NORTH CAROLINA
MARITIME Strategy

NC Maritime Strategy
Existing and Planned Port Infrastructure

Prepared for the
North Carolina Department of Transportation

by

AECOM
in association with URS

May 31, 2012

This page intentionally blank

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.

This page intentionally blank

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 *Existing and Planned Port Infrastructure* technical report provides an inventory of existing and currently-planned port facilities including water depth. Terminal size, shape and mode of operation are described to include cargo storage and handling equipment, methods, and productivity. Assuming that the demand is there, this inventory also examines how much cargo can be handled by existing NC Ports with today's operating mode and vessel parameters. Mode split between highway and rail for import and export cargo coming to and from North Carolina ports is also presented. Conceptual plans for each significant port facility have been developed from available data to identify each major piece of infrastructure on the terminal, including wharf, buildings, cargo storage area, gate, and rail access. Readers are directed to the *Highway Infrastructure Assessment* technical report for details on existing and planned roadway access to the ports and to the *Inland Ports* technical report which includes descriptions of the two facilities operated by the North Carolina State Ports Authority.

This page intentionally blank

TABLE OF CONTENTS

ACKNOWLEDGEMENTS III
EXECUTIVE SUMMARY V
TABLE OF CONTENTS VII
LIST OF TABLES IX
LIST OF FIGURES XI
1 EXISTING NCSPA PORT INFRASTRUCTURE 1
1.1 Port of Wilmington 2
1.1.1 Port of Wilmington Container Terminal 4
1.1.2 Port of Wilmington General Cargo Terminal 7
1.2 Port of Morehead City 10
1.2.1 Port of Morehead City General Cargo Terminal 14
2 PORT CAPACITY ANALYSIS 16
2.1 AECOM PRECAP Model 16
2.2 NCSPA Existing Container Operations Data 17
2.3 NCSPA Container Operations Capacity Analysis 22
3 NCSPA NON-CONTAINER OPERATIONS CAPACITY ANALYSIS 29
3.1 Port of Wilmington Bulk/ Breakbulk Capacity 29
3.2 Port of Morehead City Bulk/Breakbulk Capacity 34
4 ROAD AND RAIL ACCESS 39
4.1 Road Network 39
4.2 Rail Network 41
5 OTHER PORT FACILITIES 43
5.1 Charlotte Inland Terminal 43
5.2 Piedmont Triad Inland Terminal 43

This page intentionally blank

LIST OF TABLES

Table 1: Port of Wilmington Berths Used by Commodity 9

Table 2: Port of Morehead City Berths Use by Commodity 15

Table 3: List of Input Parameters in PRECAP Model 16

Table 4: Port of Wilmington Container Vessel Arrival Data 17

Table 5: Port of Wilmington Quay Crane Productivity Summary 18

Table 6: Actual Quay Crane Productivity for Week 49 (ending 06/06/2011)..... 18

Table 7: Actual Quay Crane Productivity for Week 50 (ending 06/13/2011)..... 18

Table 8: Actual Quay Crane Productivity for Week 51 (ending 06/20/2011)..... 19

Table 9: Actual Quay Crane Productivity for Week 52 (ending 06/27/2011)..... 19

Table 10: Existing Container Berth Capacity at Port of Wilmington 25

Table 11: Existing Container Yard Capacity Calculation at Port of Wilmington 26

Table 12: Port of Wilmington Berths Sharing for Bulk/Breakbulk Commodities..... 29

Table 13: Port of Wilmington Berth Capacity Calculations for Bulk/Breakbulk Commodities 30

Table 14: Port of Wilmington Storage Capacity Calculations for Bulk/Breakbulk Commodities . 31

Table 15: Port of Morehead City Berth Capacity Calculations for Bulk/Breakbulk Commodities 34

Table 16: Port of Morehead City Berth Sharing for Bulk/Breakbulk Commodities 35

Table 17: Port of Morehead City Storage Capacity for Bulk/Breakbulk Commodities 36

This page intentionally blank

LIST OF FIGURES

Figure 1: Location of NCSPA Port Facilities 1

Figure 2: Port of Wilmington Aerial 2

Figure 3: Port of Wilmington – Existing Port Infrastructure 3

Figure 5: Existing Port of Wilmington Container Terminal 4

Figure 4: Schematic Diagram of 100' gauge quay cranes at Port of Wilmington 5

Figure 6: Example Picture of a Reach Stacker 6

Figure 7: Port of Wilmington General Cargo Terminal 7

Figure 8: Port of Morehead City Aerial 10

Figure 9: Port of Morehead City – Existing Port Infrastructure 12

Figure 10: Containers per Vessel Call vs. Dock Cranes Used at Port of Wilmington 20

Figure 11: Containers per Vessel Call vs. Vessel Draft at Port of Wilmington 21

Figure 12: Port of Wilmington Existing Container Terminal Capacity 27

Figure 13: Port of Wilmington Bulk/Breakbulk Berth vs. Storage Capacity Chart 32

Figure 14: Port of Wilmington Bulk/Breakbulk Capacity Summary 33

Figure 15: Port of Morehead City Bulk/Breakbulk Berth vs. Storage Capacity Chart 37

