8. ENVIRONMENTAL EFFECTS

This section describes the probable consequences (impacts and effects) of the selected alternative on significant environmental resources within the project area. Refer to Table 5.3 for a comparative matrix of environmental impacts among main categories of possible plans considered. 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 six proposed borrow areas for this project are located between 1 and 5.5 miles offshore; therefore, dredging operations will not adversely impact wetlands or floodplains of Topsail Beach. The selected 1250X beach nourishment plan consists of a 26,200-foot long dune and berm system which is within the floodplain. The plan has a main fill length of 23,200 feet, from approximately 400 feet southwest of Godwin Avenue, in reach 3, to the Topsail Beach town limit in reach 26 (See Section 7.01.1). A 2,000-foot northern transition and a 1,000 southern transition will extend beyond the limits of the main fill. The transition areas will consist of a tapered berm only resulting in a starting transition berm width of 155 feet that uniformly tapers to zero (See Section 7.01.2). Although, fill will be placed in the floodplain, nourishment operations would not adversely impact floodplains. No wetlands would be affected by the proposed project.

8.01.2 Inlet, Flats, and Sounds

The six proposed borrow areas for this project are located between 1 and 5.5 miles offshore and will not adversely impact the inlet, flats, and sound of Topsail Beach. Considering that no sediment will be removed from the inlet complex for beach nourishment, impacts to inlet dynamics will not occur. In order to achieve the initial construction template consisting of a 12 ft. dune and a 50 ft. berm, approximately 3.2 million cubic yards of sediment will be placed on the beach. In order to maintain the project template, renourishment of approximately 866,000 cubic yards of sediment will be placed on the beach at four-year intervals. Total volume of material required to construct and maintain the 50-year project is approximately 13.6 million CY. The total volume of sediment added to the littoral system will not significantly increase the volume of sand in the littoral system. Therefore, the placement of additional sediment to the beach would not significantly impact sand flat and shoal development within New Topsail inlet. 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 not well understood. 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 16 November to 30 April 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). Placement of beach quality sand 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 nursery area (Ross and Lancaster, 2002) and may not avoid secondary impacts (turbidity) from construction. 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 construction 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 beach nourishment 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 nourishment 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 nourishment 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.

Sand placement 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 16 November to 30 April 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. Susceptibility to this effect is largely dependent on proximity to the cutter-head or drag-head and the pumping rate of the dredge. Those larvae present near the channel 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 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.

Assessment of potential entrainment impacts of the proposed 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 form the nearshore zone. Larval impacts from dredging to this concentrated system would be greater than dredging in offshore borrow areas.) The largest hydraulic dredge likely to work in the 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 0.0006 to 0.0007 percent of the daily volume flux through the inlet. 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 Attachment 1 of Appendix I for a more detailed analysis). Though any larvae entrained (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.

8.01.5 Nekton

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 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 or hopper dredge (See Larval Entrainment, Section 8.01.4). Organisms close to the dredge cutterhead or draghead may be captured by the effects of its suction 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 organisms present near the ocean bottom would be closer to the dredge cutterhead or 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). A 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 of dredging of borrow material for the this project are expected to be insignificant.

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 and Naughton, 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 and Naughton, 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 construction 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).

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. 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.

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).*

While the proposed beach nourishment will adversely impact intertidal macrofauna, these effects will be localized, short-term, and reversible.

Project construction is expected to run from about 16 November 2011 through 30 April 2012 and will occur during the overwintering period of intertidal organisms on the beach. Beach nourishment will be completed prior to the onshore recruitment of most intertidal organisms. In North Carolina, the majority of invertebrate species recruit between May and September (Hackney *et al.*, 1996; Diaz, 1980; Reilly and Bellis, 1978). Any loss of intertidal organisms would be temporary, as re-population would be expected to begin as soon as the nourishment operation ends. Intertidal organisms are expected to recover upon completion of project construction from recolonization of the beach by organisms from adjacent areas and offshore.

