed coastal storm damage reduction as well as navigation needs. Reports particularly pertinent to the present study are briefly described below. Other reports related to the study area are cited in the Section 15, References.

Coastal Storm Damage Reduction

- House Document No. 480, 89th Congress, "Topsail Beach and Surf City, North Carolina." This report, approved by Congress in 1966, presents the results of an investigation of Topsail Island conducted during the period 1963 – 1965 as part of a comprehensive study of shore protection needs for the segment of the North Carolina coast extending between Bogue and Moore Inlets. With approval of this report, Congress authorized coastal storm damage reduction projects for the towns of Topsail Beach and Surf City. Improvements along the northernmost 11.7 miles of Topsail Island, referred to as West Onslow Beach, were determined to be economically infeasible. The improvements authorized by this report were not constructed, and the project was deauthorized August 5, 1977. The reason for this deauthorization was that there was no apparent non-Federal interest in the project following authorization.

- House Document No. 393, 102nd Congress, 2nd Session, "West Onslow Beach and New River Inlet, North Carolina." This report (HD 393/102/2) was conducted pursuant to four congressional resolutions adopted between 1970 and 1979. The resolutions addressed beaches, channels and inlets in the greater vicinity of Topsail Island. Studies for navigation purpose were conducted separately. The recommendation of the Final Feasibility Report and Environmental Impact Statement on Hurricane Protection and Beach Erosion Control was a dune and berm system at Topsail Beach as described below in Section 1.09, Authorized Project.

Navigation

- House Document No. 450, 69th Congress, "Inland Waterway, Beaufort – Cape Fear River." This house document, approved by Congress in 1927, authorized construction of the AIWW from Beaufort to the Cape Fear River, with dimensions of 12 feet deep by 90 feet wide.

- House Document No. 421, 80th Congress, "Inland Waterway from Beaufort to Jacksonville, NC and New River to Jacksonville." This house document, approved by Congress in 1948, authorized construction of a 12-foot deep by 90-foot wide channel in New River. However, the project was deferred for restudy and has not been constructed. The natural river channel is considered adequate for existing river traffic and no improvements are being considered.

- House Document No. 691, 75th Congress, "Channel to New River Inlet." This house document, approved by Congress June 20, 1938, authorized construction of a 6-foot deep by 90-foot wide channel from the AIWW through New River Inlet to the Atlantic Ocean.

- "Detailed Project Report on Improvement of Navigation, New Topsail Inlet and Connecting Channels." This July 1965 report, approved by the Chief of Engineers April 7, 1966, authorized construction of a channel 8 feet deep by 150 feet wide through New Topsail Inlet. A connecting channel through Banks Channel to the Atlantic Intracoastal Waterway was also authorized under Continuing Authorities Program, Section 107 of the River and Harbor Act of July 14, 1960.

- "Detailed Project Report on Improvement of Navigation, New River Inlet, December 1987." This report by the Wilmington District addresses that portion of the study authority concerning navigation at New River Inlet. The report recommends deepening of the authorized navigation channel from 6 to 8 feet and widening from 90 to 150 feet.

1.08 Existing Federal Projects

The nearest Federal coastal storm damage reduction project is at Wrightsville Beach, which is 16 miles to the southwest and beyond this study area. There is authorization for a Federal coastal storm damage reduction project at the south half of the Town of Topsail Beach. The sponsor did not execute the Project Cooperation Agreement, and no project was built. A General Reevaluation Report for Topsail Beach is in progress.

A number of Federal navigation projects are located in this study area. They are listed and briefly described below.

- **Atlantic Intracoastal Waterway (AIWW)** - The AIWW provides an important inland navigation route from Norfolk, Virginia to the St. Johns River, Florida. The 308-mile-long North Carolina portion is the state's only north-south commercial navigation thoroughfare. The authorized project includes a navigation channel with a depth of 12 feet and widths varying from 90 feet in land cuts to 300 feet in open waters; side channels and basins at a number of locations; and five highway bridges. The Beaufort to Cape Fear River Section was authorized by House Document No. 450, 69th Congress, "Inland Waterway, Beaufort – Cape Fear River." The main channel of the AIWW in North Carolina was completed in 1940, and it has since been maintained by dredging to remove shoals that develop periodically. Some of the dredged material removed during maintenance activities is beach quality sand. This material is placed directly on nearby ocean beaches, when practicable; otherwise, it is stockpiled in confined disposal areas near the shoreline of the AIWW. This sand can serve as a viable

source of beach fill where it exists in sufficiently large volumes and in proximity to beaches.

- **New Topsail Inlet and Connecting Channels** – Channel 8 feet deep and 150 feet wide through New Topsail Inlet, with connecting channels 7 feet deep and 80 feet wide to the AIWW. The connecting channels are through Old Topsail Creek (1.42 miles) and Banks Channel (6.27 miles), both between the AIWW and New Topsail Inlet.

- **New River Inlet** – Channel 6 feet deep and 90 feet wide through New River Inlet to the AIWW, a length of 2.3 miles. The channel continues another 18.8 miles from the AIWW to highway US 17 at Jacksonville, NC, but has not been maintained.

2. AFFECTED ENVIRONMENT

The project is located in Pender and Onslow Counties in the towns of Surf City and North Topsail Beach, NC. Topsail Island is a 22-mile long barrier island on North Carolina's south-central coast consisting of three communities, from south to north; Topsail Beach, Surf City, and North Topsail Beach. Significant Resources found within the vicinity of the project area, in both the marine and terrestrial environment, are described below. Physical resources, socioeconomic resources, recreation and aesthetic resources, cultural resources, Section 122, P.L. 91-611 Resources, and water quality conditions are also discussed in this section. Vertical datum for this report is NGVD29.

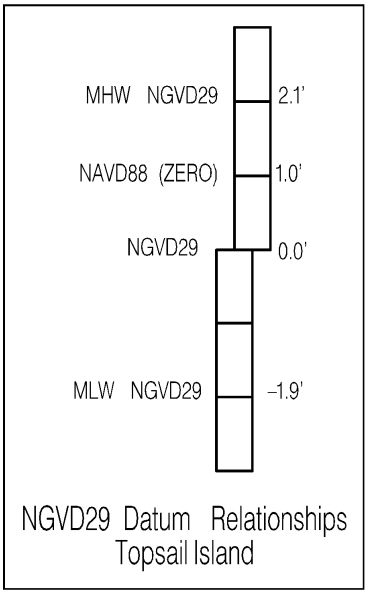

Figure 1.2, Datum Relationships

2.01 Marine Environment

Marine waters in the vicinity of the beach nourishment area and offshore borrow sites provide habitat for a variety of ocean fish and are important commercial and recreational fishing grounds (Appendix A, Figure A-1). Kingfish, spot, bluefish, weakfish, spotted sea trout, flounder, red drum, king mackerel, and Spanish mackerel are actively fished from boats, the beach, and local piers. According to the North Carolina Division of Marine Fisheries (NCDMF) commercial and recreational harvest statistics, these species compose approximately 18 and 37 percent, respectively, of the total pounds of fish landed in North Carolina in 2007 (http://www.ncfisheries.net/statistics/index.html). The surf zone typically exhibits a high diversity of fish fauna. Based on data collected from surf zone seine sampling along the South Atlantic Bight, 130 species of fishes are known from the surf zone between North Carolina and southern Georgia of which 47 species have been recorded from North Carolina beaches. The major recruitment period for juvenile fishes to surf zone nurseries is late spring through early summer. These waters also accumulate juvenile, ocean spawning, and estuarine dependent fish and invertebrates in the late winter and early spring prior to their transport through New Topsail and New River Inlets (Hackney *et al*., 1996).

The intertidal zone within the proposed beach nourishment area serves as habitat for invertebrates including mole crabs, coquina clams, amphipods, isopods, and polychaetes, which are adapted to the high energy, sandy beach environment. These species are not commercially important; however, they provide an important food source for surf-feeding fish and shore birds. Offshore bottoms also provide habitat for benthic-oriented organisms. Special concerns are hardbottom areas, which generally support a diversity of soft corals, anemones and sponges and provide habitat for reef fish such as black seabass,

red porgy, and groupers. Hardbottoms are also attractive to pelagic species such as king mackerel, amberjack, and cobia.

2.01.1 Wetlands and Flood Plains

Coastal wetlands of the project vicinity include tidal salt marshes, which occur along the shorelines and island fringes along the backside of Topsail Island (Appendix A, Figure A-2). Intertidal wetlands of the area are very important ecologically due to their high primary productivity, their role as nursery areas for larvae and juveniles of many marine species, and their refuge/forage value to wildlife. In addition, they provide esthetically valuable natural areas. Many types of wetland communities are present in the project area including; smooth cordgrass marsh, needlerush marsh, saltmeadows, and high marsh. All are important primary producers of organic matter and, therefore, serve as part of the base of the aquatic food chain. Smooth cordgrass (*Spartina alterniflora*) marshes occur within the intertidal zone along the sounds and tidal creeks, and provide valuable nursery habitat for many commercially valuable species of marine and estuarine organisms. The frequent removal of organic material and the daily tidal sedimentation processes make salt marsh communities very productive (Schafale and Weakley, 1990). Needlerush marsh is dominated by black needlerush (*Juncus romerianus)* and occurs in areas that are irregularly flooded. Saltmeadows are essentially pure stands of salt meadow cordgrass (*Spartina patens*), which can occur between 3.5-5.0 feet above mean sea level. Salt grass (*Distichlis spicata*), sea lavender (*Limonium carolinianum*), glasswort (*Salicornia* Spp.), and sea ox-eye (*Borrichia frutescens*) are also prominent plants in this community. High marsh is a transitional community between high ground areas and wetlands and, depending on location and frequency of flooding, may have characteristics of either. It is important in stabilizing the shifting sands of the barrier island. Given time and protection, it will eventually become vegetated with dominant shrub species such as marsh elder (*Iva frutescens*), wax myrtle (*Myrica cerifera*), and yaupon (*Ilex vomitoria*) (Wilson, 1981).

The State of North Carolina defines Primary Nursery Areas (PNA) as tidal saltwaters, which provide essential habitat for the early development of commercially important fish and shellfish (Appendix A, Figure A-3). It is in these estuarine areas that many fish species undergo initial post-larval development. Primary Nursery Areas are designated by the North Carolina Marine Fisheries Commission and currently total 80,144 acres statewide. With the exception of navigation channels, these include most estuarine waters of the project vicinity, including those bounded by New River (north), New Topsail Inlet (south), AIWW (west), and the landward side of Topsail Island. Protection of juvenile fish is provided in these areas through prohibition of many commercial fishing activities, including the use of trawls, seines, dredges, or any mechanical methods of harvesting clams or oysters (http://www.ncfisheries.net/rules.htm; 15 NC Administrative Code 3B .1405).

2.01.2 Inlet, Flats, and Sounds

New Topsail Inlet separates Topsail Beach to the northeast from Lea Island to the southwest and serves as the major ocean outlet for the waters of the Atlantic Intracoastal Waterway through Howard's Creek, Topsail Creek, and Banks Channel. The mean minimum inlet width for the past 60 years has been 480 meters (1,575 ft.) and over the past decade, the average rate of migration has been southwest 30 meters (98 ft.) per year. New River Inlet separates North Topsail Beach to the southwest from military-controlled Onslow Beach to the northeast and serves as an ocean outlet for New River. In recent history, the width of New River inlet has varied considerably and has been influenced by dredging activities. Since the initiation of maintenance dredging activities in 1963, inlet migration rates have altered and the average inlet width has been 225 meters. Currently, North Topsail Beach is experiencing oceanfront erosion trends related the changing shape of the ebb-tidal delta, which in turn is primarily governed by the ebb-channel orientation (Cleary and Marden, 1999). Ebb channel orientation and subsequent inlet migration response at New Topsail inlet and New River inlets has a dramatic impact on the accretion and erosion patterns currently experienced at Topsail Beach and North Topsail Beach respectively. As New Topsail inlet migrates southwest towards Lea Island, the southern spit of Topsail Beach continues to accrete; whereas, North Topsail Beach continues to erode under the current ebb-channel alignment of New River inlet. Portions of the sound located around New Topsail Inlet and mouth of New River inlet may contain large intertidal shoals and mud flats, which are very important to migrating and wintering waterbirds, including the Piping Plover; however, the quantity and quality of this habitat is dependent on the inlet dynamics and subsequent shape of the ebb tidal delta and ebb-channel orientation at any point in time. Both inlets are a critical migratory pathway for many organisms entering and exiting the sounds and river, including larval fishes and crustaceans (Section 2.01.5), and anadromous and catadromous fishes.

An estuary is a partly enclosed body of water where freshwater from rivers mixes with saltwater from the sea. North Carolina has the largest estuarine system of any state on the Atlantic Coast with estuarine-dependent species comprising ninety percent of commercial landings and sixty percent of recreational landings (by weight) (Street *et al*. 2004). The large estuarine system within the vicinity of Surf City and North Topsail Beach, including the sounds (i.e. Topsail and Stump Sounds) and bays (i.e. Chadwick and Alligator Bays), are separated from the ocean by Topsail Island. Many variables influence the character of the estuary including wind direction and force, inlet flows, river discharge, etc. Salinity near New Topsail and New River inlets varies depending on tides and freshwater discharge and could range between 10 and 32 parts per thousand (Hettler and Barker, 1993). Tides near these inlets normally follow those of the sea; however, there are times when the combined forces of freshwater discharge and wind overwhelm incoming tides and force water out of the inlet throughout the tidal cycle. Below the surface of the estuarine environment around the inlets is a mosaic of shifting sand habitats. Small areas of SAV habitat have been observed in the past few years by biologists from the North Carolina Division of Marine Fisheries Topsail Sound (NCDENR, 2005). The Carolina diamondback terrapin is a state listed species of concern for Pender County, North Carolina and may be found on the soundside of

Topsail Island in brackish water areas and feeds mostly feed on clams, shrimp, crabs, snails, and small fish. They have been known to eat some vegetation but they are primarily carnivores (http://www.chelonia.org/).

2.01.3 Nearshore Ocean

Sand excavation and material disposal for beach and berm construction will occur in the nearshore ocean in an area described by Day *et al.* (1971) as the "turbulent zone". The turbulent zone includes ocean waters from below low tide to a depth of about 60 feet NGVD (National Geodetic Vertical Datum). Identified sediment borrow areas proposed for project construction and periodic nourishment are located approximately 1 to 6 miles offshore between –35 foot to -50 foot Mean Lower Low Water (MLLW) (Appendix A, Figure A-6). Those borrow sites located beyond 3 nautical miles offshore are subject to federal mining requirements imposed by the Minerals Management Service (MMS). Beach nourishment will introduce fill into nearshore waters with a depth of closure of -23 feet NGVD. Benthic organisms, phytoplankton, and seaweeds are the major primary producers in this community with species of *Ulva* (sea lettuce), *Fucus*, and *Cladocera* (water fleas) being fairly common where suitable habitat occurs. Many species of fish-eating birds are typically found in this area including gulls, terns, cormorants, loons, and grebes (Section 2.02.3). Marine mammals and sea turtles also are frequently seen in this area (See Appendix I). Fishes and benthic resources of this area are discussed in Sections 2.01.7 and 2.01.9 respectively.

2.01.4 Surf Zone Fishes

The surf zone along the area beaches provides important fishery habitat of which some species are dependent. Surf zone fisheries are typically diverse, and 47 species have been identified from North Carolina; however, the actual species richness of fishes using the North Carolina surf area for at least part of their life history is much higher (Ross, 1996; Ross and Lancaster, 1996). According to Ross (1996), the most common species in the South Atlantic Bight surf zone are Atlantic menhaden (*Brevoortia tyrannus*), striped anchovy (*Anchoa hepsetus*), bay anchovy (*Anchoa mitchilli*), rough silverside (*Membras martinica*), Atlantic silverside (*Menidia menidia*), Florida pompano (*Trachinotus carolinus*), spot (*Leiostomus xanthurus*), Gulf kingfish (*Menticirrhus littoralis*), and striped mullet (*Mugil cephalus*). Two species in particular, the Florida pompano and gulf kingfish (*Menticirrhus littoralis*) seem to use the surf zone exclusively as a juvenile nursery area and are rarely found elsewhere. The major recruitment time for juvenile fishes to surf zone nurseries is late spring through early summer (Hackney *et al*., 1996). Recent studies by Ross and Lancaster (1996) indicate that the Florida pompano and gulf kingfish may have high site fidelity to small areas of the beach and extended residence time in the surf zone suggesting its function as a nursery area. Major surf zone species consume a variety of benthic and planktonic invertebrates, with most of the prey coming from the water column. The dominant benthic prey are coquina clams; however, this is not the dominant food item throughout the South Atlantic Bight. Furthermore, many surf zone fishes exhibit prey switching in relation to prey availability, which could mitigate impacts from beach nourishment (Ross, 1996).

2.01.5 Larval Fishes

New Topsail and New River Inlets are important passageways for the larvae of many species of commercially or ecologically important fish. Spawning grounds for many marine fishes are believed to occur on the continental shelf with immigration to estuaries during the juvenile stage. The shelter provided by the marsh and creek systems within the sound serves as nursery habitat where young fish undergo rapid growth before returning to the offshore environment.

Transport from offshore shelves to estuarine nursery habitats occurs in three stages: offshore spawning grounds to nearshore, nearshore to the locality of an inlet or estuary mouth, and from the mouth into the estuary (Boehlert and Mundy, 1988). Hettler *et al*. (1997) documented, through analysis of larvae otoliths, that a large number of young Atlantic menhaden (*B. tyrannus*) larvae averaging 55 days post hatch arrived in mid-March on the date of maximum observed daily concentration (160 larvae per 100 m^3 (3,531 ft^3). For all species recorded in this study, abundance varied as much as an order of magnitude from night to night. The methods these larvae use to traverse large distances over the open ocean and find inlets are uncertain. Various studies have hypothesized such mechanisms as passive wind and depth-varying current dispersal and active horizontal swimming transport. However, little is known regarding larval distribution in the nearshore area.

Little research has been conducted within the New Topsail and New River Inlet systems regarding larval species composition and abundance. However, the Beaufort Inlet system located about 40 miles north/northeast of New River Inlet has been extensively studied and significant amounts of data have been collected regarding larval transport of commercially and ecologically important fish. Considering the close proximity of these inlet systems it can be expected that species composition would be similar (Larry Settle, pers. comm.; Thomas Lankford, pers. comm.). During the winters of 1992-1993 and 1993-1994, Hettler and Hare (1998) conducted an experiment at Beaufort Inlet, North Carolina in order to further understand the estuarine ingress of offshore spawning species. A complex lateral structure in estuarine circulation, independent of the inlet opening size, was found in regards to larval concentration with significant interactions among inlet side, distance offshore, and date of ichthyoplankton tows. Length of species caught varied by cruise, inlet side, and distance offshore. The differences in larval concentration offshore and inshore and the species differences in length suggest species-specific rates controlling the net number of larvae entering the nearshore from offshore, the net number of larvae entering the inlet mouth from nearshore, and the larval mortality in the nearshore zone. Results from this study suggest two bottlenecks for offshore-spawning fishes with estuarine juveniles: the transport of larvae into the nearshore zone and the transport of larvae into the estuary from the nearshore zone (Hettler and Hare, 1998).

Egg and larval transport from offshore spawning grounds to the inshore environment of Beaufort Inlet was studied by Hettler and Hare (1998) in seven estuarine dependent

species, including Atlantic menhaden (*Brevoortia tyrannus*), spot (*Leiostomus xanthurus*), Atlantic croaker (*Micropogonias undulatus*), pinfish (*Lagodon rhomboides*), summer flounder (*Paralichthys dentatus*), southern flounder (*P. lethostigma*) and Gulf flounder *(P. albigutta*). Research conducted by the National Marine Fisheries Service (NMFS) Beaufort Laboratory through June 2002 collected a total of 120 species of larval fish fauna off the Beaufort Inlet and adjacent waters. According to Hettler and Hare (1998), average weekly concentration (number per 100 m^3 (3,531 ft^3) for all of the above estuarine dependent species, with the exception of Gulf flounder, was calculated during the October 1994 to April 1995 immigration season. Concentrations were 22.9, 4.8, 25.7, 12.4, 0.3, and 0.8 larvae/100m^3 (3,531 ft^3) respectively (Hettler, 1998). According to the spring tide flow calculated by Jarret (1976) and the calculated daily larval concentration within the water column, approximately 32.5, 6.8, 36.5, 17.6, 0.43, and 1.1 million larvae pass through the inlet during a single spring tide for each respective species. Concentrations for all species combined (Appendix Q) entering the inlet during a single tidal prism range from 0.5 to 5 larvae/m^3. Therefore, daily calculated larval concentration at Beaufort Inlet for all species within the tidal prism ranges between 66 to 710 million (Larry Settle, Pers. Comm.).

2.01.6 Anadromous Fishes

A number of anadromous fish species occur in ocean waters along the North Carolina coast (within ~3 miles) and migrate into rivers and their tributaries to spawn in freshwater. These include the striped bass (*Morone saxatilis*), Atlantic sturgeon (*Acipenser oxyrhynchus*) and shortnosed sturgeon (*Acipenser brevirostrum*), as well as several members of the herring family (Clupeidae) such as the American shad *(Alosa sapidissima*), hickory shad (*Alosa mediocris*), alewife (*Alosa pseudoharengus*), and blueback herring (*Alosa aestivalis*). Historically, most accessible coastal streams in North Carolina were utilized by these species, and highest use occurred from mid-winter to mid-spring during the spawning runs. Sampling in the New River in 1974 and 1975 by the NC Division of Marine Fisheries (NCDMF) identified the presence of blueback herring, alewife, American shad, and Atlantic sturgeon, although egg-netting results indicated very poor spawning success for all anadromous species. This 1975 study concluded that anadromous fish stocks in New River were very low and that, as a result, there was little or no utilization of the fishery (Sholar, 1975) and no recent anadromous fish studies have been completed in New River since then (F. Rhode 2008, pers. comm.). Recent reports from the NCDMF indicate the presence of juvenile Atlantic sturgeon in the lower New River and inlet vicinity; however, there are no recent records of shortnose sturgeon in the project area (F. Rhode 2008, pers. comm.) (See Appendix I, Biological Assessment). Because of the lack of suitable freshwater spawning areas in the project area and the requirement of low salinity waters by juveniles, any shortnose sturgeons present would most likely be non-spawning adults (NMFS, 1998).

2.01.7 Nekton

Nekton collectively refers to aquatic organisms capable of controlling their location through active movement rather than depending upon water currents or gravity for passive

movement. Nekton of the nearshore Atlantic Ocean along Topsail Island, North Carolina can be grouped into three categories: estuarine dependent species; permanent resident species; and seasonal migrant species. The most abundant nekton of these waters are the estuarine dependent species, which inhabit the estuary as larvae and the ocean as juveniles or adults. This group includes species which spawn offshore, such as the Atlantic croaker (*Micropogon undulatus*), spot (*Leiostomus xanthurus*), Atlantic menhaden (*Brevoortia tyrannus*), star drum (*Stellifer lanceolatus*), southern kingfish (*Menticirrhus americanus*), flounders (*Paralichthys* spp.), mullets (*Mugil* spp.), anchovies (*Anchoa* spp.), blue crab (*Callinectes sapidus*), and penaeid shrimp (*Farfantepenaeus* spp. and *Lilopenaeus* sp.), as well as species which spawn in the estuary, such as red drum (*Sciaenops ocellatus*) and weakfish (*Cynoscion regalis*). Species which are permanent residents of the nearshore marine waters include the black sea bass (*Centropristis striata*), longspine porgy (*Stenotomus caprinus*), Atlantic bumper (*Chloroscombrus chrysurus*), inshore lizardfish (*Synodus foetens*), and searobins (*Prionotus* spp.). Common warm water migrant species include the bluefish (*Pomatomus saltatrix*), Spanish mackerel (*Scomberomorus maculatus*), king mackerel (*Scomberomorus cavalla*), cobia (*Rachycentron canadum*), Florida pompano (*Trachinotus carolinus*), and spiny dogfish (*Squalus acanthias*). Oceanic large nekton located offshore of Topsail Island are composed of a wide variety of bony fishes, sharks, and rays, as well as fewer numbers of marine mammals and reptiles. Marine mammals and reptiles that may be present in the offshore borrow sites are addressed in the biological assessment (see Appendix I).

2.01.8 Benthic Resources -Beach and Surf Zone

The intertidal zone of the beach shoreface is extremely dynamic and is characterized as the area from mean low tide landward to the high tide mark. This area serves as habitat for invertebrate communities adapted to the high-energy sandy beach environment. Important invertebrates of the surf zone and beach/dune community include the mole crab (*Emerita talpoida*), coquina clams (*Donax variabilis*), polychaete worms, amphipods, and ghost crabs (*Ocypode quadrata*). Mole crabs and coquinas represent the largest component of the total macrofaunal biomass of North Carolina intertidal beaches, and they are consumed in large numbers by important fish species such as flounders, pompanos, silversides, mullets, and kingfish (Reilly and Bellis, 1978; Leber, 1982; Johnson, 1994). Beach intertidal macrofauna are also a seasonally important food source for numerous shorebird species.

Through recent studies supported by the U.S. Fish and Wildlife Service and the U.S. Army Corps of Engineers, the distributions and abundance of these animals on nearby beaches is fairly well documented. Extensive sampling of the intertidal and nearshore beach environment was performed and documented in the USACE New York District's biological monitoring report titled, "Final Report for The Army Corps of Engineers New York District's Biological Monitoring Program for the Atlantic Coast of New Jersey, Sea Bright to Manasquan Inlet, Beach Erosion Project (2001)." Results from this study indicate that the intertidal infaunal assemblage was dominated by rhynchocoels, the polychaetes *Scolelepis squamata*, *Protodriloides (LPIL)*, and *Microphthalmus spp*., oligochaetes, the mole crab *Emerita talpoida*, as well as a number of haustoriid

amphipods. The nearshore infaunal assemblage included many of the same taxa, but was dominated by the wedge clam, *Donax variabilis*, the polychaete *Magelona papillicornis*, the clams *Spisula solidissim*a and *Tellina agilis,* and the amphipods *Acanthohaustorius millsi* and *Psammonyx nobilis*, and the polychaete *Asabellides oculata*. These documented infaunal assemblages are consistent with other studies throughout the Atlantic Coast (USACE, 2001). In North Carolina, along Bogue Banks and Topsail Island, infaunal assemblages are dominated by Donax variabilis, Donax parvula, and Emerita talpoida which function as an important first link in the flow of energy within the intertidal system (Leber, 1982; Reilly and Bellis, 1978). Other organisms occurring less frequently are Amphipods (*Haustorius canadensis, Talorchestia megalopthalma*, and *Amphiporia virginiana*) and Polychaetes (*Scolelepis squamata* and *Nephtys picta*) (Lindquist and Manning, 2001; Nelson, 1989; Leber, 1982; Reilly and Bellis, 1978).

2.01.9 Benthic Resources – Nearshore Ocean

Aquatic organisms that live in close association with the bottom, or substrate, of a body of water, are collectively called the benthos. Benthos communities provide a link between planktonic and benthic production and commercially important fish species (Posey, 1991). Benthic communities of the project area exhibit a wide range of organism composition and density, and community structure may vary considerably depending on substrate type, salinity regime, proximity to structural habitat, etc. Most nearshore benthic invertebrates tend to be r-strategists, which are characteristically small-bodied, short-lived, and have high fecundity, efficient dispersal mechanisms, and rapid growth rates. Thus, recolonization of a disturbed area is generally initiated by r-strategists (Bowen and Marsh, 1988).

A myriad of benthic surveys of representative sandy bottom nearshore ocean sites have been conducted throughout the Mid-Atlantic and South Atlantic regions, including within the vicinity of the proposed project area. Three nearshore ocean sites located off Virginia Beach were conducted for the USDOI Minerals Management Service (MMS) in 1996 and 1997 by Cutter and Diaz (1998). They collected a total of 119 taxa from 13 Smith-MacIntrye grabs collected in 1996. Half of the top 14 taxa (occurrence and abundance) were polychaetes. The remainder included representatives from the amphipods, decapods, bivalves, nemerteans, tanaids, echinoderms, and chordates. They found the overall community composition to be typical for sandy shallow continental shelf habitats and with similar species composition for similar depths and sediment types reported by Day *et al*. (1971) for North Carolina (Table 2.1). Day *et al*. (1971) defines the nearshore ocean as the "turbulent zone", which includes ocean waters from below low tide to a depth of about 60 feet. According to Day *et al*., polychaete species are highly represented in this zone with pelecypods, decapods, amphipods, echinoderms, and cephalochordates also present. Biological characterization results from field surveys performed by MMS of offshore shallow shelf habitats in the Outer Banks, North Carolina identified members of the major invertebrate and vertebrate groups commonly found in the general area. Dominant infaunal groups consisted of crustaceans, echinoderms, mollusks, and polychaetes, while epifaunal taxa consisted primarily of decapods, sea stars, and squid. Dominant demersal fish species included clearnose skate (*Raja eglanteria*), flounder (*Paralichthys* sp.), scup (*Stenotomus chrysops*), and searobin

(*Prionotus scitulus*) (Byrnes *et al*., 2003). Posey and Alphin (2000), collected offshore benthic infaunal samples at depths of 30-40 ft. from pre-borrow sites of Kure Beach, North Carolina. Results indicate that the benthic community was very diverse, with over 600 species, and largely dominated by polychaetes, with crustaceans and bivalves comprising most of the remaining taxa.

Benthic infaunal samples were collected by Dial Cordy and Associates Inc. within six borrow sites offshore of Topsail Beach in 2007 (USACE, 2009; USACE, 2007a). Benthic invertebrate abundance, species composition, and biomass were calculated and qualitative comparisons of the data were made to the results of other pertinent benthic studies in the Mid- and South-Atlantic regions. Results indicate that the benthic resources in the sampled borrow areas off of Topsail Beach are similar in composition and taxa dominance to those described in other studies along the North Carolina and South Carolina coasts (Table 2.1) (Byrnes *et al*., 2003; Van Dolah *et al*., 1984; Versar, 2002 and 2006; and Posey and Alphin 2000 and 2002). However, the benthic community found offshore of Topsail Beach was less diverse and abundant than baseline sampling performed for the Kure Beach restoration project (Posey and Alphin, 2000 and 2002) and for the Dare County beach coastal storm damage reduction project (Versar, 2006). It is likely that the differences between the benthic community off Topsail Beach and the two referenced studies are due to the more extensive sampling effort associated with baseline monitoring programs as compared to a less intensive sampling regime for a general characterization study (e. g. ten sampling stations per site off Dare County as compared to three to five stations per site for the Topsail Beach benthic characterization study). Of the 104 total taxa collected for the one-time sampling performed off Topsail Beach, polychaetes also dominated the community, comprising over 30% of the relative abundance at four of the six borrow sites (USACE, 2009; USACE, 2007a).

Though specific borrow areas identified for the Surf City and North Topsail Beach Coastal Storm Damage Reduction Project have not been sampled, considering (1) the similarities in species composition and taxa dominance throughout all previously conducted benthic studies offshore of Virginia, North Carolina, and South Carolina, (2) the nearness of the Topsail Island sampled borrow areas (USACE, 2009; USACE, 2007a) to the proposed SCNTB project borrow areas, and (3) the similarity in sediment characteristics among the previous studies, it is expected the benthic infaunal communities within the borrow areas offshore of SCNTB will be similar to previous studies.

Table 2.1. Most abundant benthic species within the Topsail Island offshore borrow sites (USACE, 2007a)

Group	**Species**
Polychaeta	*Mediomastus sp.*
	Onuphidae sp.
	Armandia maculata
	Bhawania heteroseta
	Glyceridae sp.
	Goniada littorea
	Goniadides carolinae
	Caulleriella sp. J
	Magelona papillicornis
	Spionidae sp.
Malacostraca	*Rhepoxynius hudsoni*
	Eudevenopus honduranus
Ostracoda	*Eusarsiella texana*
Leptocardia	*Branchiostoma sp.*
Ophiuroidea	*Ophiuroidea sp.*
Bivalvia	*Crassinella dupliniana*
	Crassinella lunulata
	Lucinidae sp.
	Tellina sp.
Gastropoda	*Acteocina canaliculata*
	Cylichna alba
	Caecum pulchellum
Turbellaria	*Turbellaria sp.*
Rhynchocoela	*Rhynchocoela sp.*

2.01.10 Hard Bottoms

Historical Database

Hard bottoms are defined as localized areas not covered by unconsolidated sediments, where the ocean floor consists of hard substrate. In the South Atlantic Bight (SAB) these hard bottoms vary in relief from high (>2.0 m (6.6 ft) to low (<0.5 m (1.6 ft) profile and range nearshore (within the states' 3 nautical mile limit) to beyond the continental shelf edge (>200 m (656 ft) (Moser *et al*. 1995). Hard bottoms are also called "live-bottoms" because they support a rich diversity of invertebrates such as corals, anemones, and sponges, which are refuges and food sources for fish and other marine life. They provide valuable habitat for reef fish such as black sea bass, red porgy, and groupers. Hard bottoms are also attractive to pelagic species such as king mackerel, amberjack, and cobia. While hard bottoms are most abundant in southern portions of North Carolina, they are located along the entire coast. Storms play a major role in the distribution of hard bottom benthic communities as they remove sediments accumulated from bioerosion and redistribute the ephemeral bottom sediments, exposing or burying hard bottom surfaces (Riggs *et al.*, 1998). The surficial sand sheet on the upper flat hard bottom is generally very thin, has an irregular distribution, and is highly mobile (Riggs *et al.*,

1996). According to Cleary (2003), the environment offshore of the proposed Surf City and North Topsail Beach (SCNTB) project area is characterized by undulating, relatively flat hard bottom platform punctuated by scattered low-relief hard bottom scarps (moldic limestone and siltstone) and sediment filled depressions.

Existing databases of hard bottom habitat throughout the North Carolina, including offshore of Topsail Island, are fairly limited. In 1985, the Southeast Area Monitoring and Assessment Program (SEAMAP-South Atlantic) established a bottom mapping work group to develop a regional database that describes the location and characteristics of bottom habitats throughout the South Atlantic Bight. The primary focus of this effort was to identify the location and quantify the extent of hard-bottom reef habitats in order for state and federal resource agencies to adequately assess reef-fish populations and the effects of changes in fishing pressure as well as provide protection of these habitats from adverse effects related to various anthropogenic stresses. The three major objectives of SEAMAP were to (1) conduct an extensive search of existing databases to classify the presence of hard bottom reef habitats, (2) use standardized protocols to analyze whether hard bottom habitat is present, possibly present, or absent, as well as identify the location of artificial reef habitats, and (3) summarize the data into easy to use databases for researchers and mangers.

As a component of the SEAMAP database, Moser *et al.* (1995) and Moser and Taylor (1995) provided a summary of the distribution and aerial extent of hard bottom habitats on the continental shelf of North Carolina. Existing hard bottom data (i.e. fisheries, *in-situ* observations, core data, artificial reef data, and geophysical data) were compiled and evaluated to map bottom types on the continental shelf. Bottom type classifications for North Carolina were based primarily on geophysical and fish trawl surveys. A total of 11,890 observations were added to the SEAMAP hard bottom database. The location of the hard bottom communities offshore of Surf City, North Topsail Beach, and Onslow Beach, as identified in this study, are found in Table 2.2.

Table 2.2. Hard bottom locations within waters off Surf City, North Topsail Beach, and Onslow Beach, North Carolina according to Moser and Taylor (1995).

Location # According To Moser And Taylor (1995)	Nearest Town	Nearest Inlet Access	Vertical Distances Ft		Reef Site Location		
			Approximate Water Depth (Ft)	* Relief High (H), Medium (M), Low (L)	Latitude	Longitude	Type Of Location
24	Surf City	New River	25-40	M	3422.59	7732.87	Point
25	Surf City	New River	25-40	M	3422.67	7732.83	Point
26	Surf City	New River	25-40	M	3422.98	7733.12	Point
27	Surf City	New River	25-40	M	3423.13	7733.21	Point
28	Surf City	New River	25-40	NA	3423.46	7732.64	Point
29	Surf City	New River	25-40	M	3422.69	7732.31	Point
30	Surf City	New River	25-40	NA	3422.97	7732.04	Point
31	Surf City	New River	25-40	NA	3423.25	7732.11	Point
32	Surf City	New River	25-40	NA	3423.6	7731.95	Point
33	Surf City	New River	25-40	M	3424.47	7731.26	Point
34	Surf City	New River	25-40	NA	3424.7	7731.26	Point
35	Surf City	New River	25-40	M	3424.66	7731.07	Point
36	Surf City	New River	25-40	H	3425.51	7729.71	Point
37	Surf City	New River	25-40	H	3423.63	7730.62	Point
38	Surf City	New River	25-40	H	3424.04	7730.53	Point
94	N. Topsail	New River	30	NA	3428.32	7722.25	Point
95	N. Topsail	New River	30	NA	3429.08	7721.02	Point
110	N. Topsail	New River	40	NA	3425.68	7724.17	Point
117	N. Topsail	New River	35-40	NA	3429.45	7721.1	Line
					3429.45	7722.2	Line
145	Surf City	New River	35-40	NA	3421.73	7730.71	Point
146	Surf City	New River	35-40	NA	3423.24	7729.56	Point
151	Surf City	New River	45	NA	3422	7736	Line
					3424	7734	Line
155	Surf City	New River	25	NA	3426.1	7727.8	Line
					3426.5	7728.2	Line
156	Onslow	New River	25	NA	3430.3	7717.9	Line
					3429.8	7718.5	Line

Table 2.2 – continued. Hard bottom locations within waters off Surf City, North Topsail Beach, and Onslow Beach, North Carolina according to Moser and Taylor (1995).

Location # According To Moser And Taylor (1995)	Nearest Town	Nearest Inlet Access	Vertical Distances Ft		Reef Site Location		
			Approximate Water Depth (Ft)	* Relief High (H), Medium (M), Low (L)	Latitude	Longitude	Type Of Location
171	N. Topsail	New River	35-40	H	3428.1	7723.1	Polygon
					3427.2	7722.3	Polygon
					3427	7722.5	Polygon
					3427.9	7723.4	Polygon
180	N. Topsail	New River	25-35	NA	3427.6	7722.7	Point
181	N. Topsail	New River	25-35	NA	3427.9	7723	Point
182	N. Topsail	New River	25-35	NA	3428.1	7723.1	Point
183	N. Topsail	New River	25-35	NA	3429.4	7723.9	Point
184	N. Topsail	New River	25-35	NA	3429.7	7723.2	Point
185	N. Topsail	New River	25-35	NA	3429.9	7722.6	Point
186	N. Topsail	New River	25-35	L	3430.2	7722.3	Line
					3430.5	7721.6	Line
187	N. Topsail	New River	25-35	L	3430.7	7721.3	Point
188	N. Topsail	New River	25-35	L	3430.7	7720.9	Point
189	N. Topsail	New River	25-35	H	3430	7721.3	Polygon
					3430.7	7722.2	Polygon
					3428.6	7723.8	Polygon
					3429.3	7724.2	Polygon
190	Onslow	New River	25-35	H	3431.2	7719.3	Polygon
					3432.4	7717.9	Polygon
					3431.5	7717.5	Polygon

* Low relief (L) was defined as <0.5m (1.6 ft), Moderate relief (M) was defined as 0.5-2.0 m (1.6-6.6 ft), and High relief (H) was defined as profiles >2 m (>6.6 ft) (Moser and Taylor, 1995).

Summary of Corps Sand Resource and Hard Bottom Investigations Contracts

In order to identify and delineate the most economical and environmentally acceptable borrow areas in the offshore environment (>-7 m (-23 ft.)) NGVD) that could provide a sufficient volume of sediment for the SCNTB Hurricane Storm Damage Reduction project, the Corps contracted with multiple engineering and environmental companies. The objectives of these contracts were to provide an assessment of the availability of beach fill quality sand offshore as well as an assessment of underlying geology and exposed offshore hard bottom features. Furthermore, in order to assess the potential impact of the proposed project on: (1) nearshore hard bottom habitat as a result of burial or sedimentation from the beach fill equilibration process and (2) offshore habitat from hopper dredging activities, the Corps contracted side scan sonar, multibeam, and diver ground truth data collection. The following paragraphs summarize, in chronological order, the hard bottom data collection components of both the offshore and nearshore survey contracts:

Offshore (>-7 m (-23 ft.) MLLW)

(1) USACE. 2003. An Assessment of the Availability of Beach Fill Quality Sand Offshore North Topsail Beach and Surf City, North Carolina. HDR Engineering Inc. of the Carolinas in association with William J. Cleary, PhD, PG. (Appendix R; Attachment 1)

The goals of this study were to: (1) investigate the area offshore of North Topsail Beach and Surf City utilizing published reports and available unpublished data, (2) summarize existing vibracore, fathometer, seismic, and sidescan sonar data, (3) groundtruthing of sidescan sonar seafloor mosaic - SCUBA based diver mapping and seafloor sampling surveys, and (4) identify and delineate the most economical and environmentally acceptable borrows sites that could support the proposed projects on Topsail Island while avoiding environmentally sensitive hard bottoms.

Results of this report indicated an extremely complex exposure pattern of hard bottom throughout the study area, extending from the -9.1 m (-30 ft.) contour seaward to a distance of ~8 km (5.0 miles) offshore between the Town of Surf City through the southern end of Onslow Beach. Throughout the offshore environment surface sediments are easily reworked during storms, exposing hard bottom platforms and low relief scarps in areas where the sediment cover is thin. As identified in the sidescan imagery, a patchy veneer of silty sand and gravel produces a “pock-marked’ or “patchwork” appearance on the surface of the underlying flat hard bottom areas. The southern portion of North Topsail Beach and Surf City was characterized by undulating, relatively flat hard bottom platform punctuated by scattered low-relief hard bottom scarps (moldic limestone and siltstone) and sediment filled depressions; whereas, high relief hard bottom locations dominate the North Topsail Beach vicinity (Alligator Bay to New River Inlet (Onslow Beach)). Two notable areas of high relief hard bottom were located (1) offshore of Mile Hammock Bay on the Onslow Beach portion of the shoreface and (2) between Alligator Bay and New River Inlet. Furthermore, several linear,

shore-normal depressions that were interpreted to be channel remnants and/or rippled scour depression (RSD) features were identified through the study area.

Based on the information collected by HDR Engineering Inc., the Corps was able to refine the locations of potential borrow site locations and implement a detailed vibracore plan to adequately assess the compatibility of sediments within these target borrow areas. Additional recommendations for future work in the proposed borrow areas included: (1) geophysical analysis in order to better interpolate potential sediment quantities relative to underlying geology, and (2) high-resolution sidescan sonargraph surveys of the borrow sites in order to assess the presence of exposed hard bottom resources.

(2) USACE. 2004a. Marine Geophysical Investigation for the Evaluation of Sand Resource Areas Offshore Topsail Island North Carolina. Final Report. Contract DACW54-02-D-0006, Delivery Order 0002. Prepared by Greenhorne and O'Mara, Inc., with consultant Ocean Surveys Inc. (OSI). (Appendix C; Attachment 1))

Using "Chirp" and "boomer" profiles, USACE Core Samples (412), hydrographic survey, and previous studies (HDR 2002 and 2003), OSI was able to further delineate limits of suitable borrow material for the proposed project. Specific goals of this study were to: (1) Determine water depths and general morphology, (2) Map aerial extent and thickness of available unconsolidated sediment, (3) Delineate the extent of bedrock units on and below the seafloor, and (4) Use data to evaluate proximity of sand borrow areas to hard bottom outcrops.

The OSI investigation further confirmed that Onslow Bay is a sediment starved system consisting mostly of a thin patchy veneer (<0.9-1.8 m (3-6 ft)) of modern sediments covering the low relief Oligocene limestone and siltstone. Consistent with HDR, OSI also identified numerous quaternary channel fill sequences or RSD features. Wave and current action move the surface material periodically exposing the rock units just below the seafloor. The moldic sandy limestone protrudes above the seafloor as scarps exhibiting relief of 0.6-4.6 m (2-15 ft.) in some areas with areas of relatively flat low lying hard bottom in between; however, the siltstone unit rarely identified outcropping. The thicker sediment deposits (~3 m (10 ft.)) have filled in the broad depressions of the rock surface.

Though this study further refined the limits of the proposed offshore borrow areas, as well as the extent of the exposed offshore hard bottom, the spacing of the hydrographic survey data was still too wide; thus, small scale features could not be identified. High resolution side scan sonar was necessary to identify and define hard bottom within the refined borrow areas.

(3) USACE. 2005. An Archaeological Remote Sensing Survey of Surf City – North Topsail Beaches Offshore Borrow Areas. Contract Number DACW 54-03-D-0002, Delivery Order 0005. Submitted by Mid-Atlantic Technology and Environmental Research (MATER), Principal Investigator Wess Hall. (Appendix U)

Within the limits of the refined borrow areas identified by HDR, OSI, and the Corps, MATER implemented high resolution side scan sonar to identify and delineate hard bottom within the proposed borrow areas. Sidescan sonar is a marine geophysical technique used to map

underwater topography and for identifying features on the surface of water body bottoms. Generally, hard materials provide high amplitude echoes and soft, fine grained materials provide weak signals. As a result, side scan sonar provides a visual representation of the change in density of the surface material of a water body bottom. Data was collected along parallel lines spaced at 20 m (65 ft) intervals using a Marine Sonic 600-kHz side-scan sonar. Relief was classified in accordance with Moser and Taylor (1995) and Moser *et al.* (1995): (1) **Low-relief** - the majority of the area less than 0.5 m (1.6 ft.) above the bottom, (2) **Moderate-relief** - the majority of the area between 0.5 m (1.6 ft.) and 2.0 m (6.6 ft.) above the bottom, and (3) **High-relief** – the majority of the area more than 2 m (6.6 ft.) above the bottom.

Based on the interpretation of the acoustic signatures from the side scan sonar data, hard bottom was identified and delineated within all proposed borrow areas as follows:

Borrow Area G = 2% hard bottom all low relief.
Borrow Area I = 73% hard bottom with mix of low, moderate, and high relief.
Borrow Area H, J, L, N, O, P = 13% hard bottom with mix of low, moderate, and high relief.
Borrow Area K, M = 48% hard bottom with mix of low, moderate and high relief.
Borrow Area S = 19% hard bottom all low relief.
Borrow Area Q, R = 20% hard bottom with mix of low and moderate relief.
Borrow Area T = 46% hard bottom with mix of low to moderate relief.

The extensive hard bottom plus the remaining low volume of beach compatible material identified in borrow areas I, K, and M, resulted in their removal from consideration for borrow material. Borrow area T has enough accessible, beach compatible material for continued consideration. Delineation of hard bottom resources within each borrow area allowed for further refining of the proposed borrow areas in order to avoid potential impacts to hard bottom resources from hopper dredging activities.

Nearshore (<-7 m (-23 ft.) NGVD)

(1) USACE. 2006. High-Resolution Remote Sensing of Potential Hard Bottom Habitats: Topsail Island, NC July 2006 Contract DACW54-02-D-0006. Submitted by: Greenhorne and O'Mara Consulting Engineers with sub-consultant Geodynamics. (Appendix R; Attachment 2)

In order to assess potential project impacts to nearshore hard bottom resources, as a result of the equilibration process associated with the constructed beach template, surveys for hard bottom resources within the calculated depth of closure (i.e. -7 m (-23 ft.) NGVD) for this project were necessary. As a component of the USACE scope of work for identifying nearshore (<9.1 m (30 ft.)) hard bottom resources off SCNTB, the Corps requested a two phased effort to (1) locate and quantify "potential hard bottom" sites within the project impact area utilizing side scan sonar and, if targets were identified, (2) use multibeam survey techniques to assess the bathymetry (i.e. relief). This scope of work was coordinated with and received approvals from the environmental resource agencies. Nearshore survey data located outside the scope of this contract in North

Topsail Beach were collected by Coastal Planning and Engineering, Inc. (CPE) as a component of the Draft EIS for the local, non-federal "North Topsail Beach Shoreline Protection Project". CPE's procedural steps for identifying hard bottom communities were consistent with the Corps' procedures and entailed: (1) side scan sonar data collection and interpretation, (2) identification and delineation of potential hard bottom features, and (3) diver groundtruthing and biological characterization of representative sites. Details of the CPE investigation of the nearshore environment of North Topsail Beach can be found in the November 2007 Draft Environmental Impact Statement for the "North Topsail Beach Shoreline Protection Project (USACE, 2007b)."

The USACE nearshore side scan sonar survey (phase 1) commenced in July 2006 and was comprised of 6 planned survey lines spaced 100 m apart (320 ft.) in depths ranging from ~1.5 m (5 ft.) MLLW to ~9.1 m (30 ft.) MLLW. The distance between survey lines was calculated in separate zones of relatively equal depths using 42 times the water depth for multibeam and 120 m swaths (394 ft.) for sidescan as indicated on the NOAA digital nautical chart 11541_4.kap. Interpretation of the sidescan sonar data identified several areas in SCNTB which had higher density material than the adjacent area. These high backscatter features were located cross-shore throughout the survey area. Based on these density differences, the areas of high backscatter were considered "potential hard bottom" anomalies and were delineated. Generally, the "potential hard bottom" targets identified started approximately 244 m (800 ft) offshore (2004 wet/dry line) and extended to the end of the survey, located approximately 545 m (1800 ft.) offshore (2004 wet/dry line).

(2) USACE. 2007c. High-Resolution 3D Bathymetric Assessment of Potential Hard Bottom Habitats: Topsail Island, Surf City and North Topsail Island, NC January / February 2007. Contract DACW54-02-D-0006. Submitted by: Greenhorne and O'Mara Consulting Engineers with sub-consultant Geodynamics. (Appendix R; Attachment 3).

Using information gained from the USACE 2006 side scan sonar survey, the Corps implemented a multibeam survey contract to further investigate the bathymetry of the target "potential hard bottom" areas. The multibeam survey was comprised of 18 planned survey lines (6 lines per survey area) spaced 21 m (70 ft.) to 27 m (90 ft.) apart to obtain 100% seafloor coverage. The total area of the survey encompassed 0.85 square miles with a total of 57 line miles and employed a Simrad EM3002 shallow water multibeam sonar system to collect spatially dense bathymetric data for the development of an accurate surface model. Data interpretation of seafloor bathymetry indicated that areas of high backscatter with cross-shore orientation identified in the phase one side scan sonar survey were areas of gradual seafloor depressions with approximately 0.5 m (1.5 ft.) vertical relief per 101 m (330 ft.) horizontal distance. Additional groundtruth investigations of "potential hard bottom" features were necessary to confirm the absence or presence of hard bottom in order to better interpolate these features from the acoustic signatures.

(3) USACE. 2008. Surf City/North Topsail Beach, NC Shore Protection Project, Hard Bottom Resource Confirmation and Characterization Study. Contract W912HN-08-C-0009. Submitted by ANAMAR Environmental Consulting Inc. and Coastal Planning and Engineering, Inc.

During a Project Deliver Team (PDT) meeting with environmental resource agencies held on 08 August 2007, a summary of all nearshore and offshore hard bottom data collection contracts conducted off of Topsail Island were presented to the resource agencies. Furthermore, details of the North Carolina state (State) hard bottom buffer rule language (NCAC 07H. 0208(b) (12)(A)(iv)) were discussed. Specifically, the rule states that, "*Mining activities shall not be conducted on or within 500 meters of significant biological communities, such as high relief hard bottom areas. High relief is defined for this standard as relief greater than or equal to one-half meter per five meters of horizontal distance*." In accordance with the state's definition of "high relief" hard bottom, the Corps created a buffer around all identified high relief hard bottom delineated by MATER in 2005. However, the Corps questioned the interpretation of the 500 m (1640 ft) buffer rule with respect to hard bottom relief that is less than the defined characteristics of "high-relief" hard bottom identified in the State rule language. Adherence to a 500 m (1640 ft) buffer for all identified hard bottom (i.e. low, medium, and high relief) would result in a reduction of available sediment to a volume that is less than that required for the 50 year life of the project. In order to provide sufficient compatible sand resources for the 50 year project, the Corps proposed to implement a 122 m (400 ft.) dredging buffer around the low relief hard bottom (<0.5 m (1.6 ft.)) identified by MATER in the offshore borrow sites while still adhering to the 500 m buffer for high relief hard bottom as defined within the State rule language. The implementation of a 122 m (400 ft.) buffer is consistent with the recommended buffer distances in the state of Florida, which currently recommends a 122 m (400 ft.) dredging buffer around hard bottom communities, including coral reefs, in their state dredging permit conditions. Additionally, the NMFS recommends a 122 m (400ft) dredging buffer in their Gulf Regional Biological Opinion (GRBO) for dredging activities in the Gulf of Mexico in order to avoid impacts to hard bottom foraging grounds for sea turtles. This buffer recommendation is based on lessons learned from a history of sedimentation and turbidity monitoring data collected in association with dredging projects within the vicinity of coral reefs throughout Florida. Though the Florida does include a 122 m (400 ft.) buffer in their state permit conditions, there are site specific circumstances that are considered for individual projects which may warrant a decrease or increase in this buffer guideline (see Section 8.01.8.2 for additional information pertaining to Florida monitoring reports).

Recognizing the room for interpretation of the NC state rule pertaining to "low relief" hard bottom and the Corps' subsequent request to dredge closer to low-relief hard bottom resources than outlined in the state rule language, based on limited sediment availability, the PDT requested additional *in-situ* biological characterization of identified low-relief hard bottoms using divers. Furthermore, in order to assess potential beach nourishment impacts as a result of beach profile equilibration process, the PDT requested *in-situ* diver groundtruthing of the nearshore side scan sonar survey data. The purpose of this

investigation was to confirm the presence or absence of hard bottom within high backscatter areas identified by Geodynamics as "potential hard bottom." As identified in the contract scope of work, which was approved by the environmental resource agencies, the Corps required a phased approach in the nearshore environment to (1) confirm the presence and/or absence of "potential" hard bottom resources identified by Geodynamics and, if necessary, (2) biologically characterize the identified hard bottom habitat including fish species observation and identification. The nearshore investigation sites were located approximately 335 m (1100 ft.) from the shore between the -5.5 m (-18 ft.) and the -9.1 m (-30 ft.) NGVD contours from the Surf City / Topsail Beach town border and extending through the southern end of North Topsail Beach and consisted of 8 bounce dives. The groundtruth investigation of offshore sites identified by MATER consisted of biological characterization of the delineated hard bottom community as well as observation and identification of fish species. Confirmation and characterization of hard bottom was conducted at five borrow sites for a total of 12 transects (G=2, J=2, L=2, O=3, and T=3). The borrow sites were located approximately 1 to 6 miles from the coast in water depths between -9.1 m (-30 ft.) to -14.3 m (-47 ft.) MLLW. All dives included in water digital video documentation of the site.

In order to refine sampling locations and maximize site diversity, previously collected remote sensing data conducted by Geodynamics and MATER were thoroughly evaluated prior to transect site selection. This analysis of the remote sensing data helped determine if previously identified "potential" hard bottom anomalies could be further classified as unconsolidated sediments, shell hash, or rubble prior to *in-situ* dive efforts. Furthermore, transect site locations, relative to distance offshore and cross-shore, were considered in order to optimize the collection of data to assure that the diversity of habitat type and area were captured. The following paragraphs summarize the data collected from the nearshore and offshore dives:

Nearshore

Diver ground truth confirmation of the 8 selected areas previously identified as "potential" hard bottom, in conjunction with the sidescan interpretation, support the conclusion that no hard bottom was identified landward of the calculated -7 m (-23 ft.) Depth of Closure (DOC). Additional refined analyses of the remote sensing data coupled with the (1) diver ground truth transects, (2) collected sediment samples, and (3) digital video, identified the previously defined "high backscatter anomalies" to be regions of coarse gravel and shell hash. Careful selection of dive sites enabled divers to traverse backscatter transitional areas identified in the remote sensing data. Diver confirmation and corresponding sediment samples identified these transitional areas to be a sorting of sediment characteristics from fine grained to course grained sediments. These features identified in the nearshore environment off Surf City and North Topsail Beach are consistent with previously identified "rippled scour depressions (RSD)" (Cacchione *et al*., 1984; Thieler *et al*., 1999; Thieler *et al*., 2001), "ripple channel depressions (RCD)" (McQuarrie, 1998), or "sorted bedform"(Murray and Thieler, 2004) features identified throughout the coast of NC (Wrightsville Beach, Figure Eight Island, Topsail Island, etc.). These features are thought to be the result of a feedback mechanism whereby an

existing deposit of coarse shell hash and gravel material is built upon and segregated from fine material due to wave motion interacting with the enhanced roughness of the seafloor bed around these patches of coarse material (Murray and Thieler, 2004). This interaction between wave motion and seafloor roughness results in near-bed turbulence that is greatly enhanced relative to other areas of the seafloor. The increase in near-bed turbulence enhances entrainment and inhibits settling of fine material, thereby further expanding and maintaining the coarse patches of material.

Upon completion of the 8 nearshore dives and the confirmation that no hard bottom resources were located within the -7 m (-23 ft.) contour, the Corps requested the contractor ground truth 2 additional features located approximately 183 m (600 ft.) offshore of the -7 m (-23 ft.) contour. Based on preliminary side-scan data interpretation, ANAMAR documented that these sites closely resembled exposed rock outcrops. Using diver ground-truth data from the previous dives, a more refined analysis and interpolation of sidescan imagery for hard bottom resources was possible. Diver confirmation of hard bottom in areas which, in the sidescan interpretation, appeared to more closely resemble exposed rock outcrops on the seafloor than any of the seafloor features located landward of the depth of closure, added further confidence to the sidescan data interpretation for presence/absence of hard bottom. Divers verified the presence of low relief ephemeral hard bottom features at both sites with a maximum vertical relief of approximately 15 cm.

Offshore

A total of twelve temporary transects were established among the five borrow areas (T=3, O=3, L=2, J=2, and G=2) identified for biological characterization of hard bottoms. Hard bottom of varying low (<0.5 m (1.6 ft.)) to moderate (0.5 m (1.6 ft.) to 2.0 m (6.6 ft.)) relief (i.e. large contiguous hard bottom, patchy outcroppings, and/or distinct ledges) and total area were confirmed and characterized for all sites, with the exception of one transect in borrow area J (J1) in which no hard bottom was identified. Remote sensing data was carefully analyzed prior to selecting transect locations in order to maximize diversity of habitat covered within a transect line by traversing areas of relief transition. Furthermore, transects were also distributed among borrow areas in order to capture the potential differences associated with the distance offshore and the location alongshore, as well as potential association with nearness to New River Inlet. Based on the data collected, the hard bottom benthic community did not differ relative to nearness to New River inlet or distance offshore. The surveyed borrow areas contained intermittent areas of well-developed benthic cover and areas of frequent burial. Some of the sites contained small hard bottom patches interspersed with sand and had relatively undeveloped benthic communities; whereas other sites contained more extensive communities. Furthermore, there was evidence of periodic burial or sand scouring in areas with less rugosity and site relief was not correlated with diversity or amount of benthic growth. Vertical surfaces (i.e. outcroppings/ledges) had an increased diversity of organisms (i.e. bryozoans, tunicates, hydrozoans, etc.) as well as adult *Oculina sp*. colonies; thus, indicating a more stable environment along the vertical faces. The horizontal surfaces of the hard bottom outcrops were predominantly covered with macro-algae. About 80% of the transects

were low relief hard bottom which contained little biotic diversity dominated by emergent octocorals and sponges. However, borrow area G represented a unique area of low relief hard bottom which contained diverse and persistent benthic communities. The following contains brief summaries of the data for each borrow area investigated:

Borrow area G: Sites investigated in borrow area G were indicative of a more persistent low relief hard bottom community as evidenced by the mature colonies of *Oculina sp* and highest percent stony coral cover and density (i.e. transect G1).

Borrow area J: Contained the least amount of confirmed hard bottom of any of the investigated borrow areas. Specifically, no hard bottom was identified in transect J1, an area previously delineated as potential hard bottom based on side scan sonar interpretation provided by MATER. Furthermore, transect J2 was confirmed to be an extremely ephemeral system based on the observation of *L. virgulata* colonies attached to buried hard bottom and protruding through a thin veneer of sand.

Borrow area L: Transects L1 and L2 were placed along previously identified transition areas of moderate and high relief hard bottom, based on side scan sonar data. As expected, these transects contained the highest maximum relief of all sites. The myriad of relief patterns, crevices, ledges, etc. resulted in the highest diversity index identified for L1. However, though these transects had the highest maximum relief of .50 m (1.6 ft.) and .55 m (1.8 ft.) respectively, based on *in-situ* dive investigations, they were previously mapped as "moderate" and "high" relief based on side scan sonar interpretation. The confirmed *in-situ* maximum relief of these sites is on the low end of the "moderate" relief classification as defined by Moser and Taylor (1995) and Moser *et al.* (1995). Furthermore, the average relief of these sites was 0.16 m (0.5 ft.) and 0.07 m (.23 ft.) respectively, indicating that the areas of "moderate" relief were isolated peaks rather than a continuous "moderate" relief shelf.

Borrow area O: Three transects were placed throughout borrow area O in order to capture previously determined areas of low, moderate, and high relief. Though two transects were placed along areas of moderate and high relief transitions based on side scan sonar interpretation and mapping, the *in-situ* dive confirmation indicated only areas of intermittent varying low relief hard bottom with interspersed patches of sand. Though the side scan sonar interpretation and subsequent mapping indicated differing relief patterns between the three transects (i.e. O1, O2, and O3), the in-situ dive confirmation did not support this preliminary delineation of hard bottom.

Borrow area T: Transect locations throughout borrow area T were specifically located to capture site diversity. Transect T1 was unique in that it traversed a distinct "moderate" relief ledge (i.e. maximum relief of 0.47 m (1.5 ft.)) and extended into a low relief ledge with an average relief of 0.05 m (0.16 ft.). Transects T3 and T4 were generally low relief (i.e. maximum relief of 0.14 m (0.5 ft.) and 0.22 m (0.7 m) respectively) and ephemeral in nature as evidenced by sediment cover and less site diversity. However, *Oculina sp*. were identified in areas with higher relief.

Though this study was limited to the winter months during period of limited biological activity, similar work has been conducted by CPE within the project area vicinity in June, August, and October of 2005 (USACE, 2007). Field investigations with similar methodologies were performed to ground truth potential hard bottom resources as well as characterize the benthic community of representative locations. Sessile benthos observed along the hard bottom were dominated by macroalgae, octocorals, encrusting red algae, sessile worms, and stony corals and were consistent with those identified during the USACE March 2008 investigation (Table 2.3). Therefore, the offshore hard bottom habitats of borrow areas have been characterized during the spring, summer, fall, and winter and there does not appear to be significant differences in species composition and diversity for each sampling period. However, as expected, the finfish species observed during the warm water sampling periods were more diverse than the cold water sampling period.

Table 2.3. Consolidated species list for all 12 transects investigated throughout borrow areas T, O, L, J, and G in March 2008.

	Species	Common Name
INVERTEBRATES		
SPONGES	*Cliona celata**	Boring sponge
	Unidentified gray sponge (Possibly *Ircinia* sp.)*	
	Several unidentified species*	
HYDROIDS	Several unidentified species	
BRYOZOANS	*Bugula turrita**	Spiral-tufted bryozoan
	Hippopodina feegeensis	Pearly orange encrusting bryozoan
	Unidentified fan bryozoans*	
ANEMONES	Cerianthid anemone*	Tube-dwelling anemone
	Several unidentified species*	
SCLERACTINIAN CORAL	*Oculina sp.**	Ivory tree coral
OCTOCORAL	*Leptogorgia hebes**	Regal sea fan
	*Leptogorgia virgulata**	Colorful sea whip
	Telestaceans (*Carijoa riisei* and/or *Telesto sp.)**	Telestos
	*Titanideum frauenfeldii**	Brilliant sea fingers
MOLLUSCS	*Fasciolaria tulipa*	Tulip snail
	Simnia sp.*	Simnia
ECHINODERMS		
Urchins	*Arbacia punctulata**	Common Arbacia urchin
	*Lytechinus variegatus**	Variegated urchin
Sea Stars	*Astropecten articulatus**	Beaded sea star
	*Asterias forbesii**	Forbe's sea star
	*Echinaster sp.**	Orange-ridged sea star
	*Luidia alternata**	Banded sea star
Sea Cucumbers	Unidentified sea cucumber*	
ARTHROPODS	*Anoplodactylus lentus*	Lentel sea spider
	Various hermit crabs	
	Balanus sp.	Barnacles
TUNICATES	*Botryllus/Botrylloides* spp.*	Flat/row/geometric encrusting tunicates
	*Distaplia corolla**	Button tunicate
	Eudistoma spp.	Condominium tunicates
	Several unidentified species*	
VERTEBRATES		
FISH	*Archosargus probatocephalus**	Sheepshead
	*Centropristis striatus**	Black sea bass
	*Diplodon holbrookii**	Spottail pinfish
PLANTS		
MACROALGAE	*Caulerpa*	green alga
	*Codium**	Dead man's fingers
	Cryptonemia	red alga
	*Dasya**	red alga
	Gelidiella	red alga
	Gelidium	red alga
	*Halymenia**	red alga
	*Lobophora**	Encrusting fan-leaf alga
	*Sargassum**	Sargassum weed
	Wrangelia	red alga
	Encrusting Red Algae	

Artificial Reef

The State of North Carolina, Department of Environment and Natural Resources, Division of Marine Fisheries Artificial Reef Program manages 6 reefs that are located off Topsail Island. They are AR 355, AR 360, AR 362, AR 364, AR 366, and AR 368. Of these

managed reefs, AR360 "Topsail Reef" is within close proximity of the proposed offshore borrow areas and is located at 34º 20' 59" N and 77º 36' 11" W (Table 2.4). It was deployed in 1984 and modified in 1992 and consists of about 49,000 tires and 850 4'x8' pieces of concrete pipe. Currently this reef no longer exists in its confined location but rather, is broken up and spread out well beyond its original footprint and is exposed or buried at different locations. The location of these hard bottom habitats and artificial reef sites, in relation to project features, is shown in Appendix A, Figure A-1.

Table 2.4 Artificial reefs, NC Division of Marine Fisheries (http://www.ncfisheries.net/download/ReefGuide2005.pdf.)

NC Reef Site No.	Nearest Inlet Access and Distance	Approx. Water Depth	LORAN Position Coordinates	Latitude and Longitude	Comment
355	New River 9.7 miles	60 feet	27210.0 39324.4	$34^0$21'11" $77^0$20'00"	230' Bridge span
360	New Topsail 2.5 miles	44 feet	27256.9 39252.5	34^0 20'59" $77^0$36'11"	Concrete pieces
362	New Topsail 8.7 miles	54 feet	27233.1 39244.5	$34^0$15'43" $77^0$30'27"	Concrete pieces
364	New Topsail 6.0 miles	44 feet	27267.4 39169.6	$34^0$14'50" $77^0$42'50"	174' JELL II Boat mold
366	New Topsail 13.9 miles	66 feet	27214.6 39255.0	$34^0$12'57" $77^0$25'15"	Concrete pieces
368	New Topsail 15.5 miles	66 feet	27211.7 39195.0	$34^0$09'34" $77^0$25'50"	Small vessel

Since the placement of tire-based artificial reefs throughout North Carolina, many have broken loose from their original footprint and wash up consistently throughout the North Carolina beaches. In 2001 (December – April), during Phase I of the Bogue Banks Beach Nourishment project in Bogue Banks, North Carolina, the dredging contractor encountered about 5,000 tires within the borrow sites that had broken free from an artificial reef site. Based on this history, the NCDMF has identified concerns that, though the historical placement of tire-based artificial reefs are outside of the identified borrow sites, there is a potential for loose tires to be located within the borrow sites. The NCDCM's artificial reef program has a team to document and pick up tires that wash up on the local beaches. (Appendix A, Figure A-1).

2.01.11 Essential Fish Habitat

The 1996 Congressional amendments to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (PL 94-265) set forth new requirements for the National Marine Fisheries Service (NMFS), regional fishery management councils (FMC), and other

Federal agencies to identify and protect important marine and anadromous fish habitat. These amendments established procedures for the identification of Essential Fish Habitat (EFH) and a requirement for interagency coordination to further the conservation of Federally managed fisheries. Table 2.5 lists the Federally managed fish species of North Carolina for which Fishery Management Plans have been developed by the South Atlantic Fishery Management Council (SAFMC), Mid-Atlantic Fishery Management Council (MAFMC), and National Marine Fisheries Service (NMFS). In addition, this table shows EFH by fish lifestage and ecosystem type for those species that have designated EFH. Table 2.6 shows the categories of EFH and Habitat Areas of Particular Concern (HAPC) for managed species, which were identified in the Fishery Management Plan Amendments affecting the South Atlantic area. The fish species and habitats shown in these tables require special consideration to promote their viability and sustainability. The potential impacts of the proposed action on these fish and habitats are discussed in Section 8.01.8 of this report.