Figure 16: Port of Morehead City Bulk/Breakbulk Capacity Summary 38

Figure 17: North Carolina Freight Nodes and Facilities 39

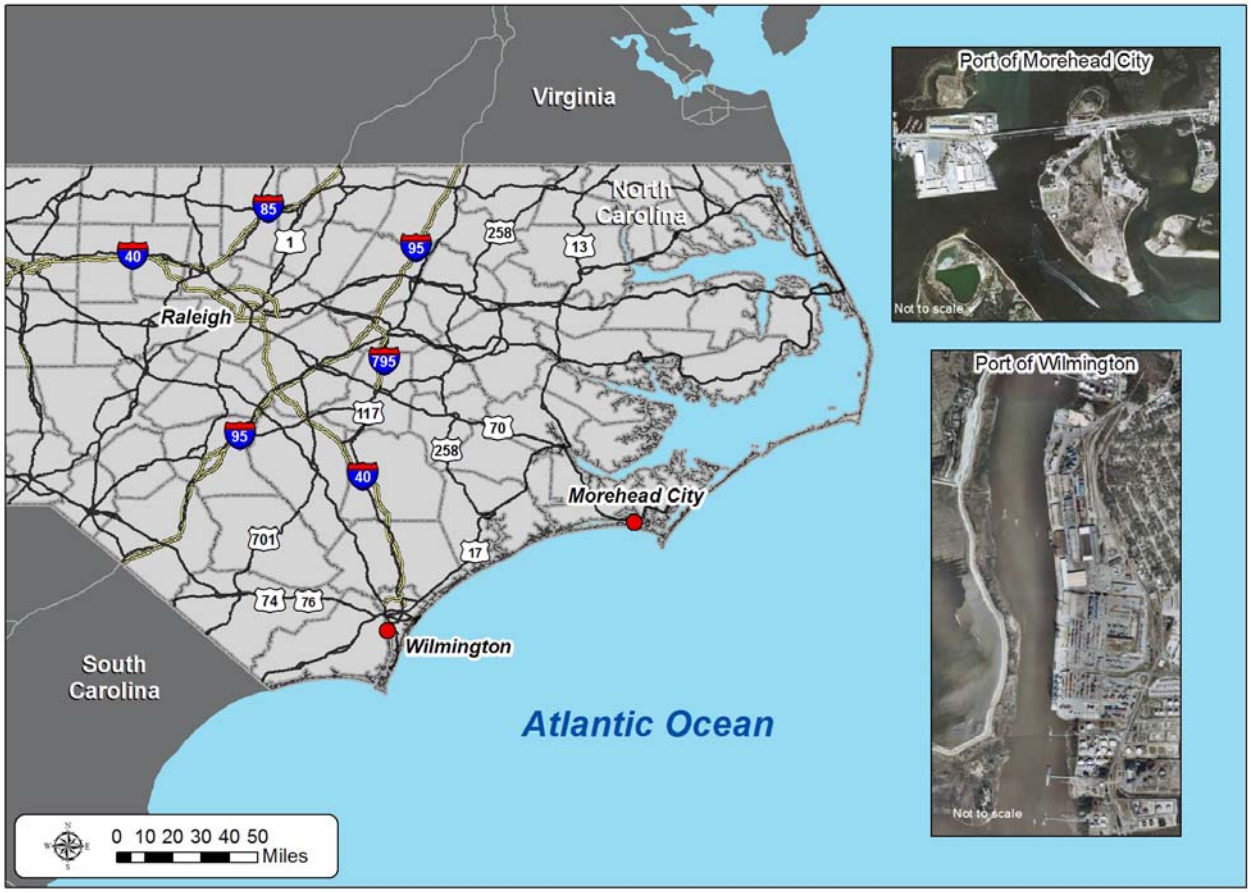
Figure 18: Railroads in North Carolina 41

This page intentionally blank

1 EXISTING NCSPA PORT INFRASTRUCTURE

This section describes the existing cargo handling facilities at the Port of Wilmington (POW) and Port of Morehead City (MHC) that are owned and operated by the North Carolina State Ports Authority (NCSPA). Figure 1 shows the location of each port on the map.

Figure 1: Location of NCSPA Port Facilities



Source: ESRI, NCDOT, NC Office of Geospatial Technology Management

1.1 Port of Wilmington

The Port of Wilmington is located approximately 26 miles from the open sea on the Cape Fear River. Currently it has a channel depth of 42 ft. Mean Low Low Water (M.L.L.W). The port has nine berths with approximately 6,800 linear ft. of wharf and provides cargo storage space for container, bulk, and breakbulk operations. Figure 2 shows an aerial of the Port of Wilmington.

Figure 2: Port of Wilmington Aerial

Source: Bing Maps

Figure 3 provides a map of existing land uses at the Port of Wilmington, color-coded by the type of commodity handled, including the approximate size of each area. A full size map is provided in Appendix A for reference.

The details of Figure 3 were compiled based on the Facilities Guide provided by the NCSPA and input received from the NCSPA staff.

The container storage area is primarily on the south side of the terminal and north side features general cargo, including breakbulk and bulk, handling facilities.

The following subsections describe the Port of Wilmington container terminal and general cargo terminal in more detail.