8.01.7 Benthic Resources – Nearshore Ocean

Monitoring studies of post construction borrow areas in the southeast indicate 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). The selected borrow areas for this project are located in waters with depths between 40 and 50 feet and the anticipated maximum depth of dredging is approximately 10 ft. Currents in the area are expected to contribute to some filling of the borrow area with material from sloughing of undisturbed areas adjacent to the construction sites; however, it is expected that the bathymetric feature of the post-dredging borrow area will persist.

Dredging in the selected borrow areas should not have an adverse impact on any hardbottoms in the area. Based on magnetometer and side-scan sonar survey of the selected borrow areas, there was no indication of any hardbottoms within the areas surveyed (Hall, 2004).

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).

Impacts associated with dredging methods may differ depending on type of dredge and associated equipment used. Dredging impacts on benthic invertebrates would be similar, since the sediment surface where the organisms are found would be removed with an associated loss of all inhabitants under all scenarios. A hopper dredge takes a shallower and wider cut that may impact a larger surface area during a given event. Since a hopper dredge drag head operates at or above the bottom surface and pipeline cutterhead would be operated below the sediment surface the ability of benthic fish to avoid the dredge may be different. Hopper dredges also include associated risks of collision with marine mammals (See Appendix I). Methods that use pipelines to transport dredged material may have temporary impacts to any benthic organism covered by the pipeline. The environmental differences are considered insignificant.

Borrow areas A, B, C, D, E, and F are located beyond the –30 foot NGVD contour to approximately 5.5 miles offshore of Topsail Beach. Areas A, B, D, E, and F will be dredged for sediment at some point throughout the life of the project (Figures A-1 and A-6, Appendix A). Relative to all of the borrow areas, borrow area C is the greatest distance from the project area and is the least cost effective. Therefore, borrow area C will be reserved for contingency purposes. The offshore borrow areas beyond 3 nautical miles offshore are subject to federal mining requirements of the Minerals Management Service (MMS). Excavation will directly impact an area of about 4,210 acres (6.58 square miles) when completely utilized (year 50). Initial construction will impact a total area of about 2,297 acres (3.59 square miles) of sandy ocean bottom in borrow area A using a pipeline dredge (Table 7.1) from 16 November to 30 April. Periodic re-nourishment will occur every four years using a hopper dredge and will utilize a combination of offshore borrow areas (A, B, C, D, E, and F). The proposed window for hopper dredging is 1 December to 31 March. Multiple dredging areas within a given borrow area may be used to reduce material transport and/or allow for concurrent operation of more than one dredge in a given area. Existing depths at the proposed borrow areas range from about 40 feet to 50 feet. The depth of cut will vary depending on the availability of suitable sandy material and dredge plant capabilities. The average proposed cut for initial construction in borrow area A, using a pipeline dredge, is 6 feet to 10 feet. Optimum thickness of material necessary for efficient use of a pipeline dredge is only found in borrow area A; thus, maximum cuts of 10' will occur using a pipeline dredge and all other hopper dredge work will remove shallower cuts. Some refilling from sedimentation and side sloughing is expected over time. It is expected, however, that the depression created by the removal of sand will persist. Considering the existing depths (40 feet to 50 feet) of the borrow areas and an anticipated maximum dredge cut of 10 feet, post project borrow area depressions will not exceed about 50 feet to 60 feet.

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. 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, *et al*. 1988, Johnson and Nelson, 1985, Saloman *et al*., 1982, and, 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, some changes in species composition and population may occur (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.

Considering that all proposed offshore borrow areas (A, B, C, D, E, and F) are located beyond the –30 foot contour and the proposed depth of closure for this project is 23 foot, it is anticipated that no significant infilling of the borrow areas will occur. Though the borrow areas are beyond the depth of closure and are outside of the normal littoral transport of sediment, some infilling of sediments will still occur at less significant rates. The infilling rate, the quality, and the type of the material would be factors in 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. Some infilling from sedimentation and sloughing of bottom substrate from surrounding areas is expected.