Table 2.5 Essential Fish Habitat (EFH) Species for Coastal North Carolina.[1]

Management Plan Agency[2]	Management Plan Species Group	Common Name Of Species	Scientific Name Of Species	EFH for Life Stages by Ecosystem[3]		Geographically Defined Habitat Areas Of Particular Concern (HAPC) (North Carolina Locations Only)
				Marine	Estuarine	
SAFMC	Calico Scallop	Calico scallop	*Argopecten gibbus*	A		
SAFMC	Coastal Migratory Pelagics	Cobia	*Rachycentron canadum*	E L P J A	L P J A	Capes Fear, Lookout, & Hatteras sandy shoals; The Point; Ten Fathom Ledge; Big Rock; Bogue Sound; New River; hardbottom
SAFMC	Coastal Migratory Pelagics	Dolphin	*Coryphaena hippurus*	L P J A		Capes Fear, Lookout, & Hatteras sandy shoals; The Point; Ten Fathom Ledge; Big Rock; Bogue Sound; New River; hardbottom
SAFMC	Coastal Migratory Pelagics	King mackerel	*Scomberomorus cavalla*	J A		Capes Fear, Lookout, & Hatteras sandy shoals; The Point; Ten Fathom Ledge; Big Rock; Bogue Sound; New River; hardbottom
SAFMC	Coastal Migratory Pelagics	Spanish mackerel	*Scomberomorus maculatus*	L J A	J	Capes Fear, Lookout, & Hatteras sandy shoals; The Point; Ten Fathom Ledge; Big Rock; Bogue Sound; New River; hardbottom
SAFMC	Coral & Coral Reef	Corals	100s of species	Florida only		Big Rock; Ten Fathom Ledge; The Point
SAFMC	Golden Crab	Golden crab	*Chaceon fenneri*	A		
SAFMC	Red Drum	Red drum	*Sciaenops ocellatus*	E L A	P J S A	tidal inlets, state nursery, spawning sites, SAV
SAFMC	Shrimp	Brown shrimp	*Farfantepenaeus aztecus*	E L A	P J S	tidal inlets, state nursery, overwintering habitats

Table 2.5 – continued. Essential Fish Habitat (EFH) Species for Coastal North Carolina.[1]

Management Plan Agency[2]	Management Plan Species Group	Common Name Of Species	Scientific Name Of Species	EFH for Life Stages by Ecosystem[3]		Geographically Defined Habitat Areas Of Particular Concern (HAPC) (North Carolina Locations Only)
				Marine	Estuarine	
SAFMC	Shrimp	Pink shrimp	*Farfantepenaeus duorarum*	E L A	P J S	tidal inlets, state nursery, overwintering habitats
SAFMC	Shrimp	Rock shrimp	*Sicyonia brevirostris*	A		
SAFMC	Shrimp	Royal red shrimp	*Pleoticus robustus*	A		
SAFMC	Shrimp	White shrimp	*Lilopenaeus setiferus*	E L A	P J S	tidal inlets, state nursery, overwintering habitats
SAFMC	Snapper Grouper	Blackfin snapper	*Lutjanus buccanella*	J A		hardbottom, SAV, oyster/shell, inlets, state nursery, The Point, Ten Fathom Ledge, Big Rock, Hoyt Hills
SAFMC	Snapper Grouper	Blueline tilefish	*Caulolatilus microps*	E A		hardbottom, SAV, oyster/shell, inlets, state nursery, The Point, Ten Fathom Ledge, Big Rock, Hoyt Hills
SAFMC	Snapper Grouper	Golden tilefish	*Lopholatilus chamaeleonticeps*	A		hardbottom, SAV, oyster/shell, inlets, state nursery, The Point, Ten Fathom Ledge, Big Rock, Hoyt Hills
SAFMC	Snapper Grouper	Gray snapper	*Lutjanus griseus*	L A	P J A	hardbottom, SAV, oyster/shell, inlets, state nursery, The Point, Ten Fathom Ledge, Big Rock, Hoyt Hills
SAFMC	Snapper Grouper	Greater amberjack	*Seriola dumerili*	J A		hardbottom, SAV, oyster/shell, inlets, state nursery, The Point, Ten Fathom Ledge, Big Rock, Hoyt Hills

Table 2.5 – continued. Essential Fish Habitat (EFH) Species for Coastal North Carolina.[1]

Management Plan Agency[2]	Management Plan Species Group	Common Name Of Species	Scientific Name Of Species	EFH for Life Stages by Ecosystem[3]		Geographically Defined Habitat Areas Of Particular Concern (HAPC) (North Carolina Locations Only)
				Marine	Estuarine	
SAFMC	Snapper Grouper	Goliath Grouper	*Epinephelus itajara*	Florida only	Florida only	hardbottom, SAV, oyster/shell, inlets, state nursery, The Point, Ten Fathom Ledge, Big Rock, Hoyt Hills
SAFMC	Snapper Grouper	Mutton snapper	*Lutjanus analis*	Florida only	Florida only	hardbottom, SAV, oyster/shell, inlets, state nursery, The Point, Ten Fathom Ledge, Big Rock, Hoyt Hills
SAFMC	Snapper Grouper	Red snapper	*Lutjanus campechanus*	L P J A		hardbottom, SAV, oyster/shell, inlets, state nursery, The Point, Ten Fathom Ledge, Big Rock, Hoyt Hills
SAFMC	Snapper Grouper	Scamp	*Mycteroperca phenax*	A		hardbottom, SAV, oyster/shell, inlets, state nursery, The Point, Ten Fathom Ledge, Big Rock, Hoyt Hills
SAFMC	Snapper Grouper	Silk snapper	*Lutjanus vivanus*	J A		hardbottom, SAV, oyster/shell, inlets, state nursery, The Point, Ten Fathom Ledge, Big Rock, Hoyt Hills
SAFMC	Snapper Grouper	Snowy grouper	*Epinephelus niveatus*	E L A		hardbottom, SAV, oyster/shell, inlets, state nursery, The Point, Ten Fathom Ledge, Big Rock, Hoyt Hills
SAFMC	Snapper Grouper	Speckled hind	*Epinephelus drummondhayi*	A		hardbottom, SAV, oyster/shell, inlets, state nursery, The Point, Ten Fathom Ledge, Big Rock, Hoyt Hills

Table 2.5 – continued. Essential Fish Habitat (EFH) Species for Coastal North Carolina.[1]

Management Plan Agency[2]	Management Plan Species Group	Common Name Of Species	Scientific Name Of Species	EFH for Life Stages by Ecosystem[3]		Geographically Defined Habitat Areas Of Particular Concern (HAPC) (North Carolina Locations Only)
				Marine	Estuarine	
SAFMC	Snapper Grouper	Red snapper	*Lutjanus campechanus*	L P J A		hardbottom, SAV, oyster/shell, inlets, state nursery, The Point, Ten Fathom Ledge, Big Rock, Hoyt Hills
SAFMC	Snapper Grouper	Scamp	*Mycteroperca phenax*	A		hardbottom, SAV, oyster/shell, inlets, state nursery, The Point, Ten Fathom Ledge, Big Rock, Hoyt Hills
SAFMC	Snapper Grouper	Silk snapper	*Lutjanus vivanus*	J A		hardbottom, SAV, oyster/shell, inlets, state nursery, The Point, Ten Fathom Ledge, Big Rock, Hoyt Hills
SAFMC	Snapper Grouper	Snowy grouper	*Epinephelus niveatus*	E L A		hardbottom, SAV, oyster/shell, inlets, state nursery, The Point, Ten Fathom Ledge, Big Rock, Hoyt Hills
SAFMC	Snapper Grouper	Speckled hind	*Epinephelus drummondhayi*	A		hardbottom, SAV, oyster/shell, inlets, state nursery, The Point, Ten Fathom Ledge, Big Rock, Hoyt Hills
SAFMC	Snapper Grouper	Vermillion snapper	*Rhomboplites aurorubens*	J A		hardbottom, SAV, oyster/shell, inlets, state nursery, The Point, Ten Fathom Ledge, Big Rock, Hoyt Hills
SAFMC	Snapper Grouper	Warsaw grouper	*Epinephelus nigritus*	E A		hardbottom, SAV, oyster/shell, inlets, state nursery, The Point, Ten Fathom Ledge, Big Rock, Hoyt Hills
SAFMC	Snapper Grouper	White grunt	*Haemulon plumieri*	E L A		hardbottom, SAV, oyster/shell, inlets, state nursery, The Point, Ten Fathom Ledge, Big Rock, Hoyt Hills

Table 2.5 – continued. Essential Fish Habitat (EFH) Species for Coastal North Carolina.[1]

Management Plan Agency[2]	Management Plan Species Group	Common Name Of Species	Scientific Name Of Species	EFH for Life Stages by Ecosystem[3]		Geographically Defined Habitat Areas Of Particular Concern (HAPC) (North Carolina Locations Only)
				Marine	Estuarine	
SAFMC	Snapper Grouper	Wreckfish	*Polyprion americanus*	A		hardbottom, SAV, oyster/shell, inlets, state nursery, The Point, Ten Fathom Ledge, Big Rock, Hoyt Hills
SAFMC	Spiny Lobster	Spiny Lobster	*Panulirus argus*	L J A	L J A	Spiny lobster EFH and HAPC located only in Florida
SAFMC	Dolphin-Wahoo	Common Dolphin	*Coryphaena hippurus*	ELPJSA		The Point, Ten Fathom Ledge, and Big Rock, Pelagic Sargassum
SAFMC	Dolphin-Wahoo	Pompano Dolphin	*C. equiselis*	ELPJSA		The Point, Ten Fathom Ledge, and Big Rock, Pelagic Sargassum
SAFMC	Dolphin-Wahoo	Wahoo	*Acanthocybium solanderi*	ELPJSA		The Point, Ten Fathom Ledge, and Big Rock, Pelagic Sargassum
SAFMC	Sargassum	Sargassum	*Sargassum sp.*			
MAFMC	Atlantic Mackerel, Squid, Butterfish	Atlantic butterfish	*Peprilus triacanthus*			
MAFMC	Atlantic Mackerel, Squid, Butterfish	Atlantic mackerel	*Scomber scombrus*			
MAFMC	Atlantic Mackerel, Squid, Butterfish	Long finned squid	*Loligo pealei*			
MAFMC	Atlantic Mackerel, Squid, Butterfish	Short finned squid	*Illex illecebrosus*			
MAFMC	Atlantic Surfclam & Ocean Quahog	Ocean quahog	*Artica islandica*			
MAFMC	Atlantic Surfclam & Ocean Quahog	Surfclam	*Spisula solidissima*			

Table 2.5 – continued. Essential Fish Habitat (EFH) Species for Coastal North Carolina.[1]

Management Plan Agency[2]	Management Plan Species Group	Common Name Of Species	Scientific Name Of Species	EFH for Life Stages by Ecosystem[3]		Geographically Defined Habitat Areas Of Particular Concern (HAPC) (North Carolina Locations Only)
				Marine	Estuarine	
MAFMC	Bluefish	Bluefish	*Pomatomus saltatrix*	L J A	J A	
MAFMC	Spiny Dogfish	Spiny dogfish	*Squalus acanthias*	J A		
MAFMC	Summer Flounder, Scup, Black Sea Bass	Scup	*Stenotomus chrysops*			
MAFMC	Summer Flounder, Scup, Black Sea Bass	Scup	*Stenotomus chrysops*			
MAFMC	Summer Flounder, Scup, Black Sea Bass	Summer flounder	*Paralichthys dentatus*	L J A	L J A	SAV for larvae and juveniles
MAFMC	Summer Flounder, Scup, Black Sea Bass	Black sea bass	*Centropristis striata*			
MAFMC	Atlantic Mackerel, Squid, Butterfish	Atlantic butterfish	*Peprilus triacanthus*			
MAFMC	Summer Flounder, Scup, Black Sea Bass	Scup	*Stenotomus chrysops*			
MAFMC	Summer Flounder, Scup, Black Sea Bass	Summer flounder	*Paralichthys dentatus*	L J A	L J A	SAV for larvae and juveniles

Table 2.5 – continued. Essential Fish Habitat (EFH) Species for Coastal North Carolina.[1]

Management Plan Agency[2]	Management Plan Species Group	Common Name Of Species	Scientific Name Of Species	EFH for Life Stages by Ecosystem[3]		Geographically Defined Habitat Areas Of Particular Concern (HAPC) (North Carolina Locations Only)
				Marine	Estuarine	
NMFS	Billfish	Blue marlin	*Makaira nigricans*	E L J A		
NMFS	Billfish	Longbill spearfish	*Tetrapturus pfluegeri*	J A		
NMFS	Billfish	Sailfish	*Istiophorus platypterus*	E L J A		
NMFS	Billfish	White marlin	*Tetrapturus albidus*	J A		
NMFS	Sharks	Atlantic angel shark	*Squatina dumerili*			
NMFS	Sharks	Atlantic sharpnose shark	*Rhizoprionodon terraenovae*	J A	J	
NMFS	Sharks	Basking shark	*Cetorhinos maximus*			
NMFS	Sharks	Big nose shark	*Carcharhinus altimus*	J		
NMFS	Sharks	Bigeye sand tiger shark	*Odontaspis noronhai*			
NMFS	Sharks	Bigeye sixgill shark	*Hexanchus vitulus*			
NMFS	Sharks	Bigeye thresher shark	*Alopias superciliosus*	E L P J S A		
NMFS	Sharks	Blacknose shark	*Carcharhinus acronotus*	J A		
NMFS	Sharks	Blacktip shark	*Carcharhinus limbatus*	J A		
NMFS	Sharks	Blue shark	*Prionace glauca*	J S A		
NMFS	Sharks	Bonnethead	*Sphyrna tiburo*	J A	J A	
NMFS	Sharks	Bull shark	*Carcharhinus leucas*	J	J	
NMFS	Sharks	Caribbean reef shark	*Carcharhinus perezi*	Florida only		
NMFS	Sharks	Carribean sharpnose shark	*Rhizoprionodon porosus*			
NMFS	Sharks	Dusky shark	*Carcharhinus obscurus*	A	J A	

Table 2.5 – continued. Essential Fish Habitat (EFH) Species for Coastal North Carolina.[1]

Management Plan Agency[2]	Management Plan Species Group	Common Name Of Species	Scientific Name Of Species	EFH for Life Stages by Ecosystem[3]		Geographically Defined Habitat Areas Of Particular Concern (HAPC) (North Carolina Locations Only)
				Marine	Estuarine	
NMFS	Sharks	Finetooth shark	*Carcharhinus isodon*	E L P J S A		
NMFS	Sharks	Longfin mako shark	*Isurus paucus*	E L P J S A		
NMFS	Sharks	Narrowtooth shark	*Carcharhinus brachyurus*			
NMFS	Sharks	Night shark	*Carcharhinus signatus*	J A		
NMFS	Sharks	Nurse shark	*Ginglymostoma cirratum*	J A		
NMFS	Sharks	Oceanic whitetip shark	*Carcharhinus longimanus*	J S A		
NMFS	Sharks	Porbeagle shark	*Lamna nasus*			
NMFS	Sharks	Sand tiger shark	*Odontaspis taurus*	J A		
NMFS	Sharks	Sandbar shark	*Carcharhinus plumbeus*	J A	J A	Pamlico Sound adjacent to Hatteras and Ocracoke Islands and offshore
NMFS	Sharks	Scalloped hammerhead	*Sphyrna lewini*	J A		
NMFS	Sharks	Sharpnose sevengill shark	*Heptranchias perlo*			
NMFS	Sharks	Shortfin mako shark	*Isurus oxyrinchus*	E L P J S A		
NMFS	Sharks	Silky shark	*Carcharhinus falciformis*	J		
NMFS	Sharks	Sixgill shark	*Hexanchus griseus*			
NMFS	Sharks	Smalltail shark	*Carcharhinus porosus*			
NMFS	Sharks	Smooth hamerhead	*Sphyrna zygaena*			
NMFS	Sharks	Spinner shark	*Carcharhinus brevipinna*	J A		
NMFS	Sharks	Thresher shark, common	*Alopias vulpinus*			
NMFS	Sharks	Tiger shark	*Galeocerdo cuvieri*	J S A		
NMFS	Sharks	White shark	*Carcharodon carcharias*	J		

Table 2.5 – continued. Essential Fish Habitat (EFH) Species for Coastal North Carolina.[1]

Management Plan Agency[2]	Management Plan Species Group	Common Name Of Species	Scientific Name Of Species	EFH for Life Stages by Ecosystem[3]		Geographically Defined Habitat Areas Of Particular Concern (HAPC) (North Carolina Locations Only)
				Marine	Estuarine	
NMFS	Swordfish	Swordfish	*Xiphias gladius*	E L J S A		
NMFS	Tuna	Albacore	*Thunnus alalunga*	A		
NMFS	Tuna	Atlantic bigeye tuna	*Thunnus obesus*	J A		
NMFS	Tuna	Atlantic Yellowfin tuna	*Thunnus albacares*	E L J S A		
NMFS	Tuna	Skipjack tuna	*Katsuwonus pelamis*	E L J S A		
NMFS	Tuna	Western Atlantic bluefin tuna	*Thunnus thynnus*	E L J S A		

Notes:
1. These Essential Fish Habitat species were compiled from Essential Fish Habitat: A Marine Fish Habitat Conservation Mandate for Federal Agencies. February 1999 (Revised 08/2004) (Appendices 2, 3, 6, 7, and 8). Although 46 species are listed in Appendix 3 under National Marine Fisheries Service management, only 35 of these species have EFH listed in Appendix 8.
2. Organizations responsible for Fishery Management Plans include: SAFMC = South Atlantic Fishery Management Council; MAFMC = Mid-Atlantic Fishery Management Council; NMFS = National Marine Fisheries Service.
3. Life stages include: E = Eggs, L = Larvae, P = PostLarvae, J = Juveniles, S = SubAdults, A = Adults

(End of Table 2.5)

Table 2.6. Categories of Essential Fish Habitat and Habitat Areas of Particular Concern identified in Fishery Management Plan Amendments affecting the South Atlantic Area.[1, 2]

ESSENTIAL FISH HABITAT	GEOGRAPHICALLY DEFINED HABITAT AREAS OF PARTICULAR CONCERN
Estuarine Areas	**Area – Wide**
Estuarine Emergent Wetlands	Council-designated Artificial Reef Special Management Zones
Estuarine Scrub / Shrub Mangroves	Hermatypic (reef-forming) Coral Habitat & Reefs
Submerged Aquatic Vegetation (SAV)	Hard Bottoms
Oyster Reefs & Shell Banks	Hoyt Hills
Intertidal Flats	*Sargassum* Habitat
Palustrine Emergent & Forested Wetlands	State-designated Areas of Importance of Managed Species
Aquatic Beds	Submerged Aquatic Vegetation
Estuarine Water Column[2]	
Seagrass	
Creeks	
Mud Bottom	
Marine Areas	**North Carolina**
Live / Hard Bottoms	Big Rock
Coral & Coral Reefs	Bogue Sound
Artificial / Manmade Reefs	Pamlico Sound at Hatteras / Ocracoke Islands
Sargassum	Capes Fear, Lookout, & Hatteras (sandy shoals)
Water Column[2]	New River
	The Ten Fathom Ledge
	The Point

[1]Essential Fish Habitat areas are identified in Fishery Management Plan Amendments for the South Atlantic and Mid-Atlantic Fishery Management Councils. Geographically Defined Habitat Areas of Particular Concern are identified in Fishery Management Plan Amendments affecting the South Atlantic Area. Information in this table was derived from Essential Fish Habitat: A Marine Fish Habitat Conservation Mandate for Federal Agencies. February 1999 (Revised 08/2004) (Appendices 4 and 5).

[2]EFH for species managed under NMFS Billfish and Highly Migratory Species generally falls within the marine and estuarine water column habitats designated by the Fishery Management Councils.

2.02 Terrestrial Environment

2.02.1 Maritime Shrub Thickets

This community normally occurs landward of the dune where it is protected from salt spray and the full force of ocean winds. Maritime shrub thicket is located sporadically

throughout Surf City and North Topsail Beach, occurring on the backside of the island, west of the highway, and is interspersed with marsh areas, which border the sound. Dominant shrubs and trees in this community are wax myrtle (*Myrica cerifera*), yaupon (*Ilex vomitoria*), red cedar (*Juniperus virginica*), live oak (*Quercus virginiana*), and loblolly pine (*Pinus taeda*). Vines are also common with greenbriar (*Smilax bonanox*), pepper-vine (*Ampelopsis arbore*a) and grape (*Vitus rotundifolia*) being particularly abundant. This community type offers excellent cover for neo-tropical migrating songbirds. Other important species that may be found in the maritime thicket include the seaside sparrow, painted bunting, saltmarsh sharp-tailed sparrow, Nelson's sharp-tailed sparrow, and marsh and sedge wrens. Raptors may also be common during migration (e.g. American kestrel, merlin, peregrine falcon, bald eagle, northern harrier) (Sue Cameron, pers. comm.).

2.02.2 Beach and Dune

Terrestrial areas that may be influenced by the proposed actions include a 9.9 mile area that includes all of Surf City (reaches 27-58) and the southern 3.8 miles of North Topsail Beach (reaches 58-78). Terrestrial habitat types within these areas include sandy or sparsely vegetated beaches and vegetated dune communities. The first line of stable vegetation is outside or landward of the proposed project limits. Utility corridors may have herbaceous or shrub cover. Barren areas are also widespread due to the disturbed nature of the utility corridors. Mammals occurring within this environment are opossums, cottontails, red foxes, gray foxes, raccoons, feral house cats, shrews, moles, voles, and house mice.

Among North Carolina's upland habitats, the beach and dune community could be considered depauperate in both plants and animals. The beach environment is severe due to constant exposure to salt spray, shifting sands, wind, and sterile soils with low water retention capacity. Common vegetation of the upper beach includes beach spurge (*Euphorbia polygonifolia*), sea rocket (*Cakile edentula*) and pennywort (*Hydrocotyle bonariensis*). The dunes are more heavily vegetated, and common species include American beach grass (*Ammophila breviligulata*), panic grass (*Panicum amarum*), sea oats (*Uniola paniculata*), broom straw (*Andropogon virginicus*), seashore elder (*Iva imbricata*), and salt meadow hay (*Spartina patens*) (Nash and Rogers, 2003). Seabeach amaranth is present throughout Surf City and North Topsail Beach and is addressed in Appendix I. Important macro-invertebrates of the beach/dune community include the mole crab (*Emerita talpoida*), coquina clams (*Donax varia*bilis) (See Section 2.01.8), and ghost crabs (*Ocypode quadrata*).

Ghost crabs occupy the upper zone of the beach environment and functions as an important predator in the beach community. Up to 60% of their diet consists of mole crabs up to 25% consists of coquina clams (Wolcott, 1978). During the sea turtle nesting season, ghost crabs are also known to prey on incubating sea turtle eggs and newly hatched sea turtle hatchlings. *Ocypode quadrata* is the only ghost crab occurring in the southeastern United States and, though little is know regarding its life history aspects, the various reproductive and larval components most likely reflect that of other decapods.

Though timing of recruitment is poorly understood, it most likely occurs between late spring and early fall (Hackney *et al*., 1996).

2.02.3 Birds

Birds common to the nearshore ocean in the project area include loons, grebes, gannets, cormorants, scoters, red-breasted mergansers, gulls, and terns. The waters off of Topsail Island are very important to migrating and wintering northern gannets, loons and grebes because of the abundant hard bottom habitat located offshore of Surf City and North Topsail Beach (See Section 2.01.10) (Sue Cameron, pers. comm.). The USFWS indicate that sea ducks raft in large numbers in the nearshore ocean waters of the project area during spring and fall migrations. Ducks, geese, and many kinds of shorebirds may also be found here during the spring and fall.

The beaches and inlets of the project vicinity are heavily used by migrating shorebirds. However, dense development and high public use of project area ocean front beaches may reduce their value to shorebirds. Along the ocean beach, black-bellied plovers, ruddy turnstones, whimbrels, willets, red knots, semi-palmated sandpipers, and sanderlings may be found. Table 2.7 provides a more complete list of waterbirds found in the project area. The dunes of the project area support fewer numbers of birds but can be very important habitats for resident species and for other species of songbirds during periods of migration. The maritime forest along Topsail Island is important for painted buntings and in the herbaceous dune areas, the American kestrel, merlin, bald eagle, peregrine falcon, northern harrier, and other raptors may be found during migration. Other birds occurring in this area are mourning doves, swallows, fish crows, starlings, meadowlarks, redwinged blackbirds, boat tailed grackles, and savannah sparrows.

The black skimmer, least tern, and common tern are State listed species of concern for Pender and Onslow counties, North Carolina and are found on Topsail Island year round during both the breeding season and during migration, with peak abundance occurring in the summer months. Terns feed by diving from the air upon insects and small fish and the black skimmer feeds on shrimp or small fish by flying just above the water with the tip of the long lower mandible shearing the surface. All of these bird species may use Topsail Island for roosting, foraging, breeding, and nesting (Potter et al., 1980).

Table 2.7. List of waterbirds that occur within the Surf City and North Topsail Beach project area and their status (LeGrand, 1983).

Common Name	Scientific Name	Season[1]	NC Status[2]
Red-throated loon	*Gavia stellata*	M, W	
Common loon	*Gavia immer*	M, W	
Horned Grebe	*Podiceps auritus*	M, W	
Brown pelican	*Pelecanus occidentalis*	B, M, W	SR
Double-crested cormorant	*Phalacrocorax auritus*	B, M, W	SR
Northern Gannet	*Morus bassanus*	M, W	
Great blue heron	*Ardea herodias*	B, M, W	
Great egret	*Ardea albus*	B, M, W	
Snowy egret	*Egretta thula*	B, M	SC
Reddish egret	*Egretta rufescens*	M	
Tricolored heron	*Egretta tricolor*	B, M	SC
Little blue heron	*Egretta caerulea*	B. M. W	SC
Black-crowned night heron	*Nycticorax nycticorax*	B, M, W	
White ibis	*Eudocimus albus*	B, M, W	
Glossy ibis	*Plegadis falcinellus*	B, M	SC
Osprey	*Pandion haliaetus*	B, M	
Clapper rail	*Rallus longirostris*	B, M, W	
Black-bellied plover	*Pluvialis squatarola*	M, W	
Wilson's plover	*Charadrius wilsonia*	B, M	SR
Semipalmated plover	*Charadrius semipalmatus*	M	
Piping plover	*Charadrius melodus*	B, M, W	T (T)
Killdeer	*Charadrius vociferus*	B, M, W	
American oystercatcher	*Haematopus palliatus*	B, M, W	SR
American avocet	*Recurvirostra americana*	M	
Black-necked stilt	*Himantopus mexicanus*	B, M	SR
Greater yellowlegs	*Tringa melanoleuca*	M, W	
Lesser yellowlegs	*Tringa flavipes*	M, W	
Willet	*Catoptrophorus semipalmatus*	B, M, W	
Spotted sandpiper	*Actitis macularia*	M	
Whimbrel	*Numenius phaeopus*	M	
Marbled godwit	*Limosa fedoa*	M, W	
Ruddy turnstone	*Arenaria interpres*	M, W	
Sanderling	*Calidris alba*	M, W	
Semipalmated sandpiper	*Calidris pusilla*	M	
Western sandpiper	*Calidris mauri*	M, W	
Least sandpiper	*Calidris minutilla*	M, W	
Red Knot	*Calidris canutus*	M, W	
Dunlin	*Calidris alpina*	M, W	

Table 2.7 – continued. List of waterbirds that occur within the Surf City and North Topsail Beach project area and their status (LeGrand, 1983).

Common Name	Scientific Name	Season[1]	NC Status[2]
Short-billed dowitcher	*Limnodromus griseus*	M, W	
Bonaparte's gull	*Larus philadelphia*	M, W	
Laughing gull	*Larus atricilla*	B, M	
Ring-billed gull	*Larus delawarensis*	M, W	
Herring gull	*Larus argentatus*	B, M, W	
Great black-backed gull	*Larus marinus*	B, M, W	
Gull-billed tern	*Sterna nilotica*	B, M	T
Caspian tern	*Sterna caspia*	B, M, W	SR
Royal tern	*Sterna maxima*	B, M, W	
Sandwich tern	*Sterna sandvicensis*	B, M	
Common tern	*Sterna hirundo*	B, M	SC
Forster's tern	*Sterna forsteri*	B, M, W	
Least tern	*Sterna antillarum*	B, M	SC
Black tern	*Chlidonias nigra*	M	
Black skimmer	*Rynchops niger*	B, M	SC

[1] Season: B = Breeding; M = Migrating; W = Wintering

[2] NC Status: Endangered (E); Threatened (T); Special Concern (SC); Significantly Rare (SR). E, T, and SC status species are given legal protection status by the NC Wildlife Resources Commission. SR status is defined as any species which has not been listed by the NC Wildlife Resources Commission as E, T, or SC species, but which exists in the state in small numbers and has been determined by the NC Natural Heritage Program to need monitoring. Federal status is indicated in parentheses.

Annual shorebird surveys conducted by the NCWRC within the project vicinity are limited and complete surveys for American oystercatchers and Wilson's plovers have only been conducted in 2004 and 2007. However, annual surveys for nesting piping plovers in appropriate habitat have been conducted since 1989 and complete coast-wide wintering surveys were conducted most recently in 1996, 2001, and 2006. Table 2.8 summarizes the Topsail Island vicinity annual shorebird surveys and database provided by NCWRC. Surveys encompassed the wintering, breeding, and spring and fall migration periods.

Table 2.8. Summary of annual shorebird surveys. *Piping plover surveys conducted during the winter did not identify any birds. (AIWW – Atlantic Intracoastal Waterway; UNI – Un-named Island)

SPECIES	SITE	BIRDS	BREEDING PAIRS
American Oystercatcher	AIWW Bogue Inlet south to North Topsail	14	6
	AIWW North Topsail south to S. Figure Eight	32	14
	AIWW South Topsail	21	10
	New River Inlet	23	10
	Topsail Beach North	2	1
	UNI, New River Channel 1	2	1
	UNI, New River Channel 2	4	2
	UNI, New River Channel 3	10	5
	UNI, New River Channel 4	2	1
	TOTAL	**110**	**50**
Black-necked Stilt	Surf City, AIWW 1	1	
	TOTAL	**1**	**0**
Killdeer	AIWW Bogue Inlet south to North Topsail	4	2
	AIWW North Topsail south to S. Figure Eight	4	2
	AIWW South Topsail	2	1
	North Topsail Overwash	2	1
	Topsail Beach North	4	2
	UNI, New River Channel 2	4	2
	UNI, New River Channel 3	4	2
	TOTAL	**24**	**12**
Piping Plover*	North Topsail Overwash	0	0
	Topsail Beach North	10	2
	TOTAL	**10**	**2**
Willet	AIWW Bogue Inlet south to North Topsail	20	10
	AIWW North Topsail south to S. Figure Eight	22	11
	AIWW South Topsail	1	1
	New River Inlet	24	12
	North Topsail Overwash	2	1
	Topsail Beach North	20	10
	UNI, New River Channel 2	4	2
	UNI, New River Channel 3	20	10
	UNI, New River Channel 4	6	3
	TOTAL	**119**	**60**
Wilsons Plover	AIWW Bogue Inlet south to North Topsail	22	11
	North Topsail Overwash	40	19
	Topsail Beach North	41	18
	UNI, New River Channel 1	4	2
	UNI, New River Channel 2	14	7
	UNI, New River Channel 3	4	2
	TOTAL	**125**	**59**

Colonially nesting waterbirds are an important part of the project area ecosystem. These species formerly nested primarily on the barrier islands of the region but have had most of these nesting sites usurped by development or recreational activities. With the loss of their traditional nesting areas, these species have retreated to the relatively undisturbed dredged material disposal islands, which border the navigation channels throughout the State. These islands often offer ideal nesting areas as they are close to food sources, well removed from human activities, and are isolated from mammalian egg and nesting predators. Other species also use the islands for loafing or roosting during migratory periods or the winter months including painted buntings. Surveys conducted by the NCWRC for American oystercatchers and Wilson's plovers indicate that the dredge islands, natural islands, and shell rakes behind Topsail Island are very important nesting areas for these species. However, dredged material islands within the immediate vicinity of the project area that are diked are used by only a small number of nesting waterbirds. Since 1972, Coast-wide breeding colonial waterbird surveys have been conducted every 2-3 years with the most recent completed survey conducted in 2007. Seven of the survey sites are located within the project vicinity and, between 1972 and 2007, have supported a total of 978 nests from 9 different species of colonial nesting waterbirds (Table 2.9).

Table 2.9. Summary of colonial nesting waterbird data (1972-2007) conducted by NCWRC within the SCNTB vicinity. (AIWW – Atlantic Intracoastal Waterway; UNI – Un-named Island) (Shaded areas represent 0 documented nesting records)

SITE	Colonial Nesting Waterbirds (# of nests from 1972 through 2007)								
	Green Heron	Least Tern	Black Skimmer	Common Tern	Gull Billed Tern	Cattle Egret	Little Blue Heron	Snowy Egret	Tri-colored Heron
UNI, New River Channel 1	2	66							
UNI, New River Channel 2	65	297	25	6					
UNI, New River Channel 3	64	18	5	14	4				
UNI, New River Channel 4	13								
UNI, Alligator Bay 1	33					75	49	10	11
ICW, Dredge Island South of Surf City		29							
New Chadwick Bay Inlet		192							
TOTAL	177	602	30	20	4	75	49	10	11

Though most of the project area is heavily developed, the southern end of Topsail island and the north end of North Topsail Beach, as well as nearby Lea and Hutaff islands and Onslow beaches, provide important and unique undeveloped habitat for breeding birds including terns, skimmers, piping plovers, Wilson's plovers, and American oystercatchers. These undeveloped barrier island areas are rare within the project vicinity and are very important breeding habitats for these species. The north end of North Topsail Beach is important for many shorebird and water bird species and secretive marsh birds such as sharp-tailed sparrows. Though historically the north end of North Topsail Island had not been roped off for nesting shorebirds, in 2008 the NCWRC was permitted to post a section of the north end for nesting birds and a colony of least terns (~40 pairs) attempted to nest. Furthermore, a single migrant piping plover was identified utilizing an area on the north end. Information on birds utilizing the north end of North Topsail Beach as well as the ocean facing beaches of the project area during the non-breeding season are limited. However, as a component of the ongoing shorebird monitoring plan for the non-federal North Topsail Beach coastal storm damage reduction project, Coastal Planning and Engineering, Inc. (CPE) has been conducting regular surveys of the North Topsail Beach and New River Inlet vicinity. Specifically, seven bird monitoring transect areas have been surveyed by CPE within the New River Inlet complex since 19 November 2007. As identified in the pre-construction bird monitoring plan of the November 2007 Draft Environmental Impact Statement (USACE, 2007b), the transect sites include: transect No. 1 - Riverside of North Topsail Beach inlet shoreline beginning at River Road; transect No. 2 - Oceanside of North Topsail Beach inlet

shoreline beginning at the southeastern end of Topsail Reefs Condominiums and ending at River Road; transect No. 3 - Onslow Beach inlet shoreline extending approximately 1,060 m (3,500 ft) to the northeast; transect No. 4 - shoal formations approximately 609 m (2,000 ft) north of inlet mouth; and transect No. 5 - subtidal habitat of New River Inlet and oceanfront surf zones of transects 2 and 3. The pre-project data collection component of the monitoring plan as well as a detailed analysis and summary of the data has not yet been completed by CPE. However, in order to provide a preliminary assessment of key species within the proposed federal project vicinity that utilize habitat on the north end of North Topsail Beach, a summary of the current data within transects 1 and 2 (located on the north end of North Topsail Beach) is provided in Table 2.10. Of particular importance are the state listed species which include the black skimmer (*Rynchops niger*) (n=2) (species of concern), least tern (*Sterna antillarum*) (n=197) (species of concern), and common tern (*Sterna hirundo*) (n=57) (species of concern), Wilsons plover (*Charadrius wilsonia*) (n=38) (significantly rare), American oystercatcher (*Haematopus palliates*) (n=61) (significantly rare), as well as the federally listed Piping Plover (threatened) (n=1).

Table 2.10. Summary of key waterbird species identified along the inlet and ocean facing shorelines of North Topsail Beach based on ongoing pre-construction monitoring performed by CPE as a component of the bird monitoring plan for the non-federal North Topsail Beach Shoreline Protection Project (USACE, 2007b)

SPECIES	**Survey Period**				**TOTAL**
	WINTER (Nov - Feb)	SPRING (Mar - Jun)	SUMMER (Jul-Aug)	FALL (Sept - Oct)	
Common Loon	7	1	0	0	**8**
Brown Pelican	84	73	22	42	**221**
Double-crested Cormorant	112	22	3	1	**138**
Great Blue Heron	1	0	5	4	**10**
Great Egret	0	0	77	46	**123**
Snowy Egret	0	0	17	19	**36**
Little Blue Heron	0	0	11	5	**16**
Tricolored Heron	0	0	1	1	**2**
White Ibis	13	0	12	35	**60**
Glossy Ibis	0	0	0	0	**0**
Black-bellied Plover	22	16	17	38	**93**
Wilson's Plover	0	3	30	5	**38**
Semipalmated Plover	0	0	61	66	**127**
Piping Plover	0	0	1	0	**1**
Killdeer	0	2	3	0	**5**
American Oystercatcher	0	2	28	31	**61**
Greater Yellowlegs	9	3	6	10	**28**
Solitary Sandpiper	0	0	0	0	**0**
Willet	6	11	31	15	**63**
Spotted Sandpiper	0	0	2	1	**3**
Whimbrel	0	0	0	0	**0**
Marbled Godwit	0	0	1	0	**1**

Table 2.10 – continued. Summary of key waterbird species identified along the inlet and ocean facing shorelines of North Topsail Beach based on ongoing pre-construction monitoring performed by CPE as a component of the bird monitoring plan for the non-federal North Topsail Beach Shoreline Protection Project (USACE, 2007b)

SPECIES	Survey Period				TOTAL
	WINTER (Nov - Feb)	SPRING (Mar - Jun)	SUMMER (Jul-Aug)	FALL (Sept - Oct)	
Ruddy Turnstone	15	3	9	24	**51**
Red Knot	59	0	4	0	**63**
Sanderling	22	7	101	114	**244**
Semipalmated Sandpiper	0	0	29	29	**58**
Western Sandpiper	17	22	4	28	**71**
Least Sandpiper	0	0	31	44	**75**
Pectoral Sandpiper	0	0	0	0	**0**
Dunlin	309	87	0	12	**408**
Short-billed Dowitcher	39	0	104	95	**238**
Long-billed Dowitcher	0	0	0	1	**1**
Laughing Gull	432	30	479	1174	**2115**
Bonaparte's Gull	167	104	0	0	**271**
Ring-billed Gull	658	147	88	138	**1031**
Herring Gull	256	12	68	184	**520**
Lesser Black-backed Gull	0	0	0	2	**2**
Great Black-backed Gull	129	2	18	51	**200**
Gull-billed Tern	0	0	0	0	**0**
Caspian Tern	0	0	16	186	**202**
Royal Tern	0	2	147	232	**381**
Sandwich Tern	1	1	96	148	**246**
Common Tern	0	0	7	50	**57**
Forster's Tern	14	5	0	147	**166**
Least Tern	0	76	121	0	**197**
Black Tern	0	0	1	0	**1**
Black Skimmer	0	0	2	93	**95**
TOTAL	**2372**	**631**	**1653**	**3071**	**7727**

2.02.4 Endangered and Threatened Species

Updated lists of federally listed threatened and endangered (T&E) species for the project area (Pender and Onslow Counties, NC) were obtained from the NMFS (Southeast Regional Office, St. Petersburg, FL) (http://sero.nmfs.noaa.gov/pr/pdf/North%20Carolina.pdf) and the USFWS (Field Office, Raleigh, NC) (http://www.fws.gov/raleigh/es_tes.html) websites. These were combined to develop a composite list of T&E species that could be present in the area based upon their historical occurrence or potential geographic range (Table 2.11). However, the actual occurrence of a species in the area depends upon the availability of suitable habitat, the season of the year relative to a species' temperature tolerance, migratory

habits, and other factors. The likelihood of occurrence and potential project impacts regarding T&E species are provided in the Biological Assessment (Appendix I.)

Table 2.11. Federally listed threatened and endangered (T&E) species for the project area (Pender and Onslow Counties, NC).

Species Common Names	**Scientific Name**	**Federal Status**
Mammals		
West Indian Manatee	*Trichechus manatus*	Endangered
North Atlantic Right whale	*Eubaleana glacialis*	Endangered
Sei whale	*Balaenoptera borealis*	Endangered
Sperm whale	*Physeter macrocephalus*	Endangered
Finback whale	*Balaenoptera physalus*	Endangered
Humpback whale	*Megaptera novaeangliae*	Endangered
Blue Whale	*Balaenoptera musculus*	Endangered
Birds		
Piping Plover	*Charadrius melodus*	Threatened
Red-cockaded woodpecker	*Picoides borealis*	Endangered
Reptiles		
American alligator	*Alligator mississippiensis*	T(S/A)
Green sea turtle	*Chelonia mydas*	Threatened[1]
Hawksbill turtle	*Eretmochelys imbricata*	Endangered
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered
Leatherback sea turtle	*Dermochelys coriacea*	Endangered
Loggerhead sea turtle	*Caretta caretta*	Threatened
Fish		
Shortnose sturgeon	*Acipenser brevirostrum*	Endangered
Vascular Plants		
Golden sedge	*Carex lutea*	Endangered
Chaffseed	*Schwalbea Americana*	Endangered
Cooley's meadowrue	*Thalictrum cooleyi*	Endangered
Rough-leaved loosestrife	*Lysimachia asperulaefolia*	Endangered
Seabeach amaranth	*Amaranthus pumilus*	Threatened

Status	**Definition**
Endangered	A taxon "in danger of extinction throughout all or a significant portion of its range."
Threatened	A taxon "likely to become endangered within the foreseeable future throughout all or a significant portion of its range."
T(S/A)	Threatened due to similarity of appearance (e.g., American alligator)--a species that is threatened due to similarity of appearance with other rare species and is listed for its protection. These species are not biologically endangered or threatened and are not subject to Section 7 consultation.

An updated list of State listed species for Pender County and Onslow County, North Carolina was obtained from the North Carolina Natural Heritage Program website, http://www.ncnhp.org . (Table 2.12). Bird species are addressed within Sections 2.02.3 and 8.02.3 and the Carolina diamondback terrapin is addressed in Sections 2.01.2 and 8.01.2 of this EIS.

Table 2.12. State listed species for Pender and Onslow Counties, NC.

Species Common Name	Scientific Name	State Status
Birds		
Black skimmer	*Rynchops niger*	Species of concern
Least tern	*Sterna antillarum*	Species of concern
Common tern	*Sterna hirundo*	Species of concern
Gull billed tern	*Sterna nilotica*	Threatened
Bald eagle	*Haliaeetus leucocephalus*	Threatened
Reptiles		
Carolina diamondback terrapin	*Malaclemys terrapin centrata*	Species of Concern

2.03 Physical Resources

2.03.1 Wave Conditions

Waves selected as input for the study were taken from the Corps of Engineers' Coastal and Hydraulics Laboratory Wave Information Study (WIS). Updated WIS wave hindcast data for Station 292, located about 10 miles offshore of Topsail Island for years, for the period 1990 to 1999 were used. Based on these data, waves commonly approach the southeast-facing study area from east through south directions (nearly two-thirds of the time), with east-southeast and southeast approaching waves occurring most frequently (nearly one-third of the time). Annually, the most frequently occurring wave heights range from 1.6 to 3.2 feet, with a mean wave height of about 3.3 feet. In winter, the most frequently occurring wave heights range from 1.6 up to 4.9 feet due to storms, with easterly to northeasterly approaching waves increasing in frequency. Summer wave conditions have more of a southeasterly component and are commonly in the 1 to 3 foot range, except for tropical systems that can generate the infrequent, but extreme waves of 15 feet or more.

2.03.2 Shoreline and Sand Transport

The contiguous 9.9 miles of the study area consisting of Surf City and the southern portion of North Topsail Beach was divided into 52 reaches (27 through 78), each of which were about 1000 feet wide, except for the southernmost reach (27) which was 1300 feet wide. The two separate, smaller non-CBRA sections were each divided into 2 smaller reaches of varying lengths (reaches 107-108 and 114-115). These 1,000-foot long study reaches are visible in Section 7, Figure 7.2 and in Appendix A, Figures A-7 and A-8.

Long-term shoreline changes were determined by comparing MHW shoreline positions for each reach. Between 1963 and 2002, erosion rates were relatively low (less than one foot per year) in the southern half of the main study area (reaches 27-43); however, erosion rates in the northern half of the main study area (reaches 44-78) averaged nearly 2 feet per year. Erosion rates increased significantly to over 5 feet per year in portions of the non-study CBRA area (reaches 79-106), but decreased to 2 to 3 feet per year in

reaches 107-108 study segment. Shoreline changes in reaches 114-115 study segment begin to be significantly influenced by inlet processes as erosion precipitously changed to minor accretion and then back to significant erosion within a span of only a few reaches approaching New River Inlet.

Sediment transport modeling indicates an average gross longshore transport rate of 567,000 cubic yards per year (cy/yr) for all of Topsail Island, with a northerly average net longshore transport rate of about 2,000 cy/yr for Topsail Island. The net longshore transport rate along North Topsail Beach averages about 110,000 cy/yr to the south, while net longshore transport along Surf City is to the north at about 58,000 cy/yr. See Appendix D, Section 5.b. for tabular and graphic representations of longshore transport.

2.03.3 Geology and Sediments

The study area is located in the Atlantic Coastal Plain Physiographic Province bordering Onslow Bay. The geomorphology of the area is characterized by beaches, dunes, and marshes typical of a barrier island complex. The Atlantic Coastal Plain and Onslow Bay are both underlain by relatively flat-lying sedimentary units which gently dip and thicken to the southeast. This large sedimentary wedge includes both sediments which have not been indurated or cemented and rock units. These sedimentary units range in age from Cretaceous to Quaternary and overlie crystalline basement rock. A patchy veneer of Holocene sands and gravels overlies the Quaternary strata. The sand soils found on the Topsail Island beaches are classified as fine-to-medium-grained poorly-graded sands (SP) according to the Unified Soils Classification System.

The small rivers and streams entering Onslow Bay contribute small sediment loads as a significant fraction is deposited within the estuaries. This in turn contributes to the sand-starved nature of the coast in this area.

2.03.4 Climate

The climate of Surf City and North Topsail beaches is typically seasonal and generally mild. Temperatures are moderated by the ocean temperature which ranges between 65° F -80° F in the spring and summer and 50° F - 65° F in the fall and winter. The summers are warm and humid with highs averaging between 80° F -90° F and winters are short and mild averaging around 55° F. Predominant winds in the winter are from the north and northeast whereas in the summer the winds are predominantly out of the south to southeast. Average monthly precipitation ranges from 3-8 inches throughout the year. October through December are the driest months, averaging 2-3 inches of precipitation, and July through September are the wettest months, averaging between 6-7 inches of precipitation.

Surf City and North Topsail Beach are low elevation and narrow barrier islands and the orientation of these coastal communities on the Atlantic coastline lend them particularly vulnerable to tropical systems, including a long history of hurricanes. Though a

significant number of historic hurricanes have approached within the vicinity of Topsail Island, Hurricane Bertha, in 1996, was the first direct hit on Topsail Island since Hurricane Donna in 1960. In the same year Hurricane Fran, a category 3 hurricane, struck the same area hit by Bertha with sustained winds of about 115 miles per hour and gusts to at least 125 miles per hour with significant coastal property loss extending from Cape Fear northward to Topsail Island.

Northeasters occur far more frequently than hurricanes and are much larger and longer lasting. The North Carolina coastline is vulnerable to large persistent northeasters because of its orientation to the winter track of the polar jet stream. Significant coastal storm damage can result from these storm events. The most memorable coastal northeasters of the 20th century include the 1962 Ash Wednesday Storm and the 1993 Storm of the Century which caused extensive damage on Topsail Island as well as the rest of the coastal North Carolina.

2.03.5 Physical Oceanography

The coastline of Surf City and North Topsail Beach is controlled by tidal and wind driven currents and experiences semi-diurnal tides with an average tidal range of about 3 ft. The longshore current is predominantly towards the northeast in the summer and towards the southwest in the winter. The predominant wave direction is from the South to Southeast in the spring and summer and from the North to Northeast in the Fall and Winter (See Section 2.03.1).

2.04 Socio-Economic Resources

The local economic impact area includes all of Topsail Island and the nearby areas of both Pender and Onslow Counties, North Carolina. Topsail Island includes not only Surf City and North Topsail Beach on the north end of the island but also Topsail Beach on the south end of Topsail Island. Highways 50 and 210 connect the island to the mainland portion of the two counties.

2.04.1 Demographics

Demographics for the existing economic conditions for the two-county study area include census data for population, housing, and personal income are shown in Table 2.13. The total population of the two county area was over 190,000 in 2000. The study area had 2,236 permanent residents in 2000. According to the towns of Surf City and North Topsail Beach officials, the estimated peak summer time population of the two towns is greater than 30,000.

Table 2.13 - Socioeconomic Conditions Pender and Onslow Counties, NC

Category	Pender County	Onslow County	Surf City	North Topsail Beach
Population year-round(2007 estimate)	50,430	169,302	1,766	898
Population year-round (2000 census)	41,082	150,355	1,393	843
Population peak season (Estimated)			15,438	15,000-20,000
Households				
Ave. Household size	2.49	2.72	2.02	1.87
Housing Units	20,798	55,726	2,578	2,085
Occupied year-round	16,054	48,122	689	451
Seasonal or vacant	4,744	7,604	1,889	1,634
Employment				
In Labor Force	19,087	85,054	754	545
Civilian	18,972	52,670		
Unemployed	1,076	3,650		
Armed Forces	115	32,384		
Employment by Leading Industry				
Construction	2,468	5,022		
Manufacturing	2,632	2,682		
Retail trade	2,367	7,496		
Education, health & social services	2,704	10,865		
Per capita & Household Income				
Per capita money income	$17,882	$14,853	$25,242	$33,972
Median Household Income 1999	$35,902	$33,756	$40,521	$45,982
Source: U.S. Census Bureau (http://factfinder.census.gov) and U.S. Dept. of Commerce – Bureau of Economic Analysis (http://bea.doc.gov/bea) Office of State Budget and Management (2007 population estimates)				

The population of Pender County grew from 28,855 in 1990 to 41,082 in 2000, an increase of 42 percent. Onslow County population was virtually unchanged during the same period. The State of North Carolina grew by 21 percent during that same period. Figure 2.1 shows both historical population from 1920 to 2000 and population projections by the NC State Demographer for Pender and Onslow counties through 2029. Personal per capita income for Pender and Onslow counties was reported to be $27,720 and $25,317 respectively. Personal per capita income for the State of North Carolina was $20,307.

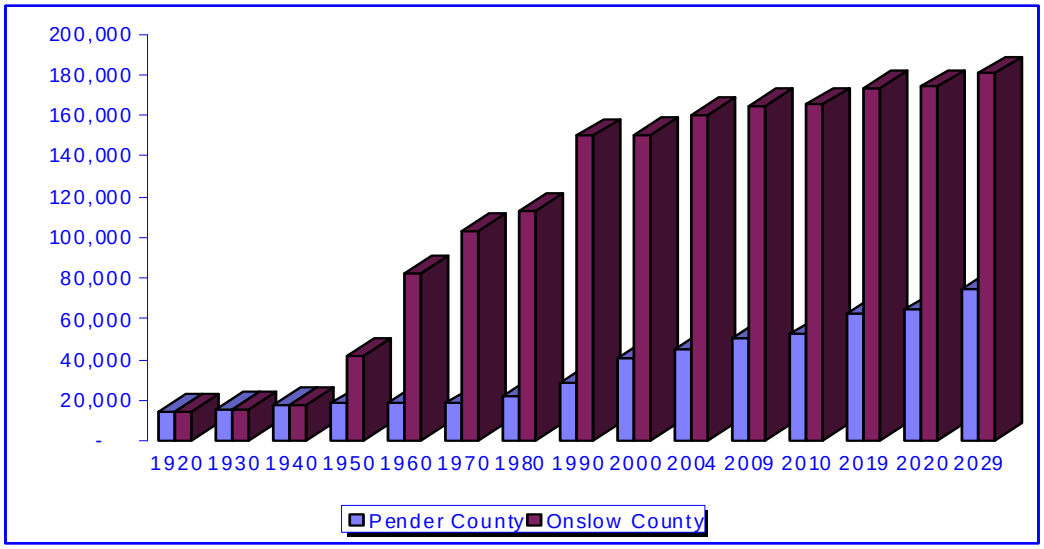

Figure 2.1, Population history and projections.

2.04.2 Esthetic and Recreational Resources

The Towns of Surf City and North Topsail Beach are urbanized beach communities characterized by paved streets, bridges, parking lots, hotels, single-family dwellings, hotels, and low-rise condominiums. Land use is primarily recreational and residential with few commercial properties. A scenic setting is provided by waters of the Atlantic Ocean, New River Inlet, the AIWW and Stump Sound and the numerous vessels common to these waters. The marine environment provides opportunities for boating and fishing, as well as an escape from the faster pace of land-based activities. Beaches generally offer extensive recreational opportunities for activities such as swimming, sunbathing, walking, surfing, bird watching, and fishing. In addition, two ocean fishing piers are located in the study area (one in the project area) and are considered important recreational facilities at Topsail Island. Although, Surf City and North Topsail Beach have lost some of their visual appeal due to severe erosion caused by the hurricanes of 1996-1999 and 2003, the enduring esthetic value of this beach community is evidenced by the popularity of the area for family oriented use and tourism. During the summer months a large portion of the homes within the study area are available as summer rentals to vacationers primarily from inland North Carolina and other locations around the Eastern United States. Based on the Table B-2 (Appendix B), Socioeconomic Conditions, Pender and Onslow Counties, North Carolina, The number of housing units at Surf City and North Topsail Beach is 2,578 and 2,085, respectively. Of those units, 689 at Surf City and 451 at North Topsail Beach are occupied year-round. The remaining units are designated as seasonal or vacant. The estimated peak seasonal populations for Surf City and North Topsail Beach are 15,438 and 15,000-20,000, respectively. In the off-season the populations drop to about 1,400 residents at Surf City and 840 residents at North Topsail Beach.

2.04.3 Commercial and Recreational Fishing

The North Carolina Division of Marine Fisheries (NCDMF) reported approximately 136,000 pounds of commercial finfish and shellfish landings in the vicinity of Stump Sound in 2006 and nearly 162,000 pounds in 2007 (NCDMF, 2008). The top five species included blue crabs (hard), oysters, white shrimp, southern flounder and clams (hard). Total commercial seafood landings by county for 2006 and 2007 were as follows: Pender - 635,549 pounds in 2006, valued at $754,742 and 695,051 pounds in 2007, valued at $1,083,330; Onslow – 2,549,223 pounds in 2006 valued at $5,060,902 and 2,550,206 pounds in 2007, valued at $5,542,501 (NCDMF, 2008). Areas in the vicinity of the study area that are closed to shellfishing are shown in Appendix A, Figure A-4.

Recreational fishing includes fishing from head boats, charter boats, private boats, piers, and the surf. Fishing from head boats is best in the winter months for snapper and grouper. Fishing from charter boats is excellent for king mackerel and bottomfish during the winter. Offshore, gulfstream species, like yellowfin tuna and wahoo are available. Inside fishing has been successful for inshore species such as red drum, speckled trout, and flounder.

Private boat anglers can find bluefin tuna in the nearshore area, king mackerel and other bottomfish species in the offshore, and other species such as speckled trout, red drum, and flounder can be found in the inside areas of the creeks and Atlantic Intracoastal Waterway.

2.05 Cultural Resources

Recent archaeological findings in the Mid-Atlantic and Southeastern regions demonstrate that coastal areas were being exploited soon after human occupations began in North America. The most complete regional evidence of these early Americans comes from the Cactus Hill site, located on the coastal plain of the Nottaway River in Sussex County, Virginia. This site has abundant evidence of a Clovis occupation, which is so named after the distinctive fluted Clovis projectile point. This point is a marker for this nationally widespread horizon. The Clovis occupation at Cactus Hill is firmly dated and supports other dates from throughout North America, which place Clovis occupations around 13,000 B.P. Research at this and other sites throughout the Mid-Atlantic and Southeastern coasts of Virginia and North and South Carolina demonstrate that Paleoindian occupation of the coastal plain was widespread during these times of much lower sea level and cooler climate. At this time, Native American populations were known to be hunting large megafauna associated with the post-Pleistocene era. Some research, particularly at Cactus Hill, suggests a pre-Clovis occupation going back to 18,000 years ago. Both archaeological and geological research suggests that the Paleoindians and the megafauna they hunted disappeared or become very scant in the archaeological record around 12,900 years ago, presumably as a result of a catastrophic event (Goodyear).

After the demise of post-Pleistocene mega-fauna, Native Americans adapted with a new lifestyle and associated tool kit. These people, referred to by archaeologists as Archaic, focused on plant gathering and the hunting of modern game animals. Their tool kit was still limited but elegant, including a variety of projectile points, ground stone tools, and basketry. Archaic populations appear in the archaeological record around 10,000 years ago and persist until the advent of agriculture around 3,000 years ago. Social organization probably still centered on extended families and bands, with possible larger seasonal gatherings. The Archaic period was an extremely important foundation upon which later, more complex societies would grow. The early Woodland period, in particular, probably inhabited the same riverside locations and followed much the same lifestyle as their Archaic predecessors. However, regional subsistence specialization and incipient agriculture allowed for the development of a more settled lifestyle, support of larger permanent populations, and the establishment of defended territories.

While there are many scattered coastal Archaic and Early Woodland period sites and artifact finds, the most significant occupations tend to occur during Middle and Late Woodland periods. This is a time of increasing reliance of agriculture, more settled village life, the development of pottery, and especially sophisticated political organization. Through time, many regional affiliations appear along the coast with several cultural and language affiliations with groups to the north, west, and south. Seasonal exploitation of sound-side resources is now full blown and some villages persisted long enough to establish large settlement, complete with ossuary pits (mass burials). The Colington phase of the Woodland Period is equated with the Carolina Algonkian culture, who greeted the first English explorers.

To date, there are few indications that Native American populations made significant use of ocean-side resources. Indeed, the intensive use of the sounds may indicate that resources there were so plentiful that an interest in exploiting the open-ocean never developed.

The proposed borrow areas are located 1 to 6 miles offshore of the towns of Topsail Beach (USACE, 2009), Surf City and North Topsail Beach, and stretch from the New Topsail Inlet to the New River Inlet. This area has seen significant maritime activity since at least the early 18th century when permanent settlement began. One of the earliest land grants included the inlet and area surrounding the sound, and by 1755 New Topsail Sound was designated as an official inspection point for export commodities in New Hanover County, along with counties Brunswick, Wilmington, and New Exeter. Inspections were conducted for export commodities of fish, flour, butter, flax seed, beef, pork, rice, tar, pitch and turpentine, staves and headings, sawed lumber and shingles. Throughout the Colonial Period, the inlet was relatively stable and was suitable for passage by schooners and small sloops. During the latter part of the eighteenth century and throughout most of the nineteenth century, New Topsail Inlet migrated significantly to the north. According to Wilson Anglely's (1984) analysis, the Mouzon Map of 1775 and the Price-Strother Map of 1808, the inlet migrated northward some 2 miles. While the Mac Rae-Brazier Map of 1833 indicates no significant change, the U.S. Coast Survey Map of 1865 shows that an additional migration of 2 miles occurred during that period.

The migration appears to have abated during the end of that century, as is suggested by review of the Kerr-Cain Map of 1882 and the Post Route Map of 1896. A detailed U.S. Coast Survey Map of 1885 indicates that the New Topsail Inlet was approximately 3,000 feet wide at that time.

Five miles northeast of North Topsail Beach lies New River, another important river in coastal North Carolina history. In 1705, three Englishmen established a settlement at Town Point, the first in Onslow County. Within 20 years, the population had grown to approximately 35 families with English, German, and French Huguenot ancestry. The Moseley map of 1733 indicates that settlement spread along the coast and up the rivers and streams, a pattern typical of the southern colonies. A county seat was platted at Mittam's Point on New River in 1742. The town, called “Johnston," was struck by a hurricane in 1752 that devastated much of the coastal southeast. In response to the destruction of the storm, the county seat was moved inland. Land was acquired from James Wantland, who operated a ferry and tavern at the site where the Boston–Charleston Post Road crossed the New River. This road was the precursor to US Highway 17, following nearly the same route as the present-day road.

In 1775, a bill officially established a town at the ferry to be known as "Onslow Courthouse" but in 1842 the name of the town was changed to Jacksonville in honor of Andrew Jackson. Production of turpentine and naval stores (tar and pitch) represented the primary occupation of small and large landholders in Onslow County. Substantial acres were planted in corn, with smaller investments in wheat, flax, and rice. In 1860, several military companies were formed. Hostilities concentrated along the lower New River and Bear Inlet. Union raids, intended to quash blockade running and to demolish the coastal saltworks, occurred from 1862 to 1864. As was the case elsewhere in the South, the Civil War resulted in poverty, economic stagnation, and strained relations in Onslow County. Share-cropping and tenancy replaced plantation agriculture. In response to the gradual decline of the naval stores industry in southeastern North Carolina, local people turned to crop and livestock farming, mostly on the basis of relatively small-scale farms. Cotton began to emerge as a prominent market crop in the first postbellum decade, followed by tobacco in the 1890s, though neither became a dominant factor in the county's economy.

Eleven vessels are reported or believed to have been lost in the area of Topsail Inlet (USACE, 2009) (Table 2.14), and an additional 19 recorded in the vicinity of New River Inlet. This number includes one of four vessels lost in 1750 as part of the Spanish Plate Fleet. That ship, the packet boat, *El Salvador*, was lost in the vicinity of Topsail Inlet on August 18, 1750. Due to the shifting sands, the surviving remains were buried in a matter of days, making salvaging operations difficult.

Table 2.14 NC Division of Archives and History,
Underwater Archaeology Section Shipwreck Files

1737	UNK, wrecked at mouth of New River with ten lives lost
1750	EL SALVADOR, wrecked at Topsail Inlet
1765	UNK, sloop lost in vicinity of New River
1769	UNK, brigantine lost below Topsail Inlet
1771	BETSY, merchant ship lost at Old Topsail Inlet
1799	SALLY, schooner lost east of New River Inlet bar channel
1815	UNK, vessel and cargo and crew (?) lost at mouth of New River
1837	SEAMAN, lost in or near New River Inlet
1838	PULASKI, wrecked off-shore of New River with 141 lives lost
1841	SUPERIOR, schooner driven ashore near Topsail Inlet
1858	ALBION, lost inside New River Inlet bar
1862	ADELAIDE, schooner wreck at mouth of New Topsail Inlet
1863	ALEXANDER COOPER, schooner wrecked at New Topsail
1863	INDUSTRY, schooner lost 5 miles north of Topsail Inlet
1863	PHANTOM, steamer sunk 200 yards off Topsail Inlet in 30 feet of water
1863	UNK, schooner lost west of Stump Inlet
1864	NUTFIELD, blockade runner, run ashore at New River Inlet
1867	ELLIS, federal gun boat lost 5 miles above New River Inlet, possibly salvaged
1871	HERTFORD, steamer aground inside New River Inlet bar, may have gotten off
1879	MARION GAGE, schooner lost in New River, total loss
1880	UNK, lost at mouth of New River
1881	N.W. DREW, schooner disabled and ashore 3 miles south of New River Inlet
1881	UNK, shipwreck at mouth of New River
1881	MARY BEAR, schooner wrecked 4 miles south of New River Inlet
1884	UNK, shipwreck at mouth of New River
1890	CHARLES, schooner aground on New River inlet bar, total loss
1892	LORENZO, schooner wrecked in New River Inlet, total loss
1894	UNK, lost in New River Inlet
1895	UNK, sharpie sunk at its mooring near Jacksonville
1919	WILLIAM H. SUMNER

Before the Civil War, the following vessels were lost in the vicinity: schooner *Superior*, driven ashore November 24, 1841; an unknown brig in September 1769, run ashore below Topsail Inlet; and English merchantman *Betsy* in 1771 at Old Topsail Inlet. The Civil War also resulted in a number of wrecks, including the schooner *Adelaide* of Halifax, an unidentified schooner west of Stump Inlet, the iron-hulled steamer *Phantom*, and the schooner *Industry*. During the late 19th and early 20th centuries the following losses are recorded: the schooner *Mary Bear* on September 9, 1881, at New Topsail Inlet; and schooner *William H. Sumner* on September 7, 1919, grounded at Topsail Inlet.

As was indicated by the vessels seized, the inlet was active in salt production. An 1864 military map shows at least 2 Confederate salt works situated on either side of Holmes Landing. The presence of the salt works is further substantiated in a letter of November

1, 1862, written by USS Lieutenant William Cushing to his superior.

In 1932, a 12-feet deep and 90-feet wide segment of the Intracoastal Waterway between Beaufort and the Cape Fear south of Wilmington was completed. The channel allowed for an increase in vessel traffic from 33,710 tons in 1932 to 243,000 tons in 1939. As reported the previous year, the character of the vessel traffic – of around 9,000 vessel trips – consisted of approximately 8,500 motor vessels, 300 tugs, 200 barges, and a smattering of pleasure craft. Cargo vessels transported agricultural commodities, lumber, petroleum products, seafood, fertilizer, and general merchandise.

2.06 Water Resources

Water resources are described in this section, including the availability and quality of both fresh water and salt water.

2.06.1 Hydrology

Tides in the area are semidiurnal and the mean tidal range is about 3.0 feet at New River Inlet and at New Topsail Inlet. Regular reversals of flow occur with each tidal cycle except during periods of high fresh water flow. The salinity of the area varies due to many factors including freshwater inflow, tidal action, and wind. From 2002 to 2004, average salinities in the Topsail Island vicinity range from an average of 14.2 parts per thousand (ppt) near New River Inlet, to 23.9 ppt in the Atlantic Intracoastal Waterway behind Topsail Island, to 35.9 ppt in the nearshore ocean at the Surf City Pier (Stan Sherman, pers. comm.).

2.06.2 Water Quality Classification

All surface waters in North Carolina are assigned a primary classification by the NC Division of Water Quality (NCDWQ)(15A NC Administrative Code 02B .0301 to .0317). Waters in the vicinity of Topsail Island fall into three of these classifications. Waters of the Atlantic Ocean between Drum Inlet and Baldhead Island are classified as "SB," and are suitable for primary recreation, including frequent or organized swimming and all "SC" uses (secondary recreation such as fishing, boating, and other activities involving minimal skin contact; aquatic life propagation and survival; and wildlife). Stormwater controls are required under the Coastal Area Management Act (CAMA), and there are no categorical restrictions on discharges.

All other surface waters of the vicinity, including the New River, Atlantic Intracoastal Waterway (AIWW), Topsail Sound, and Banks Channel, meet the "SA HQW" classification and are suitable for shellfishing for marketing purposes as well as all "SB" and "SC" uses (See Appendix A, Figure A-5). All "SA" waters are "HQW" (High Quality Waters) by definition, and stormwater controls are required and domestic discharges are prohibited. Waters of the AIWW from Daybeacon # 17 (between Chadwick Bay and Alligator Bay) to Morris Landing (south of Spicer Bay) and waters of Topsail Sound southward from approximately New Topsail Inlet to Middle Sound are classified as "SA

ORW." The "ORW" (Outstanding Resource Waters) designation is a supplemental classification intended to protect unique and special waters having excellent water quality and an exceptional state or national ecological or recreational significance. Waters of this classification must have one of the following outstanding resource values:

- Outstanding fish habitat or fisheries,
- Unusually high level of water based recreation,
- Some special designation such as North Carolina or National Wild/Scenic/Natural/Recreational River, National Wildlife Refuge, etc.,
- Important component of state or national park or forest, or
- Special ecological or scientific significance (rare or endangered species habitat, research, or educational areas).
- No new or expanded wastewater discharges are allowed in these waters. ORW are HQW by definition.

2.06.3 Groundwater

The sole source of water supply for both public and private systems in Pender and Onslow Counties is groundwater. A vast aquifer system from which potable water can be drawn lies below the Counties. The cretaceous aquifer is used as the water source for the various communities located on Topsail Island. Pender County does not have a county-wide water system and the current system is concentrated in the southern part of the county in the Rocky Point area (Pender County, 2006). In Surf City, water is supplied through 2 wells located on the mainland. A third well has been constructed, but is not fully operational yet (Town of Surf City, 2005). Water is supplied to the Town of North Topsail Beach by the Onslow County water system and is initiated at the Sneads Ferry elevated storage tank located near the intersection of Highway 210 and Highway 172. A 12-inch water main carries the water from the tank to the intersection of Highway 210 and SR 1568 where it intercepts a water main that extends into the Town of North Topsail Beach where it is further distributed (Town of North Topsail Beach, 1996).

Regionally, the horizontal groundwater movement is eastward with some southeast movement. The resultant groundwater movement is toward the coast.

2.07 <u>Other Significant Resources (Section 122, P.L. 91-611)</u>

Section 122 of P.L. 91-611 identifies other significant resources that must be considered during project development. These resources, and their occurrence in the study area, are described in the following subsections.

2.07.1 Air, Noise, and Water Pollution

Areas of the country where air pollution levels persistently exceed the national ambient air quality standards may be designated "non-attainment." All of Topsail Island is in an attainment area. There are no known air quality problems in the study area.

Noise is a prominent feature in the study area due to the sound of the breakers and at times, tourists and traffic on the beach. The sounds of breakers are tranquil and add to the pleasure experienced by visitors. There are the normal complaints of municipal residents concerning noise in the downtown area of Surf City. However, the Town does not experience a problem to the extent that maximum densities for residential dwellings have been established nor have noise level reduction standards (outdoor to indoor or indoor to outdoor) been established. There are no large manufacturing, industrial or mining type operations in Town. No airports or other area establishments or entities are affecting unbearable noise levels on the community (Town of Surf City, 2005). The Town of North Topsail Beach has a Noise Ordinance Code (Article VII) that is enforced 24 hours a day (Town of North Topsail Beach, 1998).

Water quality is discussed in Section 2.06.2 and in the Section 404(b)(1) (PL 95-217) evaluation that is included as Attachment G of this document.

2.07.2 Man-made and Natural Resources, Esthetic Values, Community Cohesion, and the Availability of Public Facilities and Services

Only one pier, the Surf City Ocean Pier, is located within the proposed beach fill area. This Pier complex includes a bait and tackle shop, restaurant facilities with a screened dining area and a game room. This 937-foot long ocean pier is open from March through November. Esthetic values are discussed in Section 2.04.2.

In regard to wastewater disposal, nearly all of Surf City's residential and commercial structures are connected to the Town's wastewater collection and treatment system. The wastewater collection and treatment system discharge is pumped to a land application treatment facility off of North Carolina Highway 50 between Surf City and Holly Ridge. This system includes 30 pump stations. There are no private wastewater systems operating within the Town of Surf City (Town of Surf City, 2005). North Topsail Beach sewer services are provided by a private utility under state regulatory authority.

Water supply is discussed above in Section 2.06.3 Groundwater. There are no private water supply systems operating within the planning jurisdiction of Surf City or North Topsail Beach.

Topsail Island, including Topsail Beach, Surf City, and North Topsail Beach is served by two bridges. Surf City has a system of well maintained roads and accident rates within the town of Surf City's jurisdiction are low due to a well designed traffic system (Town of Surf City, 2005). In the southern end of Surf City Highway 50 is very vulnerable to ocean erosion and required repair after Hurricane Fran in 1996. This section of road is the only access by land to the entire town of Topsail Beach to the south. Highway 210 from the high-rise bridge south to the Pender County line is the only primary roadway within North Topsail Beach. The most serious transportation issue at North Topsail Beach continues to be the overwash of the road (SR 1568) at Galleon Bay (Town of North Topsail Beach, 1996).

The Surf City Volunteer Emergency Medical Services (EMS) and Pender EMS provide emergency services to Surf City. Other emergency services at Surf City are provided by the Town's Fire and Police Departments. Emergency services at North Topsail Beach are provided by the North Topsail Beach Police Department, Fire Department and Rescue and Emergency Medical Services. Electricity is provided by Jones-Onslow Electric Membership Corporation. Sprint provides telecommunications service within the town limits, and the cable television franchise is operated by Charter Communications.

Details regarding beach access and parking are discussed in Section 3.04 and in Appendix O.

2.07.3 Hazardous, Toxic and Radioactive Wastes (HTRW)

Due to past military activities in the project area, the presence of Hazardous, Toxic and Radiological Wastes (HTRW) warrants discussion. The potential for encountering HTRW in the project area is discussed below as documented in the Defense Environmental Restoration Program For Formerly Used Defense Sites (DERP-FUDS), Ordnance And Explosive Waste, Archives Search Report, Findings For The Former Camp Davis, Holly Ridge, North Carolina, Project Number 104nc001702, May 1994.

In 1941 Camp Davis was established as an Anti-Aircraft Training Center at Holly Ridge, North Carolina. Acquisition of land for Camp Davis took place from 1941 through 1943. A total of approximately 46,682 acres was acquired by lease from numerous individuals, corporations, and governmental agencies by the War Department for a World War II Army Air Corps training facility. The Training Center was later used as a convalescent hospital and rehabilitation center and became home to various military units. Coast Artillery Anti-Aircraft Regiments were the dominant groups, moving thousands of recruits through basic training and anti-aircraft weaponry. Although the main part of Camp Davis was located on the mainland, northwest of Topsail Island, the Coastal Gunnery Range Emplacement Area was located on Topsail Island near the Surf City bridge and the Coastal Gunnery Potential Range Impact Area was located offshore of Topsail Island (Appendix A, Figure A-1).

The Gunnery Emplacement area was located 4.5 miles southeast of the main portion of the former Camp Davis. The site was known as the Sears Landing and occupied a narrow strip of land between the inland waterway and the Ocean. As a gun emplacement, the ordnance used on site would have been fired or returned to the point of issue; therefore, the possibility of ordnance residue is extremely remote. The inspection team did not observe any Ordnance or Explosive Wastes (OEW) in this area and there were no reports of OEW within the gun emplacement area.

The Coastal Gunnery Range Impact Area, which was located offshore of Topsail Island, was viewed by inspectors from the beach (no offshore survey was conducted). The AA coastal gunnery range impact area has potential ordnance contamination based upon its use when it was active; however, no evidence of residual OEW contamination has been found or documented since the anti-aircraft gunnery range was closed. No records or documentation were located as to the exact types of ordnance used, although it is

presumed that mostly practice rounds were used based upon the fact that gunners fired at a target that was pulled/towed behind an aircraft. Practice round sizes would have varied, but are presumed to include the following: 37 mm (1.46 inches), 40 mm (1.57 inches), 3-Inch, 9O mm (3.54 inches), 105 mm (4.13 inches), and 155 mm (6.10 inches).

After World War II, Camp Davis was assumed by the Navy for their secret guided missile testing program, code-named "Operation Bumblebee." Topsail Island was the third of three widespread test sites established along the Atlantic seaboard in the closing years of World War II, and the first permanent ground for missile testing. The Topsail Island site, placed in operation in March 1947, incorporated rigid structures that were designed and built for specific uses related to the assembly, firing, monitoring and perfecting of experimental ramjet missiles. The Navy used only a small portion of Camp Davis for the testing of rocket motor propulsion systems. An arsenal center for the assembly and storage of rockets was built on the sound-side of the island, and launching pads were constructed on the oceanfront. Concrete observation towers were built throughout the island to monitor the experimental launchings and many of the military structures remain standing today. During the 18 months that Operation Bumblebee was active at Topsail, an estimated 200 experimental rockets, each measuring six inches in diameter and between three and 13 feet in length, were fabricated at the Assembly Building, dispatched to the launch site, and fired along a northeasterly angular deflection of 15 degrees to the shoreline for a maximum clear distance of 40 miles. Despite the initial success of the US Naval Ordnance Testing facility at Topsail Island, its location did not fulfill completely the needs of a permanent base because weather conditions and increased sea traffic interfered with testing, and the facility was abandoned and its equipment moved to other sites (http://www.cr.nps.gov/nr/travel/aviation/usn.htm).

Although, over 200 rocket launchings took place on the island between 1946 and 1948, no OEW was associated with the testing procedures and all leased land was returned to the original landowners. Currently, most of the former Camp Davis lands are being used for state wildlife game lands (Holly Shelter) and for the production of forestry products.

Several databases were reviewed to obtain information pertaining to releases, treatment, storage, and disposal of hazardous substances in the project area. Based on this review and the review of the Camp Davis Archives Search Report, referenced above, there are no documented active or inactive hazardous waste sites on Topsail Island.

3. PROBLEMS, NEEDS, AND OPPORTUNITIES

The main public concerns identified in the study area are economic losses resulting from (1) damages to structures and their contents due to hurricane and storm activity, and (2) the loss of beachfront land due to progressive shoreline erosion. In addition, periods of severe shoreline recession have adversely affected nesting habitat for endangered and threatened sea turtles. These economic losses and environmental concerns are discussed below.

3.01 Hurricane and Storm Damage

Being located between Cape Lookout and Cape Fear, Topsail Island is a frequent target for hurricanes and tropical storms tracking along the mid-Atlantic coast. Table 3.1 is excerpted from hurricane history information on the State Climate Office of North Carolina website and shows the frequency and severity of hurricanes and tropical storms directly affecting southeastern North Carolina since 1800. In addition to these direct landfalling storms, many storms that have passed offshore without making landfall have also impacted the study area. Local impacts to the study area varied depending on the landfall location and strength of the storm. However, Bertha and Fran in 1996 and Floyd in 1999 were among the most damaging and costly storms ever to hit North Carolina.

3.02 Beach Erosion

Between 1963 and 2002, erosion rates were relatively low (less than one foot per year) in the southern half of the main study area (reaches 27-43); however, erosion rates in the northern half of the main study area (reaches 44-78) averaged nearly 2 feet per year. Erosion rates increased significantly to over 5 feet per year in portions of the non-study CBRA area (reaches 79-106), but decreased to 2 to 3 feet per year in reaches 107-108 study segment. Shoreline changes in reaches 114-115 study segment begin to be significantly influenced by inlet processes as erosion precipitously changed to minor accretion and then back to significant erosion within a span of only a few reaches approaching New River Inlet. Refer to Figure A-7 in Appendix A for reach locations. Major storms in the late 1990s caused significant erosion and decimated the island's natural dunes, resulting in major property damage.

Table 3.1 Direct Landfalling Hurricanes and Tropical Storms in Southeastern North Carolina since 1800.

Approximate Date of Landfall	Storm Name	Saffir-Simpson Intensity at Landfall	Approximate Location of Landfall	Estimated Wind Speed (knots)	Storm Surge (ft.)
9/16/1999	Floyd	2	Topsail Island	95	9-10
8/26/1998	Bonnie	3	Cape Fear	100	6-8
9/6/1996	Fran	3	Cape Fear	100	8-12
7/13/1996	Bertha	2	Topsail Beach	90	5
9/9/1984	Diana	1	Long Beach	80	5-6
9/11/1960	Donna	2	East of Wilmington	95	6-8
8/17/1955	Diane	1	Carolina Beach	75	5-9
10/15/1954	Hazel	4	NC/SC border	125	10-20
7/6/1946		Tropical Storm	Wilmington	60	
8/1/1944		1	Southport	80	
12/2/1925		1	Wilmington/Hatteras	65	
9/22/1920		1	Topsail Beach	65	
9/6/1916		Tropical Storm	Southport	35	
10/31/1899		1	Wrightsville Beach	80	8
9/11/1883		1	Southport	85	
9/9/1881		NA	Wilmington/Wrightsville		
08/18/1879		4	Wilmington/Cape Lookout	120	
9/17/1876		Tropical Storm	NC/SC border	60	
11/10/1875		NA	Long Beach		
9/28/1874		NA	Southport	60	
8/19/1871		NA	Southport		
9/4/1856		NA	Wrightsville Beach		
8/18/1837		NA	Cape Fear		
9/4/1834		NA	NC/SC border		
9/3/1815		NA	Wilmington/New Bern		10

3.03 Beach Recreation

All reaches within the study area are available for typical beach recreation activities – swimming, surfing, wading, walking, sightseeing, picnicking, sunbathing, surf fishing, jogging, and so on. The concern regarding beach recreation is that shore erosion will continue, resulting in a narrowing of the width between the surf, especially at high tide, and the landward limits of recreational use. Such landward limits are the toe of the dune, streets, or existing structures. As the available width decreases, some of these activities are hindered and eventually prevented.

3.04 Public Access

Many public beach access points and parking areas are present within the limits of the study area. Surf City has 33 public beach access points within the allowable project limits and North Topsail has 22. The access sites are shown in Figures 3.1 and 3.2, Public Access and Parking. The access points generally consist of small parking areas and wooden walkways to the beach. There are only 3 areas of the study area that presently do not have access points within ¼ mile. Those areas are indicated in red on the access site figures. One such area in Surf City near Elizabeth Street in reaches 34 and 35 is 900 feet long. There are two sites in North Topsail Beach. One between Sloan Street and Lincoln Street in reaches 62 and 63 is 900 feet long. Another north of 2nd Street in reaches 76 and 77 is 1,000 feet long. The total length without adequate public access is 2,800 feet. Additional access points will be necessary to meet the requirements for Federal Cost sharing.