Figure 3: Port of Wilmington – Existing Port Infrastructure

VACANT LAND

NAME	DESCRIPTION	AREA
	VACANT AREA	+/- 100 ACRES
AREA A	VACANT AREA	+/-6.47 ACRES
AREA B	VACANT AREA	+/- 9.26 ACRES
AREA G	VACANT AREA	+/- 1.5 ACRES
AREA H	PERMITTED ROADS	+/- 1.5 ACRES
AREA I	VACANT AREA	+/- 5.5 ACRES
AREA J	VACANT AREA	+/- 1.5 ACRES
AREA K	VACANT AREA	+/- 3 ACRES
TOTAL		+/- 128.73 ACRES

WETLANDS

AREA C	WETLAND	+/- 4.5 ACRES
AREA D	WETLAND	+/- 7.5 ACRES
AREA E	WETLAND	+/- 4.4 ACRES
AREA L	WETLAND	+/- 5 ACRES
TOTAL		+/- 21.4 ACRES

BUILDING

NAME	DESCRIPTION	AREA
B1	NCSPA OFFICE	+/- 15,000 S.F.
B2	CONTAINER OFFICE	+/- 3,200 S.F.
B3	CONTAINER INSPECTION	+/- 11,000 S.F.
B4	EQUIPMENT GARAGE	+/- 23,000 S.F.
B5	ENGINEERING	+/- 2,500 S.F.
B6	SEAMEN'S CENTER	+/- 5,000 S.F.
B7	PORT SECURITY	+/- 11,000 S.F.
B9	STEVEDORE GARAGE	+/- 40,700 S.F.
B10	CARGO CONTROL CENTR.	+/- 2,300 S.F.
B11	MATERIALS MNGMT.	+/- 15,000 S.F.
ZONE 12	FUMIGATION / MIX USE	+/- 140,000 S.F.
TOTAL		+/- 268,700 S.F.

CEMENT FACILITIES

NAME	DESCRIPTION	AREA
W4	WAREHOUSE	+/- 91,000 S.F.

STEEL / METAL

NAME	DESCRIPTION	AREA
ZONE 3	OPEN STORAGE AREA	+/- 250,000 S.F.
T2	SENSITIVE METALS	+/- 33,000 S.F.
SR	DRI	+/- 47,000 S.F.
TOTAL		+/- 330,000 S.F.

CHEMICAL FACILITY

NAME	DESCRIPTION	AREA
VOPAK	CHEMICAL FACILITY	+/- 22.85 ACRES

ANIMAL FEED / GRAIN FACILITY

NAME	DESCRIPTION	AREA
B8	BULK GRAIN FACILITY	+/- 170,000 S.F.

BULK FERTILIZER

NAME	DESCRIPTION	AREA
W3	WAREHOUSE	+/- 88,000 S.F.
W5	WAREHOUSE	+/- 94,300 S.F.
CI	WAREHOUSE	+/- 260,000 S.F.
TOTAL		+/- 442,300 S.F.

RORO / MACHINERY

NAME	DESCRIPTION	AREA
ZONE 5	MIX USE STORAGE	+/- 3.2 ACRES
ZONE 6	OPEN STORAGE	+/- 1.3 ACRES
TEMP A	OPEN STORAGE	+/- .2 ACRES
TEMP B	OPEN STORAGE	+/- 3.5 ACRES
TOTAL		+/- 8.2 ACRES

OPEN STORAGE AREA

NAME	DESCRIPTION	AREA
ZONE 7	OPEN STORAGE	+/- 3.4 ACRES
ZONE 8	OPEN STORAGE	+/- 3.6 ACRES
ZONE 9	OPEN STORAGE	+/- 1.2 ACRES
ZONE 11	OPEN STORAGE	+/- 4 ACRES
ZONE 15	OPEN STORAGE	+/- 10.5 ACRES
ZONE 17	OPEN STORAGE	+/- 4.2 ACRES
ZONE 18	OPEN STORAGE	+/- 2.6 ACRES
B12	OPEN STORAGE	+/- 1.5 ACRES
TOTAL		+/-31 ACRES

FOREST PRODUCTS / FLUFF

NAME	DESCRIPTION	AREA
T4	GENERAL MERCH.	+/- 72,500 S.F.
T5	GENERAL MERCH.	+/- 130,800 S.F.
T6	WOOD PULP	+/- 185,530 S.F.
T7	WOOD PULP / FLUFF	+/- 252,000 S.F.
ZONE 2	WOOD CHIPS	+/- 185,000 S.F.
TOTAL		+/- 825,830 S.F.

CONTAINER YARD

NAME	DESCRIPTION	AREA
CY-A	CONTAINER YARD	+/- 54 ACRES
CY-B	CONTAINER YARD	+/- 31 ACRES
CY-C	CHASSIS STORAGE	+/- 12.3 ACRES