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 Amendments of the South Atlantic Fishery Management Council identify over 30 categories of Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC), which are listed in Tables 8.1. 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. Those absent include estuarine scrub/shrub mangroves which require a more tropical environment and several areas that are geographically removed from the project area including: Hoyt Hills located in the Blake Plateau area in water 450-600 meters deep, the Point located off Cape Hatteras near the 200-meter contour, and sandy shoals off Cape Hatteras and Cape Fear. In addition, there are no Council-designated Artificial Reef Special Management Zones, Estuarine Emergent Wetlands, Palustrine Emergent & Forested Wetlands, Intertidal Flats, Oyster Reefs & Shell Banks, Aquatic Beds, Wetlands, Creeks, Seagrass Beds, or Submerged Aquatic Vegetation in the potential project impact area. Impacts on habitat categories potentially present in the project vicinity are discussed in the following subsections.

Table 8.1. Categories of Essential Fish Habitat and Habitat Areas of Particular Concern in the Project Vicinity and Potential Impacts.

ESSENTIAL FISH HABITAT	**Potential Presence**		**Potential Impacts**	
Estuarine Areas	**In / Near Project Vicinity**	**Project Impact Area**	**Dredge Plant Operation**	**Sediment Placement 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	insignificant
Seagrass	no	no	no	no
Creeks	no	no	no	no
Mud Bottom	no	no	no	no
Marine Areas				
Live / Hard Bottoms	nearshore ocean	no	insignificant	insignificant
Coral & Coral Reefs	offshore	no	no	no
Artificial / Manmade Reefs	2 miles offshore	no	no	no
Sargassum	offshore	no	no	no
Water Column	yes	yes	insignificant	insignificant

Table 8.1. (Continued) Categories of Essential Fish Habitat and Habitat Areas of Particular Concern in the Project Vicinity 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	nearshore ocean	no	insignificant	insignificant
Hoyt Hills	no	no	no	no
Sargassum Habitat	offshore	no	insignificant	no
State-designated Areas of Importance of Managed Species (PNAs)	yes	no	no	insignificant
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	no	no	no	no
The Ten Fathom Ledge	distant offshore	no	no	no
The Point	distant offshore	no	no	no

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8.01.8.1 Impacts on the Estuarine Water Column

All 6 proposed borrow areas are located approximately 1 to 5.5 miles offshore beyond the –30 foot NGVD contour; thus, dredging operations will not directly impact the estuarine water column. However, the selected 1250X beach nourishment plan consists of a 26,200-foot long dune and berm system. The plan has a main fill length of 23,200 feet, from approximately 400 feet southwest of Godwin Avenue, in reach 3, to the Topsail Beach town limit in reach 26 (See Section 7.01.1). A 2,000-foot northern transition and a 1,000 southern transition will extend beyond the limits of the main fill. The transition areas will consist of a tapered berm only resulting in a starting transition berm width of 155 feet that uniformly tapers to zero (See Section 7.01.2). Potential turbidity from the beach nourishment operation may extend into the New Topsail Inlet vicinity and the estuarine water column from longshore currents and tidal influx. Though elevated turbidity levels may occur during the nourishment operation, it is expected that they will be short-term, depending on the location of the outflow pipe and the movement of longshore and tidal currents, and will be no more significant than turbidity from a natural storm event. Therefore, turbidity impacts to the estuarine water column are insignificant.

8.01.8.2 Impacts on Hardbottoms

Hardbottom communities in the vicinity of Topsail Beach are within state waters and are potentially vulnerable to shoreline alterations (Moser and Taylor, 1995). During both the dredging (hopper dredge and cutterhead pipeline dredge) and placement process, identified live hardbottom communities will be avoided (offshore pipeline routes will be developed to avoid live hardbottom); thus, no direct impacts will occur. However, 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. 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 for this study is 23 ft.