In addition to direct access pathways to the beach, nearby public parking is necessary to provide public access to the shoreline. There are a wide variety of public parking spaces throughout Surf City and North Topsail Beach. These are located at the access sites, on nearby street right-of-ways, and at 4 large parking lots. In 2003 and in 2008, parking space counts were administered on site visits by the Wilmington District and town officials. All right of way areas were considered eligible for parking with the exception of areas that met designated restrictions (e.g. driveways, fire hydrants, intersection, physical barriers). For North Topsail Beach, only the reaches south of the CBRA zone were included in the count. The combined total from the 2008 count was 1,992 spaces, with 785 at Surf City and 1,207 at North Topsail. These numbers are included in Tables 3.2 and 3.3. The distribution of parking spaces is uneven with some areas not meeting a minimum of 10 publicly available parking spaces within ¼ mile. Areas having access, but needing parking, are indicated in yellow in the access site figures. One area in the southern part of Surf City is 7,600 feet long. Another area in North Topsail Beach is 600 feet long. The total length of study area with access, but without minimum parking requirements is 8,200 feet. A total of 37 additional parking spaces are needed in the southern portion of the project limits in Surf City and a minimum of 20 in North Topsail Beach are needed to satisfy the 10-space minimum requirements.

Table 3.2, Public Access and Parking, Surf City, July 2008.

Access Points	Parking Spaces			Access Points	Parking Spaces		
	Lot	ROW	Total		Lot	ROW	Total
2111 N. Shore	8	0	8	Roland/Central	15	8	23
9th St.	0	10	10	Kinston	15	20	35
2001 N. Shore	9	9	18	High Point	8	3	11
5th St.	9	9	18	Raleigh	6	2	8
1719 N. Shore	5	28	33	Durham	9	8	17
Broadway	43	7	50	Charlotte	20	19	39
Pender	6	40	46	Quarterhorse	0	37	37
Lenior	8	32	40	1140 S. Shore	0	33	33
Jones	2	34	36	Windward	0	35	35
Craven	12	42	54	Oceanair Estates	0	39	39
Mecklenburg	0	11	11	Elizabeth St.	0	6	6
Dolphin	17	34	51	Roberts St.	0	1	1
508 N. Shore	15	5	20	Pirates Cove	0	0	0
Wilmington	10	16	26	Abigail Place	0	4	4
New Bern	12	15	27	Bland Shores	0	2	2
Goldsboro	10	12	22	Hispanola	0	6	6
Greensboro	6	13	19				
Total							785

Table 3.3, Public Access and Parking, North Topsail Beach, July 2008.

Access Points	Parking Spaces			Access Points	Parking Spaces		
	Lot	ROW	Total		Lot	ROW	Total
Myrtle	32	67	99	14th Ave	0	27	27
2nd Ave	0	39	39	15th Ave	0	34	34
4th Ave	0	32	32	18th Ave	0	41	41
5th Ave	0	19	19	20th Ave	0	13	13
6th Ave	0	23	23	21st Ave	12	51	63
7th Ave	0	15	15	OCBA #4	400	34	434
9th Ave	0	43	43	Chestnut St	12	30	42
10th Ave	0	27	27	Gray St	12	23	35
11th Ave	0	16	16	Green St	6	0	6
12th Ave	0	23	23	Reeves	0	83	83
13th Ave	0	22	22	Sea Shore Dr	6	65	71
Total							1207

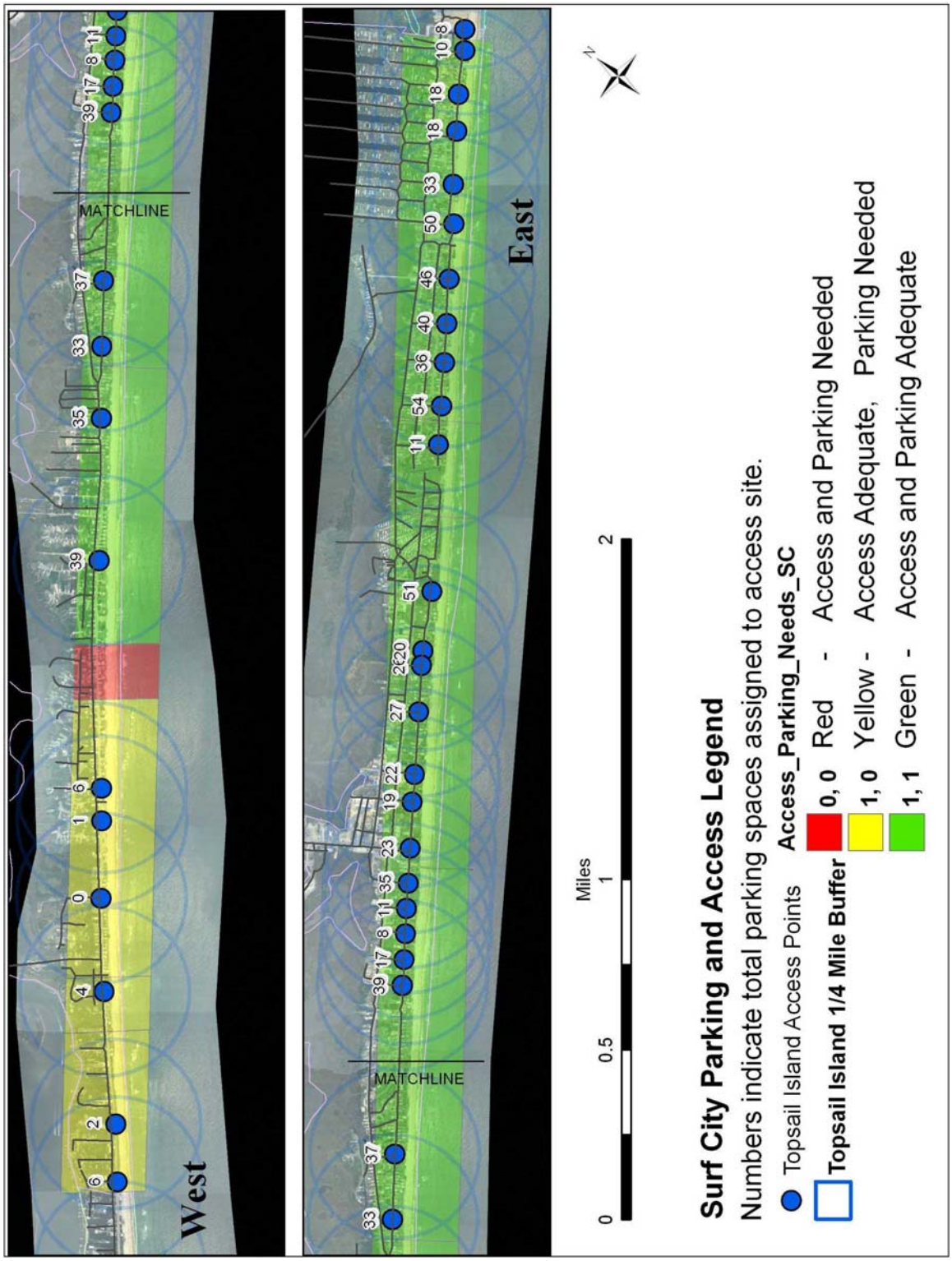

Figure 3.1, Public Access and Parking, Surf City

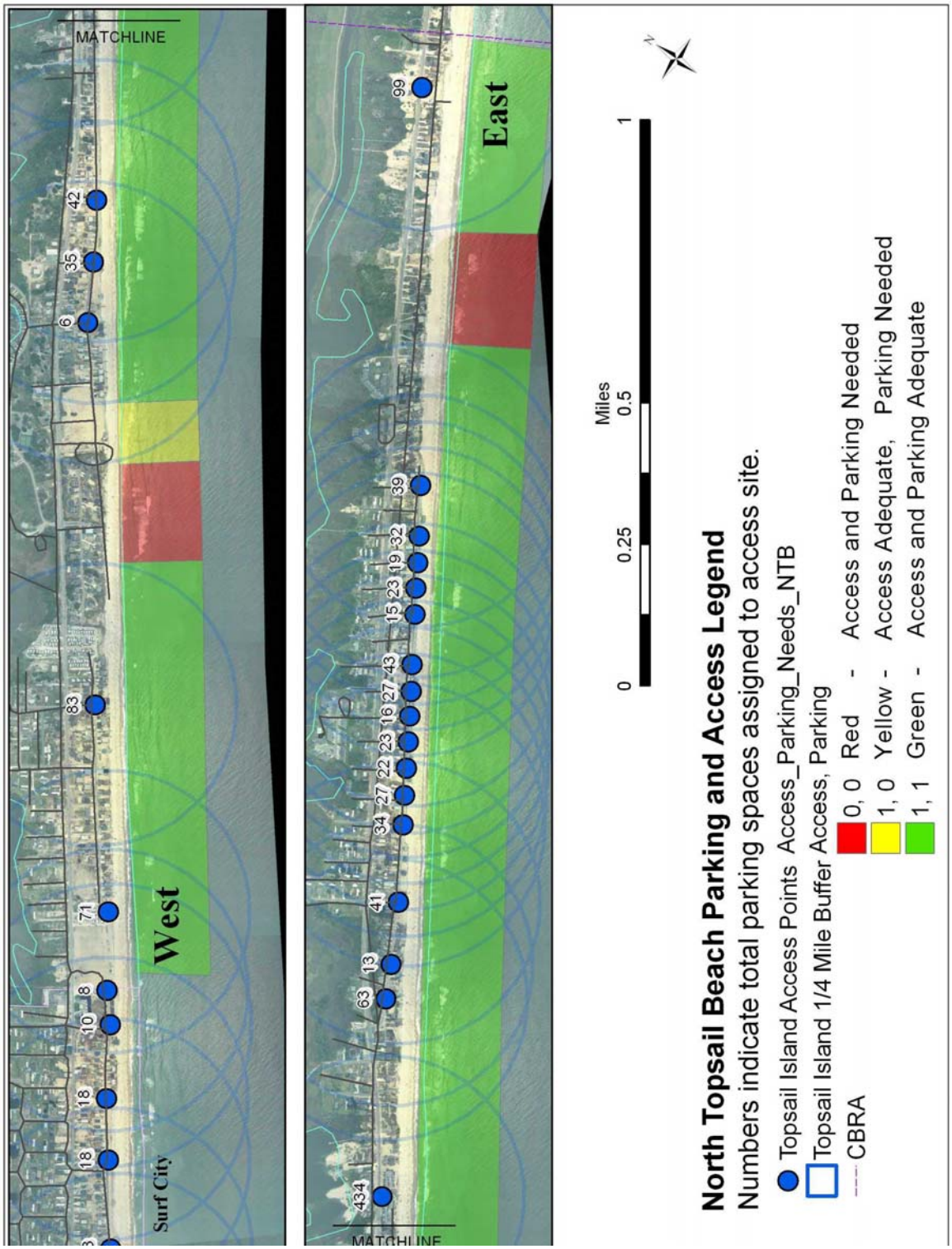

Figure 3.2, Public Access and Parking, North Topsail Beach

3.05 Loss of Sea Turtle Nesting Habitat

A shoreface comprised of beach, berm, and dune components can provide valuable nesting habitat for sea turtles. The loggerhead and green sea turtles, which are on the Federal list of threatened and endangered species, have been documented to nest in the study area on Topsail Island. However, long-term shoreline erosion processes coupled with historical short-term hurricane events have led to significant sediment losses from the shoreface. As a result of these existing erosional activities, substantial portions of the berm and dune system have been lost as the shoreline is being "squeezed" between the ocean and adjacent development. This puts nesting sea turtles at risk since limited high quality nesting habitat remains in these eroded areas. In some cases, nests laid in high erosion areas where available nesting habitat is lost need to be relocated to avoid tidal inundation (Jean Beasley, pers. comm.) (See Appendix I).

Persistent erosion along the towns of Surf City and North Topsail Beach could lead to site specific loss of nesting habitat. Additionally, as short-term erosional processes scour the existing shoreface and the nesting beach environment slowly erodes away, large scarps may form at the toe of the primary dune; thus, preventing a turtle from encountering suitable nesting habitat above the mean high tide line. Re-establishment of a berm and dune system with a gradual slope can enhance nesting success of sea turtles by providing suitable nest sites without escarpment obstacles and away from tidal inundation.

3.06 Existing Shore Condition

In March 2002, beach profile surveys were taken along Topsail Island at 1000-foot intervals to determine existing conditions of the project shoreline. Of the 56 shoreline profiles in the study area, 16 profiles were selected as representative of the existing condition and used for analysis. These typical profiles are shown in Figures 3.3 and 3.4.

The existing condition includes a fairly substantial constructed dune that was rebuilt following the decimation of the existing dune by Hurricane Fran in 1996. The existing dune varies in height from 15 to 20 feet along most of the study area, however, the dune has very little crest width, if any, and very steep side slopes. At the time of the surveys, the dry beach width from the base of the dune (at about elevation 7 ft-NGVD) out to the MHW line (at elevation 2.1 ft-NGVD) was rather narrow, generally averaging only about 60 feet. No well-defined berm feature existed either, with the beachface generally sloping directly from the base of the dune seaward.

Over the last 25 to 30 years, material resulting from maintenance dredging of New River, the AIWW and connecting channels has been placed on the northernmost mile of the study area in the vicinity of New River Inlet. Records from FY1998 through FY2007 show that this total placement of 680,000 cubic yards has occurred on an irregular basis, generally every 1 to 3 years, with dredging quantities varying from 70,000 to 170,000 cubic yards and averaging about 110,000 cubic yards per event.

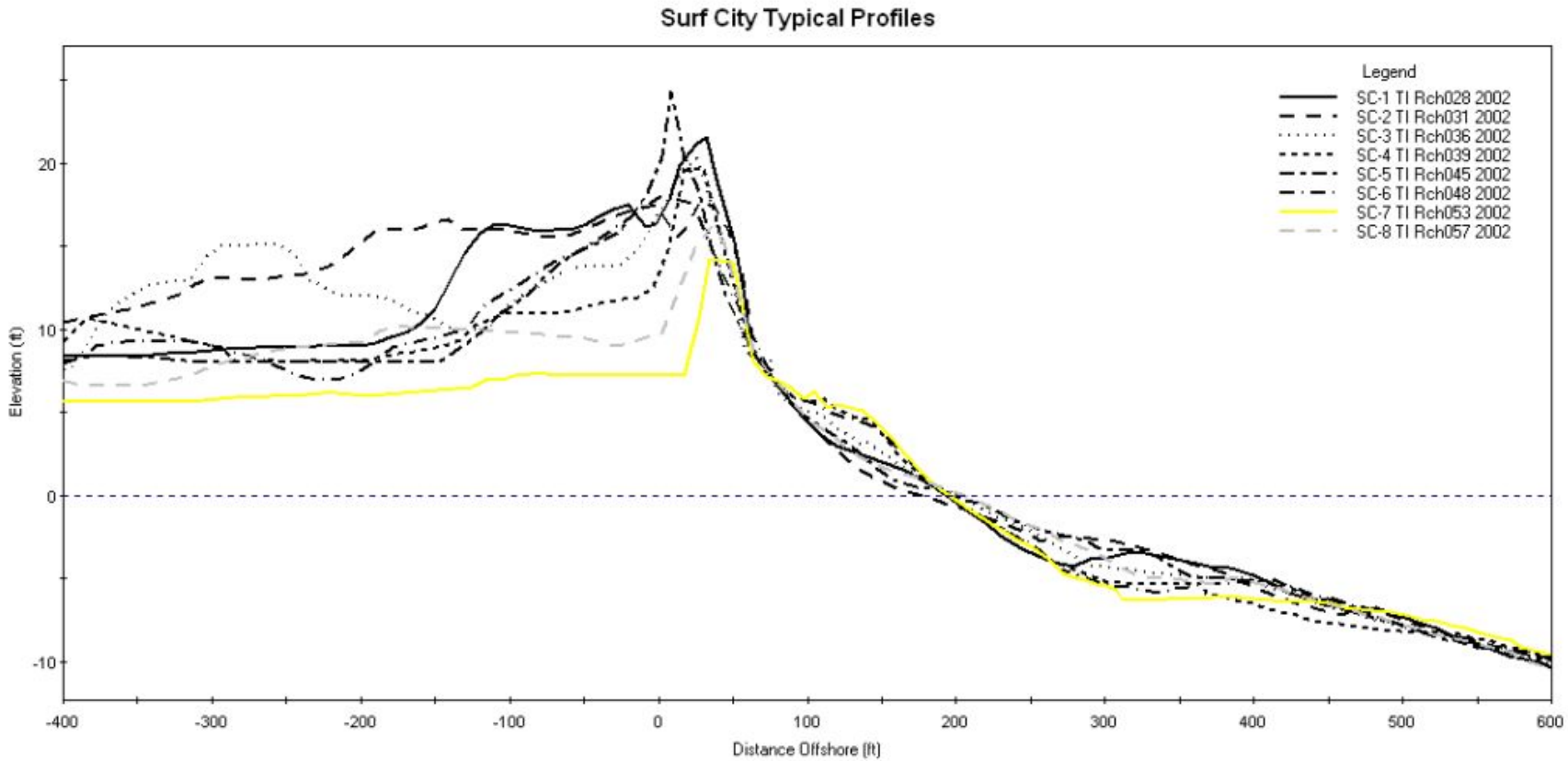

Figure 3.3. Surf City, Typical Profiles

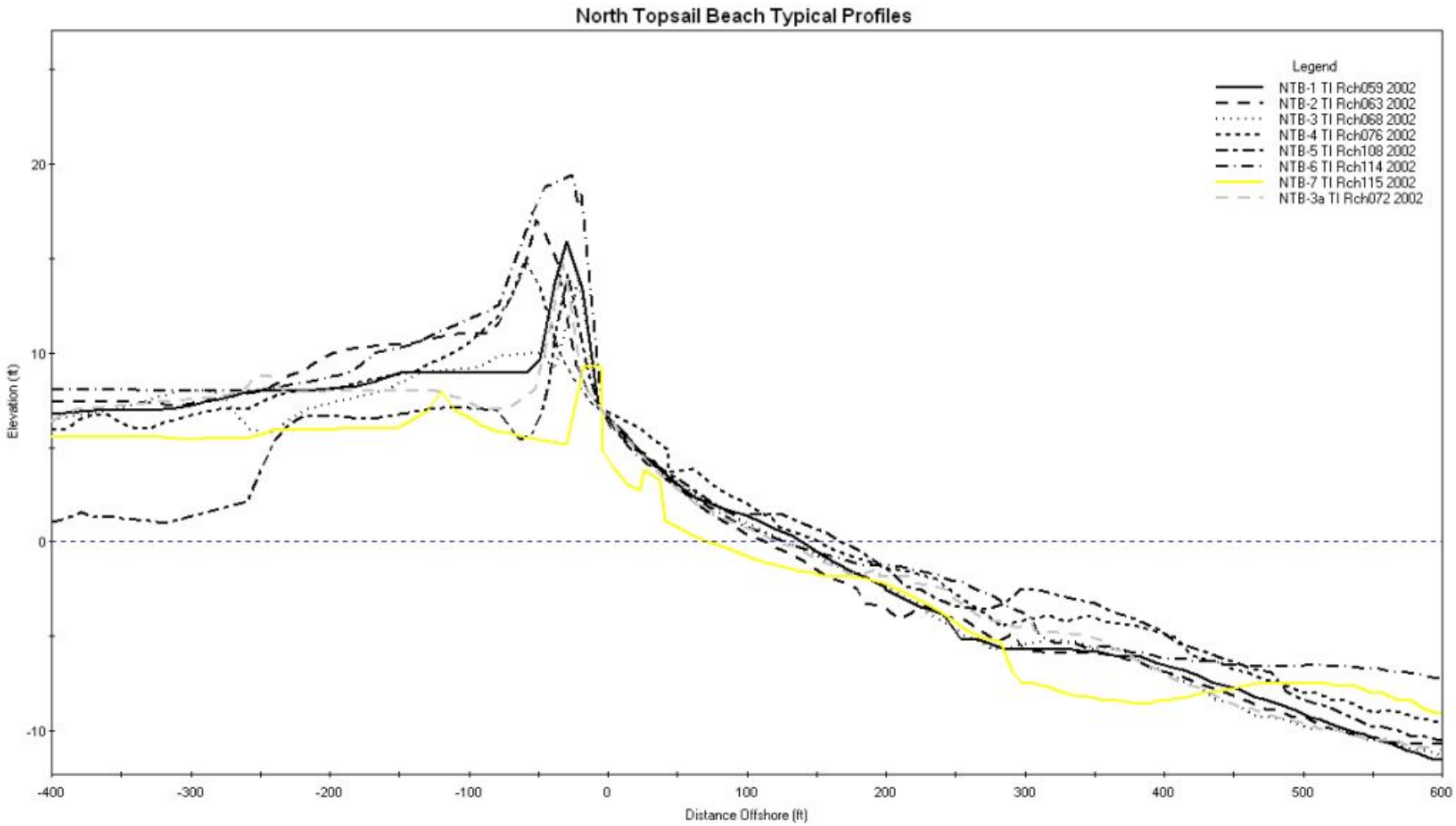

Figure 3.4. North Topsail Beach, Typical Profiles

3.07 Without Project Hydraulic Analysis

The without project condition was analyzed using the Generalized Risk AND Uncertainty - Coastal (GRANDUC) model to establish the base condition for alternative evaluation. A range of storm responses (erosion distance, water level, volume lost, etc.) was determined for each of the typical existing profiles. The study area was subdivided into reaches of approximately 1,000 feet each. Reach 27 is located near the Topsail Beach – Surf City town boundary and reach 117 is located near New River Inlet. Based on 1,000 different 50-year storm simulations, in conjunction with existing long-term erosion rates, average land losses and structure damages for each reach were computed to allow for comparative economic analysis of alternatives. No allowance was made for future placement of maintenance dredging material because of the sporadic and variable nature of this work.

3.08 Without Project Economic Analysis

The without project condition displays the implication of storm damage and erosion if a Federal project is not constructed in the study area. The base year for the without project condition is the same year that construction of an authorized Federal project would be completed. Construction is estimated to begin in December 2014 with completion 4 years later in March 2018, making the base year 2018.

The study area will be fully developed and any remaining vacant lots are expected to be developed by the base year. New structures built on vacant lots or replacing existing structures will be required to meet certain building codes for reducing storm damages. There is a horizontal setback 60 feet landward from the established line of stable vegetation. Vertically, the first living floor will be elevated on pilings, above the minimum Federal Flood Insurance elevation. Additionally pilings for all first row replacement structures will be 16 feet below grade or 5 feet below mean sea level. Even with these building codes applied to new structures, the potential for hurricane-wave damage will increase without a project given the weakened natural dune system in this area. Unlike long-term erosion which can be predicted, to some extent, based on past trends and observed shore processes, damages from hurricane wave attack can occur in any year, and can be predicted only as a mathematical probability.

Hurricane and storm damages in the study area include damages to structures and contents, and to transportation infrastructure. Unlike long-term erosion which can be predicted, to some extent, based on past trends and observed shore processes, damages from hurricane wave attack can occur in any year, and can be predicted only as a mathematical probability. Average annual hurricane and storm damages for the study area were computed using Wilmington District's computer models. These models integrate coastal engineering data, including storm frequency, storm surge, and long term erosion rates, with economic data, including the values of structures which could be damaged or destroyed, and the value of land which could be lost to erosion. This subject is addressed in greater detail in Appendix D, Coastal Engineering.

When evaluated at an interest rate of 4.625% over the 50-year period of analysis, the present worth (October 2008 price levels) of the expected damages totals $451 million; equivalent average annual damages are $23.3 million. For the continuous group of reaches 27 through 78 the present worth of the expected damages totals $371 million; equivalent average annual damages are $19.1 million. The storm and erosion damages calculated for the without project condition are presented in Table 3.4 – Present Value of Damages Without Project Conditions and graphically in Figure 3.5 - Present Value of Damages Without Project Conditions. The vast majority of damage is categorized as Erosion, which is the loss of structures from undermining as the supporting ground is eroded away. Flood damages are limited because most structures in the study area are now elevated. Wave damages are caused by the impacts of waves on the structures. Finally land damages are losses in the acreage of land.

Table 3.4 – Estimated Value of Damages, Without Project Conditions, October 2008 Price Levels, 4.625% Interest Rate

Reach	Damages					
	Present Value					Annual Total
	Storm Erosion	Flood	Wave	Land/LTE	Total	
27	$5,588,367	$1,942	$0	$205,393	$5,795,702	$299,000
28	$258,690	$319	$0	$101,448	$360,458	$19,000
29	$6,270,657	$1,675	$0	$123,659	$6,395,992	$330,000
30	$4,214,581	$5,523	$0	$206,223	$4,426,327	$229,000
31	$2,416,310	$1,066	$0	$379,306	$2,796,682	$144,000
32	$1,676,856	$25,669	$0	$620,956	$2,323,481	$120,000
33	$3,266,825	$23,086	$0	$291,327	$3,581,238	$185,000
34	$1,366,617	$29,962	$0	$109,423	$1,506,002	$78,000
35	$4,114,369	$53,478	$0	$109,115	$4,276,962	$221,000
36	$2,574,429	$25,533	$954	$109,115	$2,710,031	$140,000
37	$4,977,953	$20,680	$261	$116,034	$5,114,927	$264,000
38	$7,701,802	$25,320	$77,077	$126,621	$7,930,820	$410,000
39	$6,681,997	$68,759	$29,688	$370,549	$7,150,993	$369,000
40	$8,854,852	$59,024	$181,091	$530,911	$9,625,879	$497,000
41	$8,045,505	$16,923	$8,910	$371,410	$8,442,748	$436,000
42	$6,099,098	$6,356	$3,760	$379,102	$6,488,316	$335,000
43	$10,491,237	$15,246	$36,177	$439,312	$10,981,972	$567,000
44	$9,832,216	$104,961	$207,496	$1,080,265	$11,224,938	$580,000
45	$8,454,568	$158,302	$703	$985,421	$9,598,995	$496,000
46	$6,304,084	$144,164	$5,041	$988,678	$7,441,966	$384,000
47	$11,867,798	$166,909	$117,786	$1,290,210	$13,442,702	$694,000
48	$13,578,323	$159,385	$71,510	$1,633,674	$15,442,891	$797,000
49	$16,246,807	$48,518	$16,976	$1,837,877	$18,150,177	$937,000
50	$10,550,456	$38,279	$270	$1,052,684	$11,641,689	$601,000
51	$2,356,784	$134,880	$241,831	$784,128	$3,517,623	$182,000
52	$12,897,953	$68,475	$1,508,403	$917,614	$15,392,445	$795,000
53	$11,573,492	$35,963	$1,147,630	$1,346,831	$14,103,917	$728,000
54	$6,502,874	$10,372	$783,977	$1,315,238	$8,612,461	$445,000
55	$3,266,337	$60,496	$157,643	$844,474	$4,328,951	$224,000
56	$625,498	$46,672	$199,490	$580,361	$1,452,022	$75,000
57	$3,899,708	$42,863	$247,732	$1,438,711	$5,629,014	$291,000
58	$5,538,905	$51,406	$264,239	$1,610,195	$7,464,745	$385,000
59	$4,857,057	$38,040	$498,944	$1,391,237	$6,785,278	$350,000
60	$6,615,910	$26,484	$665,831	$1,223,394	$8,531,620	$441,000
61	$3,111,582	$65,234	$651,980	$621,897	$4,450,692	$230,000
62	$7,332,040	$11,850	$31,780	$1,164,259	$8,539,929	$441,000
63	$5,501,259	$66,869	$119,320	$867,518	$6,554,966	$338,000
64	$5,385,116	$101,356	$1,031,666	$1,308,210	$7,826,348	$404,000
65	$5,234,966	$91,846	$543,471	$996,453	$6,866,736	$355,000
66	$4,614,837	$42,215	$217,913	$816,972	$5,691,937	$294,000
67	$6,888,279	$8,561	$198,824	$1,373,107	$8,468,771	$437,000
68	$3,830,820	$129,444	$624,798	$790,137	$5,375,199	$278,000
69	$3,845,987	$331,996	$491,570	$598,232	$5,267,785	$272,000
70	$3,130,996	$126,273	$815,945	$522,805	$4,596,019	$237,000
71	$3,488,747	$14,639	$749,823	$844,212	$5,097,420	$263,000
72	$10,167,825	$559	$693,596	$1,512,553	$12,374,534	$639,000
73	$9,262,765	$757	$686,277	$1,399,171	$11,348,970	$586,000
74	$8,143,686	$3,341	$635,589	$1,055,272	$9,837,888	$508,000
75	$2,902,421	$70,896	$275,861	$912,403	$4,161,580	$215,000
76	$2,423,710	$33,099	$132,167	$889,043	$3,478,020	$180,000
77	$3,171,639	$109,332	$200,994	$852,451	$4,334,416	$224,000
78	$2,814,190	$34,915	$239,933	$491,537	$3,580,575	$185,000
107	$14,050,000	$285,000	$1,379,000	$5,037,000	$20,751,000	$1,071,000
107&108	$5,205,000	$42,000	$654,000	$1,716,000	$7,617,000	$393,000
114	$26,814,000	$33,000	$11,000	$1,547,000	$28,405,000	$1,467,000
115&116	$20,295,000	$20,000	$814,000	$2,630,000	$23,759,000	$1,227,000
Totals	$377,183,780	$3,339,912	$17,672,927	$52,857,000	$451,053,749	$23,292,000
Portion	83.6%	0.7%	3.9%	11.7%	100.0%	

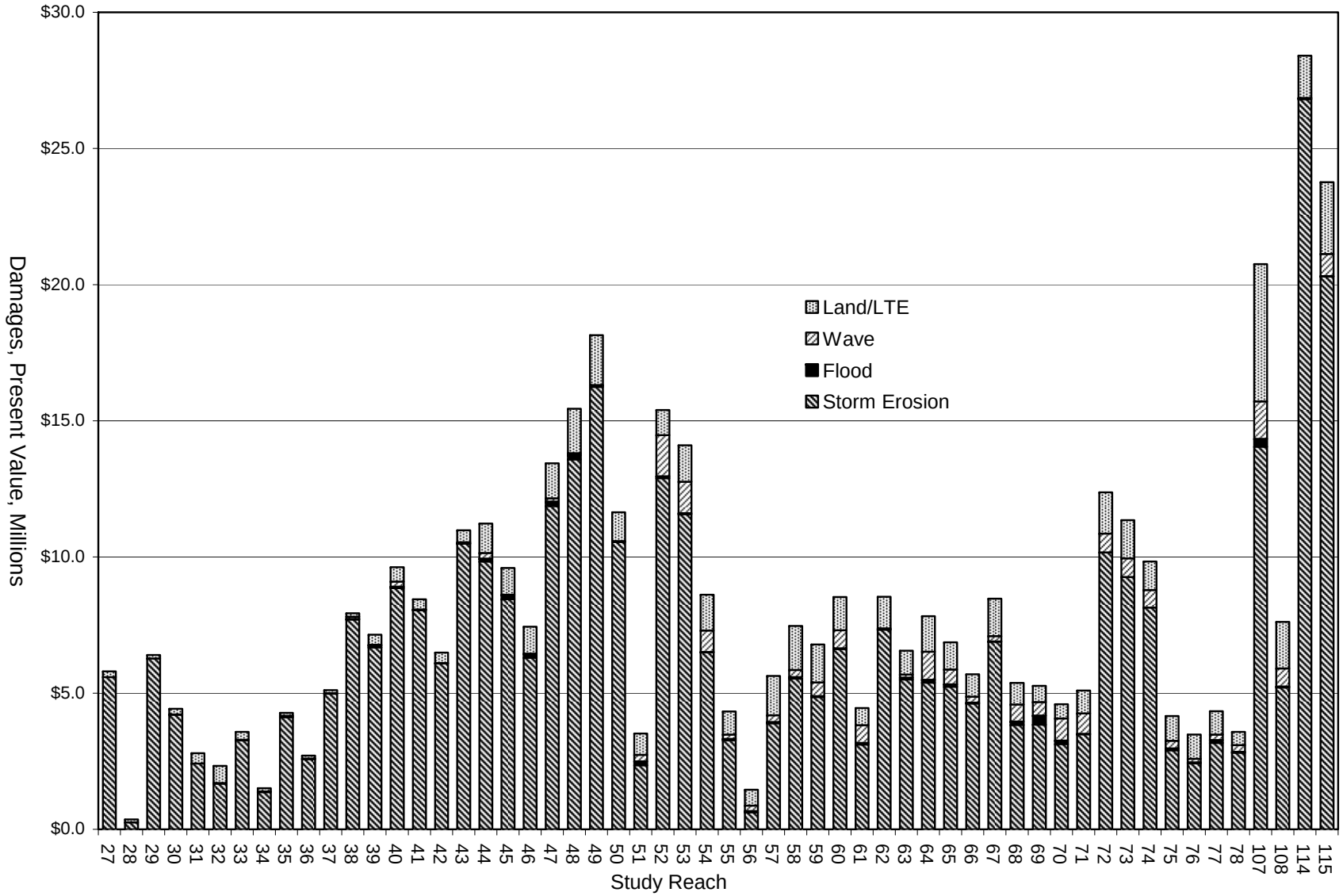

Figure 3.5 Estimated Damages by Reach, Present Value (Note: 106&107 combined, 115 & 116 combined)

3.09 Without Project Environmental Analysis

Only those resources that have the potential to be affected by the no action alternative are included in the analysis, below.

Sea Turtles. There are no documented nesting attempts of hawksbill, leatherback, and Kemp's ridley sea turtles on Topsail Island. However, in regard to loggerhead and green sea turtles, Topsail Island is considered to be one of the more heavily nested areas along the North Carolina coast. Without the proposed project, continued erosion of the beach would result in losses of sea turtle nesting habitat and possible poor nest site selection by females.

Seabeach Amaranth. Since 1992 the USACE has surveyed Topsail Island for seabeach amaranth. From 1992 until 2008, the average number of plants found on Topsail Island during any given year was 3,034. Within the Surf City and North Topsail Beach project area, the number of plants declined immediately following hurricane events as evidenced by the fluctuating numbers between 1996 and 2001 (Appendix I, Table 4). However, long-term beach erosion is probably the primary threat to the continued presence of seabeach amaranth in the area as evidenced by the consistent decline in plant numbers since 2001. Failure to construct the proposed project could result in continued loss of seabeach amaranth habitat.

Water Resources. Natural sedimentation and turbidity rates would continue to vary based on storm activity, rainfall, currents, and other natural phenomenon.

Esthetic and Recreational Resources. Continued erosion of the beach would result in a continually narrowing beach front that is squeezed between the ocean and existing development, thus adversely affecting the recreation experience and esthetics of the study area on Topsail Island.

Community Cohesion, public facilities and services. Ongoing erosion of the beach and degradation of the dune system by erosion and storms could result in damage to public facilities, such as roads and utilities, and threats to human lives. All of which would adversely affect services and community cohesion. Highway NC50 is especially important since it is the only road to the town to the south, Topsail Beach.

Beach and Dune. The currently eroding beach and dune complex would continue to deteriorate, thus endangering public infrastructure, public and private property, human lives, and important habitat for a variety of plants and animals.

Floodplains. The floodplain in the study area is currently being adversely affected by erosion and the continued deterioration of the beach and dune complex. These effects will become more pronounced as the beach continues to erode and future storms encroach upon the area.

4. PLANNING OBJECTIVES

4.01 Goals

Identification and consideration of the problems, needs, and opportunities of the study area in the context of Federal authorities, policies, and guidelines resulted in the establishment of the following goals:

a. Reduce the adverse economic and environmental effects of hurricanes and other storms at Surf City and North Topsail Beach.

b. Find problem solutions that are protective of the environment through avoidance or minimization of impacts to natural resources, including beach invertebrates, shorebirds, marine fish, marine mammals, and their habitats, throughout the economic life of any proposed Federal action.

c. Protect endangered and threatened species and their habitats within the project area.

4.02 Constraints

The planning process is subject to the limitations imposed by the following constraints:

a. Geographic limits of the study authority but including the affected area of the environment.

b. Applicable Federal and State laws.

c. Current limits of knowledge, information, and predictive ability.

d. The CBRA zone in North Topsail Beach will be excluded from any proposed Federal project.

5. PLAN FORMULATION AND EVALUATION OF ALTERNATIVES

Following identification of existing conditions, problems, needs, opportunities, planning goals and planning constraints, this section describes the plan formulation process. A number of alternatives are usually identified early in the planning process, and their number is reduced by screening, evaluation, and comparison in an iterative sequence in increasing levels of detail to lead to identification of the tentatively selected plan.

Plan formulation for this study consisted of the following: (1) establishment of criteria by which alternatives would be evaluated; (2) identification, analysis, and screening of measures; (3) identification of alternative plans; (4) screening of alternative plans; and (5) evaluation of alternative plans. Each of these steps is discussed below.

5.01 Formulation and Evaluation Criteria

Alternative plans are evaluated through application of numerous, rigorous criteria. These include basic, general criteria as well as four categories of technical criteria, including (1) engineering, (2) economic, (3) environmental, and (4) institutional items. These are as follows:

General Criteria

- Plan must comply with applicable Federal laws and regulations;
- Plan must comply with applicable State and local laws and regulations, to the maximum extent practicable;
- Plan must comply with Corps of Engineers regulations.

Engineering Criteria

- Must represent sound, acceptable, and safe engineering solution;

Economic Criteria

- Plan must contribute benefits to National Economic Development;
- Tangible benefits of a plan must exceed economic costs;
- Each separable unit of improvement must provide benefits at least equal to costs;
- Recreation benefits may not be more than 50 percent of the total benefits required for economic justification;
- Plan implementation may not preclude development of more economical means of accomplishing the same purpose;

Environmental Criteria

- Plan will fully comply with all relevant environmental laws, regulations, policies, executive orders;
- Plan will represent an appropriate balance between economic benefits and environmental sustainability;
- Plan will be developed in a manner that is consistent with the Corps' Environmental Operating Principles (EOP);
- Adverse impacts to the environment will be avoided. In cases where adverse impacts cannot be avoided, mitigation shall be provided to minimize impacts to at least a level of insignificance.

Institutional Criteria

- Plan must satisfactorily address the identified needs and concerns of the public;
- Plan must be implementable with respect to financial and institutional capabilities;
- Plan must be implementable with regard to public support

5.02 Identification, Examination, and Screening of Measures

There are an extremely large variety of potential measures that might be considered and combined in the formulation of plans. The measures generally are categorized as either structural or nonstructural. Structural measures are those that directly affect conditions that cause storm damage and erosion. The nonstructural measures are those taken to reduce damages without directly affecting those conditions. Finally there is the No-Action Plan where no institutional or structural measure is applied.

A wide variety of structural measures are possible, such as beachfills, breakwaters, seawalls, and groins.

- Beachfill measures consist of berms, dunes, and terminal sections. The beachfill measures are considered some of the most appropriate, since they mimic the natural environment and can be shaped to maximize net storm damage reduction benefits.
- Groins can be a terminal groin near an inlet, or can be installed as a repetitive groin field throughout the project length. Groin fields can be used to prolong the life of a beach nourishment project. However, groin fields create the risk of potential adverse effects on adjacent shorelines due to trapping or shunting sand offshore. Groin fields have high initial costs, don't provide storm protection, have the potential to negatively impact turtles seeking beach nesting sites, and would require an extensive monitoring program with triggers that would initiate remediation. There are situations that warrant the acceptance of the risk that accompanies the use of a groin field. These situations include short beach fills, hot spots, areas adjacent to sediment sinks, and offset or convex shorelines. The study area does not include any of the situations which warrant the use of a groin field.
- Seawalls, bulkheads, and revetments are appropriate for reducing structural damage; however they do not meet the goal of preserving the environmental value

of the beach, and would reduce the usable recreation area of the beach at high tide.

- Breakwaters can be used in erosional hotspots where it is difficult to maintain a beachfill, however, no such condition appropriate for breakwaters was found in the project area. Moreover, while offshore breakwaters may reduce erosion in their lee, these benefits may be offset by accelerated erosion of the downdrift shoreline due to interruption of the littoral drift.
- Vegetation and sand fencing help retain windblown sand, but do not provide adequate storm protection for moderate to severe storms.

Nonstructural measures considered are changes in regulations and physical modifications to reduce damages.

- Regulatory measures. Some regulatory measures are coastal building codes, building construction setbacks, and floodplain regulations. Most regulatory measures are no longer considered for potential in the alternative plans because these measures have already been implemented, they do not affect older structures, and there are few buildable, vacant lots remaining that would benefit. These measures are considered as part of the existing conditions. They have reduced damages from past events, and as older structures are replaced, will help to reduce future damages.
- Removal. Another category of nonstructural measures is reduction of the damage threat by removing beachfront structures from the threat. The three removal measures are retreat, relocation, and demolition. Retreat is moving an existing structure away from the shoreline a short distance within the same property parcel. Relocation is moving an existing structure away from the shoreline a longer distance to a vacant property. Acquisition of the property and demolition of the structure is a third measure where retreat or relocation is not feasible. These three removal measures were retained for consideration in the nonstructural alternative.

The selected structural measure for detailed evaluation and consideration is beach fill. The selected nonstructural measures for detailed evaluation and consideration are retreat, relocation, and demolition. These measures can be applied independently and in combinations with each other to develop alternative plans.

5.03 Identification of Initial Alternative Plans

Beachfill plans were initially developed to extend the entire study area, including the two, separate, short groups of reaches in the non-CBRA area in the north end of North Topsail Beach. The two basic types of beachfills are a berm only and a berm and dune together. For all plans the berm elevation is 7 feet, the locally natural berm elevation for this coast. This selection of 7 ft-NGVD was made because of concerns that the artificially high berm would result in persistent scarping along the beach face.

The ends of typical beachfill plans have tapered transition sections. For the Surf City and North Topsail Beach the ends of the project would abut other beachfill projects planned

to the south and north of the study area. Either the transition section would not be needed, or would be a smaller transition between the two projects' cross sections. Plan formulation was conducted assuming a full cross section for each reach.

The nonstructural plans consist of retreats, relocations, and demolitions applied to threatened structures on an individual case basis.

The No Action plan remains in the list of alternative plans.

5.04 Screening of Alternative Plans

All but one of the initial alternative plans developed using the selected measures were considered to have sufficient potential for feasibility to be continued into economic evaluations of costs and benefits. The No Action plan was not evaluated since both costs and benefits are zero.

5.05 Evaluation of Alternative Plans

The remaining alternative plans would now be evaluated based on costs, benefits, and net benefits. Benefits of all the plans were evaluated using the GRANDUC program. The program estimates the present worth of storm damages for the no-action plan, and the various alternative plans, including the nonstructural plan.

5.05.1 Nonstructural Evaluation.

The structures included in the analysis are those located in the first row from the ocean. Those structures farther landward from the shoreline are not likely to be severely threatened for a few decades, and therefore are not included in the plan. Of the 1,815 structures in the study area, 904 were considered for the nonstructural alternative. Costs for moving structures are very specific and vary greatly depending on site conditions, travel route, and on structure size and construction. Several broad assumptions were necessary to make a manageable evaluation of this plan. Structures were categorized as one of three general relocation types, plus large commercial structures such as hotels. Because of the rapid rate of development on Topsail Island, only one third of the existing vacant lots were assumed available for relocation. Costs for each relocation type of structure were estimated for each of the three measures – retreat, relocation, and demolition. The costs for each structure were subtotaled by project reach and for the entire project area. More detailed discussion of the nonstructural plan is contained in Appendix P, Nonstructural Alternatives

The GRANDUC program was also used to evaluate benefits of the nonstructural plan. The structure database was modified to delete all first row structures, whether actually planned for retreat or for removal. The without project condition damages were recomputed based on this revised database to estimate residual damages for the

nonstructural plan. The difference in residual damages represented the present worth of average annual storm damage reduction benefits. Because the nonstructural plan does not prevent beach erosion, no recreation benefits were assigned. The nonstructural plan does not benefit highway NC50 where it is threatened by erosion at the south end of Surf City.

The present value economics of the nonstructural plan are displayed in Table 5.1. The overall net benefits are less than zero with a benefit to cost ratio of 0.26, and is not economically feasible. Combination plans of nonstructural measures in some reaches with beachfill in other reaches were also considered, but no applicable reach was found in this project area. Because the nonstructural plan is not economically feasible, it was not further evaluated for technical feasibility or for acceptability.

Table 5.1. Nonstructural plan economics, present worth, October 2004 levels, 5.375% interest rate.

Items	Amount
Cost, Demolition cost and value lost, 615 structures	$96,200,000
Cost, Relocation and retreat, 289 structures	$34,500,000
Cost, Purchase of lots, demolition and relocation, 739 lots	$389,500,000
Cost, Total, Nonstructural Plan	$520,200,000
Benefits, Total, Nonstructural Plan	$135,000,000
Net Benefits, Total, Nonstructural Plan	($385,000,000)

5.05.2 Beachfill Evaluations.

As explained previously the GRANDUC program is used to estimate benefits of alternative plans. To evaluate alternative plan storm damage reduction benefits, a comparison was made of without-project damages with the with-project residual damages. This difference defines the storm damage reduction benefits. These benefits were determined for each reach and for each alternative. Recreation benefits were not included at this level of plan evaluation.

GRANDUC also estimates present worth costs for the alternative beachfill plans based on initial sand volumes and renourishment sand volumes needed to replenish sand lost due to long-term and storm erosion. GRANDUC applies unit costs for dredging these sand volumes and applies mobilization and demobilization costs for each job. Other estimated costs included are engineering and design costs and contract supervision and administration. Other minor costs for tilling, vegetation, and walkover structures were omitted from the beachfill formulation process because the incremental differences between plans are negligible. These costs would later be included in the evaluation of the final plans.

A common assumption of all beachfill plans was regarding borrow material. While geotechnical, environmental and cultural resource surveys of the borrow sites were conducted, beachfill plans were being simultaneously evaluated. It was assumed that

sufficient quantity of off-shore sand was available for the project within 6 miles and that both initial construction and following renourishments will be performed by hopper dredges. Costs for all beachfill alternatives used the same mobilization costs and unit costs per cubic yard of dredging. A common loss factor between volume dredged and volume placed was used for all beachfill plans.

To assist in incremental analysis of the beachfill plans, costs and benefits of the beachfill plans were estimated for each reach. The process of identifying potentially feasible reaches was called scoping. A mid-range dune and berm cross section was selected as being representative for reach scoping. For this project, the representative cross section selected had a dune with a 25-foot top width at elevation 13 feet NGVD fronted by a 50-foot wide berm at elevation 7 feet NGVD.

The results of the scoping showed most reaches had relatively good net benefits, some had very high net benefits, and a few had negative net benefits. The set of continuous reaches, 27 to 78, in Surf City and the non-CBRA portions of North Topsail Beach were all found to be economically feasible for beachfill. The two separate, short groups of reaches, 104 to 106 and 115 to 117, in the non-CBRA areas in the north end of North Topsail Beach were not found to be economically feasible for beachfill. These were the only reaches excluded by the scoping analysis.

5.06 Optimization and Comparison of Beachfill Alternative Plans

Evaluation of plans at this point has narrowed the alternatives to beachfills in reaches 27 through 78. Cost estimates were developed using construction quantities produced from the GRANDUC evaluations.

5.06.1 Cross sections.

Plans were designated in the format, Plan DDBB, where DD represents the dune elevation in feet NGVD datum, and BB represent the berm width from the seaward toe of dune to the top of the foreshore slope. For example, a plan with a 12 foot elevation dune and a 25 foot wide berm is named Plan 1225. Table 5.2 presents the beachfill plan naming system.

Table 5.2 Beachfill Plan Names

Dune Elevation, Feet, NGVD	Berm Widths, feet				
	25	50	75	100	150
11	1125†	1150†*	1175†	-	-
13	1325†	1350†*	1375†	-	-
14	-	1450*	-	-	-
15	1525†	1550†*	1575†*	-	-
16	-	1650*	-	-	-
17	-	1750*	-	-	-
No dune, berm only	-	750†	-	7100†	7150†

† Initial screening.
* Selected for additional evaluation after screening

Higher storm dunes and wider berms result in both higher benefits and higher costs. Initially, dune elevations of 11, 13, and 15 feet were evaluated for berm widths of 25, 50, and 75 feet, and the 50-foot wide berm was found to consistently yield the greatest net benefits. Next various dune elevations were evaluated with the preferred 50-foot berm width. Dune elevations between 11 and 17 feet were all found to be economically feasible. There was little difference in net benefits for dune elevations between 13 and 16 feet with Plan 1550 having the maximum net benefits.

5.06.1.1 Berm Only Cross Sections.

The berm only plan is a fill extending seaward from the existing profile, with an elevation of 7 feet NGVD, approximately the elevation of the existing berm along the study area beaches. Berm width is measured seaward along the top of the berm from the point where the top of proposed berm intersects the natural profile. Seaward of the designed berm width, the with-project profile parallels the existing profile out to the closure depth of –23 feet NGVD. The widths included in preliminary plan screening of berm only plans were 50, 100, and 150 feet. Berm only plans with widths less than 50 feet were not considered practical because they provide very little effective coastal storm

damage risk reduction. In spite of a fairly substantial existing dune, these berm-only plans did not provide the level of coastal storm damage risk reduction as did the dune-and-berm plans, resulting in significantly lower total net benefits and did not warrant further consideration.

5.06.1.2 Dune and Berm Combination Cross Sections.

Existing dunes were assumed to remain in place, with the designed dunes abutting them. Designed dune templates were tied to a construction line, which is based on both the existing shoreline and the existing development. The construction line is landward of the 7-foot contour of the existing profile. The landward slope of the dune template is 5 horizontal to 1 vertical, the top of the dune is 25 feet wide, and the seaward slope is 10 horizontal to 1 vertical. The berm elevation is 7 feet NGVD, with berm width measured from the toe of the constructed dune. Seaward of the designed berm width, the with-project profile parallels the existing profile out to a closure depth of –23 feet NGVD. Historical projects in place along the North Carolina coast have dune heights of about 13-feet above NGVD with a berm width of about 50 feet. Therefore, in addition to the 13-foot dune with a 50-foot berm, a higher 15-foot and lower 11-foot dune, each with a 25-, 50-, and 75-foot berm at 7 feet-NGVD, were selected for initial screening.

5.06.2 Economic Comparisons.

Table 5.3 presents the economic comparisons of the plans as described in Section 5.06.1 and subsections 5.06.1.1 and 5.06.1.2. All values are shown as average annual equivalent value discounted at the FY2005 federal water resources interest rate of 5 3/8 % over a 50-year project life. More detailed evaluations of the tentatively selected plan are evaluated in more detail later at current interest rates and price levels. The GRANDUC model estimates damages in three categories and selects the greatest of the three for both the with-project and without-project conditions, preventing the double counting of benefits in the analysis. Recreation benefits will be included as incidental benefits in the total benefit accounting, but they are not included in Table 5.3 in the formulation of the project with respect to size and scope.

All beachfill plan cross sections have average annual HSDR net benefits of over $7 million, indicating economic feasibility. Of those plans, the plan with the greatest net benefits is defined as the NED plan. The NED plan is Plan 1550. Plan 1550 has 3 % greater net benefits over the next highest alternative, Plan 1450.

There is no specific modification to the NED plan proposed. Any recommended plan will include a complete dune and berm section for the entire project length. During PED phase of the project, the endpoints of the project may be modified to transition to conditions outside of the project limits.

Table 5.3, Dune and Berm Plans, Alternative Screening, Reaches 27 to 78.
Net Annual Benefits, Without Recreation, in millions. October 2004 Cost levels,
FY2005 interest rate 5.375% († not separately presented in screening level)

Plan	Annual Costs	Annual HSDR Benefits	Annual Net HSDR Benefits
750	†	†	$6.9
7100	†	†	$7.9
7150	†	†	$8.2
1150	$5.7	$13.5	$7.8
1350	$6.1	$15.3	$9.2
1450	$6.5	$15.8	$9.3
1550	$6.7	$16.2	$9.6
1650	$7.0	$16.3	$9.2
1750	$7.3	$16.6	$9.3
1575	$7.3	$16.5	$9.2
Nonstructural	$30.2	$7.8	($22.4)

5.06.3 Borrow Site Comparisons.

The preliminary identification of borrow areas for the project included New River Inlet and ocean waters off Topsail Island in water depths greater than 30 feet below NGVD. The results of a geophysical investigation conducted by Ocean Surveys, Inc. (OSI) were used to define the boundaries of the offshore borrow areas.

As identified in Section 2 (b) of the Coastal Barrier Resources Act CBRA, Public Law 97-348 (96 Stat. 1653; 16 U.S.C. 3501 et seq.), the purpose of CBRA is to "minimize the loss of human life, wasteful expenditure of Federal revenues, and the damage to fish, wildlife, and other natural resources associated with the coastal barriers along the Atlantic and Gulf coasts by restricting future Federal expenditures and financial assistance which have the effect of encouraging development of coastal barriers, by establishing a Coastal Barrier Resources System, and by considering the means and measures by which the long-term conservation of these fish, wildlife, and other natural resources may be achieved." The CBRA designated various undeveloped coastal barrier islands, depicted by specific maps, for inclusion in the Coastal Barrier Resources System (CBRS). Areas so designated were made ineligible for direct or indirect Federal financial assistance that might support development, including flood insurance, except for emergency life-saving activities. These areas included in the System are to be reviewed by the Secretary of the Interior "at least once every five years in order to make minor and technical modifications to the boundaries of system units as are necessary solely to reflect changes that have occurred in the size or location of any system units as a result of natural forces." The last such boundary modification occurred in 1990, and at the time included New River Inlet. New reviews of the CBRS boundaries are currently underway; however it's unclear at this time how those boundaries will be adjusted.

In general, no Federal funding may be used for physical or planning activities carried out within a CBRS area. However, exceptions for certain activities identified in Section 6 of the CBRA allow Federal expenditures or financial assistance within the CBRS. Specifically, "the maintenance of existing channel improvements and related structures, such as jetties, and including the disposal of dredge materials related to such improvements…scientific research, including but not limited to aeronautical, atmospheric, space, geologic, marine, fish and wildlife and other research, development, and applications…[and] nonstructural projects for shoreline stabilization that are designed to mimic, enhance, or restore natural stabilization systems" are exempt from CBRA restrictions. As such, Corps geological studies of the area are authorized, as is maintenance dredging of the existing navigational channel within New Topsail Inlet and New River Inlet. The Department of the Interior, however, reads CBRA to prohibit the transfer of sand from within a CBRS to a location outside the CBRS. While Wilmington District does not necessarily agree with this interpretation, it does acknowledge that in combination with other environmental factors, which include the constituent elements of piping plover habitat and other estuarine resources, the CBRA issue makes it impractical to pursue borrow sites within CRBA zones as viable alternatives at this time.

A sediment compatibility analysis was performed for the New River Inlet. The analysis indicated New River Inlet material was compatible with native material at Surf City and North Topsail Beach. Regardless, the New River Inlet was eliminated as borrow area because it is currently located within the CBRS.

After completion of the archeological resources survey, ten offshore borrow areas were identified for the further evaluation as potential borrow sources for Surf City and North Topsail Beach. Based on the results of the compatibility analysis, the total estimated volume in these ten borrow areas is insufficient to meet the required project volume over a 50 year project life. As a result, the excess amount of material identified in six offshore borrow areas for the Topsail Beach Federal coastal storm damage reduction project (USACE, 2009) have been included with the aforementioned ten borrow areas to meet the project requirements for the Surf City/North Topsail Beach project. These offshore borrow areas were assumed to be the source of material in evaluation of the alternative plans. The borrow areas are discussed in more detail in Section 7.04.

5.06.4 Environmental Comparisons of Plans.

In addition to the economic comparison, the impacts of the major categories of plans on the resources described in Section 2.00, Affected Environment, are considered. Table 5.4 presents the comparative impacts on these resources. The "No Action" alternative is defined as no action by the Federal government on this particular proposed coastal storm damage reduction project.

Table 5.4 Comparative Impacts of the Proposed Plan to the Nonstructural and No Action Alternative, Part 1 of 5.

Resource → Alternative ↓	Beachfill Alternatives	Nonstructural Alternative	No Action
Socioeconomic Resources	1. Improved recreational quality on expanded beach 2. Greater protection of oceanfront land, roads/utilities, structures, and personal property 3. Economically Justified	1. More remote undisturbed beach 2. Eliminates need for future protection of structures, land loss continues 3. Displaces beachfront homeowners and businesses. Reduced tax base. Expected cost exceeds benefits.	1. Continued deterioration of the existing beach 2. Continued threat to oceanfront land, roads/utilities, structures, and personal property 3. NED benefits foregone
Recreational and Aesthetic Resources	1. Improved appearance of beach will enhance recreational experience. Wider berm would increase recreation area. 2. Temporary inconvenience to beach users during initial construction and future maintenance.	1. More natural appearance along the beach. Recreation capacity would decrease as the beach erodes. 2. Temporary inconvenience to beach users during demolition or removal of structures.	1. Continued deterioration of beach appearance and berm width 2. Status quo maintained

Table 5.4 - continued. Comparative Impacts of the Proposed Plan to the Nonstructural and No Action Alternative, Part 2 of 5.

Resource → Alternative ↓	Beachfill Alternatives	Nonstructural Alternative	No Action
Marine Resources	1. Benthic organisms in borrow areas will be removed, but will be recolonized by opportunistic species 2. Temporary impacts on intertidal microfauna in the immediate vicinity of the beach nourishment 3. Reduces needs for bulldozing, beach scraping, and sand bags 4. Short term, recurring impacts to fishing areas 5. Temporary impacts to adult, larval, and juvenile fish due to turbidity and reduced benthic food in dredging and renourishment areas.	1. Status quo maintained 2. Status quo maintained 3. Eliminates needs for bulldozing, beach scraping, and sand bags. Eliminates re-occurring loss of invertebrates along beach. 4. Temporary inconvenience to beach fishermen during demolition or removal of structures. Status quo maintained in near shore waters. 5. Status quo maintained.	1. to 5. Status quo maintained
Natural Communities	1. The dune and berm would be re-established and the dune vegetated, resulting in an extended shoreline 2. Bottom substrate and bathymetry within 4,210 acres of nearshore ocean would be modified.	1. The beach would continue to erode, existing overwash areas would expand and new overwash areas would form. 2. Status quo maintained	1. The beach would continue to erode, existing overwash areas would expand and new overwash areas would form. 2. Status quo maintained

Table 5.4 - continued. Comparative Impacts of the Proposed Plan to the Nonstructural and No Action Alternative, Part 3 of 5.

Resource → Alternative ↓	Beachfill Alternatives	Nonstructural Alternative	No Action
Threatened and Endangered Species	1. Placement of fill will increase nesting habitat for sea turtles. 2. Placement of fill may increase beach hardness and alter other physical characteristics of the beach that may affect the nesting environment of sea turtles. 3. May adversely affect loggerhead, green, and Kemp's Ridley sea turtle species through lethal entrainment within hopper dredge dragheads. 4. May affect piping plover foraging, sheltering, and roosting areas. 5. Placement of fill would increase seabeach amaranth habitat. 6. Minimal threat of collision with whales during dredging operations.	1. Conditions for loggerhead and green sea turtle nesting would be improved by reduced disturbance and artificial lighting 2. Status quo maintained 3. Status quo maintained 4. Conditions for piping plover may be improved by reduced disturbance and new overwash areas. 5. Conditions for seabeach amaranth may be improved by reduced disturbance 6. Status quo maintained	1. Continued erosion of the beach would result in losses of sea turtle nesting habitat and possible poor site selection by females. 2. Status quo maintained 3. Status quo maintained 4. Status quo maintained 5. Continued erosion of beaches would result in loss of seabeach amaranth habitat 6. Status quo maintained
Water Quality	1. Temporary elevated turbidities over existing conditions during initial construction and nourishment in nearshore areas and offshore borrow areas.	1. Status quo maintained	1. Status quo maintained

Table 5.4 - continued. Comparative Impacts of the Proposed Plan to the Nonstructural and No Action Alternative Part 4 of 5.

Resource → Alternative ↓	Beachfill Alternatives	Nonstructural Alternative	No Action
Cultural Resources	1. No effects	1. Potential resource impacted by natural processes or storms. Relocation could affect any historic structures.	1. Potential resource impacted by natural processes or storms.
Contaminated Sediments	1. Remote possibility exists that OEW (anti-aircraft ammunition) could be present in the material to be dredged from offshore borrow areas and placed on the beach. The only ordnance that would be expected to be encountered would be spent shells from anti-aircraft target practice. In 1994, inspectors surveyed the beach area to the water's edge and did not find evidence of ordnance. Offshore areas were not surveyed. 2. Remote possibility that dredging in offshore borrow areas could encounter a missile (no OEW) and place it on beach. The missiles that were tested during Operation Bumblebee contained no OEW and were fired approximately 40 miles offshore, well beyond the project area, so the likelihood of encountering them in an offshore borrow area is remote.	1. Status quo maintained 2. Status quo maintained	1. Status quo maintained 2. Status quo maintained

Table 5.4 - continued. Comparative Impacts of the Proposed Plan to the Nonstructural and No Action Alternative, Part 5 of 5.

Resource → Alternative ↓	Beachfill Alternatives	Nonstructural Alternative	No Action
Other significant resources	1. Temporary noise increases during construction and maintenance events 2. Minor, short-term increases in boat/floating plant traffic 3. Beneficial effects of the storm protection project on community cohesion, public facilities (including roads and utilities) and services.	1. Temporary noise increases during demolition or removal of structures 2. Status quo maintained 3. Initially detrimental to community cohesion, public facilities (near beach) and some services.	1. and 2. Status quo maintained 3. Continued erosion of beaches would be detrimental to community cohesion and public facilities.

6. PLAN SELECTION

6.01 National Economic Development Plan

The National Economic Development (NED) Plan is the alternative among plans with the greatest net economic benefits. The dune and berm plan, named Plan 1550, having the greatest net economic benefits, is the NED plan. Plan 1550 consists of a 52,150-foot long dune and berm system to be constructed to a height of 15 feet NGVD fronted by a 7-foot NGVD (50-foot wide) beach berm.

6.02 Locally Preferred Plan (LPP)

The Towns of Surf City and North Topsail Beach have indicated they approve of the NED plan. There is no Locally Preferred Plan.

6.03 Other Plans

No other plan has been proposed as being the tentatively selected plan.

6.04 Tentatively Selected Plan

The NED Plan, Plan 1550, is the tentatively selected plan for recommendation for Federal action. Average annual storm damage reduction benefits as shown in Table 5.3 are $16.2 million for the NED Plan. Average annual costs of shown in Table 5.3 are $6.7 million for the NED Plan. Annual Net HSDR Benefits for Plan 1550 are $9.6 million.

The costs and benefits described in this section and in Table 5.3 were developed during Fiscal Year 2005 and use October 2004 costs and prices and the Federal Water Resources FY 2005 interest rate of 5.375%. This concludes comparative evaluations of the alternatives. From this point forward in the Feasibility Report costs and benefits for the NED Plan will be reported at October 2008 costs and prices and the FY2009 interest rate of 4.625%.

7. THE TENTATIVELY SELECTED PLAN

The purpose of this report section is to centralize information concerning the Tentatively Selected Plan. The Tentatively Selected Plan is discussed in terms of features, construction, maintenance, real estate requirements, accomplishments, and economic feasibility.

7.01 Plan Description and Components

The Tentatively Selected Plan is Plan 1550, which is the National Economic Development (NED) Plan. Plan 1550 consists of a 52,150-foot long dune and berm system. Sand for the beachfill would be delivered from offshore borrow areas by dredge. A cross section is shown in Figure 7.1 and a plan view is shown in Figure 7.2, and in more detail in Appendix A, Project Maps.

7.01.1 Main fill

The plan has a main fill length of 52,150 feet, from the Surf City town boundary in reach 27 to reach 78 in North Topsail Beach at the CBRA zone boundary. The two essential features of the tentatively selected plan are the dune and the berm.

The plan has a dune at an elevation of 15 feet NGVD and with a crest width of 25 feet. The side slopes of the dune are 5H:1V on the landward side and 10H:1V on the seaward side to the berm.

The plan includes a berm seaward of the dune. The berm has a flat, level section with an elevation of 7 feet NGVD and an optimum width of 50 feet. The seaward slope of the berm extends the beach fill approximately another 100 feet at a slope of approximately 15H:1V down to Mean Low Water (MLW) elevation (-1.9 feet NGVD), below which the with-project profile parallels the existing profile out to a closure depth of 23 feet. A construction berm at elevation 7 feet NGVD and varying width supplies sufficient volume to allow for the redistribution of material within the active profile while maintaining the optimum NED Plan berm width of 50 ft.

The landward construction line for the project is placed to minimize impacts on existing structures, to parallel the existing shoreline, to allow the Perpetual Beach Storm Damage Reduction Easement to extend about 20 feet landward of the dune toe, and to tie the fill into a minimum elevation of 7 feet NGVD.

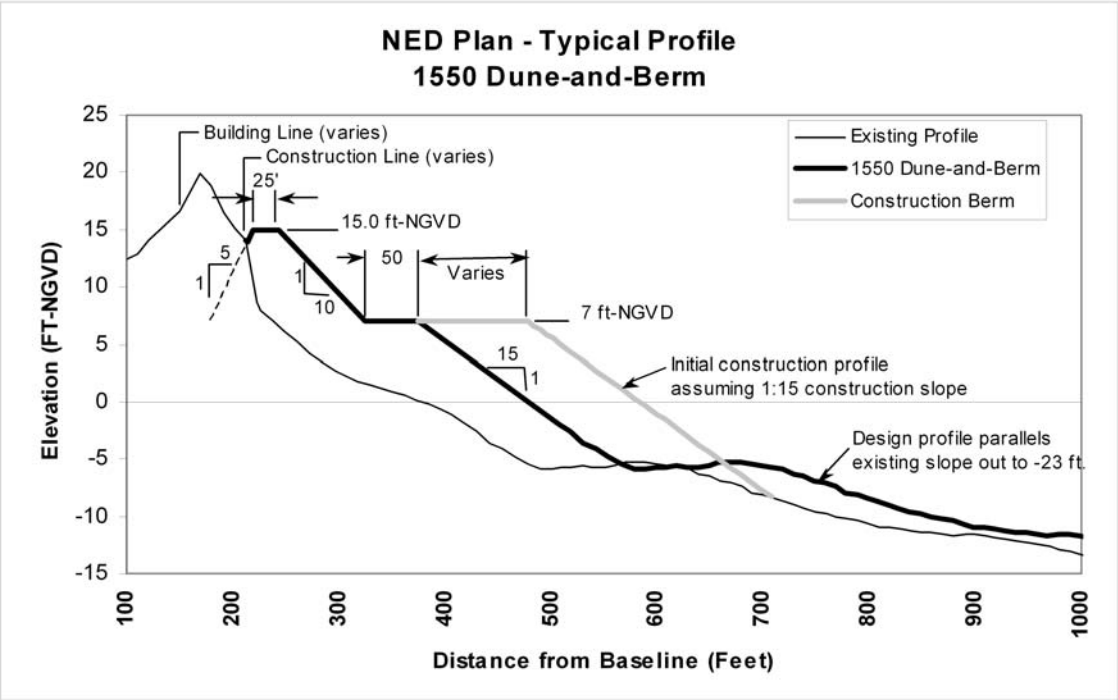

Figure 7.1 Plan 1550, NED Plan, Cross Section

7.01.2 Transition Sections

The Tentatively Selected Plan includes the complete berm and dune cross section for the entire project length. Depending on endpoint conditions found at construction, up to 2,000 feet of each of the project endpoints may be replaced with transitions sections. The transition sections at both ends of the main fill are necessary to improve project stability and reduce end losses. In the event there is no adjacent beachfill project, the plan would include a transition consisting of a tapered berm only, starting with a transition berm width of 200 feet that uniformly tapers to zero. If there is an adjacent beachfill project, any transition would be shorter and designed to fit the adjacent project.

Figure 7.2 Plan 1550, NED Plan, Plan View

7.02 Rationale for Support of the Locally Preferred Plan

The Towns of Surf City and North Topsail Beach have indicated they approve of the NED plan. There is no Locally Preferred Plan.

7.03 Design and Construction Considerations

7.03.1 Initial Construction and Renourishment

The tentatively selected plan requires about 11.5 million cubic yards of borrow material during initial construction, averaging 220 cy/lf. Project renourishment requirements for the 4-year renourishment cycle are about 1.6 million cubic yards of borrow material, which also accounts for about 12 percent of additional borrow material to offset placement losses. In total, about 31.1 million cubic yards of borrow material will be required for the 50-year project. These borrow volume quantities are actually 12 percent greater than the desired volumes to account for placement losses during construction, which equates to an average loss factor of 1.12. Placement losses are defined as the extra volume of material that must be removed from the borrow area in order to realize the required in-place volume of material on the beach.

The material will be pumped to the beach from hopper dredges and shaped on the beach by earth moving equipment. The initial construction profile will extend seaward of the final design berm profile a variable distance to cover anticipated sand movement during and immediately following construction. This variable distance will generally range from 100 to 200 feet along the project depending upon foreshore slopes established by the fill material. Once sand redistribution along the foreshore occurs, the adjusted profile should resemble the design berm profile. The anticipated construction plan is to use 2 hopper dredges during 4 separate construction seasons to complete the initial project. Environmental windows limit the construction season to mostly the winter months from 1 December to 31 March.

Renourishment is estimated to require 1,639,000 CY of sand by 2 hopper dredges in 1 construction season. Renourishment would be repeated on a 4 year cycle. Because of the long initial construction period, the first renourishment will only occur 1 year after the most recently completed construction and 4 years after the sections of the project completed first. Therefore the first renourishment volume would be estimated to be half the volume compared to a project completed all within one year. The estimated volume for the first renourishment is 819,500 CY.

Delivery of sand could occur by hauling filled scows to a pumping station buoy or by hopper dredge hauling sand to the pipeline buoy. In both initial construction and during renourishment material between the toe of dune and mean high water line would be tilled to prevent compaction.

7.03.2 Dune vegetation

The dune portion of the project will be stabilized against wind losses by planting appropriate native beach grasses. Dune stabilization would be accomplished by the vegetative planting of the dune during the optimum planting seasons and following the berm and dune construction. Planting stocks will consist of a variety of native dune plants including sea oats (*Uniola paniculata*), American beachgrass (*Ammophila breviligulata*), panic grass (*Panicum amarum*), and seaside little bluestem (*Littoralis variety*). The vegetative cover shall extend from the landward toe of the dune to the seaward intersection with the storm berm for the length of the dune. Plant spacing guidelines will follow the recommendations provided by the North Carolina Sea Grant publication, "The Dune Book" (Nash and Rogers, 2003). Sea oats will be the predominant plant with American beach grass and panic grass as a supplemental plant. Seaside little bluestem will be planted on the backside of the dune away from the most extreme environment. The total area for dune plantings is estimated to be 165 acres.

7.03.3 Construction Access and Public Access

Surf City has 33 public beach access points within the project limits and North Topsail has 22. Most access sites have wooden dune walkovers. Both Surf City and North Topsail Beach each have a vehicle cross-over in the project limits for beach maintenance and emergency access. The drive-over sites will provide access during construction of the beachfill for delivery and removal of the dredge pipeline and for other construction equipment.

Most of the existing public dune walkovers will be totally or partially removed prior to beachfill construction. After the beachfill is completed, new walkovers will be built and remaining walkovers will be extended over the dune. Including 5 new proposed public access sites, the total number of walkovers required is estimated to be 60. Of these, approximately 12 will be constructed to allow wheelchairs to cross the dune. The walkovers are to be constructed as a shared project construction cost. The real estate cost of providing the public access locations is not part of the project cost and is not creditable.

7.03.4 Renourishment Interval

An analysis of various renourishment intervals from 2 to 7 years determined that a 6-year periodic nourishment interval results in slightly higher net benefits. Net benefits increase as a function of renourishment interval from 2 to 4 years, beyond which net benefits fluctuate about 1 percent as the interval increases. Longer renourishment intervals increase the risks between renourishment events of allowing accumulated erosion to create escarpments, narrow the non-dune portion of the beachfill, erode the toe of the dune, and damage dune vegetation. The potential reduction in the project's ability to sustain recreational uses and to provide a suitable habitat for sea turtles and other species on the beach outweigh the slight gain in net storm damage reduction benefits. Therefore

the recommended renourishment interval is 4 years which captures over 99% of the maximum economic benefits and better sustains other benefits.

7.03.5 Beachfill Monitoring

A comprehensive monitoring program in accordance with USACE guidance (CEM Part V, Chapter 4 and CHETN II-35) is planned for the Surf City and North Topsail Beach project to assess and ensure project functionality throughout its design lifetime. This monitoring supports the design efforts for periodic renourishment and is cost shared 50% Federal and 50% non-federal. Estimated annual costs for beachfill monitoring are $483,000. The annual monitoring plan will consist of (1) semi-annual beach profile surveys, $362,000, (2) New River Inlet monitoring, $6,000, (3) annual aerial photography of New River Inlet and the beach (cost included in the inlet hydrographic survey), (4) an annual monitoring report, $100,000, and (5) monitoring program coordination, $15,000. Beach profile surveys will allow assessment of anticipated beachfill performance and determination of renourishment volume requirements. An aerial photographic record of the beach will further facilitate assessment of the beachfill performance. An annual monitoring report will be prepared that presents the data collected and the corresponding analysis of project performance, including recommendations on renourishment requirements.

7.03.6 Environmental Monitoring and Other Commitments.

The environmental goal of this project is to avoid and minimize adverse impacts to the maximum extent practicable. Table 7.1 is a summary of environmental commitments to protect species and habitat types related to the construction and maintenance of the proposed project. This summary includes commitments to federally listed threatened and endangered species as identified in Appendix I. Included in the table are other commitments to support coastal management plans and floodplain management.

Environmental monitoring costs associated with hopper dredging and beach tilling are estimated to be $31,050 for initial construction and $10,000 for each periodic nourishment. These environmental monitoring costs are included in the construction management costs and include only costs that are known at this time. It is anticipated that post-construction monitoring may be required, described as follows. Monitoring of sea turtle nesting activities in beach nourishment areas, item (10) is estimated to have an effective average cost of about $68,000 per year. This is an item currently occurring as part of the without-project condition and is not included as part of the project OMRR&R costs. Monitoring sea turtle nest temperature on the nourished beach, item (15) is estimated to cost about $10,000 for each nourishment event. Satellite tracking of sea turtle distribution within the project area, item (16) is estimated to cost about $25,000. Seabeach amaranth surveys, item (17) are estimated to cost about $6,000 following each nourishment event. Benthic Invertebrate Monitoring, part of item (19), of initial construction is estimated to cost $120,000. Physical monitoring of potential sedimentation impacts to hard bottom from initial construction dredging activities, item (23) is estimated to cost $300,000. When evaluated over the 50-year project life at 4.625% discount rate, the present value equivalent of environmental monitoring is estimated at $472,000 with an equivalent annual value of $24,000.

