NORTH CAROLINA
MARITIME Strategy

NC Maritime Strategy
Site Assessment and Environmental Screening

Prepared for the
North Carolina Department of Transportation

by

AECOM
in association with URS

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ACKNOWLEDGEMENTS

Initiated by the Governor's Logistics Task Force (GLTF), the *North Carolina Maritime Strategy* takes a fresh look at North Carolina's maritime assets and the needs for improvement to ensure that our State remains competitive in the future. A *Maritime Strategy* Executive Team has been formed to oversee this process, evaluate the results and provide an objective technical and economic analysis. The *Maritime Strategy* Executive Team includes: Lieutenant Governor Walter Dalton; the Governor's Senior Policy Advisor, Al Delia; Secretary of Transportation, Gene Conti; Secretary of Commerce, J. Keith Crisco; and Secretary of Environment and Natural Resources, Dee Freeman. The following North Carolina Department of Transportation (NCDOT) and North Carolina Department of Commerce (NCDOC) staff have provided day-to-day direction, guidance and support for study execution: NCDOT Director of Strategic Initiatives, Roberto Canales PE; NCDOT Project Manager, Virginia Mabry; NCDOT Liaison to the Lieutenant Governor, W. Seth Palmer; NCDOT/Commerce Liaison Joseph (Jed) McMillan; and Transportation Consultant to NCDOT and Global TransPark, Charles Diehl.

A Maritime Advisory Council, comprising State officials and staff, along with industry representatives from ocean shipping, trucking, rail and manufacturing interests, as well as community-at-large representatives, has provided further guidance and support to the study team. A roster of Advisory Council membership is included in the appendix of this report.

Finally, broad-based stakeholder outreach is key to successful development of the statewide *Maritime Strategy*. A comprehensive and ongoing public involvement program has provided additional input to the study by engaging the public, agencies and others through a series of informational meetings, public workshops and focused discussions with industry, as well as environmental and community groups.

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EXECUTIVE SUMMARY

The *North Carolina Maritime Strategy* is being developed to connect maritime goods and economic development in North Carolina. This is accomplished through the following primary tasks:

- Facilitated collaboration of freight transportation, economic development and community interests as input to the statewide strategy,
- Definition of North Carolina's economic context and maritime market positioning strategies that would offer the greatest economic benefit to the State, and
- Identification of infrastructure investments and policies that would most significantly enhance North Carolina's economy through improved performance of the State's maritime gateways and related trade corridors.

The *North Carolina Maritime Strategy* will define maritime market scenarios in which the State could realize economic and public benefit. Opportunities to be explored will include those associated with import and export of containerized cargo, as well as the potential for expanded bulk, breakbulk, petrochemical and military cargos. Special emphasis will be made to link potential market positions with industry in the State. The range of market position alternatives to be investigated may include regional transshipment of goods, container-on-barge service and major international container terminal operations.

For each viable market scenario, the Strategy will define its infrastructure needs. Transportation investments to be examined may include reconfiguration or modernization of existing port facilities, new terminal developments, wharf and channel improvements, road and rail connections, and inland intermodal facilities. A comparative analysis of development alternatives will be conducted to measure the relative benefits, effectiveness and costs associated with various alternatives for market positions and associated infrastructure.

As input to the definition of infrastructure needs and opportunities, this *Site Assessment and Environmental Screening* technical report conducts an assessment to determine the feasibility of potential deep-water port sites that could accommodate new development for potential container terminal operations. The assessment included site selection, environmental screening, and site assessment using a three-tiered approach. The entire analysis considered the following: 1) land suitability, 2) infrastructure proximity, 3) general meteorological and oceanographic factors, 4) dredging elements and navigation factors and costs, and 5) alternative site evaluations.

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LIST OF ABBREVIATIONS

ASC	Automated Stacking Cranes
BIMP	Beach Inlet Management Plan
CDF	Confined Disposal Facilities
CIDMMA	Craney Island Dredged Material Management Area
COBRA	Coastal Barrier Resource Act
CSX	CSX Transportation Inc.
CY	Container Yard
DMMP	Dredge Material Management Plan
DTM	Digital Terrain Model
ESRI	Environmental Systems Research Institute
FAF	Freight Analysis Framework
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System
GLTF	Governor's Logistics Task Force
HMTF	Harbor Maintenance Trust Fund
MHC/RI	Morehead City/ Radio Island
MOTSU	Marine Ocean Terminal Southport
NC	North Carolina
NC-CREWS	North Carolina Coastal Region Evaluation of Wetland Significance
NCDOT	North Carolina Department of Transportation
NCIT	North Carolina International Terminal
NCRR	North Carolina Railroad Company
NCSPA	North Carolina State Port Authority
NEPA	National Environmental Policy Act
NFIP	National Flood Insurance Program
NPDES	National Pollution Discharge Elimination System
NS	Norfolk Southern
ODMDS	Ocean Dredged Material Disposal Site
POW	Port of Wilmington
Ro/Ro	Roll-on/ Roll-off
RTG	Rubber Tired Gantry Crane
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act
SAV	Submerged Aquatic Vegetation
SHA	Strategic Habitat Area
STIP	State Transportation Improvement Program
TEU	Twenty-Foot Equivalent Units
USACE	U.S. Army Corps of Engineers
USDOT	United States Department of Transportation
USGS	United States Geologic Survey

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1 INTRODUCTION

The AECOM/ URS team (Team) conducted an assessment to determine the feasibility of potential deep-water port sites that could accommodate new development for potential container terminal operations. The assessment included site selection, environmental screening, and site assessment using a three-tiered approach. The entire analysis considered the following: 1) land suitability, 2) infrastructure proximity, 3) general meteorological and oceanographic factors, 4) dredging elements and navigation factors and costs, and 5) alternative site evaluations.

The analysis screened and identified six potential port sites, including alternatives for the Port of Wilmington (POW) and the Port of Morehead City (MHC). The screening criteria are outlined below.

- Tier 1 - this screening process began with a broad-level screening of locations and major constraints that could preclude port development in some regions versus others.

- Tier 2 – this analysis screened and evaluated coastal areas brought forward from the Tier 1 screening to select sites available for future port development. The screening first identified potential port sites and then an environmental screening was conducted to rate each site as having either high, medium, or low suitability as potential port sites.

- Tier 3 – this screening conducted a site-specific evaluation for alternatives brought forward from Tier 2. It included detailed cost estimates for construction (capital investment costs) and operation (maintenance costs) for a more refined comparison of each alternative.

The following sections describe the site assessment methods and the results of the screening process which assessed sites available for port development.

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2 TIER 1 - MAJOR CONSTRAINTS ANALYSIS

The Tier 1 screening was conducted using a GIS-based evaluation of port terminal development to determine major constraints which would preclude development due to legal, regulatory, environmental, and/or existing development. Examples of major constraints include protected areas, military bases, existing commercial and residential areas, and national and state parks. The Tier I screening assessed shoreline areas within the following North Carolina coastal counties:

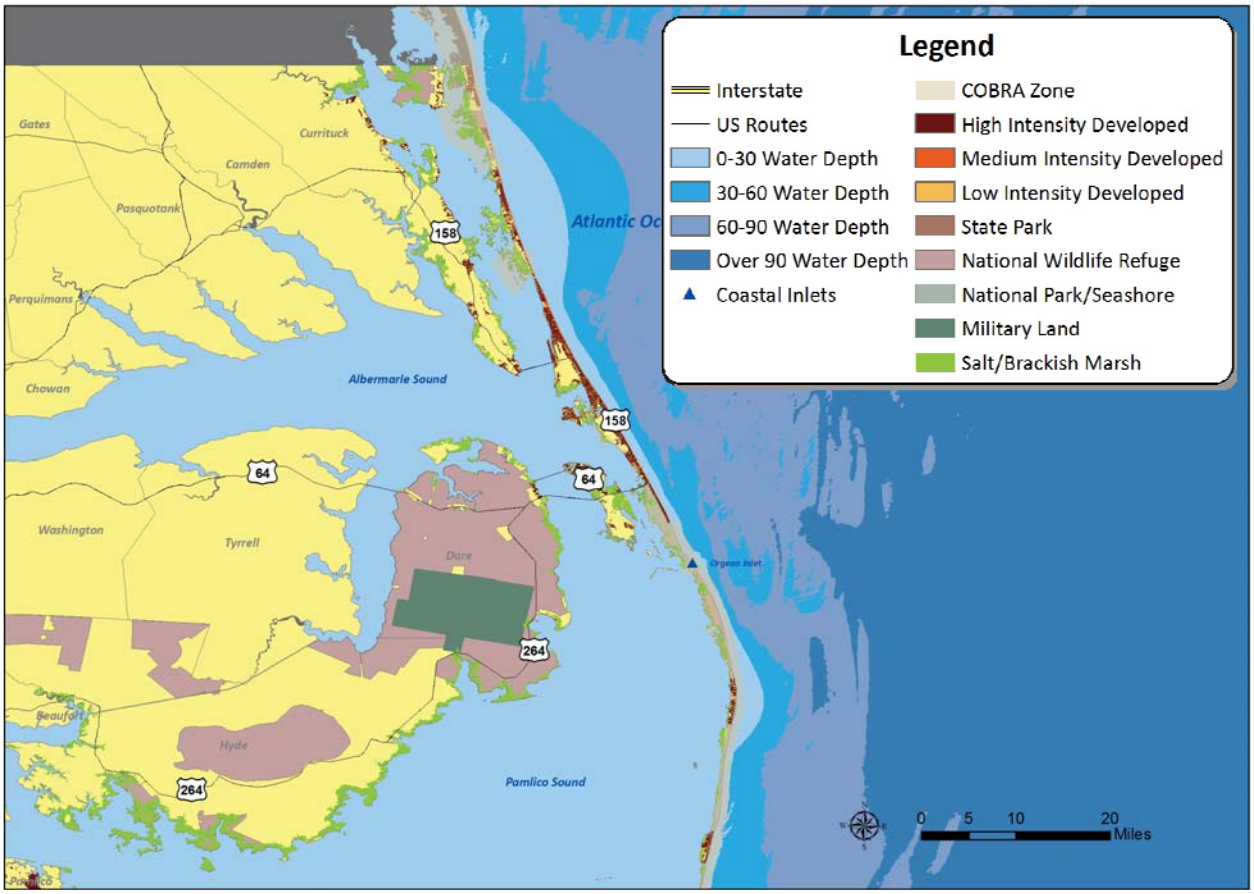
- Currituck,
- Dare,
- Pamlico,
- Hyde,
- Onslow,
- Pender,
- Carteret,
- New Hanover, and
- Brunswick.

The analysis determined each coastal county's shoreline area that was not available for development. For example, the Cape Hatteras seashore is comprised predominantly of federally-designated lands and protected natural resources. Many of these areas are additionally designated as COBRA (Coastal Barrier Resource Act) zones. Combined, these major constraints preclude any further consideration for port elements such as deep-water inlets (for port access) and also potential terminal locations. Developed residential areas are also shown and were excluded from further evaluation. The Tier 1 analysis utilized the following constraints as benchmarks for significant factors of consideration for sites deemed not suitable for deep-water port development:

- COBRA zones,
- Federal, State, and County Parks / National Seashore,
- Federal and State Wildlife and Waterfowl Refuges / Management Areas,
- Concentrated developed areas (parcel data, USGS land cover data and land use data), and
- Areas of salt/brackish marsh.

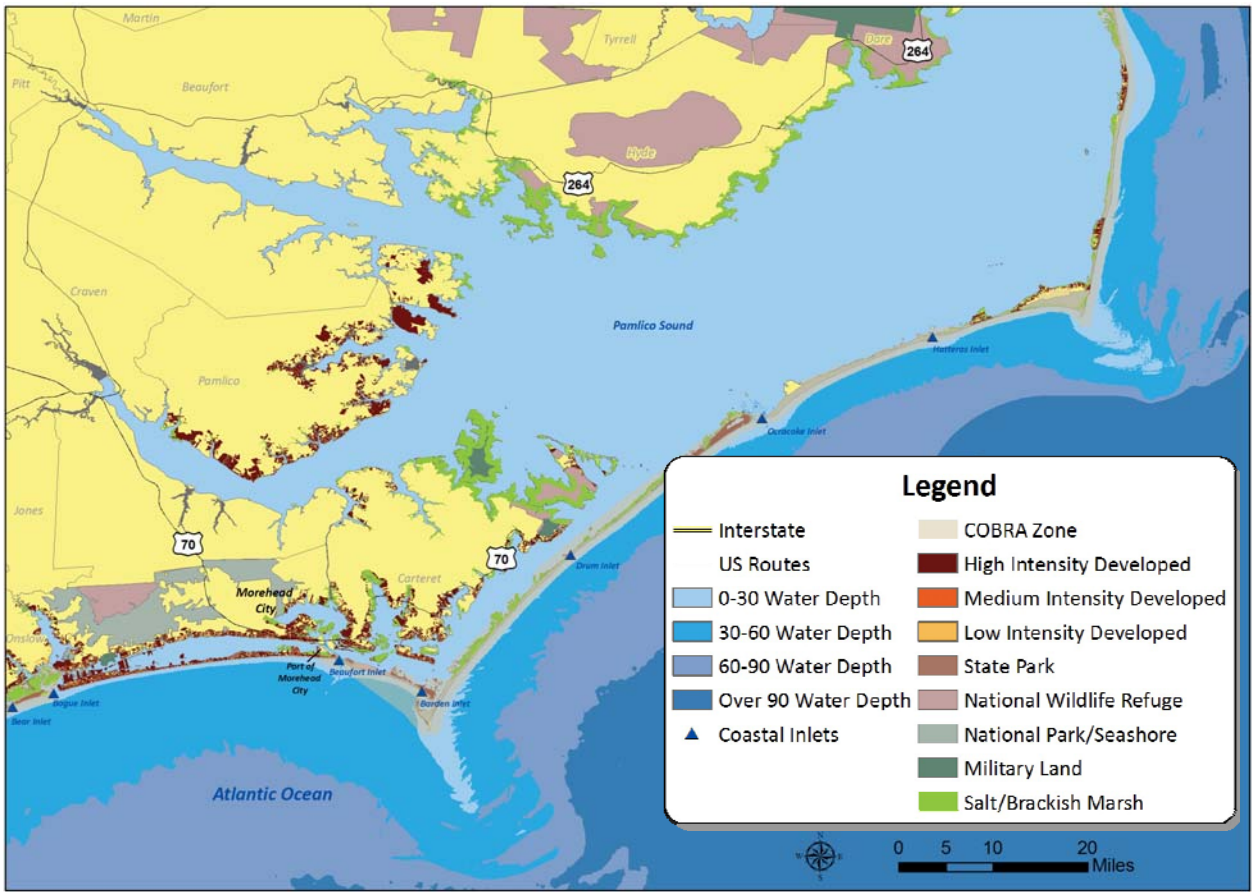
The assessment of the Tier 1 screening criteria defined areas with resources that are protected or preserved through legal and regulatory programs, and/or are developed areas that may be precluded from further evaluation as potential deep-water port sites. Sites that contain areas of salt/brackish marsh were not necessarily removed from further consideration. Combined constraints are mapped to illustrate the results of Tier 1 screening (see Figure 1, Figure 2, and Figure 3). The mapped areas depict water depth although bathymetry was initially considered not a constraint to development.