<u>Offshore (>-23 ft. NGVD)</u>

Though construction activities will not directly impact offshore hardbottom through crushing or burial, it is possible that secondary impacts through sedimentation and/or chronic turbidity may occur beyond the equilibrium depth. A study by Thieler *et. al*. (1999) traced sediment dispersal on nourished beaches in Wrightsville Beach, NC and Folly Beach, SC. Data from both sites demonstrate significant quantities of nourishment sediment are being transported seaward onto the inner shelf as a result of severe storms and enhanced bottom stresses. Sedimentation accumulation from over 30 years of beach nourishment on Wrightsville Beach appears to have exceeded shoreface accommodation space resulting in deposition onto the inner shelf. This seaward thinning wedge of sediment extends over a kilometer onto the inner shelf to depths of nearly 46 ft (14 m). Roughly 2 million m^3 of nourishment sediment has dispersed to the lower shoreface and inner shelf seaward of the assumed 28 ft (8.5 m) depth of closure used for project design. About 950,000 m^3 of this material is within the inner shelf (Thieler *et al*., 1999).

Though, according to Thieler *et al*. (1999) it is possible that sedimentation may occur beyond the 23 ft. depth of closure calculated for Topsail Beach, the available information of hardbottom off the coast of Topsail Beach indicate that these hardbottom areas of influence are low lying and ephemeral (Moser and Taylor, 1995; Cleary, 2002; Greenhorne & O'Mara, 2004) and sedimentation would not impact high relief significant live hardbottom. According to Lybolt and Tate (2003), most nearshore low vertical relief hardbottoms are ephemeral, and short-term buried hardbottom is not necessarily dead. Data from a study in Florida indicate that in some surveyed transects, portions of hardbottom were covered for at least 2-days and exposed one week later with macroalgae and coral colonies still present. Nevertheless, on Topsail Beach the potential for sedimentation of low lying, and ephemeral hardbottom located offshore of the closure depth (-23 ft. NGVD) still exists. As identified by Thieler *et. al*. (1999), the potential may exist for these communities to be gradually buried by the movement of sand during equilibrium profile translation. Though not anticipated, if sedimentation occurs beyond the 23 ft depth of closure, it is possible that more stable epibenthic hardbottom communities located offshore may shift towards less diverse more stressed ephemeral hardbottom communities. However, high value live hardbottom of significant relief is not expected to be subject to burial at depths beyond 23 ft. Therefore, though the potential for sedimentation exists, its effects on low lying ephemeral hardbottom communities are not expected to be significant and high relief hardbottom should be outside the zone of influence.

During dredging operations, offshore hardbottom 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. Dredging in five (B, C, D, E, and F) of the six borrow areas is expected to be solely performed by hopper dredge. Hopper dredge suction arms hydraulically remove sediment from the sand flat and discharge the material into the storage hoppers on the dredge. During filling, fine sediments (primarily silt, clays, and fine-sands) are washed overboard to maximize the load of course sand for transport to the beach. This washing and overflow process is the source of turbidity plumes and sedimentation generated by the hopper dredge. 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 borrow area. Elevated sediment levels from hopper dredge operations have been recorded at about 1,100 feet from the borrow area (Blair *et al*. 1990). Furthermore, according to Neff (1981 and 1985), concentrations of 1000 ppm immediately after discharge decreased to 10 ppm 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.

According to Hall (2004), side scan sonar was used to define hardbottom locations throughout all six proposed borrow areas (A, B, C, D, E, and F). A review of these acoustic records indicate that there was no evidence of any hard bottom within the borrow area boundaries. In areas of moderate acoustic return, grab samples were performed to ground truth the acoustic records. Grab samples of areas of harder return confirmed that these areas were course sand associated with sand waves of 6" to 1' in height. Of all the proposed borrow area sites, only areas D and F are within the vicinity of identified offshore hardbottom. However, the nearest point of both D and F is still about 2,000 ft away from the identified hardbottom and is, thus, beyond the zone of elevated sediment levels according to Blair *et al*. (1990).