Table 7.1 Project Commitments

Species, Habitat, Other	**Commitments to Reduce Environmental Impacts and Other Impacts**
Sediment Compatibility	(1) Only beach compatible sediment (i.e. in accordance with NC Sediment Criteria Rule Language) will be placed on the beach as a component of this project. (2) During the P&S phase of this project additional borings and/or geophysical surveys will be performed to better delineate the borrow area boundaries and material types. (3) If necessary, the Wilmington District will make the decision on a suitable contingency measure which may include moving the dredge to another site within the borrow area or to another borrow area and will notify the agencies of this contingency measure.
Piping Plover & Other Shorebirds	(4) The Corps will adhere to appropriate windows to the *maximum* extent practicable. (5) All staging areas, pipeline routes, and associated construction activities will avoid high value piping plover and shorebird habitat, located within the vicinity of New River Inlet, to the maximum extent practicable.
Manatee	(6) The Corps will implement precautionary measures for avoiding impacts to manatees during construction activities as detailed in the "Guidelines for Avoiding Impacts to the West Indian Manatee in North Carolina Waters" established by the USFWS.

Table 7.1 - continued. Project Commitments

Species, Habitat, Other	**Commitments to Reduce Environmental Impacts and Other Impacts**
Sea Turtles	(7) The Corps will strictly adhere to all conditions outlined in the most current National Marine Fisheries Service RBO for dredging of channels and borrow areas in the southeastern United States. Furthermore, as a component of this project, hopper dredging activities for both initial construction and each nourishment interval will adhere, to the maximum extent practicable, to a dredging window of 1 December to 31 March in order to avoid periods of peak sea turtle abundance. The use of turtle deflecting dragheads, inflow and/or overflow screening, and NMFS certified turtle and whale observers will also be implemented. (8) In order to determine the potential taking of whales, turtles and other species by hopper dredges, NMFS certified observers will be on board during all hopper dredging activities. Recording and reporting procedures will be in accordance with the conditions of the current NMFS RBO. (9) The Corps will avoid the sea turtle nesting season during initial construction and each nourishment interval. If, due to unforeseen circumstances, construction extends into the nesting season, the Corps will implement a sea turtle nest monitoring and avoidance/relocation plan through coordination with USFWS and NCWRC. (10) Monitoring of sea turtle nesting activities in beach nourishment areas will be required to assess post nourishment nesting activity. This will include daily surveys beginning at sunrise from May 1 until September 15. Information on false crawl location, nest location, and hatching success of all nests will be recorded and provided to NCWRC.

Table 7.1 - continued. Project Commitments

Species, Habitat, Other	**Commitments to Reduce Environmental Impacts and Other Impacts**
Sea Turtles (continued)	(11) The beach will be monitored for escarpment formation prior to each nesting season. Escarpments that are identified prior to and/or during the nesting season that interfere with sea turtle nesting (exceed 18 inches in height for a distance of 100 ft.) will be leveled. If it is determined that escarpment leveling is required during the nesting or hatching season, leveling actions should be directed by the USFWS. (12) Only beach compatible sediment (i.e. in accordance with NC Sediment Criteria Rule Language) will be placed on the beach as a component of this project. Post nourishment beach compaction (hardness) will be evaluated by the Corps, in coordination with the NCWRC and USFWS, using qualitative assessment techniques to assure that impacts to nesting and incubating sea turtles are minimized and, if necessary, identify appropriate mitigation responses. (13) Local lighting ordinances will be encouraged to the maximum extent practicable in order to reduce lighting impacts to nesting females and hatchlings. The local sponsors will be encouraged to work with the USFWS, local monitoring groups, and other concerned organizations to develop the best plan for the Towns of Surf City and North Topsail Beach. (14) Throughout the duration of each nourishment event, both initial construction and periodic nourishment, the Contractor will be required to monitor for the presence of stranded sea turtles, live or dead. If a stranded sea turtle is identified, the Contractor will immediately notify the NCWRC of the stranding and implement the appropriate measures, as directed by the NCWRC. Construction activities will be modified appropriately as not to interfere with stranded animals, live or dead.

Table 7.1 - continued. Project Commitments

Species, Habitat, Other	**Commitments to Reduce Environmental Impacts and Other Impacts**
Sea Turtles (continued)	(15) The Corps is interested in understanding the threshold of sediment color change and resultant heat conduction on impacting temperature dependent sex determination of sea turtles. The Corps will contribute funds for the NCWRC to continue its temperature studies in order to gather nest temperatures on nourished beaches throughout the state, including Topsail Island, in comparison to non-nourished native sediment temperatures. This data could be used to help develop management criteria for sediment color guidelines. (16) In order to assess the abundance of sea turtles, and potential risk of hopper dredge take, within the proposed borrow areas for this project, the Corps will participate in the NCWRC's current satellite telemetry efforts to track the distribution and habitat usage of sea turtles in NC offshore waters.
Seabeach Amaranth	(17) Monitoring for seabeach amaranth on Surf City and North Topsail Beaches will be implemented to assess the post nourishment presence of plants. This survey will be broken down into survey reaches for each town in accordance with the designated USACE sea beach amaranth survey reaches from 1991-2008 in order to maintain consistent data and survey techniques over time and results will be provided to USFWS.
Benthic Invertebrates	(18) The anticipated construction timeframe for initial and periodic nourishment events will avoid peak recruitment and abundance time period for surf zone fishes and benthic invertebrates. (19) The Corps will convene a work group to identify study objectives that answer questions regarding critical life cycle requirements of benthic invertebrates and will contribute funds to carry out subsequent scientific investigations. (20) Initial construction will be completed over the course of four construction stages, each stage entailing a full constructed template. This staged initial construction approach will increase the speed of benthic invertebrate recovery for impacted areas by allowing for recruitment from adjacent un-impacted areas of the beach.

Table 7.1 - continued. Project Commitments

Species, Habitat, Other	**Commitments to Reduce Environmental Impacts and Other Impacts**
Hard Bottom Monitoring	(21) In order to (1) assure that required buffer distances are adhered to, (2) avoid physical impacts to hard bottom resources, and (3) monitor the potential for leakage of sediment, the Corps will require all dredges to implement the Silent Inspector automated dredge plant monitoring system. (22) In the event that a physical impact by the hopper dredge dragheads to previously unexposed hard bottom occurs, the incident will be thoroughly documented and coordinated with the appropriate state and federal resource agencies. Based on the outcome of this coordination, appropriate action will be taken to investigate and mitigate potential impacts. (23) Project monitoring of sedimentation impacts from dredging activities within the proposed 122 m (400 ft.) buffer will be implemented when appropriate. Sediment monitoring at select offshore transects, including controls, will occur before, during, and, if necessary, after construction and will include the installation of sediment traps (collectors) and *in-situ* sediment depth measurements. If sediment accumulation at the compliance transects is >10% of the sediment accumulated on average per day at the three control sites, then the Corps will direct the contractor to stop dredging operations within the 122 m (400 ft.) buffer and move to another area located 500 m (1640 ft.) from the identified hard bottom sites.
Shellfishing	(24) The Corps will contact the North Carolina Shellfish Sanitation and Recreational Water Quality Section prior to start of work, so the project area may be posted as required.

Table 7.1 - continued. Project Commitments

Species, Habitat, Other	**Commitments to Reduce Environmental Impacts and Other Impacts**
Erosion/Sediment Control	(25) If required, an erosion and sediment control plan will be developed and approved.
Water Quality	(26) Prior to construction, the Corps will obtain Section 401 Water Quality Certification from the North Carolina Division of Water Quality.
Terrestrial Impacts	(27) Land-based equipment necessary for beach nourishment work shall be brought to the site through existing accesses. Should the work result in any damage to existing accesses, the accesses will be restored to pre-project conditions immediately upon project completion.
Other Commitments	(28) Prior to construction the existing Mean High Water (MHW) line will be surveyed, and a copy provided to the NC Division of Coastal Management. If construction is not initiated within sixty days (60) and/or there is a major shoreline change prior to the commencement of beach nourishment, a new survey will be conducted. (29) Prior to construction the first line of stable natural vegetation will be surveyed. This survey must be conducted no more than 60 days prior to project initiation and be coordinated with the NC Division of Coastal Management. (30) Upon completion of the post construction beach profile surveys, the Corps will coordinate with the NC Floodplain Mapping Program to support revisions to the Digital Flood Insurance Rate Maps (DFIRMs). As part of this coordination the Corps will provide a Letter of Map Revision.

7.04 Borrow Areas

Sixteen borrow areas have been identified for the Surf City/North Topsail Beach Coastal Storm Damage Reduction Project. These borrow areas include 10 identified for the Surf City/North Topsail Beach project and the excess amount from 6 borrow areas identified for the Topsail Beach Federal project (USACE, 2009). These areas are typically between 1 and 6 miles offshore and have pre-dredge bottom depths between 35 and 50 feet. Material from the borrow areas were classified in accordance with the Unified Soil Classification System. The material classification (EM 1110-1-1906) types for the material identified as compatible from the borrow areas consisted of poorly graded clean sand (SP) or gravelly sand (SP-SM). Borrow areas within the project area were identified based on material characteristics and depth of suitable material. See Appendices C and E for more information on the borrow areas. Borrow area characteristics are summarized in Table 7.2.

As discussed in section 2.01.10, an extensive geophysical investigation was conducted to identify hard bottom presence and delineate hard bottom which was identified in and near several borrow areas. Hard bottom buffers of 500 meters (1,640 feet) were established for high and moderate relief hard bottom and 122 meters (400 feet) were established for low relief hard bottom. These buffers were proposed by the USACE, Wilmington District and concurred on by several state and federal resource agencies. See section 8.01.8.2 for more specific information regarding impacts to hard bottoms.

7.04.1 Borrow Area Material Compatibility

The compatibility analysis compares the grain size of the "native beach" or the "reference beach" with the material in the proposed borrow material. The overfill ratio is the primary indicator of the compatibility of the borrow material to the beach material, with a value of 1.00 indicating that one cubic yard of borrow material is needed to match one cubic yard of beach material. An overfill ratio of up to 1.5 is generally considered acceptable as a match of compatibility. Table 7.3 illustrates the overfill ratios for potential borrow areas for the Surf City/North Topsail Beach project. The overfill ratios for the borrow areas are all below 1.5 with the exception of borrow area C, which was 1.56. Because the overfill ratio for borrow area C was only slightly above 1.5, it has been retained for further evaluation when additional characterization is conducted during the design phase.

The state of North Carolina implemented new beach fill standards in 2007, which require compatibility of the native beach with borrow sources in regards to the percentage of silt (< 0.062 mm), granular sediment, (< 4.76 mm and ≥ 2.0 mm), gravel (≥ 4.76 mm), and calcium carbonate. A visual estimate of shell content can be used in lieu of carbonate weight percent for samples collected prior to the effective date of beach fill rules which applies to the Surf City/North Topsail Beach project. The standards require that percent silt, granular sediment, and gravel in borrow material not exceed the amount found in the native beach plus 5% and the percent carbonate in borrow material not exceed the

amount found in the native beach plus 15%. These characteristics for the native beach and borrow material are illustrated in Table 7.3. The analysis for the native beach material indicates the silt, granular sediment, and gravel content are 1.2%, 1.1%, and 0.5% respectively. The visual shell content for the native beach is 9%. After incorporating the tolerance permitted by the beach fill standards, the silt, granular sediment, gravel, and shell content permitted for borrow areas to be used for the Surf City/North Topsail Beach are 6.2%, 6.1%, 5.5%, and 24% respectively.

As illustrated in Table 7.3, all of the borrow areas comply with the beach fill standards in regards to the percentage of silt with the exception of borrow areas A (6.6%) and L (6.3%). Both of these borrow areas exceed the standard slightly by 0.4 and 0.1% respectively. All of the borrow areas comply with the beach fill standards in regards to the percentage of granular sediment with the exception of borrow areas F (7.0%) and S (6.6%), which exceed the standard by 0.9 and 0.5% respectively. All of the borrow areas comply with the beach fill standards in regards to the percentage of gravel sediment with the exception of borrow areas F (8.5%) and P (6.6%), which exceed the standard by 3.0 and 1.1% respectively. All of the borrow areas comply with the beach fill standards in regards to the percentage of shell content (carbonate). The borrow areas in which the standards were exceeded for the various characteristic (A, F, L, S, and P) have been retained as all borrow areas will be further characterized during the design phase of this project. Additional vibracores will be performed to comply with the beach fill standards of 1 core/acre or 1,000 foot spacing. Vibracores will be performed to produce a density of 1,000 foot spacing in a borrow area prior to its use as a borrow source. See Appendix E for more information on borrow material compatibility.

Table 7.2 Topsail Island Borrow Area Characteristics.

Borrow Area	Mean Grain Size	Estimated Volume (Million yd^3)	Distance Offshore (miles)	Surface Elevation (ft. MLLW)
A	2.36 phi (0.20 mm)	*	1 to 3	-38.5 to –49.0
B	2.17 phi (0.22 mm)	*	1.5 to 2.5	-42.2 to –43.2
C	2.32 phi (0.20 mm)	*	4 to 5.5	-45.5 to -47.7
D	2.13 phi (0.23 mm)	*	3.5 to 4.5	-43.5 to –46.9
E	2.15 phi (0.23 mm)	*	4.5 to 5.5	-49 to –50
F	1.09 phi (0.47 mm)	*	4.5 to 5.5	-47.2 to -48
G	2.05 phi (0.24 mm)	2.51	4 to 5.5	-46.5 to -49
H	2.21 phi (0.22 mm)	0.72	3.5 to 4.5	-44.4 to -45.2
J	2.12 phi (0.23 mm)	4.08	3 to 4.5	-42 to -47.4
L	2.05 phi (0.24 mm)	6.62	3 to 5.5	-42.3 to -47
N	1.86 phi (0.28 mm)	5.70	4 to 6	-43.6 to -46.7
O	2.12 phi (0.23 mm)	4.09	1.5 to 4	-40.6 to -43.9
P	2.01 phi (0.25 mm)	2.85	2 to 3.5	-39.5 to -40.5
Q	2.30 phi (0.20 mm)	0.73	1 to 1.5	-35.2 to -35.4
S	1.62 phi (0.32 mm)	1.66	3.5 to 4.5	-43.8 to -44.8
T	1.78 phi (0.29 mm)	0.25	2 to 4	-37.2 to -42

* - These borrow areas are planned to be used for the Topsail Beach Federal and non-Federal projects (USACE, 2009). The excess material not used for these projects is expected to be available for the Surf City/North Topsail Beach project. This amount is approximately 9.68 million cubic yards.

Table 7.3: Surf City/North Topsail Beach Compatibility Table

Native Beach	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
Surf City/North Topsail Beach	**2.15**	**0.23**	**0.71**	**0.61**	**1.2**	**1.1**	**0.5**	**9**

Borrow Site	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell	Overfill Ratio	Silt Correction Factor	Final Overfill Ratios Corrected for Silt Content
A ^	2.36	0.20	0.88	0.54	6.6	3.4	2.2	11	1.29	1.07	1.38
B ^	2.17	0.22	0.99	0.50	4.0	1.7	0.8	13	1.18	1.04	1.23
C ^	2.32	0.20	0.63	0.64	3.9	1.7	2.6	9	1.50	1.04	1.56
D ^	2.13	0.23	0.99	0.50	5.2	4.6	2.2	10	1.15	1.06	1.21
E ^	2.15	0.23	0.69	0.62	3.2	0.9	1.2	5	1.02	1.03	1.15
F ^	1.09	0.47	1.78	0.23	3.8	7.0	8.5	10	1.14	1.04	1.19
G	2.05	0.24	0.98	0.51	5.2	2.7	5.2	10	1.11	1.05	1.17
H	2.21	0.22	0.65	0.64	2.6	1.6	2.0	7	1.16	1.03	1.19
J	2.12	0.23	0.75	0.60	4.5	2.3	1.1	10	1.01	1.05	1.15
L	2.05	0.24	0.94	0.52	6.3	2.8	3.1	10	1.09	1.07	1.16
N	1.86	0.28	0.96	0.51	3.6	3.2	4.8	9	1.05	1.04	1.15
O	2.12	0.23	0.86	0.55	6.2	2.0	4.7	9	1.08	1.07	1.15
P	2.01	0.25	0.96	0.52	5.5	2.4	6.6	7	1.09	1.06	1.15
Q	2.30	0.20	0.66	0.63	5.9	2.4	2.3	10	1.37	1.06	1.46
S	1.62	0.32	1.12	0.46	3.3	6.6	4.1	21	1.06	1.03	1.15
T	1.78	0.29	0.95	0.52	2.8	3.0	3.9	17	1.03	1.03	1.15

^ These borrow areas have been identified for the Topsail Beach Federal project. The excess material not used for these projects is planned to be available for the Surf City/North Topsail Beach Federal project. This amount is approximately 9.68 million cubic yards.

7.04.2 Regional Sand Requirements

There are four beachfill projects planned or being planned for Topsail Island as shown schematically in Figure 7.3. These projects consist of the Surf City/North Topsail Beach Federal Coastal Storm Damage Reduction Project, the North Topsail Beach Non-Federal Project, the West Onslow Beach and New River Inlet (Topsail Beach) Federal Coastal Storm Damage Reduction Project, and the Topsail Beach Non-Federal Project. All of these projects are planning to use material from offshore borrow areas identified for the Federal projects. The estimated volume requirements for 50-year period of analysis of these projects are shown in Table 7.4.

By evaluating all Topsail Island offshore borrow areas together, the sixteen borrow areas contain approximately 53.49 million cubic yards of borrow material. The four Topsail Island project volume requirements are approximately 46.1 million cubic yards or about 86% of the available borrow material in all of the borrow areas evaluated for the Federal projects.

Proponent		Topsail Beach	Surf City	North Topsail Beach	
Local			(none)		
Federal					(CBRA zone)

Figure 7.3 Town and Project Limits, 1 inch = 25,000 feet

Table 7.4 Lifetime Borrow Requirements, Topsail Island

Project	Volume, Million CY
Surf City/North Topsail Beach Federal *	31.1
North Topsail Beach Non-Federal	0.34 #
Topsail Beach Federal	13.6
Topsail Beach Non-Federal	1.
Total, required	46.1
Total, available	53.49

* brought back from NED plan identification.
# The amount estimated for the project is approximately 4 million cubic yards. However, only 340,000 cubic yards will be required from the borrow areas identified for the Federal project.

7.04.3 Borrow Area Use Plan

There are many possible sequences and methods for placing available material on the beach for the project. The purpose of this plan is to discuss the following subjects: borrow area characteristics; dredging specifics; project construction plan; project sand requirements, and borrow area utilization. The economic optimization of the use of the borrow areas for the life of the project will be further evaluated when the final borrow area data has been collected and fully analyzed during the Plans and Specifications (P&S) phase. Additional vibracore boring data will be collected and made a part of the

final borrow area use plan, but for now, the currently defined borrow areas will be utilized. In addition to borrow area parameters (material quantities and location), the dredging production rates and dredging window are critical to selection of the optimum borrow use plan.

The offshore borrow areas beyond 3 nautical miles offshore will be subject to federal mining requirements of the Minerals Management Service (MMS). The borrow areas have been configured based on a geotechnical evaluation (Appendix C, Geotechnical Analysis) and results of the compatibility analysis (Appendix E, Sand Compatibility Analysis).

Areas to be used for borrow will be further defined during the Plans and Specifications phase of this project. Additional borings and/or geophysical surveys will be performed to better delineate the borrow area boundaries and material types. Vibracore borings will be performed in a grid pattern, on a 500 foot to 1000 foot spacing, in any area prior to its use as a borrow source.

7.04.4 Borrow Area Contingency Plan

Borrow area compatibility is determined based on grain size analyses from borings taken prior to construction, during both the feasibility study and plans and specifications phase. The borings conducted during the plans and specifications phase will provide any additional data necessary to help further refine the borrow area to comply with the NC beach fill standard of 1 core/acre or 1,000 foot spacing when combined with the borings conducted during the feasibility study. This additional characterization of the borrow material will increase the level of confidence for borrow material compatibility and decrease the degree of interpolation between boring locations. Qualitative visual characterizations of the in-place material will be made by representatives of the U.S. Army Corps of Engineers (USACE) construction and environmental offices throughout the project construction.

Furthermore, dredging production rates are specific to each dredge and its operation and can be quantified. The recommended construction plan identified in Section 7.04.1.4 discusses the use of hopper dredges during initial construction as well as each periodic nourishment event. Hopper dredges will utilize pumpout facilities for each dredged hopper load. Considering hopper dredges have a maximum capacity per load and are self propelled, potential incompatible material can feasibly be managed by the Corps.

Federal and state environmental agencies will be notified if, and how much, potentially incompatible material is encountered during dredging operations. If necessary, the Wilmington District will make the decision on a suitable contingency measure which may include moving the dredge to another site within the borrow area or to another borrow area, depending on availability of sediment, and will notify the agencies of this contingency measure.

7.05 Dredging and Material Shaping

The following discussion describes the dredging and construction plan.

7.05.1 Dredging Production

Dredging production refers to the average volume transported per day and relates to factors such as plant, material, distance, and weather. This information is used to estimate project cost and construction time. Production rates are estimated to average 14,000 CY/day for each hopper dredge for initial construction and for periodic nourishment.

7.05.2 Dredging Window

In determining the optimum borrow use plan, the hopper dredging window restriction was evaluated, with respect to sea turtles, using a 1 December to 31 March dredging window. This plan considers that in order to work within the hopper dredging window, the initial construction will take 4 seasons to complete.

A 4-year periodic nourishment cycle using hopper dredges is considered for the 50-year life of the project. Hopper dredging operations for this project will work in accordance with the "1997 National Marine Fisheries Service (NMFS) South Atlantic Regional Biological Opinion (SARBO) for the continued hopper dredging of channels and borrow areas in the Southeastern United States" or any superseding SARBO that is prepared by NMFS. Though, under the 1997 SARBO, the NMFS does not window hopper dredging operations from Pawley's Island, SC through North Carolina, both the USACE South Atlantic Division (SAD) office and South Atlantic Wilmington (SAW) District office currently recommend implementation of a 1 December to 31 March dredging window, to the extent practicable, in order to minimize impacts to sea turtles in the offshore environment. A summary for the recommended construction plan follows with a brief discussion of start-stop times, number of contracts required, type and number of dredges required, and dredging presence in the project area during the life of the project.

7.05.3 Recommended Construction Plan

Initial construction would begin 1 December of project year 1. The initial construction would consist of hopper dredging one or more of the offshore borrow areas and proceed until sea turtle activity resumes about 31 March of the following year. The process would continue each winter for 4 years until the full project length is completed in project year 4. To meet this schedule, 2 hopper dredges would be used in each season. Due to the relatively thin sand layer in the borrow areas, a cutterhead-pipeline dredge is unlikely to be effective.

Periodic nourishment would begin in project year 5 and consist of hopper dredging due to limited thickness of available material in the borrow areas and long haul distances.

Periodic nourishment for the project would use a combination of offshore borrow areas. Renourishment would adhere to the hopper-dredging window and begin December 1 for each cycle and proceed until completion before March 31 of the following year. In summary, every 4 years one hopper dredge would be expected to complete the renourishment within the designated hopper-dredging window. The plan would require separate contracts for initial construction and for each periodic nourishment cycle. This first renourishment would apply material mostly in reaches constructed in project year 1 and a small volume in reaches constructed in project year 4. The overall volume to be placed in the first renourishment may therefore be only half the volume required in each following renourishment.

7.06 Real Estate Considerations

Real estate requirements for the Tentatively Selected Plan include lands, easements, rights-of-way and relocations, and disposal/borrow areas, which are referred to as LERRD. Real estate requirements in each of these categories are discussed and followed by a summary of estimated real estate costs. There will be no utility relocations. There is no existing Federal project within the acquisition area. Further details are provided in the Appendix M, Real Estate Report, Section 9, LERRD.

7.06.1 Borrow Areas

Proposed borrow areas are located offshore. Upon final selection of borrow areas to be used for the project, coordination and concurrence for the sand removal from the offshore borrow areas will be required from appropriate state and/or federal agencies.

7.06.2 Pipeline

Material for initial project construction and beach nourishment will be dredged by hopper dredge from the offshore borrow areas, and then moved by pipeline to the beach. The pipeline will be routed along the ocean shoreline, where it will be placed either below Mean High Water or within the acquired Perpetual Beach Storm Damage Reduction Easements.

7.06.3 Construction Area

The project limits extend along the shoreline of Surf City and North Topsail Beach northward to reach 78, a total length of 52,150 feet. The estate to be acquired for the project will be a Perpetual Beach Storm Damage Reduction Easement for approximately 828 easements. . Based on project maps and ground examination, there are 3 parcels with structures located so far seaward, that it will be necessary to acquire the parcel and structures in fee. Another 2 parcels will be used temporarily as construction staging areas. There will be no relocation of landowners. Improvements (other than the pier) within the project include walkover structures that allow beach access from private and public property. The easement specifies that construction of walkover structures shall

not violate the integrity of the constructed dune. Approval of plans and specifications for construction of new walkover structures must be obtained from the Project Sponsor.

7.06.4 Real Estate Costs

Estimated real estate costs for the Tentatively Selected Plan of Improvement are shown in Table 7.5. The land value for the Perpetual Beach Storm Damage Reduction Easements is $0. As "off setting benefits" applies, a determination is made that the project will not reduce the value of the land. Rather it will remain the same or increase after construction of the project.

Table 7.5 Real Estate Estimate, Beachfill Plan.

a. Lands, 2 Temporary Staging Areas		$	58,000
b. Improvements, 3 residences		$	1,158,300
c. Mineral Rights		$	0
d. Damages		$	0
e. P.L. 91-646 Relocation costs		$	4,000
f. Acquisition Administrative Costs,		$	2,825,400
3 parcels in fee, 828 easements			
Federal	$ 332,400		
Non-federal	$ 2,493,000		
Subtotal		$	4,182,888
Contingencies, 25%		$	1,045,722
Total, rounded		$	5,229,000

7.07 Operation and Maintenance Considerations

Operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) requirements of the sponsors will consist of project inspections and maintenance. The beachfill monitoring actions are different from the non-Federal sponsors' OMRR&R project inspections and surveillance, which include assessment of dune vegetation, access facilities, dune crest erosion, trash and debris, and unusual conditions such as escarpment formation or excessive erosion. Periodic renourishment and beachfill monitoring (including the semi-annual beach profile surveys) are classified as continuing construction, not as OMRR&R. Dune vegetation maintenance includes watering, fertilizing, and replacing dune plantings as needed. Other maintenance is reshaping of any minor dune damage, repairs to walkover structures and vehicle accesses, and grading of any large escarpments. Estimated OMRR&R annual costs are $52,000.

7.08 Plan Accomplishments

The Tentatively Selected Plan will significantly reduce expected annual damages to structures and roads from storm and hurricane damages along the project reaches 27

though 78. It also will significantly reduce damages due to long-term progressive erosion.

The Tentatively Selected Plan will reduce, but not entirely eliminate, damages due to short term erosion, inundation, and wave overwash during storms. Although the Tentatively Selected Plan will substantially reduce damages due to hurricane-wave overwash, it should be noted that the plan provides for storm protection only in terms of protecting development from the action of ocean storm surge and wave action. There are no provisions in the project to protect the area against storm-tide flooding occurring from increased water levels in the sounds landward of Topsail Island.

The Tentatively Selected Plan will reduce emergency costs and other damages and will increase the width of beach available for recreation and for beach habitat, providing incidental benefits. Topsail Island was included in a study of recreation demand and benefits to four barrier islands on the North Carolina coast. A contingent valuation on-site and telephone survey was used to gather information about willingness to pay for recreation or improvement of Topsail Island along with information about socio-economic and other characteristics of the respondents. These data were used to predict annual and peak visitation by day visitors at Topsail Island. In addition, the survey data was used to determine NED recreation benefits for the with-project conditions. It is predicted from analysis of the survey data that an increase in beach width will increase both demand for and the willingness to pay for beach recreation at Topsail Island. The Tentatively Selected Plan will increase the useable recreation beach width by 65 feet for Surf City and 73 feet for North Topsail Beach (see Appendix O). The expected average annual benefit (AAB) for the with-project condition of the Tentatively Selected Plan is estimated at $20,000,000.

7.09 Economics of the Tentatively Selected Plan

Many suitable plans were identified that have benefits that exceed costs. The Tentatively Selected Plan is the NED Plan, having the greatest net benefits. Benefits and costs of the Tentatively Selected Plan are presented in this section at October 2008 price levels. The Water Resources Interest Rate for Fiscal Year 2009 of 4.625 percent is used to develop present values and annual values for benefits, costs, and net benefits.

7.09.1 Tentatively Selected Plan - Benefits

The total expected annual benefits for the Tentatively Selected Plan are estimated at $39,957,000. An itemized listing of expected annual benefits is presented in Table 7.6. Regarding the increase in flood damages, as storm erosion and long-term land losses are reduced, flood damages begin to become the dominant category. Also, structures that might have otherwise been taken out by storm and wave damage without a project are now subject to residual flood damages.

Table 7.6, Expected Annual Benefits, October 2008 levels, 4.625% interest rate.

Benefit Category	Expected Annual Benefit
	Tentatively Selected Plan, NED
Hurricane and Storm Damage Reduction	
Storm Erosion	$14,370,000
Flood	$(100,000)
Wave	$463,000
Land and Long Term Erosion	$2,162,000
Subtotal, rounded	$16,895,000
Recreation	$ 20,000,000
Benefits During Construction	$ 3,062,000
TOTAL EXPECTED ANNUAL BENEFITS, TENTATIVELY SELECTED PLAN OF IMPROVEMENT	$39,957,000

7.09.2 Tentatively Selected Plan - Costs

Determination of the economic costs of the Tentatively Selected Plan consists of four basic steps. First, project First Costs are computed. First Costs include expenditures for project design and initial construction and related costs of supervision and administration. First Costs also include the lands, easements, and rights of way for initial project construction and periodic nourishment. Total First Costs are estimated to be $118,415,000 at October 2008 price levels as presented in Table 7.7. The baseline cost estimate for construction in FY2014 is $130,000,000.

Table 7.7 Project First Costs – Plan 1550 NED (October 2008 price levels)

Acct. Code	Item	Quantity	Unit	Unit Price	Amount	Contin-gency	Total Cost
01	Lands and Damages						
	Lands Ownership				$1,216,000	$304,000	$1,520,000
	Improvements				$137,000	$34,000	$171,000
	PL 91-646 Relocation costs				$4,000	$1,000	$5,000
	Acquisition Cost, Federal				$332,000	$83,000	$415,000
	Acquisition Cost, Non-federal				$2,493,000	$624,000	$3,117,000
	Subtotal				$4,182,000	$1,046,000	$5,228,000
17	Beach Replentishment						
	Mobilization and Demobilization	1	JOB	LS	$7,600,000	$1,596,000	$9,196,000
	Dredging and Beach Fill	11,500,000	CY	$6.80	$78,200,000	$16,422,000	$94,622,000
	Dune Vegetation	165	AC	$10,000	$1,650,000	$347,000	$1,997,000
	Beach Tilling	150	AC	$750	$113,000	$24,000	$137,000
	Public Walkovers	60	EA	$31,100	$1,866,000	$392,000	$2,258,000
	Subtotal				$89,429,000	$18,781,000	$108,210,000
30	Planning, Engineering, And Design				$2,454,000	$614,000	$3,068,000
31	Construction Management				$1,527,000	$382,000	$1,909,000
	Total First Cost				$97,592,000	$20,823,000	$118,415,000

Second, Interest During Construction is added to the project First Cost. Interest During Construction is computed from the start of PED through the 4-year initial construction period. Interest During Construction for the Tentatively Selected Plan is estimated to be $10,318,000. The project First Cost plus Interest During Construction represents the Total Investment Cost required to place the project into operation. Total Investment Cost for the Tentatively Selected Plan is estimated to be $128,733,000 as shown in Table 7.8.

Table 7.8 Total Investment Cost – Plan 1550 NED (October 2008 price levels)

ITEM	AMOUNT
Total First Cost	$118,415,000
Interest During Construction	$10,318,000
Total Investment Cost	$128,733,000

Third, Scheduled Renourishment Costs are computed. These costs are incurred in the future for each renourishment. At this point neither discounting to present value, nor escalation for anticipated inflation is included.

Each renourishment is estimated to require 1,639,000 CY of sand by 1 hopper dredge in 1 construction season. Renourishment would be repeated on a 4 year cycle. As explained in Section 7.03.1 first renourishment volume is unique and only 819,500 CY. At October 2008 price levels the renourishment costs including non-contract costs and other support costs are estimated to be $10,120,000 for the first event and $17,557,000 for all following renourishments. Details are shown in Tables 7.9 and 7.10.

Table 7.9 Project Renourishment Costs – Plan 1550 NED (October 2008 price levels) First Event.

Acct. Code	Item	Quantity	Unit	Unit Price	Amount	Contin-gency	Total Cost
17	Beach Replentishment						
	Mobilization and Demobilization	1	JOB		$1,072,000	$225,000	$1,297,000
	Dredging and Beach Fill	819,500	CY	$7.50	$6,146,000	$1,151,000	$7,437,000
	Beach Tilling	66	AC	$792	$52,000	$11,000	$63,000
	Subtotal				$7,270,000	$1,527,000	$8,797,000
30	Planning, Engineering, And Design				$658,000	$165,000	$823,000
31	Construction Management				$400,000	$100,000	$500,000
	Total First Cost				$8,328,000	$1,792,000	$10,120,000

Table 7.10 Project Renourishment Costs – Plan 1550 NED (October 2008 price levels) Second and following events.

Acct. Code	Item	Quantity	Unit	Unit Price	Amount	Contin-gency	Total Cost
17	Beach Replentishment						
	Mobilization and Demobilization	1	JOB	LS	$1,072,000	$225,000	$1,297,000
	Dredging and Beach Fill	1,639,000	CY	$7.50	$12,293,000	$2,581,000	$14,874,000
	Beach Tilling	66	AC	$792	$52,000	$11,000	$63,000
	Subtotal				$13,417,000	$2,817,000	$16,234,000
30	Planning, Engineering, And Design				$658,000	$165,000	$823,000
31	Construction Management				$400,000	$100,000	$500,000
	Total First Cost				$14,475,000	$3,082,000	$17,557,000

Fourth, Expected Annual Costs are computed. These costs consist of interest and amortization of the Total Investment Cost, and the equivalent annual cost of project operation, maintenance, monitoring and renourishment. The Expected Annual Costs provide a basis for comparing project costs to expected annual benefits. Expected Annual Costs for the Tentatively Selected Plan are estimated to be $10,938,000. A summary of the computations involved in each of these three steps is presented in Table 7.11.

Table 7.11 Project Annual Costs – Plan 1550 NED (October 2008 price levels)

ITEM	YEAR	AMOUNT	PRESENT VALUE, 2014
Total Investment Cost	2014	$128,733,000	$128,733,000
Renourishment	2018	$10,120,000	$8,446,000
Renourishment	2022	$17,557,000	$12,228,000
Renourishment	2026	$17,557,000	$10,205,000
Renourishment	2030	$17,557,000	$8,517,000
Renourishment	2034	$17,557,000	$7,108,000
Renourishment	2038	$17,557,000	$5,932,000
Renourishment	2042	$17,557,000	$4,951,000
Renourishment	2046	$17,557,000	$4,132,000
Renourishment	2050	$17,557,000	$3,448,000
Renourishment	2054	$17,557,000	$2,878,000
Renourishment	2058	$17,557,000	$2,401,000
Renourishment	2062	$17,557,000	$2,004,000
Total Investment Cost, Present Value			$200,984,000
Annual Costs			
Interest & Amortization, 50 years at 4.625 %			$10,378,000
Monitoring, Annual Equivalent			$508,000
OMRR&R			$52,000
Total Annual Cost			**$10,938,000**

7.09.3 Benefit to Cost Ratio

With expected annual benefits of $39,957,000 and average annual costs of $10,938,000 the benefit to cost ratio for the Tentatively Selected Plan, Plan 1550, is 3.7 to 1. The annual net benefits are $29,019,000.

7.09.4 Incremental Analysis

Incremental costs and benefits by reach are shown in Table 7.12 and graphically in Figure 7.4. For the incremental feasibility test, allowable recreation benefits cannot exceed hurricane and storm damage reduction benefits. There are 4 reaches that are shown with negative net benefits, Reaches 28, 31, 34 and 56. These reaches are included within the tentatively selected plan because a transition across these reaches would be required if the reaches were omitted. The costs of the transitions would be close to the costs of the full dune and berm cross section. Therefore omitting those sections does not actually omit the full cost of that reach as indicated in the table. The table and graph were developed using October 2008 cost levels. Therefore both cost and benefits may be very slightly different than the more precise values shown elsewhere in the report. However the overall conclusion on selection of project length does not change.

Table 7.12 Incremental Analysis

Incremental Analysis of Typical Plan, 1550, by Reach, Annual Value 2008 Costs and Benefits, FY2009 interest rate							
REACH	1550 HSDR Benefits	1550 Costs	1550 Net HSDR Benefits	1550 Recreation Benefits	1550 Allowable Recreation Benefits	1550 Total Benefits	1550 Total Net Benefits
27	$288,000	$252,000	$36,000	$387,500	$288,000	$576,000	$324,000
28	$18,000	$208,000	($190,000)	$387,500	$18,000	$36,000	($172,000)
29	$315,000	$237,000	$78,000	$387,500	$315,000	$630,000	$393,000
30	$172,000	$188,000	($16,000)	$387,500	$172,000	$344,000	$156,000
31	$80,000	$188,000	($108,000)	$387,500	$80,000	$160,000	($28,000)
32	$99,000	$189,000	($90,000)	$387,500	$99,000	$198,000	$9,000
33	$144,000	$186,000	($42,000)	$387,500	$144,000	$288,000	$102,000
34	$36,000	$186,000	($150,000)	$387,500	$36,000	$72,000	($114,000)
35	$201,000	$177,000	$24,000	$387,500	$201,000	$402,000	$225,000
36	$124,000	$177,000	($53,000)	$387,500	$124,000	$248,000	$71,000
37	$239,000	$177,000	$62,000	$387,500	$239,000	$478,000	$301,000
38	$379,000	$208,000	$171,000	$387,500	$379,000	$758,000	$550,000
39	$340,000	$206,000	$133,000	$387,500	$340,000	$680,000	$474,000
40	$468,000	$207,000	$262,000	$387,500	$387,500	$855,500	$648,500
41	$391,000	$207,000	$184,000	$387,500	$387,500	$778,500	$571,500
42	$273,000	$206,000	$67,000	$387,500	$273,000	$546,000	$340,000
43	$504,000	$207,000	$297,000	$387,500	$387,500	$891,500	$684,500
44	$526,000	$206,000	$320,000	$387,500	$387,500	$913,500	$707,500
45	$476,000	$151,000	$325,000	$387,500	$387,500	$863,500	$712,500
46	$367,000	$151,000	$216,000	$387,500	$367,000	$734,000	$583,000
47	$648,000	$194,000	$454,000	$387,500	$387,500	$1,035,500	$841,500
48	$739,000	$194,000	$546,000	$387,500	$387,500	$1,126,500	$932,500
49	$890,000	$194,000	$696,000	$387,500	$387,500	$1,277,500	$1,083,500
50	$590,000	$151,000	$439,000	$387,500	$387,500	$977,500	$826,500
51	$149,000	$225,000	($75,000)	$387,500	$149,000	$298,000	$73,000
52	$649,000	$256,000	$393,000	$387,500	$387,500	$1,036,500	$780,500
53	$642,000	$257,000	$385,000	$387,500	$387,500	$1,029,500	$772,500
54	$392,000	$256,000	$136,000	$387,500	$387,500	$779,500	$523,500
55	$200,000	$225,000	($25,000)	$387,500	$200,000	$400,000	$175,000
56	$61,000	$225,000	($164,000)	$387,500	$61,000	$122,000	($103,000)
57	$254,000	$200,000	$54,000	$387,500	$254,000	$508,000	$308,000
58	$346,000	$200,000	$146,000	$387,500	$346,000	$692,000	$492,000
59	$314,000	$180,000	$133,000	$380,000	$314,000	$628,000	$448,000
60	$386,000	$180,000	$206,000	$380,000	$380,000	$766,000	$586,000
61	$199,000	$180,000	$18,000	$380,000	$199,000	$398,000	$218,000
62	$386,000	$168,000	$218,000	$380,000	$380,000	$766,000	$598,000
63	$315,000	$183,000	$132,000	$380,000	$315,000	$630,000	$447,000
64	$358,000	$200,000	$158,000	$380,000	$358,000	$716,000	$516,000
65	$307,000	$200,000	$107,000	$380,000	$307,000	$614,000	$414,000
66	$256,000	$200,000	$56,000	$380,000	$256,000	$512,000	$312,000
67	$349,000	$199,000	$149,000	$380,000	$349,000	$698,000	$499,000
68	$235,000	$198,000	$36,000	$380,000	$235,000	$470,000	$272,000
69	$201,000	$185,000	$16,000	$380,000	$201,000	$402,000	$217,000
70	$188,000	$185,000	$3,000	$380,000	$188,000	$376,000	$191,000
71	$219,000	$195,000	$24,000	$380,000	$219,000	$438,000	$243,000
72	$580,000	$183,000	$396,000	$380,000	$380,000	$960,000	$777,000
73	$533,000	$184,000	$349,000	$380,000	$380,000	$913,000	$729,000
74	$466,000	$184,000	$282,000	$380,000	$380,000	$846,000	$662,000
75	$199,000	$182,000	$16,000	$380,000	$199,000	$398,000	$216,000
76	$164,000	$182,000	($18,000)	$380,000	$164,000	$328,000	$146,000
77	$196,000	$184,000	$13,000	$380,000	$196,000	$392,000	$208,000
78	$139,000	$157,000	($17,000)	$380,000	$139,000	$278,000	$121,000
27 to 78	$16,990,000	$10,200,000	$6,788,000	$20,000,000	$14,274,000	$31,264,000	$21,064,000

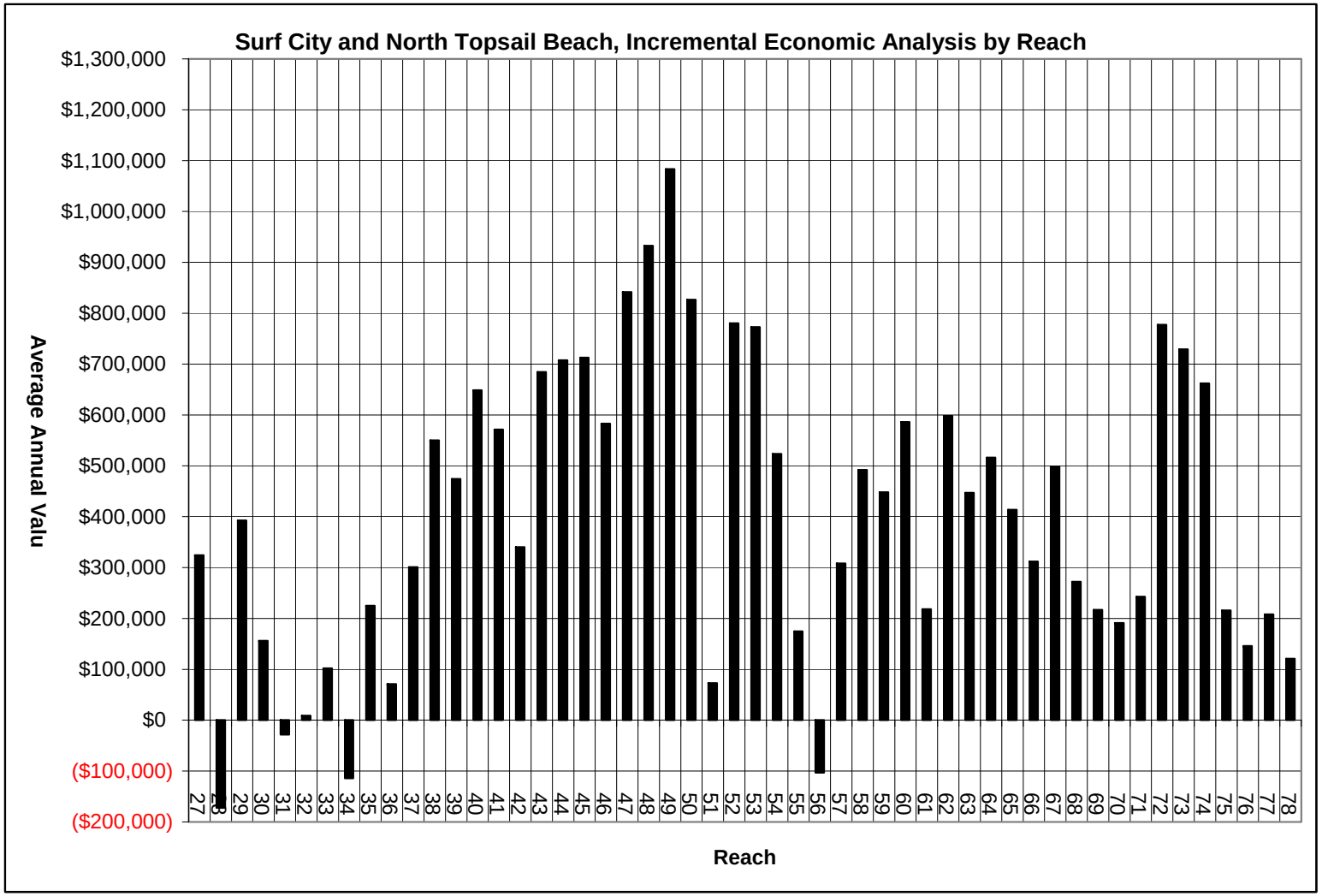

Figure 7.4 Net benefits by project reach.

7.10 Evaluation of Risk and Uncertainty

7.10.1 Residual Risks

The proposed beachfill plan would greatly reduce average annual storm damages. The tentatively selected plan, Plan 1550 will reduce combined wave and erosion damages by 88%. Some wave and erosion damages will still occur, estimated to average $2,238,000 per year over the 50-year period of analysis. The project is designed to protect mainly against storm waves and storm-induced erosion, two major categories of storm damage. The project will not prevent any damage from sound side flooding, therefore any ground level floors of structures, ground level floor contents, vehicles, landscaping, and property stored outdoors on the ground will still be subject to saltwater flooding that will flow in through New Topsail Inlet and New River Inlet and the soundside channels. Structures will continue to be subject to damage from hurricane winds and windblown debris. Damages from flooding and winds will decrease as older structures are replaced with those meeting floodplain ordinances and wind hazard building construction standards. But even new construction is not immune damage, especially from severe storm events. Also, the condition of the HSDR project at the time of storm occurrence can affect the performance of the project for that event.

The proposed beachfill reduces damages, but does not have a specific design level. In other words, the project is not designed to fully withstand a certain category of hurricane or a certain frequency storm event. The project purpose is storm damage reduction, and the berm-and-dune is not designed to prevent loss of life. Loss of life is prevented by the existing procedures of evacuating the barrier island completely well before expected hurricane landfall and removing the residents from harms way. The erratic nature and unpredictability of hurricane path and intensity require early and safe evacuation. This policy should be continued both with and without the storm damage reduction project.

Table 7.13 Residual Risks - Average Annual Values, 50 year duration, 4 5/8% interest rate, October 2008 costs levels.

Plan	Residual Damages	HSDR Benefits
No Action	$19,133,000	$0
Plan 1550, NED	$2,238,000	$16,895,000

7.10.2 Risk and Uncertainty in Economics

GRANDUC's lifecycle approach to plan formulation explicitly incorporates risk and uncertainty into the formulation process. Three significant variables in GRANDUC are currently programmed to incorporate uncertainty, namely:

1) erosion distance – plus or minus 5.0 feet
2) structure distance – plus or minus 2.0 feet
3) structure elevation – plus or minus 0.1 feet

Given the probabilistic nature of the analysis, the dune-and-berm alternatives were evaluated to determine the percent chance that the given alternative would have positive net benefits, or conversely, the risk of having negative net benefits. Based on analysis of 1,000 lifecycles, the Tentatively Selected Plan (15-ft dune elevation with 50-ft berm) has a 99.8% chance of having positive net benefits (i.e., less than a 0.2% risk of negative net benefits in any given year).

7.10.3 Risk and Uncertainty in Borrow Availability

The borrow areas are estimated to have enough material to supply the initial construction over the 50-year life of the project. The surplus of material is a relatively low percentage of the total. There is the possibility that at sometime in the future no more material is available in the designated borrow areas. In that scenario, borrow material for those last renourishments would come from a site(s) not originally identified as a borrow source at higher costs. A Limited Reevaluation Report (LRR) on borrow sources would be initiated if that scenario begins to develop. The scope of the LRR would be to identify additional suitable borrow sources, and to conduct a feasibility analysis of remaining costs and remaining benefits over the expected life of the project.

7.10.4 Risk and Uncertainty in Sea Level Rise Assumptions

Sea-level change can cause a number of impacts in coastal in estuarine zones, including changes in shoreline erosion and changes in storm and flood damages. Sea Level Rise (SLR) rates over time are the subject of many predictions. Historical trends in Mean Sea Level (MSL) are determined using measurement data from tide gauge records. Tidal records from nearby National Ocean Service (NOS) tidal station in Wilmington, NC (No. 865810) show a historical trend of 0.008 feet per year from 1953 to 1993. This planning study uses this historical SLR rate to formulate the NED plan.

Climate research has documented global warming during the 20th Century, and has predicted continued or accelerated global warming ultimately resulting in continued or accelerated rise in sea-level. In 1987 the National Research Council (NRC) published *Responding to Changes in Sea Level* outlining three proposed scenarios concerning sea level rise over the next century. The three scenarios resulted in three curves of sea level rise thru 2100. The curves (labeled Curve 1 through Curve 3) represent global eustatic sea-level rise values of 0.5 meters, 1.0 meters, and 1.5 meters over the next 125 years. In order to investigate the sensitivity of the NED plan to sea level rise, Curves 1 and 3 were used to bracket estimates in SLR. Curve 1 projection indicates a SLR of 0.7 feet 50 years after construction (year 2064), while Curve 3 indicates 1.9 feet of SLR in 2064. For comparison, the historic SLR rate projects about 0.4 feet of SLR in 2064. (see Figure 7.5)

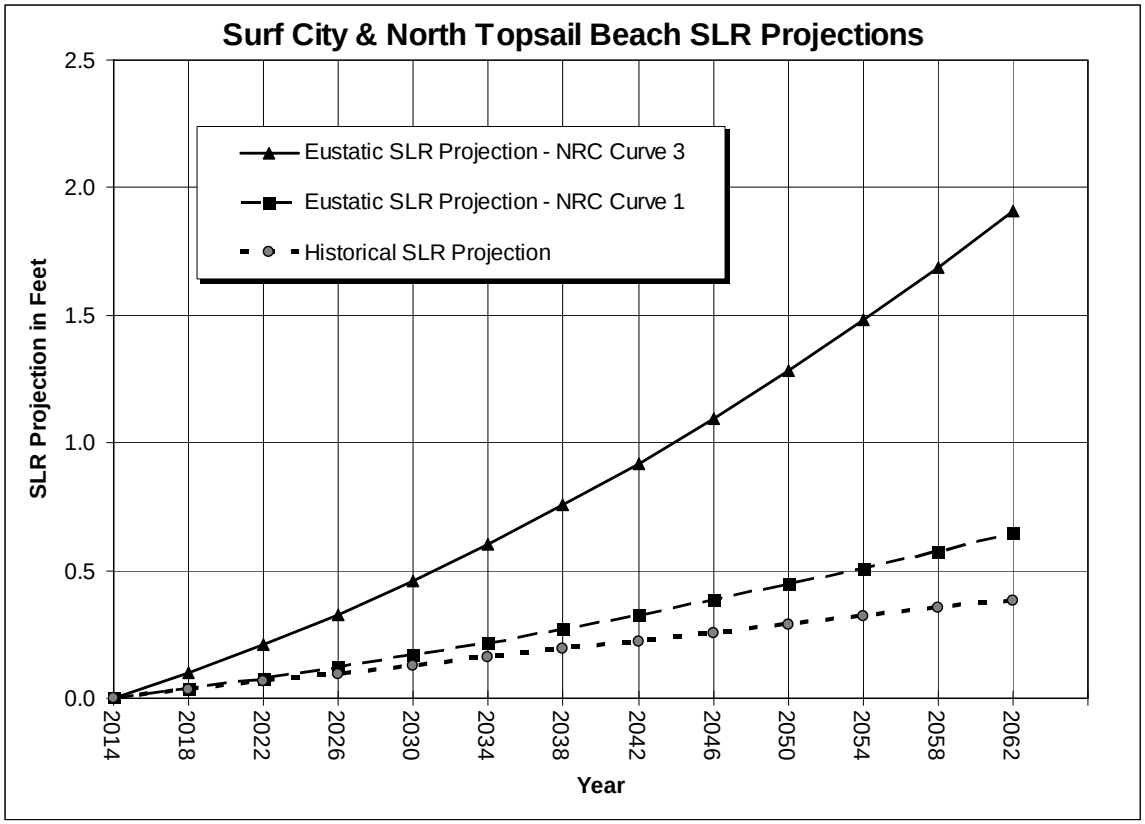

Figure 7.5 Sea Level Rise Projections

A sensitivity analysis of SLR effects upon the NED plan was conducted to estimate the with-project and without-project damages, benefits and costs. Full details of the analysis are included in Appendix D – Coastal Engineering. In summary, with accelerated SLR scenarios, the without-project damages are about six-times greater than the with-project damages. Total project costs could increase 30% due to additional erosion (using the most extreme estimate of SLR in 50 years) but the project provides an additional 100% of damage reduction benefits. A summary graph of the SLR scenarios analyzed and resulting modeling output is provided in Figure 7.6.

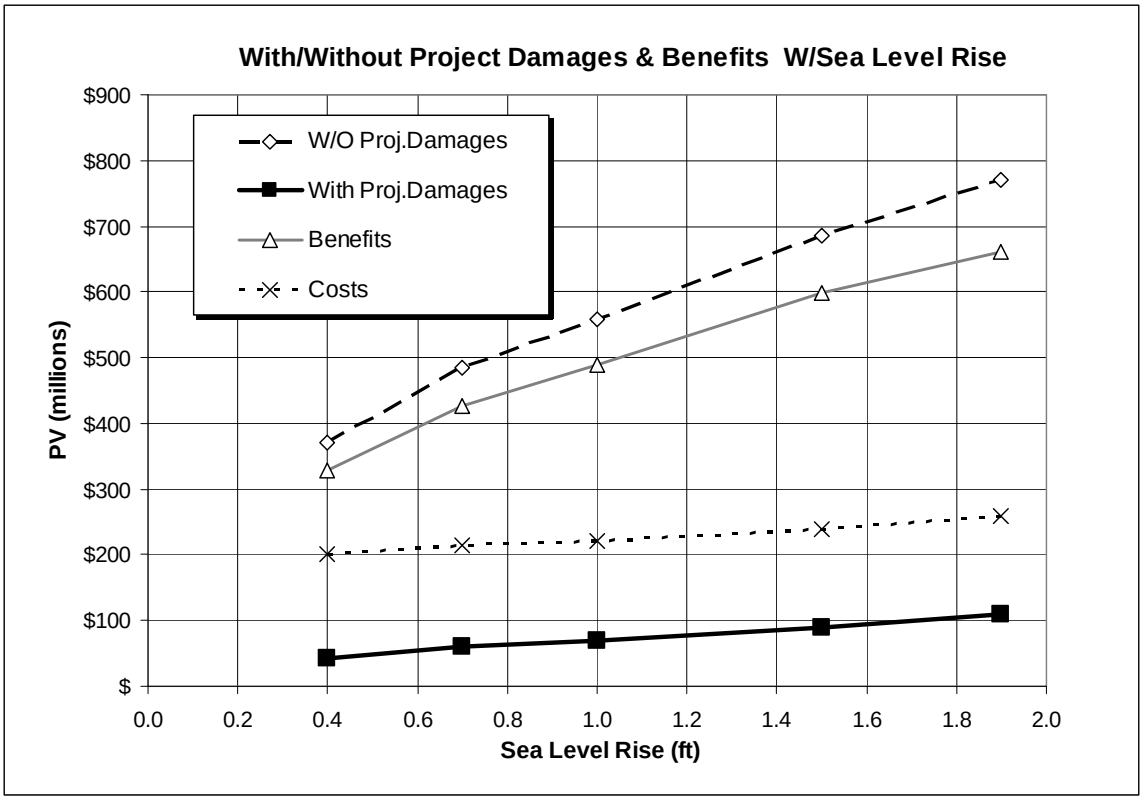

Figure 7.6 Sea Level Rise Effects on Project Economics

The proposed beach nourishment project is not a hard structure and adjusts to natural forces. Regardless of the rate of SLR, the beach fill project is monitored annually and renourished every 4 years. Monitoring data provides input to determining the details of each renourishment of the beach. If an accelerated SLR occurs, erosion volumes increase and renourishment volumes will increase, shortening the life of designated borrow areas. A Limited Reevaluation Report (LRR) on borrow sources would be conducted to investigate additional borrow sources (see Section 7.10.3). All alternative plans contain a 7-foot elevation berm and all would be affected similarly by accelerated SLR. Therefore, no change to the Tentatively Selected Plan by accelerated SLR is expected other than minor modification of the berm elevation and possibly the dune elevation. There is no expectation that accelerated SLR would result is selection of other major categories of alternative plans such as the nonstructural plan or hard structure plans.

7.11 System of Accounts Evaluation

The plan selected for recommendation, Beachfill Plan 1550, was based on the National Economic Development (NED) account alone. The plan is compared to the Nonstructural Plan and the No Action Plan in Table 7.14, System of Accounts. The plans are compared quantitatively in the NED account and qualitatively in the other 3 accounts – Regional Economic Development (RED), Environmental Quality (EQ) and Other Social Effects (OSE).

Table 7.14. 1 of 6, System of Accounts, National Economic Development

Item	Beach fill	Nonstructural	No Action
Plan Description	Vegetated Dune (elevation varies) fronted by non-vegetated, sandy beach berm at elevation 7 feet NGVD, with beach then sloping to approximate natural slope. Includes NED Plan 15 foot elevation dune with 50 foot wide berm. Specific amounts shown for Plan 1550	Combinations of relocation of existing beach structures either demolition, removal to new tract, or moving within same tract away from shoreline. Allow natural re-vegetation to occur on vacated lands upon and landward of existing dune. Amounts for nonstructural plan shown for Oct. 2004 level at 5.375%.	No Federal action, nor significant changes to existing non-federal actions.
a. Damages Prevented	$16,895,000	$7,800,000	$0
b. Recreation Benefits	$20,000,000	$0	$0
c. Ben. During Construction	$3,062,000	$0	$0
d. Total Benefits	$39,957,000	$7,800,000	$0
e. Costs	$10,680,000	$30,200,000	$0
f. Net Benefits	$29,277,000	($22,400,000)	$0
g. Residual Damages	$2,238,000	$11,400,000	$19,133,000

Table 7.14 - continued. 2 of 6, System of Accounts, Regional Economic Development

Item	Beach fill Alternatives	Nonstructural Alternative	No Action
a. Sales Volume	Preserves rental sales and tourism markets.	Reduces rental market and tourism market.	Occasionally changes from tourism to reconstruction.
b. Income	Increased recreation visitation may improve the income of service industries.	Decreased recreation visitation may reduce the income of service industries.	Occasional loss of tourism income.
c. Employment	Preserves seasonal employment. Project construction employment increases during winter dredging months and when walkovers and dune vegetation are installed.	Minor reduction in employment related to maintaining structures and serving tourists. Increase in project construction employment during relocations and demolition.	Occasionally changes from tourism services to reconstruction.
d. Tax Changes	Tax base and property values preserved.	Moderate loss to tax base as front row structures and property are removed from property tax base and rental market.	Continued occasional storm losses to revenues, tax base and buildable lots.

Table 7.14 - continued. 3 of 6, System of Accounts, Other Social Effects, Part 1

Item	Beach fill Alternatives	Nonstructural Alternative	No Action
a. Security of Life, Health and Safety	Significant reduction in stress related to concern of amount of damage and recovery. Significant reduction in hazards associated with post-storm recovery and reconstruction.	Moderate reduction in stress related to concern of amount of damage and recovery. Moderate reduction in hazards associated with post-storm recovery and reconstruction.	No change. Continued stress during damaging storms.
b. Preservation of Life	No change. Evacuation required before storm landfall.	No change. Evacuation required before storm landfall.	No change. Evacuation required before storm landfall.
c. Community Cohesion	Reduces displacements of all permanent residents.	Permanently displaces oceanfront residents/visitors. Periodic displacement of other residents. Continued threat to NC50.	Occasional displacement of all permanent residents. Continued threat to NC50.
d. Community Growth	Growth trends in population and recreation visitation will continue.	No significant net change.	Occasional reductions in population and recreation visitation trends.

Table 7.14 - continued. 4 of 6, System of Accounts, Other Social Effects, Part 2

Item	Beach fill Alternatives	Nonstructural Alternative	No Action
e. Man-made Resources	Reduces risks to buildings, houses, and other structures.	Eliminates erosion risks to structures relocated. Demolishes those not suitable for relocation.	Continued erosion risks to buildings, houses, and other structures. Occasional replacement of heavily damaged structures.
f. Public Facilities	Reduces erosion and wave damages to streets and utilities nearest the shoreline.	Continued threat to streets and utilities near shoreline.	Continued threat to streets and utilities near shoreline.
g. Displacement of Business	Reduces displacement of business.	Continued occasional disruption.	Continued occasional disruption.
h. Recreation and Public Access.	Improved appearance and utility of beach for recreation and requirement to maintain access for public. Infrequent storm litter.	Reduced lodging available for visitors. Continued narrowing of beach width. Infrequent storm litter.	Continued narrowing of beach width. Occasional littering of beach with storm debris.
i. Traffic and Transportation	Prevents damage to streets and sole highway to Topsail Beach.	Continued risk to streets and highways. Major disruptions during house relocations.	Continued risk to streets and highways.

Table 7.14 - continued. 5 of 6, System of Accounts, Environmental Quality, Part 1

Item	Beach fill Alternatives	Nonstructural Alternative	No Action
a. Ecosystem Restoration	Indirectly only, not an authorized project purpose.	Indirectly only, not an authorized project purpose.	No change.
b. Natural Resources	Increase in vegetated primary dune and upper beach habitat area.	Increase in undeveloped natural primary dune habitat.	Reduction of upper beach, dune, and upland habitat areas.
c. Biological Resources	Bottom substrate and bathymetry of nearshore ocean would be modified. Benthic organisms in borrow areas during dredging will be temporarily lost; however, recovery is expected to occur within 1-2 years. Beach bulldozing very infrequently.	Occasional beach bulldozing and scraping will result in temporary losses to intertidal habitat and biota.	Occasional beach bulldozing and scraping will result in temporary losses to intertidal habitat and biota.
d. Threatened and Endangered Species	Re-establishment of beach and dune will benefit sea turtle nesting suitability and seabeach amaranth habitat. Hopper dredging offshore may increase risk of sea turtle take. Temporary loss to piping plover foraging habitat during construction.	Sea turtle nesting suitability would be reduced by continued erosion of beach, but improved by reduction of artificial lighting. No risk of incidental sea turtle take from hopper dredging. Improved piping plover conditions from reduced disturbance.	Continued erosion of beach would impact suitability and success of sea turtle nesting. No risk of incidental sea turtle take from hopper dredging. Continued loss of seabeach amaranth habitat. Piping Plover foraging reduced occasionally by beach bulldozing.

Table 7.14 - continued. 6 of 6, System of Accounts, Environmental Quality, Part 2

Item	Beach fill Alternatives	Nonstructural Alternative	No Action
e. Water Quality	Temporary elevated turbidity during construction and renourishment in nearshore area and in off-shore borrow areas. Temporary impacts to benthic invertebrates feeding activities of shorebird and surf zone fish species.	No change.	No change.
f. Air Quality	Reduction offshore from dredging operations and onshore from earthmoving equipment.	Reduction during relocation and during demolition and hauling.	Occasional reduction during hauling of debris and reconstruction.
g. Noise Level Changes	Noise from mob/de-mob of equipment and pipeline. Noise from earthmoving equipment.	Noise during relocations, demolitions, and hauling.	Occasional noise from storm recovery and reconstruction.
h. Aesthetic Values	Improve appearance of beach and enhanced recreational quality. Temporary inconvenience during construction and renourishments, winter only.	More natural appearance of landscape immediately landward of dune on vacated properties. Continued deterioration of dune and beach appearance.	Continued deterioration of dune and beach appearance.
i. Cultural and Historical Preservation	No change, no such objects found in beach construction or borrow sites.	No change.	No change.
j. Total Quality of the Environment	Improvement of beach and dune. Temporary reduction during construction.	Short term and long term degradation of the beach and dune would continue. Increase habitat areas created landward of dune.	Short term and long term degradation of the beach and dune would continue.

8. ENVIRONMENTAL EFFECTS

The tentatively selected plan consists of a sand dune constructed to an elevation of 15 feet above the National Geodetic Vertical Datum (NGVD), fronted by a 50-foot wide beach berm constructed to an elevation of 7 feet above NGVD. The berm and dune project extends along a reach of 52,150 feet. Depending on endpoint conditions found at construction, up to 2,000 feet of the berm and dune on the ends of the project may be replaced with a tapered transition section.

The proposed borrow sites are located between 1 and 6 miles offshore at depths of 35 to 50 feet, MLLW. Initial construction will require 11.5 million cubic yards of borrow material. Renourishment will require 1.6 million cubic yards of borrow material at 4 year intervals. In total, about 31.1 million cubic yards of borrow material will be required for the 50-year project.

This section describes the probable consequences (impacts and effects) of the selected alternative on significant environmental resources within the project area. Natural communities that would be affected by the proposed action include the beach and dune and nearshore ocean as described below. Wetlands and floodplains, inlets, flats, sounds and Maritime shrub habitat would not be affected.

8.01 Marine Environment

8.01.1 Wetlands and Floodplains

The proposed borrow areas for this project are located between 1 and 6 miles offshore; therefore, dredging operations will not adversely impact wetlands and floodplains of Surf City or North Topsail Beach. Nourishment operations will not adversely impact wetlands and floodplains. Section 10 includes additional discussion of wetlands and floodplains pursuant to Executive Order 11988 (Floodplain Management) and Executive Order 11990 (Protection of Wetlands).

8.01.2 Inlet, Flats, and Sounds

The proposed borrow areas for this project are located between 1 and 6 miles offshore and will not adversely impact the inlet, flats, and sound of Surf City or North Topsail Beach. Considering that no sediment will be removed from the inlet complex for beach nourishment, impacts to inlet dynamics will not occur. Though large quantities of sediment will be added to Surf City and North Topsail Beach to construct and maintain this project, the total volume of sediment added to the littoral system will not be significantly more than pre-project conditions. Furthermore, the southern and northern limits of the project are located approximately 5 and 7 miles from New Topsail and New River Inlets, respectively. Therefore, the placement of additional sediment to the beach would not significantly impact sand flat and shoal development within the inlet systems.

This additional material would only accentuate the natural dynamics of the sand sharing system that currently exists. Therefore, nourishment operations will not adversely impact the inlet, flats, and sounds.

8.01.3 Surf Zone Fishes

The surf zone is a dynamic environment of which the community structure of organisms that inhabit it (ex. surf zone fishes and invertebrates) is complex. Representative organisms of both finfish and the invertebrate inhabitants of which they consume exhibit similar recruitment time periods. In North Carolina, the majority of invertebrate species recruit between May and September (Hackney *et al*., 1996; Diaz, 1980; Reilly and Bellis, 1978) and surf zone fish species from March through September (Hackney *et al*., 1996). The anticipated construction timeframe for this project is from 1 December to 31 March and would avoid a majority of the peak recruitment and abundance time period of surf zone fishes and their benthic invertebrate prey source.

The surf zone represents habitat areas of particular concern (HAPC) for some species, including adult bluefish and red drum, which feed extensively in this portion of the ocean. The surf zone is suggested to be an important migratory area for larval/juvenile fish moving in and out of inlets and estuarine nurseries (Hackney *et al*., 1996). Disposal operations along the beach can result in increased turbidity and mortality of intertidal macrofauna, which serves as food sources for these and other species. Therefore, feeding activities of these species may be interrupted in the immediate area of beach sand placement. These mobile species are expected to temporarily relocate to other areas as the project proceeds along the beach. However, some species like Florida pompano and Gulf kingfish exhibit strong site fidelity during the middle portion (summer) of the nursery period (Ross and Lancaster, 2002) and may not avoid secondary impacts (turbidity) from disposal. Considering that this project will avoid impacts to the surf zone during the summer months, it is expected that this project will not impact this period of strong site fidelity. Though a short-term reduction in prey availability may occur in the immediate disposal area, only a small area is impacted at any given time, and once complete, organisms can recruit into the nourished area. This recovery will begin immediately following disposal activity if the material is similar to the native beach (See Benthic Resources – Beach and Surf Zone Section 8.01.6).

According to Ross (1996) some surf zone fishes exhibit prey switching in relation to prey availability. Therefore, during periods of low prey availability, as a result of short-term impacts to the benthic invertebrate population during beach disposal activities, surf zone fishes may temporarily utilize alternative food sources. Considering the dynamic nature of the surf zone, this opportunistic behavior of avoidance and prey switching may enable some surf zone fishes to adapt to disturbances like beach nourishment. A combination of short-term prey switching and temporary relocation capabilities may help mitigate short-term prey reductions during beach disposal operations. Once the placement operation has passed, physical conditions in the impact zone quickly recover and biological recovery soon follows. Surf-feeding fish can then resume their normal activities in these areas. This is supported in Ross and Lancaster's (2002) study in which Florida pompano

and Gulf kingfish appeared to remain as long near a recently nourished beach as a beach that was not recently nourished.

Disposal and subsequent turbidity increases may have short-term impacts on surf zone fishes and prey availability. However, the opportunistic behavior of these organisms within the dynamic surf zone environment enables them to adapt to short-term disturbances. Considering the adaptive ability of representative organisms in this area and the avoidance of peak recruitment and abundance timeframes with a 1 December to 31 March construction timeframe, these impacts are considered temporary and minor.

8.01.4 Larval Entrainment

For many marine fishes, spawning grounds are believed to occur on the continental shelf with immigration to estuaries during the juvenile stage through active or passive transport. According to Hettler and Hare (1998), research suggests two bottlenecks that occur for offshore-spawning fishes with estuarine juveniles: the transport of larvae into the nearshore zone and the transport of larvae into the estuary from the nearshore zone. During this immigration period from offshore to inshore environments, the highest concentration of larvae generally occurs within the inlets as the larvae approach the second bottleneck into the estuary. Once through the inlet, the shelter provided by the marsh and creek systems within the sound serve as nursery habitat where young fish undergo rapid growth before returning to the offshore environment.

These free floating planktonic larvae lack efficient swimming abilities and are therefore, susceptible to entrainment by an operating hydraulic or hopper dredge as they immigrate from offshore to inshore waters. However, all of the proposed borrow areas are located between 1 and 6 miles offshore and none of the borrow areas are located within the vicinity of the New River Inlet or New Topsail Inlet complexes. Therefore, though concentrations of larvae will likely be present within offshore borrow areas, dredging activities will not occur in the highest concentration “inlet bottleneck” areas.

Susceptibility to this effect of entrainment is largely dependent on proximity to the cutter-head or drag-head and the pumping rate of the dredge. Those larvae present near the bottom would be closer to the dredge area and would, therefore, be subject to higher risk of entrainment. Assessment of the significance of this entrainment is difficult. Assuming the very small volumes of water pumped by dredges relative to the total amount of water in the dredging vicinity, a small proportion of organisms are presumed to be impacted. Potential reasons for low levels of impact include the extremely large numbers of larvae produced by most estuarine-dependent species and the extremely high natural mortality rate for early life stages of many fish species. Since natural larval mortalities may approach 99 percent (Dew and Hecht, 1994; Cushing, 1988), entrainment by a hydraulic dredge should not pose a significant additional risk in most circumstances.

An assessment of potential entrainment impacts of the proposed dredging action may be viewed in a more site-specific context by comparing the pumping rate of a dredge with

the amount of water present in the water body affected. For the purposes of this assessment, assumptions will be made that "inlet bottlenecks" would have the highest concentrations of larvae as they are transported into the estuarine environment from the nearshore zone. Larval impacts from dredging in this "high concentration" system would be significantly greater than the entrainment risk of dredging in offshore borrow areas. The larval fish distribution, abundance seasonality, transport, and ingress at Beaufort Inlet, North Carolina has been extensively studied (Blanton *et al*., 1999; Churchill *et al*., 1999; Hettler and Barker, 1993; Hettler and Chester, 1990; Hettler and Hare, 1998) and therefore; represents a good case study site for assessing larval entrainment of a hydraulic dredge. The largest hydraulic dredge likely to work in offshore borrow areas would have a discharge pipe about 30 inches in diameter and would be capable of transporting about 30,600 m^3 of sand per day if operated 24 hours (due to breakdown, weather, etc., dredges generally do not work 24 hours per day, 7 days per week). The dredged sediment would be pumped as slurry containing about 15% sand and about 85% water by volume. The volume of water discharged would, thus, be about 173,000 m^3 per day, or about 2.0 m^3 per second. In contrast, the calculated spring tide flow through Beaufort inlet (a representative North Carolina inlet) is approximately 142,000,000 m^3 * 2 = 284,000,000 m^3 (i.e. two tides a day) of water and 264,000,000 m^3 during neap tide. Thus, the dredge would entrain only 0.06 to 0.07 percent of the daily volume flux through the inlet. According to Larry Settle (2002), the percentage of the daily flux of larvae entrained during a spring and neap tide is very low regardless of larval concentration and the distribution of larvae within the channel. Under the worst-case scenario with the highest concentrations of larvae possible based on spatial and temporal distribution patterns, the maximum percentage entrained barely exceeds 0.1 % per day (see Appendix Q for a more detailed analysis conducted by Larry Settle). Though any larvae entrained (calculations indicate 914 to 1.8 million depending on the initial concentration within the tidal prism) will likely be killed, the impact at the population level would be insignificant. Based on these calculations indicating an "insignificant" larval entrainment impact, at the population level, from hydraulic dredging activities within a representative high concentration "inlet bottleneck" located at Beaufort Inlet, North Carolina, it is expected that the risk of larval entrainment from dredging activities in the offshore borrow areas associated with this project would be even less and would not adversely effect marine fish larvae.

8.01.5 Nekton

Oceanic nekton are active swimmers, not at the mercy of the currents, and are distributed in the relatively shallow oceanic zone. They are comprised of three phyla, chordates, mollusks, and arthropods, with chordates (i.e. fish species) forming the larges contribution. Any entrainment of adult fish, and other motile animals in the vicinity of the borrow area during dredging is expected to be minor because of their ability to actively avoid the disturbed areas. Fish species are expected to leave the area temporarily during the dredging operations and return when dredging ceases (Pullen and Naqvi, 1983). Larvae and early juvenile stages of many species pose a greater concern than adults because their powers of mobility are either absent or poorly developed, leaving them subject to transport by tides and currents. This physical limitation makes

them potentially more susceptible to entrainment by an operating hydraulic dredge (See Larval Entrainment, Section 8.01.4). Benthic oriented organisms close to the dredge draghead may be captured by the effects of its suction field and may be entrained in the flow of dredged sediment and water. As a worst-case, it may be assumed that entrained animals experience 100 percent mortality, although some small number may survive. Susceptibility to this effect depends upon avoidance reactions of the organism, the efficiency of its swimming ability, its proximity to the cutterhead, the pumping rate of the dredge, and possibly other factors. Behavioral characteristics of different species in response to factors such as salinity, current, and diurnal phase (daylight versus darkness) are also believed to affect their concentrations in particular locations or strata of the water column. Any benthic oriented organisms present near the ocean bottom (i.e. calico scallops and spiney dogfish (SAFMC managed species) would be closer to the dredge draghead and, therefore, subject to higher risk of entrainment.