Figure 1: North Carolina Maritime Tier 1 Screening – Combined Constraints



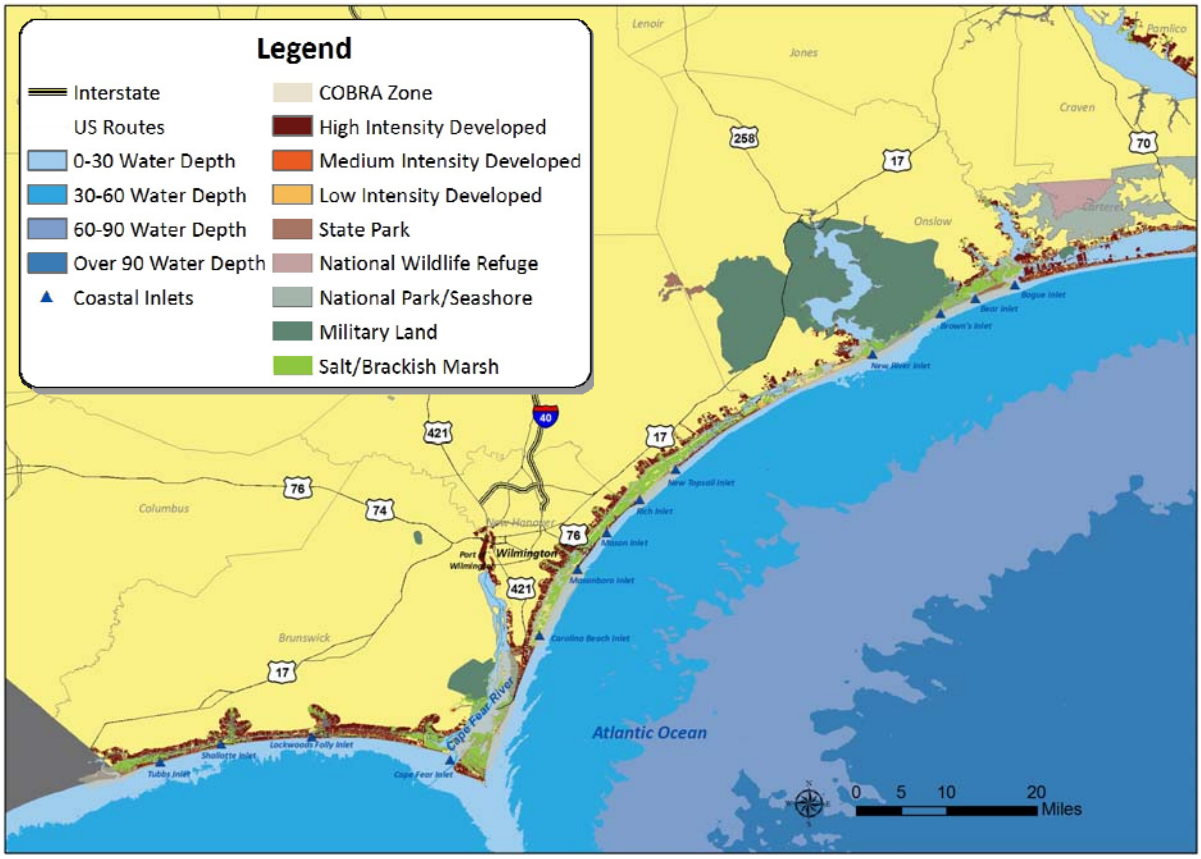
Source: ESRI, NCDOT, USDOT Freight Analysis Framework v3.1, USGS ThematicMapping world borders dataset, Seamap-SA, 2001 and Moser and Taylor, 1995.

Figure 2: North Carolina Maritime Tier 1 Screening – Combined Constraints



Source: ESRI, NCDOT, USDOT Freight Analysis Framework v3.1, USGS ThematicMapping world borders dataset, Seamap-SA, 2001 and Moser and Taylor, 1995.

Figure 3: North Carolina Maritime Tier 1 Screening – Combined Constraints



Source: ESRI, NCDOT, USDOT Freight Analysis Framework v3.1, USGS ThematicMapping world borders dataset, Seamap-SA, 2001 and Moser and Taylor, 1995.

3 TIER 2 - SITE SELECTION AND LAND SUITABILITY ANALYSIS

3.1 Methodology and Results

The Team collected and assembled available data to further define potential port sites within the unconstrained areas identified in the previous Tier 1 screening. The identification of potential deep-water port sites was conducted in a two-step process: 1) using Geographic Information System (GIS) based parcel data in a computerized site-selection analysis, and 2) verifying and modifying information based on input from team members utilizing professional judgment.

The GIS analysis selected vacant single or multiple contiguous parcels with a minimum of 3,000 linear feet of shoreline frontage and 300 acres of adjacent available land. Nine sites were initially selected through a GIS parcel search, but three were eliminated since they did not meet all of the site criteria. The evaluation of alternatives included the existing Port of Wilmington and the existing Port of Morehead City. The six sites are shown in Figure 4 and described below.

- Site 1 Pamilico Sound, Parch Corn Bay, near the Town of Vandemere
- Site 2 Pamlico Sound, Bonner Bay, east of the Community of Stonewall
- Site 3 Beaufort Inlet, Radio Island, adjacent to the Port of Morehead City
- Site 4 Cape Fear River, River Road Southeast
- Site 5 Cape Fear River, Port of Wilmington
- Site 6 Cape Fear River, near the Town of Southport

The six sites carried forward were assessed using a GIS land suitability analysis. The Tier 2 analysis used GIS to create, query, and analyze the environmental criteria data. The analysis rated the potential port sites based on their relative proximity to the environmental criteria listed below and assessed land use based on current zoning designations, current land use and future land use designations. The environmental criteria used to analyze alternatives were selected referencing the National Environmental Policy Act (NEPA), Federal Highway Administration (FHWA) guidance document, titled “SAFETEA-LU Environmental Review Process Final Guidance," November 15, 2006. Criteria used to evaluate land suitability for coastal planning, developed by the NC Division of Coastal Management, were also used. The Tier 2 criteria are listed below:

- Vacant contiguous parcels assembled to accommodate terminal space needs of ≥ 300 acres with ≥ 3,000 linear feet of shoreline frontage,
- Geology, Shell and Hard Bottom locations,
- Zoning and Future Land Use (compatibility),
- NC Coastal Region Evaluation of Wetland Significance (NC-CREWS),
- Proximity to Significant Natural Heritage Areas,
- Proximity to Protected Land/Conservation Easements,
- Proximity to National Pollution Discharge Elimination System (NPDES),
- Proximity to protected resources (including National Register properties and Districts),
- Proximity to Public Water Wells,

- Proximity to Submerged Aquatic Vegetation (SAV) / Shellfish Growing Areas / Primary Nursery Areas, and
- Proximity to Designated Critical, Threatened, and Endangered Species Habitats.

The land suitability analysis is based on the NC Division of Coastal Management's Land Suitability Model. The criteria for suitability for development (high, medium and low suitability) were identified as areas located within, or within a specified distance from the following:

- Within coastal wetlands – low suitability;
- Within 500 ft. of Significant Natural Heritage Areas – low suitability;
- Within 500 ft. of Protected Land – low suitability;
- Within 500 ft. of Public water wells/aquifer – low suitability;
- Within 500 ft. of NPDES sites – low suitability;
- Within Hazardous Waste Disposal Site – low suitability;
- Within 500 ft. of Submerged Aquatic Vegetation (SAV) / Shellfish Growing Areas / Primary Nursery Areas, and Hard Bottom areas – low suitability;
- Within 500 ft. of Designated Critical, Threatened, and Endangered Species Habitats – low suitability;
- Within a zoned port or industrial area - high suitability; and
- Within ½ mile of existing roadway or rail infrastructure - high suitability.

Values assigned are -2 (negative 2), +1, and +2 (positive 2) for low, medium and high suitability, respectively. For example, an area that is within 500 feet of a Significant Natural Heritage Area has a low suitability rating, so it receives a score of "-2". An area that is close to existing roadway or rail infrastructure has a high suitability for development, so it receives a score of "+2". If they are within one-half to one mile of infrastructure they receive a score of "+1", and if they are greater than one mile from infrastructure they receive a score of "-2". The Land Suitability Model was modified by adding data not originally included in the model, and including shellfish growing areas, hard bottom, shell bottom, and fish nursery areas. The scoring results range from "+9" for Site 1, Pamlico Sound, Parch Corn Bay, to "-17" for Site 4, Cape Fear River, and River Road Southeast. The results of the Land Suitability Analysis are provided in Table 1.

Table 1: Tier 2 Environmental Screening Results

High Suitability
Site 1 - Pamlico Sound Parch Corn Bay – Score of +9
Medium High Suitability
Site No. 2 – Pamlico Sound Bonner Bay - Score of +6 Site No. 6 – Cape Fear River, Southport – Score of +5 Site No. 3 - Carteret County MHC and Radio Island – Score of +5
Medium Low Suitability
Site No. 5 – New Hanover County POW – Score of +2
Low Suitability
Site No. 4 – Brunswick County Cape Fear River, River Road Southeast – Score of -17

The Tier 2 analysis also included a quantitative assessment of resources contained within the proposed sites, and within a one-mile buffer surrounding each site. These data are provided in the appendix. All of the environmental criteria listed above, with the exception of land use and zoning, were quantified and supporting data are provided in the appendix. The environmental

criteria assessed included point data and area acreage, which was quantified using GIS to calculate the resources contained within the site and a one-mile buffer area. This analysis identifies the areas and locations of resources mapped using GIS data sets (See Figure 5 through Figure 10). Actual field surveys would be required to definitively indicate the presence and abundance of resources identified within the selected sites.

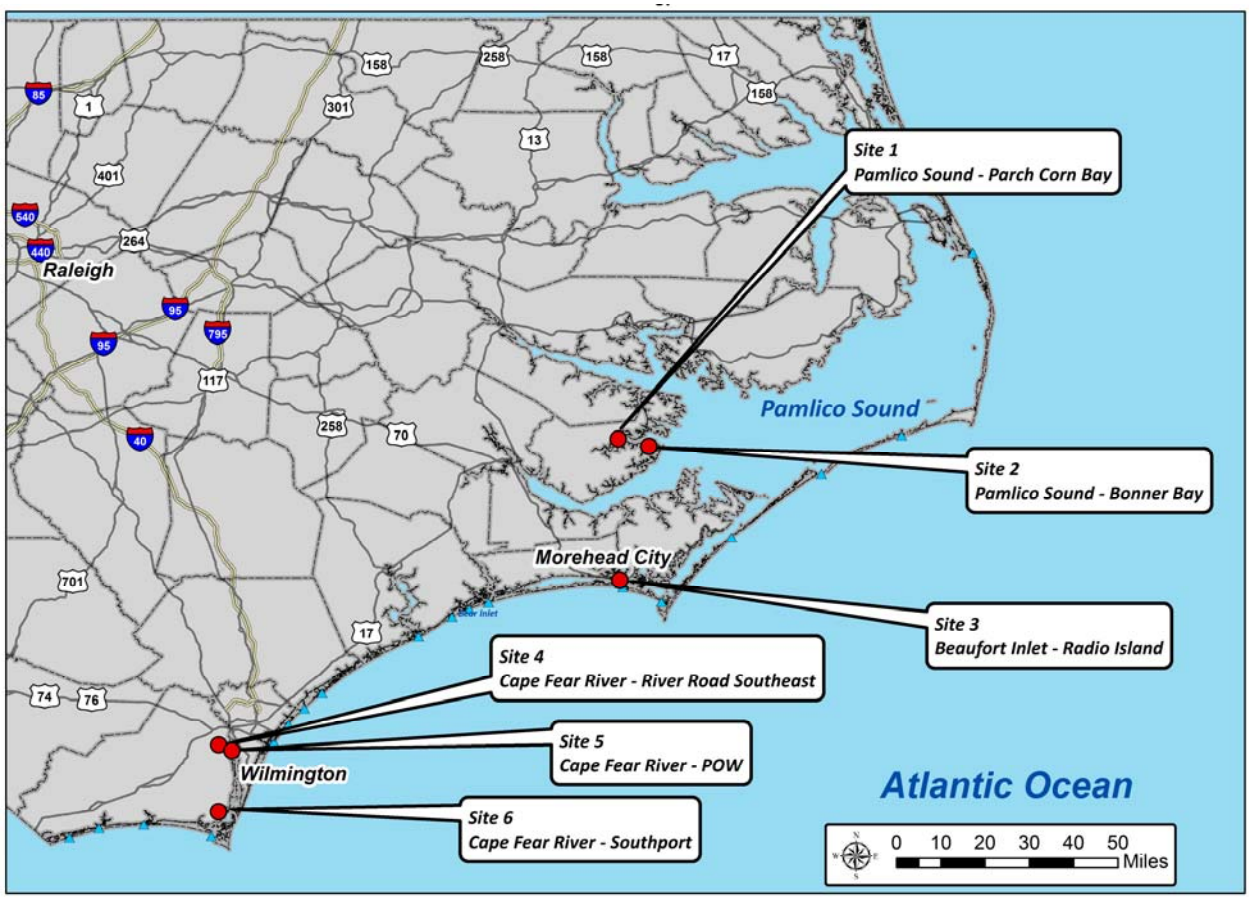
3.2 Discussion

Significant Natural Heritage Areas were identified within Site 3, Radio Island; Site 4, River Road Southeast; and Site 5, Cape Fear River, POW. A 100-foot buffer parallel to the shoreline of each site was used to conduct a waterside environmental screening to account for the proposed berths. All of the sites contained shellfish growing areas, all but Site 3 and Site 6 contained fish nursery areas, and all contained wetlands except Site 3 and Site 5. None of the sites contained protected lands, historic properties, public water wells, hard bottom areas, or mapped Threatened and Endangered Species.

It is notable that the identification of Strategic Habitat Areas (SHA's) for marine and coastal resources has been conducted (by others) for northern coastal areas of the state only, including Pamlico Sound. This assessment, a component of the adopted NC Coastal Habitat Protection Plan (CHPP), defines strategic habitat areas as locations of fish habitat, or systems of habitats that provide exceptional habitat functions or are at-risk due to imminent threats, vulnerability, or rarity. The Pamlico County Bonner Bay site is identified as a SHA. This assessment has not been completed for the other sites, so it was not utilized in the GIS analysis.