Though elevated turbidity levels may occur from hopper dredging overflow, the overflow process only occurs during dredging. Considering that maximum load efficiency will be attained before transit to the nearshore pumpout location, overflow of material will not occur once the dredging process is complete. Therefore, though the hopper dredge will transit over hardbottom 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. Considering that: (1) hopper dredge turbidity and sedimentation plumes will be confined to the offshore borrow areas during the dredging operation, (2) based on side scan sonar, no hardbottom was identified in these borrow areas, and (3) only 2 of the six borrow areas are within the vicinity of offshore hardbottom and the nearest point to the borrow area is about 2,000 ft., the effects of turbidity and sedimentation plumes on offshore hardbottom will be insignificant.

Nearshore (<-23 ft. NGVD)

As identified in Appendix R, the side scan and multibeam survey results did not identify hardbottom resources within the -23' depth of closure limit of the project but rather very shallow depressional features located perpendicular to shore. These features are consistent with Rippled Scour Depressions (RSD's), Rippled Channel Depressions (RCD's), and or sorted bedforms as identified in the literature. During the equilibration process, the nourished sediment will move offshore as the constructed beach profile equilibrates to a more natural beach profile. The total area of the RSD, RCD, and/or sorted bedform features that occurs within the -23 ft. depth of closure limit is 0.3834 acres. Though nourished sediment could gradually move within the depressional features, 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).

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. The identified borrow areas for this project have been surveyed using side scan sonar and no significant hardbottom communities were identified. Furthermore, according to Cleary (2003), hardbottom communities offshore of Topsail Beach are low lying and ephemeral (See Section 2.01.10 Hardbottoms). Therefore, suitable habitat is not known within the immediate project vicinity, and they should not be affected by the proposed action.

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 off Topsail Beach. They are AR 355, AR 360, AR 362, AR 364, AR 366, and AR 368. Of these managed reefs, AR360 "Topsail Reef" is within about two-miles of the nearest proposed offshore borrow area and about two-miles from the shore and is located at 34º 20.983N and 077º 36.183W (Table 2.3). Though artificial reefs are within the proposed project area, dredging and placement of material on Topsail Beach will not be done in close proximity to any of these artificial reefs, so no adverse impacts would occur. Turbidity plumes may be produced by dredging and by placement of the dredged material on Topsail Beach in the nearshore area as fine sediments are washed away by littoral processes. If such plumes are still detectable as far offshore as the NCARP reefs, their effects should be minor, temporary, and should quickly dissipate. The proposed action will not significantly impact any NCARP reefs.

8.01.8.5 Impacts on Sargassum

Sargassum is pelagic brown algae, which occurs 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. *Sargassum* is positively buoyant and, depending on the prevailing surface currents, will remain on the continental shelf for extended periods or be cast ashore. Though *Sargassum* species may drift through the vicinity of the dredge plant operation, it typically occurs much further offshore; thus, impacts will be insignificant. In any case, since it occurs in the upper few feet of the water column, it is not subject to impacts from dredging or beach nourishment activities associated with the proposed action (South Atlantic Fishery Management Council, 1998.)

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). 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.

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 is 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 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 Topsail 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 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).

8.01.8.9 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).

8.01.8.10 Impact Summary for Essential Fish Habitat

The proposed action is not expected to cause any significant adverse impacts to Essential Fish Habitat of EFH species. Impacts are expected to be minor on an individual and cumulative effects basis.