The biological effect of hydraulic entrainment has been a subject of concern for more than a decade, and numerous studies have been conducted nationwide to assess its impact on early life stages of marine resources, including larval oysters (Carriker *et al.*, 1986), post-larval brown shrimp (Van Dolah *et al*., 1994), striped bass eggs and larvae (Burton *et al*., 1992), juvenile salmonid fishes (Buell, 1992), and Dungeness crabs (Armstrong *et al*., 1982). These studies indicate that the primary organisms subject to entrainment by hydraulic dredges are bottom-oriented fishes and shellfishes. The significance of entrainment impact depends upon the species present; the number of organisms entrained; the relationship of the number entrained to local, regional, and total population numbers; and the natural mortality rate for the various life stages of a species. Assessment of the significance of entrainment is difficult, but most studies indicate that the significance of impact is low. Impacts of dredging activities on marine mammals and sea turtles are addressed in the biological assessment (Appendix I). Though entrainment of benthic oriented organisms is expected from the proposed dredging activities, a hydraulic dredge operating in the open ocean would pump such a small amount of water in proportion to the surrounding water volume that any entrainment impacts associated with dredging of borrow material for this project are not expected to adversely effect species at the population level. In accordance with threatened and endangered species observer requirements for hopper dredging activities (See appendix I), inflow screening, as well as observation of dredged material is required to assure accountability of species entrained by the draghead. As a component of hopper dredge observer requirements, all other biota (i.e. fish, bivalves, etc.) captured by the inflow screening are recorded and submitted to the Corps for incorporation into a historic entrainment database.

8.01.6 Benthic Resources – Beach and Surf Zone

Beach nourishment may have negative impacts on intertidal macrofauna through direct burial, increased turbidity in the surf zone, or changes in the sand grain size or beach profile. Literature dating back to the early 1970's along the southeast coast indicate that opportunistic infauna species (ex. *Emerita* and *Donax*) found in the nourished areas are subject to direct mortality from burial; however, recovery often occurs within 1 year (Hayden and Dolan, 1974; Saloman, 1984; Van Dolah *et al*., 1992; Van Dolah *et al*.,

1993; Jutte, P.C. *et al*., 1999) especially if compatible material is placed on the beach (Hayden and Dolan, 1974; Reilly and Bellis, 1978; Saloman, 1984; Nelson, 1989; Van Dolah *et al*., 1992; Van Dolah *et al*., 1993; Hackney *et al*., 1996; Jutte, P.C. *et al*., 1999; Peterson *et al*., 2000). In North Carolina, post-nourishment studies have documented similar reductions in abundance of coquina clams (*Donax* spp.), mole crabs (*Emerita talpoida*), and amphipods (*Haustoriid* spp.) immediately following disposal with recovery times persisting between 1 and 3 seasons after project construction depending on sediment compatibility (Reilly and Bellis 1983;, Peterson *et al*., 2000; and Coastal Science Associates *Inc*., 2002).

Reilly and Bellis (1978) stated, "Beach nourishment virtually destroys existing intertidal macrofauna; however, recovery is rapid once the pumping operation ceases. In most cases, recovery should occur within one or two seasons following the project completion." Similar findings were reached by Van Dolah (1992) in a study of the impacts of a beach nourishment project in South Carolina. A study by Dolan *et al*. (1992) of the effects of beach fill activities on mole crabs at the Pea Island National Wildlife Refuge, Dare County, North Carolina, indicates that while nourishment has a dramatic impact on mole crabs in the area where beachfill is placed, mole crabs returned to the beach areas that were nourished soon after pumping stopped.

While beach nourishment may produce negative effects on intertidal macrofauna, these are localized in the vicinity of the nourishment operation. Beach nourishment conducted as a component of the proposed action would be expected to move along the beach at a relatively slow rate (i.e., about a mile per month or about 200 feet per day). This rate of progress is slow enough that surf-feeding fishes and shorebirds may move to other areas that are not affected by the nourishment operation. As the dredging operation passes by a given section of beach, that area is soon available for recolonization by invertebrates.

In a 1999 Environmental Report on the use of Federal offshore sand resources for beach and coastal restoration, US Department of Interior, Minerals Management Service provided the following assessment of potential impacts to beach fauna from beach nourishment.

> *Because benthic organisms living in beach habitats are adapted to living in high energy environments, they are able to quickly recover to original levels following beach nourishment events; sometimes in as little as three months (Van Dolah et al. 1994; Levisen and Van Dolah, 1996). This is again attributed to the fact that intertidal organisms are living in high energy habitats where disturbances are more common. Because of a lower diversity of species compared to other intertidal and shallow subtidal habitats (Hackney et al. 1996), the vast majority of beach habitats are re-colonized by the same species that existed before nourishment (Van Dolah et al. 1992; Nelson 1985; Levisen and Van Dolah, 1996; Hackney et al. 1996).*

As a component of their review of the potential impacts from beach nourishment on surf zone fishes and invertebrates in the South Atlantic Bight, Hackney *et al*. (1996) identified

nine fish species and five invertebrate species/groups that are important inhabitants of the intertidal and subtidal beach environment. Based on their literature review of associated impacts to these species and how best to protect the natural resources associated with beach nourishment, they identified four management questions to address for each nourishment project: (1) project timing, (2) sediment compatibility, (3) nourishment duration, and (4) innovative ways to minimize impacts (i.e. staging nourishment events). These questions were considered during planning efforts associated with the proposed dredging and beach construction efforts for this project. The proposed dredging window of 1 December through 31 March for initial construction and each nourishment event avoids the identified peak recruitment periods for surf zone fish (March through September (Hackney *et al*., 1996)) and invertebrate species (May through September (Hackney *et al*., 1996; Diaz, 1980; Reilly and Bellis, 1978)) in North Carolina. Beach nourishment will therefore be completed prior to the onshore recruitment of most surf zone fishes and invertebrate species. Furthermore, in order to complete the full initial construction template, while adhering to the 1 December to 31 March dredging window, the construction effort will occur over a four year time period. Therefore, the duration of each initial construction effort as well as each subsequent re-nourishment effort will be limited so that it does not preclude recruitment for any species during its entire recruitment period. Additionally, in accordance with recommendations provided by Hackney *et al.* (1996), the four initial construction events will occur in stages along the beach, with the full template being constructed for each stage, instead of the entire beach being impacted within each construction event. This approach would also increase the speed of recovery for impacted areas by allowing for recruitment from adjacent un-impacted areas of the beach. In order to assure compatibility of nourishment material with native sediment characteristics and minimize impacts to benthic invertebrates from the placement of "incompatible" sediment, all sediment identified for use for this project will meet the "Technical Standards for Beach Fill Projects" (15A NCAC 07H.0312) identified in the NCDCM rule language. During each re-nourishment interval, any loss of intertidal organisms would be temporary, as re-population would be expected to begin as soon as the re-nourishment operation ends with re-colonization of the beach by organisms from adjacent un-impacted areas and offshore.

In summary, temporary impacts on intertidal macrofauna in the immediate vicinity of the beach nourishment project are expected as a result of discharges of nourishment material on the beach. While the proposed beach nourishment may adversely impact intertidal macrofauna, with the implementation of environmental measures discussed above, these effects will be localized, short-term, and reversible. Any reduction in the numbers and/or biomass of intertidal macrofauna present immediately after beach nourishment may have localized limiting effects on surf-feeding fishes and shorebirds due to a reduced food supply. In such instances, these animals may be temporarily displaced to other locations.

8.01.7 Benthic Resources – Nearshore Ocean

Individual borrow areas, or a combination of borrow areas, may be used for each construction event throughout the 50 year duration of the project. All of the borrow areas

are located offshore of Topsail Island between 1 and 6 miles offshore. The offshore borrow areas located beyond 3 nautical miles offshore will be subject to federal mining requirements of the Minerals Management Service (MMS). Multiple dredging areas within a given borrow site may be used to reduce material transport and/or allow for concurrent operation of more than one dredge in a given area. Considering the distance offshore and the shallow volumes of sediment within the borrow areas, it is anticipated that all dredging activities associated with initial construction and each re-nourishment interval will be conducted using a hopper dredge. Hopper dredges are mobile and are most productive dredging smaller depths of cut of approximately 3 feet over larger areas rather than dredging to larger depths of cut over smaller areas, as is the case with hydraulic cutterhead dredges. The depth of hopper dredge cut will vary depending on the availability of suitable sandy material within each borrow area and dredge plant capabilities. Based on existing vibracore data, the anticipated average dredging depths for all borrow areas located off of Topsail Island are provided in Table 8.1.

Table 8.1. Anticipated dredge cut depths and subsequent post-dredge surface elevations for borrow areas located offshore of Topsail Island based on vibracore data.

Borrow Area	Pre-Dredge Surface Elevation (MLLW)	Post-Dredge Surface Elevation (MLLW)	Thickness Range	Average Thickness
A	-38.5 to -49	-40.5 to -54.8	2 to 9.3	4.4
B	-42.2 to -43.2	-45.2 to -47.6	2 to 5.4	3.7
C	-45.5 to -47.7	-48 to -51	2 to 4.5	2.8
D	-43.5 to -46.9	-46.5 to -53.6	2 to 6.7	3.9
E	-49 to -50	-52.8 to -53	2.8 to 4	3.4
F	-47.2 to -48	-49.7 to -51	2.5 to 3	2.8
G	-46.5 to -49	-49.3 to -54	2 to 5.5	3.7
H	-44.4 to -45.2	-46.6 to -50	2.2 to 4.8	3.5
J	-42 to -47.4	-45.6 to -55	2 to 8.3	3.7
L	-42.3 to -47	-45.3 to -60.8	2 to 13.8	4.2
N	-43.6 to -46.7	-46.4 to -59.1	2.3 to 14.8	5.1
O	-40.6 to -43.9	-44.7 to -55	2 to 12.7	6.4
P	-39.5 to -40.5	-42.5 to -51	2 to 10.5	5.7
Q	-35.2 to -35.4	-39.6 to -41.2	4.2 to 6	5.1
S	-43.8 to -44.8	-46.1 to -47.7	2.2 to 3.5	2.6
T	-37.2 to -42	-40.4 to -49.2	2.2 to 8.6	4.2

A few outlier vibracores with compatible sediment thicknesses of 10.5 ft., 12.7 ft., 14.8 ft., and 13.8 ft. were identified in borrow areas P, O, N, and L, respectively; however, insufficient vibracore data currently exists to assume that dredging depths significantly greater than the identified averages would be achieved. Based on the existing pre-dredge depths and the anticipated average depths of material removed, post project borrow area depressions will likely not exceed about 50 to 60 feet of depth.

Considering that all proposed offshore borrow areas are located beyond the –35 ft. contour and the proposed depth of closure for this project is -23 ft, significant infilling of the borrow areas as a result of longshore sediment transport processes will not occur.

However, considering the shallow dredge volumes of material to be removed from the borrow areas, some infilling of sediments may still occur from other storm and current driven processes. Monitoring studies of post construction borrow areas in the southeast indicated that borrow areas can fill in and return to near pre-dredging conditions when there is adequate transport of sediment under the influence of strong currents in the area (Bowen and Marsh, 1988). Though, some infilling of the borrow areas is anticipated from sedimentation and side sloughing, as well as wind and tidal driven currents, the bathymetric feature of the post-dredging borrow area is expected to persist.

The post dredge infilling rate and quality and type of the material are contributing factors to the recovery of the area dredged. Data collected by Saloman (1974) indicated that low densities and diversities of benthic fauna within the borrow area compared to control sites can be attributed to thick deposits of gelatinous, organic-rich sediments that lead to low dissolved oxygen concentrations. The Minerals Management Service (1999) indicates that the bottom substrate at and near a borrow area may be modified in several ways. A change in bottom contour may be evident throughout the project life and post-construction populations may differ from pre-construction conditions. A change in the hydrologic regime as a consequence of altered bathymetry may result in the deposition or scour of fine sediments, which may result in a layer of sediment that differs from the existing substrate. Also, once material in the borrow areas is dredged, it is possible that different post-dredging underlying sediment types will be exposed and will be different from pre-dredging sediment types.

Benthic organisms within the defined borrow areas dredged for construction and periodic nourishment will be lost. However, re-colonization by opportunistic species is expected to begin soon after the dredging activity stops. Due to the opportunistic nature of the species that inhabit these soft bottom benthic habitats, recovery is expected to occur within 1-2 years. Rapid recovery is expected from re-colonization from the migration of benthic organisms from adjacent areas and by larval transport. Monitoring studies of post dredging effects and recovery rates of borrow areas indicates that most borrow areas usually show significant recovery by benthic organisms approximately 1 to 2 years after dredging (Naqvi and Pullen, 1982; Bowen and Marsh, 1988; Johnson and Nelson, 1985; Saloman *et al*., 1982; Van Dolah *et al*., 1984; and Van Dolah *et al*. 1992). According to Posey and Alphin (2000), benthic fauna associated with sediment removal from borrow areas off of Carolina Beach recovered quickly with greater inter-annual variability than differences from the effects of direct sediment removal. However, a potential change in species composition, population, and community structure may occur from the initial sediment removal impact as well as the change in surficial sediment characteristics, resulting in the potential for longer recovery times (2-3 years) (Johnson and Nelson, 1985; Van Dolah *et al*., 1984). Differences in community structure may occur that may last 2-3 years after initial density and diversity levels recover (Wilber and Stern, 1992). Specifically, large, deeper-burrowing infauna can require as much as 3 years to reach pre-disturbance abundance. According to Turbeville and Marsh (1982), long term effects of a borrow site at Hillsboro Beach, FL, indicated that species diversity was higher at the borrow site than at the control site. Jutte *et al.* (1999 and 2001) evaluated recovery rates of post-hopper dredged borrow areas and found that hopper dredging creates a series of

ridges and furrows, with the ridges representing areas missed by the hopper dredge. Rapid recolonization rates were documented due to the dredge's inability to completely remove all of the sediment. Furthermore, Jutte *et al*. (2002) documented that dredging to shallower depths is less likely to modify wave energy and currents at a borrow site; thus, reducing the likelihood of infilling of fine grained sediment.

According to Cahoon *et al*. (1990 and 1992), primary production in Onslow Bay is characterized as being dominated by benthic microalgae, rather than phytoplankton. Therefore, Onslow Bay food web interactions with demersal zooplankton grazers is significant. However, based on existing depths of the proposed borrow areas, the maximum post dredging depth will likely not exceed about 60 ft. According to Cahoon (Personal Communication, Dr. Larry Cahoon (24 October 2006), though a direct short-term dredging impact will occur, benthic microalgae are very adaptable to disturbance and the effects of dredging will likely be no more significant than large storm events. The chlorophyll a concentrations decrease as depth increases; however, solar irradiance at 60' is not a limiting factor and recruitment of benthic microalgae at the proposed post dredging depths (maximum of ~60') will occur fairly quickly (about 4-6 weeks). Furthermore, microalgae biomass is less in the winter; thus, considering that the dredging window for initial construction and each nourishment interval is 1 December through 31 March, biomass will be low during periods of impact and upon termination of dredging window, spring time recruitment will begin (Personal Communication, Dr. Larry Cahoon (24 October 2006)).

As identified in Section 8.01.8.2, dredging in the selected borrow areas will not have an adverse physical impact on any hardbottoms in the area. However, strong trophic linkages exist between hard bottom communities and adjacent soft bottom habitat. Though hard bottom communities have been considered highly productive self-sustaining habitats, the primary food resource of reef associated fishes is not solely supported by attached or associated motile benthic organisms. Data collected off North Carolina's Onslow Bay hard bottom communities suggest that benthic microalgae may be an important source of soft bottom primary production supporting reef fishes (Lindquist *et al.,* 1994). Benthic microalgae are concentrated at the sediment-water interface and are grazed by demersal zooplankton, meiobenthos, and many macrofaunal sandbottom animals (Cahoon *et al*., 1990). According to Lindquist *et al*. (1994), gut content analysis of reef fishes indicated that an important benthic food chain connection between benthic microalgae concentrations, associated demersal zooplankton, and infaunal macro-invertebrates from sand substrata adjacent to hard bottom communities are important to the diet of reef fishes. Therefore, rather than hard bottoms being self sustaining communities, reef associated predators depend adjacent soft bottom communities for food. According to Posey and Ambrose (1994), benthic macrofaunal abundances located near a rock ledge near Wrightsville Beach, NC indicated significantly higher abundances of total infauna, and of polychaetes, bivalves, isopods, and scaphopods, at a distance of 75 m (225 ft) from the rock ledge. These data, suggesting a zone of decreased prey abundance (i.e. "halo") adjacent to predator refugia, provide support for a trophic link between hard bottom ledges and soft bottom communities. Based on the proposed hard bottom dredging buffer distances discussed in section 8.01.8.2, dredging of sediment

within the vicinity of hard bottom resources (moderate and high relief – 500 m (1,640 ft.) buffer; low relief – 400 ft. (122 m)) will not directly affect this documented tropic link located within the 75 m (225 ft) halo from the hard bottom ledge.

Impacts to estuarine-dependent organisms are not expected to be significant since construction-related activities in the offshore borrow areas and on beaches proposed for nourishment would be localized. A study of nearshore borrow areas after dredging offshore of South Carolina revealed no long-term impacts to fishery and planktonic organisms, as a result of the dredging (Van Dolah *et al*., 1992). In a 1999 Environmental Report on the use of Federal offshore sand resources for beach and coastal restoration, the US Department of Interior Minerals Management Service provided the following assessment of potential turbidity impacts.

> *The impacts from turbidity on benthic organisms during dredging operations were reviewed in detail by Pequegnat et al. (1978) and Stern and Stickle (1978). Both studies concluded that impacts to the benthic populations of the marine ecosystem from turbidity are local and temporary but not permanent. Similarly, recent studies show that benthic impacts may be limited to the immediate vicinity of dredging operations (e.g., Hitchcock et al. 1998; MMS 1996).*

8.01.8 Essential Fish Habitat

The Fishery Management Plan (FMP) amendments of the South Atlantic Fishery Management Council (SAFMC) identify over 30 categories of Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC), which are listed in Tables 8.2. Fish species managed by the SAFMC and their association with these categories of EFH and HAPC are identified in Table 8.2. While all of these habitat categories occur in waters of the southeastern United States, only a few occur in the immediate project vicinity and/or the project impact zone. The proposed project will avoid direct impacts to estuarine areas; therefore, only identified EFH and HAPC in marine areas may be directly impacted. Impacts on habitat categories potentially present in the project vicinity are discussed in the following subsections.

Table 8.2. Categories of Essential Fish Habitat and Habitat Areas of Particular Concern and Potential Impacts.

ESSENTIAL FISH HABITAT	**Potential Presence**		**Potential Impacts**	
Estuarine Areas	**In / Near Project Vicinity**	**Project Impact Area**	**Dredge Plant Operation**	**Sediment Disposal Activities**
Estuarine Emergent Wetlands	no	no	no	no
Estuarine Scrub / Shrub Mangroves	no	no	no	no
Submerged Aquatic Vegetation (SAV)	no	no	no	no
Oyster Reefs & Shell Banks	no	no	no	no
Intertidal Flats	no	no	no	no
Palustrine Emergent & Forested Wetlands	no	no	no	no
Aquatic Beds	no	no	no	no
Estuarine Water Column	Yes	no	no	no
Seagrass	no	no	no	no
Creeks	no	no	no	no
Mud Bottom	no	no	no	no
Marine Areas				
Live / Hard Bottoms	Yes	Yes	W/in Acceptable Limits	no
Coral & Coral Reefs	no	no	no	no
Artificial / Manmade Reefs	Yes	no	no	no
Sargassum	offshore	no	no	no
Water Column	Yes	yes	W/in Acceptable Limits	W/in Acceptable Limits

Table 8.2 - continued. Categories of Essential Fish Habitat and Habitat Areas of Particular Concern and Potential Impacts.

GEOGRAPHICALLY DEFINED HABITAT AREAS OF PARTICULAR CONCERN

Area – Wide				
Council-designated Artificial Reef Special Management Zones	no	no	no	no
Hermatypic (reef-forming) Coral Habitat & Reefs	offshore	no	no	no
Hard Bottoms	Yes	Yes	W/in Acceptable Limits	no
Hoyt Hills	no	no	no	no
Sargassum Habitat	offshore	no	W/in Acceptable Limits	no
State-designated Areas of Importance of Managed Species (PNAs)	yes	no	no	W/in Acceptable Limits
Submerged Aquatic Vegetation (SAV)	no	no	no	no
North Carolina				
Big Rock	distant offshore	no	no	no
Bogue Sound	no	no	no	no
Pamlico Sound at Hatteras / Ocracoke Islands	no	no	no	no
Cape Fear sandy shoals	No	no	no	no
Cape Hatteras sandy shoals	No	no	no	no
Cape Lookout sandy shoals	No	no	no	no
New River	Yes	no	no	no
The Ten Fathom Ledge	distant offshore	no	no	no
The Point	distant offshore	no	no	no

8.01.8.1 Impacts on the Estuarine Water Column

All proposed borrow areas are located approximately 1 to 6 miles offshore beyond 35 ft. MLLW; thus, dredging operations will not directly impact the estuarine water column and; therefore, will not directly impact estuarine life cycle requirements of managed species in the South Atlantic Region. However, the selected 1550 beach nourishment plan consists of a berm and dune project along a reach of 52,150 feet. Short term elevated turbidity levels may occur during the nourishment operation and may be transported outside of the immediate disposal area via longshore and tidal currents. However, the nearest inlet (New River Inlet) is located over 7 miles to the north of the northern terminus of the project. Therefore, turbidity associated with the beach nourishment operation may extend into the New River Inlet vicinity and the estuarine water column from longshore currents and tidal influx; however, the associated impacts are not expected to be significant.

8.01.8.2 Impacts on Hardbottoms

Background

Hard bottom communities are located within state waters throughout the North Carolina coast, including the vicinity of the proposed SCNTB coastal storm damage reduction project. Depending on the location of these hard bottom communities to the proposed project site, they may potentially be vulnerable to shoreline alterations and/or dredging operations (Moser and Taylor, 1995). However, as discussed in Section 2.01.10 in order to develop a detailed understanding of the existing hard bottom resources located both in the nearshore and offshore environments of the project area, multiple contracts including remote sensing and *in-situ* ground truth dive operations were implemented. The collection of this detailed hard bottom resource data provided a better understanding of location and characterization of these sites relative to available sand resources; thus, enabling the Corps to refine the limits of the identified borrow areas in order to avoid impacts to the resources. In order to guide the decision process for collecting hard bottom resource data, a PDT was developed to specifically discuss hard bottom issues as a component of this project. This team consisted of state and federal resource agency representatives with an interest or expertise in hard bottom communities. Also, concurrent with the resource evaluations being developed for this project, the Town of North Topsail Beach and their consultant Coastal Planning and Engineering (CPE) were performing hard bottom resource evaluations as a component of a separate non-Federal coastal storm damage reduction project for North Topsail Beach. In order to assure consistency in the collection of resource data as well as avoid duplication of data collection efforts, representatives of CPE were also included in the PDT. Members of this team provided comment on the development of scopes of work for each field investigation contract to assure that all concerns for the data collection procedures were addressed prior to task completion. Upon completion of each consecutive contract, the PDT was briefed of the results and comments were solicited to identify what data gaps still existed and what actions were still necessary to assure avoidance of hard bottom resource impacts in both the nearshore and offshore environment as a component of the

beach profile equilibration and dredging processes respectively. The consistent coordination of hard bottom resource evaluations among the PDT throughout the planning process of this project ensured team concurrence on what steps were necessary to fulfill critical data gaps and resulted in a detailed understanding of hard bottom resource location and characterization throughout the project area.

Based on the hard bottom resource evaluations completed in both the nearshore and offshore areas of Surf City and North Topsail Beach, actions associated with both the nearshore beach-fill template construction (including hopper dredge pumpout stations and associated pipeline routes), as well as the associated offshore dredging operations, were refined to avoid impacts to identified hard bottom communities. Therefore, no direct impacts associated with the physical dredging operation or associated construction activities (i.e. pipeline route) will occur. A discussion of potential project impacts relative to the beach fill construction and associated equilibration process in the nearshore environment as well as the dredging and associated sedimentation and turbidity in the offshore environment are discussed below:

Nearshore (<-7 m (-23 ft.) NGVD)

The long-term and short-term limits of cross-shore sediment transport are important in engineering and environmental considerations of beach profile response. Significant quantities of sand-sized sediments can be transported and deposited seaward as a result of short-term erosional events and the equilibration of a constructed beach profile. Over time, the evolving profile advances seaward into deeper water until it approaches equilibrium; however, sediment particles may be in motion at greater depths than those at which profile readjustment occurs. The seaward limit of effective profile fluctuation over long-term time scales is referred to the "closure depth". Based on calculations derived from the USACE Coastal Engineering Manual (2002), the calculated Depth Of Closure (DOC) for this study is -7 m (-23 ft.) NGVD. Based on the remote sensing data collected within the -7 m (-23 ft.) contour as well as the *in-situ* diver ground truth investigations of identified anomalies from the remote sensing data, no hard bottom features were identified within the calculated depth of closure for this study. The anomalies identified from the side scan and multibeam survey results were not hard bottom resources but rather regions of course gravel and shell hash which extended as shallow depressional features located perpendicular to shore. Groundtruth dive investigation transects were specifically located to traverse transitional areas identified in the side scan sonar data. Divers were able to capture video of the transitional regions of sediment grain size and sediment samples were gathered both within and outside of these features to confirm that the side scan sonar acoustic signature documented a transition from fine to course grained sediment, not consolidated hard bottom features. These "Rippled Scour Depressions (RSD's) / Rippled Channel Depressions (RCD's) / Sorted Bedform" features are common throughout North Carolina and are thought to be the result of a feedback mechanism whereby an existing deposit of coarse shell hash and gravel material is build upon and segregated from fine material due to wave motion interacting with the enhanced roughness of the seafloor bed around these patches of coarse material (Cacchione *et. al*., 1984; Thieler *et. al*., 1999; Thieler *et. al*., 2001; Murray and Thieler, 2004).

"Rippled Scour Depressions (RSD's) / Rippled Channel Depressions (RCD's) / Sorted Bedforms"

On the Pacific Coast, Cacchione *et. al*. (1984) identified surficial sedimentary features of the shoreface and inner shelf environments with slight topographic expressions (~1 m (3.28 ft.) total relief) about 100-200 m (328-656 ft.) wide and extending hundreds to thousands of meters in the cross-shore direction. These features were composed of course sand (in some cases shell hash and gravel) and arranged into large wave generated ripples. Termed, "Rippled Scour Depressions (RSD)" these features were attributed to areas of intensified cross-shore flow that preferentially winnow fine material, leaving a course lag parallel to flow. Similar geologic features were later identified throughout the Atlantic coast, including off the coast of North Carolina and South Carolina (McQuarrie, 1998; Thieler *et. al*., 1999; Thieler *et. al*., 2001).

According to McQuarrie (1998), an approximately 102 km^2 area was surveyed using sidescan sonar, high resolution seismic, and vibracores on the shoreface and inner shelf of Onslow Bay. This study characterized the inner shelf off Topsail Island as Tertiary and Pleistocene outcrops with a thin, discontinuous, loose surficial sheet of sediment. In addition to continuous quaternary fluvial channels traced shore perpendicular across the shore face, wave and current action on the shoreface generates "ripple channel depressions (RCD's)" on the shoreface. Vibracore and surface sediment samples within and outside of these features were consistent with RSD sediment data identified in other studies (Cacchionne *et. al*., 1984; Thieler *et. al*., 1999; Thieler *et. al*., 2001).

Side scan imagery from Theiler *et. al*. (1999) identified subtle shore oblique bathymetric expressions of high acoustic reflectivity dominating the shoreface and inner shelf of Wrightsville Beach, NC and Folly Beach, SC. The depressional features had 1 m (3.28 ft.) vertical relief across widths of 100's of meters and were associated with RSD's as defined by Cacchione *et. al*. (1984). According to Thieler (1999), individual RSD's were approximately 40-100 m (131-328 ft.) wide on Wrightsville Beach, NC and Folly Beach, SC and are up to 1 m (3.28 ft.) deep on the upper shoreface, but have a much more subdued (~50 cm (~1.6 ft.)) bathymetric expression further offshore. Most depressions develop just outside the surf zone at 3-4 m (9.8-13.1 ft.) water depth and extend into the inner shelf at 15 m (49.2 ft.). Vibracore data from Thieler *et. al*. (2001) indicate that these RSD features are floored by course sand, shell hash, and quartz gravel and are surrounded by areas of fine sand. These study sites appear to be relatively stable or represent a recurring, preferential morphologic state to which the seafloor returns after storm induced perturbations. This apparent stability is interpreted to be the result of interactions at several scales that contribute to a repeating, self-reinforcing pattern of forcing and sedimentary response which ultimately causes the RSD's to be maintained as bedforms responding to both along-and across shore flows. According to Dr. Bill Cleary (Personal communication), the presence of RSD's/RCD's/Sorted bedforms as identified through side scan imagery off Topsail Beach are ubiquitous from Topsail beach through Wrightsville Beach. Side Scan sonar imagery identifying the same features exists for Figure Eight Island and also Lee/Hutaff Island.

Murray and Thieler (2003) reviewed data within Wrightsville Beach, NC RSD's and did not indicate any significant offshore-directed currents as identified by Cacchione *et. al*. (1984), suggesting the dominance of along-shelf transport rather than cross shelf flow. These depressional features are independent of geologic factors and are a result of oceanographic process such as the interaction of waves, mean currents, and poorly sorted bed material in a moderately high-energy environment. Considering that their observations suggested the dominance of along-shelf transport rather than cross-shelf flow and transport, Murray and Thieler (2004) adopted the term "sorted bedforms" to describe the features off Wrightsville Beach and elsewhere.

The North Carolina Coastal Habitat Protection Plan (CHPP) was adopted by the North Carolina Marine Fisheries, Environmental Management, and Coastal Resources Commissions in December 2004. The CHPP identifies six types of habitats that produce North Carolina's coastal fisheries resources including shell bottom, sea grasses, wetlands, hard bottoms, soft bottoms, and the water column. Rippled scour depressions are identified as soft bottom habitat in Chapter 6 of the CHPP under the subsection titled "Ocean Intertidal Beaches and Subtidal bottom:"

> *"The surf zone is the shallow subtidal area of breaking waves seaward of the intertidal beach. Within the surf zone, longshore sandbars frequently develop and shift seasonally in response to wave energy. Seaward of the surf zone, the subtidal bottom consists of a series of minor ridges and swales. Ripple scour depressions, ranging from 40–100 m (130–330 ft) in width and up to 1 m (3 ft) in depth, occur along the southern portion of the coast and are perpendicularly oriented to the beach, extending to the base of the shoreface (Thieler et al. 1995; Reed and Wells 2000). These features are located adjacent to areas experiencing chronic severe beach erosion, and may be indicative of rapid offshore transport of sand during storms (Thieler et al. 1995)."*

According to the CHPP, RSD's are not considered Essential Fish Habitat (EFH), Habitat Areas of Particular Concern (HAPC), Primary Nursery Area (PNA) or Strategic Habitat Area (SHA). Though soft bottom habitat is probably the most resilient to physical alterations because of its lack of structure and dynamic nature, it plays a vital role as nursery and foraging grounds for fish and invertebrate species. During the equilibration process, nourished sediment from the constructed berm could gradually move within the "RSD / RCD / Sorted Bedform" features; however, it is likely that the features will be maintained as a preferential morphologic state through the repeating, self-reinforcing pattern of forcing and sedimentary response which causes the features to be maintained as sediment starved bedforms responding to both along-and across shore flows (Thieler *et al*., 2001). Therefore, it is expected that benthic organisms normally associated soft and coarse grained sediments within the nearshore environment would not be significantly altered by the project. The "RSD / RCD / Sorted Bedform" data collected off of Wrightsville Beach, NC, a beach with a long nourishment history, further suggests that these features are self-reinforcing, independent of beach construction activities. Additionally, a significant amount of historic side scan data has been collected offshore

of Topsail Island (1992, 1994, and 1996) (Rob Thieler, Personal Communication; McQuarrie, 1998). This historic data matches well with the 2006 side scan data collected by Geodynamics, providing some additional insight to the offshore extent and stability of these features. Considering that the data are spread over a 15 year timeframe and imagery still matches well, it appears that these features are fairly stable, at least over a decadal time frame (Rob Thieler; Personal Communication); thus, further suggesting that these features are maintained by the localized interaction of oceanographic processes and poorly sorted bed material.

Though, according to Thieler *et al*. (1999) it is possible that sedimentation may occur beyond the -7 m (-23 ft.) depth of closure calculated for SCNTB, the available information of hard bottom off the coast of Topsail Island indicate that these hard bottom areas of influence are low lying and ephemeral (USACE, 2008; USACE, 2004a; USACE, 2003; Moser and Taylor, 1995) and associated sedimentation would not impact high relief significant hard bottom. Biological characterization of low relief hard bottom habitats in the nearshore and offshore environment of SCNTB confirmed that the species associated with low lying features are more adapted to sediment loading associated with the ephemeral nature of these systems and; therefore, would not experience impacts greater than existing natural conditions. Therefore, no burial of exposed hard bottom features will occur in the nearshore environment as a result of the constructed beach fill template and associated beach profile equilibration process. Furthermore, no impacts will occur from the associated beach fill construction equipment (i.e. pumpout station and associated pipeline) as well as sedimentation from beach fill construction operation.

Offshore (>-7 m (-23 ft.) NGVD)

As identified in Section 2.01.10, preliminary investigations of hard bottom communities throughout each proposed borrow area were identified using high resolution side scan sonar and delineated as “low,” “moderate,” and “high” relief, in accordance with Moser and Taylor (1995) and Moser *et al.* (1995). Follow-up diver groundtruth efforts confirmed their presence and characterized the associated biota. In order to ensure protection of the hard bottom resources from the physical dredging operation and the associated sedimentation and turbidity, a conservative approach was applied by the Contractor when delineating hard bottom features from the side scan sonar acoustic signature data. For example, areas where hard bottom was interspersed with large areas of sediment, a line was drawn around the entire area to define the limits of the hard bottom feature instead of delineating each individual feature. It is important for reviewers of these hard bottom data to be aware of this conservative methodology and not assume that all of the delineated features are large consistently exposed hard bottom platforms. In some instances, the delineated limits of a hard bottom area may consist of several very small pinnacles of low relief and highly ephemeral outcroppings rather than a persistent hard bottom platform. Furthermore, though the delineation of hard bottom resources from the acoustic signature data incorporated high, medium, and low relief classification, ground truth diver verification of these sites confirmed that no high relief hard bottom was identified and most of the mapped areas consisted of low relief hard bottom. As a component of the ground truth effort, transect locations were specifically

placed to traverse pre-defined areas of medium and high relief; however, divers confirmed that the areas were predominantly low relief systems.

Biological characterization data of offshore hard bottom resources were evaluated using the Benthic Ecological Assessment for Marginal Reefs (BEAMR) model developed by CPE. This methodology for characterizing benthic communities has been implemented throughout Florida and has also been implemented for the non-Federal North Topsail Beach Shore Protection project. The BEAMR methodology samples three core characteristics in each sample quadrant: (1) physical characteristics (including maximum sediment depth), (2) abiotic and biotic percent cover, (3) and coral density. During BEAMR surveys, biologists look for indications of natural sediment movement stress. Visual inspections include indentifying whether benthic organisms are being, or have recently been, stressed. Visual inspections include observations and evaluation of stress indicators such as standing sediment not removed by normal currents or wave actions. As identified in Table 8.3, sediment loading was evident in all sampled transects.

Table 8.3. Physical characteristics of hard bottom at each transect.

	Transect										
Physical Parameters	**G1**	**G3**	**J2**	**L1**	**L2**	**O1**	**O3**	**O4**	**T1**	**T3**	**T4**
Number of Quadrants Surveyed	10	10	9	10	10	10	10	10	14	10	10
Number of 100% Sediment Quadrants	0	5	6	1	2	4	3	7	0	2	4
Percent Sediment Cover	27.4	60	90	33	35	43	46	30	46	55	48
Average Sediment Depth (cm)	4.7	6.8	8.3	3.3	2.1	4.5	4.3	6	2	4.5	6.2

Overall, most hard bottom areas investigated within the proposed borrow areas of this study were characterized by a combination of moderate- and low-relief habitats. Most areas included some regions of relatively moderate-relief rock outcroppings or ledges what were able to support adult *Oculina sp*. colonies and high cover by tunicates and sponges, and other areas of lower relief that were subject to more frequent burial and were characterized by low stony coral cover and higher cover by fast growing corals. The lower relief areas identified in each borrow area appeared to be more ephemeral. The increased benthic diversity and high numbers of adult *Oculina sp*. found on ledges and crevices are likely the result of protection from ambient sedimentation offered by the vertical and overhanging surfaces. The persistent growth of organisms on these protected surfaces compared to the flat surfaces suggests a natural environment with high sedimentation. Details of these results can be found in Attachment 4 of Appendix R.

Additional benthic characterization data of the nearshore and offshore environment collected by CPE in 2005 and 2006, for the adjacent non-Federal North Topsail Beach

Coastal Storm Damage Reduction Project, also suggest a high sedimentation environment. In some instances, heavy sediment and particulate loading observed in the water column during summer and fall sampling periods prevented divers from completing flora and fauna surveys. Furthermore, in June 2005 CPE marine biologists confirmed hard bottom at two sites which where later found covered with greater than 60 cm (1.9 ft.) of mud during subsequent October 2005 dives. The ephemeral nature of many of these sites was also confirmed through a comparison of side scan sonar hard bottom edge digitization from 2005 to 2006 which indicated a change in exposed hard bottom by as much as 3 acres.

Hopper Dredge - Sedimentation and Turbidity

During dredging operations, hard bottom within the vicinity of offshore borrow areas can be impacted by turbidity and sediment plumes generated from filling and overflow of the hopper dredge depending on the characteristics and suspension time of the sediment being dredged. Considering the distance offshore and the limited thickness of available sediment within the proposed borrow areas for this project, all dredging activities are expected to be performed using hopper dredge. Hopper dredge suction dragheads hydraulically remove sediment from the sand bottom and discharge the material into the storage hoppers on the dredge. The screened sandy material fills the hopper until an economic load is achieved for transit and subsequent pumpout to the beach placement location. As discussed in Figure 8.1, there are two types of sedimentation and turbidity sources from this operation: S1 from the overflow (which for most US dredges now is through the bottom of the hull) and S2 associated with suspension of sediment at the draghead. During filling of the hopper, any fine sediments (primarily silt, clays, and fine-sands) are washed overboard through "overflow" ports (i.e. S1) either over the side of the vessel or through "weirs" that release the slurry through the hull of the vessel. This "washing" of the dredged material is the predominant source of turbidity plumes and sedimentation generated by the hopper dredge. Some turbidity is expected from the physical interaction of the draghead with the bottom substrate (i.e. S2) during the dredging operation; however, it is not expected to be significant considering most of the disturbed sediments will be confined to the suction field of the hopper dredge dragheads and will be dredged and disposed into the hopper. Sediment discharged overboard from the hopper overflow moves faster than would be anticipated from simple Gaussian models based on the settlement velocity of component particles. This is due to high sediment concentration and discharge rate of the overflowed material, factors that lead to the development of a density current that moves through the water column in a 'dynamic phase' of settlement, at least initially. Sediment is stripped away as the dynamic plume moves through the water column forming a passive plume that is advected and dispersed by ambient currents, with the particles settling according to Gaussian models (MMS, 2004).

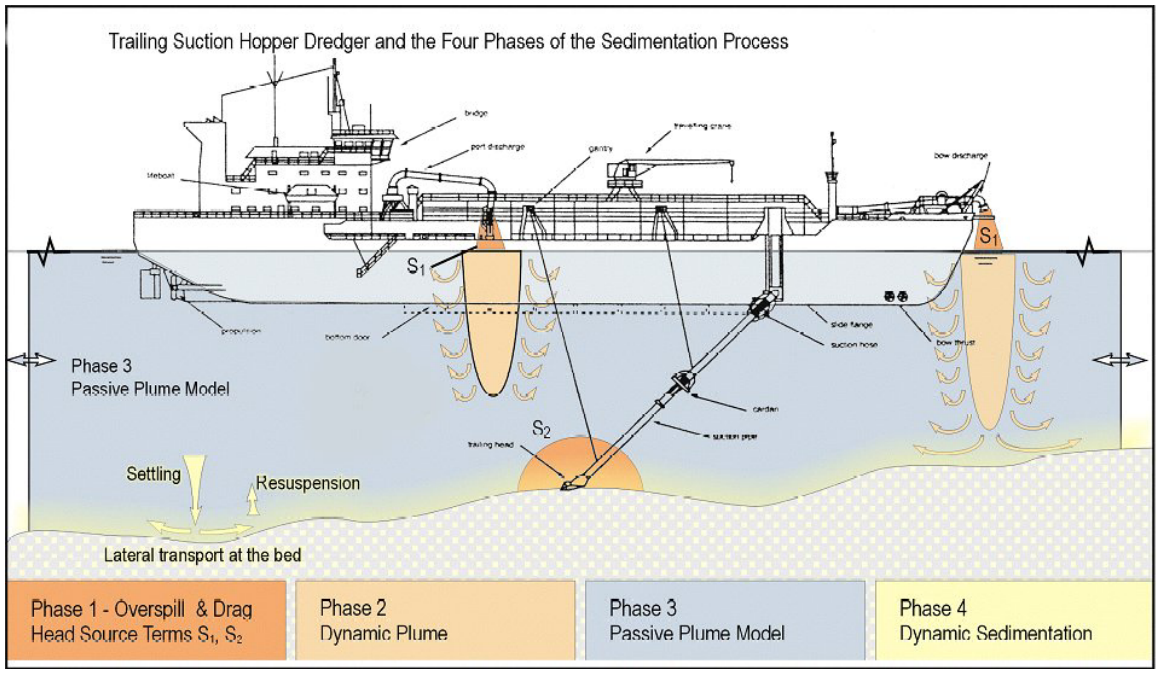

Figure 8.1. Hopper dredge sedimentation processes (note this figure shows two S1 sources at overflows from a screening operation; in almost all US dredges the S1 source is through the bottom of the hull) (MMS, 2004).

Hitchcock and Drucker (1996) summarized values for material lost through the overflow process on a typical 4500 t hopper dredge operating in UK waters. Results from this study indicate that during an average loading time of 290 minutes, 4185 t of dry solids are retained as cargo, while 7,973 t of dry solids are returned overboard from overflow. Sand sized particles fall directly to the seabed and are reduced to background levels over a distance of 200-500 m (656-1640 ft.) and smaller silt-sized particles have a typical settling velocity of 0.1 to 1.0 mm/s and are reduced to background values of 2-5 mg/l over a similar distance. According to Neff (1981 and 1985), concentrations of 1000 mg/l immediately after discharge decreased to 10 mg/l within one hour. The minimal impact of settling particles from hopper dredge turbidity plumes was further supported by a study from Poopetch (1982), which found that the initial hopper dredge overflow concentrations of 3,500 mg/l were reduced to 500 mg/l within 50 m (164 ft.).

The distance that sediment plumes may extend is dependent upon the type of dredge, how it is operated, currents, and the nature of the sediments within the dredged area. As discussed in Section 7.03.6, only beach compatible sandy sediments will be used for this project in accordance with the North Carolina sediment compatibility rules. Dredging of sandy sediments will minimize the amount of turbidity and sedimentation associated with the dredging operation and will reduce the suspension time and advection distance of overflow sediments. A study performed by Newell and Siederer (2003) in the UK (high current velocities) showed that, in most cases, coarse material up to sand-size particles settles within 200 m (656 ft.) to 600 m (1968 ft.) of the point source of discharge, depending on depth of water, tidal velocity, and the velocity of flow from the discharge pipe. During hopper dredging operations in the Baltics, Gajewski and Uscinowicz (1993)

noted that the main deposition of sand from hopper dredge overflow was confined to distances within 150 m (492 ft.) on each side of the dredge. This study further supported that the initial sedimentation associated with overflow material behaves like a density current where particles are held together by cohesion during the initial phase of the sedimentation process and are mainly confined to a zone of a few hundred meters from the discharge chutes. According to a plume dispersion model developed by Whiteside *et al.* (1995) (based on field study measurements obtained while hopper dredging in Hong Kong waters), the contours for sediment deposition remain as a narrow band extending for approximately 100 m (328 ft.) on each side of the vessel, consistent with that recorded by Gajewski and Uscinowicz. As a component of the sedimentation associated impacts to hard bottom from hopper dredging in adjacent borrow areas offshore of Bal Harbor, Florida, Blair *et al.* (1990) recorded elevated sediment levels at about 335 m (1,100 ft) from the borrow area when dredged sediment had a higher silt/clay composition.

Though elevated turbidity levels may occur from hopper dredging overflow, the overflow process only occurs during the physical dredging operation. Considering that maximum load efficiency will be attained before transit to the pumpout location, overflow of material will not occur once the dredging process is complete. Therefore, though the hopper dredge may transit over hard bottom locations in route to the beach, no significant turbidity or sedimentation will occur during this process. Once at the pumpout location, all turbid water generated by the hopper dredge slurry for pumpout will be retained in the hopper.

Hard bottom Buffer

As discussed in Section 2.01.10, the North Carolina hard bottom buffer rule language (NCAC 07H. 0208(b) (12)(A)(iv)) states that, "*Mining activities shall not be conducted on or within 500 meters of significant biological communities, such as high relief hard bottom areas. High relief is defined for this standard as relief greater than or equal to one-half meter per five meters of horizontal distance*." Adherence to a 500 m (1640 ft.) buffer for high relief hard bottom, as defined within the North Carolina state rule language (NCAC 07H. 0208(b) (12)(A)(iv)), will be adhered to. However, the implementation of a 500 m (1640 ft.) buffer for all delineated hard bottom (i.e. including low and medium relief) would result in a reduction of available sediment to a volume that is less than that required for the 50 year life of the project. In order to provide sufficient compatible sand resources for the 50 year project while minimizing impacts to hard bottom resources, a 122 m (400 ft.) dredging buffer around the low relief hard bottom (<0.5 m (1.6 ft.)) in the offshore borrow sites will be implemented; while still adhering to the 500 m (1640 ft.) buffer for moderate and high relief hard bottom (as defined by MATER report (Appendix U)). In a PDT meeting conducted on 28 August, state and federal resource agency representatives from the NC Wildlife Resources Commission (NCWRC), NC Division of Marine Fisheries (NCDMF), and National Marine Fisheries Service (NMFS) concurred with this dredging buffer proposal based on an evaluation of all of the Surf City and North Topsail Beach hard bottom resource data collected by the Corps. Furthermore, the implementation of a 122 m (400 ft.) buffer around low relief is consistent with the recommended buffer distances in the state of Florida, which currently

recommends a 122 m (400 ft.) dredging buffer around all hard bottom, including coral reefs, in their state dredging permit conditions. Additionally, this buffer recommendation is consistent with the decision made by the PDT for the non-federal North Topsail Beach Coastal Storm Damage Reduction project which allowed dredging within 122 m (400 ft.) of all identified hard bottom resources. A discussion of Florida's buffer recommendation and associated project specific monitoring results are provided below:

Florida's 122 m (400 ft.) Dredging Buffer

Beach nourishment in Southeast Florida is commonly accomplished by dredging sand deposits from between offshore coral reefs and moving the sand to shore. As a component of Florida Department of Environmental Protection (FLDEP) permit process for coastal storm damage reduction and dredging projects, a 122 m (400 ft.) buffer distance for hopper dredging within the vicinity of coral reef and hard bottom communities is recommended as a guideline in the permit conditions for dredging projects. However, site specific and project specific circumstances are considered for each permit request and expansions of the recommended buffer distances are considered based on the site context (i.e. 183 m (600 ft.) buffer recommendation for projects with high silt content). The establishment of this buffer distance recommendation by FLDEP is based on a history of lessons learned from previous projects with a myriad of different buffer distances and associated monitoring of sedimentation impacts. Historically, 46 m (150 ft.) dredging buffer distances from hard bottom were considered adequate for cutterhead dredging operations. However, for hopper dredge operations, buffer recommendations ranged from 46 m (150 ft.) to 76 m (250 ft.) with site specific impacts ranging from no impact to significant impact depending on the site and the project. In 1998, significant impacts were documented for the Bal Harbor (Miami-Dade county) dredging project which resulted in a reconsideration of the recommended buffer distance as well as the development of improved techniques for monitoring coral sedimentation stress through the development of a visual stress index (Vargas-Angel *et al.*, 2006). Based on lessons learned from previous projects, the FLDEP later implemented a 122 m (400 ft.) dredging buffer distance from hard bottom communities and the state monitoring of coral stress now incorporates histological and visual investigations of coral response to dredging associated sedimentation. Modifications to this buffer recommendation are pursued for individual projects depending on habitat quality and site and project specific conditions (i.e. currents, sediment quality, etc.) of the project area.

As a component of the Town of Reach 7, Phipps Ocean Park Beach Restoration project (Lybolt and Tate, 2003; Delaney *et al*., 2006)), pre-, during, and post-construction biological monitoring was required to assess dredging impacts to adjacent coral reef. Project permits mandated the Town of Palm Beach implement a program to monitor sedimentation rates, baseline biological conditions of live organisms, and coral stress associated with hopper dredging within 122 m (400 ft.) of barrier coral reef formations. Analysis of the collected data demonstrated that project associated turbidity, sedimentation, and coral stress did not exceed previously defined threshold criteria used to assess impacts to offshore hard bottom resources (Delaney *et al*., 2006). In 2005, Broward County, Florida constructed 10.9 km of beach utilizing a hopper-dredge and

moving 1.9 million cubic yards of sand from 5 different sand borrow areas located as close as 122 m (400 ft.) from offshore coral reefs. A visual stress index was developed for three coral species to monitor a real-time response of stony corals to potentially increased sediment induced stress environment during the dredging process. An average stress index threshold was developed to allow for cessation of dredging at specific borrow areas should the stress threshold be exceeded. However, the threshold shutdown criteria were not exceeded throughout the project (Lou Fisher, personal communication, 07/24/08). As a component of the Boca Raton Beach Restoration Project conducted in 1988, a 3 year environmental monitoring program was implemented to monitor potential impacts to the surrounding hard bottom habitats. Based on the data collected, the environmental conditions at the offshore hard bottom monitoring stations did not appear to be affected by the dredging efforts associated with the restoration project. The borrow areas were located between two offshore hard bottom zones and associated dredging was separated from the patch hard bottom zone by a minimum of 122 m (400 ft.) and from the barrier hard bottom zone by 305 m (1000 ft.) The average sedimentation rates recorded during the construction and post-construction phases were less than the background, or pre-construction sedimentation rate.

Summary

As identified through the myriad of investigative studies discussed in Section 2.01.10 to identify and avoid nearshore and offshore hard bottom resources, the Corps has demonstrated a commitment to avoidance and minimization of impacts to hard bottom communities. Early in the planning process, a Project Delivery Team (PDT) composed of state and federal resource agency representatives was developed in order to identify and discuss key concerns specific to hard bottom resource concerns and develop appropriate avoidance and minimization guidelines. These avoidance efforts include the elimination of three borrow areas, I, K, and M, from the project design due to the discovery of significant hard bottom resources within and adjacent to the proposed borrow areas. Furthermore, in coordination with the PDT, specific dredging buffer guidelines were developed and incorporated into the borrow area design providing appropriate buffer distances from the dredging and associated overflow activities to the varying hard bottom resource areas. Specific buffer requirements include adherence to a 500 meter hard bottom buffer around high and moderate relief hard bottom, as defined in NCAC 07H. 0208(b) (12)(A)(iv)), while implementing a 122 m (400 ft.) buffer around low relief hard bottom (based on hard bottom mapping data provided by MATER (Appendix U)).

Recognizing that it is too costly to ground truth, delineate, and map all hard bottom resources throughout each borrow area, the Corps requested mapping of low, moderate, and high relief hard bottom from the side scan sonar data collected by the MATER contract. A conservative approach to mapping these resources was used in order to limit the amount of dredging activities in and around patchy hard bottom resources. For example, if multiple anomalies were identified to be hard bottom throughout an area, the entire feature was identified instead of separating each individual anomaly. Furthermore, though the best effort was made to differentiate low, moderate, and high relief hard

bottom from the remote sensing data, the exact relief patterns were not revealed until ground truth efforts were pursued. As a component of the ground truth effort, transect locations were carefully selected to traverse the transition areas of previously identified by MATER as low, moderate, and high relief hard bottom. In some instances, the ground truth efforts did not support the moderate to high relief classifications defined by MATER, but rather site specific maximum relief points of low to moderate relief with an average of low relief features throughout the study area. Therefore, when adding the additional data from the ground truth efforts of the offshore hard bottom communities to the previously mapped hard bottom features based on side scan interpretation, it becomes apparent that the hard bottom mapping provided by MATER using side scan sonar is a very conservative effort.

Though *in-situ* dive efforts confirmed that areas previously defined as high relief hard bottom were actually moderate or low relief, for those areas that have not been groundtruthed, the North Carolina 500 m (1640 ft.) buffer requirement is still included to offer sufficient protection of potentially more stable hard bottom resources associated with higher relief systems. However, a buffer distance of 122 m (400 ft.) for hopper dredging within the vicinity of lower relief systems throughout all borrow areas associated with this project will be implemented. This plan is consistent with that developed by the PDT, and addressed in the Draft EIS, for the adjacent non-federal coastal storm damage reduction project proposed for North Topsail Beach, North Carolina (USACE, 2007). The rationale for establishing a buffer zone limit of 122 m (400 ft.) for low relief hard bottom resources in the project area instead of the State standard of 500 m (1,640 ft.) (15A NCAC 07H.0208(b)(12)(A)(iv)) is based on lessons learned from 40 years of dredging experience in less turbid South Florida waters adjacent to sensitive coral reef systems where site specific borrow area buffer zones ranging from 76 m (250 ft.) to 122 m (400 ft.) have proven effective in protecting hard bottom and coral reef habitats. Based on the species list provided from the *in-situ* dive investigations offshore of Surf City and North Topsail Beach, North Carolina as well as the natural sediment loaded nature of this hard bottom system, it is apparent that these species are more adapted to sedimentation than the reef building coral species of Florida. The potential turbidity and sedimentation impacts associated with proposed activities are not expected to significantly different than those associated with disturbances from natural storm events.

Based on the available information pertaining to the dredged sediments, hopper dredge overflow activities, and associated potential turbidity plumes, as well as the implementation of a 122 m (400 ft.) to 500 m. (1640 ft.) buffer distance depending on relief, no significant impacts are expected from the sedimentation and turbidity associated with the proposed dredging activities. The potential impacts to the hard bottom communities are not expected to exceed the natural sedimentation and turbidity conditions of the project area.

Monitoring

Silent Inspector (SI) – Automated Dredge Plant Monitoring System

In order to assure that the required buffer distance is adhered to and to avoid physical impacts to hard bottom resources, the Corps will require all dredges to implement the Silent Inspector automated dredge plant monitoring system. The SI Program is a Corps-Dredging Industry partnership for automated dredging monitoring of Corps dredging projects. Onboard sensors monitor dredge activities, operations and efficiency. Data is routed to the SI Support Center for data retrieval and storage and Corps-provided software can be used by contract managers, dredge inspectors, biologists, etc. to monitor performance and ensure environmental compliance. Silent Inspector produces many different reports including dredge location history, volume history, disposal location history, and operational status and helps monitor all aspects of dredge operations from contract compliance to assurance that the operation is being performed in an environmentally safe manner. In addition to providing detailed tracking information of dredge location, SI also tracks the hopper dredge displacement status throughout the entire dredging operation, including hopper filling, transit, and pumpout. Therefore, the potential for any leakage of sediment through the hopper during transit can be tracked to assure accountability of any misplaced material. In the unexpected event that material is misplaced, appropriate coordination and mitigative action will be taken by the Corps. Additional information and specifications regarding the SI can be found at: http://si.wes.army.mil/.

Though unlikely, in the event that a physical impact by the hopper dredge dragheads to previously unexposed hard bottom occurs, the exact location of impact will be recorded using SI. The Corps will direct the dredge to move to a new borrow area or different portion of the existing borrow area in order to avoid additional risk of impact. The incident will be thoroughly documented and coordinated with the appropriate state and federal resource agencies. Based on the outcome of this coordination, appropriate action will be taken to investigate and mitigate potential impacts.

Offshore Hard bottom Sedimentation Monitoring

As a component of the November 2007 Draft Environmental Impact Statement (EIS) for the permitted non-federal North Topsail Beach Shore Protection Project, prepared by Coastal Planning and Engineering Inc (CPE) for the Town of North Topsail Beach, an Agency approved sedimentation monitoring plan was provided. Detailed methodologies for documenting potential sedimentation impacts from the dredging operation on offshore hard bottom were discussed. As a component of the agency coordination for the federal coastal storm damage reduction project (28 August 2008 – PDT meeting), agency representatives requested that similar sedimentation monitoring methodologies be applied for the federal project in the event that monitoring for the non-federal project is not completed prior to commencement of the federal project. If monitoring for the non-federal project is completed prior to commencement of the federal project, and no sedimentation impacts are documented from dredging with a 122 m (400 ft.) buffer, no

additional monitoring as a component of the federal project will be implemented. Considering that multiple borrow areas will be used throughout the 50 year project, and dredging will not occur within the vicinity of hard bottom communities at all times, during project monitoring of sedimentation impacts from dredging activities will not occur until dredging within the proposed 122 m (400 ft.) buffer is required. Details of the proposed sedimentation monitoring plan, based on methodologies developed by CPE (USACE, 2007b), are provided below. Specific contract monitoring requirements and subsequent scope of work will be circulated for agency concurrence prior to implementation.

Marine resource investigations of the offshore communities conducted by ANAMAR and CPE in March 2007 included the establishment of 12 temporary transects throughout five borrow areas (G=2; J=2; L=2; O=3; and T=3). A representative sample of these 12 sites will be established as permanent transects prior to construction. Additional control transects will be established prior to construction for comparison purposes in order to determine changes in community cover and/or possible sedimentation effects from dredging activities on proximate hard bottom. Monitoring stations will include stainless steel pins that will be installed into the hard bottom using a hammer and/or drill at 5.0 m (16.4 ft) spacing along each of the permanent transects.

Sediment monitoring at the offshore transects will occur before, during, and, if necessary, after construction and will include 1) the installation of sediment traps (collectors) (Figure 8.2) and 2) *in-situ* sediment depth measurements. Sediment collectors will be installed on both ends of the transects and may consist of a replaceable two (2) liter High Density Polypropylene (HDPE) bottle with a triple PVC tube lid, installed in a permanent housing. The three (3) tube lid is screwed onto the top of the bottle for the collection of settling particles. Design of the collectors allows sediment from the water column to enter through the open tubes and accumulate in the collector.

Figure 8.2. Sediment trap permanently installed at each end of a monitoring transect.

During each monitoring event, the HDPE bottle is removed and replaced with empty bottles and the lid is checked for biofouling and replaced or cleaned if blocked. The contents in each of the sediment bottles will be combined to produce a composite sample in the lab. Each composite sample will be dried and mechanically sieved to determine both the dry weight of the sample (in milligrams) and the silt/clay fraction (the material that passed through a No. 200 U.S. standard sieve). The resulting weights are divided by the area of the tubes open to the water column and the number of days the trap was in place. The area of the tubes used to calculate the sedimentation rates shall be adjusted if one or more of the sediment traps is lost or if debris/organism growth is observed in the collector tubes preventing unrestricted access to the collection jar. The offshore monitoring transects adjacent to the borrow area will be installed and sampled for sedimentation bi-weekly for two months prior to construction (weather and sea state conditions permitting) and once every two weeks for the initial two months of construction. If sediment accumulation at the compliance transects is >10% of the sediment accumulated on average per day at the three control sites, then the Corps will direct the contractor to stop dredging operations within the 122 m (400 ft.) buffer and move to another area located 500 m (1640 ft.) from the identified hard bottom sites. Dredging will not be allowed to resume within the 500 m (1640 ft.) buffer until measures can be implemented to reduce sedimentation impacts to adjacent hard bottom resources, such as no hopper dredge overflow within 500 m (1640 ft.) from hard bottom. All

monitoring data will be coordinated with appropriate state and federal resource agencies throughout the construction process and all proposed modifications of the dredging operation to minimize sedimentation impacts will be coordinated prior to implementation.

8.01.8.3 Impacts on Reef-forming Corals

Hermatypic, or reef-forming, corals consist of anemone-like polyps occurring in colonies united by calcium encrustations. Reef-forming corals are characterized by the presence of symbiotic, unicellular algae called zooxanthellae, which impart a greenish or brown color. Since these corals derive a very large percentage of their energy from these algae, they require strong sunlight and are, therefore, generally found in depths of less than 150 feet. They require warm water temperatures (68º to 82º F) and generally occur between 30°N and 30°S latitudes. Off the east coast of the United States, this northern limit roughly coincides with northern Florida; however, they may occur off the North Carolina coast. As identified in Section 2.01.10, extensive limestone and siltstone hard bottom communities have been identified within the offshore borrow areas proposed action. As a component of the in water diver benthic characterization of these communities, Oculina *sp*. were identified in each surveyed transect. However, the percentage of Oculina sp. relative to other functional groups identified along the transects ranged from 0.3 to 3.7%. Oculina colonies identified were predominantly small recruits (1-cm); however, some of the higher relief outcroppings or ledges supported larger adult colonies.

Oculina *sp.* range from Cape Hatteras, North Carolina through the Gulf of Mexico and Caribbean. Oculina Banks, located off east-central Florida, are the area of main concern and have been identified as a Habitat Area of Particular Concern (HAPC). Colonies are semi-isolated, patchy, and low growing in shallow water; however, they form larger, massive coalescing aggregates with substantial topographic relief in 160 to 330 ft. (50-100 m) depth (http://www.nmfs.noaa.gov/pr/pdfs/species/ivorytreecoral_detailed.pdf). Though Oculina colonies were identified within the project area, as discussed in section 8.01.8.2, buffers will be incorporated in order to avoid sedimentation and turbidity impacts associated with hopper dredging activities. Therefore, though Oculina *sp*. are present within the project vicinity, appropriate buffers have been incorporated into the project design in order to avoid impacts to these species.

8.01.8.4 Impacts to Artificial / Manmade Reefs

The State of North Carolina, Department of Environment and Natural Resources, Division of Marine Fisheries Artificial Reef Program (NCARP) manages 6 reefs that are located offshore of Topsail Island. They are AR 355, AR 360, AR 362, AR 364, AR 366, and AR 368. With the exception of AR 360, which is located offshore of Topsail Beach about 2.5 nm from the New Topsail Inlet sea buoy, all of these sites are located offshore of the proposed borrow sites and are not within the immediate project area. Therefore, dredging and placement of material associated with the Surf City and North Topsail Beach Shore Protection Project will not adversely affect artificial reef sites managed by NCARP.

8.01.8.5 Impacts on Sargassum

Benthic and pelagic *Sargassum sp*. are found within the vicinity of the proposed project area. *Sargassum filipendula* is a benthic species of *Sargassum* and is often the predominant macrophyte in near-shore areas where *Sargassum* beds grow subtidally in moderately exposed or sheltered rocky or pebble areas near hard bottom or coral reef communities (Schneider *et al*, 1991). Pelagic *Sargassum sp*. occur in large floating mats on the continental shelf, in the Sargasso Sea, and in the Gulf Stream. Most pelagic *Sargassum* circulates between 20º N and 40º N latitudes and 30º W longitude and the western edge of the Florida Current / Gulf Stream and forms a dynamic structural habitat with a diverse assemblage of marine organisms including fungi, micro-and macro-epiphytes, at least 145 species of invertebrates, 100 species of fishes, four species of sea turtle, and numerous marine birds It is a major source of productivity in a nutrient-poor part of the ocean. Unregulated commercial harvest of *Sargassum* for fertilizer and livestock feed has prompted concerns over the potential loss of this important resource.

As discussed in Section 2.01.10, in water benthic characterization surveys (i.e. BEAMR) of offshore hard bottom communities were completed by ANAMAR Environmental Consulting Inc. and Coastal Planning and Engineering Inc. (CPE) in March 2008. In situ dives were conducted along 12 representative transects throughout the proposed offshore borrow areas. Benthic *Sargassum sp*. were identified as a dominant macroalgae in almost all surveyed transects. Though benthic *Sargassum sp*. are dominant macroalgal species in vicinity of the dredging operation, their presence is associated with the hard bottom attachment substrate. Considering that dredging buffers have been incorporated into the project plan to avoid impacts to hard bottom communities, dredging operations will avoid direct and indirect impacts to benthic *Sargassum sp*.

Pelagic *Sargassum* is positively buoyant and, depending on the prevailing surface currents, will remain on the continental shelf for extended periods or be cast ashore. Therefore, pelagic *Sargassum* species could potentially be transported inshore from the Gulfstream and drift through the vicinity of the dredge plant operation. Since it occurs in the upper few feet of the water column, it is not subject to impacts from dredging or sediment disposal activities associated with the proposed action (South Atlantic Fishery Management Council, 1998.); thus, impacts from the dredging and/or disposal operations will not be significant.

8.01.8.6 Impacts on the Marine Water Column

The potential water quality impacts of dredging and beachfill placement are addressed in Section 8.07.2. Dredging and beachfill placement conducted during project construction and periodic nourishment may create impacts in the marine water column in the immediate vicinity of the activity potentially affecting the surf zone and nearshore ocean. These impacts may include minor and short-term suspended sediment plumes and related turbidity, as well as the release of soluble trace constituents from the sediment. In the case of overflowing hopper dredges or scows to obtain economic loading, sediment which is more than 90 percent sand is not likely to produce significant turbidity or other water

quality impacts (USACE, 1997) (See section 8.01.2 for sedimentation and turbidity associated with hopper dredges). Overall water quality impacts of the proposed action are expected to be short-term and minor. The various life stages of fish species associated with marine and estuarine resources dependent upon good water quality are not expected to experience significant adverse impacts due to water quality changes.

Scientific data are very limited with regard to the effects of beach nourishment on fishery resources. These effects may be similar, on a smaller scale, to the effects of storms; storm effects may include increased turbidity and sediment load in the water column and in some cases, changes in fish community structure (Hackney *et al*., 1996). Storms of great severity, such as hurricanes, have been documented to create conditions resulting in fish kills, but such situations are not usually associated with beach nourishment.

In a 1999 Environmental Report on the use of Federal offshore sand resources for beach and coastal restoration, the US Department of Interior Minerals Management Service provided the following assessment.

> *In order to assess if turbidity causes an impact to the ecosystem, it is essential that the predicted turbidity levels be evaluated in light of conditions such as during storms. Storms on the Mid-Atlantic shelf may generate suspended matter concentrations of several hundred mg/l (e.g., Styles and Glenn 1999). Concentrations in plumes decrease rapidly during dispersion. Neff (1981, 1985) reported that solids concentrations of 1000 ppm two minutes after discharge decreased to 10 ppm within one hour. Poopetch (1982) showed that the initial concentration in the hopper overflow of 3,500 mg/l decreased rapidly to 500 mg/l within 50 m. For this reason, the impact of the settling particles from the turbidity plume are expected to be minimal beyond the immediate zone of dredging.*

Beach nourishment can affect fishery resources and EFH through increases in turbidity and sedimentation that, in turn, may create localized stressful habitat conditions, and may result in temporary displacement of fish and other biota. However, the sediment proposed for beach placement on Surf City and North Topsail Beach would average 90 percent or more sand (See Appendix C, Geotechnical Analysis). Because of the low silt/clay content, water column impacts are expected to be localized, short-term, and minor. Furthermore, the beach nourishment operation is expected to proceed at a slow rate. Mobile biota, including juvenile and adult fish, should be able to relocate outside the more stressful conditions of the immediate nourishment operation. Cumulative effects of multiple simultaneous beach nourishment operations could be potentially harmful to fishes of the surf zone. The high quality of the sediment selected for beach fill and the small amount of beach affected at any point in time would not suggest that this activity poses a significant threat.

8.01.8.7 Impacts on State-designated Areas Important for Managed Species

Primary Nursery Areas (PNA's) are designated by the NC Marine Fisheries Commission and are defined by the State of North Carolina as tidal saltwaters which provide essential

habitat for the early development of commercially important fish and shellfish (http://www.ncfisheries.net/rules.htm; 15 NC Administrative Code 3B .1405). Many fish species undergo initial post-larval development in these areas. Primary nursery Areas will not be directly impacted by this project. However, PNA's located adjacent to the New River Inlet vicinity may experience indirect and short-term elevated turbidity levels from the nourishment operation on the shoreface. These turbidity effects are dependent on the location of the outflow pipe and the direction of longshore and tidal currents. Considering these elevated turbidity levels will be short-term and within the range of elevated turbidity from natural storm events, the impacts to state-designated PNA's are insignificant.

8.01.8.8 Impacts to New River

New River Inlet is located approximately 7 miles north of the northern terminus of the project. No direct impacts associated with dredging or beach placement of sediment will occur within New River Inlet. However, short term elevated turbidity levels may occur during the nourishment operation and may be transported outside of the immediate disposal area via longshore and tidal currents. These elevated turbidity levels may extend into the New River Inlet vicinity; however, the associated impacts not expected to be significant and will not affect HAPC for managed fish species.

8.01.8.9 Impacts to Big Rock and Ten Fathom Ledge

Big Rock and the Ten Fathom Ledge are located south of Cape Lookout, North Carolina. Ten Fathom Ledge is located at 95-120 m (312-394 feet) depth on the Continental Shelf in Onslow Bay, North Carolina and consists of 136 square miles of ocean floor containing patch reefs and rock outcroppings. Big Rock is located approximately 36 miles south of Cape Lookout at about 50-100 meters (164-328 feet) of water. Hard substrate consists of algal limestone and calcareous sandstone. Both of these sites are located offshore of the proposed borrow areas and would not be impacted by the project (South Atlantic Fishery Management Council, 1998).

8.01.8.10 Impacts to The Point

The Point is located near Cape Hatteras near the 200-meter (656 feet) contour and is a confluence zone of six major water masses including the Gulf Stream, Western Boundary Under Current (WBUC), Mid-Atlantic Shelf Water (MASW), Slope Sea Water (SSW), Carolina Capes Water (CCW), and the Virginia Coastal water. A result of the convergence of these currents is a dynamic and highly productive environment. This area is located well offshore of the proposed project and would not be affected (South Atlantic Fishery Management Council, 1998).

8.01.8.11 Impact Summary for Essential Fish Habitat

The proposed action is not expected to cause any significant adverse impacts to EFH or HAPC for those species managed by the SAFMC and MAFMC. Impacts are expected to be minor on an individual and cumulative effects basis.

8.02 Terrestrial Environment

8.02.1 Maritime Shrub Thicket

The maritime shrub thicket community is located sporadically throughout Surf City and North Topsail Beach, occurring on the backside of the island, west of the highway, and is interspersed with marsh areas, which border the sound. Since this community is located landward of the proposed project construction limits, no significant impacts are expected.

8.02.2 Beach and Dune

Under the proposed plan, approximately 52,150 feet of beach berm and dune would be constructed. Constructed dunes will be waterward of the first line of stable vegetation, will tie into existing dunes where practical, and be re-vegetated with native dune grasses to minimize impacts. This will result in a seaward movement of the shoreline.

Project construction and periodic nourishment is not expected to have an adverse impact on wildlife found along the beach or that utilizes the dune areas. However, short-term transient impacts may occur to mammalian species using the dune and fore-dune habitat, but these species are mobile and would be expected to move to other, undisturbed areas of habitat during construction and periodic nourishment events. Re-vegetation of dune areas would be expected to increase the amount and quality of habitat available to mammal and avian species dependent on those areas.

Project construction will result in disturbance and removal of some of the existing vegetation along the seaward side of the existing dune. However, construction would be followed by measures designed to stabilize the constructed dunes. Dune stabilization would be accomplished by the vegetative planting of the dune during the optimum planting seasons and following the berm and dune construction. Planting stocks shall consist of sea oats (*Uniola paniculata*), American beachgrass (*Ammophila breviligulata*), panic grass (*Panicum amarum*), and seaside little bluestem (*Littoralis* variety). The vegetative cover shall extend from the landward toe of the dune to the seaward intersection with the storm berm for the length of the dune. Sea oats will be the predominant plant with American beach grass and panic grass as a supplemental plant. Seaside little bluestem will be planted on the backside of the dune away from the most extreme environment. Planting would be accomplished during the season best suited for the particular plant. Periodic nourishment of the project would involve placing material along the berm. Therefore, minimal impacts to dune vegetation should occur.

It is expected that the nourishment operation at Surf City and North Topsail Beach may directly impact ghost crabs through burial (USACE, 2004b; Lindquist and Manning, 2001; Peterson *et. al*., 2000; Reilly and Bellis, 1983). Considering that ghost crabs are vulnerable to changes in sand compaction, it is possible that short-term impacts may occur from changes in sediment compaction and grain size. According to Hackney *et al*.

(1996), management strategies are recommended to enhance recovery after beach nourishment are: (1) timing activities so that they occur prior to recruitment and, (2) providing beach sediment that favors prey species and burrow construction. Ghost crabs are present on the project beach year-round (Hackney *et al*., 1996); therefore, direct impacts from burial may occur during the proposed construction timeframe of 1 December to 31 March. However, the peak larval recruitment timeframe will be avoided and, considering that only compatible borrow material will be used, it is expected that ghost crab populations will recover within one-year post-construction (USACE, 2004b; Lindquist and Manning, 2001; Peterson *et. al*., 2000; Reilly and Bellis, 1983). Considering that ghost crabs recover from short-term impacts and that recommended management strategies to avoid long-term impacts are adhered to, it is expected that no significant long-term impacts to the ghost crab population will occur.

8.02.3 Birds

The waters off of Topsail Island and Onslow Beach are very important to migrating and wintering northern gannets, loons and grebes because of the abundant hard bottom habitat. It has been suggested that migrating and wintering birds key on the hardbottom areas (Sue Cameron, pers. comm.) because such habitat supports significant prey species for these birds. However, appropriate dredging buffers have been incorporated into the project design so disturbance of birds using those areas for feeding is expected to be minimal. Nonetheless, distribution patterns of sea ducks or other birds using the offshore environment within the project vicinity could be affected during dredging operations for construction and periodic nourishment. Congregation or rafting of sea ducks in these areas is primarily for loafing (Bob Nofsinger, pers. com.). Due to the depth in these areas (greater than 30'), they are not expected to provide a benthic food source for sea ducks. It is expected that since the area of ocean disturbed is small when compared to available loafing or foraging areas, any impacts would be minor.