Sites were assessed using existing zoning, as well as current and future land use designations. The Port of Wilmington, Port of Morehead City, portions of Radio Island, and the Southport site are owned by the NC State Ports Authority and are zoned for port and heavy and general industrial uses. The Cape Fear River, River Road Southeast site is currently zoned Rural Residential which permits low density residential development and non-residential agricultural uses that rely on individual water wells and individual septic systems. This site contains large expanses of wetlands. Currently, Pamlico County does not have a zoning ordinance; however, the Current Land Use Map (November 2004) shows the Pamlico Sound depicting Parch Corn Bay site as wooded area and Pamlico Sound Bonner Bay site as open land. The Pamlico County Future Land Use Map (November 2004) designated a portion of the Parch Corn Bay as Town Center, and a portion as rural with services. The Bonner Bay site is designated as conservation. The Future Land Use Map is intended to serve as a guide for planning future projects in Pamlico County and describes where growth is intended to occur, and the general location of resources the County wishes to conserve.

Figure 4: North Carolina Maritime Strategy Tier 2 Site Selection



Sources: ESRI, NCDOT, USDOT Freight Analysis Framework v3.1, USGS Thematic Mapping world borders dataset, Seamap-SA, 2001 and Moser and Taylor, 1995.

Figure 5: Site 1 – Pamlico Sound – Parch Corn Bay – North Carolina Maritime Strategy Tier 2 Screening – Environmental Screening Criteria

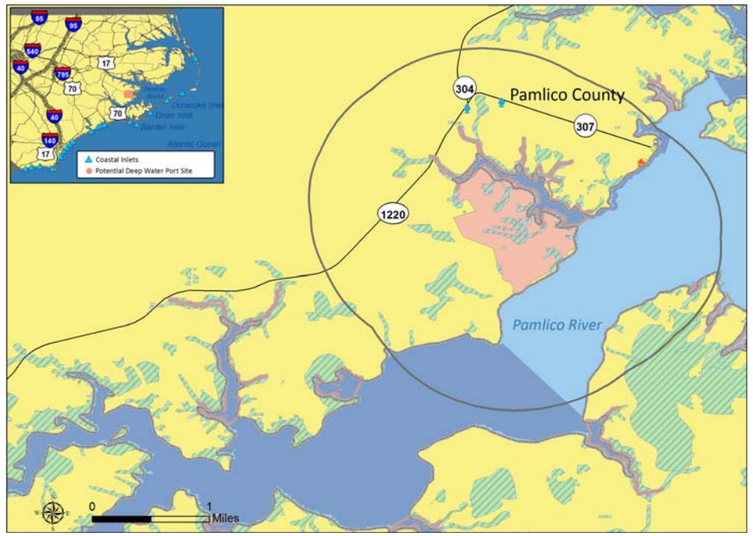


Figure 6: Site 2 – Pamlico Sound – Bonner Bay – North Carolina Maritime Strategy Tier 2 Screening – Environmental Screening Criteria

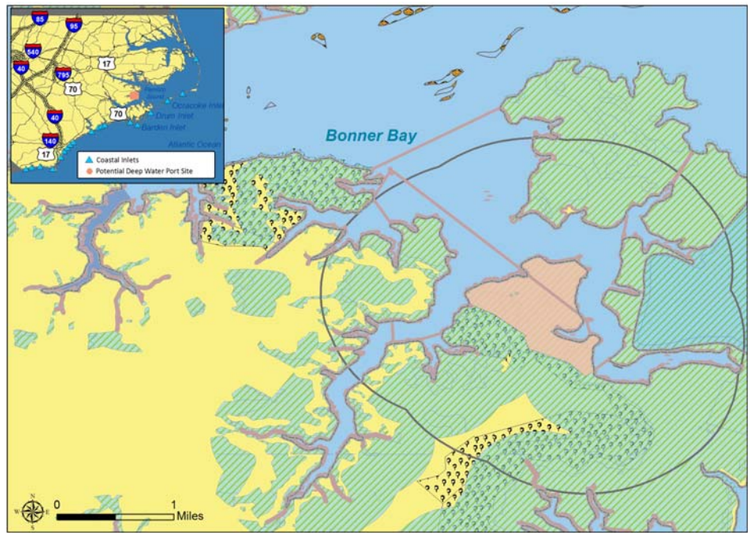
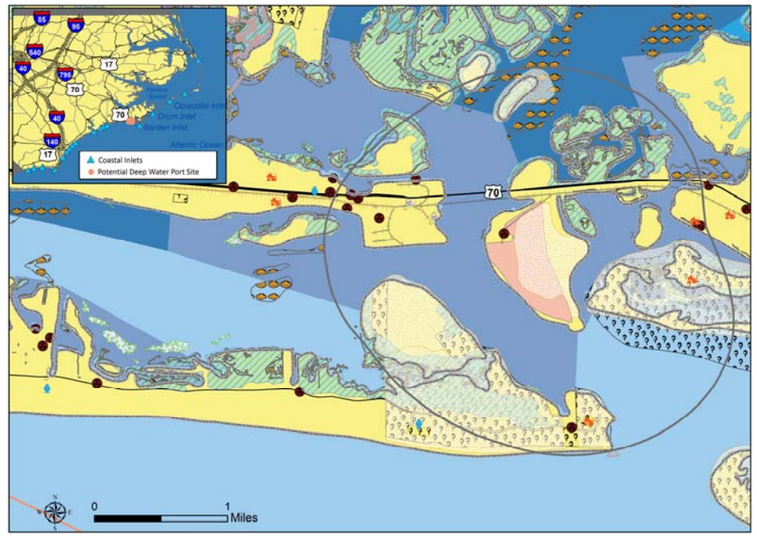
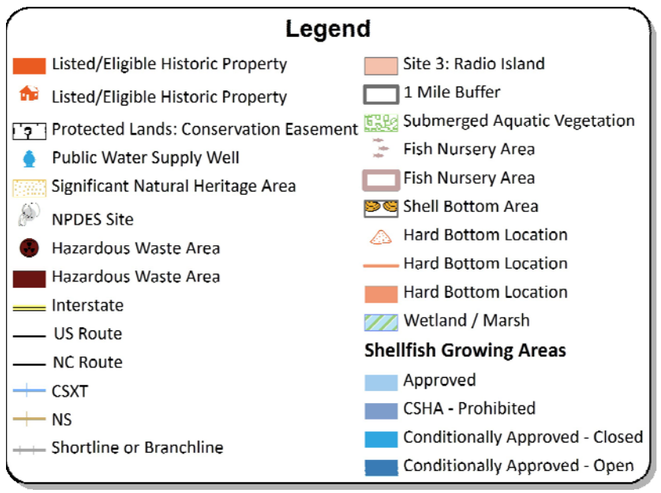


Figure 7: Site 3 – Radio Island – North Carolina Maritime Strategy Tier 2 Screening – Environmental Screening Criteria





Source: AECOM/URS from ESRI, NCDOT, FAF 3.1, USGS ThematicMapping with world borders dataset, Seamap-SA 2001, and Moser and Taylor, 1995

Figure 8: Site 4 – River Road – North Carolina Maritime Strategy Tier 2 Screening – Environmental Screening Criteria

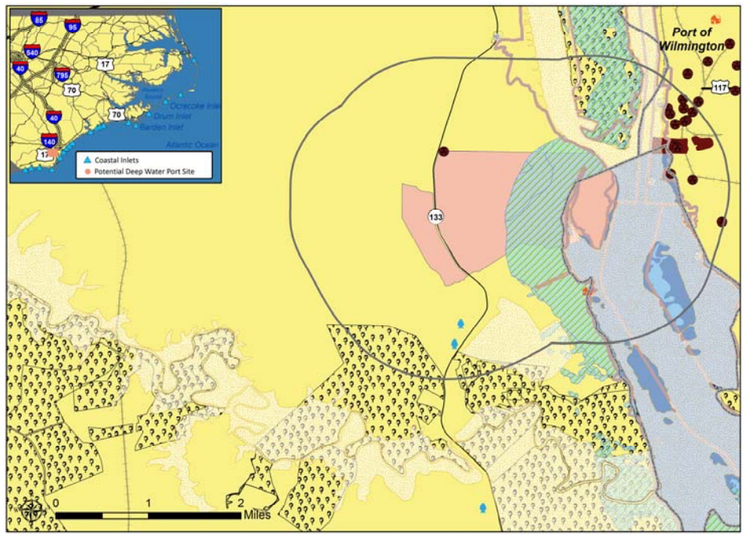


Figure 9: Site 5 – Cape Fear River – Port of Wilmington – North Carolina Maritime Strategy Tier 2 Screening – Environmental Screening Criteria

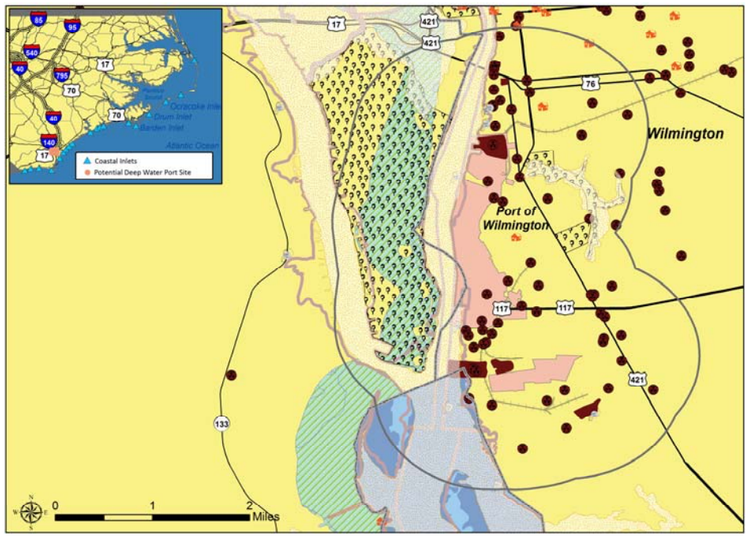
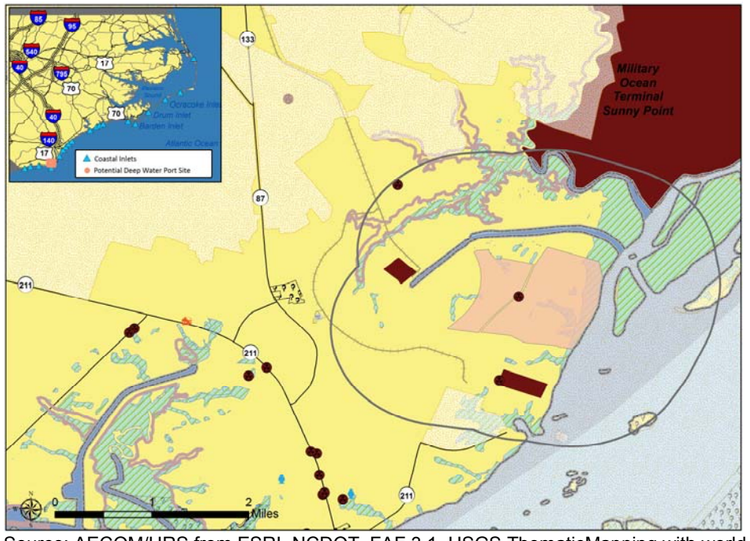
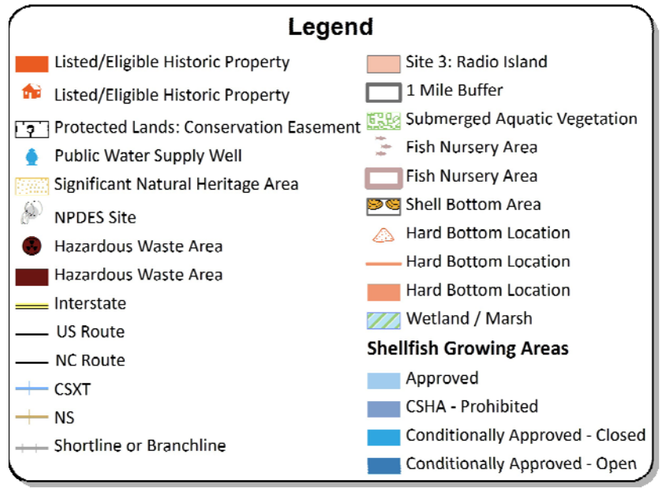


Figure 10: Site 6 – Cape Fear River – Site 6 – Southport– North Carolina Maritime Strategy Tier 2 Screening – Environmental Screening Criteria





Source: AECOM/URS from ESRI, NCDOT, FAF 3.1, USGS ThematicMapping with world borders dataset, Seamap-SA 2001, and Moser and Taylor, 1995

4 TIER 2 - INFRASTRUCTURE SCREENING

The Tier 2 analysis also includes a qualitative and quantitative assessment of the existing North Carolina roadway network's proximity to the proposed port alternative sites. Approximate times and distances from each port site are presented below.

Table 2: Roadway Screening Times and Distances

2007 Road Screening Criteria	Site 1 – Pamlico Sound, Parch Corn Bay	Site 2 – Pamlico Sound, Bonner Bay	Site 3 – Beaufort Inlet, Radio Island	Site 4 – Cape Fear River, River Road Southeast	Site 5 – Existing Wilmington Port	Site 6 – Cape Fear River, Southport
Time from potential port to an interstate	1 hr 43 min	1 hr 41 min	1 hr 48 min	25 min	11 min	58 min
Distance from potential port to an interstate (mi)	84	83	77	10	7	34
Time from potential port to Charlotte	5 hr 55 min	5 hr 54 min	6 hr 4 min	4 hr 5 min	4 hr 17 min	4 hr 34 min
Distance from potential port to Charlotte (mi)	276	277	306	203	205	225
Time from potential port to Greensboro	4 hr 51 min	4 hr 50 min	5 hr 8 min	4 hr 25 min	4 hr 4 min	4 hr 55 min
Distance from potential port to Greensboro (mi)	230	228	244	223	228	245

*Closest FAF road is 8 miles straight Line from Site 2
Source: Freight Analysis Framework, version 3.1, 2010

The routes from each site alternative to the selected nodes were assumed to be current truck routes and were selected with truck freight transportation in mind. The most direct routes were not necessarily used if the roadways were not freeways or four-lane divided highways; rather, freeways and multi-lane divided facilities were given preference if they provided a reasonable and close alternative to a more direct route. In several instances, prior knowledge of preferred truck routes and engineering judgment were used to determine which routes should be utilized for the travel time and distance analysis. However, in most cases, there was a reasonably obvious route from the port locations to the nodes.

The results displayed in Table 2 show data that is consistent with the routes chosen. Routes that mainly consist of freeways are clearly faster than routes that mainly consist of multi-lane divided facilities and other types of roadways. Three of the port sites are located significantly closer to interstate highways than the other three sites, which provide much quicker and easier access to the North Carolina roadway network. It should be noted that the proposed Site 2, Bonner Bay in Pamlico County is located eight miles from any roadway on the Freight Analysis Framework (FAF) produced by the Federal Highway Administration in 2007. Because of this, the closest roadway was used as the origin point. All other sites include FAF roadways within or adjacent to them.