Source: North Carolina State Ports Authority

1.1.1 Port of Wilmington Container Terminal

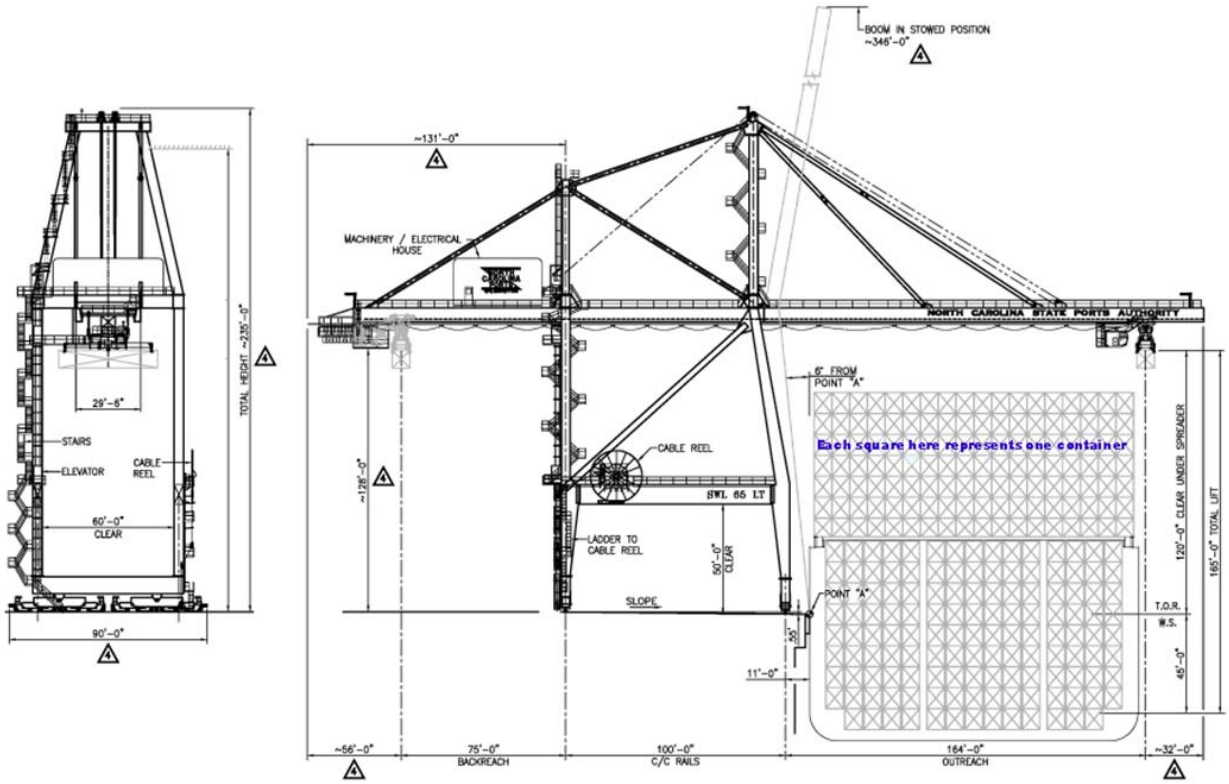
The Port of Wilmington container terminal area is shown in detail in Figure 4 (in purple). The existing container terminal has a gross area of approximately 106 acres. Container yard areas A and B are primarily used for storage and provide approximately 6,000 Twenty-foot Ground Slots (TGS) for container storage. Container yard area C is used for chassis storage.

Figure 4: Existing Port of Wilmington Container Terminal

Source: North Carolina State Ports Authority

While the Port of Wilmington has other berths (Berths 6, 7, and 8), the container yard is primarily served by a single berth (Berth 9) of approximately 1,250 ft. at the southern-most end of the container terminal and a 400-foot-long portion of Berth 8, which has been recently rebuilt to be able to accommodate 100 ft. gauge quay cranes. The existing four 100 ft. gauge cranes have an outreach of 18 containers and can load/unload container vessels up to about 8,000-8,500 TEU (twenty-foot equivalent units), as shown in Figure 5.

Figure 5: Schematic Diagram of 100' gauge quay cranes at Port of Wilmington



Source: http://www.ncports.com/gallery_detail.htm?i=70

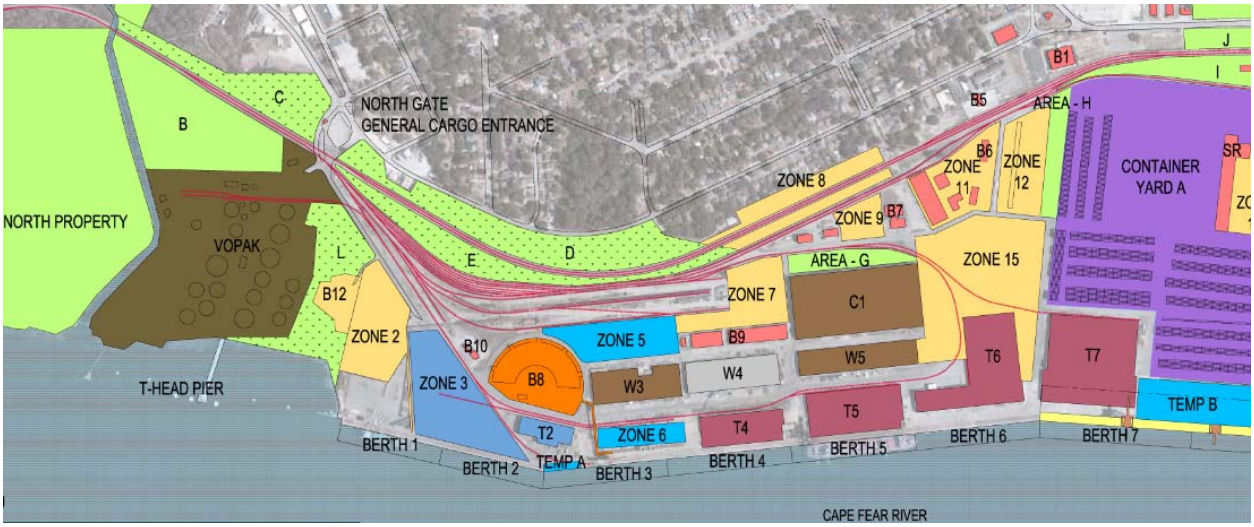
The existing gate that provides truck access to the container yard is located in the southeast end of the terminal, but extends inside the middle of the container storage area. All containers are handled with Reach Stackers (RS) inside the yard. A reach stacker is a mobile loader, as shown in Figure 6 that is used to pick up and move containers within the terminal once they are unloaded from the vessel.

Figure 6: Example Picture of a Reach Stacker

1.1.2 Port of Wilmington General Cargo Terminal

The Port of Wilmington General Cargo Terminal handles various types of import and export breakbulk and bulk commodities. Figure 7 shows a detailed map of the general cargo terminal including storage locations of various bulk and breakbulk cargoes.