The identified project limits avoid important shorebird habitat located within the New River and New Topsail Inlet complexes. Though the project area is heavily developed and sustains heavy recreational use, migratory shorebirds may still use the project area for foraging and roosting habitat. As mentioned in Section 2.02.3 of this report, beach nourishment activities may temporarily impact the roosting and intertidal macro-fauna foraging habitat; however, recovery often occurs within 1 year if nourishment material is compatible with native sediments. A recent 2-year study in Brunswick County, NC (USACE, 2004b) indicated that beach nourishment had no measurable impact to shorebird use. Additionally, in order to complete the full initial construction template while still adhering to the 1 December to 31 March dredging window, initial construction will be staged into four intervals. Though temporary impacts to the shorebird prey base may occur in the impacted areas, the staggering of the initial construction effort will allow for availability of adjacent un-impacted foraging habitat. Considering that: 1.) areas of diminished prey base are temporary and isolated, 2.) recovery occurs within 1 year if material is compatible, and 3.) adjacent un-impacted foraging and roosting habitat will be available throughout the project; foraging and roosting habitat will not be significantly impacted by the proposed action.

Though it is possible that shorebird nesting may occur within the project area during the spring and summer months (1 April – 31 August), most of these bird species have been displaced by development pressures and heavy recreational use along the beach; thus, traditional nesting areas on the project beach have been lost. Many of these bird species have retreated to the relatively undisturbed dredged material disposal islands, which border the navigation channels in the area. Nonetheless, it is possible that shorebird species may still attempt to nest in the project area (Sue Cameron, pers. comm.). To protect bird nesting, the North Carolina Wildlife Resources Commission (NCWRC) discourages beach work between 1 April and 31 August. All work is proposed to be accomplished by hopper dredges within the hopper dredging window of 1 December to 31 March, thus avoiding the bird nesting window. Additionally, as discussed in Section 2.02.3, a significant amount of shorebird activity occurs year-round on the north end of North Topsail Beach and within the New River Inlet complex. In order to avoid disturbance to this important shorebird habitat, all associated construction activities for this project will avoid these areas to the maximum extent practicable.

Undeveloped and undisturbed barrier island systems with associated saltmarsh, beach and adjacent sand flats offer ideal migratory shorebird and waterbird microhabitats. Specifically, these undeveloped islands are dominated by overwash processes and the formation of bare sand habitats which offer prime nesting habitat for some shorebird species. Undeveloped barrier islands located to the north (Onslow Beach and Bear Island) and south (Lea Island) of the project area are overwash dominated systems and support thousands of shorebirds during migration and winter, hundreds of beach-nesting seabirds and shorebirds, wading birds, waterfowl and marsh birds. However, the project limits within Surf City and North Topsail beach are heavily developed on both the ocean and sound sides of the island; thus, limiting the opportunity for overwash fan formation. The Corps recognizes that natural barrier island overwash processes are an important factor in the creation and maintenance of shorebird nesting habitat and that the creation of a constructed dune as a component of this project would further inhibit natural overwash processes. However, the without project condition within the project area is not an undisturbed barrier system that is supportive of these habitat features, but rather a continued developed shoreline. As identified in Section 3.08 of the report, the Corps' without project future economic condition assumes that all structures impacted by hurricane and storm erosion damages will be replaced to a level similar to the existing distribution of residential and commercial use. Thus, if an existing structure is replaced by an overwash fan as a result of a significant storm event, the home would likely be rebuilt on top of the overwash fan. This process of structural loss and redevelopment on top of overwash features was experienced in North Topsail Beach in the years following Hurricane Fran in 1996. Furthermore, it is assumed that residential structures removed by long-term erosion will not be replaced during the 50-year period of analysis; however, the second row structures will become first row structures. Therefore, in regards to the Corps evaluation of without project conditions relative to economics, post-storm structural losses will be replaced and any washover fan formation that occurs within property limits that are deemed rebuildable by the state will have a new structure rather than offering new bird habitat. The project area is, and will continue to be, a highly

developed beach whose residential and commercial development practices have led to the degradation of available washover habitat prior to the construction of a shoreline protection project.

Based on the following considerations, the proposed construction activities will not significantly impact breeding and nesting shorebirds or colonial waterbirds within the project area: 1.) timing of the initial construction activities and periodic renourishments will adhere to the 1 April to 31 August bird nesting window, 2) beach nourishment and construction activities will not occur within the New River and New Topsail Inlet complexes, which most likely to support foraging, loafing, roosting, and nesting shorebirds, and 3) project construction timing and planning will allow for rapid recovery of intertidal foraging habitat in the project area.

8.03 Physical Resources

8.03.1 Wave Conditions

Localized deepening of offshore borrow areas is the only potential source of impacts on wave conditions, however, these changes are not expected to be significant. The borrow area use plan identifies sixteen borrow areas scattered across approximately 24 miles in water depths of 35 to 50 feet MLLW, which should have less impact on wave conditions than dredging of a large, contiguous area. The anticipated average dredging depths for the majority of the borrow areas range from 2.8 to 4.4 feet with the exception of borrow areas N, O, P, and Q, where the average dredging depth ranges from approximately 5.1 to 6.4 feet. Specific locations within borrow areas A, J, L, N, O, P, and T indicate isolated locations of compatible material at depths ranging from 8.3 to almost 15 feet. The potential to dredge these specific borrow areas to the deeper depths will be dependent on additional investigation conducted during the design phase to comply with the NC beach fill standards. Even considering the greater depths up to 15 feet in the borrow areas, negligible changes in wave conditions would be expected along the project shoreline due to pre-dredge water depths at these borrow areas ranging from 38 to 48 feet MLLW.

8.03.2 Shoreline and Sand Transport

Existing water depths in the borrow areas range from 35 to 50 feet MLLW, which is substantially deeper than the estimated active profile depth of 23 feet NGVD. Therefore no impacts to the active profile are expected due to borrow area dredging.

Planform evaluation indicates that without project erosion rates of 0 to 3 feet per year will increase to 4 to 17 feet per year with a beachfill project in place, with rates increasing toward the ends of the project. Renourishment will take place every 4 years to replenish these losses, unless project monitoring indicates that renourishment can be reasonably delayed. Net movement of this material will be predominantly to the north based on transport analysis, with northerly sediment transport being roughly twice that of southerly transport on average.

8.0.3.3 Geology and Sediments

8.03.3.1 Borrow Area Dredging

About 11.5 square miles of sandy ocean bottom will be affected over the 50-year economic life of the project. Within the borrow areas (Figures A-1 and A-6, in Appendix A) existing water depths (greater than –35-foot MLLW) will be deepened, and recolonization of affected areas is expected within 1-3 years. As discussed in section 2.01.10, an extensive geophysical investigation was conducted to identify hard bottom presence and delineate hard bottom which was identified in and near several borrow areas. Hard bottom buffers of 500 meters (1640 feet) were established for high and moderate relief hard bottom and 122 meters (400 feet) were established for low relief hard bottom. These buffers were proposed by the USACE, Wilmington District and agreed upon by several state and federal resource agencies. See section 8.01.8.2 for more specific information regarding impacts to hard bottoms.

8.03.3.2 Beachfill Construction

Hopper dredging will be the anticipated method used during the construction and renourishment phases. Negative impacts during the construction phase will be minor and temporary. Potential impacts associated with this type of operation include:

1) Increased turbidity in the surf zone, and
2) Sedimentation of nearshore and offshore hardbottoms.

Impacts should be insignificant considering turbidity and sedimentation plumes will be confined to the offshore borrow areas during hopper dredging operations and hardbottoms were only identified within the vicinity of 8 of the offshore borrow areas. See Section 8.01.8.2 for more information.

During nourishment operations, there will be an increase in the turbidity in the surf zone in the immediate area of sand deposition. Deposition and subsequent turbidity increases may have short-term impacts on surf zone fishes and prey availability. The anticipated hopper dredging timeframe for the project is from 1 December to 31 March and avoids the peak recruitment and abundance timeframe of the surf zone fishes. Considering the construction timeframe and the adaptive availability of representative organisms, the impacts should be temporary and minor. See Section 8.01.3 for more information.

8.03.3.3 Sediment Compatibility

The compatibility analysis compared the grain size of the “native beach” or the “reference beach” with the material in the proposed borrow areas. The overfill ratio is the primary indicator of the compatibility of the borrow material to the beach material, with a value of 1.00 indicating that one cubic yard of borrow material is needed to match one cubic yard of beach material. The procedure for calculating the overfill ratio for borrow areas in relation to the reference beach was performed in accordance with the

U.S. Army Corps of Engineers Coastal and Hydraulics Laboratory Automated Coastal Engineering System (ACES) software version 4.01. This procedure is discussed in section V-4-1.e.(2)i. of the U.S. Army Corps of Engineers Engineer Manual (EM) 1110-2-1100, part V, titled Coastal Engineering Manual. An overfill ratio of up to 1.5 is generally considered acceptable as a match of compatibility. Although no studies have been conducted concerning overfill ratios and post project water quality, post construction studies conducted for beach erosion control projects have concluded the effects of beach fill operations on short-term turbidity appeared to be limited to the immediate area of the operation. Total suspended sediment concentrations outside the swash zone seldom exceed 25 milligrams per liter, a value comparable to concentrations many species experience in estuaries or during storms (USACE New York District, 2001). Because the project borrow area sediment generally consists of a low percentage of silt, post-project impacts to water quality are expected to be minimal.

Table 7.3 illustrates the overfill ratios for potential borrow areas for the Surf City/North Topsail Beach project. The overfill ratios for the borrow areas are all below 1.5 with the exception of borrow area C, which was 1.56. Because the overfill ratio for borrow area C was only slightly above 1.5, it has been retained for further evaluation when additional characterization is conducted during the design phase.

As stated in section 7.04.1, the state of North Carolina implemented new beach fill standards in 2007, which require compatibility of the native beach with borrow sources in regards to the percentage of silt, granular sediment, gravel, and calcium carbonate (or shell content for projects initiated before implementation of the rules). The standards require that percent silt, granular sediment, and gravel in borrow material not exceed the amount found in the native beach plus 5% and the percent carbonate in borrow material not exceed the amount found in the native beach plus 15%. As illustrated in Table 7.3, the silt, granular sediment, gravel content, and visual shell content for the Surf City/North Topsail Beach project are 1.2%, 1.1%, 0.5%, and 9% respectively. Incorporating the tolerance permitted by the beach fill standards results in the following criteria silt (6.2%), granular sediment (6.1%), gravel (5.5%), and calcium carbonate (24%).

As shown in Table 7.3, all of the borrow areas comply with the beach fill standards in regards to the percentage of silt with the exception of borrow areas A (6.6%) and L (6.3%). Both of these borrow areas exceed the standard slightly by 0.4 and 0.1% respectively. All of the borrow areas comply with the beach fill standards in regards to the percentage of granular sediment with the exception of borrow areas F (7.0%) and S (6.6%), which exceed the standard by 0.9 and 0.5% respectively. All of the borrow areas comply with the beach fill standards in regards to the percentage of gravel sediment with the exception of borrow areas F (8.5%) and P (6.6%), which exceed the standard by 3.0 and 1.1% respectively. All of the borrow areas comply with the beach fill standards in regards to the percentage of shell content (carbonate). The borrow areas in which the standards were exceeded for the various characteristic (A, F, L, S, and P) have been retained as all borrow areas will be further characterized during the design phase of this project. Additional vibracores will be performed to comply with the beach fill standards of 1 core/acre or 1,000 foot spacing. Vibracores will be performed to produce a density

of 1,000 foot spacing in a borrow area prior to its use as a borrow source. See Appendix E for more information on borrow material and sediment compatibility.

8.04 Socioeconomic Resources

8.04.1 Commercial and Recreational Fisheries

The economic impacts of the NED plan or other nourishment plans during construction are not expected to be significant. Impacts on shore fishing would be limited to the area where material is being placed on the beach. This localized temporary impact can easily be avoided by anglers in the area. Nearshore fishing boats can operate around the dredging equipment operating in the area. The beach nourishment plan is not expected to impact inside fishing or the operation of commercial fishing boats operating inside or going through New Topsail Inlet or New River Inlet. Unless there is extreme weather, the ocean going dredge will operate continuously. Therefore, the economic impact of commercial and recreational fishing is not expected to change with the project construction.

8.05 Recreation and Esthetic Resources

Implementation of the proposed action may cause temporary reduction of esthetic appeal and interference with recreational activities in the areas of project construction. However, since project construction will be conducted in relatively small areas at any particular point in time, recreational and esthetic impacts will be localized. Also, construction and maintenance would be done between 1 December and 31 March thereby avoiding the peak summer tourist season. Upon completion of work activities in any area, esthetic values and recreational opportunities will be restored or enhanced as construction equipment is moved away.

The ocean and navigable waters in the vicinity of Surf City and North Topsail Beach will be affected to only a minor extent in that dredges, barges, and other watercraft associated with the work would be on-site for several months during construction and during renourishment events. However, this is judged to be an insignificant effect.

Placement of beachfill will result in temporary use of dredge pipeline, bulldozers, and other equipment on the beach, and these objects will detract from the normal appearance of the beach. Also, recreational activities on beaches may experience some interruption or interference during work periods, but the degenerated, eroded conditions of the beaches already present recreational constraints. After work is completed on any beach and the heavy equipment is removed, the resulting wider beach is expected to represent an esthetic enhancement and an improvement for recreation.

One ocean pier, the Surf City Ocean Pier, is within the construction area. The placement of beach fill under this pier may temporarily reduce the area available for fishing. Beach

nourishment during the fishing season may also impact the recreational catch. During past projects at Wrightsville Beach and Carolina Beach, no special provisions were made during placement of beach-fill around the piers and no major objections were raised during the process. However, for Atlantic Beach, during the pumpout of Brandt Island, the beach-fill was wider than usual, thus raising concerns from fishing interests. The Surf City and North Topsail Beach project is similar to the Wrightsville and Carolina Beach projects. In the vicinity of the pier, immediately following construction, the shoreline may extend out approximately 300 feet from its present position. However, natural forces will reshape the beach area and within a few months, beach fill material will be more evenly distributed throughout the nearshore zone. Following this redistribution of material it is expected that the new beach profile will extend out approximately 150 feet beyond its current position, thus having minimal impact on the 937-foot pier. Any turbidity that may occur during placement will be dissipated during several tidal cycles and should have no significant long-term impact on fishing from either the piers or the surf zone. These impacts are not expected to significantly reduce public use at the pier.

Overall, esthetic and recreational impacts of the proposed action represent minor improvements.

8.06 Cultural Resources

Whereas the Topsail Island vicinity is known to have had an active historical maritime trade, the Wilmington District, in consultation with the North Carolina Division of Archives and History, undertook contracted remote sensing survey designed to meet the intent of the National Historic Preservation Act and the Abandoned Shipwreck Act. During summer and fall of 2004, Mid-Atlantic Technology and Environmental Research, Inc. conducted a magnetometer and side-scan sonar survey of the ten proposed borrow areas. The results of that survey are reported in *Archaeological Remote Sensing Survey of Topsail and West Onslow Beaches Offshore Borrow Areas (*Contract DACW54-03-D-0002, Order 0003, Wes Hall, Principal Investigator, December 2004). Data was collected along parallel lines spaced at 65-foot (20-meter) intervals. Magnetic data, along with corresponding positioning data, was recorded at one-second sample intervals (or approximately every 8 feet along a track line at 5 knots).

No single, isolated magnetic anomalies or acoustic targets were identified during the survey of the ten borrow areas and no further cultural resources studies are anticipated for the project. By letter of November 2, 2004, the North Carolina State Historic Preservation Officer concurred with the reported findings.

No prehistoric sites were specifically considered in the survey. While there has been some success developing upland-offshore site location correlations in Florida and perhaps elsewhere, the methodology is not very well developed for sites within the Carolinas region, nor are there a significant number of upland locations that could be used to model settlement in now inundated areas. Monitoring may be a way to determine if such sites were encountered during dredging, but the use of heavy equipment

throughout the renourishment process might make precise relocation of sites very difficult. The District will discuss the option of monitoring with archaeologists from the UAB. In their reviews of the project, the UAB has not mentioned prehistoric sites or impacts to other types of sites; shipwrecks have been the major concern. The SHPO letter accepting the final report of investigations is dated March 1, 2005 and is included in Appendix H of the Draft Feasibility Report and EIS.

It should be noted, originally seven potential offshore borrow areas (extending from the Topsail Beach/Surf City town limit to New River Inlet) were identified at the time the cultural resources survey was conducted. After completion of the survey, hard bottom was identified in several borrow areas, which required modification to the boundaries of several borrow areas and elimination of three borrow areas (currently identified as I, K, and M). Consequently, the remaining viable borrow areas were renamed and reconfigured into ten borrow areas. The boundaries of these reconfigured borrow areas are completely contained within the boundaries of the original seven borrow areas.

8.07 Water Resources

8.07.1 Hydrology

Marine waters of the project area display considerable daily variation in current and salinity conditions due to fresh water inflow, tides, and wind. Within the ocean environment, any project-induced changes in the vicinity of the proposed work would be very small (if any) in comparison and are, therefore, considered to be insignificant.

8.07.2 Water Quality

Dredging in the selected borrow areas would involve mechanical disturbance of the bottom substrate and subsequent redeposition of suspended sediment and turbidity generated during dredging. Factors that are known to influence sediment spread and turbidities are grain size, water currents and depths. Monitoring studies done on the impacts of offshore dredging indicate that sediments suspended during offshore are generally localized and rapidly dissipate when dredging ceases (Naqvi and Pullen, 1983; Bowen and Marsh, 1988, and Van Dolah *et al*., 1992). Some infilling of the borrow area after dredging is expected from side sloughing of native bottom sediments which consist of predominately sandy material with a small amount of fine or organic material.

During construction, there will be elevated turbidity and suspended solids in the immediate area of sand deposition when compared to the existing non-storm conditions of the surf zone. Significant increases in turbidity are not expected to occur outside the immediate construction/maintenance area (turbidity increases of 25 nephelometric turbidity units ((NTUs)) or less are not considered significant). Turbid waters (increased turbidity relative to background levels but not necessarily above 25 NTU's) will hug the shore and be transported with waves either northeast or southwest depending on wind conditions. Due to the low percentage of silt and clay in the borrow areas (<10 percent),

turbidity impacts are not expected to be greater than the natural increase in turbidity and suspended material which occurs during storm events. Any increases in turbidity in the borrow areas during project construction and maintenance are expected to be temporary and limited to the area surrounding the dredging. Turbidity levels are expected to return to background levels in the surf zone upon cessation of dredging.

Overall water quality impacts of the proposed action are expected to be short-term and minor. Living marine resources dependent upon good water quality should not experience significant adverse impacts due to water quality changes.

A Section 401 Water Quality Certificate under the Clean Water Act of 1977 (PL 95-217), as amended, is required for the proposed project and will be obtained from the North Carolina Division of Water Quality prior to the start of construction.

Pursuant to Section 404 of the Clean Water Act, the impacts associated with the discharge of fill material into waters of the United States are discussed in the Section 404(b)(1) (P.L. 95-217) Guidelines Analysis in Appendix G. Discharges associated with dredging in the offshore borrow areas are considered incidental to the dredging operation, and therefore, are not being considered as being a discharge addressed under the Section 404 (b)(1) Guidelines Analysis.

8.07.3 Groundwater

Dredging with beach placement of material will not adversely affect groundwater of the area. Groundwater in the area moves generally east and southeast along a regional gradient of about 8 feet per mile. The potential for saltwater intrusion into groundwater does not exist unless a reversal of hydrologic gradient occurs due to excessive groundwater pumping. Water supplies of nearby communities will not be affected by the proposed action.

8.08 Other Significant Resources (as per Sect. 122 of P. L. 91-611)

8.08.1 Air, Noise, and Water Pollution

Temporary increases in exhaust emissions from construction equipment are expected during the construction and periodic nourishment period, however, the pollution produced will be similar to that produced by other large pieces of machinery and should be readily dispersed. All dredges must comply with the applicable EPA standards. Additionally, ozone is North Carolina's most widespread air quality problem, particularly during the warmer months. High ozone levels generally occur on hot sunny days with little wind, when pollutants such as nitrogen oxides and hydrocarbons react in the air. High levels of fine particles are more of a problem in the western Piedmont region but can occur throughout the year, particularly during episodes of stagnant air and wildfires. The project will be constructed outside of ozone season. The air quality in Pender and Onslow Counties, North Carolina, is designated as an attainment area. The State of

North Carolina has a State Implementation Plan ("SIP") approved or promulgated under Section 110 of the Clean Air Act (CAA), however, for the following reasons; a conformity determination is not required.

a. 40 CFR 93.153 (b), "For Federal actions not covered by paragraph (a) of this section, a conformity determination is required for each pollutant where the total of direct and indirect emissions in a nonattainment or maintenance area caused by a Federal action would equal or exceed any of the rates in paragraphs (b) (1) or (2) of this section." Pender and Onslow Counties have been designated by the State of North Carolina as an attainment area.

b. The direct and indirect emissions from the project fall below the prescribed deminimus levels (58 Fed. Reg. 93.153(c)(1)) and, therefore, no conformity determination would be required.

c. The project is located within the jurisdiction for air quality of the Wilmington Regional Office of the NCDENR. The ambient air quality for Pender and Onslow Counties has been determined to be in compliance with the National Ambient Air Quality Standards. Furthermore, Table 8.4 includes an analysis of total emissions for the proposed dredging and land based operations associated with this project as well as a comparison of the project calculated emissions to the USEPA NEI data for Pender and Onslow Counties. Calculations are in accordance with USEPA's "Current Methodologies and Best Practices in Preparing Port Emission Inventories" dated Jan 5, 2006 (Final Report).

The following assumptions were made when calculating the emissions outputs for the dredging and beach placement equipment:

1. Hopper Dredge emissions calculations were based on representative hopper dredge (i.e. RN Weeks) emissions calculated by Minerals Management Service (MMS) for the Sandbridge Beach Restoration project in Virginia. The following assumptions were made by MMS:

a. Hopper Dredge(with pump ashore capability) is working 120 days and pumps 2,000,000 cubic yards of material to the beach.

b. The following equipment is part of the in-water dredging operation:

1) 2 tender tugs
2) 1 derrick barge
3) 2 work barges
4) 1 bulldozer

c. The following equipment is part of the beach placement operation:

1) 2 bull dozers (215 horsepower (HP))
2) 1 flat bed truck

2. Pipeline Dredge and beach placement associated equipment inventories were provided by industry and associated emissions calculations are in accordance with USEPA (2006). The following assumptions were made by the Corps:

a. The following equipment is part of the in-water dredging operation:

1) The 30-inch pipeline dredge total HP is 5200 (includes onboard generators). Booster pump total HP is 2000.

2) One crew boat/survey boat has 800 HP (includes generator).

3) One tug tender (move anchors etc.) has 1100 HP (includes generator).

b. The following equipment is part of the beach placement operation:

1) Equipment: Bulldozers- Two D-8 (310 HP) and Two D-6 (125 HP)

2) Tire Front End Loader- Two 180 HP loaders

3) 1 Dump Shack (with 100 HP Diesel Generator).

3. Total time working onsite.

a. Dredge and booster, tug tender and crew boat/survey boat can only work a maximum of 80% (maintenance, breakdown, moving anchors, etc.) of available working time.

b. Load factor (LF) (percent of vessel's total power) for the dredge and booster is 1 or 100%, tug tender is 31%, and crew/survey boat is 69%. Both the tug and crew boat LF was taken from USEPA (According to USEPA's "Current Methodologies and Best Practices in Preparing Port Emission Inventories" dated Jan 5, 2006 (Final Report)).

c. Beach Operation. Time for dozers and front end loader is 1992 hour. LF for this equipment is 1 or 100%.

4. Equations used: From EPA: 1 kilowatt = 1.34102209 horsepower, 1gm = 0.00000110231131 tons, and According to the Port of Portland Spreadsheets: VOC= 1.005 HC.*

Based on the analysis provided in Table 8.4, this project is not anticipated to create any adverse effect on the air quality of this attainment area and the project is in compliance with Section 176 (c) of the Clean Air Act, as amended.

Noise from construction equipment is slightly out of character for some of the project area; however, construction sounds will be readily attenuated by background sounds from wind and surf. Water quality impacts are discussed in Section 8.07.2 and in the Section 404(b)(1) (P.L. 95-217) evaluation included with this document as Appendix G.

Table 8.4 Project Emissions Analysis

Activity	Emissions (tons)				
	NOX	CO	HC	PM10	SO2
Pipeline Dredge	177.1	34.1	3.7	4.1	8.6
Booster	68.1	13.1	1.4	1.6	3.3
Tug Tender	11.6	2.2	0.2	0.3	0.6
Crew/Survey Boat	18.8	3.6	0.4	0.4	0.9
Beach Operation	16.0	6.4	1.2	1.1	1.2
Sub-total, Pipeline Dredge	291.6	59.4	6.9	7.5	14.5
Hopper Dredge*	133.0	34.3	4.8	4.9	12.2
TOTALS	424.6	93.7	11.7	12.4	26.7
USEPA NEI Data for Pender County (tons/year)	2,702.3	26,177.3	3,399.1	1,935.1	230.5
Project Percent of Pender Total	15.7%	0.36%	0.34%	0.64%	11.6%
USEPA NEI Data for Onslow County (tons/year)	4,123.5	41,470.5	6,198.8	3,001.8	1,048.9
Project Percent of Onslow Total	10.3%	0.22%	0.19%	0.41%	2.5%

* - Calculated emissions include dredging operations (hopper dredge, tugs, crewboats, and barges), land based operations (dozers, trucks, pumpout facility, etc), and all other associated equipment.

8.08.2 Man-made and Natural Resources, Esthetic Values, Community Cohesion, and the Availability of Public Facilities and Services

Beach nourishment will require the extension of dune crossover structures along the beach. Dredging in the offshore borrow areas is not expected to cause significant interference with commercial and recreational boat traffic. The mobility of a hopper dredge will preclude any interference with regular commercial ship traffic as a result of travel to and from the borrow areas.

Impacts to esthetic values are discussed in Section 8.05. Impacts to natural resources are discussed previous through Sections 8. Impacts to cultural resources are discussed in Section 8.06. Coastal storm damage risk reduction will benefit numerous roads, business, and residences. The NED alternative will have beneficial effects on community cohesion and will protect many public facilities and services (i.e. roads and utilities) from storm events.

8.08.3 Hazardous, Toxic and Radioactive Wastes (HTRW)

The U.S. Army Corps of Engineers standard tiered approach for analyzing the potential for encountering contaminated sediments in the potential borrow areas was used to assess the potential borrow areas for HTRW. According to this analysis, before any chemical or physical testing of sediments is conducted, a reason to believe that the sediments may be

contaminated must be established. The sources of the sediments in the selected borrow areas are derived from sediment transport and deposition by ocean currents. The probability of the areas being contaminated by pollutants is low, however, the beach front (potential nourishment area) and the potential borrow areas are located in areas that were impacted by the operations of Camp Davis and the Navy's Operation Bumblebee.

Due to the location of the project area relative to Camp Davis operations, a very remote possibility exists that OEW could be present in the material to be dredged from offshore borrow areas. However, the only ordnance that would be expected to be encountered would be spent shells from anti-aircraft target practice. The missiles that were tested during Operation Bumblebee contained no OEW and were fired approximately 40 miles offshore, well beyond the project area and the likelihood of encountering them in an offshore borrow area is remote.

As described in Section 2.07, the anti-aircraft shells that were fired from the beach during WWII were presumed to range in size from 37 mm (1.46 inches) to 155 mm (6.10 inches). A cultural resources survey, which utilized magnetometer and side-scan sonar, was completed for all proposed offshore borrow areas. Survey line spacing was 20 meters and no anomalies were found within the areas surveyed (See Section 8.06 for Cultural Resources summary). Although the cultural resources survey would have identified large anomalies, it was not intended to, nor capable of identifying smaller anomalies, such as anti-aircraft shells. Since the survey did not identify any anomalies, it is presumed that any materials found offshore would be small and therefore would not impede the dredging and disposal operations and would not present a safety hazard to workers on the dredge or to anyone on the beach. However, to mitigate the very remote chance of encountering ordnance, the beach will be inspected on a daily basis and any ordnance discovered will be handled in accordance with the Military Munitions Rule, 40 CFR 260-270. The Marine Corps Base Explosive Ordnance Disposal Team will be available ("on call") during the dredging process. Additionally, the contract specifications for the proposed project would direct the contractor to immediately stop work and inform the contracting officer if unexploded ordnance is encountered during dredging or disposal. At that time, additional measures will be implemented, as necessary, including inspection of dredged material on the beach and installation of outflow screens on the dredge pipeline. Any unexploded ordnance found on the beach would be promptly removed.

The bottom sediments that will be dredged from the borrow areas and placed on the beach will consist of predominately fine-to-medium grain size with some shell. Therefore, no further analyses or physical and chemical testing of the sediments is recommended. It is not expected that any hazardous and toxic waste sites would be encountered during construction or periodic nourishment. However, if any hazardous and toxic waste sites are identified, response plans and remedial actions will be the responsibility of the local sponsor.

8.09 SUMMARY OF CUMULATIVE EFFECTS

The detailed analysis of cumulative effects is included as Appendix J. The assessment of cumulative effects focused on impacts of dredging from the proposed ocean borrow sites, and impacts of placement of sand material on the beach (whether for beach nourishment or disposal of dredge maintenance material) on significant coastal shoreline resources In completing the cumulative effects analysis, we reviewed two Environmental Reports prepared for and published by the U.S. Department of the Interior, Minerals Management Service, entitled "Use of Federal Offshore Sand Resources for Beach and Coastal Restoration in New Jersey, Maryland, Delaware, and Virginia," dated November 1999 (DOI 1999) and "Collection of Environmental Data Within Sand Resource Areas Offshore North Carolina and the Environmental Implications of Sand Removal for Coastal and Beach Restoration," dated 2003 (Byrnes et al. 2003); the U.S. Army Corps of Engineers Dare County Beaches (Bodie Island Portion) Final Feasibility Report and EIS on Hurricane Protection, dated September 2000; the U.S. Army Corps of Engineers Draft Evaluation Report and Environmental Assessment, Morehead City Harbor Section 933, dated May 2003, and the Final Integrated General Reevaluation Report and Environmental Impact Statement, Shore Protection, West Onslow Beach and New River Inlet (Topsail Beach), dated March 2008, the last three of which included comprehensive assessments of state-wide cumulative impacts. In discussing the potential cumulative impacts of offshore borrow area dredging and beach nourishment, we considered time crowded perturbations, and space crowded perturbations, as defined below, to be pertinent to this action.

> ***Time crowded perturbations*** *– repeated occurrence of one type of impact in the same area.*
> ***Space crowded perturbations*** *– a concentration of a number of different impacts in the same area.*

Relatively small portions of North Carolina beaches (approximately 12 percent) are presently affected by these activities. With the proposed action, the impact area would not increase significantly since portions of the areas proposed for fill have previously had sand deposition. On a statewide scale, the existing and approved disposal sites are well distributed in northern, central and southern parts of the state with undeveloped protected beaches (i.e., National/Federal and State Parks and Estuarine Reserves) in between. It is unlikely that cumulative impacts from space crowded perturbation are occurring or will occur due to the construction of this project. The analysis suggests that the potential impact area from the proposed and existing actions is small relative to the area of available similar habitat on a vicinity and statewide basis. Also, for some species such as sea turtles and seabeach amaranth, beach projects will improve habitat by replacing beach material lost to erosion. Lastly, all impacted areas are expected to recover invertebrates, which should continue to be available as food resources.

9. PLAN IMPLEMENTATION

9.01 Project Schedule

Table 9.1 shows the schedule through initial construction for the Tentatively Selected Plan. This schedule assumes expeditious review and approval of the project through all steps, including authorization and funding. Actual project implementation could take longer. This schedule is subject to availability of funds.

Table 9.1 Project Schedule.

Study Authority	February 16, 2000
Reconnaissance Report, HQ Approval	June 12, 2001
Execute FCSA	February 13, 2002
Initiate Feasibility Study	February 2002
Alternative Formulation Briefing	12 / 2006
Complete Draft Feasibility Report & EIS	8 / 2009
Begin 45-day Public Review	9 / 2009
Complete Final Feasibility Report & EIS	12 / 2009
Civil Works Review Board	6 / 2010
Begin 30-day Public Review	7 / 2010
Sign Record of Decision (ROD)	3 /2011
Execute Design Agreement	8 / 2011
Initiate Initial Plans & Specifications	8 / 2011
Project Authorization (WRDA)	11 / 2011
Execute Project Cooperation Agreement	3 / 2012
Complete Initial Plans & Specifications	3 / 2012
Initiate Real Estate Acquisition	4 / 2012
Initiate Final Plans & Specifications	9 / 2013
Complete Real Estate Acquisition	3 / 2014
Complete Final Plans & Specifications	4 / 2014
Advertise Initial Construction Contract	5 / 2014
Open Bids	6 / 2014
Award Initial Construction Contract	7 / 2014
Begin Initial Construction, Season 1 of 4	11 / 2014
Begin Initial Construction, Season 2 of 4	11 / 2015
Begin Initial Construction, Season 3 of 4	11 / 2016
Begin Initial Construction, Season 3 of 4	11 / 2017
Complete Beachfill Construction	4 / 2018
Complete Remaining Construction Items	6 / 2018
Begin First Renourishment	11 / 2018
Complete First Renourishment	2 / 2019
Begin Second Renourishment	11 / 2022
Complete Second Renourishment	4 / 2023

9.02 Division of Plan Responsibilities

9.02.1 General

Federal policy requires that costs for water resources projects be assigned to the various purposes served by the project. These costs are then apportioned between the Federal government and the non-Federal sponsor according to percentages specified in Section 103 of the Water Resources Development Act of 1986 (PL 99-662). For projects that provide protection to publicly owned shores, the purposes are usually (1) hurricane and storm damage reduction and (2) separable recreation. For the Surf City and North Topsail Beach project there is no separable recreation component.

9.02.2 Cost Sharing

Cost sharing for initial construction of the Tentatively Selected Plan would be consistent with that specified in Section 103(c)(5) of WRDA 86 as amended by WRDA 96 (generally 65 percent Federal and 35 percent non-Federal). Non-Federal interests are required to provide all lands, easements, rights of way, and dredged material disposal areas and perform all necessary relocations (LERRD) necessary for the project. The value of the non-Federal portion of the LERRD is $4,814,000 and is included in the non-Federal share of initial project construction costs. The remainder of the non-Federal share of initial project construction costs consists of $36,632,000 cash contribution.

Cost sharing for periodic nourishment (continuing construction) would be consistent with Section 215 of WRDA 99, which requires that such costs be shared 50 percent Federal and 50 percent non-Federal.

Annual operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) costs, such as inspection costs and dune vegetation maintenance costs, are 100 percent non-Federal responsibility. The Federal Government is responsible for preparing and providing an OMRR&R manual to the sponsor.

As noted previously, current Federal policy requires that, unless there are other, overriding considerations, the plan that produces the maximum net benefits, the (NED) plan, will be the selected plan recommended for implementation. In this case, the tentatively selected plan recommended for implementation is the NED plan. Cost sharing for the tentatively selected plan is shown in Table 9.2 at October 2008 price levels.

The sponsor is in the process of obtaining the required public access sites and public parking to meet the definition of a public shoreline. The cost apportionment is computed to assume that 100% of the project will be a public shoreline by the time the PCA is executed. There will be no private-use shores. All project costs are allocated to the purpose of hurricane and storm damage reduction.

Table 9.2 Cost Allocation and Apportionment, October 2008 price levels

INITIAL PROJECT CONSTRUCTION COSTS					
Project Purpose	Project First Cost	Apportionment %		Apportionment $	
		Non-Federal	Federal	Non-Federal	Federal
Hurricane & Storm Damage Reduction	$118,416,000	35%	65%	$41,446,000	$76,970,000
LERRD Credit				$4,814,000	
Cash Portion				$36,632,000	$76,970,000
TOTAL FINANCIAL INITIAL PROJECT CONSTRUCTION COSTS					
Project Purpose	Project First Cost	Apportionment %		Apportionment $	
		Non-Federal	Federal	Non-Federal	Federal
Hurricane & Storm Damage Reduction	$118,416,000	35%	65%	$41,446,000	$76,970,000
Sunk Feasibility Phase Costs	$4,240,000	50%	50%	$2,120,000	$2,120,000
Total Financial Cost	$122,656,000	35%	65%	$43,566,000	$79,090,000
PERIODIC RENOURISHMENT COSTS					
Project Purpose	Cost per Operation	Apportionment %		Apportionment $	
		Non-Federal	Federal	Non-Federal	Federal
Hurricane & Storm Damage Reduction (first)	$10,120,000	50%	50%	$5,060,000	$5,060,000
Hurricane & Storm Damage Reduction (other)	$17,557,000	50%	50%	$8,778,000	$8,778,000
Project Purpose	Cost per Year	Apportionment %		Apportionment $	
		Non-Federal	Federal	Non-Federal	Federal
Monitoring	$508,000	50%	50%	$254,000	$254,000
ANNUAL OMRR&R COSTS					
Project Purpose	Cost per Year	Apportionment %		Apportionment $	
		Non-Federal	Federal	Non-Federal	Federal
General Repair, Maintenance, Inspection	$52,000	100%	0%	$52,000	$0

If parking and access minimums were not met, then those areas would be categorized as private shorelines and would not be eligible for Federal cost sharing. As described in Section 3.04 there are three areas totaling 2,800 feet that do not presently meet shoreline access requirements to be defined as a public shoreline. Two adjacent areas, totaling 8,200, although having access, do not meet the criterion of having at least 10 public parking spaces within ¼ mile, and so do not meet requirements. These areas have a total length of 11,000 feet and include both the 2,800 feet without access and the 8,200 feet lacking sufficient parking. These reaches presently not meeting Federal cost sharing requirements represent 21% of the 52,150-foot total project length. The cost sharing percentage impacts of the present categorization of the project shorelines are shown in Table 9.3. Table 9.3 is based on Appendix C, of ER 1165-2-130, Federal Participation in Shore Protection. Without the required access, the Federal cost sharing decreases from 65% to 61.5% for initial construction and decreases from 50% to 47.3% for renourishment. Without both the required access and parking, the Federal cost sharing decreases from 65% to 51.3% for initial construction and decreases from 50% to 39.5%

for renourishment. As stated previously the Towns of Surf City and North Topsail Beach intend to provide access and parking along the entire shoreline.

Table 9.3 Cost Sharing Based on Shoreline Category

Shore Ownership	Public or Private Shores		Private Shores	
	Developed Public Use	Developed No Public Use	Not Developed	Total
Federal Participation, Construction	65%	0%	0%	
Length, ft (based on access)	49,350	2,800	0	52,150
Federal Cost Share	61.5%	0.0%	0.0%	61.5%
Federal Participation, Renourishment	50%	0%	0%	
Length, ft (based on access)	49,350	2,800	0	52,150
Federal Cost Share	47.3%	0.0%	0.0%	47.3%
Federal Participation, Construction	65%	0%	0%	
Length, ft (based on parking)	41,150	11,000	0	52,150
Federal Cost Share	51.3%	0.0%	0.0%	51.3%
Federal Participation, Renourishment	50%	0%	0%	
Length, ft (based on parking)	41,150	11,000	0	52,150
Federal Cost Share	39.5%	0.0%	0.0%	39.5%

9.02.3 Financial Analysis

The non-Federal sponsors have submitted financial plans and statements of financial capability, and have requested a letter from the State of North Carolina which declares the State's financial capability and financing plan relative to a Surf City and North Topsail Beach, NC coastal storm damage reduction project. Preliminary documentation of the sponsors' financial capability is to be provided in Appendix H.

9.02.4 Project Cooperation Agreement

The model Project Cooperation Agreement (PCA), based on the tentatively selected plan, was fully discussed with the non-Federal sponsors. The non-Federal sponsors have a clear understanding of the type of agreement that must be signed prior to the start of project construction. The terms of local cooperation to be required in the PCA are described in Section 13.0, Recommendations. Letters of intent from the non-Federal sponsors are to be provided in Appendix H.

Federal commitments regarding a construction schedule or specific provisions of the PCA cannot be made to the non-Federal sponsors on any aspect of the recommended plan or separable element until:

- The recommended plan is authorized by Congress;
- Construction funds are provided by Congress, apportioned by the Office of Management and Budget, and their allocation is approved by the Assistant Secretary of the Army for Civil Works (ASA {CW}); and
- The draft PCA has been reviewed and approved by the ASA (CW).

The PCA would not be executed nor would construction be initiated on this project or any separable element until compliance requirements have been met for applicable Federal and state statutes. Compliance is met once the Final Environmental Impact Statement has been fully coordinated and a Record of Decision has been signed.

After this report is approved and the project budgeted for construction, Wilmington District can conduct negotiations with the non-Federal sponsors regarding the PCA, and submit a draft PCA package to higher authority for review and approval by the ASA (CW). The PCA would be executed only after approval of this report and enactment into law of an Appropriations Bill providing funds for this project. Federal construction funds for the project will not allocated by the Chief of Engineers until the ASA (CW) approves the non-Federal sponsors' financing plans and the PCA has been executed.

9.03 Views of the Non-Federal Sponsor

The Tentatively Selected Plan of Improvement is acceptable to the non-Federal sponsors. Letters of support from the Town of Surf City and the Town of North Topsail Beach are to be provided in Appendix H.

9.04 Views of the State of North Carolina

The State of North Carolina, Department of Environment and Natural Resources, Division of Water Resources has indicated support for implementation of the Tentatively Selected Plan.

9.05 Views of the U.S. Fish & Wildlife Service

Views of the USFWS are provided in the attached Draft Fish and Wildlife Coordination Act Report in Appendix L. The recommendations of the USFWS and responses by USACE are presented in Section 11.02, Fish & Wildlife Coordination, of this report.

10. COMPLIANCE WITH ENVIRONMENTAL REQUIREMENTS

10.01 General

The following paragraphs summarize the relationship of the proposed action to the most pertinent Federal, State, and local requirements. Table 10.1 lists the compliance status of all Federal Laws and Policies that were considered for the proposed Surf City and North Topsail Beach project.

10.02 Water Quality

10.02.1 Section 401 of Clean Water Act of 1977

A Section 401 Water Quality Certificate under the Clean Water Act of 1977 (PL 95-217), as amended, is required for the proposed project and will be obtained from the North Carolina Division of Water Quality prior to the start of construction. Work will not proceed until the certificate is received.

10.02.2 Section 404 of Clean Water Act of 1977

Pursuant to Section 404 of the Clean Water Act, the impacts associated with the discharge of fill material into waters of the United States are discussed in the Section 404(b)(1) (P.L. 95-217) evaluation in Appendix G. Discharges associated with dredging in the offshore borrow areas are considered incidental to the dredging operation, and therefore, are not being considered as being a discharge addressed under the Section 404 (b)(1) Guidelines Analysis.

10.03 Marine, Protection, Research, and Sanctuaries Act

In 1972, Congress enacted the Marine Protection, Research and Sanctuaries Act (MPRSA), declaring that it is the policy of the United States to regulate the dumping of all types of materials into ocean waters. The Act is designed to prevent or strictly limit the dumping into ocean waters of any material, which would adversely affect human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities. The proposed shoreline protection project does not involve ocean disposal of dredged material. Therefore, the project is considered to be in compliance with the requirements of the MPRSA.

10.04 Essential Fish Habitat

Potential project impacts on Essential Fish Habitat species and their habitats have been evaluated and are addressed in Section 8.01.8 of this document. It has been determined that the proposed action will not have a significant adverse effect on these resources. By coordination of this document with the National Marine Fisheries Service, consultation is officially initiated and concurrence with our findings is requested. Compliance obligations

related to Essential Fish Habitat provisions of the 1996 Congressional amendments to the Magnuson-Stevens Fishery Conservation and Management Act (PL 94-265) will be fulfilled prior to initiation of the proposed action.

10.05 Fish and Wildlife Resources

The Fish and Wildlife Coordination Act, as amended (16 U.S.C. 661, et seq), requires that the Corps of Engineers coordinate and obtain comments from the USFWS, the National Marine Fisheries Service, where applicable, and appropriate state fish and wildlife agencies, including the North Carolina Division of Marine Fisheries and the North Carolina Wildlife Resources Commission. A Draft Fish and Wildlife Coordination Act Report (Appendix L) has been provided by the USFWS under the Fish and Wildlife Coordination Act.

10.06 Endangered and Threatened Species

A biological assessment evaluating the potential impacts of the proposed action on endangered and threatened species has been prepared (Appendix I) and is being coordinated with the USFWS (jurisdiction over the Florida manatee, nesting sea turtles, piping plovers, and seabeach amaranth) and NMFS (jurisdiction over other protected marine and aquatic species which may occur in the project vicinity) pursuant to Section 7 of the Endangered Species Act of 1973 (PL 93-205), as amended. All compliance obligations under Section 7 will be satisfied prior to implementation of the proposed action.

10.06.1 Commitments to Reduce Impacts to Listed Species

The following list is a summary of environmental commitments to protect listed species related to the construction and maintenance of the proposed project. These commitments address agreements with agencies, mitigation measures, and construction practices and should be considered preliminary. The list of commitments may be modified pending new information acquired through the public and agency review process.

1. The Corps will strictly adhere to all conditions outlined in the most current National Marine Fisheries Service RBO for dredging of channels and borrow areas in the southeastern United States. Furthermore, as a component of this project, hopper dredging activities for both initial construction and each nourishment interval will adhere, to the maximum extent practicable, to a dredging window of 1 December to 31 March in order to avoid periods of peak sea turtle abundance. The use of turtle deflecting dragheads, inflow and/or overflow screening, and NMFS certified turtle and whale observers will also be implemented.

2. In order to determine the potential taking of whales, turtles and other species by hopper dredges, NMFS certified observers will be on board during all hopper dredging activities. Recording and reporting procedures will be in accordance with the conditions of the current NMFS RBO.

3. The Corps will avoid the sea turtle nesting season during initial construction and each nourishment interval. If, due to unforeseen circumstances, construction extends into the nesting season, the Corps will implement a sea turtle nest monitoring and avoidance/relocation plan through coordination with USFWS and NCWRC.

4. Monitoring of sea turtle nesting activities in beach nourishment areas will be required to assess post nourishment nesting activity. This will include daily surveys beginning at sunrise from May 1 until September 15. Information on false crawl location, nest location, and hatching success of all nests will be recorded and provided to NCWRC.

5. The beach will be monitored for escarpment formation prior to each nesting season. Escarpments that are identified prior to and/or during the nesting season that interfere with sea turtle nesting (exceed 18 inches in height for a distance of 100 ft.) will be leveled. If it is determined that escarpment leveling is required during the nesting or hatching season, leveling actions should be directed by the USFWS

6. Only beach compatible sediment (i.e. in accordance with NC Sediment Criteria Rule Language) will be placed on the beach as a component of this project. Post nourishment beach compaction (hardness) will be evaluated by the Corps, in coordination with the NCWRC and USFWS, using qualitative assessment techniques to assure that impacts to nesting and incubating sea turtles are minimized and, if necessary, identify appropriate mitigation responses.

7. Local lighting ordinances will be encouraged to the maximum extent practicable in order to reduce lighting impacts to nesting females and hatchlings. The local sponsors will be encouraged to work with the USFWS, local monitoring groups, and other concerned organizations to develop the best plan for the Towns of Surf City and North Topsail Beach.

8. Throughout the duration of each nourishment event, both initial construction and periodic nourishment, the Contractor will be required to monitor for the presence of stranded sea turtles, live or dead. If a stranded sea turtle is identified, the Contractor will immediately notify the NCWRC of the stranding and implement the appropriate measures, as directed by the NCWRC. Construction activities will be modified appropriately as not to interfere with stranded animals, live or dead.

9. The Corps is interested in understanding the threshold of sediment color change and resultant heat conduction on impacting temperature dependent sex determination of sea turtles. The Corps will contribute funds for the NCWRC to continue its temperature studies in order to gather nest temperatures on nourished beaches throughout the state, including Topsail Island, in comparison to non-nourished native sediment temperatures. This data could be used to help develop management criteria for sediment color guidelines.

10. In order to assess the abundance of sea turtles, and potential risk of hopper dredge take, within the proposed borrow areas for this project, the Corps will participate in the NCWRC's current satellite telemetry efforts to track the distribution and habitat usage of sea turtles in NC offshore waters.

11. Monitoring for seabeach amaranth on Surf City and North Topsail Beaches will be implemented to assess the post nourishment presence of plants. This survey will broken down into survey reaches for each town in accordance with the designated USACE sea beach amaranth survey reaches from 1991-2008 in order to maintain consistent data and survey techniques over time and results will be provided to USFWS

12. The Corps will implement precautionary measures for avoiding impacts to manatees during construction activities as detailed in the "Guidelines for Avoiding Impacts to the West Indian Manatee in North Carolina Waters" established by the USFWS.

10.07 Cultural Resources

Significant impacts to known archaeological or historic resources are not anticipated due to the proposed work. Project-specific historic survey data have been coordinated with the NCSHPO, and concurrence has been obtained that the proposed action will not cause significant adverse impacts to submerged cultural resources.

The SHPO letter accepting the final report of investigations is dated March 1, 2005 and is included in Appendix H.

10.08 Executive Order 11988 (Flood Plain Management)

This Executive Order was enacted to avoid to the extent possible the long and short term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative. IWR Report 96-PS-1, FINAL REPORT: An Analysis of the U.S. Army Corps of Engineers Shore Protection Program, June 1996 states: "The presence of a Corps project has little effect on new housing production. The econometric results presented imply that general economic growth of inland communities is sufficient by itself to drive residential development of beachfront areas at a rapid pace. The statistical evidence indicates that the effect of the Corps on induced development is, at most, insignificant, compared to the general forces of economic growth which are stimulating development in these areas, many of which are induced through other municipal infrastructure developments such as roads, wastewater treatment facilities, etc. The results presented for beachfront housing price appreciation are consistent with the findings from the more general econometric model of real estate development in beachfront communities. The increasing demand for beachfront development can be directed related to the economic growth occurring in inland areas. There is no observable significant effect on the differential between price appreciation in inland and beachfront areas due to Corps activity. The housing price study could not demonstrate that Corps

shore protection projects influence development. Corps activity typically **follows** significant development." In fact, the requirements for Federal participation in coastal storm damage reduction projects essentially dictate that these projects be constructed along areas that have a high degree of development. Additionally, part of the conceptual framework of the Unified National Program for Floodplain Management consists of a series of strategies and tools that can be used to manage floodplains to reduce losses to both human and natural resources. As part of the broader, national vision of floodplain management, the Water Resources Council submitted the Unified National Program for Floodplain Management to the President in 1976. This report, which updated the 1966 Unified National Program for Managing Flood Losses, reflects a shift in focus from flood damage reduction to floodplain management. Through Executive Orders and Interagency Task Forces, the 1976 report was revised and strengthened during the 1980's and 1990's and continues to serve as the focus of the national need to evaluate flood damages within the context of floodplain management. In the 1994 Unified National Program Report, four strategies for managing floodplains wisely were developed (FEMA, 1994). One of the four strategies, which is also a purpose of EO11988, is to preserve and restore the natural resources and functions of floodplains. The 1994 report further identified beach nourishment and building sand dunes as tools to support this strategy. Clearly, beach nourishment has been accepted as a valuable tool in moderating flooding and protecting floodplains. Placement of beachfill will occur in the floodplain of area beaches. This placement will be conducted specifically for its beneficial effect in offsetting erosion and restoring damaged beaches, and is, therefore judged acceptable. The action is expected to have an insignificant effect on the floodplain, therefore, the proposed action is in compliance with the requirements of Executive Order 11988 and with State/local flood plain protection standards.

10.09 Executive Order 11990 (Protection of Wetlands)

Executive Order 11990 directs all Federal agencies to issue or amend existing procedures to ensure consideration of wetlands protection in decision making and to ensure the evaluation of the potential impacts of any new construction proposed in a wetland. The proposed action would not require filling any wetlands and would not produce significant changes in hydrology or salinity affecting wetlands. The proposed action is in compliance with Executive Order 11990.

10.10 Executive Order 13186 (Responsibilities of Federal Agencies to Protect Migratory Birds)

Executive Order 13186 directs departments and agencies to take certain actions to further implement the Migratory Bird Treaty Act (MBTA). Specifically, the Order directs Federal agencies, whose direct activities will likely result in the take of migratory birds, to develop and implement a Memorandum of Understanding (MOU) with the FWS that shall promote the conservation of bird populations. As discussed in Section 8.02.3, the proposed project would not adversely affect migratory birds and therefore, is in compliance with EO 13186.

10.11 Outer Continental Shelf Lands Act

The Outer Continental Shelf (OCS) law provides the Secretary of the Interior, on behalf of the Federal Government, with authority to manage the mineral resources, including oil and gas, on the OCS. The Minerals Management Service (MMS) Leasing Division is charged with environmentally responsible management of Federal Outer Continental Shelf (OCS) sand and gravel resources. The OCS is a zone that generally extends from 3 nautical miles seaward of the coastal State boundaries out to 200 nautical miles. Nine of the 16 potential borrow sites for the Surf City and North Topsail Beach project are located within the OCS. Public Law 102-426 (43 U.S.C. 1337(k)(2)), enacted 31 October 1994, gave MMS the authority to negotiate, on a noncompetitive basis, the rights to OCS sand, gravel, and shell resources for coastal storm damage reduction, beach or wetlands restoration projects, or for use in construction projects funded in whole or part by or authorized by the Federal government.

The MMS is a cooperating agency with the Corps of Engineers on this project (see correspondence in Appendix H) and coordination with MMS is ongoing. Pursuant to Public Law 103-426, which authorizes the Secretary of the Interior to negotiate agreements for the use of Outer Continental Shelf sand, gravel, and shell resources, any Federal agency which proposes to make use of sand, gravel and shell resources shall enter into a Memorandum of Agreement with the MMS concerning the potential use of those resources. Previous procedures for obtaining a non-competitive lease for OCS sand from the MMS included execution of a Memorandum of Agreement (MOA) between the MMS and the Corps of Engineers' district office making the request. Later in the process, the MMS would then complete a lease agreement with the local government entity receiving the sand. However, the MMS has changed that part of the procedure; instead of the two separate agreements, MMS now requires only one MOA signed by the local sponsor, the Corps, and the MMS. Under this new procedure, the three-party MOA becomes the lease instrument. It is developed as the required National Environmental Policy Act (NEPA) steps are completed and terms and conditions identified by the NEPA consultations with other agencies are incorporated into the MOA. The required MOA will be signed prior to commencement of construction. The MMS will not issue a lease until all applicable Federal requirements have been appropriately satisfied.

10.12 North Carolina Coastal Management Program

The proposed action will be conducted in the designated coastal zone of the State of North Carolina. Pursuant to the Federal Coastal Zone Management Act (CZMA) of 1972, as amended (PL 92-583), Federal activities are required to be consistent, to the maximum extent practicable, with the Federally approved coastal management program of the state in which their activities will occur. The components of the proposed action have been evaluated and determined to be consistent with the NC Coastal Management Program and local land use plans. Concurrence with this determination is being requested from the NC Division of Coastal Management.

10.12.1 Areas of Environmental Concern (15A NCAC 07H .0204)

The tentatively selected plan would take place in areas under the North Carolina Coastal Management Program designated as AEC (15A NCAC 07H). Specifically, the activities may affect the following AECS: Coastal Wetlands, Estuarine Waters, Public Trust Areas, Coastal Shorelines, and Ocean Hazard Areas. The following determination has been made regarding the consistency of the proposed project with the State's management objective for each AEC affected:

Coastal Wetlands. Coastal wetlands are defined as any salt marsh or other marsh subject to regular or occasional flooding by tides, including wind tides (whether or not the tide waters reach the marshland areas through natural or artificial watercourses), provided this shall not include hurricane or tropical storm tides. The highest priority of use shall be allocated to the conservation of existing coastal wetlands. Second priority of coastal wetland use shall be given to those types of development activities that require water access and cannot function elsewhere. Unacceptable land uses may include, but would not be limited to, the following examples: restaurants and businesses; residences, apartments, motels, hotels, and trailer parks; parking lots and private roads and highways; and factories. Examples of acceptable land uses may include utility easements, fishing piers, docks, and agricultural uses, such as farming and forestry drainage, as permitted under North Carolina's Dredge and Fill Act or other applicable laws. The management objective is to conserve and manage coastal wetlands so as to safeguard and perpetuate their biological, social, economic and esthetic values; to coordinate and establish a management system capable of conserving and utilizing coastal wetlands as a natural resource essential to the functioning of the entire estuarine system. No dredge pipelines would cross coastal wetlands during project construction or renourishment events, therefore no impacts would be incurred, making the project consistent with the management objective for this AEC.

Estuarine Waters. Estuarine waters are defined in G.S. 113A-113(b)(2) to include all the waters of the Atlantic Ocean within the boundary of North Carolina and all the waters of the bays, sounds, rivers and tributaries thereto seaward of the dividing line between coastal fishing waters and inland fishing waters. The highest priority of use shall be allocated to the conservation of estuarine waters and their vital components. Second priority of estuarine waters use shall be given to those types of development activities that require water access and use which cannot function elsewhere such as simple access channels; structures to reduce erosion; navigation channels; boat docks, marinas, piers, wharfs, and mooring pilings. The management objective is to conserve and manage the important features of estuarine waters so as to safeguard and perpetuate their biological, social, esthetic, and economic values; to coordinate and establish a management system capable of conserving and utilizing estuarine waters so as to maximize their benefits to man and the estuarine and ocean system. The tentatively selected plan would not involve estuarine waters and therefore will not be detrimental to estuarine waters.

Public Trust Areas. These areas include (1) waters of the Atlantic Ocean and the lands thereunder from the mean high water mark to the 3 nautical mile limit of state

jurisdiction, (2) all natural bodies of water subject to measurable lunar tides, and all lands thereunder, to the mean high water mark, and (3) all navigable natural bodies of water, and all lands thereunder, except privately owned lakes to which the public has no right of access. Acceptable uses include those that are consistent with protection of the public rights for navigation and recreation, as well as conservation and management to safeguard and perpetuate the biological, economic, and esthetic value of these areas. The management objective is to protect public rights for navigation and recreation and to conserve and manage the public trust areas so as to safeguard and perpetuate their biological, economic and esthetic value. Placement of beach compatible material on Surf City and North Topsail Beach will result in a wider, more stable beach, thus enhancing recreational opportunities, biological habitat and economic and esthetic values. For a more thorough discussion of project impacts, please see Section 8 Environmental Effects, of the DEIS, specifically Sections 8.05 Recreational and Esthetic Resources, 8.04 Socio-Economic Resources, 8.01 Marine Environment, and 8.02 Terrestrial Environment. The tentatively selected plan is an acceptable use within public trust areas and will not be detrimental to the biological and physical functions of Public Trust Areas.

Coastal Shorelines. The Coastal Shorelines category includes estuarine shorelines and public trust shorelines. Estuarine shorelines AEC are those non-ocean shorelines extending from the normal high water level or normal water level along the estuarine waters, estuaries, sounds, bays, fresh and brackish waters, and public trust areas. Acceptable uses shall be limited to those types of development activities that will not be detrimental to the public trust rights and the biological and physical functions of the estuarine and ocean system. The management objective is to ensure that shoreline development is compatible with both the dynamic nature of coastal shorelines as well as the values and the management objectives of the estuarine and ocean system. Other objectives are to conserve and manage the important natural features of the estuarine and ocean system so as to safeguard and perpetuate their biological, social, esthetic, and economic values; to coordinate and establish a management system capable of conserving and utilizing these shorelines so as to maximize their benefits to the estuarine and ocean system and the people of North Carolina. The tentatively selected plan would not involve estuarine shorelines and therefore will not be detrimental to these areas. Please see the paragraph above regarding Public Trust Areas and the references to pertinent sections of the DEIS for information regarding public trust shorelines. Additionally, as discussed in Appendix J (Cumulative Effects) of the DEIS, on a regional basis, renourishment projects add material to the longshore transport system, thus providing positive impacts. Although a regional sediment budget analysis has not been completed, it is expected that the proposed action and the combined effects of all other existing and proposed beach projects will have a minimal effect on shoreline and sand transport. Therefore, the proposed project would not be expected to negatively impact coastal shorelines.

Ocean Hazard Areas. These areas are considered natural hazard areas along the Atlantic Ocean shoreline where, because of their special vulnerability to erosion or other adverse effects of sand, winds, and water, uncontrolled or incompatible development could

unreasonably endanger life or property. Ocean hazard areas include beaches, frontal dunes, inlet lands, and other areas in which geologic, vegetative and soil conditions indicate a substantial possibility of excessive erosion or flood damage. The specific Ocean Hazard Areas and potential project impacts are described below.

Ocean Erodible Area. This is the area in which there exists a substantial possibility of excessive erosion and significant shoreline fluctuation. The seaward boundary of this area is the mean low water line. The landward extent of this area is determined as follows:

(a) a distance landward from the first line of stable natural vegetation to the recession line that would be established by multiplying the long-term annual erosion rate times 60, provided that, where there has been no long-term erosion or the rate is less than two feet per year, this distance shall be set at 120 feet landward from the first line of stable natural vegetation. For the purposes of this Rule, the erosion rates shall be the long-term average based on available historical data. The current long-term average erosion rate data for each segment of the North Carolina coast is depicted on maps entitled "Long Term Annual Shoreline Change Rates updated through 1998 and approved by the Coastal Resources Commission on January 29th, 2004 (except as such rates may be varied in individual contested cases, declaratory or interpretive rulings). Erosion rates are variable along Surf City and North Topsail Beach. See Appendix D (Figure D-5) for a comparison of the shoreline rate change, referenced above, to recently computed erosion rates at subject beaches.

(b) a distance landward from the recession line established in Sub-Item (1)(a), above, to the recession line that would be generated by a storm having a one percent chance of being equaled or exceeded in any given year.

Construction of the proposed beach template, which consists of 15-foot elevation dune (NGVD) and 50-foot wide berm, will result in a wider, more stable beach, thus providing significant benefits to the ocean erodible area. Beach-related work, including the discharge of dredged material, the associated temporary operation of heavy equipment, and placement of dredge pipeline, would not cause any significant adverse effects to the ocean erodible area.

High Hazard Flood Area. This is the area subject to high velocity waters (including, but not limited to, hurricane wave wash) in a storm having a one percent chance of being equaled or exceeded in any given year, as identified as zone V1-30 on the flood insurance rate maps of the Federal Insurance Administration, U.S. Department of Housing and Urban Development. Placement of beach nourishment on the beach would provide short-term protection benefits for high hazard flood areas.

Inlet Hazard Area. The inlet hazard areas are natural-hazard areas that are especially vulnerable to erosion, flooding and other adverse effects of sand, wind, and water because of their proximity to dynamic ocean inlets. This area shall extend landward from the mean low water line a distance sufficient to encompass that area within which the

inlet will, based on statistical analysis, migrate, and shall consider such factors as previous inlet territory, structurally weak areas near the inlet (such as an unusually narrow barrier island, an unusually long channel feeding the inlet, or an overwash area), and external influences such as jetties and channelization. In all cases, this area shall be an extension of the adjacent ocean erodible area and in no case shall the width of the inlet hazard area be less than the width of the adjacent ocean erodible area. While components of the proposed action may involve the movement of equipment across these areas, no construction or periodic nourishment activities are proposed for these areas, and no adverse impacts are anticipated.

10.12.2 Use Standards (15A NCAC 07H .0208)

Primary Nursery Areas. With the exception of navigation channels, these include most estuarine waters of the project vicinity, including those bounded by New River (north), Mason Inlet (south), AIWW (west), and the landward side of Topsail Island. Protection of juvenile fish is provided in these areas through prohibition of many commercial fishing activities, including the use of trawls, seines, dredges, or any mechanical methods of harvesting clams or oysters (http://www.ncfisheries.netirules.htm; 15 NC Administrative Code 3B .1405). Primary nursery Areas (Figure A-3) will not be directly impacted by this project. However, PNA's located adjacent to the project area may experience indirect and short-term elevated turbidity levels from the nourishment operation on the shoreface. These turbidity effects are dependent on the location of the outflow pipe and the direction of longshore and tidal currents. Considering these elevated turbidity levels will be short-term and within the range of elevated turbidity from natural storm events, the impacts to state-designated PNA's are insignificant (DEIS Section 8.01.8.7).

Outstanding Resource Waters. Waters of the AIWW from Daybeacon 17 (between Chadwick Bay and Alligator Bay) to Morris Landing (south of Spicer Bay) and waters of Topsail Sound southward from approximately New Topsail Inlet to Middle Sound are classified as "SA ORW" (Figure A-5). As stated above, waters in the vicinity of New Topsail and New River Inlets may experience temporary elevated turbidities over existing conditions during initial construction and renourishment. Monitoring studies done on the impacts of offshore dredging indicate that sediments suspended during offshore are generally localized and rapidly dissipate when dredging ceases (Naqvi and Pullen, 1982: Bowen and Marsh, 1988, and Van Dolah et al., 1992). Overall water quality impacts of the proposed action are expected to be short-term and minor. Living marine resources dependent upon good water quality should not experience significant adverse impacts due to water quality changes. Therefore, no impacts to ORW in the vicinity of the project, with the exception of minor, short-term impacts in the vicinity of New Topsail Inlet, would be expected. See Section 8.07.2 of the DEIS for more information on water quality.

Submerged Aquatic Vegetation (SAV). As depicted in the DEIS, Table 8.2, Categories of Essential Fish Habitat and Habitat Areas of Particular Concern in the

Project Vicinity and Potential Impacts, SAV does not occur in or near the project vicinity and would not be directly or indirectly impacted by the proposed project.

Please see section 10.12.8 for compliance with 15A NCAC 07H. 0208(b)(12) Submerged Lands Mining.

10.12.3 Shoreline Erosion Policies (15A NCAC 07 M .0202)

Pursuant to Section 5, Article 14 of the North Carolina Constitution, proposals for shoreline erosion response projects shall avoid losses to North Carolina's natural heritage. All means should be taken to identify and develop response measures that will not adversely affect estuarine and marine productivity. As discussed in detail in Section 8.01 Marine Environment and Appendix J Cumulative Effects of the DEIS, the project is not expected to result in adverse impacts to estuarine and marine productivity.

The public right to use and enjoy the ocean beaches must be protected. The protected uses include traditional recreational uses (such as walking, swimming, surf fishing, and sunbathing) as well as commercial fishing and emergency access for beach rescue services. The U.S. Army Corps of Engineers has several requirements that must be met in order to fully cost share in a coastal storm damage reduction project (see ER 1105-2-100 and ER 1165-2-130). One of these requirements is that the beaches must be available for public use. As described in ER 1165-2-130 (Federal Participation in Shore Protection, paragraph 6.h.) public use implies reasonable access and parking. The Corps' Wilmington District, additionally, has developed more specific public access and parking requirements for participation in coastal storm damage reduction projects within the District's boundaries of North Carolina and Virginia. Public Access and Parking is discussed in detail in Appendix O of the DEIS.

Erosion response measures designed to minimize the loss of private and public resources to erosion should be economically, socially, and environmentally justified. The DEIS demonstrates that the proposed coastal storm damage reduction project at Topsail Beach is economically, socially and environmentally justified. Pertinent sections of the DEIS include: Section 7.08 Economics of the Selected Plan, Section 8.00 Environmental Effects, Appendix B Economic Analyses, Appendix I Biological Assessment, and Appendix J Cumulative Effects.

The following are required with state involvement (funding or sponsorship) in beach restoration and sand renourishment projects: The entire restored portion of the beach shall be in permanent public ownership and it shall be a local government's responsibility to provide adequate parking, public access, and services for public recreational use of the restored beach. Public ownership of the shore in the Towns of Surf City and North Topsail Beach include dedicated roads and lands below mean high water (MHW) owned by the State of North Carolina. Other parcels are owned by the Towns of Surf City and North Topsail Beach, including Coastal Area Management Act (CAMA) public access points and the ends of all roads. The project area includes more than 500

parcels in Surf City and nearly 350 parcels in North Topsail Beach. The primary ownership of the oceanfront parcels is private, including two fishing piers. The entire restored portion of the beach is in public ownership. Other information related to ownership of the shoreline is contained in Appendix M - Real Estate. Parking, public access and services for the public recreational use of the restored beach are addressed in preceding paragraphs, above. Additionally, details are available in Appendix O of the DEIS.

10.12.4 Shorefront Access Policies (15A NCAC 07M .0300)

Pursuant to 15A NCAC 07M .0300, the public has traditionally and customarily had access to enjoy and freely use the ocean beaches and estuarine and public trust waters of the coastal region for recreational purposes and the State has a responsibility to provide continuous access to these resources. It is the policy of the State to foster, improve, enhance and ensure optimum access to the public beaches and waters of the 20-county coastal region. Access shall be consistent with rights of private property owners and the concurrent need to protect important coastal natural resources such as sand dunes and coastal marsh vegetation. Surf City and North Topsail Beach have many public ocean shoreline access sites from dedicated easements, town owned sites, and street rights of way. The availability of parking varies and includes dedicated parking lots at access sites and street right of way parking. As previously stated, the U.S. Army Corps of Engineers has several requirements that must be met in order to fully cost share in a coastal storm damage reduction project (see ER 1105-2-100 and ER 1165-2-130). ER1165-2-130 stipulates that in order to qualify for Federal cost sharing of Hurricane and Storm Damage Reduction projects, the local community must, at a minimum, provide public access every one half mile and parking with a one quarter mile radius of those access points. The Wilmington District has further established a minimum of ten public parking spaces be available within one-quarter mile of each required public access point (Appendix O of the DEIS).

10.12.5 Mitigation Policy (15A NCAC 07M .0701)

It is the policy of the State of North Carolina to require that adverse impacts to coastal lands and waters be mitigated or minimized through proper planning, site selection, compliance with standards for development, and creation or restoration of coastal resources. Coastal ecosystems shall be protected and maintained as complete and functional systems by mitigating the adverse impacts of development as much as feasible by enhancing, creating, or restoring areas with the goal of improving or maintaining ecosystem function and areal proportion. Section 7.03.6 Environmental Monitoring and Commitments of the DEIS, provides a brief summary of environmental commitments to protect listed species related to the construction and maintenance of the proposed project. Further information on the development and details of these commitments is contained in Appendix I, Biological Assessment. Additionally, recently, as a mitigation condition of the 401 water quality certificate for the Morehead City 933 project, the Corps participated in funding a study performed by Philip S. Kemp Jr., of the Carteret Community College, to investigate the feasibility of harvesting, holding, and culturing

Donax spp. for resource enhancement aquaculture. The Corps will consider providing funds to continue this type of data collection in order to develop management guidelines and effective measures to mitigate identified impacts to these resources. Such a funding action would be fully coordinated with all concerned agencies. The existing commitments with agencies and construction practices may be modified following public review of the EIS and resolution of comments received.

10.12.6 Coastal Water Quality Policies (15A NCAC 07M .0800)

Pursuant to 15A NCAC 07M.0800, no land or water use shall cause the degradation of water quality so as to impair traditional uses of the coastal waters. Protection of water quality and the management of development within the coastal area is the responsibility of many agencies. The general welfare and public interest require that all state, federal and local agencies coordinate their activities to ensure optimal water quality. Overall water quality impacts of the proposed action are expected to be short-term and minor. Living marine and estuarine resources dependent upon good water quality are not expected to experience significant adverse impacts due to water quality changes. A Section 401 Water Quality Certificate under the Clean Water Act of 1977 (PL 95-217), as amended, is required for the proposed project and will be requested from the North Carolina Division of Water Quality at the appropriate time. Project construction will not begin until a Water Quality Certification has been received. For a full discussion of water resources and potential project impacts, please see Sections 2.06 and Section 8.07 Water Resources, of the DEIS, which address hydrology, water quality and groundwater. Pursuant to Section 404 of the Clean Water Act, the impacts associated with the discharge of fill material into waters of the United States are discussed in the Section 404(b)(1) (P.L. 95-217) Guidelines Analysis in Appendix G. Discharges associated with dredging in the offshore borrow areas are considered incidental to the dredging operation, and therefore, are not being considered as being a discharge addressed under the Section 404 (b)(1) Guidelines Analysis. Pursuant to the Sedimentation Pollution Control Act of 1973, a State approved soil erosion and sedimentation control plan would be implemented during construction to minimize soil loss and erosion.

10.12.7 Policies On Beneficial Use And Availability Of Materials Resulting From The Excavation Or Maintenance Of Navigational Channels (15A NCAC 07M .1100)

It is the policy of the State of North Carolina that material resulting from the excavation or maintenance of navigation channels be used in a beneficial way wherever practicable. Policy statement .1102 (a) indicates that "clean, beach quality material dredged from navigation channels within the active nearshore, beach, or inlet shoal systems must not be removed permanently from the active nearshore, beach, or inlet shoal system unless no practicable alternative exists. Preferably, this dredged material will be disposed of on the ocean beach or shallow active nearshore area where environmentally acceptable and compatible with other uses of the beach." Several navigation channels are within the Surf City and North Topsail Beach project vicinity. They are the Atlantic Intracoastal Waterway (AIWW), New Topsail Inlet and Connecting Channels and New River Inlet.

When practicable, beach compatible, maintenance dredged material from these navigation channels may be placed on the nourished beach. However, due to the distances from the navigation channels to the nourished beach this would rarely, if ever, be practicable. Any dredged material from navigation channels would be purely supplemental material that would help maintain the project profile.

10.12.8 Policies on Ocean Mining (15A NCAC 07M .1200) and 15A NCAC 07H. 0208(b)(12) Submerged Lands Mining

Mining activities impacting the federal jurisdiction ocean and its resources can, and probably would, also impact the state jurisdictional ocean and estuarine systems and vice-versa. Therefore, it is state policy that every avenue and opportunity to protect the physical ocean environment and its resources as an integrated and interrelated system will be utilized. Cultural resources and hardbottom surveys of the offshore borrow areas have been completed. No single, isolated magnetic anomalies or acoustic targets were identified during the survey of the borrow areas and no further cultural resources studies are anticipated for the project. By letter of November 2, 2004, the North Carolina State Historic Preservation Officer concurred with the reported findings. As identified through the myriad of investigative studies discussed in Section 8.01.8.2 to identify and avoid nearshore and offshore hard bottom resources, the Corps has demonstrated a commitment to avoidance and minimization of impacts to hard bottom communities. No dredging activities will occur in or near hard bottom communities. Refer to Section 8.01.8.2 for the full discussion of impacts to hard bottoms.

Dredging impacts to the benthic populations of the marine ecosystem from turbidity are local and temporary but not permanent. Similarly, recent studies show that benthic impacts may be limited to the immediate vicinity of dredging operations. Also, to minimize impacts work will be performed between 1 December and 31 March of any given year, during times of low biological activity. Refer to Sections 8.01.6 and 8.01.7 for the full discussion of benthic impacts. Considering that: (1) no cultural resources sites are present in the area, (2) no hardbottoms are in or near the proposed offshore disposal sites, and (3) the effects of turbidity and sedimentation plumes on offshore hardbottom will be insignificant, the project is not expected to adversely impact the state jurisdictional ocean and estuarine systems. Please refer to the following sections of the DEIS for more detailed information: Section 2.01 Marine Environment, 2.05 Cultural Resources, 7.04.1 Borrow Area Use Plan, 8.01 Marine Environment, 8.06 Cultural Resources, Appendix I Biological Assessment, and Appendix J Cumulative Effects.