Table 3 provides a qualitative roadway analysis.

Table 3: Roadway Qualitative Analysis

SITE NAME	SITE LOCATION
SITE 1: Pamlico County, Parch Corn Bay	**LOCATION: Immediately southwest of the Town of Vandemere**
4-lane Divided Facility Network: The closest truck network divided facility is on NC 55 east of the Town of Bridgeton (17 miles). East of that point, NC 55 is a multi-lane, un-divided facility to the Town of Bayboro. Past Bayboro, there are no multi-lane facilities. There is a 1-mile section of undivided highway on US 70 in the City of Kinston.	
Freeway Facility Network: The closest freeway is US 70 in the City of New Bern, but US 70 is not connected to the Interstate network. The closest network facility is US 264 in the City of Greenville (67 miles). Via US 70, the closest network freeway is I-795 in the City of Goldsboro and further east, the US 70 Bypass in the Town of Clayton.	
Railroad Facilities: There are no rail lines within 10 miles of the proposed site. The closest rail line is a Class 1 Norfolk Southern line located approximately 11.2 miles to the northwest.	
SITE 2: Pamlico County, Bonner Bay	**LOCATION: South side of Bonner Bay**
4-lane Divided Facility Network: The closest facility is on NC 55 east of the Town of Bridgeton (25 miles). East of that point, NC 55 is a multi-lane divided facility to the Town of Bayboro. Past Bayboro, there are no multi-lane facilities. There is a one-mile section of undivided highway on US 70 in the City of Kinston.	
Freeway Facility Network: The closest freeway is US 70 in the City of New Bern, but US 70 is not connected to the network. The closest network facility is US 264 in the City of Greenville (67 miles). Via US 70, the closest network freeway is I-795 in the City of Goldsboro and further east, the US 70 Bypass in the Town of Clayton.	
Rail Facilities: There are no rail lines within 20 miles of the proposed site. The closest rail line is a Class 1 Norfolk Southern facility located approximately 21.5 miles to the northwest around the Cape Fear River.	
SITE 3: Carteret County, Port of Morehead City and Radio Island	**LOCATION: Radio Island**
4-lane Divided Facility Network: With the exception of a one-mile section in the City of Kinston, US 70 will be a multi-lane divided highway from NC 24 in the Town of Morehead City (6 miles) until reaching I-40 in the Town of Garner. STIP Project No. R-3307 will make US 70 a four-lane divided facility from the Town of Morehead City to the Town of Beaufort.	
Freeway Facility Network: The closest freeway is US 70 in the City of New Bern, but is not connected to the interstate network. The closest freeway facility will be US 17 Hampstead Bypass (STIP Project No. R-3300) (77 miles). Via US 70, the closest interstate network is I-795 in the City of Goldsboro (104 miles).	
Rail Facilities: There is a Class 3 rail line on the property of the proposed site. Less than one mile to the west, there is a NCRR Class 1 rail line which currently accesses the Port of Morehead City.	
SITE 4: Brunswick County, Cape Fear River Southeast, River Road Site	**LOCATION: Southwest of Wilmington in Brunswick County**
4-lane Divided Facility Network: The closest facility is US 17 in Leland (6 mi.). NC 133 is multi-lane	

SITE NAME	SITE LOCATION
(R-4002), but not divided, near the interchange with US 17.	
Freeway Facility Network: The closest freeway is US 17 in Leland (6 mi.). US 17 will connect with I-140 (R-2633) which is an interstate freeway.	
Railroad Facilities: There are no rail lines that lead directly to the proposed site property. There is a Class 0 U.S.G. rail line that lies approximately 2.4 miles to the west of the site.	
SITE 5: New Hanover County, Port of Wilmington	**LOCATION: Existing Port Site**
4-lane Divided Facility Network: The current Port of Wilmington has a 4-lane divided facility to the gate, but is not connected to the network. The closest 4-lane divided facility connected to the network is US 17 (4 mi.).	
Freeway Facility Network: The closest freeway is US 17 over the Cape Fear River (4 mi.). US 17 will connect with I-140 (R-2633) which is an interstate freeway.	
Rail Facilities: There is a Class 1 CSX rail line leading directly to the property.	
SITE 6: Brunswick County, Southport Site	**LOCATION: Northeast of Southport**
4-lane Divided Facility Network: The closest facility is US 17 via NC 87 (17 mi.).	
Freeway Facility Network: The closest freeway will be I-140 (R-2633) which is an interstate freeway (20.5 miles).	
Rail Facilities: There are several Class 0 U.S.G. rail lines in the vicinity of the proposed site, mainly associated with the Military Ocean Terminal at Sunny Point (MOTSU).	

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5 WATERSIDE SCREENING TIER 2 - IMPACTS

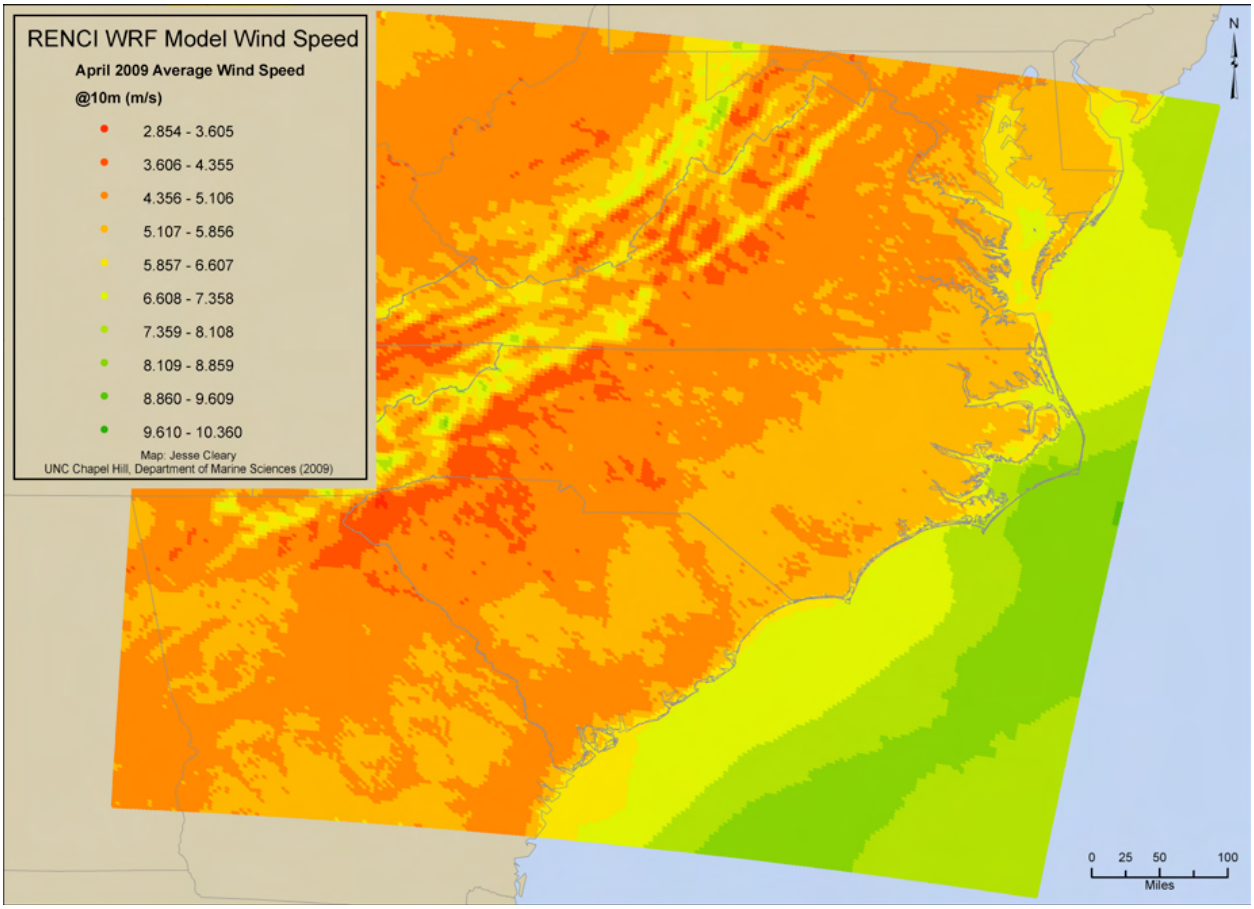
The Tier 2 analysis also integrates water access factors into the screening process criteria, which includes a general and relative comparison of deep-water port sites with respect to Meteorological-Oceanographic (met-ocean) factors such as winds, waves, water levels, currents, and sedimentation inlet. These factors consider the safe, efficient, and cost-effective navigation of vessels to/from the port. Operations, waterside access, and additional environmental factors are also included following the met-ocean comparison of sites.

5.1 Winds

Wind parameters are of interest for port locations, operations, and safe navigation of vessels to/from a port. For severe conditions, mariners consider a storm's track and 34-knot winds, which are considered to be a threshold impacting safe maneuverability of a vessel. In the onset of a storm event, mariners may decide to move vessels to other ports for safe harbor. All port alternatives can be subject to severe winds from storms (i.e., tropical storms, hurricanes, and nor-easters). In this regard, they are essentially under the same threat and no further distinction for severe winds is considered.

The average wind speed provides a relative indication of variances from one proposed site to another. A recent study of wind speeds, *Coastal Wind – Energy for North Carolina's Future* (UNC, 2009) reveals spatial variability in winds along the NC coast. As shown in Figure 11, average wind speeds in a sample month (April) are greatest in the mid-coast region of NC including Cape Lookout (near Morehead City), Pamlico Sound, and Cape Hatteras. Note that sites 4, 5, and 6 have slower average speeds than the other sites (and are sheltered by surrounding lands), which suggests that conditions "on the average" may be more suitable there for vessels than other sites further north. However, other factors exist including the direction of maneuvers with respect to the direction of winds such as is the case for maneuvering the S-turn at the POW.

Figure 11: Average Wind Speeds at 10 m Elevation for April 2009



Source: http://www.climate.unc.edu/coastal-wind
Note: Here, red = slowest winds, better conditions; yellow = moderate winds, good conditions; green = fastest winds, less favorable conditions.

From the perspective of average daily vessel operations, areas with average high winds are more difficult (least favorable) to navigate and maneuver than areas with milder wind climates (most favorable). In regards to average wind speeds, sites further south of Cape Hatteras may be considered more favorable.

5.2 Waves

Wave parameters considered for a potential port site include: wave heights, period, direction, and duration. These parameters often correlate to the wind conditions or climates. Operationally, areas with high wave exposure (least favorable) such as offshore increase the severity of heave, pitch, yaw, and roll of vessels and can negatively impact vessel safety and operations. Inland terminal sites surrounded by terrain features tend to have smaller wind fetch distances, which limits the growth of waves (more favorable). Construction and maintenance of ports subject to high wave heights and longer period waves are typically more costly (less favorable) than ports with milder wave conditions. Larger wave climates would require more substantial structural features (such as breakwaters, bulkheads, seawalls, jetty's, and moorings)

to withstand significant wave loads; collectively, this would increase construction costs for various port structures subject to larger wave conditions.

5.3 Water Levels and Currents

The variability in water levels and currents at a site are affected by astronomical (tide) and meteorological (winds, wave setup, atmospheric pressure, etc.) forces. For inshore and inland locations, river flows (and currents) can also contribute to water level variations and currents. For port operations, several tide parameters are of interest for ports, which include the tide range, type, duration, and average highs and lows. For various locations along the NC coast, tide parameters of interest for potential port locations are summarized in Table 4.

Table 4: NC Tide Datum

Site Relation	Far north of Pamlico Sound	North end of Pamlico Sound	MHC & Radio Island	POW area	Southport	Far west of Southport near SC border
Datum	Duck, NC Sta 8651370 (1977-present)	Oregon Inlet Marina, NC Sta 8652587 (1974-present)	Beaufort, NC Sta 8656483 (1964-present)	Wrightsville Beach, NC Sta 8658163 (2004-present)	Southport, NC Sta 8659084 (1974-2008)	Sunset Beach, NC Sta 8659897 (1974-2008)
Mean Higher High Water (MHHW)	3.69	1.17	3.54	4.29	4.73	5.51
Mean High Water (MHW)	3.37	1.02	3.26	3.95	4.40	5.12
Mean Tide Level (MTL)	1.76	0.58	1.70	2.05	2.28	2.65
Mean Sea Level (MSL)	1.77	0.58	1.71	2.03	2.32	2.66
Mean Low Water (MLW)	0.14	0.13	0.15	0.15	0.16	0.18
Mean Lower Low Water (MLLW)	0.00	0.00	0.00	0.00	0.00	0.00
North American Vertical Datum (NAVD)	2.19	0.67	No Data	2.44	2.78	No Data
National Geodetic Vertical Datum (NGVD)	1.23	-0.34	No Data	No Data	1.68	No Data
Maximum	6.92	5.66	6.29	6.92	6.88	7.56
Max Date	8/30/1999	9/16/1999	9/16/1999	10/9/2006	12/2/1986	10/9/2006

Source: BIMP, 2011

Tidal influences on water levels will impact vessel loads, sail times, and maneuverability. Some vessels heavily loaded can only make a call during high tide conditions. The sail distances/times are impacted by water levels also (e.g., for long sail distances such as with inland port terminals, some vessels have to schedule entry and departure times around the tide, which can be costly if delayed by extreme tide conditions). For inland locations such as along tidally influenced rivers, the interaction of currents with respect to the ebb and flood of the can create more difficult mooring conditions (less favorable).

For extreme water levels, storm surge, wave setup, and currents are of concern and can vary significantly between inland and offshore port locations. Coupled with extreme wave conditions, storm surge protection measures for offshore structures would be much more substantial (more costly and less favorable) for offshore facilities versus more acquiescent inland locations.