Figure 7: Port of Wilmington General Cargo Terminal



Source: North Carolina State Ports Authority

Bulk Cargo: Bulk cargo is cargo that flows, or fits the shape of its container, such as dry cement or fertilizer. It can be dry bulk or liquid bulk.

The following bulk cargo is handled at the Port of Wilmington:

Grains /Animal Feed (Import)

- Primarily uses Berth 3
- Stored in five dedicated domes with a total static storage capacity of approximately 55,000 tons
- Average cargo handling speed is 500 tons per hour

Cement (Import)

- Primarily uses Berth 4
- Warehouse 4 is used for storage, which has a static storage capacity of approximately 25,000 tons
- 100 percent of cargo leaves the terminal by truck
- Average cargo handling speed is 300 tons per hour using a pneumatic unloader

Fertilizer (Import)

- Primarily uses Berths 4, 5 or 6
- It is a seasonal product handled between late Fall and early Spring
- Warehouses W3 (static storage capacity = 14,000 tons), W5 (static storage capacity = 20,000 tons) and C1 (static storage capacity = 70,000 tons) are used for storage
- 75 percent of cargo leaves the terminal by truck with the remaining using rail

- Average cargo handling speed over the berth is approximately 350 tons per hour, by using a clamshell bucket attached to 32' gauge crane. Cranes 1, 2, or 8 can be used.
- Crane 8 is the preferred crane.
- Generally the process is that ship mounted gear, or a port crane, picks it up from the ship, then drops it in truck, which drives to a warehouse. It stays in the warehouse for 15 to 30 days. When a truck comes to pick it up, a front-end loader loads the truck.

Chemicals (Import and Export)

- VOPAK, a private terminal operator leases and operates approximately 23 acres of a liquid bulk chemicals storage facility, located at the North end of the Port of Wilmington
- A separate T-head pier is used for vessel loading/unloading operations
- Landside operations are carried out 100 percent by truck
- Detailed static storage capacity information was not available for this facility

Breakbulk Cargo: Breakbulk cargo is cargo that is bundled, palletized, in bales or crates, or otherwise unitized, such as coil steel, paper products, or lumber. It is handled using forklifts and other specialized lift equipment.

The following breakbulk cargo is handled at the Port of Wilmington:

Metal Products (Import)

- Primarily uses Berths 1 and 2
- Stored outside on Berths 1 and 2, in Zone 3 and Transit Shed T2
- Outside storage varies from 30,000 to 50,000 tons and T2 is primarily used to store weather-sensitive steel products such as steel coils, and can hold up to 25,000 tons
- 100 percent of CSX cargo exits the terminal by rail; for other customers both truck and rail are used for landside transportation.
- Average cargo handling speed varies from 200 to 600 tons per hour

Lumber and Forest Products (Import and Export)

- Primarily uses Berths 4, 5 and 6
- Stored in transit sheds T4, T5, T6 and T7
- Approximately 43,000 tons of static storage capacity

Woodpulp (Export)

- Primarily uses Berths 6 or 7
- Stored inside transit shed T6 (static storage capacity = 66,000 tons) and T7 (static storage capacity = 23,000 tons)
- Majority of cargo enters the terminal by truck and the remaining enters by rail

Woodchips (Export)

- Primarily uses Berths 1 and 2
- Stored in Zone 2 with a static storage capacity of approximately 70,000 tons

Table 1 provides a summary of berth use by commodity for the Port of Wilmington.

Table 1: Port of Wilmington Berths Used by Commodity

	Chemicals	Grains/ Animal Feed	Cement	Metal Products (Coils)	Machinery	General Merchandise/ Misc.	Lumber & Forest Products	Fertilizer	Wood Pulp	Wood Chips
T-End Pier	X									
Berth 1				X						X
Berth 2				X						X
Berth 3		X			X					
Berth 4			X			X	X	X		
Berth 5						X	X	X		
Berth 6						X	X	X	X	
Berth 7									X	

1.2 Port of Morehead City

The Port of Morehead City is located approximately 4 miles from the Atlantic Ocean and has a 45 ft. M.L.L.W. deep channel from the sea buoy. It has nine berths with approximately 5,500 ft. of wharf and handles both breakbulk and bulk cargo at its existing facilities. Radio Island, which is part of the Port of Morehead City, is located across the Newport River from the port and includes approximately 150 acres of land suitable for port industrial development. Figure 8 shows the location of the Port of Morehead City and Radio Island on an aerial photograph.