8.02 <u>Terrestrial Environment</u>

8.02.1 Maritime Shrub Thicket

The maritime shrub thicket community is located sporadically throughout 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 26,200 feet of beach berm and dune (including transition areas) 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 on Topsail Beach may directly impact ghost crabs through burial (USACE, 2004; 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. This project will avoid the recruitment timeframe by nourishing between 16 November and 30 April. Furthermore, considering that, based on the boring samples and subsequent grain size analyses (See Appendix C, Geotechnical Analysis), only compatible borrow material will be used; impacts to the prey species should be short-term. Compaction measurements will be performed post-construction and, if deemed necessary, compact portions of the beach will be tilled (post-construction tilling is a mitigation measure proposed for sea turtles; however, secondary benefits may occur for ghost crabs); thus, impacts to burrow construction should be minor.

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. 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, 2004; 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, dredging activities will not be conducted in hardbottom areas that have been identified, so disturbance of birds using those areas 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.

Migratory shorebirds may use the project area for foraging and roosting habitat. As mentioned in Section 8.01.6 of this report, beach nourishment activities may temporarily impact the intertidal macrofauana community, a component of shorebird foraging habitat; however, recovery often occurs within 1 year if nourishment material is compatible with native sediments. Though these temporary impacts may occur to the shorebird prey base, adjacent un-impacted foraging habitat would be available while foraging habitat in the immediate construction areas approach pre-project population levels. 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 habitat is available throughout the project; foraging habitat will not be significantly impacted by the proposed action. A recent 2-year study in Brunswick County, NC documents in detail shorebird use there (USACE, 2003). This report indicated that beach nourishment had no measurable impact to bird use.

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.

Though initial nourishment activities will extend into the 1 April bird nesting timeframe, to the maximum extent practicable the Corps will work with the NCWRC to plan construction around designated nesting areas. Under normal conditions, no construction should occur after 1 May, which is the established sea turtle nesting window. 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 should only extend into the first month of the bird nesting timeframe with subsequent periodic nourishments adhering to the 1 April to 31 August bird nesting window 2.) for the period of time when construction will extend into the nesting timeframe, the Corps will coordinate with the NCWRC to plan construction activities around potential nesting areas, and 3.) beach nourishment and construction activities would avoid the designated Piping Plover Critical Habitat at the south end of Topsail Island. This area is most likely to support potential nesting shorebirds.

Section 8.02.4 Threatened and Endangered Species.

The direct and indirect impacts from the proposed project to endangered and threatened species are discussed in detail in the biological assessment (Appendix I). In summary, it has been determined that the project may affect, but is not likely to adversely affect, piping plover and seabeach amaranth as well as nesting leatherback, loggerhead, and green sea turtles. However, proposed hopper dredging activities may occur in areas used by migrating turtles; therefore, hopper dredging activities associated with this project may affect, and are likely to adversely affect the loggerhead, green, Kemp's ridley, and hawksbill sea turtles in the water within the vicinity of the dredging operation. Cutterhead pipeline dredges have not been known to take sea turtles; however, hopper dredges potentially pose the greatest risk to sea turtles through physical injury or death by entrainment. Hopper dredges move rapidly over the bottom sediments and can injure or kill loggerhead, green, and Kemp's ridley sea turtles lying on the sea bottom. Based on historic hopper dredging take data, leatherback sea turtles are not known to be impacted by hopper dredging operations. In order to minimize potential impacts, hopper dredges would be used only from 1 December to 31 March of any year when water temperatures are cooler, generally <14°C (57.2°F). However, because some sea turtle species may be found year-round in the offshore area, hopper dredging activities may occur during low levels of sea turtle migration. The Corps will strictly adhere to Regional Biological Opinion and incidental take statement provided by the NMFS for the continued hopper dredging of channels and borrow areas in the southeastern United States dated 25 September, 1997 and will maintain observers on hopper dredges for the periods prescribed by NMFS to document any incidental takes of sea turtle species and to ensure that turtle deflector dragheads are used properly.