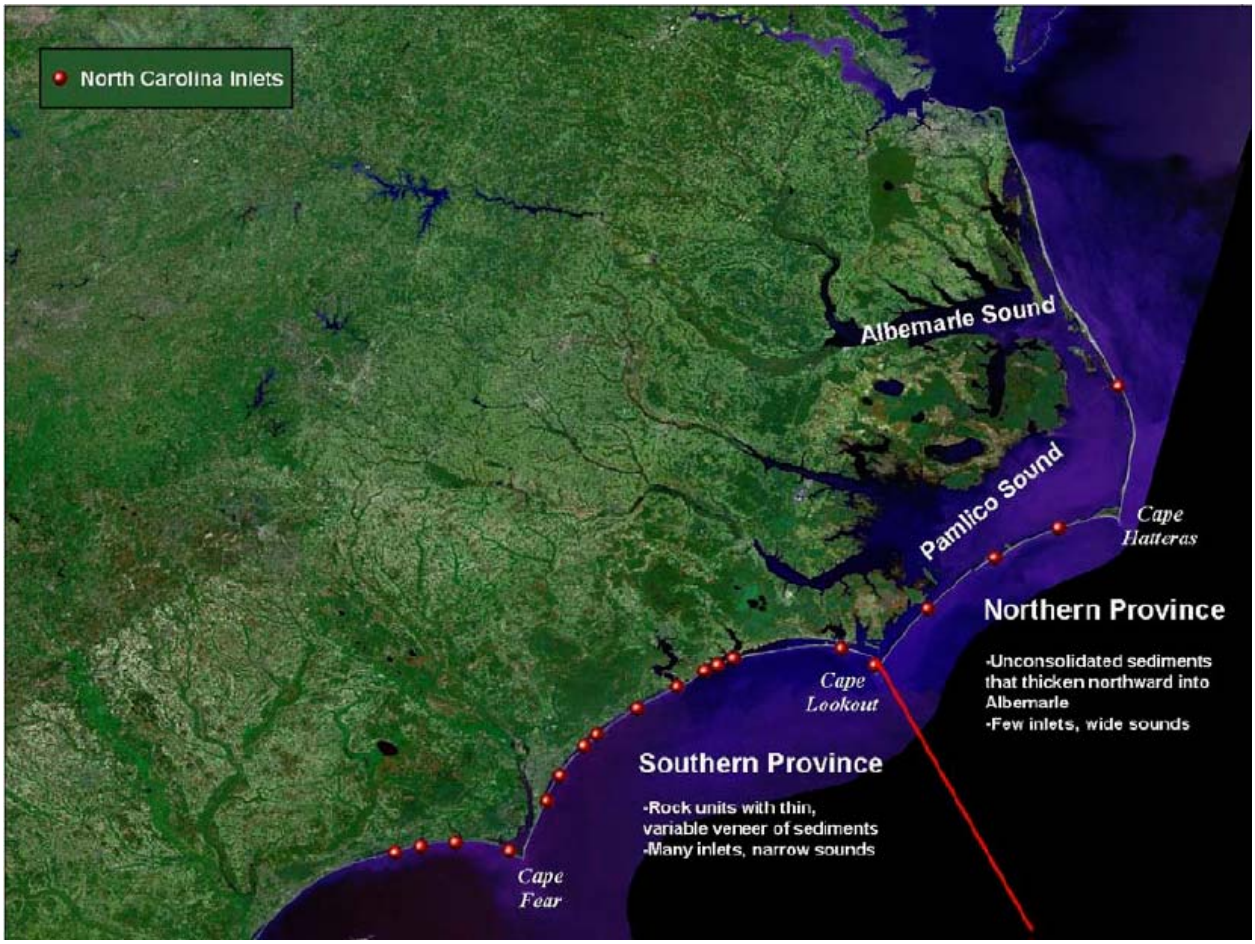
As shown in Table 4, the tide range decreases moving north along the coast. In this regard, the Port of Morehead City (especially with a much shorter sail distance) would be more favorable than ports at Wilmington. Likewise, alternatives inland of Pamlico Sound, with a smaller tide range might be considered more favorable. However, because of the sail distance, these sites would not be able to capitalize on the tide range as would be the case at Morehead City.

5.4 Sediments

Costs for dredging, managing, shoaling, and maintaining viable disposal options of sediments will be impacted by the inshore and offshore geology (and stratification of sedimentary layers such as unconsolidated sediments, rock, solidified coquina, or limestone) and coastal processes. The sedimentation rates within a region will impact shoaling and management strategies depending on the location of terminal facilities within a prospective water body.

Past geologic and geotechnical investigations (by NC universities, USACE, and others) indicate that the southern province offshore of NC is characterized by multiple rock layers at or just beneath the ocean floor (see Figure 12). This is further substantiated by hard bottom features prevalent in the region. Most any deep-draft navigation projects, whether modifications of existing channels or new ones in the southern province will involve dredging into rock strata. Past port studies (NCSPA, 2011; NCIT, 2006; USACE 905b, 2010) further substantiate the significance of the rock material prevalent in existing and proposed navigation alternatives within this region. The rock poses a unique challenge for dredging contractors and would result in higher than normal dredging and disposal challenges and costs. In addition, this would involve blasting, a significant environmental impact that would require much more stringent permitting conditions and environmental monitoring requirements.

Figure 12: Offshore Geology of NC



Source: Figure II-11. Geologic Provinces of North Carolina from BIMP Section II Data Collection

In general, capital costs for dredging new channels will be higher than for modifying existing navigation channels. Following initial capital investments to dredge navigation channels to design depths, annual costs to maintain sedimentation or infilling of navigation channels is a significant cost factor. Ports with longer interior navigation channels are expected to have higher annual dredging costs to maintain (less favorable). Measures to reduce shoaling of port entrance channels include stabilization of inlets with jetty structures, which tends to reduce annual maintenance costs. In addition, they provide safer navigation passageways for vessels entering and leaving a port. In ports with unstabilized inlets, annualized dredging costs to maintain safe navigation depths are generally higher than are those with stabilized inlets such as with jetties.

Disposal options for inland sites will typically rely on upland Confined Disposal Facilities (CDFs). Unit costs for disposal at CDFs tend to be higher than for offshore disposal sites (e.g., ODMDS). Permitting for new disposal sites will be higher than using existing disposal sites. Beneficial use of dredge materials can reduce costs and can include beach nourishment of surrounding shorelines. For some locations, sediments dredged for navigation channels can be used to create a new port terminal, thus creating opportunities for cut/fill balancing (reducing costs).

5.5 Summary of Met-Ocean Screening

The five ports were evaluated according to met-ocean screening criteria mentioned previously and taking into account the broad spectrum of less favorable to most favorable screening criteria per met-ocean factors. These were applied on a generalized comparative basis one location to another and do not necessarily reflect what would ultimately be determined with detailed modeling/analysis such as would be done for engineering and design at each of the sites proposed. Table 5 summarizes the Tier 2 met-ocean screening and comparison, which ranks sites by met-ocean criteria generally from green (most favorable), yellow (neutral), and red (least favorable).

Based on this generalized evaluation of Met-Ocean criteria, alternatives at Pamlico Sound (1 & 2) and the POW may be considered more favorable for operations regarding exposure to average wind and wave conditions. However, as noted previously, the sail distance to these locations may preclude the benefits of this factor. Based on tide ranges, the alternatives at Southport would be subject to the largest tide range. However, in regards to sail distance, this factor may be mitigated. Likewise, alternatives at Pamlico Sound have very manageable tide ranges (smaller than others), but because of the sail distances, coordinating with the tides makes these locations less viable. The POW tide range coupled with the S-turn and sail distance makes this a less favorable location with respect to tides. The MHC/RI location because of its smaller tide range (compared to Wilmington) and short sail distance makes this the more favorable location with respect to tides. Almost all alternatives due to the geophysical hydrodynamic behaviors of flow (i.e., currents) are challenging for operations and maneuverability during portions of the tide swing. The sites at Pamlico Sound are presumed to have smaller current regimes than the other locations. Sediment transport (and maintenance of navigation channels) would be considered high at all locations with some variability depending on sediment sources and sinks and the breadth of the navigation channel to be maintained with respect to the natural bathymetry.

Table 5: Summary of Met-Ocean Screening Criteria of Port Alternatives

Met-Ocean Screening Criteria						
Criteria	**Pamlico 1** S1-PS-PCB	**Pamlico 2** S2-PS-BB	**MHC/RI** S3-BI-RI	**River Road** S4-CFR-RRSE	**POW** S5-CFR-POW	**Southport** S6-CFR-S
Wind Exposure						
Wave Exposure						
Water Levels						
Currents						
Sediment Transport						

Note: green = most favorable; yellow = neutral; and red = least favorable

5.6 Water Access Screening Criteria

Water access is dependent on the location of navigation channels, sail distances, and maneuverability within port navigation channels. In addition, it is dependent on existing depths and the volume of dredging that would be required to build and maintain navigation channels to design depths. Geotechnical issues such as the type of dredge material can significantly change costs if harder material such as rock is encountered to meet the design depth. Capital and annual costs for dredging will be higher (less favorable) for ports with longer navigation

channels. In addition, operation costs are higher. Based on the access criteria, the proposed port locations were evaluated and compared generally one site to another according to access criteria and are weighted in Table 6. At this macroscopic level of analysis, MHC/Radio Island and Southport have the most favorable water access conditions whereas the Pamlico sites have the worst access.

Table 6: Summary of Water-Access Screening Criteria of Port Alternatives

Access Screening Criteria						
Criteria	**Pamlico 1** S1-PS-PCB	**Pamlico 2** S2-PS-BB	**MHC/RI** S3-BI-RI	**River Road** S4-CFR-RRSE	**POW** S5-CFR-POW	**Southport** S6-CFR-S
Water Access						

Note: green = most favorable; yellow = neutral; and red = least favorable

5.7 Environmental Screening Criteria

Other factors include an assessment of environmental impacts to hard bottom areas, marshes, bays, estuaries, water quality, threatened or endangered species, aquatic habitats, and critical coastal zones. Many of these features are protected or preserved within various regulatory programs, acts, and executive orders such as the following (some of which were previously mentioned in the Tier 1 screening):

- Coastal Barrier Resources System
- Endangered Species Act
- FEMA NFIP & Executive Order 11988
- Historic and Archaeological
- Submerged Aquatic Vegetation
- Hardbottom

A summary of the comparison of one site to another is shown in Table 7. Since sites at Pamlico Sound, River Road, and Southport are currently undeveloped, it is presumed that environmental impacts would be more severe at these sites versus existing. Because of the long channel length and distance to offshore deep waters, modifications and impacts to existing environmental features would be less than at the POW.

Table 7: Summary of Environmental Screening Criteria of Port Alternatives

Impacts Screening Criteria						
Criteria	**Pamlico 1** S1-PS-PCB	**Pamlico 2** S2-PS-BB	**MHC/RI** S3-BI-RI	**River Road** S4-CFR-RRSE	**POW** S5-CFR-POW	**Southport** S6-CFR-S
Environmental						

Note: green = most favorable; yellow = neutral; and red = least favorable

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6 TIER 3 – SITE ASSESSMENT

6.1 Vessel Types and Dredge Depth Requirements

The sites were evaluated for dredging requirements and costs associated with vessel types necessary for each market scenario. This included variations on anticipated future vessel profiles for container ships, bulk cargo, RO/RO, military vessels, and barges. Table 8 summarizes vessel types or classifications and corresponding dredging depth requirements associated with their perspective nautical profiles. Consistent with the NCSPA, a keel clearance of 4 feet for interior navigation channels was used; a keel clearance of 6 feet was used for exterior (or offshore) segments of a prospective navigation channel.

Table 8: Approximate Required Dredge Depths Associated with Prospective Vessel Types (or classes)

Vessel Class	5,000 TEU	5,000-7,000 TEU	5,000-8,000 TEU	8,000 TEU
Dredge Depth	42 feet	45 feet	47 feet	51 feet

Terminal sites were evaluated for dredge costs associated with each prospective vessel type and corresponding channel depth. Table 9 summarizes channel depths for which estimated dredging costs were determined.

Table 9: Channel Depths Evaluated for Container Terminal Sites

Site #	Case Label	Location	Facility Description	Channel Depth
1	1	Pamlico Sound, Parch Corn Bay	N/A	45', 47', 51'
2	2	Pamlico Sound, Bonner Bay	N/A	45', 47', 51'
3	3-A	Radio Island, Port of Morehead City	2-Berth RTG	45'
3	3-B	Radio Island, Port of Morehead City	2-Berth RTG, 20% Dwell Reduction	51'
4	4-A	Cape Fear River, River Road Southeast	2-Berth RTG	51'
4	4-B	Cape Fear River, River Road Southeast	2-Berth ASC	51'
5	5-A	Cape Fear River, Port of Wilmington	Existing 1-Berth Reachstacker	42' (Existing)
5	5-B	Cape Fear River, Port of Wilmington	2-Berth Reachstacker	42' (Existing)
5	5-C	Cape Fear River, Port of Wilmington	2-Berth RTG	42' (Existing)
5	5-C1	Cape Fear River, Port of Wilmington	2-Berth RTG, 20% Dwell Time Reduction	45'
5	5-C2	Cape Fear River, Port of Wilmington	2-Berth RTG, 35% Dwell Time Reduction	47'
5	5-C3	Cape Fear River, Port of Wilmington	2-Berth RTG, 35% Dwell Time Reduction	51'
6	6-A	Cape Fear River, Southport	2-Berth RTG	51'
6	6-B	Cape Fear River, Southport	2-Berth ASC	51'

6.2 Dredging Costs

Dredging costs include a range of factors that can impact costs. These include the costs of phases such as planning, engineering, design, permitting, construction, and monitoring for an alternative. Each of these factors can be influenced by a range of subfactors. For example, engineering costs can be influenced by geotechnical factors (i.e., type of material such as rock, sands, muds, and silts). Construction costs can fluctuate based on mobilization/demobilization costs, which can be impacted by fluctuating fuel costs. Permitting costs can vary with the degree of environmental impacts that have to be assessed and/or mitigated for an alternative.

For the NC Maritime Strategy, it is assumed that these factors and subfactors are implicitly accounted for in the dredge cost estimates, but recognize some specific variation will occur during actual phases implemented for an alternative. Many large projects recognize and adjust to changing unit cost factors during construction. For example, the total cost of a project (a-priori versus post-priori) can be significantly impacted by the cost of materials. Material costs can change significantly during construction due to supply chain volatility thus altering the constructed costs for the project from what was originally estimated. A comparative cost analysis applied for the NC Maritime Strategy assumes an implicit “apples to apples” comparison of aggregated factors/ subfactors, which assumes when one factor is high for one alternative, it is perhaps lower in another and vice-versa for all other factors/ subfactors comprising the estimated unit costs. In this sense, the actual total unit cost variations are “balanced out” a-priori and recognize in reality actual post-priori costs/ subcosts per factor/ subfactor will vary from one alternative to another (i.e., an explicit “apples to apples” comparison).

Regarding these factors, dredging costs were based primarily on the unit cost of volume of material to dredge a new channel or modify an existing one depending on the site under consideration. A common engineering approach for estimating channel volumes would be to create a Digital Terrain Model (i.e, DTM) of both the existing channel and the proposed channel for a prospective alternative and subtract the cut/fill volumes following the horizontal and vertical alignment of the channel. This requires a comprehensive collection, assimilation, and post processing of hydrographic surveys in addition to detailed and variable channel design widths that is beyond the scope of this effort.