Figure 8: Port of Morehead City Aerial

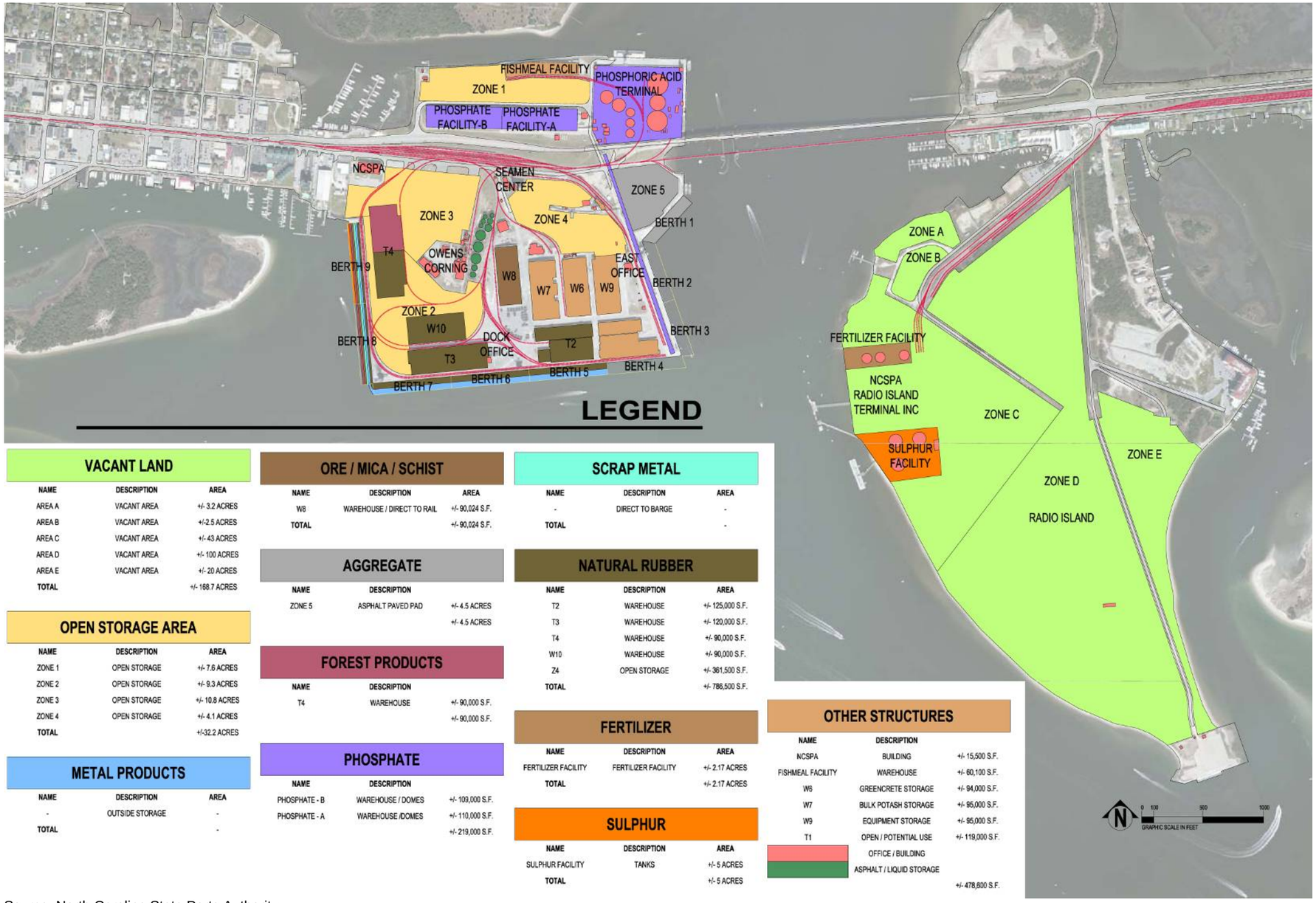
Source: Bing Maps

Figure 9 provides a map of the existing land uses at the Port of Morehead City, color-coded by the type of commodity handled, including the approximate size of each area. A full size map is provided in Appendix A for reference.

The details of Figure 9 were compiled based on the Facilities Guide provided by the NCSPA and input received from the NCSPA staff. The following subsections describe the Port of Morehead City's general cargo terminal in more detail.

This page intentionally blank

Figure 9: Port of Morehead City – Existing Port Infrastructure



Source: North Carolina State Ports Authority

This page intentionally blank

1.2.1 Port of Morehead City General Cargo Terminal

The Port of Morehead City handles the following types of import and export breakbulk and bulk commodities.

Bulk Cargo: Bulk cargo is cargo that flows, or fits the shape of its container, such as sulphur, aggregates or phosphate. It can be dry bulk or liquid bulk.

Sulphur
- Uses a dedicated pier on Radio Island for vessel unloading operations
- Uses dedicated storage tanks on Radio Island for storage with approximate static storage capacity of 30,000 tons

Aggregates
- Berth 1 is primarily used for unloading of aggregates
- Aggregates are stored in Zone 5 on asphalt paved pad of approximately 4.5 acres, with static storage capacity of approximately 60,000 tons

Phosphate
- Terminal site is on the North side of US 70 leased for PCS potash export operations
- Berths 2 and 3 are dedicated for the loading of phosphate vessels
- A dedicated warehouse and domes are used for storage of phosphate with an approximate static storage capacity of 180,000 tons
- Phosphate is barged from Aurora, NC – approximately 2MM tons per year

Breakbulk Cargo: Breakbulk cargo is cargo that is bundled, palletized, in bales or crates, or otherwise unitized, such as coil natural rubber, metal products or forest products. It is handled using forklifts and other specialized lift equipment.