The proposed coastal storm damage reduction project at Surf City and North Topsail Beach conforms to the relevant enforceable policies of Subchapters 7H and 7M of Title 15A of North Carolina's Administrative Code.

10.12.9 Other State Policies

The proposed project has been determined to be consistent with other state policies found in the State's Coastal Management Program document that are applicable. These include:

North Carolina Mining Act. The removal of material from the offshore borrow areas that are within 3 nautical miles of shore have been reviewed by the North Carolina Division of Land Resources and a determination has been made that removal of sand from the sea floor within the three miles territorial limits is not an activity that would be classified as mining under the North Carolina Mining Act (G. S. 74-7). "Mining" is defined as:

(a) The breaking of the surface soil in order to facilitate or accomplish the extraction or removal of mineral, ores, or other solid matter.
(b) Any activity or process constituting all or part of a process for the extraction or removal of minerals, ores, soils, and other solid matter from their original location.
(c) The preparation, washing, cleaning, or other treatment of minerals, ores, or other solid matter so as to make them suitable for commercial, industrial, or construction use.

North Carolina Dredge and Fill Law (G.S. 113-229). Pursuant to the North Carolina Dredge and Fill Law clean, beach quality material dredged from navigational channels within the active nearshore, beach or inlet shoal systems shall not be removed permanently from the active nearshore, beach or inlet shoal system. This dredged material shall be disposed of on the ocean beach or shallow active nearshore area where it is environmentally acceptable and compatible with other uses of the beach. As discussed in Section 10.12.7, when practicable, clean, beach quality material from maintenance dredging of navigation channels may be placed on the nourished beach at Surf City and North Topsail Beach. Any dredged material from navigation channels would be purely supplemental material that would help maintain the project profile.

Clean Water Act. A Section 401 Water Quality Certificate under the Clean Water Act of 1977 (PL 95-217), as amended, is required for the proposed project and will be requested from the North Carolina Division of Water Quality. Work will not proceed until the 401 Certification is received.

Pursuant to Section 404 of the Clean Water Act, the impacts associated with the discharge of fill material into waters of the United States are discussed in the Section 404(b)(1) (P.L. 95-217) Guidelines Analysis in Appendix G of the DEIS. Discharges associated with dredging in the offshore borrow areas are considered incidental to the dredging operation, and therefore, are not being considered as being a discharge addressed under the Section 404 (b)(1) Guidelines Analysis.

Sedimentation and Erosion Control. Pursuant to the Sedimentation Pollution Control Act of 1973, a State approved soil erosion and sedimentation control plan would be implemented during construction to minimize soil loss and erosion.

10.12.10 Local Land Use Plans

Compliance with all applicable CAMA Land Use Plans is discussed below.

Based on the information contained in the 1991 Pender County Land Use Plan Update, ocean beaches and shorelines are valuable for public and private recreation and are located within natural hazard areas. Pender County's overall policy and management objective for the estuarine system is to "give the highest priority to their protection to perpetuate their biological, social, economic, and esthetic values to ensure that development occurring within these AEC's is compatible with natural characteristics so as to minimize the likelihood of significant loss of private property and public resources." (15 NCAC 07H .0203). Also, stated in the Pender County Land Use Plan, is "Beach nourishment projects are the responsibility of Surf City." With the exception of the Island Business District/Town Center, the shoreline at Surf City is zoned "Residential." According to the Town of Surf City Land Use Plan, dated 2005, the Town of Surf City is concerned about the long-term impacts of continuing erosion and believes that beach nourishment, followed by regular renourishment, is the best method of dealing with the problem of erosion.

The Onslow County Land Use Plan, dated 1997, states "Onslow County desires to minimize the hazards to life, health, public safety, and development within flood hazard areas." According to the Onslow County Land Use Plan and the 1996 Town of North Topsail Beach Land Use Plan, the shoreline at North Topsail Beach is classified as Urban Transition (UT). Most development within this classification consists of single and multi-family residences and special uses allowed by the North Topsail Beach zoning ordinance. The town of North Topsail Beach also supports beach renourishment projects and as stated in the 1996 LUP, "…the Town is currently investigating potential funding sources for beach renourishment projects."

The proposed coastal storm damage reduction project is sponsored by the Towns of Surf City and North Topsail Beach in conjunction with the Corps of Engineers. The project will result in a wider, more stable beach, thus enhancing the recreational opportunities, biological habitat, and economic and esthetic values of the beach. Therefore, the proposed project is consistent with all applicable CAMA Land Use Plans.

Based on the information presented within this draft Feasibility Report and EIS, the proposed project is consistent with the North Carolina Coastal Management Program. This determination is being provided to the State for its review and concurrence.

10.13 Coastal Barrier Resources Act

The Coastal Barrier Resources Act (CBRA) of 1982 (P.L. 97-348) prohibits expenditure of Federal funds for activities within the designated limits of the Coastal Barrier Resources System unless specifically exempted by Section 6 of the Act. As stated in that Section, Federal expenditures are allowable in association with maintenance of existing channel improvements, including disposal of dredged material related to such improvements. Designated maps showing all sites included in the system in North Carolina show Topsail Unit (L06) to be within the Coastal Barrier Resource System and protected under the Coastal Barrier Improvement Act of 1990 (USFWS 1990). This site is **not** included in the project area (Appendix A, Figure A-1) and would not be affected by the tentatively selected plan (Appendix A, Figure A-7).

10.14 Estuary Protection Act

The Estuary (Estuarine) Protection Act provides a means to protect, conserve, and restore estuaries in a manner that maintains balance between the need for natural resource protection and conservation and the need to develop estuarine areas to promote national growth. The act authorizes the Secretary of the Interior to work with the States and other Federal agencies in undertaking studies and inventories of estuaries of the United States. The proposed project would have minimal impact on the estuarine environment, as discussed in Section 8 of this report; therefore the project is in compliance with the Estuary Protection Act.

10.15 Sedimentation and Erosion Control

Pursuant to the Sedimentation Pollution Control Act of 1973, a State approved soil erosion and sedimentation control plan would be implemented during construction to minimize soil loss and erosion.

10.16 Prime and Unique Agriculture Land

According to the Soil Surveys for Pender County and Onslow Counties, North Carolina, the soils on the beach that may be impacted by the proposed project are not designated by the Natural Resource Conservation Service (NRCS) as prime or unique agriculture lands. No impacts to prime and unique agriculture lands will occur.

Table 10.1. The Relationship of the Proposed Action to Federal Laws and Policies. Items identified as being in "Full Compliance" assumes their compliance status upon completion of the NEPA process.

Title of Public Law	US CODE	Compliance Status
Abandoned Shipwreck Act of 1987	43 USC 2101	Full Compliance
American Indian Religious Freedom Act	42 USC 1996	Not Applicable
Agriculture and Food Act (Farmland Protection Policy Act) of 1981	7 USC 4201 et seq.	Not Applicable
American Folklife Preservation Act of 1976, As Amended	20 USC 2101	Not Applicable
Anadromous Fish Conservation Act of 1965, As Amended	16 USC 757 a et seq.	Full Compliance
Antiquities Act of 1906, As Amended	16 USC 431	Full Compliance
Archeological and Historic Preservation Act of 1974, As Amended	16 USC 469	Full Compliance
Archeological Resources Protection Act of 1979, As Amended	16 USC 470	Full Compliance
Bald Eagle Act of 1972	16 USC 668	Not Applicable
Buy American Act	41 USC 102	Full Compliance
Civil Rights Act of 1964 (Public Law 88-352)	6 USC 601	Full Compliance
Clean Air Act of 1972, As Amended	42 USC 7401 et seq.	Full Compliance
Clean Water Act of 1972, As Amended	33 USC 1251 et seq.	Full Compliance
Coastal Barrier Resources Act of 1982	16 USC 3501-3510	Full Compliance
Coastal Zone Management Act of 1972, As Amended	16 USC 1451 et seq.	Full Compliance
Comprehensive Environmental Response, Compensation and Liability Act of 1980	42 USC 9601	Not Applicable
Conservation of Forest Lands Act of 1960	16 USC 580 mn	Not Applicable
Contract Work Hours	40 USC 327	Full Compliance
Convict Labor	18 USC 4082	Full Compliance
Copeland Anti-Kickback	40 USC 276c	Full Compliance
Davis Bacon Act	40 USC 276	Full Compliance
Deepwater Port Act of 1974, As Amended	33 USC 1501	Not Applicable
Emergency Flood Control Funds Act of 1955, As Amended	33 USC 701m	Not Applicable
Emergency Wetlands Resources Act	16 USC 3901-3932	Full Compliance
Endangered Species Act of 1973	16 USC 1531	Full Compliance
Estuary Program Act of 1968	16 USC 1221 et seq.	Full Compliance
Equal Opportunity	42 USC 2000d	Full Compliance
Farmland Protection Policy Act	7 USC 4201 et seq.	Not Applicable
Federal Environmental Pesticide Act of 1972	7 USC 136 et seq.	Full Compliance
Federal Water Project Recreation Act of 1965, As Amended	16 USC 4601	Full Compliance
Fish and Wildlife Coordination Act of 1958, As Amended	16 USC 661	Full Compliance
Flood Control Act of 1944, As Amended, Section 4	16 USC 460b	Full Compliance
Food Security Act of 1985 (Swampbuster)	16 USC 3811 et seq.	Not Applicable
Hazardous Substance Response Revenue Act of 1980, As Amended	26 USC 4611	Not Applicable

Table 10.1 - continued. The Relationship of the Proposed Action to Federal Laws and Policies. Items identified as being in "Full Compliance" assumes their compliance status upon completion of the NEPA process.

Title of Public Law	US CODE	Compliance Status
Historic and Archeological Data Preservation	16 USC 469	Full Compliance
Historic Sites Act of 1935	16 USC 461	Full Compliance
Jones Act	46 USC 292	Full Compliance
Land and Water Conservation Fund Act of 1965	46 USC 4601	Not Applicable
Magnuson Fishery Conservation and Management Act	16 USC 1801	Full Compliance
Marine Protection, Research and Sanctuaries Act of 1972	33 USC 1401	Full Compliance
Migratory Bird Conservation Act of 1928, As Amended	16 USC 715	Full Compliance
Migratory Bird Treaty Act of 1918, As Amended	16 USC 703	Full Compliance
National Environmental Policy Act of 1969, As Amended	42 USC 4321 et seq.	Full Compliance
National Historic Preservation Act of 1966, As Amended	16 USC 470	Full Compliance
National Historic Preservation Act Amendments of 1980	16 USC 469a	Full Compliance
Native American Religious Freedom Act of 1978	42 USC 1996	Not Applicable
Native American Graves Protection and Repatriation Act	25 USC 3001	Full Compliance
Native American Religious Freedom Act of 1978	16 USC 469a	Not Applicable
National Trails System Act	16 USC 1241	Not Applicable
Noise Control Act of 1972, As Amended	42 USC 4901 et seq.	Full Compliance
Rehabilitation Act (1973)	29 USC 794	Full Compliance
Reservoir Salvage Act of 1960, As Amended	16 USC 469	Not Applicable
Resource Conservation and Recovery Act of 1976	42 USC 6901-6987	Not Applicable
River and Harbor Act of 1888, Sect 11	33 USC 608	Not Applicable
River and Harbor Act of 1899, Sections 9, 10, 13	33 USC 401-413	Full Compliance
River and Harbor and Flood Control Act of 1962, Section 207	16 USC 460	Not Applicable
River and Harbor and Flood Control Act of 1970, Sections 122, 209 and 216	33 USC 426 et seq.	Full Compliance
Safe Drinking Water Act of 1974, As Amended	42 USC 300f	Full Compliance
Shipping Act	46 USC 883	Full Compliance
Submerged Lands Act of 1953	43 USC 1301 et seq.	Full Compliance
Superfund Amendments and Reauthorization Act of 1986	42 USC 9601	Not Applicable
Surface Mining Control and Reclamation Act of 1977	30 USC 1201-1328	Not Applicable
Toxic Substances Control Act of 1976	15 USC 2601	Not Applicable
Uniform Relocation and Assistance and Real Property Acquisition Policies Act of 1970, As Amended	43 USC 4601 et seq.	Full Compliance
Utilization of Small Business	15 USC 631, 644	Full Compliance
Vietnam Veterans	38 USC 2012	Not Applicable

Table 10.1 - continued. The Relationship of the Proposed Action to Federal Laws and Policies. Items identified as being in "Full Compliance" assumes their compliance status upon completion of the NEPA process.

Title of Executive Order	Number of Executive Order	Compliance Status
Protection and Enhancement of Environmental Quality	11514/11991	Full Compliance
Protection and Enhancement of the Cultural Environment	11593	Full Compliance
Floodplain Management	11988	Full Compliance
Protection of Wetlands	11990	Full Compliance
Federal Compliance with Pollution Control Standards	12088	Full Compliance
Environmental Effects Abroad of Major Federal Actions	12114	Not Applicable
Offshore Oil Spill Pollution	12123	Full Compliance
Procurement Requirements and Policies for Federal Agencies for Ozone-Depleting Substances	12843	Full Compliance
Federal Compliance with Right-To-Know Laws and Pollution Prevention	12856	Full Compliance
Federal Actions to Address Environmental Justice and Minority and Low-Income Populations	12898	Full Compliance
Procurement Requirements and Policies for Federal Agencies for Ozone-Depleting Substances	12843	Full Compliance
Federal Compliance with Right-To-Know Laws and Pollution Prevention	12856	Full Compliance
Federal Actions to Address Environmental Justice and Minority and Low-Income Populations	12898	Full Compliance
Energy Efficiency and Water Conservation at Federal Facilities	12902	Full Compliance
Federal Acquisition and Community Right-To-Know	12969	Full Compliance
Protection Of Children from Environmental Health Risks and Safety Risks	13045	Full Compliance
Coral Reef Protection	13089	Full Compliance
Greening the Government through Waste Prevention, Recycling and Federal Acquisition	13101	Full Compliance
Invasive Species	13112	Full Compliance
Greening the Government Through Leadership in Environmental Management	13148	Full Compliance
Marine Protected Areas	13158	Full Compliance
Consultation and Coordination with Indian Tribal Governments	13175	Not Applicable
Responsibilities of Federal Agencies to Protect Migratory Birds	13186	Full Compliance
Executive Order Facilitation of Cooperative Conservation	13352	Full Compliance

11. SUMMARY OF AGENCY AND PUBLIC INVOLVEMENT

11.01 Scoping

On February 14, 2001, a scoping letter was sent to agencies, interest groups, and the public to request identification of significant resources and issues of concern. Eleven (11) letters of comment were received. The scoping letter, a list of respondents and comment letters appear in Appendix K. Comments received addressed various aspects of the project and generally (1) identified resource concerns or (2) other aspects of the project, such as alternatives analysis, dredging window, cumulative impact analysis, etc. needing to be thoroughly addressed. All comments received were considered during the continuation of project planning and design. Additional coordination has been conducted with representatives of the U. S. Fish and Wildlife Service, National Marine Fisheries Service, North Carolina Department of Archives and History, North Carolina Wildlife Resources Commission and the Mineral Management Service.

11.02 Fish & Wildlife Coordination

The Fish and Wildlife Coordination Act, as amended (16 U.S.C. 661, et seq), requires that the Corps of Engineers coordinate and obtain comments from the USFWS, the National Marine Fisheries Service, where applicable, and appropriate state fish and wildlife agencies, including the North Carolina Division of Marine Fisheries and the North Carolina Wildlife Resources Commission. The USFWS provided a Planning Aid Report (PAR), dated September 9, 2003, which provided recommendations that have been considered during project development. Information regarding the components of the proposed action, potential alternatives, and related environmental issues has been coordinated with the USFWS, and their views are documented in a Draft Fish & Wildlife Coordination Act (FWCA) Report, dated June 2008 (Appendix L). Specific fish and wildlife recommendations and USACE responses are presented in the following paragraphs:

1. USFWS Recommendation: There should be a clear presentation of the federal interest in the project area. The discussion should distinguish between efforts to reduce damage during storms and efforts to replace land lost as rising sea level creates natural processes to move the island landward. There should be an acknowledgement that the ocean does not create permanent damage on the natural communities of barrier islands. What appears to be recession of the beach and dune results from the movement of some sand across the island to build up the natural communities on the sound side. Such movement is part of the natural, adaptive process of the island to sea level rise. The reduction in beach width is actually the result of the area being squeezed between the rising ocean and a fixed line of man-made structures. A clear presentation of the nature of the problem will provide the foundation for determining the federal interest and the development of alternatives.

Corps Response: Federal interest is demonstrated by the fact that this project has a favorable benefit to cost ratio and protects a public shoreline. The dune and berm project will reduce damages and prevent land losses due to both storm related, short term erosion and from long term erosion. In the without-project condition, erosion will continue to narrow the beach in front of existing structures, which will both reduce the suitability of the beach for recreation and for natural habitat. In addition, Topsail Beach is a fully developed barrier island, where sound-side deposition of sand by natural overwash processes is already severely restricted.

2. USFWS Recommendation: The efficacy of any program for replacing inundated beaches with imported fill material over 50 years will depend on global sea level rise during the period. Sea level rise along with more intense hurricanes will contribute to the destruction of a beach constructed, at least partially, in shallow ocean waters. Information from the Intergovernmental Panel on Climate Change (IPCC 2007) and analysis such as Rahrnstorf (2007) should be used in project planning.

Corps Response: The sea level rise value used in the Surf City and North Topsail Beach (SCNTB) analysis of 9.6 inches (0.8 feet) over the next 100 years is within the likely range of sea level rise reported for all but the most pessimistic scenario family presented in the IPCC 2007, Special Report on Emissions Scenarios (SRES), as shown below:

SRES Scenario Family	Likely Range of Sea Level Rise
Scenario B1 (most optimistic)	7 to 15 inches
Scenario A1T	8 to 18 inches
Scenario B2	8 to 17 inches
Scenario A1B	8 to 19 inches
Scenario A2	9 to 20 inches
Scenario A1FI (most pessimistic)	10 to 23 inches

Over the 50-yr project life, the difference between the SCNTB value and the average sea level rise values for each of the IPCC 2007 scenarios range from 0.7 to 3.45 inches, with all but the two most pessimistic scenarios being less than 2 inches difference. A tremendous amount of effort would be required to generate the revised storm responses for these relatively small differences in sea level. The computational precision, rounding, curve-fitting, built-in uncertainty, etc. that comprises the analysis could possibly mask much of the expected differences in outcome. Further, it is likely that the without-project condition (with its diminished dune and berm) is going to be more sensitive to sea level rise than the with-project condition will be, which will only increase the net benefits for the beachfill project.

3. USFWS Recommendation: The Corps is within the executive branch and is therefore required to comply with Executive Order (EO) 11988. This EO was enacted to avoid, to the extent possible, the long and short term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct or indirect support of

floodplain development wherever there is a practicable alternative (USACE 2006a, p. 118). Most of Topsail Island is in the IOO-year floodplain (Pilkey et al. 1998, p. 171) and most of the island would be largely underwater in a category one or two hurricane and nearly completely submerged in a category three hurricane (Pilkey et al. 1998, p. 173). Except for some dune areas, the entire Surf City-North Topsail Beach project area is subject to hurricane storm surge flooding (USACE 2006b, p. 9). These dangers are reflected in the fact that the northern portion of Topsail Island is included in the Coastal Barrier Resource System (CBRS). Areas included the CBRS were generally considered unsuitable for development because they are vulnerable to hurricanes and other storm damage and because natural shoreline recession and the movement of unstable sediments undermine manmade structures. The current project area was excluded from the CBRS because it was developed at the time of the legislation and not because the development was at less risk. The Corps should present a comprehensive discussion of the justification for any conclusion that the proposed beach construction is in compliance with the requirements of Executive Order 11988. Compliance with this EO should not be based on the high cost of removing the structures, but rather whether the presence of existing structures and the additional growth that would be supported by the federal action represents unwise development in a hazardous floodplain.

Corps Response: As discussed fully in Section 10.08, the project is in full compliance with Executive Order 11988.

4. USFWS Recommendation: The goal of reducing storm damage could be achieved with less environmental harm by using non-structural measures. However, the Draft GRR/EIS for West Onslow Beach determined (USACE 2006a, p. 54) that the non-structural plan was not economically feasible and was not fully evaluated for technical feasibility or acceptability. This decision was based on consideration of the costs of removing or relocating structures, but without any economic consideration of the economic benefits to be derived from the natural resources of the area. There was an assumption that a non-structural approach would continue to result in land losses (USACE 2006a, p. 59). Information presented in this report indicates that the non-structural approach, if implemented at all levels of government, would allow the formation of a wide, natural beach as the project adjusts its location landward. The remote, undisturbed beach which was recognized by the Corps (USACE 2006a, p. 59) as resulting from a no action approach in the area immediately south of the current project area would support tourism and provide significant economic benefits for the region. The Service recommends that the economic benefits of the nonstructural alternative receive greater consideration in the selection of the preferred course for federal action.

Corps Response: Further analysis of changes in recreation value of the nonstructural plan would most likely result in a negative value of recreational benefits, because there would be less lodging available for visitors. The B/C ratio of 0.92 was developed using the most optimistic assumptions.

5. USFWS Recommendation: If beach construction is ultimately undertaken, the fill material should have a high degree of compatibility with the native beach. The North Carolina Sediment Criteria Rule, contained in the Technical Standards for Beach Fill Projects (15A NCAC 07H .0312), should be used in regard to grain size and percent weight of calcium carbonate. In addition, compatibility should be established for other important characteristics such as organic content, heavy mineral content, and color.

Corps Response: The proposed borrow area sediments for this project will comply with grain size and percent weight requirements specified in 15A NCAC 07H .0312, Technical Standards for Beach Fill Projects. The Technical Standards require compatibility of the native beach with borrow sources in regards to the percentage of silt, granular sediment, gravel, and calcium carbonate (or shell content for projects initiated before implementation of the rules). However, there are no Federal or State requirements for compatibility in regards to organic content, heavy mineral content, or color. Therefore, a compatibility analysis for these items will not be conducted. The standards require that percent silt, granular sediment, and gravel in borrow material not exceed the amount found in the native beach plus 5% and the percent carbonate in borrow material not exceed the amount found in the native beach plus 15%. The silt, granular sediment, gravel content, and visual shell content for the Surf City/North Topsail Beach project are 1.2%, 1.1%, 0.5%, and 9% respectively. Incorporating the tolerance permitted by the beach fill standards results in the following criteria: silt (6.2%), granular sediment (6.1%), gravel (5.5%), and calcium carbonate (24%). Based on current vibracore data, borrow areas A, F, L, S, and P exceed the standards for various characteristics. However, during the plans and specs phase of this project additional borings and/or geophysical surveys will be performed to better delineate the borrow area boundaries and material types, with respect to the state sediment criteria rule, in order to assure compatibility of beach fill material prior to placement. Considering the inclusion of this additional analysis during plans and specs, these borrow areas have been retained for further characterization. Prior to initial construction and each nourishment event, all material dredged for placement on the beach will comply with the sediment criteria rule.

6. USFWS Recommendation: If beach construction is ultimately undertaken, there should be a plan to monitor the quality of the fill material as it placed on the beach. There should be an effective procedure for stopping operations if inappropriate material is being pumped onto the beach. Since such real time protective measures may not be completely effective, there should also be a plan for inspecting the constructed beach for areas of incompatible material and removing such material before the start of the nest sea turtle nesting season.

Corps Response: The Corps intends to perform rigorous boring analyses of proposed borrow areas in order to minimize the risk of placing incompatible material on the beach. Throughout the duration of construction operations, the Corps employs full time construction inspection personnel to perform on-sight inspections of the project operations to assure quality control and compliance with contract specifications. Furthermore, the Corps receives daily production reports from the contractor that provide detailed information pertaining to the Contractor's daily operations. All incompliance

issues pertaining to compatibility concerns identified in the on-sight inspections or the daily reports are immediately forwarded to the Corps environmental staff. Federal and state environmental agencies will be notified if, and how much, potentially incompatible material is encountered during dredging operations. If necessary, the Wilmington District will make the decision on a suitable contingency measure which may include moving the dredge to another site within the borrow area or to another borrow area, depending on availability of sediment, and will notify the agencies of this contingency measure. However, there is still a risk that some incompatible material is placed on the beach since real time protective measures are not 100% effective. Therefore, the Corps construction inspection personnel will inspect the beach for any significant amount of incompatible material within the project limits throughout the contract duration and if any incompatible material is identified within the constructed berm, the Corps will coordinate with the appropriate agencies to identify the quantity of material and discuss the methods of removal and disposal prior to the sea turtle nesting season.

7. USFWS Recommendation: Offshore sediment extraction and sediment disposal should be scheduled during the least sensitive period of the year for the organisms dependent on the habitats to be affected. Every effort should be made to complete all beach work, both actual placement and shaping, by the end of March for the benefit of important beach invertebrates and migratory shorebirds.

Corps Response: The proposed dredging window of 1 December through 31 March for initial construction and each nourishment event avoids the identified peak recruitment periods for surf zone fish (March through September (Hackney *et al*., 1996)) and invertebrate species (May through September (Hackney *et al*., 1996; Diaz, 1980; Reilly and Bellis, 1978)) in North Carolina. Beach nourishment will therefore be completed prior to the onshore recruitment of most surf zone fishes and invertebrate species. Furthermore, in order to complete the full initial construction template, while adhering to the 1 December to 31 March dredging window, the construction effort will occur over a four year time period. Therefore, the duration of each initial construction effort as well as each subsequent re-nourishment effort will be limited so that it does not preclude recruitment for any species during its entire recruitment period. Additionally, in accordance with recommendations provided by Hackney *et al.* (1996), the four initial construction events will occur in stages along the beach, with the full template being constructed for each stage, instead of the entire beach being impacted within each construction event. This approach would also increase the speed of recovery for impacted areas by allowing for recruitment from adjacent un-impacted areas of the beach.

8. USFWS Recommendation: The Corps should ensure that no offshore hardbottom habitats are affected by sedimentation produced by the project, either as a result of offshore dredging or sediment washing off the beach. This goal may be accomplished by actual surveys of the offshore sediment extraction sites. The use of video surveys of established transects which has been undertaken could be used to monitor the biological health of offshore borrow areas. A sufficient buffer should be required between the dredging operation and hardbottoms. At a minimum, sediment extraction should comply

with the North Carolina law (15A NCAC 07H. 0208(b)(12)(A)(iv)) requiring that mining of submerged land should not be conducted on or within 500 meters (1,640 feet) of significant biological communities, such as high relief hardbottom areas. Offshore hardbottoms that clearly show less biological significance could have reduced buffers provided that an adequate monitoring program is implemented. If the monitoring program indicates that offshore hardbottoms are being adversely affected, the project should include specific measures to mitigate any adverse impacts.

Corps Response: As discussed in Section 8.01.8.2, a myriad of nearshore and offshore investigations have been performed to assess the presence or absence of hard bottom within the proposed project area. Specifically, side scan sonar and multibeam surveys were performed within the nearshore environment (within the -30 ft. contour) and high resolution side scan sonar surveys were performed within all proposed borrow areas. Identified anomalies within the nearshore were groundtruthed using divers and video documentation to confirm the presence/absence of hardbottom. Based on ground truth results of in-situ dive efforts, no hardbottom was identified within the depth of closure limits for the project. Additional ground truth efforts were performed within select locations among the offshore borrow sites. Selected transects captured low, moderate, and high relief hard bottom areas as defined by the high resolution side scan imagery. Though hard bottom was documented at all but one transect, no high relief hard bottom was confirmed. Video surveys and benthic characterization assessments confirmed that the lower relief systems were adapted to high sedimentation conditions and reduced buffers would offer adequate protection. Based on the data collected from all of the investigative studies, the proposed project will adhere to the 500 m buffer requirement for moderate and high relief sites and will adhere to a 400 ft. buffer for identified low relief sits. In order to (1) assure that required buffer distances are adhered to, (2) avoid physical impacts to hard bottom resources, and (3) monitor the potential for leakage of sediment, the Corps will require all dredges to implement the Silent Inspector automated dredge plant monitoring system. In the event that a physical impact by the hopper dredge dragheads to previously unexposed hard bottom occurs, the incident will be thoroughly documented and coordinated with the appropriate state and federal resource agencies. Based on the outcome of this coordination, appropriate action will be taken to investigate and mitigate potential impacts.

Project monitoring of sedimentation impacts from dredging activities within the proposed 122 m (400 ft.) buffer will be implemented when appropriate. Sediment monitoring at select offshore transects, including controls, will occur before, during, and, if necessary, after construction and will include the installation of sediment traps (collectors) and *in-situ* sediment depth measurements. If sediment accumulation at the compliance transects is >10% of the sediment accumulated on average per day at the three control sites, then the Corps will direct the contractor to stop dredging operations within the 122 m (400 ft.) buffer and move to another area located 500 m (1640 ft.) from the identified hard bottom sites.

Based on the available information pertaining to the dredged sediments, hopper dredge overflow activities, and associated potential turbidity plumes, as well as the

implementation of a 122 m (400 ft.) to 500 m. (1640 ft.) buffer distance depending on relief, no significant impacts are expected from the sedimentation and turbidity associated with the proposed dredging activities. The potential impacts to the hard bottom communities are not expected to exceed the natural sedimentation and turbidity conditions of the project area. See Section 8.01.8.2 of the report for a thorough hard bottom impact evaluation.

9. USFWS Recommendation: While the use of highly compatible fill material would minimize turbidity and sedimentation due to runoff from the constructed beach, small inclusion of mud and silt pose a risk to nearshore hardbottoms. Project planning should establish a program to monitor the location, areal extent, and major organisms of nearshore hardbottoms prior to initial construction. If nearshore hardbottoms are present, these areas should be surveyed after initial construction to determine any adverse sedimentation and change in the biological community. If it appears likely that nearshore hardbottoms could be covered by sediment moving off the constructed beach, there should be a monitoring program to detect any overall loss of exposed hardbottoms and to develop and implement appropriate mitigation measures. Mitigation measures could include a reduction in the amount of beach fill near vulnerable hardbottoms.

Corps Response: See above response to USFWS recommendation #8. Based on data collected from nearshore side scan sonar, multibeam, and in-situ groundtruth surveys, no hard bottom was identified within the -30 ft. contour

10. USFWS Recommendation: Project plans should include measures to avoid adverse impacts associated with placement of the sediment pipeline and measures to monitor and mitigate any spills from the pipeline. During both initial construction and reconstruction events, the delivery pipeline should avoid areas where early shorebird reproductive activities may occur. Pipeline placement should avoid all hardbottom areas. There should be a plan to monitor pipelines for leaks and an established plan of action in the case a joint in the dredge pipe should break. This plan should describe measures to contain and clean the spill.

Corps Response: Dredging associated with this project will be accomplished using a hopper dredge. For beach nourishment projects, depending on the specific hopper dredge used, the average hopper load ranges between 6,000 CY and 12,000 CY. Upon completion of a full load, the hopper dredge will sail to a "pumpout" location just offshore of the beach. The hopper dredge will pump the material out of the hopper into a submerged pipeline which will approach the beach at a given area and extend to the placement area. Therefore, for hopper dredge pump-out operations, both submerged (in water) and exposed (on the beach) pipeline will transport the sediment to the placement area. For pipeline that is located on dry beach, the Contractor will be required to monitor the pipeline for leaks no less frequently than once every two hours. If a leak is detected, an assessment will be performed by the Contractor and the appropriate fix will be implemented to correct the problem. All pipeline inspections are logged and submitted daily to the Corps in order to document their completion.

For submerged pipeline, the Contractor will be required to traverse the pipeline via a boat to perform a visual assessment for indications of a pipe leak. In addition to visual surveys, Contractors can track pipe breaks or leaks using density gauges and meters on board the dredge. According to the standard contract specifications, any pipe leak in the water or on land is considered displaced material and its removal will be required based on an assessment of the severity of the situation. Upon completion of an assessment of the leak by the Contractor and the Corps and after coordinating the assessment with the appropriate agencies, a clean up measure will be implemented.

Bathymetric surveys, including side scan sonar and multibeam techniques, as well as diver ground truth surveys have been performed by the Corps throughout the nearshore (<-30 ft. NGVD) and have confirmed that no hard bottom communities are present within the -30 ft. contour offshore of the proposed project area. Furthermore, seismic profile coverage, vibracores, and diver surveys have provided information, between the active beach (-23 ft NGVD) and three-miles offshore of Surf City and North Topsail Beaches. Considering that hopper dredge pumpout stations will be located just offshore of the project area, existing bathymetric survey data collected by the Corps will be used to assure that submerged pipeline routes avoid hard bottom communities.

All staging areas, pipeline routes, and associated construction activities for the project will avoid high value piping plover and shorebird habitat, located within the vicinity of New River Inlet, to the maximum extent practicable.

11. USFWS Recommendation: The project should include an annual monitoring program on beach and subtidal invertebrates that form an important food resource for shorebirds and surf fishes. While other monitoring programs have been implemented in North Carolina, each project has unique features such as the sediment source and the responses of invertebrates at one location may not be application to each beach construction effort. The project should include a requirement for a pre-project assessment of beach invertebrate biomass and community composition, i.e., the number of species present. The program should have adequate control areas such as Hutaff Island, south of Topsail Island, or Bear Island, north o the project area. After construction, the Corps should monitor the recovery of intertidal and near shore invertebrate populations. If the assessments indicate a significant decline in either biomass or the number of species present when compared to control areas, there should be procedures in place to develop mitigation for this community. Data from these studies will be especially important if the reconstruction interval is reduced as sea level continues to rise. While the Corps predicted (USACE 2006a, p. 130) that benthic populations on West Onslow Beach may recovery within one to four years after large-scale sediment placement, a gradual reduction of the reconstruction interval could preclude adequate recovery and threaten these organisms which form an important base to the coastal food chain. The overall project plan should include funding for developing procedures to better understand mole crab and coquina clam life history requirements and developing effective measures to mitigate adverse impacts to these important resources.

Corps Response: Section 8.01.6 Benthic Resources – Beach and Surf Zone, addresses beach nourishment impacts to the benthic invertebrate community and discusses a thorough literature review indicating short term impacts to benthic invertebrate populations with recovery occurring between 1-4 years depending on sediment compatibility. For study sites where nourished sediments were compatible with the native beach, recovery occurred within 1-year. Several Corps contracts addressing beach nourishment impacts to benthic invertebrate populations have recently been completed or are ongoing throughout the North Carolina beaches including Bogue Banks, Brunswick Beaches, and Dare County. The data that that has come back from these studies continue to support the large historical database, which indicates an initial impact to the benthic invertebrate resource with recovery occurring immediately after nourishment when the sediment is compatible with the native beach. Furthermore, the Dare County Beaches coastal storm damage reduction project has a significant monitoring plan, which includes a pre- and post-construction benthic invertebrate assessment. Considering the large historical monitoring database, the consistency of the data from these studies, and the continuing monitoring studies that are underway on other beach projects in North Carolina, the Corps does not plan to collect additional monitoring data for Surf City and North Topsail Beaches. However, the Corps is encouraged by the Services recommendation to develop procedures to better understand benthic invertebrate life history requirements and the relationship these requirements have to beach activities. The opportunity to better understand the life cycle requirements of the benthic invertebrate community and the relationship to beach nourishment projects will allow for better management decisions to be made on future projects. The Corps recently participated in funding a study performed by Philip S. Kemp Jr., of the Carteret Community College, to investigate the feasibility of harvesting, holding, and culturing Donax spp. for resource enhancement aquaculture. The Corps is interested in putting together a work group, consisting of technical experts and resource agency representatives, to continue identifying study objectives that answer questions regarding critical life cycle requirements of benthic invertebrates. Additionally, the Corps will contribute funds to carry out subsequent scientific investigation in order to develop management guidelines and effective measures to mitigate identified impacts to these resources. Such a funding action would be fully coordinated with all concerned agencies.

12. USFWS Recommendation: A program for beach construction should include surveys for seabeach amaranth both before and for three years after sediment placement in order to avoid direct burial and to monitor recovery of the plant. If the seabeach amaranth surveys that have been conducted within the Town of Topsail Beach since 1992 (USACE 2006a, p. 1-16) do not extend into the current project area, this work should be extended to include the current sediment placement areas. With the proposed four-year reconstruction cycle, surveys for this endangered plant would be made every year. If data indicate a declining trend in the presence of this federally threatened species, the development of mitigation measures may be advisable. The project should also monitor beach vitex in the project as part of an effort to eradicate this harmful invasive foreign plant.

Corps Response: Monitoring for seabeach amaranth on Surf City and North Topsail Beaches will be performed by the Corps to assess the pre- and post-nourishment presence of plants. This survey will broken down into survey reaches for each town in accordance with the designated USACE sea beach amaranth survey reaches from 1991-2008 in order to maintain consistent data and survey techniques over time and results will be provided to USFWS. Beach vitex surveys are ancillary to seabeach amaranth surveys. Surveyors note the presence of beach vitex during amaranthus surveys and the data is provided to the USFWS, which in turn is shared with the Carolinas Beach Vitex Task Force.

13. USFWS Recommendation: Nesting by sea turtles will benefit from strict sediment compatibility standards and work schedules that avoid the nesting and hatching season (May 1 through November 15). Current plans for beach construction avoid sediment disposal during this period. However, artificial beaches pose a risk to sea turtle nesting due to: (1) sediment compaction; (2) escarpment formation; and, (3) altered sand temperature which may occur as a result of a change in sediment color. To mitigate sediment compaction, the Service recommends that compaction monitoring should occur after each construction event and for three subsequent years. Considering that reconstruction is scheduled for every four years, a sediment compaction survey should be made each year of the project. However, compaction monitoring would not be required if the sediment used to construct the beach is completely washed away. Beach tilling should only be performed as a result of an identified compaction problem and not performed routinely in place of compaction monitoring. Similarly, visual surveys for escarpments should be made along the constructed beach immediately after completion of the sediment placement and prior to May 1. Additional surveys should be made for three years following initial construction. As with compaction monitoring, escarpment survey should be made each year of the project. Survey results should be submitted to the Service prior to any action being taken. After discussion with the Service, escarpments that interfere with sea turtle nesting or exceed 18 inches in height for a distance of 100 feet should be leveled to the natural beach contour by May 1. The Service should be contacted immediately if new escarpments that interfere with sea turtle nesting or exceed 18 inches in height for a distance of 100 feet form during the nesting and hatching season to determine the appropriate action to be taken. If it is determined that escarpment leveling is required during the nesting or hatching season, the Service will provide a brief written authorization that describes methods to be used to reduce the likelihood of impacting existing nests. A program for detecting and securing appropriate care for stranded sea turtles should be part of the project.

Corps Response: The proposed dredging and beach nourishment schedule of 1 December through 31 March for both initial construction and each nourishment interval will avoid the sea turtle nesting season. Therefore, no direct impacts to nesting sea turtles or incubating hatchlings are expected. As identified in Section 4.00 "Commitments to reduce impacts to Listed Species" of the Biological Assessment, the Corps is committed to assessing post nourishment beach compaction, escarpment formation, and sea turtle nest temperature relative to sediment color. Sediment compaction may occur from the project and could impact the nesting environment of sea turtles. Though sediment placed on the beach will be compatible with the native

material, the risk of sediment compaction and subsequent impacts to the nesting environment of sea turtles still exists. The USFWS has traditionally provided guidelines for assessing beach compaction which include the use of a cone penetrometer instrument to assess compaction across 500-ft. spaced transects at varying stations and depths across the beach profile. A threshold value of 500 psi was used as an indicator for tilling requirements. Recent studies indicate that due to the variability of compaction measurement values among users (Piatkowski *et al*., 2001), among compaction instrumentation (Ferrell *et al*., 2001), as well as variability of compaction throughout a given beach (Davis *et a*l., 1999), care should be taken when performing quantitative assessments of sediment compaction. Based on the results and recommendations of these studies, the Wilmington District has modified its approach towards assessing beach compaction for nourishment and disposal projects and has been working with the NCWRC and the USFWS towards a more qualitative evaluation of post construction compaction conditions relative to native beach conditions. The results of this new coordinated process in evaluating post project beach compaction have been successful. Therefore, for initial construction and during each nourishment event, the Corps will work with the Towns of Surf City and North Topsail Beaches and the NCWRC to continue this new compaction assessment protocol, but will not adhere to the traditional USFWS compaction guidelines. Tilling will only be performed if deemed necessary by the technical staff of the NCWRC, USFWS, and USACE, based on compaction assessment results.

Additionally, the beach will be monitored for escarpment formation prior to each nesting season. If an escarpment exceeds 18 inches for a distance of 100 ft. during construction operations it will be leveled. Furthermore, if it is determined that escarpment leveling is required during the nesting or hatching season, the Towns or the Corps will coordinate with the USFWS to receive authorization that describes methods to be used to reduce the likelihood of impacting existing nests. Escarpment surveying and leveling will be performed by the Corps during initial construction and each nourishment interval and the Towns of Surf City and North Topsail Beaches will be responsible for surveys and, if necessary, leveling prior to the nesting season in the years between nourishment intervals.

The Corps is interested in understanding the threshold of sediment color change and resultant heat conduction on impacting temperature dependent sex determination of sea turtles. The Corps will contribute funds for the NCWRC to continue its temperature studies in order to gather nest temperatures on nourished beaches throughout the state, including Topsail Island, in comparison to non-nourished native sediment temperatures. This data could be used to help develop management criteria for sediment color guidelines.

Throughout the duration of each nourishment event, both initial construction and periodic nourishment, the Contractor will be required to monitor for the presence of stranded sea turtles, live or dead. If a stranded sea turtle is identified, the Contractor will immediately notify the NCWRC of the stranding and implement the appropriate measures as directed.

The Town of Topsail Beach is home to the Karen Beasley sea turtle hospital which has the facilities to provide care for stranded and injured sea turtles.

14. USFWS Recommendation: Piping plovers and other shorebirds are especially susceptible to human disturbance during territory establishment and early nesting attempts and after the chicks have hatched. Construction plans should determine whether any sections of the project area beaches are suitable nesting habitat for shorebirds and schedule work in such areas between December 1 and March 31.

Corps Response: The 1 December to 31 March construction window identified for this project will avoid disturbances to piping plovers and other shorebirds during territory establishment and early nesting attempts and after the chicks have hatched. Additionally, all staging areas, pipeline routes, and associated construction activities will avoid high value piping plover and shorebird habitat, located within the vicinity of New River Inlet, to the maximum extent practicable.

15. USFWS Recommendation: While the West Indian manatee is not likely to be in the project area during the proposed construction period, protective measures should be in place to safeguard this endangered species. Corps plans for the West Onslow Beach Project call (USACE 2006a, p. 1-12) for the implementation of the Service's "Precautions for General Construction in Areas Which May Be Used by the West Indian Manatee in North Carolina." These guidelines should provide adequate protection for this species.

Corps Response: The Corps will implement precautionary measures for avoiding impacts to manatees during construction activities as detailed in the "Guidelines for Avoiding Impacts to the West Indian Manatee in North Carolina Waters" established by the USFWS.

11.03 Coordination of this Document

This report is being provided to a standard list of Federal, State, and local agencies; elected officials; environmental groups; and interested individuals for a 45-day review and comment period.

We invite your comments and suggestions regarding the proposed action. In accordance with Council on Environmental Quality regulations (40 CFR 1500-1508) for implementing the National Environmental Policy Act (NEPA), your comments should be as specific as possible and should be made with recognition that NEPA documents must focus on the issues that are truly significant to the proposed action rather than amassing needless detail. The NEPA process is intended to help public officials make decisions based upon an understanding of environmental consequences. NEPA directs that Federal activities be conducted so as to attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable or unintended consequences. As individual resources and stakeholder interests increasingly compete for priority, public

officials are challenged to make management decisions that reflect a balance of the overall public interest. Please respond with a focus on essential issues that will be useful in guiding our decisions and actions as this project proceeds.

11.04 Recipients of this Document

(or Notice of Availability)

Federal Agencies

Advisory Council on Historic Preservation
Center for Disease Control and Prevention
Federal Emergency Management Administration
National Marine Fisheries Service, Southeastern Regional Office
National Marine Fisheries Service, Habitat Conservation Division, Beaufort Marine Fisheries Center, Beaufort, NC
National Park Service, Southeast Archeological Center
US Coast Guard, Fifth District, Portsmouth, Virginia
US Coast Guard, Marine Safety Office, Wilmington, NC
US Forest Service, Southern Region, Atlanta, GA
US Department of Agriculture, State and Area Conservationists, Natural Resources Conservation Service
US Department of Energy, Office of Environmental Compliance
US Department of Interior, Energy and Resources Division
US Department of Interior, Office of Environmental Policy and Compliance
US Department of Interior, Minerals Management Service, Herndon, VA
US Department of Housing and Urban Development, Greensboro, NC
US Department of Transportation, Federal Highway Administration, Raleigh, NC
US Environmental Protection Agency, Region 4, Atlanta, GA
US Environmental Protection Agency, Office of Federal Activities, Washington, D. C.
US Fish and Wildlife Service, Raleigh Field Office
US Marine Corps Base, Camp Lejeune, NC

State Agencies

NC Commission of Indian Affairs
NC Department of Environment and Natural Resources (NC State Clearinghouse)
NC Department of Transportation
NC Division of Coastal Management
NC Division of Marine Fisheries, Wilmington, NC
NC Division of Marine Fisheries, Shellfish Sanitation, Beaufort, NC
NC Department of Cultural Resources, Division of Archives and History
NC National Estuarine Research Reserve
NC Wildlife Resources Commission

Local Agencies

CAMA Officer, Surf City, NC
CAMA Officer, North Topsail Beach, NC
Cape Fear Council of Governments
North Topsail Beach Town Manager
Onslow County Emergency Services
Onslow County Board of Commissioners
Onslow County Planning & Development
Onslow County Manager
Onslow County Health Department
Pender County Board of Commissioners
Pender County Emergency Management
Pender County Manager
Pender County Planning Coordinator
Pender County Health Department
Sea Turtle Hospital, Topsail Beach
Surf City Town Manager
Topsail Beach Town Manager
Town of North Topsail Beach, NC
Town of Surf City
Town of Topsail Beach, NC

Elected Officials

Honorable Kay Hagan, US Senate
Honorable Richard Burr, US Senate
Honorable Walter B. Jones, US House of Representatives
Honorable Mike McIntyre, U.S. House of Representatives
Honorable Harry Brown, NC House of Representatives
Honorable George G. Cleveland, NC House of Representatives
Honorable Carolyn H. Justice, NC House of Representatives
Honorable R. C. Soles, Jr., North Carolina Senate
Honorable Russell E. Tucker, NC House of Representatives
Honorable Sandra Spaulding Hughes, NC House of Representatives
Pender County Board of Commissioners
Onslow County Board of Commissioners
Topsail Beach, Board of Commissioners

Conservation Groups

National Audubon Society
North Carolina Coastal Federation
North Carolina Coastal Land Trust
North Carolina Environmental Defense Fund

North Carolina Nature Conservancy
Pender Watch
Tar River Land Conservancy

Libraries, Museums, and News Media

NC Collection, Joyner Library, East Carolina University, Greenville, NC
Pender Chronicle
Jacksonville Daily News

Interested Businesses, Groups, and Individuals

Cape Fear Community College (Jason Rogers)
Duke University, Department of Department of Earth and Ocean Sciences(Geology), Dr. Orrin Pilkey
Land Management Group, Inc.
Mr. Ed Flynn
Mr. Glenn Hargett, Communications and Community Affairs Director, Jacksonville, NC
Mr. W. D. Aman, Sr.
Sea Turtle Hospital
UNC-Wilmington, Center for Marine Science (Troy Alphin)

12. CONCLUSIONS

The coastal storm problems and needs of the study area have been reviewed and evaluated with regard to the overall public interest and with consideration of engineering, economic, environmental, social, and cultural concerns. The conclusions of this study are as follows:

a. The Surf City and North Topsail Beach shorelines are susceptible to major damage and erosion from coastal storms.

b. The tentatively selected plan consist of a sand dune constructed to an elevation of 15 feet above the National Geodetic Vertical Datum (NGVD), fronted by a 50-foot wide beach berm constructed to an elevation of 7 feet above NGVD. The berm and dune project extends along a reach of 52,150 feet. On the north end, the project will adjoin an adjacent non-Federal beachfill project for North Topsail Beach. At the south end the project will transition into the Federal beachfill project for Topsail Beach. In the event there is no adjacent beachfill project, the plan would include a transition consisting of a tapered berm only, starting with a transition berm width of 200 feet that uniformly tapers to zero. If there is an adjacent beachfill project, any transition would be shorter and designed to fit the adjacent project.

c. The tentatively selected plan is feasible based on engineering and economic criteria and is acceptable by environmental, cultural, and social laws and standards.

d. The tentatively selected plan is supported by the non-Federal sponsor, the Towns of Surf City and North Topsail Beach. The sponsors have the capability to provide the necessary non-Federal requirements identified and described in report Section 9.02, Division of Plan Responsibilities.

13. RECOMMENDATIONS

This study has addressed the needs for coastal storm damage risk reduction for the portion of Topsail Island that includes the Towns of Surf City and North Topsail Beach. Other portions of Topsail Island have or will be addressed in separate reports. The following recommendations include items for implementation by Federal, State of North Carolina, and local governments and agencies, including the structural coastal storm damage reduction project.

Hurricane Risk Education

Numerous people die each year as a result of hurricanes, primarily due to the failure to evacuate to an area of safety. Any loss of life is tragic, and any number of those deaths may have been prevented. Even one death prevented is sufficient reason to improve our methods of educating the public on hurricane and storm threats, and to ensure that all is done to warn all those residents or visitors to the coastline of North Carolina as to the dual hazards of wind and surge/waves. It is particularly vital to inform the public as to the potential for hurricane occurrence, particularly within the dangerous hurricane season, so they pay continued attention to media reports on weather. Education needs to include articulation of effects related to the potential magnitude of the threat, the urgency to heed potential calls to evacuate, and providing the means by which to make wise choices on evacuation methods and route (see recommendations given below under "Hurricane Evacuation Planning"). The following are suggested guidelines for implementation by State and local government, in the interests of good education on hurricane storm threats:

- Provide good science and information to the residents and visitors to coastal North Carolina, so they can understand the nature of the threat, and its possibility of happening at any time within the hurricane season. This information should be provided in both written form, and as an initial "page" on televisions provided in visitor's housing, and also in a variety of venues, including:
    - Posting and televised education in supermarkets, libraries, and public buildings;
    - Teacher-provided, posted and televised education in schools and at public meetings and gatherings, at intervals not to exceed 1 year;
    - Publically-posted and visitor-housing-posted information on evacuation routes, and procedures, on publicly-accessible websites, updated regularly (minimum 1 yr.).

There is nothing humanly possible to maintain the lives and safety of coastal North Carolina residents and visitors, if they do not have sufficient warning, and if they then do not use that knowledge to evacuate in a timely manner.

Education of hurricane risks is an on-going effort of multiple agencies and educational institutions, and not a funded program under existing Corps authorities. Updating of websites containing evacuation routes and procedures should be done under existing programs implemented by the state and local governments.

Hurricane and Storm Warning

Residents and visitors to the coast of North Carolina need to recognize that they live in, or visit, a high-hazard area. Although certain times of the year pose less risk than others, each year's hurricane season provides a strong possibility of hurricane impact somewhere along the coast of North Carolina. All residents and visitors need to be made aware of the current hurricane threat, but first meteorological conditions must be evaluated, and any threat must be assessed and characterized by experts with the National Oceanic and Atmospheric Administration's National Weather Service, and that interpretation passed to national and local media for dissemination. Continued support of NOAA's program, and the following supportive activities is critical to an adequate warning process:

- On-going efforts to upgrade the existing system of NOAA buoys, transmission capabilities, and advanced warning measures that provide data on the location and nature of weather conditions.
- Efforts directed at the interpretation of that data and its dissemination to the media and public, through the National Weather Service.
- Public appreciation for the need to be aware at all times of, and the need to listen to weather reports and advice given on various media. Television weather reports, radio, and the internet all provide excellent up-to-date information on weather conditions, and the development of threatening situations. Simply living in or visiting the barrier islands of North Carolina should be sufficient to create a consistent and on-going process of being exceptionally aware of the weather, and its potential consequences.
- The vital importance of heeding the advice of experts. One should know what needs to be done in the event of an approaching storm. Family members should conduct evacuation drills, keep needed phone numbers and travel supplies on hand, and be prepared to leave on short notice. One should be aware of evacuation routes, keeping a full tank of gas during the hurricane season, and having a plan for where one should go, how to maintain contact with other family members, and where one will re-locate temporarily, particularly if this turns out to be longer than expected.

Hurricane Evacuation Planning Upgrading

The critical need for adequate evacuation planning was borne out by Hurricanes Bertha, Fran, and Floyd, of the late 1990's, and brought even more to the forefront by the monumental impacts of Hurricane Katrina in 2005. An evacuation plan is an essential component of a comprehensive plan for ensuring the safety of residents of, and visitors, to the coast of North Carolina. The preservation of life is the single most important goal and objective of the recommendations. Joint Federal Emergency Management Agency (FEMA)/ NOAA/Corps/State of North Carolina studies of evacuation routes and populations along the coastline has provided a tremendous amount of value to-date in aiding local government, individual and family readiness, in the face of approaching events. Support for this program is a critical element of the recommendations for the Towns of Surf City and North Topsail Beach, in support of its residents and visitors. The

following are important recommendations in support of efforts to support Hurricane Evacuation Planning:

- There is still much that can be done to update this on-going effort, and to provide new, and more widely-disseminated data and tools for evacuation planning by the State and the Towns of Surf City and North Topsail Beach, and also for use by individuals and families in their preparation for an impending event.
- Evacuation route signage is an important part of a successful evacuation campaign. Maintenance of hurricane evacuation route signage is viewed as a vital link in ensuring the safety of residents and visitors alike.
- The provision of additional signage illustrating surge height achieved during past events would be an added and continual link to on-going education efforts. This could take the form of signs placed in locations in which there is significant traffic, such as major thoroughfares, where pedestrians walk, and particularly in those highest hazard zones based on elevation/depth data.

Evacuation Planning is an on-going effort of multiple agencies, including the Corps of Engineers, but its implementation is not a funded program under existing Corps authorities. Updating of websites containing evacuation routes and procedures should be periodically updated under existing programs implemented by the State of North Carolina.

Floodplain Management

Management of the floodplain is a non-Federal responsibility, yet is considered a key component of all plans for hurricane and storm damage reduction. The Towns of Surf City and North Topsail Beach participate in the National Flood Insurance Program, which requires the Towns to engage in active and responsible floodplain management. Within the Towns of Surf City, property owners have 2,148 flood insurance policies comprised of nearly $480 million insurance in force. North Topsail Beach property owners possess 1,384 flood insurance policies providing approximately $240 million insurance in force. Since so much of the Towns of Surf City and North Topsail Beach are within a recognized floodplain, the Towns continue to engage in activities that reduce threats to existing and potential future development, including structure setbacks, building code and construction monitoring, and flood zone management. The Towns are encouraged to continue to update building codes, and encourage strong pursuit of activities such as first-floor elevation and building code upgrading, in the effort to reduce the potential for future structural and content damage.

Building Codes

The Towns of Surf City and North Topsail Beach have adopted the International Building Code (IBC) to guide the design and construction of residential and commercial structures in the study area. In order to assure that the latest design and construction techniques are being used that apply to hurricane-resistant construction, all future construction is encouraged to follow the latest version of the IBC (2007) and ensure enforcement of the codes through diligent building permit processing and on-site inspections of construction.

Annual training classes on the use and enforcement of the new IBC should be encouraged. In addition, the Towns of Surf City and North Topsail Beach should consider adopting the document "FEMA 550 Guidelines for Elevating Residential Structures on the Gulf Coast" as a part of their updated building codes for construction, due to the possibility of surge inundation associated with hurricane events.

Long-term Critical Infrastructure and Services Upgrading

The upgrading of critical infrastructure and services, such as Fire and Police services, is considered a vital recommendation in the reduction of threats to lives and property. The need to bring these services up to immediate restoration in the wake of a hurricane is of vital importance to the community. The methodical upgrading of the Towns' Fire and Police services facilities as past of their Capital Improvement Programs will provide long-term savings in capital outlay, and potentially save lives and residential and commercial property damage. This program may be instituted under a modified Capital Improvement Program, where structures reaching the end of their economic life are successively replaced by upgraded structures, locating vital communications and power supplies above the elevation of a Maximum Probable Surge event, and capable of surviving the ravages of wind and/or surge, as funds become available.

Upgrading or replacement of services is primarily a local charge, implemented through Capital Improvement Plans, with funding from a variety of Federal, State, and local resources, and will take many years to accomplish, due to the varying age and condition of each facility.

Structural Damage Reduction Features

Based on the conclusions of this study, I recommend the implementation of the tentatively selected plan, identified as Plan 1550, that consists of a 52,150-foot long dune system to be constructed to an elevation of 15 feet NGVD fronted by a 7-foot NGVD elevation, 50-foot wide beach berm, with such modifications thereof as in the discretion of the Commander, USACE, may be advisable, at an initial construction cost estimated at $118,000,000 (October 2008 price levels). The baseline cost estimate for construction in FY2015 is $126,000,000.

As a result of the Feasibility study and DEIS, I recommend that the project be authorized and implemented in accordance with the findings of this report.

I further recommend that construction of the proposed project be contingent on the project sponsor giving written assurances satisfactory to the Secretary of the Army that it will:

a. Provide 35 percent of initial project costs assigned to hurricane and storm damage reduction, plus 50 percent of initial project costs assigned to protecting

undeveloped public lands, plus 50 percent of initial project costs assigned to recreation, plus 100 percent of initial project costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits and 50 percent of periodic nourishment costs assigned to hurricane and storm damage reduction plus 100 percent of periodic nourishment costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits and as further specified below:

(1). Enter into an agreement which provides, prior to execution of the project cooperation agreement, 25 percent of design costs;

(2). Provide, during the first year of construction, any additional funds needed to cover the non-federal share of design costs;

(3). Provide all lands, easements, and rights-of-way, and perform or ensure the performance of all relocations determined by the Federal Government to be necessary for the initial construction, periodic nourishment, operation, and maintenance of the project;

(4). Provide, during construction, any additional amounts as are necessary to make its total contribution equal to 35 percent of initial project costs assigned to hurricane and storm damage reduction plus 100 percent of initial project costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits and 50 percent of periodic nourishment costs assigned to hurricane and storm damage reduction plus 100 percent of periodic nourishment costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits;

b. Operate, maintain, and repair the completed project, or functional portion of the project, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;

c. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal Sponsor, now or hereafter, owns or controls for access to the project for the purpose of inspecting, operating, maintaining, repairing, replacing, rehabilitating, or completing the project. No completion, operation, maintenance, repair, replacement, or rehabilitation by the Federal Government shall relieve the non-Federal Sponsor of responsibility to meet the non-Federal Sponsor's obligations, or to preclude the Federal Government from pursuing any other remedy at law or equity to ensure faithful performance;

d. Hold and save the United States free from all damages arising from the initial construction, periodic nourishment, operation, maintenance, repair, replacement,

and rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the United States or its contractors;

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

f. Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended, 42 U.S.C. 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for the initial construction, periodic nourishment, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal Sponsor with prior specific written direction, in which case the non-Federal Sponsor shall perform such investigations in accordance with such written direction;

g. Assume, as between the Federal Government and the non-Federal Sponsor, complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the initial construction, periodic nourishment, operation, or maintenance of the project;

h. Agree that, as between the Federal Government and the non-Federal Sponsor, the Non-Federal Sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, and repair the project in a manner that will not cause liability to arise under CERCLA;

i. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by (42 U.S.C. 4601 – 4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way, required for the initial construction, periodic nourishment, operation, and maintenance of the project, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

j. Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army," and all applicable Federal labor standards and requirements, including but not limited to, 40 U./S.C. 3141 – 3148 and 40 U.S.C. 3701 – 3708 (revising, codifying, and enacting without substantial change the provisions of the Davis- Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.) and the Copeland Anti-Kickback Act (formerly 40 U.S. C. 276c et seq.);

k. Comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12), which requires the non-Federal interest to participate in and comply with applicable Federal floodplain management and flood insurance programs, prepare a floodplain management plan within one year after the date of signing a Project Cooperation Agreement, and implement the plan not later than one year after completion of construction of the project;

l. Provide the non-Federal share of that portion of the costs of mitigation and data recovery activities associated with historic preservation, that are in excess of 1 percent of the total amount authorized to be appropriated for the project, in accordance with the cost sharing provisions of the agreement;

m. Participate in and comply with applicable Federal floodplain management and flood insurance programs;

n. Do not use Federal funds to meet the non-Federal sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized.

o. Prevent obstructions of or encroachment on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) which might reduce the level of protection it affords, hinder operation and maintenance or future periodic nourishment, or interfere with its proper function, such as any new developments on project lands or the addition of facilities which would degrade the benefits of the project;

p. Not less than once each year, inform affected interests of the extent of protection afforded by the project;

q. Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in preventing unwise future development in the floodplain, and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility with protection levels provided by the project;

r. For so long as the project remains authorized, the non-Federal Sponsor shall ensure continued conditions of public ownership, access, and use of the shore upon which the amount of Federal participation is based;

s. Provide and maintain necessary access roads, parking areas, and other public use facilities, open and available to all on equal terms;

t. At least twice annually and after storm events, perform surveillance of the beach to determine losses of nourishment material from the project design section and provide the results of such surveillance to the Federal Government; and

u. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5b), and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 22130, which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the Non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element.

The non-Federal sponsor has indicated that they have available the necessary funds to provide the non-Federal share of the project first costs and periodic renourishment costs. I am confident that the non-Federal sponsor will provide their share.

This recommendation is subject to the cost-sharing policies as outlined in this report and is endorsed, provided that, prior to construction, the non-Federal sponsor enters into a written PCA, as required by Section 221 of Public Law 91-611, as amended.

The recommendations contained herein reflect the information available at this time and current departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for implementation funding. However, prior to transmittal to the Congress, the sponsor, the States, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

The Administration's projections of future inflation are 1.8% percent annually. Based on these data, the total inflation adjusted (fully funded) project costs are estimated to be $552,000,000 over the 50-year period of Federal participation for the tentatively recommended plan of improvement. The Federal share of the fully funded project costs is currently estimated at $293,000,000. The non-Federal share of the fully funded costs is currently estimated at $259,000,000. Given the Administration's declared budgetary concerns, potential long-term costs associated with the proposed project may be vital to decision making. As previously indicated, the total project benefit-cost ratio is 3.7,

which means that for every dollar spent for the project there are 3 dollars and 70 cents realized in National Economic Development (NED) benefits from the project.

These recommendations comply with Section 215 of the Water Resources Development Act of 1999, which sets cost sharing for periodic renourishment at 50 per cent Federal and 50 per cent non-federal. In recent years the Federal share of periodic renourishment costs of new coastal storm damage reduction projects has been limited by the availability of funds. However, I recommend that this Feasibility Report be approved, as a basis for the initiation of construction of the project in the event that the Administration's budgetary policy changes.

Jefferson M. Ryscavage
Colonel, U. S. Army
District Commander

14. POINT OF CONTACT

Any comments or questions regarding this draft Feasibility Report and EIS should be addressed to Mr. Glenn McIntosh, Project Manager, U.S. Army Corps of Engineers, Post Office Box 1890, Wilmington, North Carolina 28402-1890, telephone (910) 251-4671.

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Draft Integrated
Feasibility Report
and
Environmental Impact Statement

on

Coastal Storm Damage Reduction

SURF CITY AND NORTH TOPSAIL BEACH, NORTH CAROLINA

Appendix A

Project Maps

Appendix A

Project Maps

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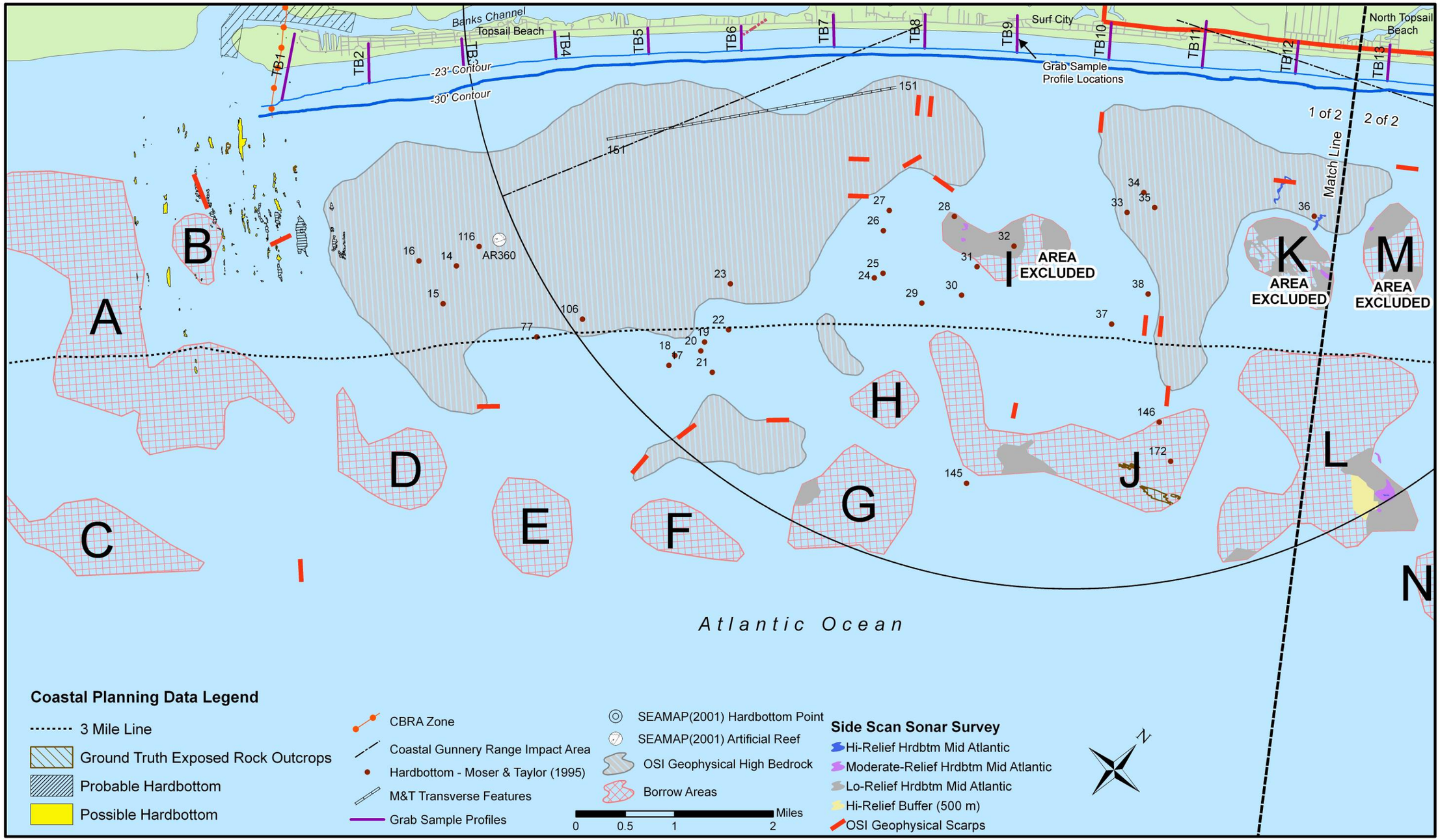
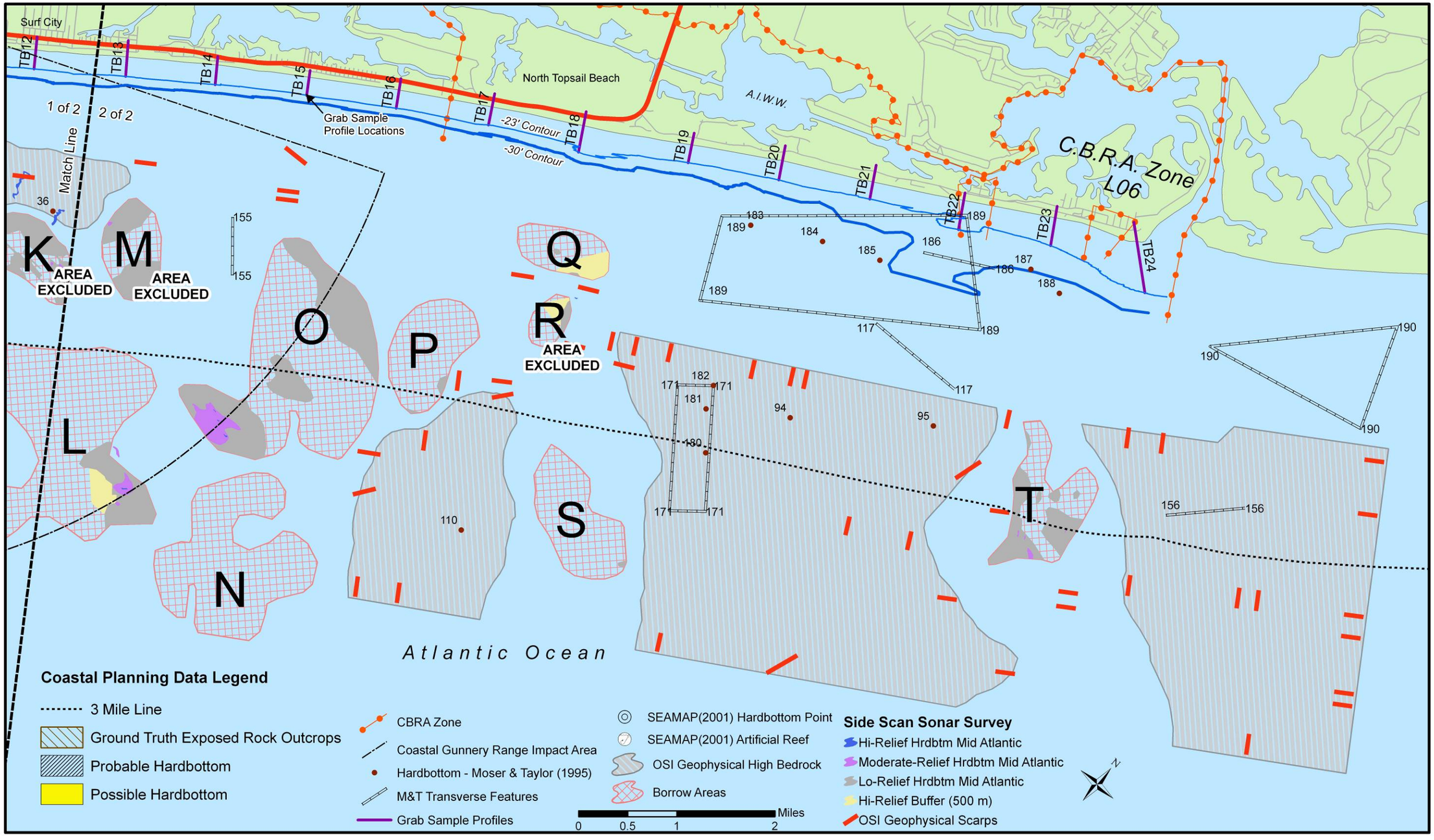


Figure A-1 Environmental Planning Considerations 1 of 2



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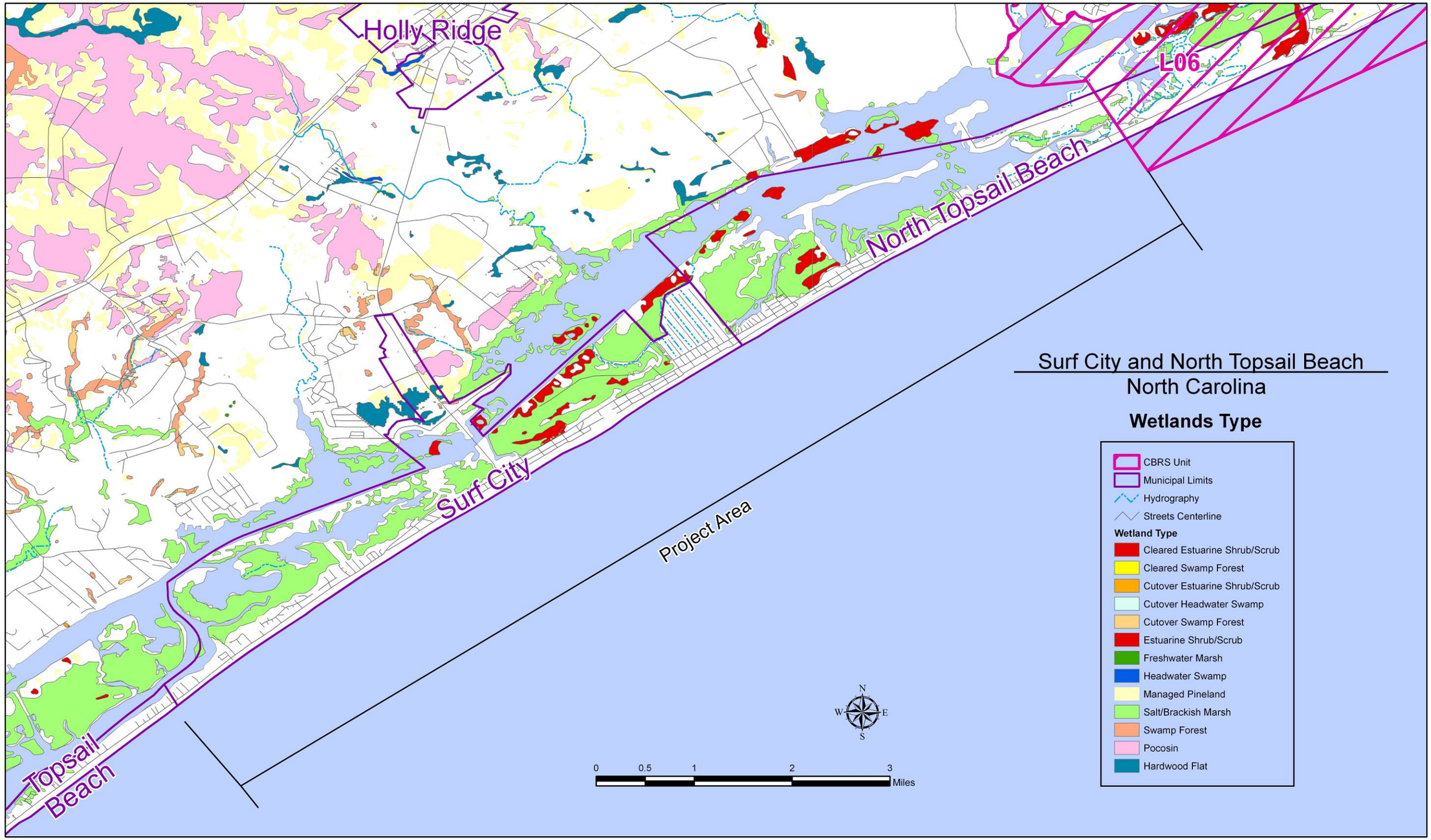