A simpler method suitable for dredge volume estimating purposes is to assume a representative shape of the channel dimensions from previous designs, modify it for deeper depths, then calculate the geometric difference in area (and sum for volume along navigation channel reaches). In this regard, Figure 13 depicts a concept for a representative channel cross section for existing USACE channels in the Port of Wilmington and at the Port of Morehead City. The additional volume is estimated as the additional cut that would be made going to deeper depths. Note: this assumes the same federally authorized channel width is maintained. Likewise, Figure 14 depicts a concept representative cross section for estimating dredge volumes in regions where a natural channel existed. These approaches do not take into account irregularities in the natural channel nor the navigation channels caused by hydrodynamics, sediment characteristics, equilibrium adjustments following construction, nor the geologic framework.

Figure 13: Additional Cut Volume Required for Going to Deeper Channel Depths in a Situation with an Existing Navigation Channel

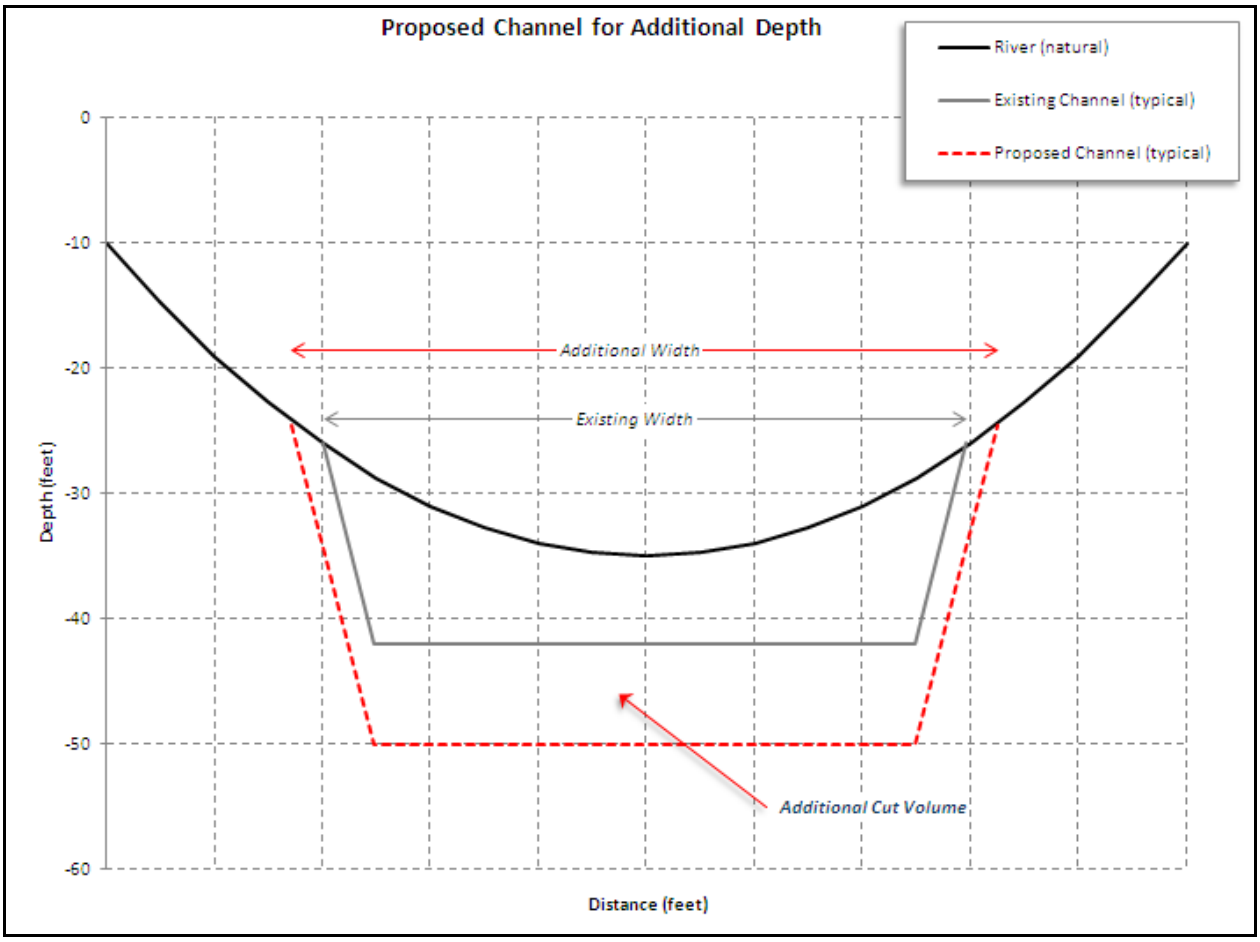
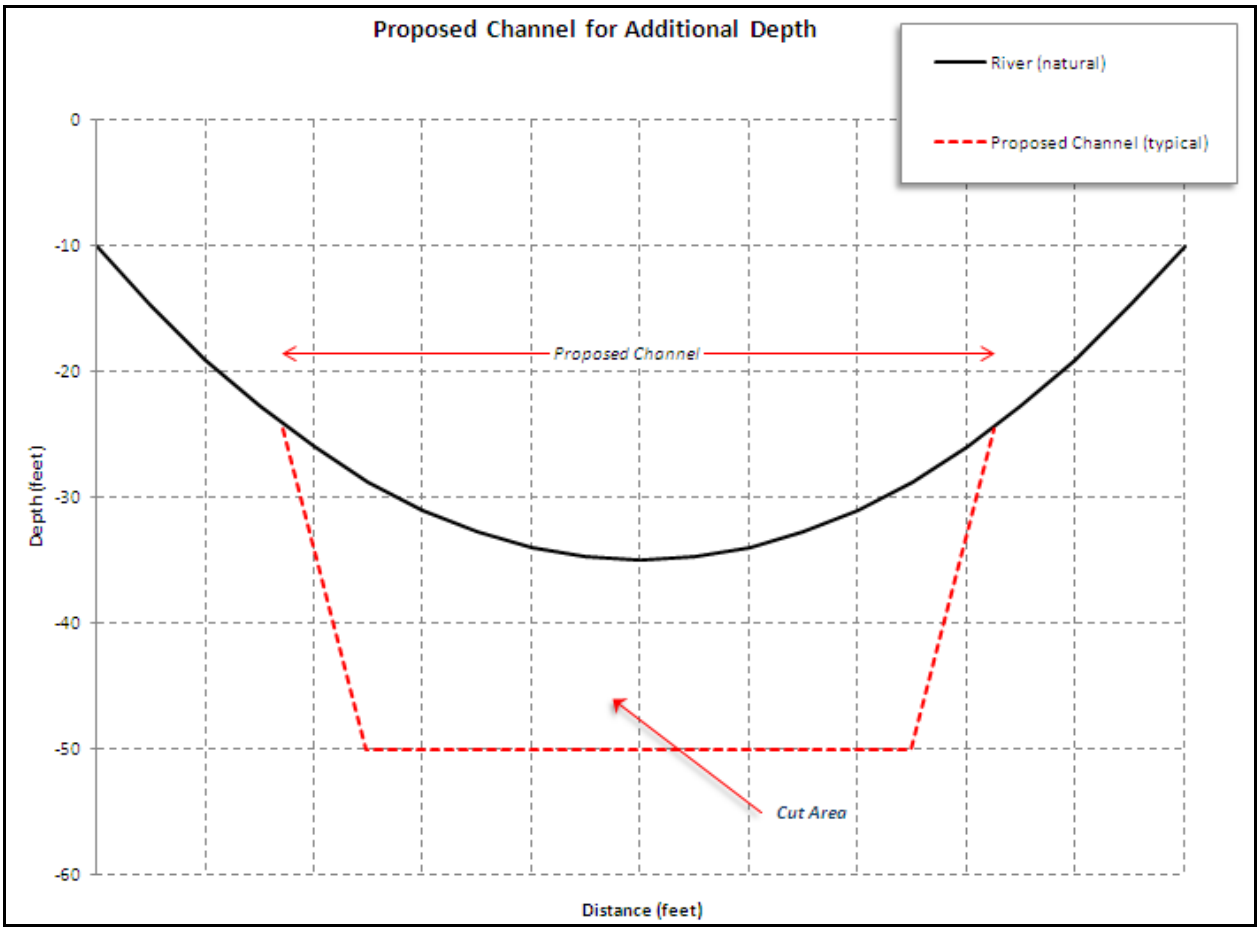


Figure 14: Estimated Cut Volume Required for Going to Deeper Channel Depths in a Situation with a Natural Channel

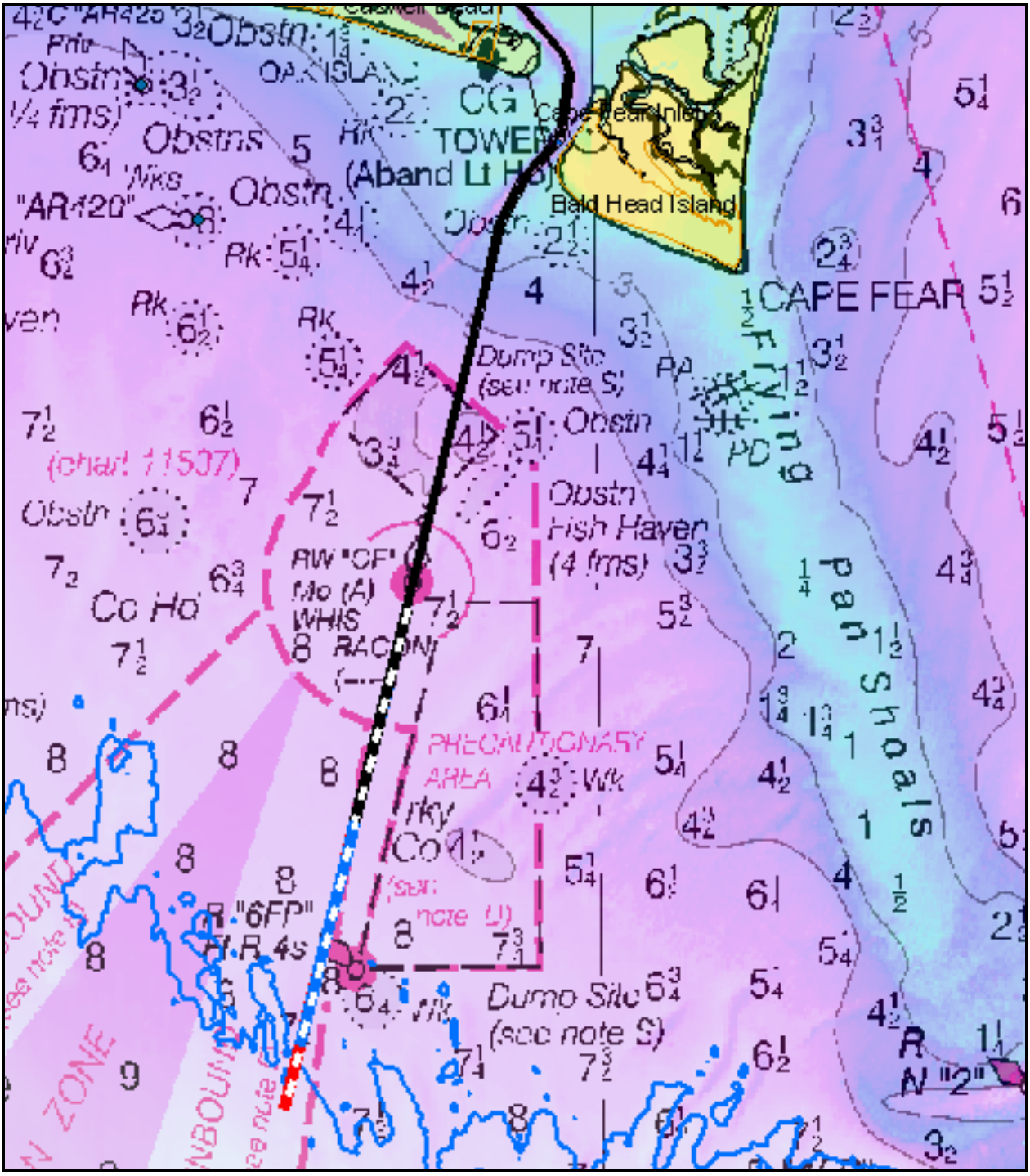


Estimates for dredging volumes and costs also included the additional distance offshore that would be required to reach natural depth for a proposed navigation depth. Figure 15 depicts an example of navigation channel extensions that would be required for deepening Wilmington Harbor to meet depths of 45', 47', and 51'. Table 10 lists the length of the extension to the navigation channel that would be required to reach a prospective depth.

Table 10: Length of the Extended Segments of the USACE Navigation Channel at the Port of Wilmington to Reach Deeper Depths

Dredge Depth (feet)	Navigation Channel Extension Length (feet)
45	18,000
47	41,000
51	63,000

Figure 15: Extension to the Existing Navigation Channel (solid black line) Required to Reach Natural Depths of 45 feet (dashed black line), 47 feet (dashed red line), and 51 feet (dashed red line)



Unit costs were derived from recent dredging contracts by the USACE Wilmington District for maintenance dredging in the Port of Wilmington and the Port of Morehead City. Because rock is so prevalent in the southern province, dredge volumes were divided to differentiate estimates for typical dredge sediments and also rock material expected to be encountered. Estimates for rock are based on past project and geologic investigations of the regions.

Table 11 summarizes the estimated total volume of dredge material including sediments and rock material. Note, this table focuses primarily on dredge volumes associated with modifications or creation of a navigation channel; it does not include estimates for other features that would be associated with a proposed project such as turning basins, berth areas, and anchorage basins. As shown in Figure 16, additional features typical for constructing new terminals would include an access channel, turning basin, and berthing area. Table 12 summarizes additional dredging volumes and costs associated with Site 6 for these additional features.

Table 11: Summary of Dredge Volumes and Costs per Dredging Depth per Site

Site	Proposed Design Depth (feet)	Estimated Volume of Dredge Material (cy)	Estimated Cost ($)
S1-PS-PCB	45	176,095,820	$1,410,527,540
	47	189,769,070	$1,620,627,830
	51	218,101,160	$1,919,290,170
S2-PS-BB	45	151,314,040	$1,212,025,500
	47	163,266,400	$1,394,295,060
	51	188,039,380	$1,654,746,520
S3-BI-RI	45	1,329,390	$10,648,390
	47	2,464,000	$21,042,560
	51	6,138,880	$54,022,140
S4-CFR-RRSE	45	22,324,850	$178,627,050
	47	33,612,130	$290,691,700
	51	44,267,280	$396,790,760
S5-CFR-POW	42	15,435,530	$109,644,359
	45	24,619,250	$197,093,010
	47	36,855,690	$314,795,080
	51	48,477,950	$426,654,310
S6-CFR-S	45	12,205,650	$103,446,980
	47	19,303,580	$176,776,440
	51	25,688,340	$243,340,320

Table 12: Estimated Volume and Costs for Additional Features Associated with Site 6, Southport

Feature	Volume (cy)	Total ($)
Access Channel	6,400,000	$60,608,000
Turning Basin	2,200,000	$20,834,000
Berthing Area	3,900,000	$36,933,000
TOTAL	**12,500,000**	**$118,375,000**

Figure 16: Additional Navigation Features for Site 6, Southport

Note, these diagrams are conceptual - use for cost estimating purposes only.