Natural Rubber
- Primarily uses Berths 5 through 9 for loading/unloading operations
- Uses warehouse W10, transit sheds T2, T3 and half of T4 for storage with a total static storage capacity of approximately 66,000 tons
- Rubber used to only come into New Orleans, but with the hurricane and severe flooding a few years ago, Goodyear and Michelin moved some of their shipping to Morehead City and it has been there ever since. This keeps their supply chain more diversified and adds redundancy.
- Dwell time in warehouse usually 1 to 1.5 months
- Sometimes Goodyear brings containers full of rubber imported at other East Coast ports into the warehouses at Morehead City for storage and future distribution. However it is not waterborne cargo and generally represents less than 10 percent of the total volume handled
- Loading baskets of natural rubber blocks (75 to 80 lbs. each) takes 10 to 15 minutes and there are 15 baskets to a truck

Scrap Metal
- Primarily uses Berths 8 and 9 for vessel loading/unloading operations
- Most of the scrap metal is directly transferred from a vessel to a barge

Ore, Mica & Schist

- Uses Berths 8 and 9
- Stored inside warehouse W8 which has a static storage capacity of approximately 20,000 tons, from where it is directly transferred to the adjacent rail

Forest Products/Woodchips

- Berths 8 or 9 are used to handle forest products
- Half of transit shed T4 is used to store them, with an approximate static storage capacity of 21,000 tons. In addition, the open storage area in Zone 3 is used for woodchips.
- Woodchips are chipped on-site from wood logs for export as a replenishable fuel source which is trucked in from various places in North Carolina and destined for Turkey

Metal Products

- Use Berths 5 through 9 depending on the availability
- Most of the cargo is stored outside in Zone 2's open storage or behind the berths with an approximate static storage capacity of 14,000 tons

In addition to the above described cargo, the US Navy also makes 10 to 15 calls through the port each year. The Roll On-Roll Off (Ro-Ro) ramp at the end of Berth 9 is used for loading/unloading of vehicles and equipment and small barracks to property used by the Navy when they are working with cargo.

Table 2 provides a summary of berth use by commodity for the Port of Morehead City.

Table 2: Port of Morehead City Berths Use by Commodity

	Natural Rubber	Sulphur	Scrap Metal	Ore, Mica, Schist	Aggregate	Forest Products	Metal Products	Phosphate
Berth 1					X			X
Berth 2								X
Berth 3								X
Berth 4								
Berth 5	X						X	
Berth 6	X						X	
Berth 7	X						X	
Berth 8	X		X	X		X	X	
Berth 9	X		X	X		X	X	
Radio Island		X						

2 PORT CAPACITY ANALYSIS

2.1 AECOM PRECAP Model

AECOM conducted the NC Ports container terminal capacity analysis using our Preliminary Capacity (PRECAP) spreadsheet analysis model. PRECAP is a static model of terminal capacity to analyze capacity of the terminal berth, backland storage area (container yard), rail operations, and gate operations. The primary outputs from PRECAP are annual capacity of each of these terminal elements, which can then be evaluated as independent features or as linked elements.

An important benefit of this model is its ability to identify the element that is constraining overall terminal capacity and to focus investments where the greatest capacity improvement can be achieved. For example, the model may be used to establish parameters for the container yard and for the gate to match available berth capacity so that the terminal has a balanced capacity across all elements. Table 3 summarizes the key inputs to PRECAP for each terminal element.

Table 3: List of Input Parameters in PRECAP Model

Berth	Backland (CY)	Rail	Gate
Cargo moved per vessel call Cranes used per vessel Crane productivity Work hours Non-work time at berth Seasonal peaking factors Maximum allowable berth utilization	Mix of cargo types Dwell time Static storage capacity Inventory peaking factors	Number of rail cranes in use Rail crane productivity Working hours Switching delay Static working track capacity	Gate to vessel move ratio Hourly arrival pattern Number of gate stages Fraction of trucks that visit each stage Truck processing time at each stage

AECOM often uses PRECAP to analyze a range of options, such as comparison of high/med/low capacity forecasts based on specific input assumptions like crane productivity, or calculation of static density that is expected to increase as a result of a particular project, or evaluation of impacts of statistical factors – like working hours or vessel size – that are expected to change over time due to external trends.

PRECAP has been developed by AECOM over many years of experience at port facilities around the globe in the planning and analysis of dozens of marine terminals. PRECAP is currently used by the Port of Los Angeles, the Port of Long Beach, and Port Metro Vancouver (Canada) as the standard tool for determining their port terminal capacity.

2.2 NCSPA Existing Container Operations Data

As a basis for assessment of container capacity analysis at the Port of Wilmington, AECOM gathered actual container vessel arrival data from 4/25/2011 through 5/25/2011 provided by the NCSPA.

Table 4 shows a summary of the data collected. From the total vessel call duration, net vessel work time was calculated by subtracting 1.5 hours each for vessel tie-up and untie. From the net vessel work time, net crane work time was calculated by subtracting the time for crane driver breaks. Net quay crane productivity was calculated by dividing total container moves by net crane working hours, further dividing by the number of dock cranes.

As indicated at the bottom of the table, an average vessel call size was 824 containers per call and an average 2.3 dock cranes were assigned per vessel at the Port of Wilmington for the data sample used herein.

Table 4: Port of Wilmington Container Vessel Arrival Data

Call	Vessel Name	Shipping Line	Dock Cranes Assigned	Actual Vessel Draft (ft)	Total Containers per Call	Lift per Dock Crane	Call Duration (days)
1	Hamburg	Yang Ming	4	34.8	1,243	310.8	0.99
2	Marseilles	Hanjin	3	38.1	1,071	357.0	0.73
3	Ind. Accord	ICL	2	34.1	565	282.5	0.43
4	Roubaix	Maersk	1	23.6	98	98.0	0.23
5	East	Yang Ming	2	35.1	1,317	658.5	1.05
6	San Francisco	Hanjin	3	33.5	1,023	341.0	0.50
7	Julius S	ICL	2	30.8	901	450.5	1.08
8	Islandia	Maersk	1	23.6	223	223.0	0.28
9	Seattle	Yang Ming	3	32.5	1,346	448.7	0.70
10	Elizabeth	Hanjin	3	33.0	967	322.3	0.46
11	Ind. Concept	ICL	2	32.2	533	266.5	0.59
12	Roubaix	Maersk	1	26.0	269	269.0	0.43
13	South	Yang Ming	3	38.4	1,279	426.3	1.28
14	Valencia	Hanjin	4	32.5	1,041	260.3	0.45
15	Jumme Trader	ICL	2	31.5	843	421.5	0.66
16	Islandia	Maersk	1	24.3	152	152.0	0.77
17	Malta	Hanjin	2	34.1	569	284.5	0.40
18	Los Angeles	Yang Ming	3	36.7	1,386	462.0	1.09
	Minimum		1.0	23.6	98	98.0	0.23
	Average		**2.3**	**32.0**	**824**	**335.2**	**0.67**
	Maximum		4.0	38.4	1,386	658.5	1.28