8.03 <u>Physical Resources</u>

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 six detached, relatively small borrow areas scattered across an 8 or 9 mile swath in water depths of 40 to 50 feet, which should have less impact on wave conditions than dredging of a large, contiguous area. Initial construction will involve the deepest dredging, with an average cut of about 6 feet over roughly one-quarter of borrow area A. Renourishment will utilize (1) the remainder of borrow area A (with about 3 to 4 feet of average deepening) and (2) the other five, much smaller borrow areas that will involve only about 2 to 3 feet of deepening, which should result in negligible changes in wave conditions along the project shoreline.

8.03.2 Shoreline and Sand Transport

Existing water depths in the borrow areas range from 40 to 50 feet, which is substantially deeper than the estimated active profile depth of 23 feet. 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.

8.03.3 Geology and Sediments

8.03.3.1 Borrow Area Dredging

About 6.5 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 –30-foot NGVD) will be deepened, and recolonization of affected areas is expected within 1-3 years. Dredging in the selected borrow areas should not have an adverse impact on any hardbottoms in the area. Based on magnetometer and side-scan sonar survey of the selected borrow areas, there was no indication of any hardbottoms within the areas surveyed. See sections 8.0.1.7 and 8.0.1.8.2 for more information regarding borrow area dredging impacts and impacts to hardbottoms.

8.03.3.2 Beachfill Construction

Both pipeline and hopper dredging methods will be used during the construction phase. Pipeline dredging will be used in initial construction and hopper dredging will be used in later renourishment. Pipeline routes will extend from the seaward borrow areas to the beach and then follow the shoreline. 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 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 2 of the 6 offshore borrow areas. No hardbottoms were found in the nearshore zone. 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 construction timeframe for the project is from November 16 to April 30 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. As stated in this manual, an overfill ratio of 1.00 to 1.05 is considered optimum for sediment compatibility. However, obtaining this level of compatibility is not always possible due to limitations in available borrow sites. The overfill ratios for all of the potential borrow areas for the Topsail Beach project are shown in Table 7.1. Table 7.1 also illustrates the average silt content (#200 sieve) was less than 10% for all borrow areas. 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. See Appendix E, Sand Compatibility Analysis, for additional information.

8.04 Socioeconomic Resources

8.04.1 Commercial and Recreational Fisheries

The economic impacts of the Selected 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. 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 November 16 and 30 April, 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 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 Jolly Roger 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 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 854-foot long 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 pier 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 Beach vicinity is know 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 eight 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 eight 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 correlates 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 integrated GRR/FEIS.

8.07 <u>Water Resources</u>

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 is being requested from the North Carolina Division of Water Quality.

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. With the exception of initial construction, which will extend into April, the project will be constructed outside of ozone season. The air quality in Pender County, 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 County has 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 North Carolina Department of Environment and Natural Resources (NCDENR). The ambient air quality for Pender County has been determined to be in compliance with the National Ambient Air Quality Standards. Furthermore, Table 8.2 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 U.S. Environmental Protection Agency (EPA) National Emissions Inventory (NEI) data for Pender County. The emissions analysis is in accordance with EPA's "Current Methodologies and Best Practices in Preparing Port Emission Inventories" dated Jan 5, 2006 (Final Report). Based on the emissions analysis, 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.

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.*

Table 8.2 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 County Total	15.7%	0.36%	0.34%	0.64%	11.6%

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

d. 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.

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. For a hydraulic pipeline dredge, the pipeline from the borrow area to the construction site will be submerged until it reaches nearshore waters. The pipeline would be marked to let commercial and recreational boaters know of its presence along the bottom. Work barges and other appurtenances associated with a pipeline dredge operating in open water would be moored so as to minimize interference with boat traffic in the area.

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. Hurricane protection and beach erosion control will benefit numerous roads, business, and residences. The Selected Plan 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 Contaminated Sediments

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 contaminated sediments. 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 beach nourishment 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.

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.

8.08.4. 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; and the U.S. Army Corps of Engineers Draft Evaluation Report and Environmental Assessment, Morehead City Harbor Section 933, dated May 2003, the last two 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 fill 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.