6.3 Annual Dredging Costs

Regular maintenance dredging of navigation channels is required to maintain the navigation channel to its design depth. Shoaling occurs from multiple sources including suspended sediments, bed load, and migration of sediments from river banks and shoals within a waterway. In the USACE Phase II DMMP Study - *Upper Portion of Wilmington Harbor Eagle Island Management Plan Report*, the USACE developed a correlation between pre-deepened volumes to later annual maintenance volumes. This approach accounted for the variability in shoaling that occurs post-dredging of a harbor or river channel. Typically, the shoaling rates will increase immediately following the initial deepening, and then taper off until some point of "equilibrium" is reached in the channel. The USACE said, "This projection includes a 50% increase in maintenance dredge volume in the dredging event immediately after the initial deepening. The dredge volume for the second dredge event after deepening includes a 25% increase in maintenance volume. After that, maintenance dredging is anticipated to stabilize at an annual volume approximately 10% greater than the predeepening dredge volume".

In a similar manner, projections were made for annual dredging volumes (and costs) for the six sites. Table 13 summarizes total volumes of maintenance dredge material over a 20-year cycle. These volumes were used to calculate average annual volumes also shown in Table 13.

Table 13: Average Annual Costs for Maintenance Dredging

Site	Proposed Design Depth (feet)	Total (cy, 20-yrs)	Average Annual Maintenance Cost ($/yr)
S1-PS-PCB	45	16,860,320	$6,752,560
	47	24,127,070	$10,302,260
	51	36,637,480	$16,120,490
S2-PS-BB	45	14,487,600	$5,802,280
	47	20,757,540	$8,863,470
	51	31,587,590	$13,898,540
S3-BI-RI	45	1,272,830	$509,770
	47	3,132,710	$1,337,670
	51	10,312,330	$4,537,430
S4-CFR-RRSE	45	21,374,950	$8,560,670
	47	42,734,150	$18,247,480
	51	74,361,910	$32,719,240
S5-CFR-POW	42	10,920,333	$4,373,590
	45	23,571,730	$9,440,480
	47	46,857,980	$20,008,360
	51	81,435,150	$35,831,470
S6-CFR-S	45	11,686,320	$4,680,370
	47	24,542,400	$10,479,600
	51	43,152,270	$18,987,000

Based solely on channel dredging costs, the port options at sites 1 and 2 are not feasible. Site 3 has the lowest dredging costs due to the shorter navigation channel distances. Note, for sites 4, 5, and 6, an investment made to deepen the channel at Cape Fear provides more opportunities for regional port expansion if multiple terminal sites are taken into consideration. In this regard, B/C ratios could be higher if port economics are aggregated to account for total services provided by one navigation channel supporting multiple terminal locations. This is the driving support for the expansion of terminal locations at the port of Charleston (Columbus Street, Wando, and North Charleston terminals).

6.4 Disposal Options

Disposal options for dredge material include offshore, inland CDFs (Confined Disposal Facilities), and beneficial use such as beach nourishment, island creation, and wetland restoration or creation. Factors impacting disposal options include the type of material (silts, muds, sands, rock), if the sediments are contaminated, the volume, and costs for disposal.

As a part of the Industry Outreach Action Plan, the AECOM / URS team contacted the Wilmington District to discuss disposal options used to support maintenance dredging of Wilmington Harbor and Morehead City Harbor. Almost all of the disposal issues discussed with the USACE would be relevant to any of the sites proposed for Wilmington Harbor. Figure 17 depicts current disposal sites for maintenance dredging of the Cape Fear River. A summary of these issues include:

Existing Disposal Site: For dredging of the Cape Fear River in the mid-river upstream segments, the Eagle Island CDF is used. This CDF is reaching full capacity soon and is one of the items to be addressed in the upcoming USACE Dredged Material Management Plan. Preliminary concept designs by the USACE have included raising the CDF levee crests to increase capacity. Another option under review by the USACE to increase capacity is to dredge the CDF and dispose of sediments at the Wilmington Ocean Dredged Material Disposal Site (ODMDS). Finally, another option involves using the area adjacent to Eagle Island or cell 4. However, this would involve considerable environmental impacts to aquatic habitats, wetlands, and marsh.

Offshore Disposal Site: The Wilmington ODMDS is currently used for disposal of sediments dredged in the lower segments of the Cape Fear River and the Entrance Channel. It has plenty of capacity, but is not suitable for disposal of sediments from the upper reaches of the harbor due to the sail distance.

Beneficial Use: Multiple projects have been conducted by the USACE involving the placement of dredged materials (mostly sand) from the lower reaches and entrance channel to surrounding shorelines and beaches at Oak Island and Bald Head Island. Based on past tests, no significant traces of contamination were found to exist in the dredged sediments. Additional beneficial uses of the sandy sediment has been to maintain levees at the Eagle Island CDF.

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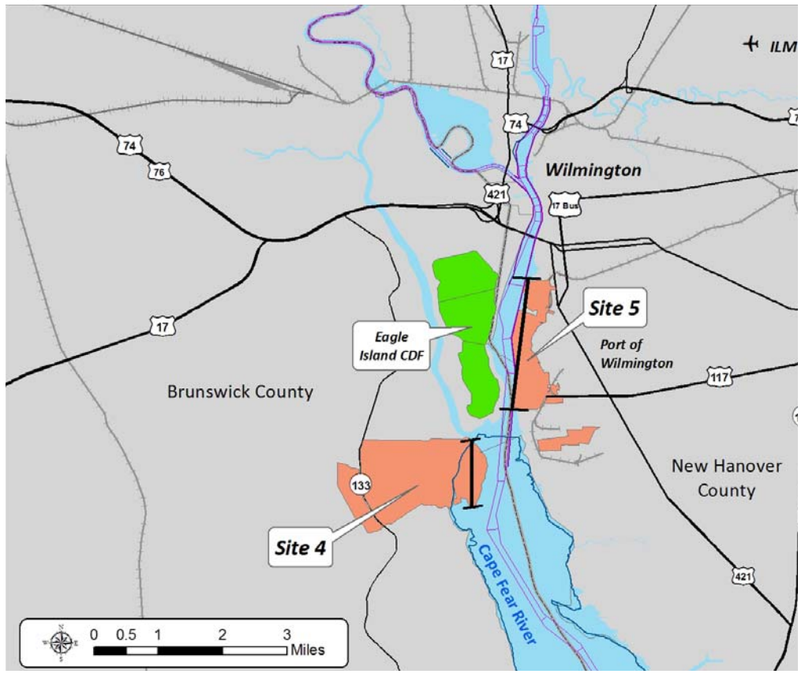
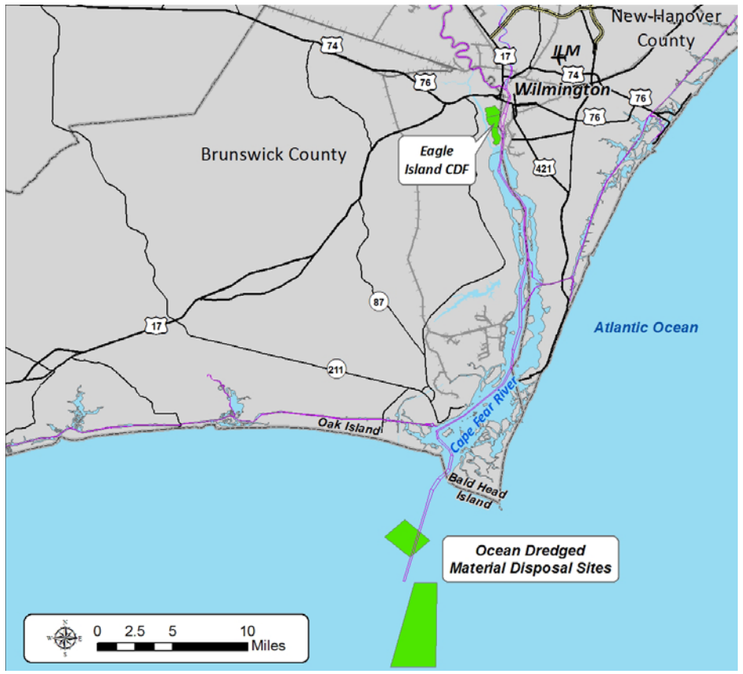
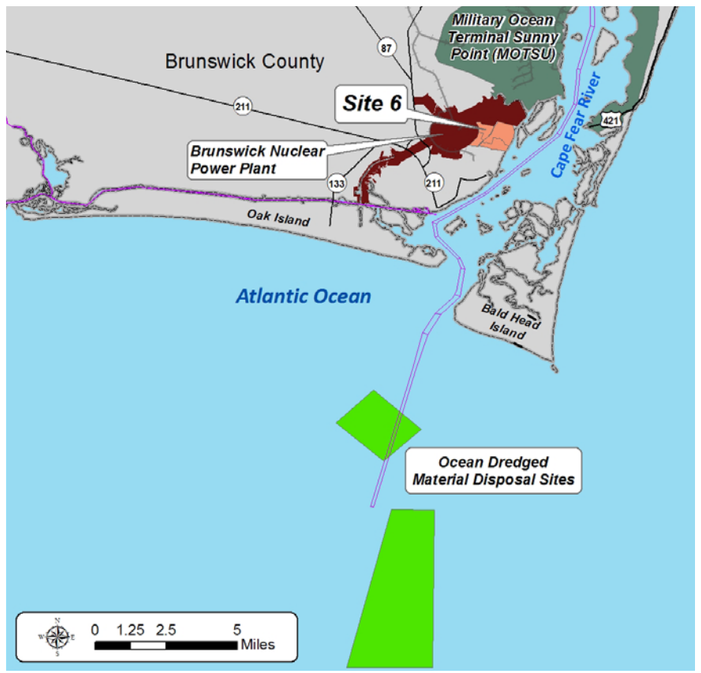
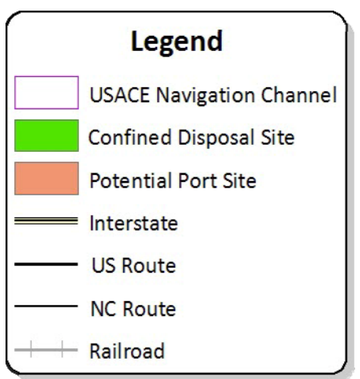
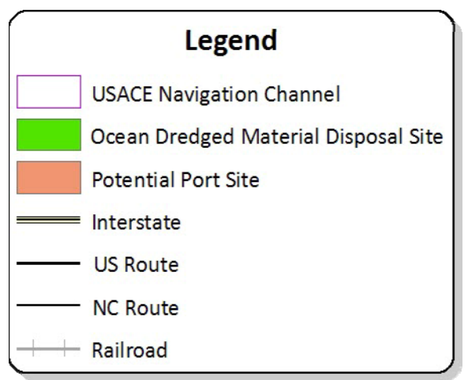
Figure 17: Disposal Sites In and Near Wilmington Harbor











Source: AECOM/URS from ESRI, NCDOT, USGS ThematicMapping with world borders dataset, and U.S. Army Corps of Engineers

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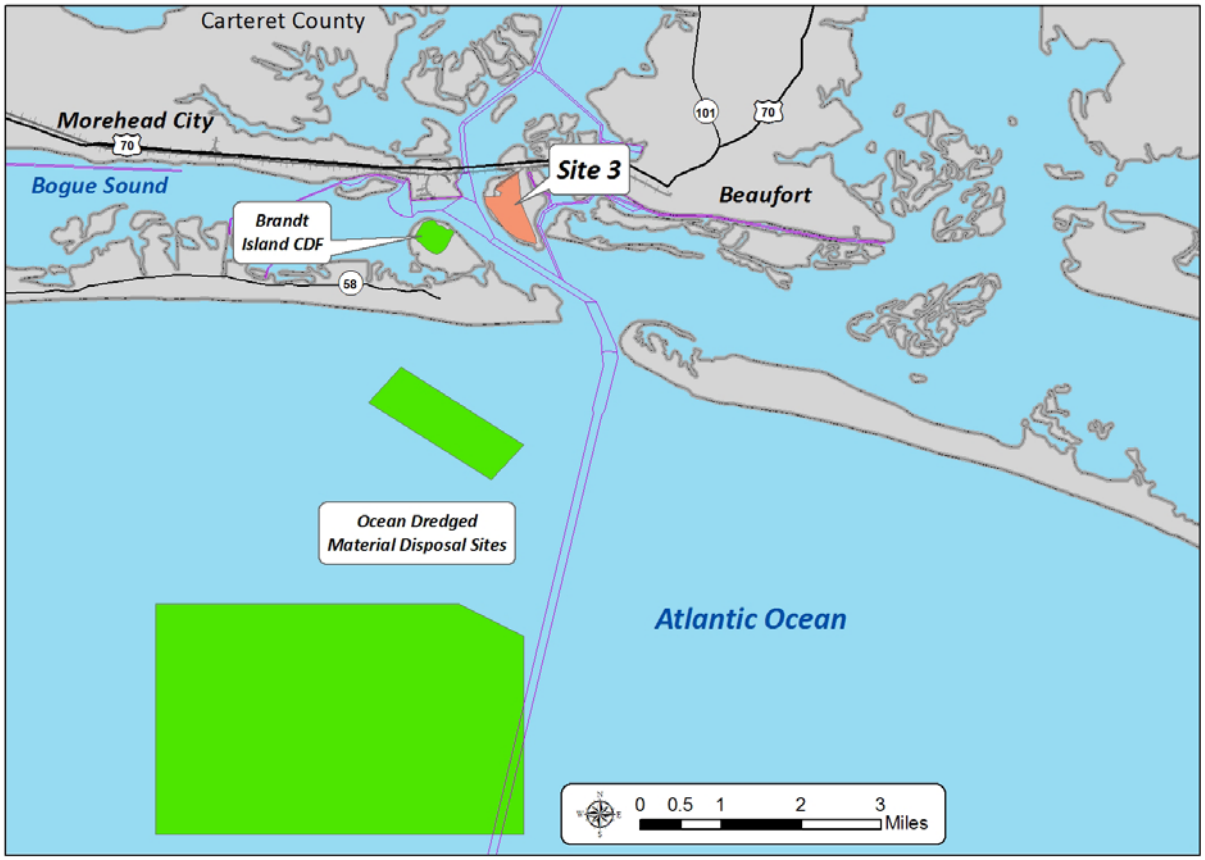
Dredge disposal options at Morehead City have involved similar approaches (see Figure 18). Sediments are placed at the nearby Brandt Island CDF, offshore at the ODMDS, and also used for nearby beach nourishment of Bogue Banks. On occasion, Brandt Island has been "pumped out" and the sediments were used for beach nourishment at Bogue Banks along Fort Macon State Park. In some instances, high concentrations of muds and silts were discovered.