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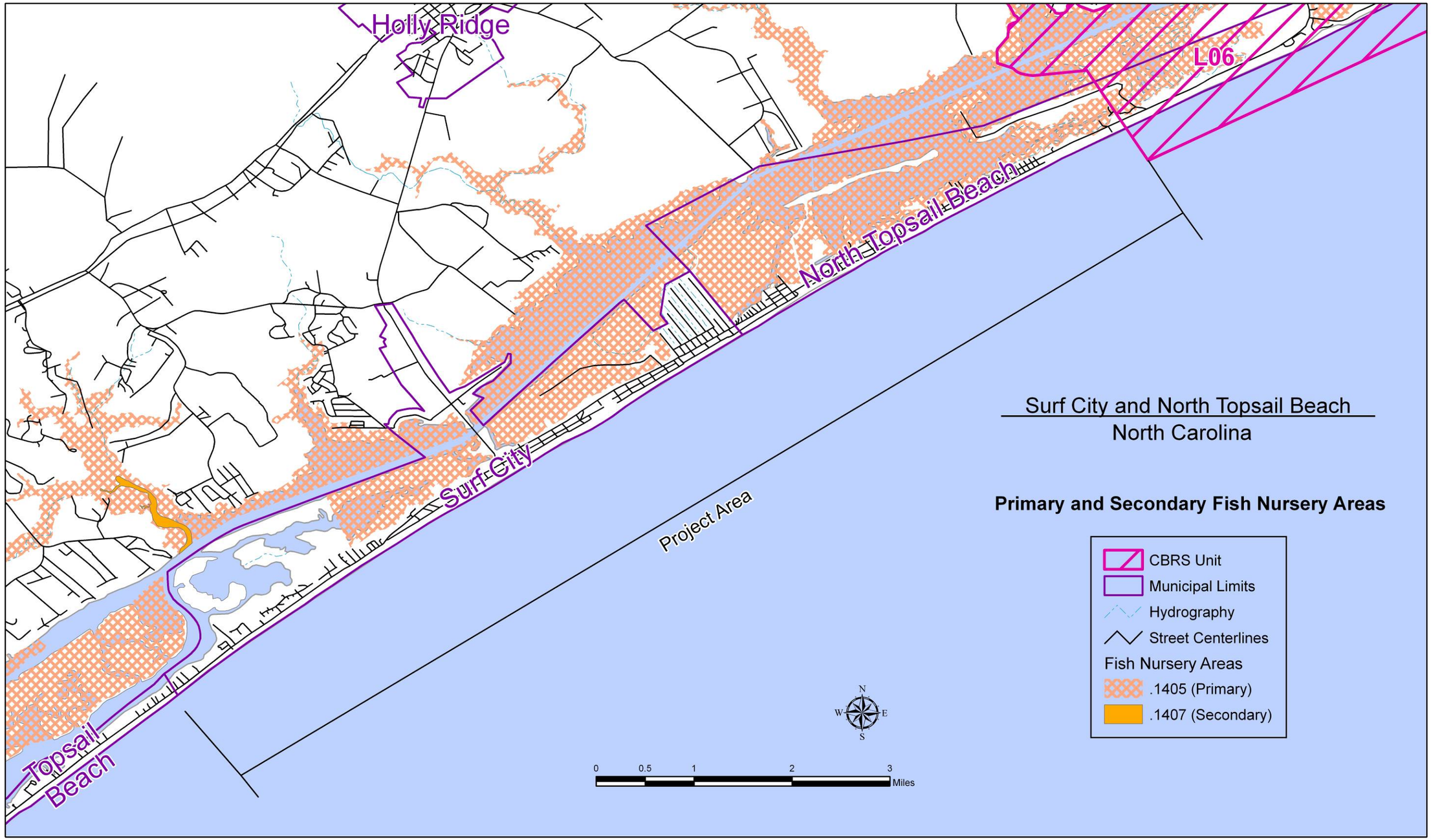
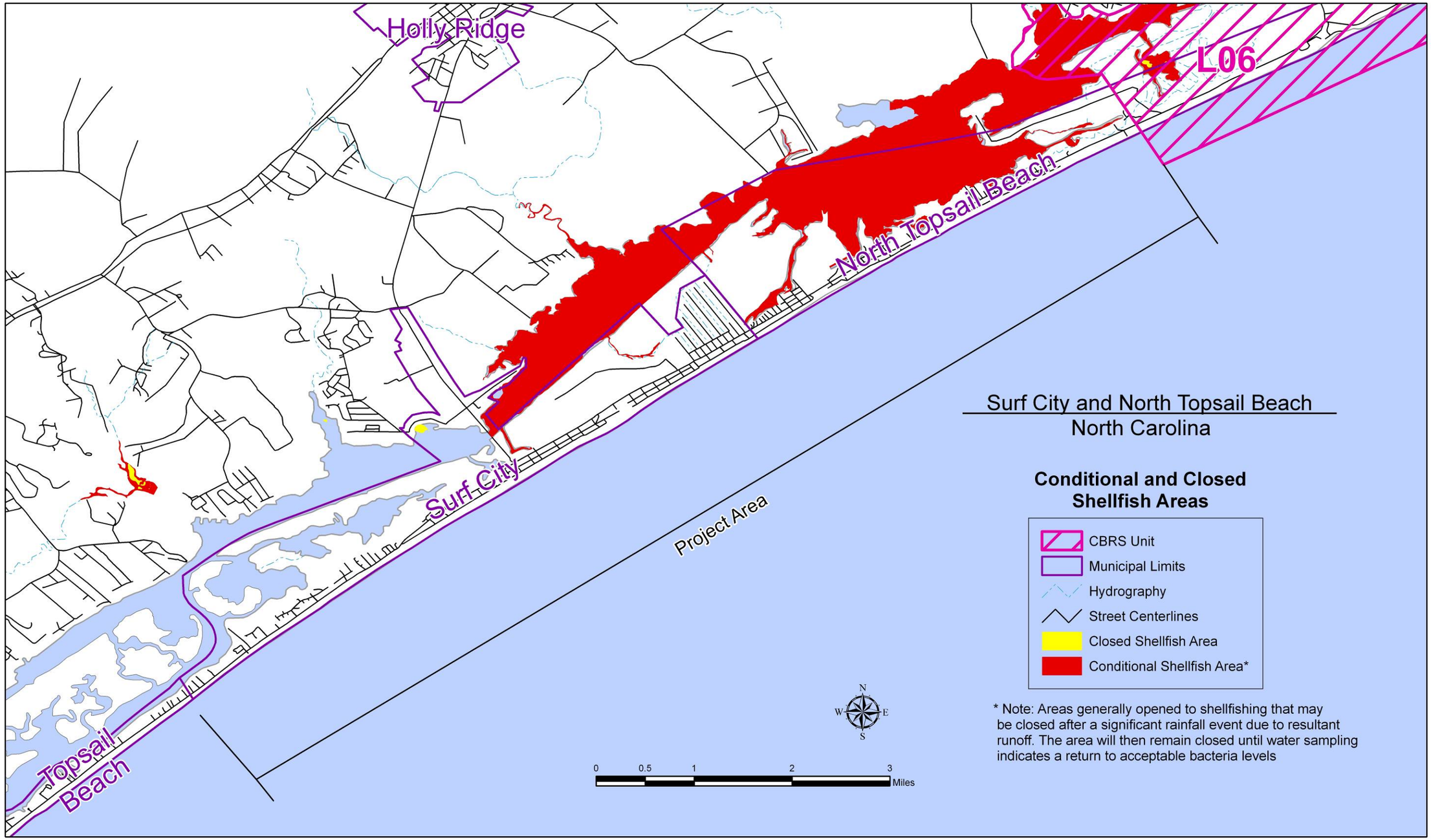


Figure A-3 Fish Nursery Areas



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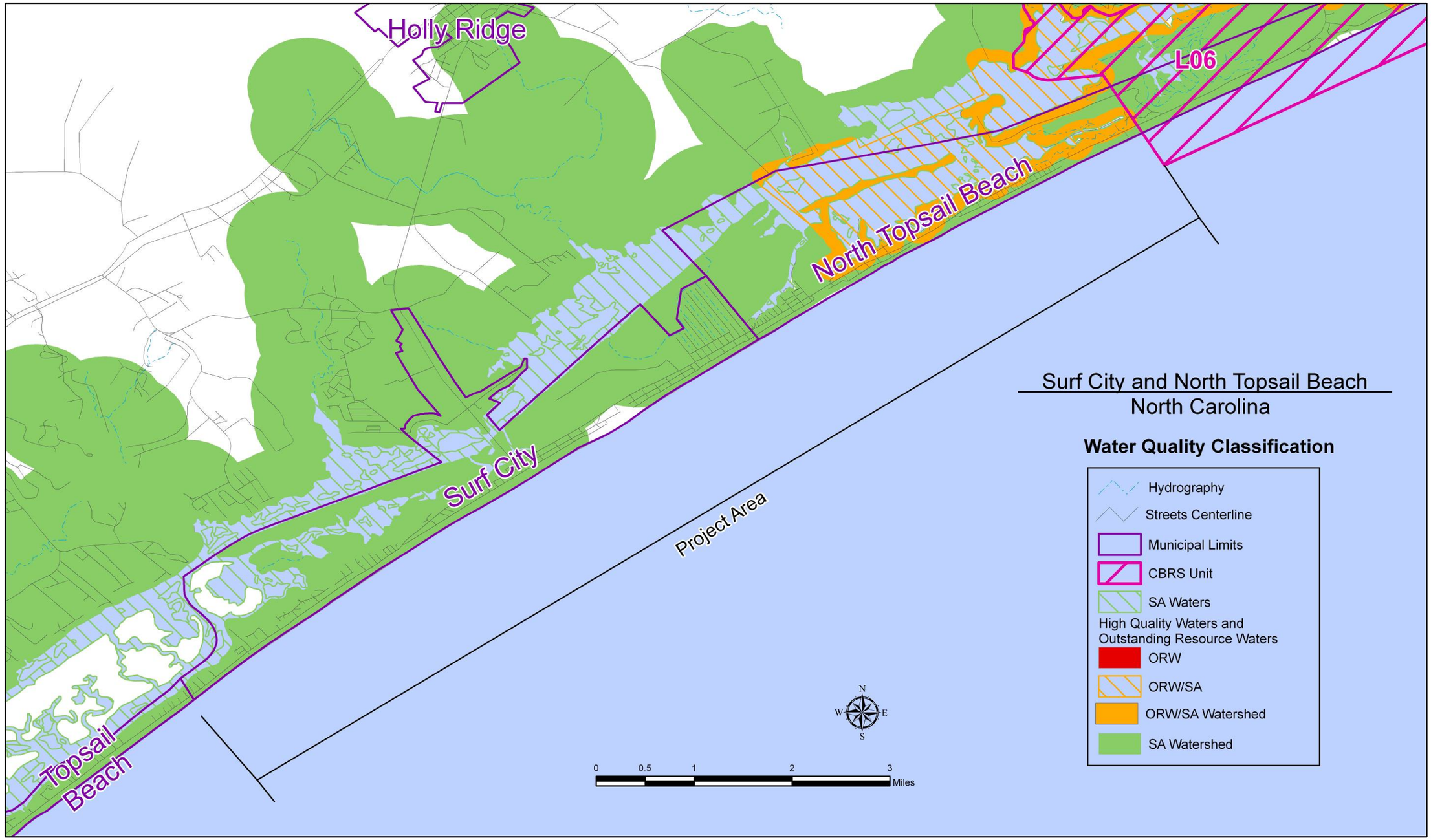

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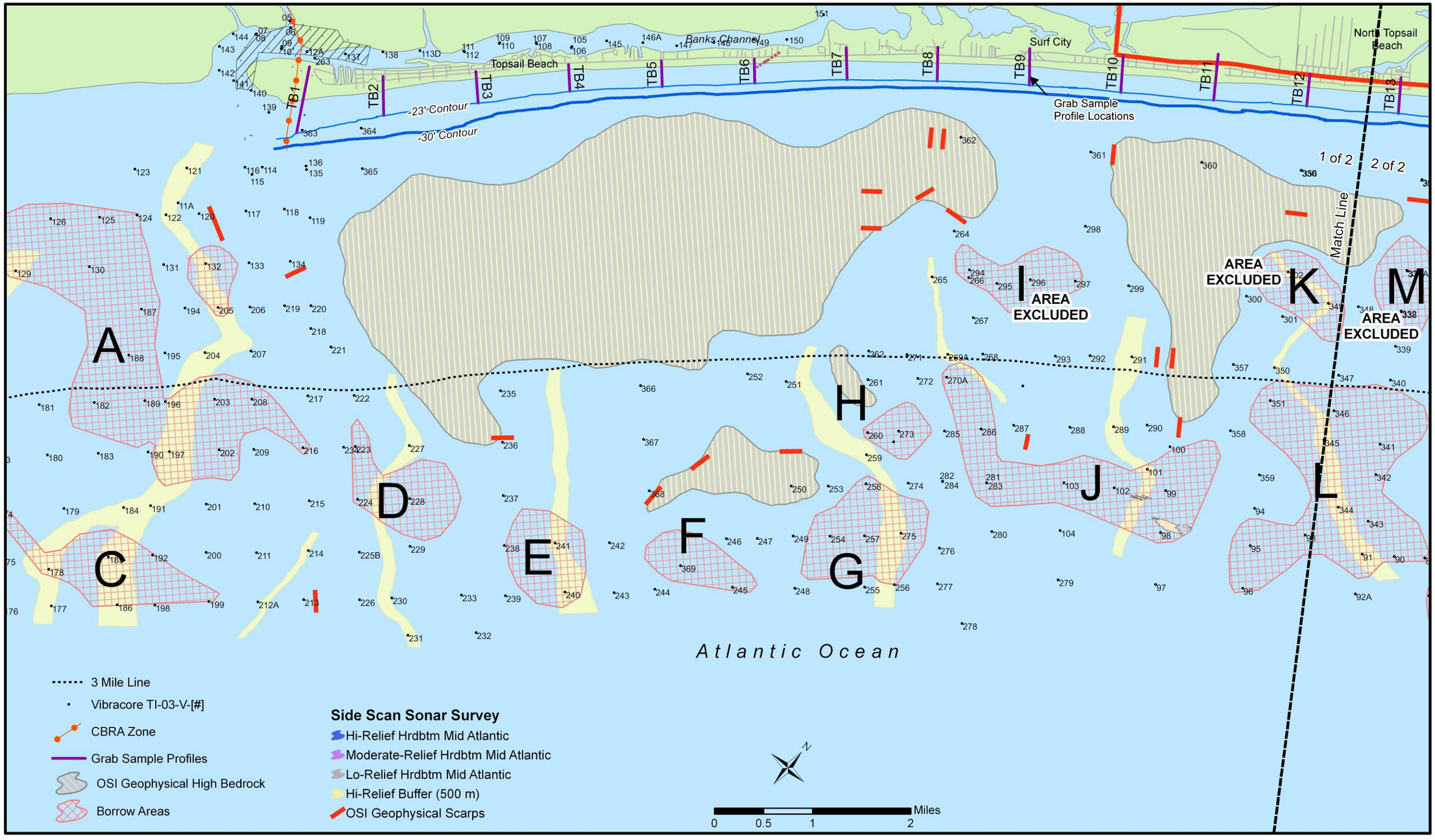


Figure A-6 Borrow Areas 1 of 2

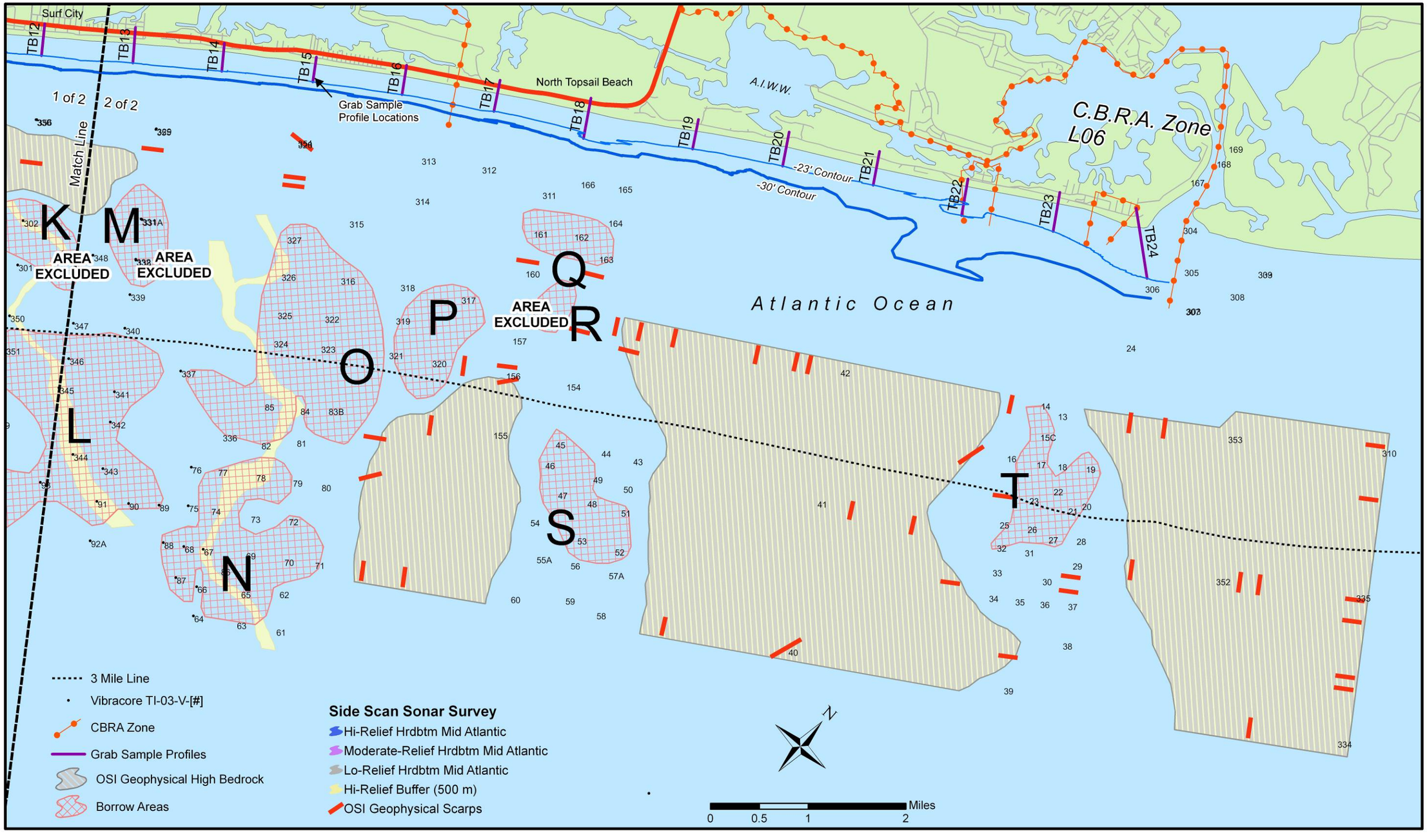


Figure A-6 Borrow Areas 2 of 2

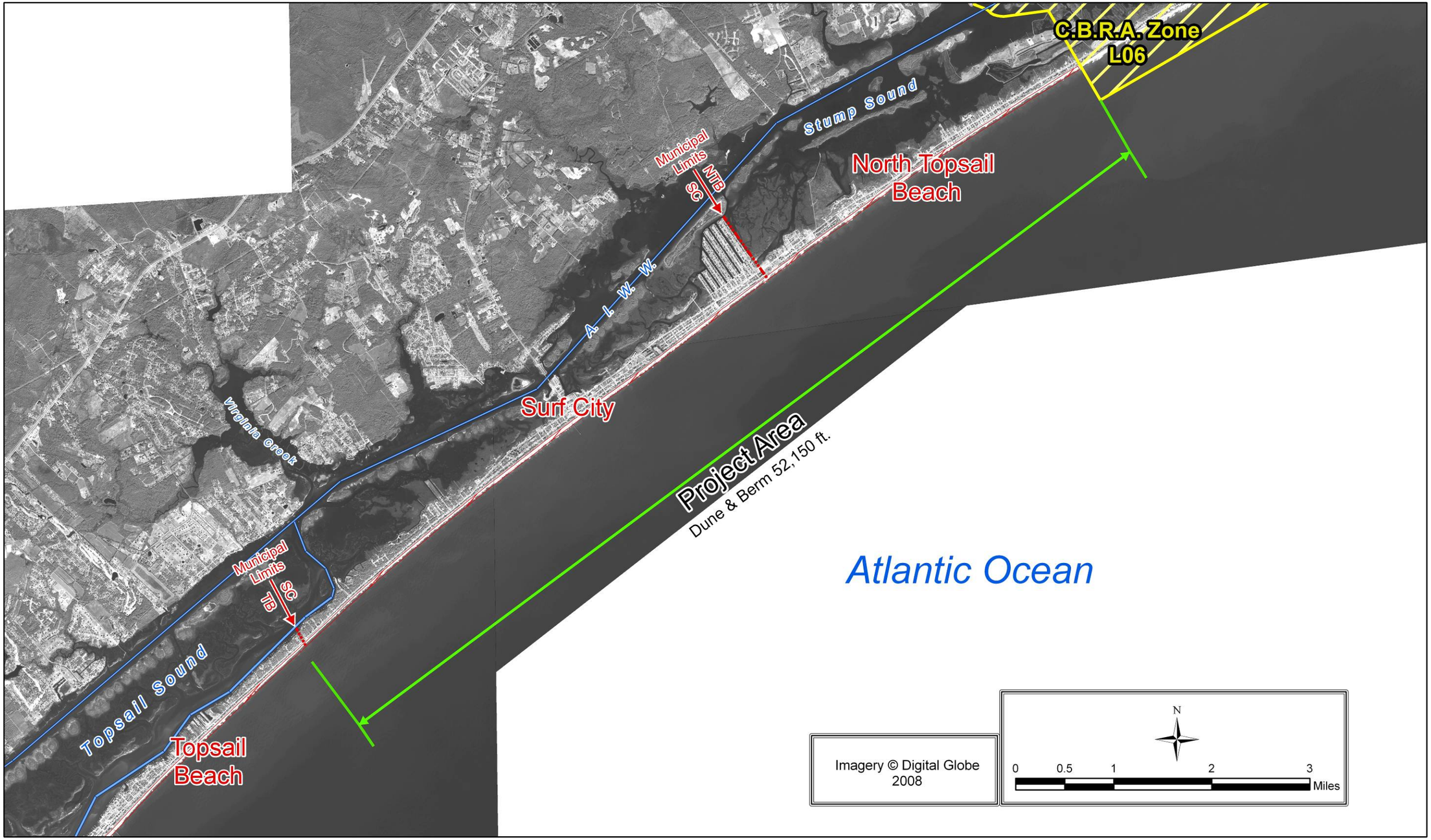
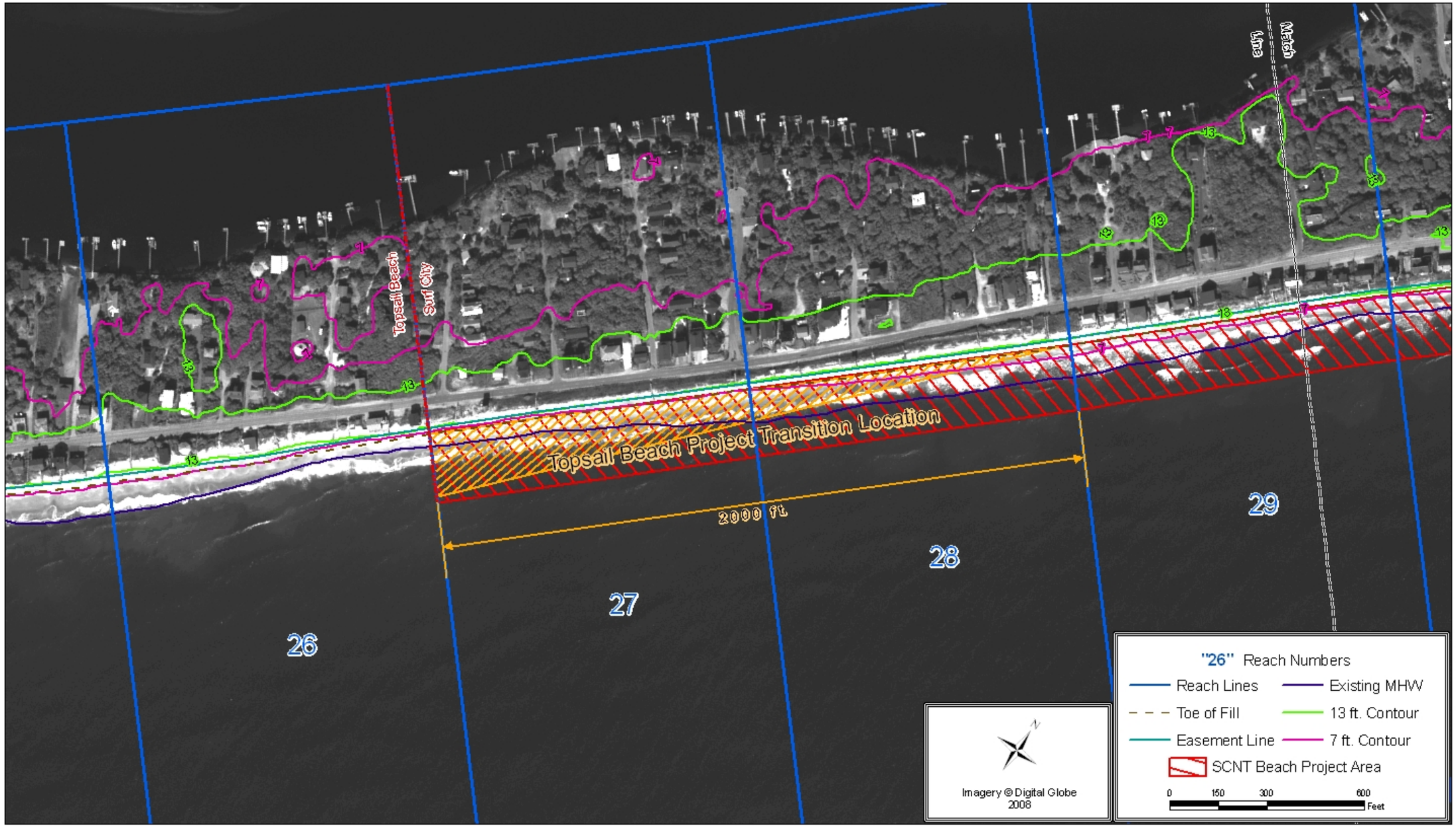


Figure A-7 Selected Plan, Plan 1550, NED Plan, Plan View



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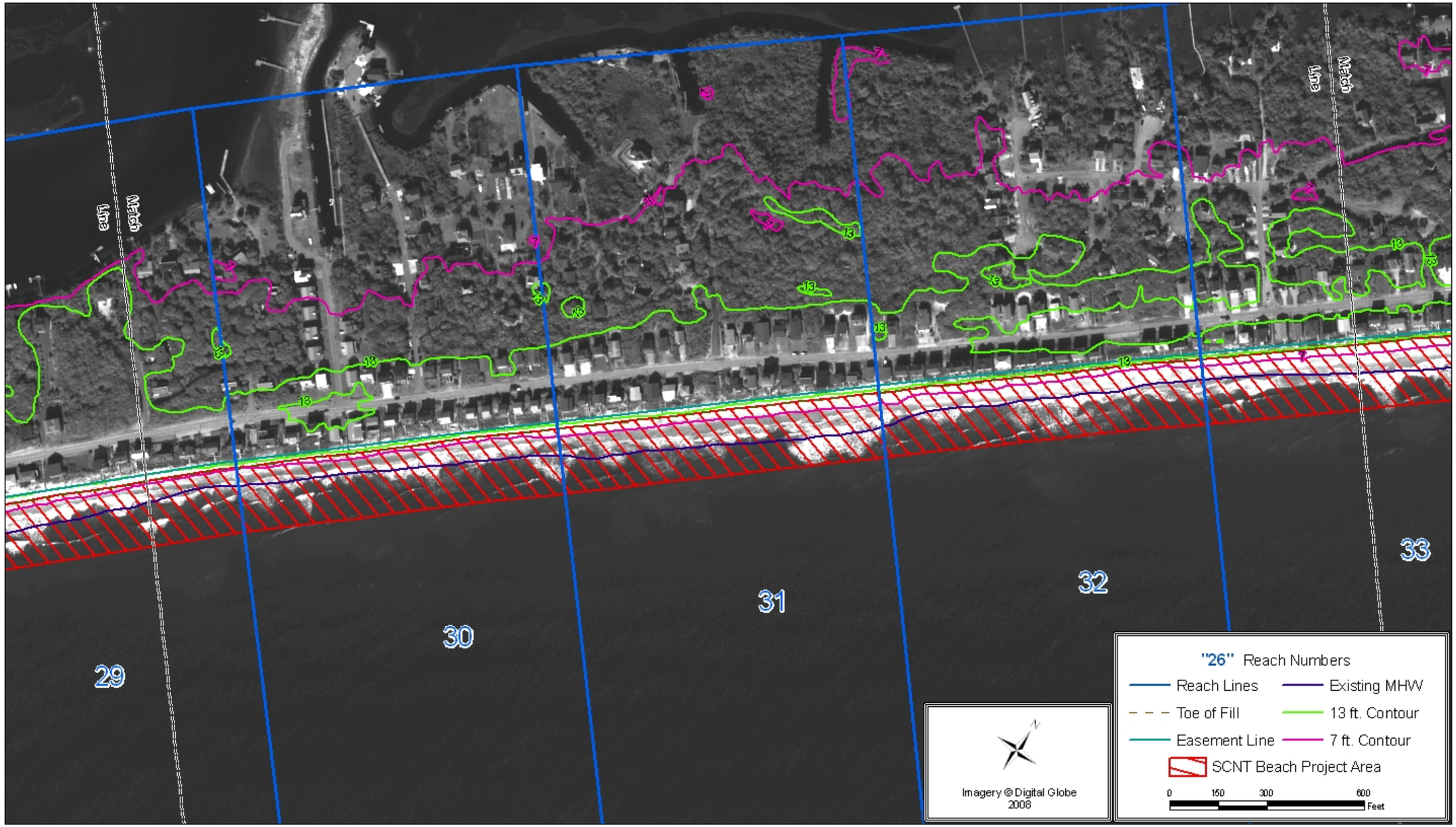

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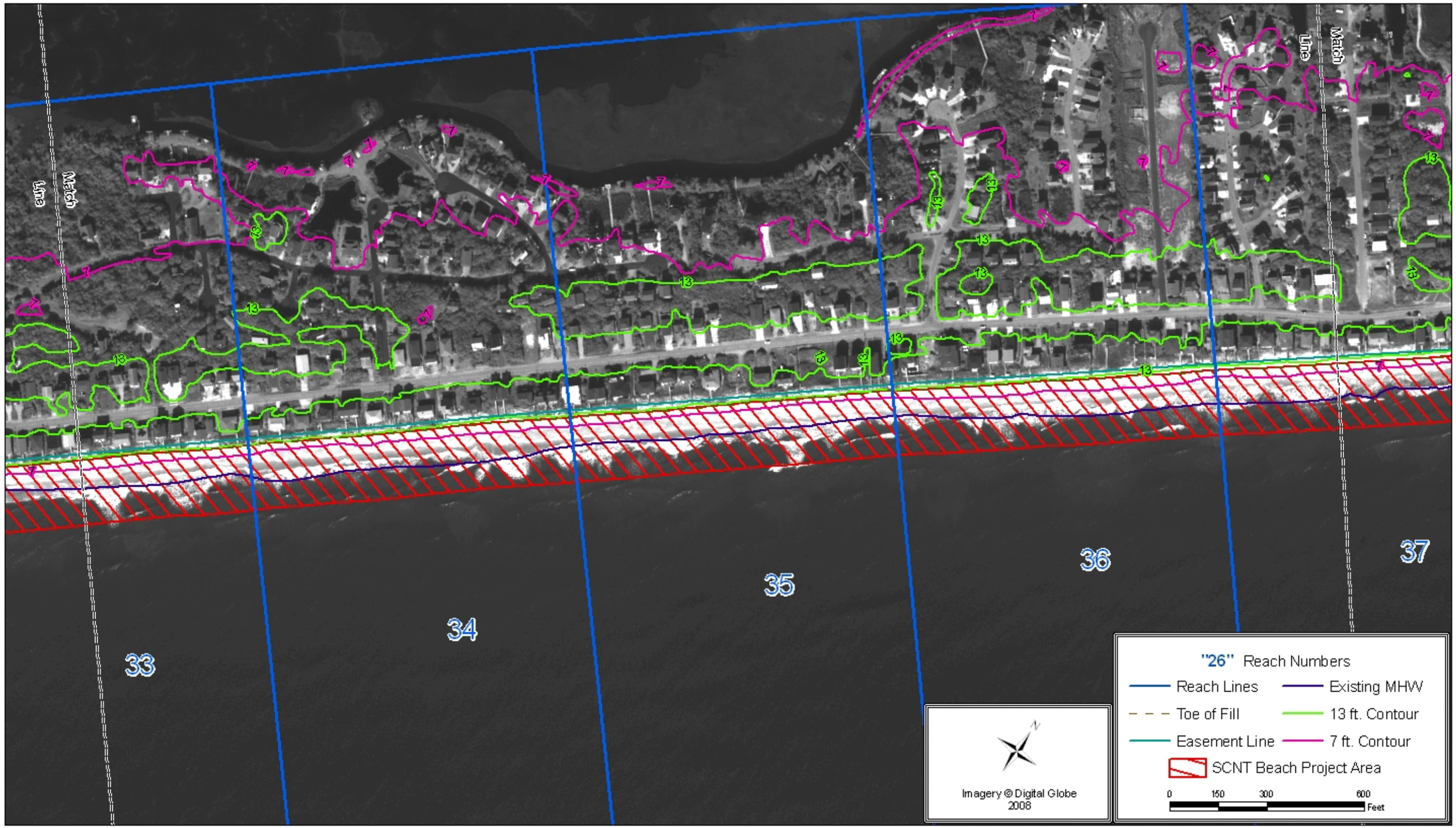

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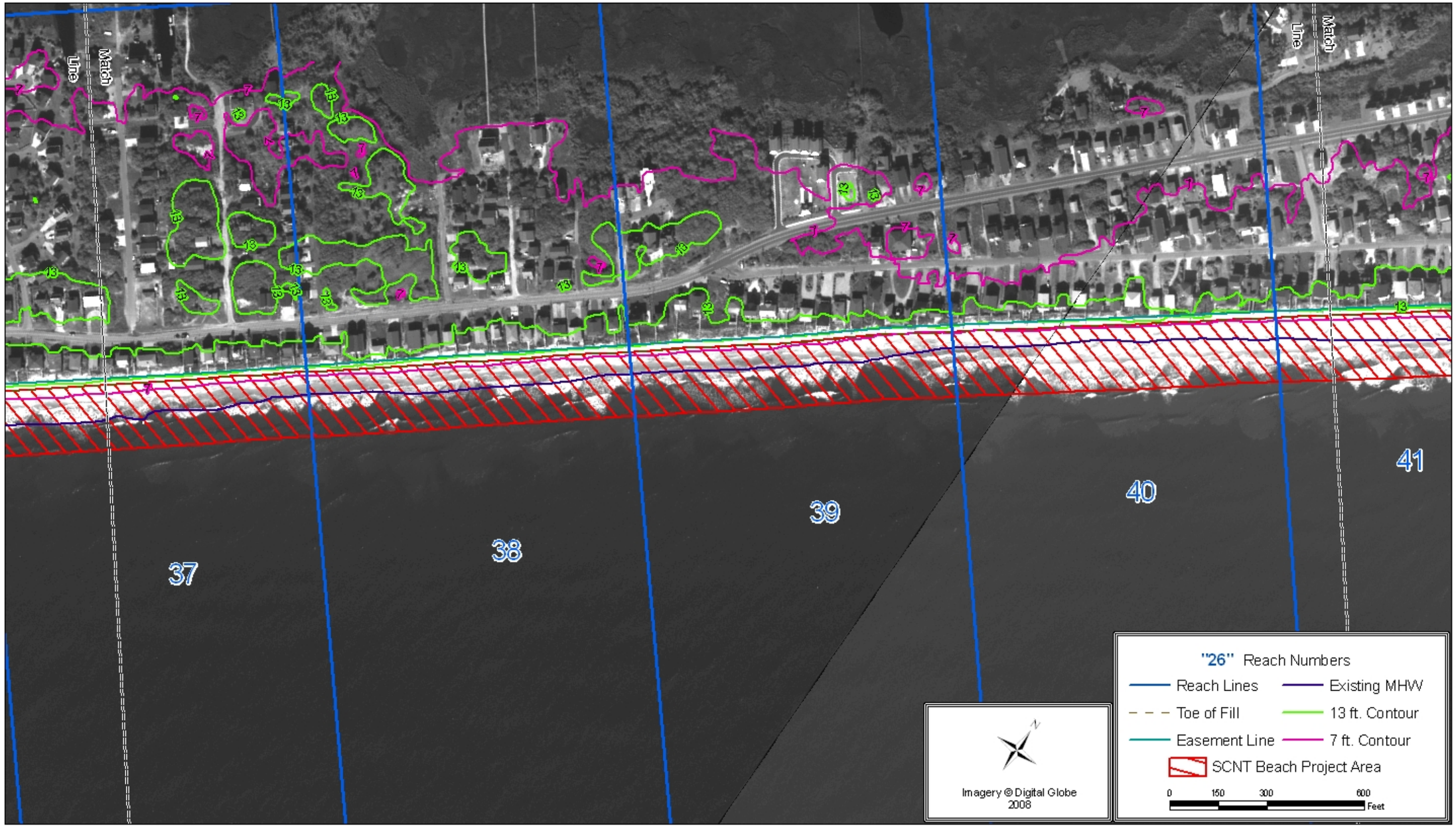

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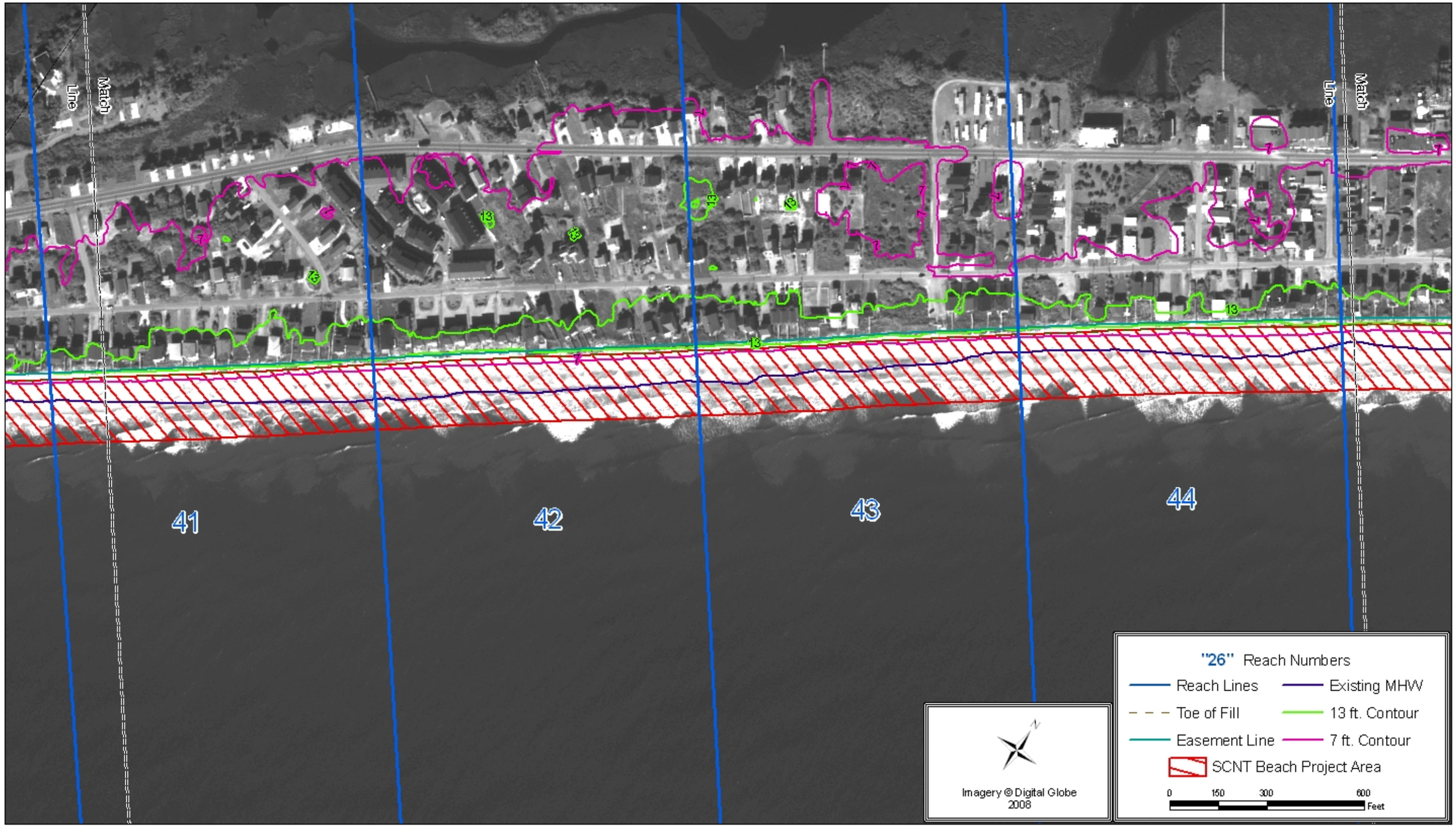

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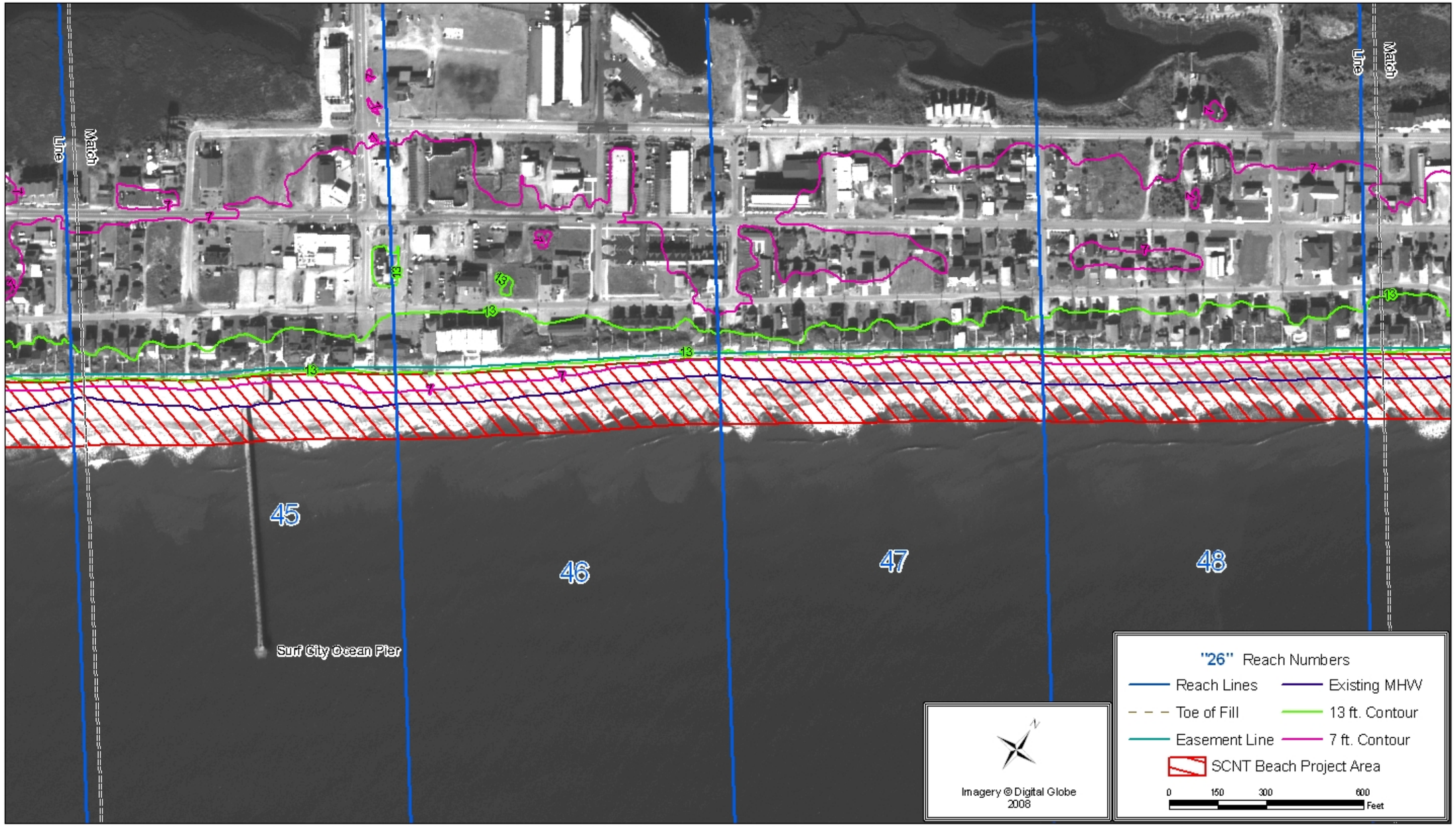

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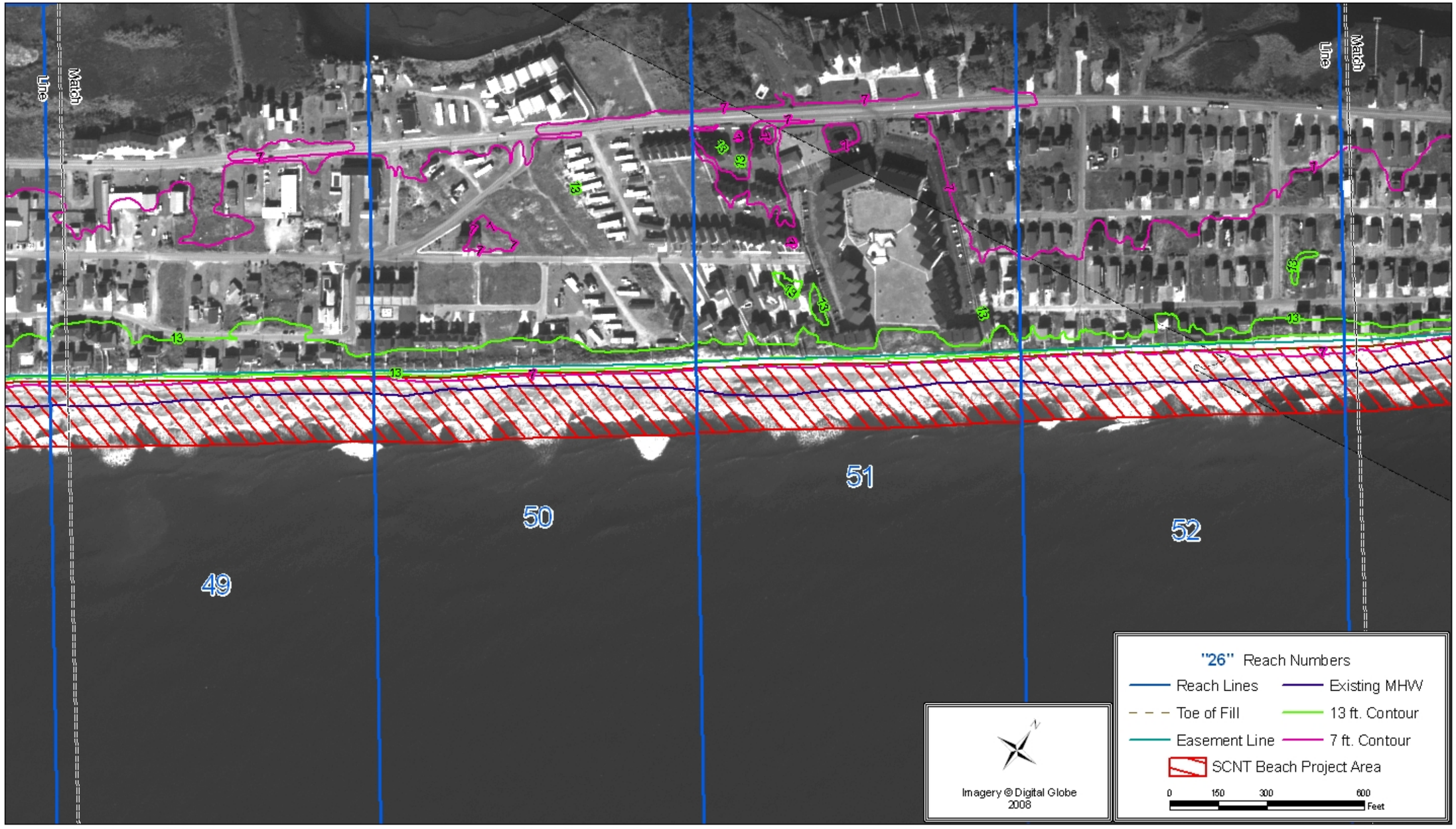

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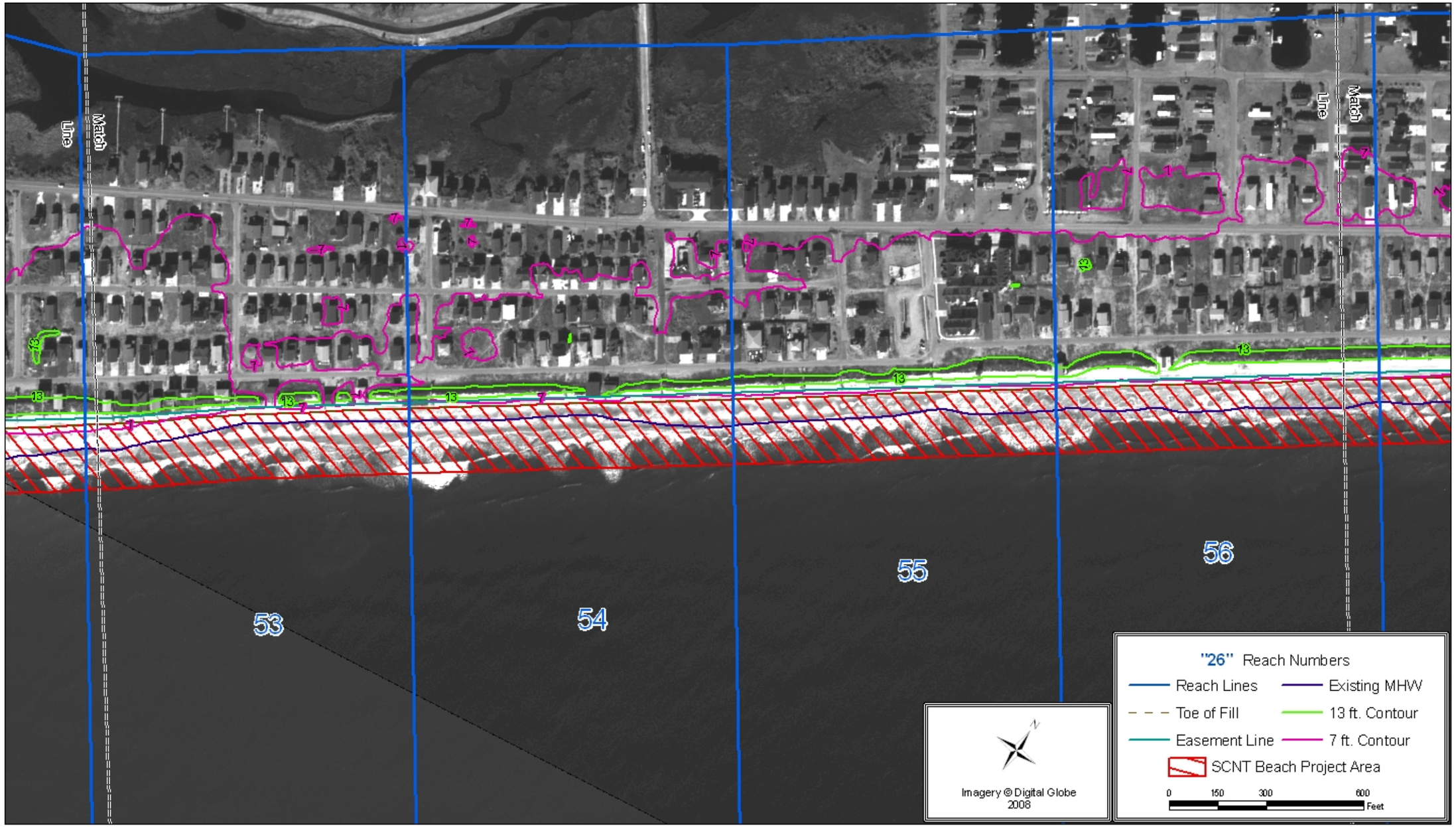

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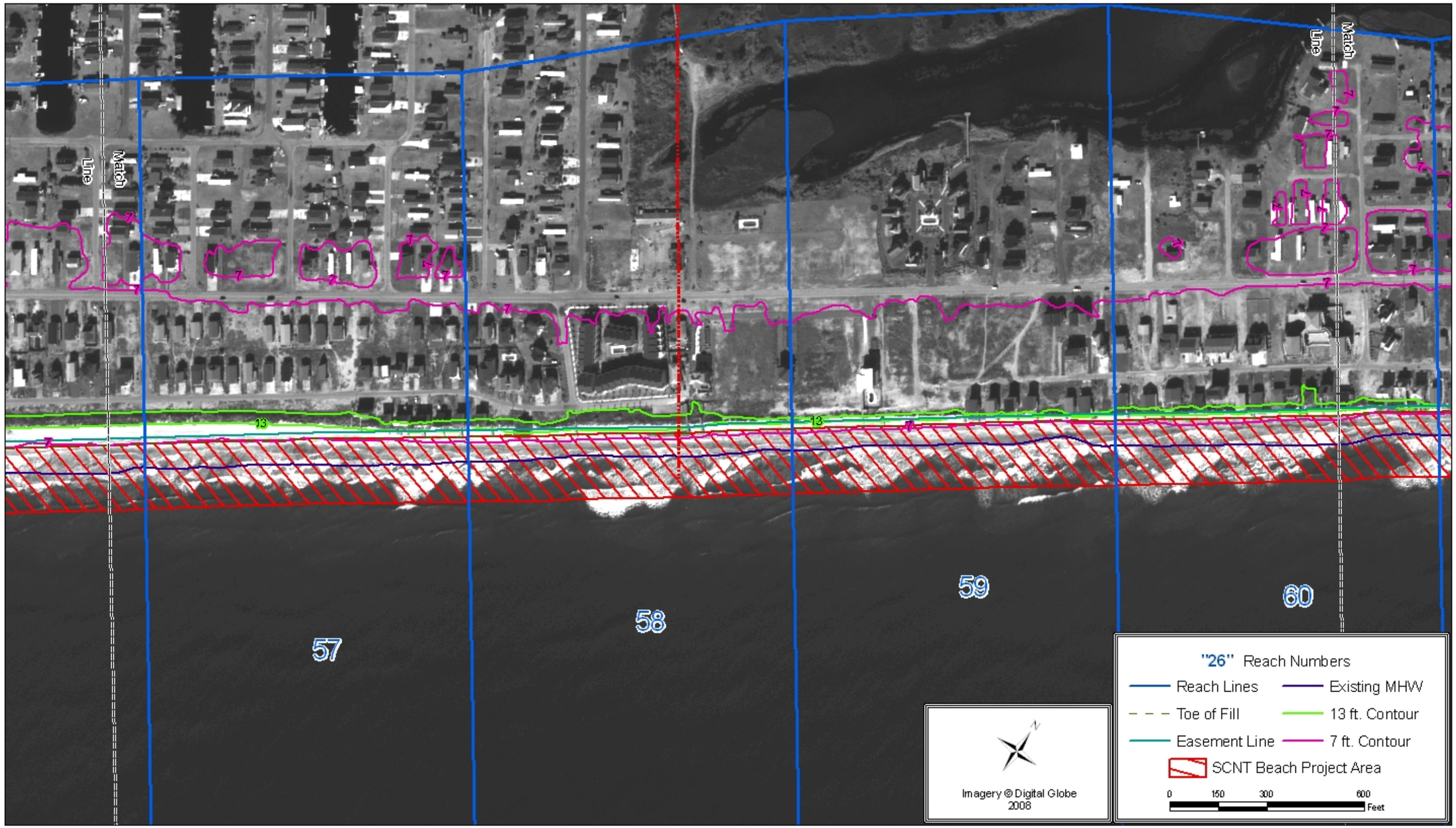

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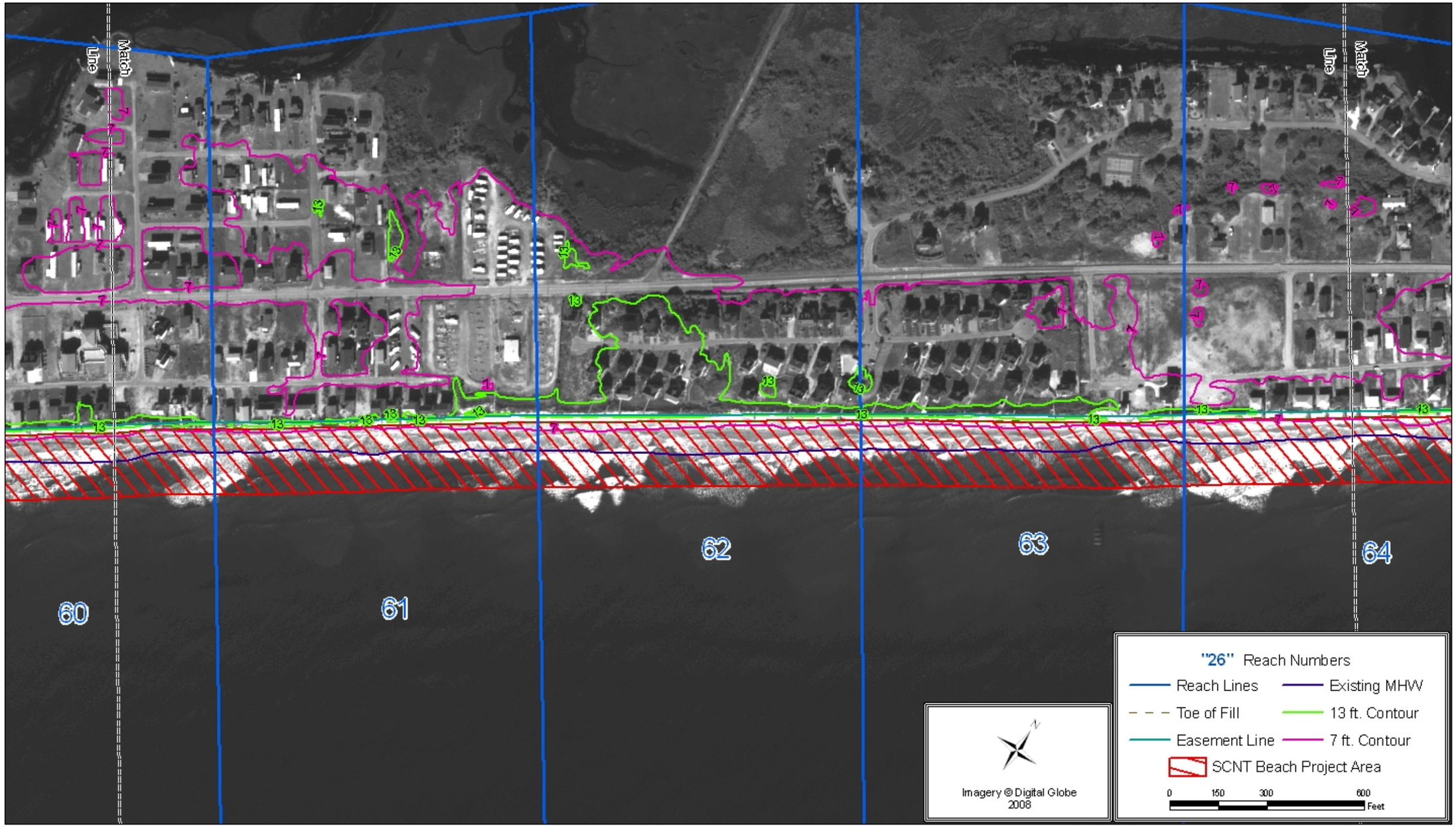

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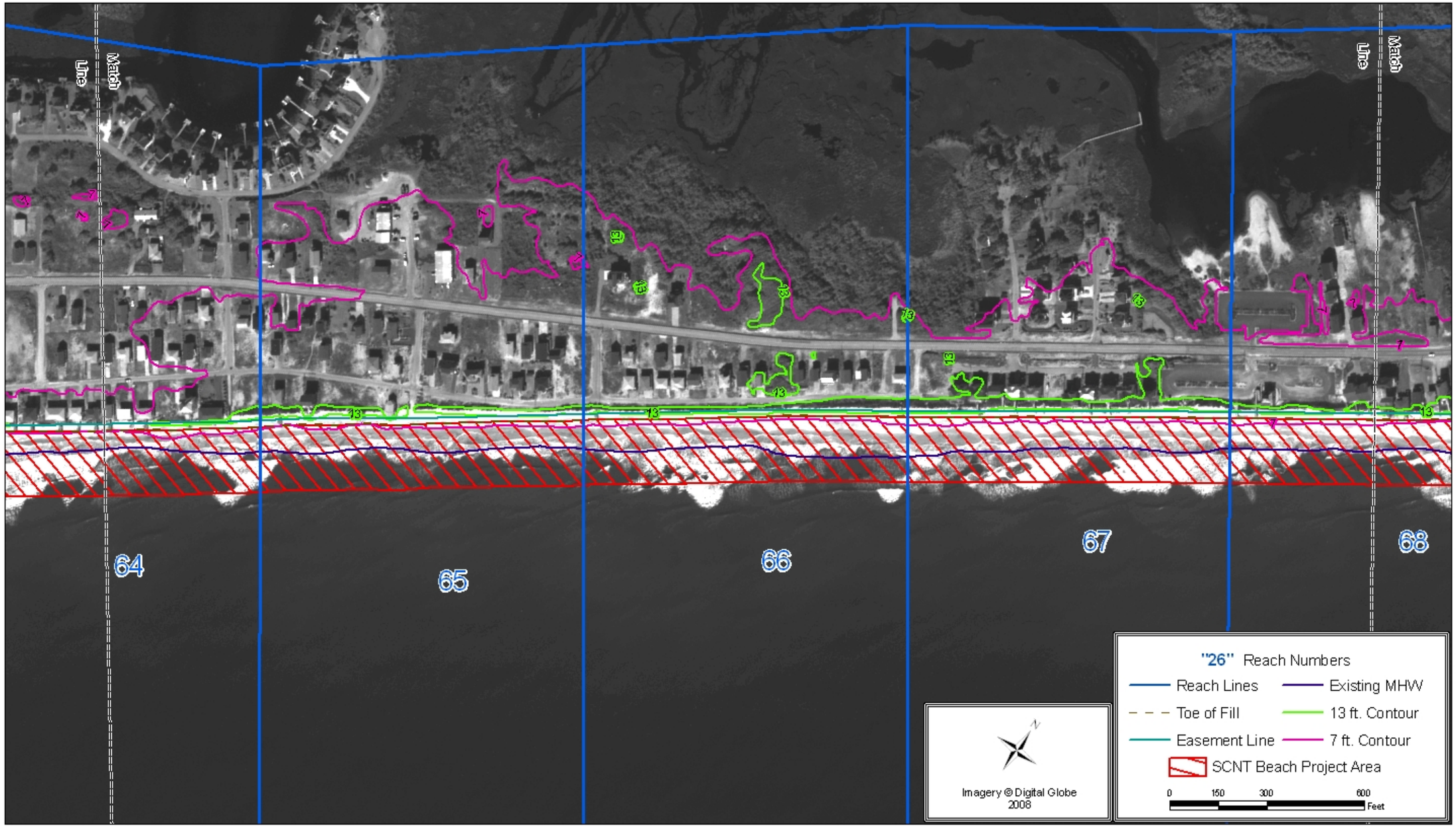

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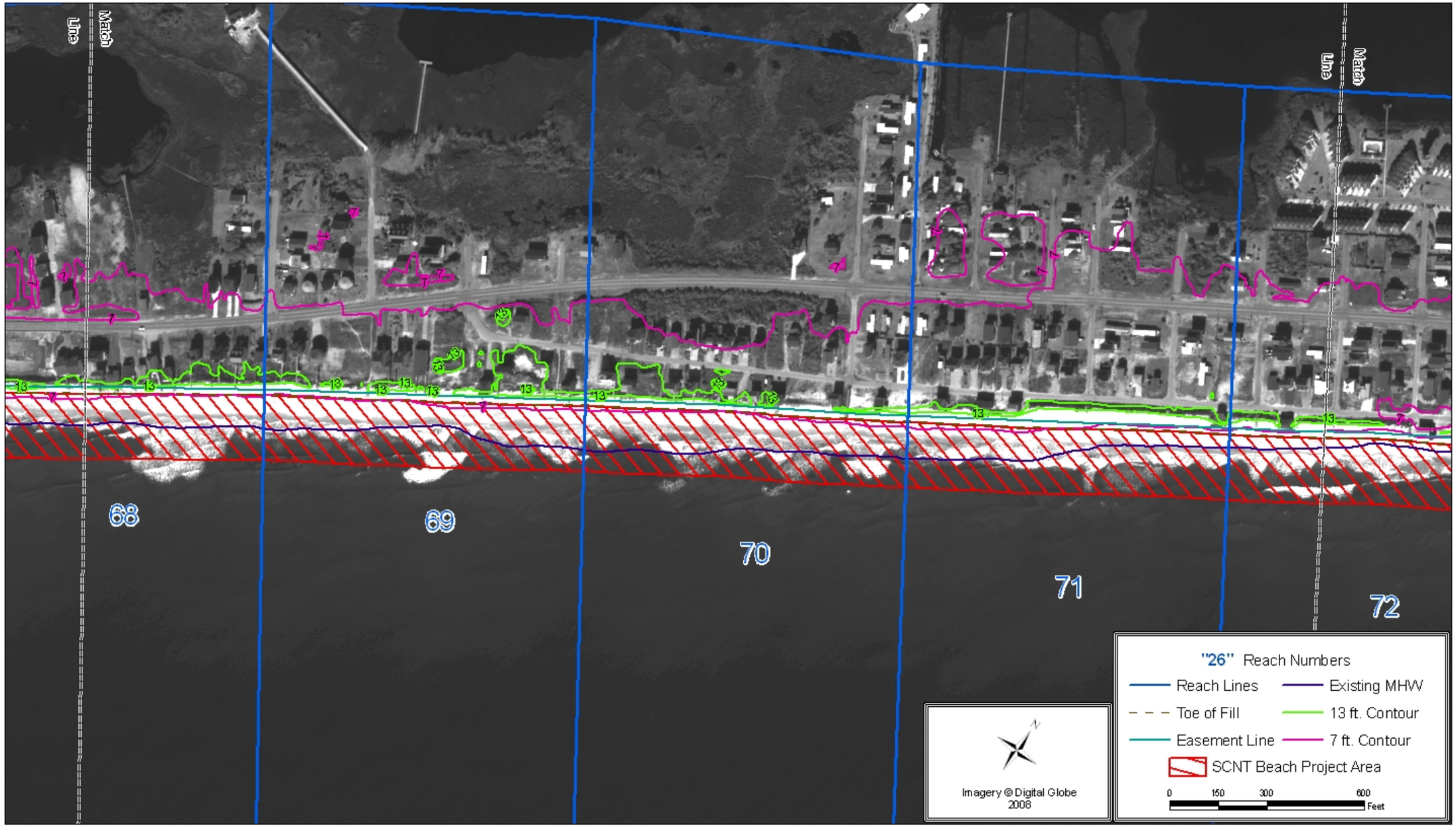

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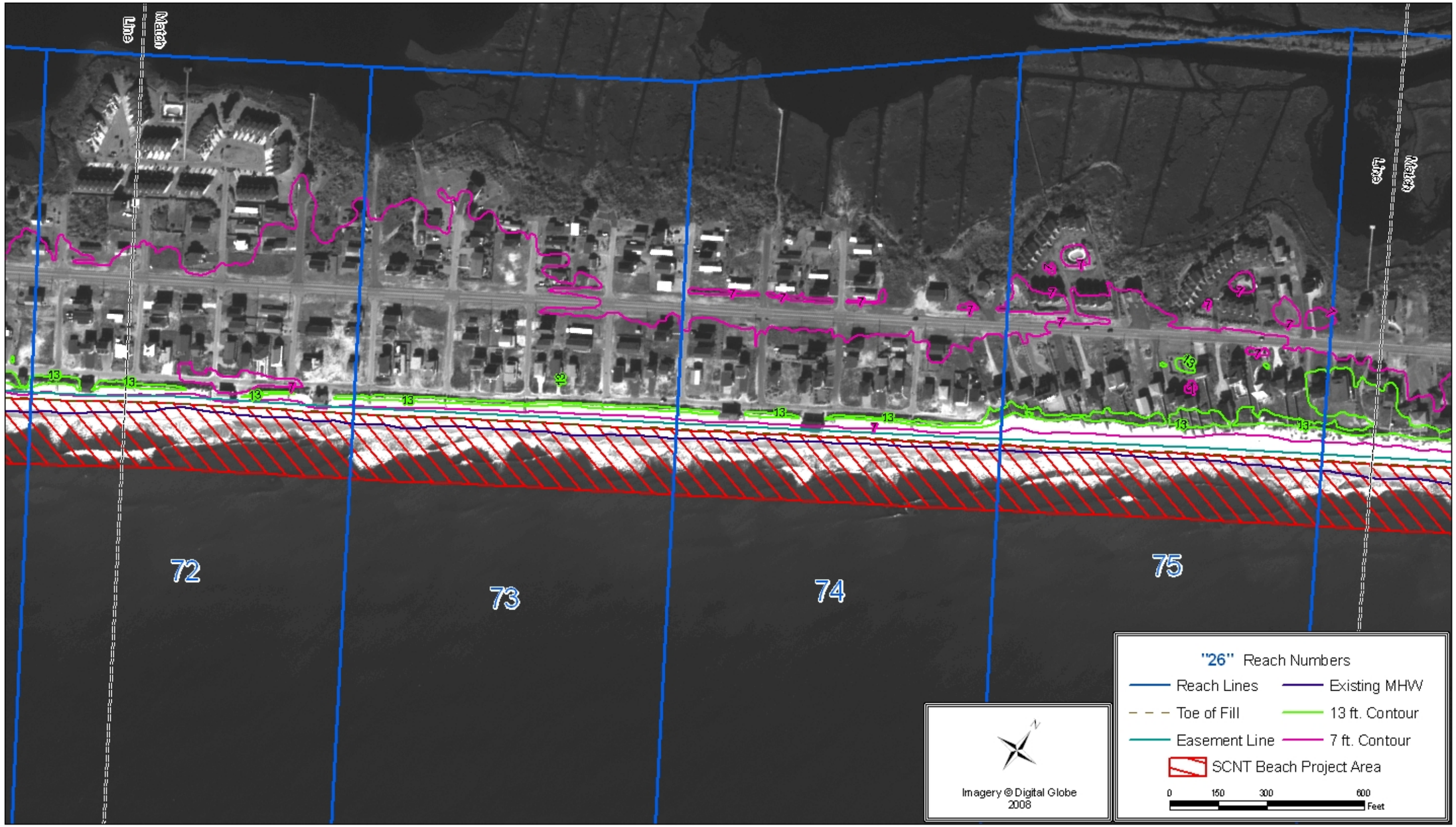

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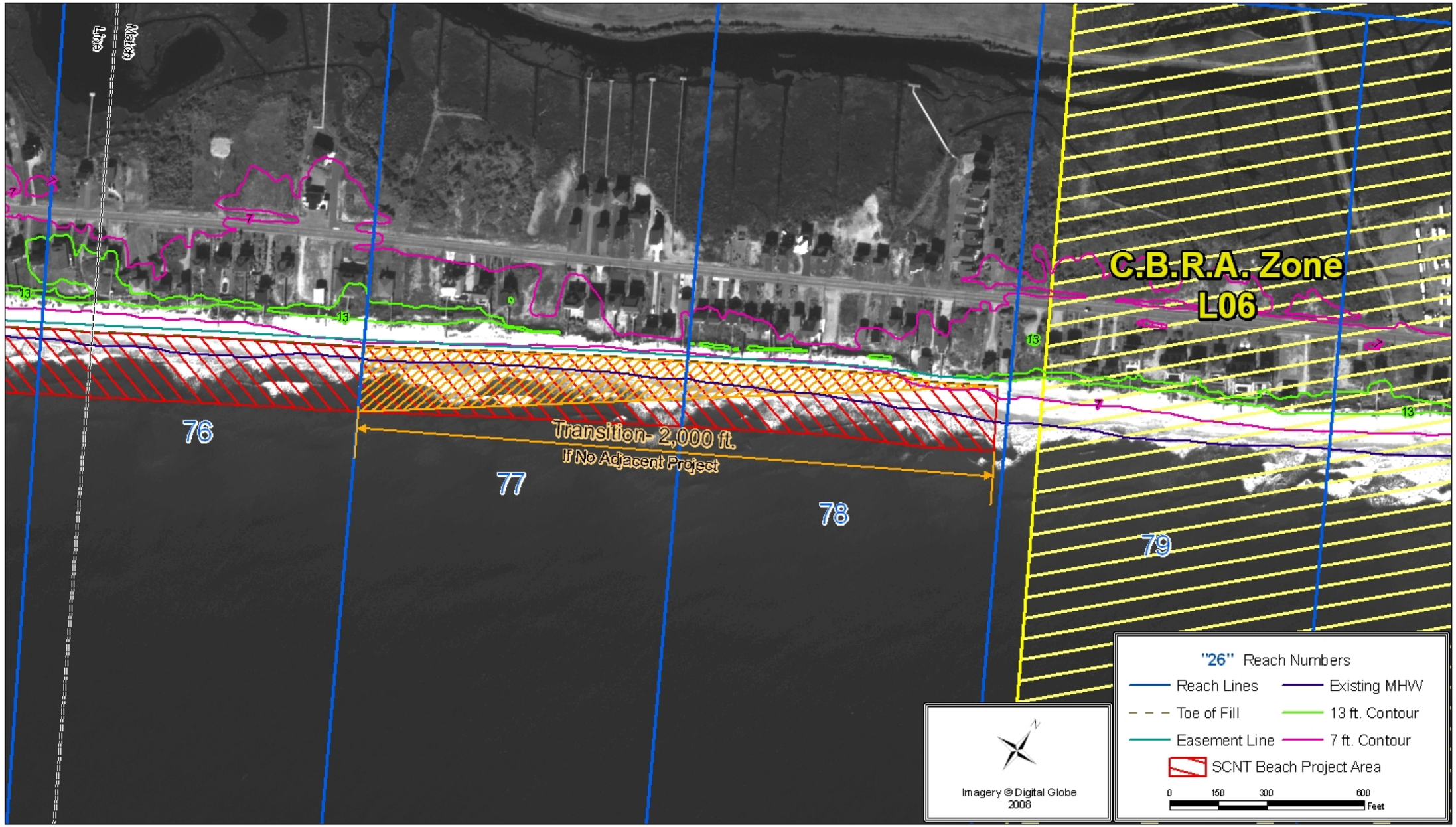

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