Figure 18: Disposal Sites near Morehead City



Note: See Figure 17 for the legends.
Source: AECOM/URS from ESRI, NCDOT, USGS ThematicMapping with world borders dataset, and U.S. Army Corps of Engineers

6.5 Channel Alignments and Widening Impacts

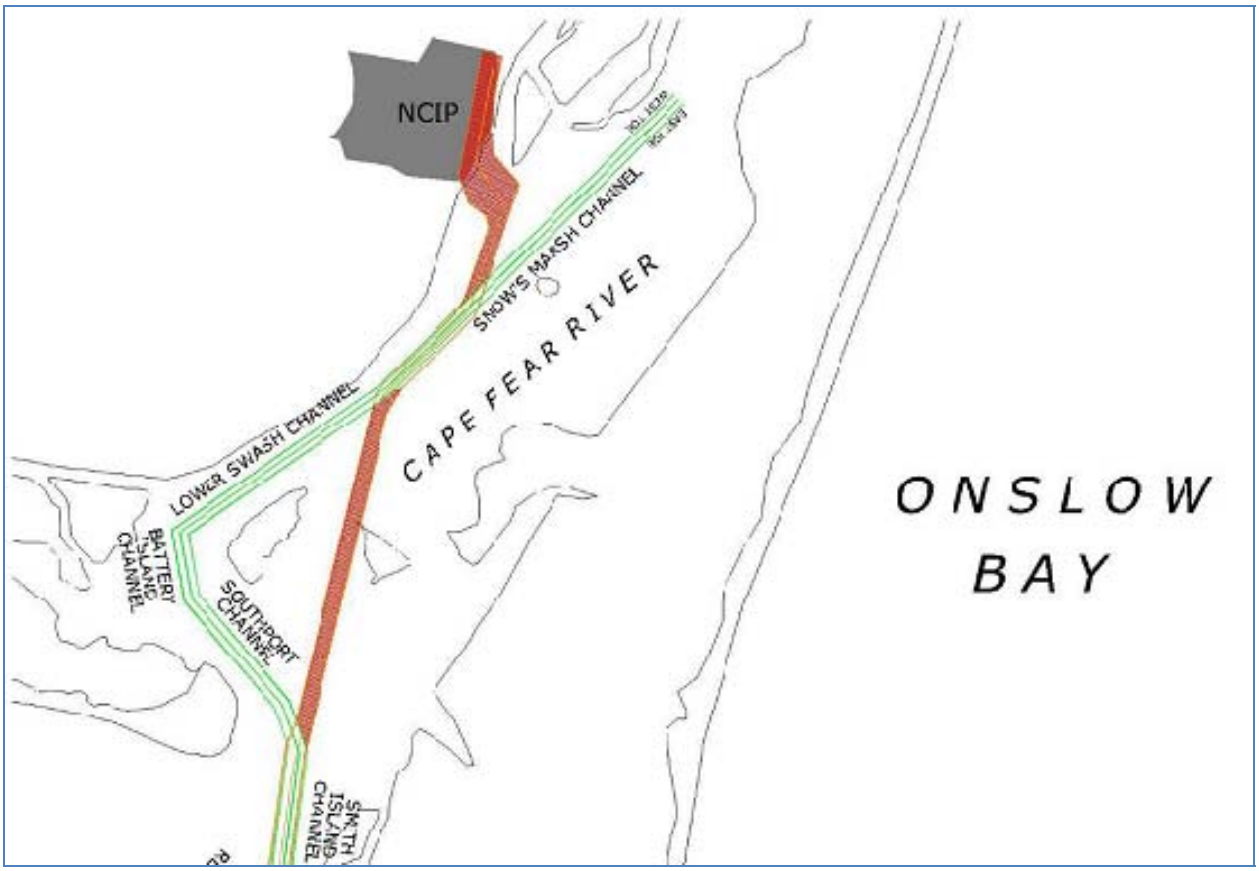
For any of the Wilmington Harbor alternatives, going to deeper depths will require an expansion of the channel "footprint". Several past investigations by the USACE and private consultants have indicated that the "S turn" at the lower reach of the Wilmington Harbor Navigation Channel near Southport would have to be widened or realigned to accommodate larger vessels making that turn. In the USACE 905b (2010), they concluded, "increasing the length of the design vessel from 950 feet to 1,200 feet increases the turning radius for the Battery Island and Smith Island turns from 2,900 feet to 3,900 feet." The USACE suggested further ship simulation would have to be conducted.

However, because of the footprint, widening this turn would impact adjacent properties causing potential erosion of the adjacent shorelines. Further, even with widening, it is not likely that a sufficient radius in this turn can accommodate larger vessels. Past numerical simulations and ship records already indicate this turn is difficult to maneuver for large vessels making a port of call today.

A better alternative from an engineering and operations perspective would be to straighten the alignment of the channel such as was proposed in the NCIT Dredging Study (Technical Memorandum, 3/15/2006). In this memo, CH2M-Hill concluded the following while attempting to design conceptually for larger vessels (and see Figure 19):

"Multiple attempts were made to design a channel that followed the existing course; however, it was found that the standards in Chapter 8 of the manual (USACE, 2006) could not be met without causing obvious impacts at the east end of Caswell Beach or the riverfront at Southport. The project team investigated several alternatives, including the alternative defined by straightening the channel by digging a new channel on the east side of Battery Island, essentially bypassing the S-curve."

Figure 19: Alternative Channel Alignment Proposed to Resolve Navigability Limitation at the "S Turn"



(Source: NCIT Technical Memorandum, 3/15/2006)

In addition to widening the navigations channel at the “S turn”, other sections of the navigation channel could be at risk. Figure 20 depicts other sections of adjacent shorelines that could be impacted by deepening of the channel, which results in a wider footprint. Beyond those at Southport, most of these shorelines are undeveloped critical coastal habitats. Further up the Cape Fear River, other shorelines potentially impacted include waterfront developments and industrial areas.

In addition to environmental impacts to shorelines, widening of the navigation channel could impact some documented archaeological sites such as historic shipwrecks. At least 65 archaeological sites are recorded in the vicinity of the harbor maintenance or widening footprint. Some of these are located within the Wilmington Historic District, National Register of Historic Places.

Past investigations have indicated a potential to impact the Castle Hayne aquifer. Some studies have suggested no significant impacts would occur based on numerical modeling. Others have suggested the aquifer layer is too close in some locations of proposed deepening and would result in significant salt water intrusion. Because of the apparent uncertainty and critical nature of the aquifer, a detailed hydrogeologic assessment of the aquifer should be conducted and compared with alternatives to determine actual impacts based on more thorough investigations and data.

Figure 20: Potential Impacts to Adjacent Shorelines from Widening the Navigation Channel

Note: red areas depict those sections of the shoreline potentially at risk from a wider footprint.

6.6 Future USACE Dredging and Navigation Focus

For future areas of focus, the USACE is planning to address three chronic issues relevant to past dredging and navigation issues at the Port of Wilmington. These are proposed for the revised Wilmington Harbor study and include:

- Bald Head Island Shoaling – USACE intends to evaluate channel realignment options to address shoaling problems;
- Battery Island "S Turn" – Options for future focus include widen the turn and/or realign. What would be the impacts to widening or realigning?
- Anchorage Basin – USACE is evaluating options to expand the anchorage basin to create a turning basin. There are plans to look at these three issues in the revised Wilmington Harbor study.

DMMP for MHC – Similar issues exist at Morehead City including shoaling at Shackleford Banks shoaling, disposal options, and costs. The USACE is going to address these in a Dredge Material Management Plan (DMMP).

6.7 Cost Comparison of Dredging Expenditures

The Congressional Research Service has published a report on expenditures from the Harbor Maintenance Trust Fund (HMTF). Almost 90% of these funds are used to maintain deep-draft navigation channels in the US. A comparison of some of the most expensive USACE projects from the HMTF rank Atlantic ports as shown in Table 14. Based on the HMTF expenditures, Wilmington ranks lowest as compared to nearby ports on the Atlantic coast.

Table 14: A List of the Most Expensive Channels in Terms of HMTF Expenditures

Port	HMTF Expenditures
Savannah	$123,447,085
Baltimore Harbor and Channels	$118,797,481
Norfolk Harbor	$96,059,577
Charleston Harbor	$75,709,695
Wilmington Harbor	$69,060,101

6.8 Tier 3 Summary Selection

The information presented in Tier 3 is applied to evaluate and compare the six site alternatives. A significant factor is the dredging cost (both capital and annual maintenance). In this regard, an investment in Sites 1 and 2 in the Pamlico Sound would not be feasible. Secondary and equally important factors are environmental impacts. Again, Sites 1 and 2 would not be feasible since the navigation channel length to these sites would involve the disruption of multiple aquatic natural resources compounded with the mitigation costs. The best alternatives from a dredging and navigation perspective would include an investment in existing port infrastructures such as those at Wilmington and Morehead City. The choice for best investments is not complete without taking into account other factors such as upland infrastructure, intermodal transport costs, and the GIS cost model. All of these factors are addressed separately in other complimentary documents to the tiered analyses.

7 SUMMARY

The analysis identified and screened six potential port sites, including alternatives for the Port of Wilmington and the Port of Morehead City. The site alternatives include inland, inshore, proposed and existing site locations (see Figure 4).

The screening of potential deep-water port sites was conducted in a tiered analysis; the first step (Tier 1) was a high level analysis of major environmental and land use constraints that would preclude development of a port terminal. The Tier 2 analysis screened and evaluated coastal areas remaining from the Tier 1 screening to select sites available for port development. Tier 2 results provided an analysis of environmental constraints and infrastructure proximity to the six potential deep-water port sites.

The Tier 3 analysis conducted a site-specific evaluation for each alternative and included detailed cost estimates for construction (capital investment costs) and operation (i.e. maintenance costs) for a more refined comparison of each alternative. Discussed herein were the Tier 3 dredging analyses.

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APPENDIX

LSA- Environmental Screening

Environmental Screening Criteria	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
	Pamlico Sound - Parch Corn	Pamlico Sound - Bonner Bay	Beaufort Inlet - Radio Island	Cape Fear River - River Road Southeast	Cape Fear River – Port of Wilmington	Cape Fear River - Southport
Protected Lands: Listed and Eligible Historic properties	1	2	1	-2	-2	2
Protected Lands: Conservation Easements	2	-2	-2	-2	-2	1
Zoning and Future Land Use	1	1	1	-2	2	2
4-lane Divided Facility Network	-2	-2	2	-2	2	-2
Railroad Facilities	-2	-2	2	-2	2	2
Public Water Supply Well / Aquifer	1	2	2	-2	2	2
Significant Natural Heritage Areas	2	2	-2	-2	-2	-2
NPDES Sites	2	2	1	1	-2	2
Submerged Aquatic Vegetation	2	2	1	2	2	2
Fish Nursery Area	-2	-2	2	-2	-2	1
Shellfish Growing Areas	-2	-2	-2	-2	-2	-2
Wetlands / Marsh	-2	-2	1	-2	1	-2
Hard Bottom Locations	2	2	1	2	2	2
Shell Bottom Areas	2	1	-2	2	2	2
Threatened and Endangered Species Occurrences	2	2	1	-2	1	-2
Hazardous Waste Disposal Sites	2	2	-2	-2	-2	-2
Site Total	**9**	**6**	**5**	**-17**	**2**	**5**
Environmental Suitability Ranking	**High Suitability**	**Medium-High Suitability**	**Medium-High Suitability**	**Low Suitability**	**Medium Suitability**	**Medium-High Suitability**

LSA- Quantitative Analysis

Environmental Screening Criteria	Buffer	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
	Within	Pamlico Sound - Parch Corn Bay	Pamlico Sound - Bonner Bay	Beaufort Inlet - Radio Island	Cape Fear River - River Road Southeast	Cape Fear River – Port of Wilmington	Cape Fear River - Southport
Protected Lands: Listed and Eligible Historic properties (Acres / Points)	1 mi	0 / 0	0 / 0	0 / 1	0 / 1	0 / 1	0 / 0
Protected Lands: Conservation Easements (Acres)	1 mi	0	182	340	460	403	0
Public Water Supply Well / Aquifer	1 mi	0	0	0	2	0	0
Significant Natural Heritage Areas (Acres)	1 mi	0	0	577	1,055	300	336
NPDES Sites (Points)	1 mi	0	0	2	0	2	0
Submerged Aquatic Vegetation (Acres)	1 mi	0	0	20	0	0	0
Fish Nursery Area (Acres)	1 mi	87	813	0	227	73	9
Shellfish Growing Areas (Acres)	1 mi	567	694	1,303	801	197	646
Wetlands / Marsh (Acres)	1 mi	206	1,216	197	398	0	273
Hard Bottom Locations (Points)	1 mi	0	0	1	0	0	0
Shell Bottom Areas (Acres)	1 mi	0	0.3	52	0	0	0
Threatened and Endangered Species Occurrences (Points)	1 mi	0	0	16	1	4	3
Hazardous Waste Disposal Sites	1 mi	0	0	2	1	30	3

LSA- Quantitative Analysis – Inside Site

Environmental Screening Criteria	Buffer	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
	Within	Pamlico Sound - Parch Corn Bay	Pamlico Sound - Bonner Bay	Beaufort Inlet - Radio Island	Cape Fear River - River Road Southeast	Cape Fear River – Port of Wilmington	Cape Fear River - Southport
Protected Lands: Listed and Eligible Historic properties (Acres / Points)	Boundary	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Protected Lands: Conservation Easements (Acres)	Boundary	0	0	0	0	0	0
Public Water Supply Well / Aquifer	Boundary	0	0	0	0	0	0
Significant Natural Heritage Areas (Acres)	100ft Waterfront	0	0	105	284	52	0
NPDES Sites (Points)	Boundary	0	0	0	0	1	0
Submerged Aquatic Vegetation (Acres)	100ft Waterfront	0	0	0	0	0	0
Fish Nursery Area (Acres)	100ft Waterfront	18	35	0	69	81	0
Shellfish Growing Areas (Acres)	100ft Waterfront	28	35	11	564	51	200
Wetlands / Marsh (Acres)	100ft Waterfront	54	300	0	366	0	98
Hard Bottom Locations (Points)	100ft Waterfront	0	0	0	0	0	0
Shell Bottom Areas (Acres)	Boundary	0	0	0.2	0	0	0
Threatened and Endangered Species Occurrences (Points)	Boundary	0	0	0	0	0	3
Hazardous Waste Disposal Sites	Boundary	0	0	0	1	8	1

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