The NCSPA also provided detailed data on quay crane productivity for four weeks, 06/06/2011 through 06/27/2011. Table 5 provides a summary of all four weeks. According to this table also, average net quay crane productivity over a month period was approximately 37 moves per hour. On the West Coast of USA and the majority of terminals on the East Coast operate at much lower productivity, with averages at 30 moves per hour. APMT Virginia averages approximately 35 moves per hour.

AECOM believes the Port of Wilmington is operating the terminal very efficiently and is able to achieve such a high productivity due to a lower intensity of operation and a more than sufficient container yard area for advanced container staging operations. Table 6 through Table 9 provides details of each week for calculation of net container lifts per hour.

Table 5: Port of Wilmington Quay Crane Productivity Summary

Weekly Crane Productivity		Total Hours	Container Lifts	Container Lifts/ Hour
Week Number 49	06/06/2011	94.25	3,470	36.9
Week Number 50	06/13/2011	129.00	4,640	36.0
Week Number 51	06/20/2011	88.25	3,341	38.0
Week Number 52	06/27/2011	101.00	3,808	37.8
Totals & Avg		**412.50**	**15,259**	**37.0**

Table 6: Actual Quay Crane Productivity for Week 49 (ending 06/06/2011)

Shipping Line	Vessel	Date	Crane #	S.T.	O.T.	Total Hours	Container Lifts	Container Lifts/ Hour
Hanjin	Hanjin Nagoya	5/30	9		12.5	12.50	481	38.5
Hanjin	Hanjin Nagoya	5/30	10		12.5	12.50	416	33.3
Yang Ming	YM Busan	5/30	12		14	14.00	512	36.6
Yang Ming	YM Busan	5/30	14		14	14.00	547	39.1
Yang Ming	YM Busan	5/30	15		12	12.00	454	37.8
ICL	Julius S	6/3	14	8.25		8.25	297	36.0
ICL	Julius S	6/3	15	7.50		7.50	297	39.6
ICL	Julius S	6/3	16	7.50		7.50	284	37.9
Maersk	Islandia	6/4	15		6	6.00	182	30.3
Totals & Avg				**23.25**	**71**	**94.25**	**3,470**	**Avg 36.9**

Table 7: Actual Quay Crane Productivity for Week 50 (ending 06/13/2011)

Shipping Line	Vessel	Date	Crane #	S.T.	O.T.	Total Hours	Container Lifts	Container Lifts/ Hour
Hanjin	Hanjin Shanghai	6/7-8	12		10.0	10.00	354	35.4
Hanjin	Hanjin Shanghai	6/7-8	14		10.0	10.00	363	36.3
Hanjin	Hanjin Shanghai	6/7-8	15		10.0	10.00	349	34.9
Yang Ming	YM Shanghai	6/7-8	9	9.5	10.0	19.50	696	35.7
Yang Ming	YM Shanghai	6/7-8	10	10.0	10.0	20.00	650	32.5
ICL	Indep Concept	6/10	15	8.5		8.50	292	34.4
ICL	Indep Concept	6/10	16	8.0		8.00	308	38.5
Maersk	Maersk Roubaix	6/11	15		5.0	5.00	191	38.2
Yang Ming	Ming Eminence	6/12	14		12.5	12.50	497	39.8
Yang Ming	Ming Eminence	6/12	15		12.5	12.50	467	37.4
Yang Ming	Ming Eminence	6/12	16		13.0	13.00	473	36.4
Totals & Avg				**36.0**	**93.0**	**129.00**	**4,640**	**Avg 36.0**

Table 8: Actual Quay Crane Productivity for Week 51 (ending 06/20/2011)

Shipping Line	Vessel	Date	Crane #	S.T.	O.T.	Total Hours	Container Lifts	Container Lifts/ Hour
Hanjin	Hanjin Colombo	6/13-14	12		8.00	8.00	319	39.9
Hanjin	Hanjin Colombo	6/13-14	14		8.00	8.00	330	41.3
Hanjin	Hanjin Colombo	6/13-14	15		8.50	8.50	295	34.7
ICL	Voyager	6/17	15	9.5		9.50	414	43.6
ICL	Voyager	6/17	16	10.5		10.50	421	40.1
Maersk	Islandia	6/18	15		7.50	7.50	194	25.9
Yang Ming	YM New Jersey	6/19	14		12.50	12.50	472	37.8
Yang Ming	YM New Jersey	6/19	15		12.50	12.50	462	37.0
Yang Ming	YM New Jersey	6/19	16		11.25	11.25	434	38.6
Totals & Avg				**20.0**	**68.25**	**88.25**	**3,341**	**Avg 38.0**

Table 9: Actual Quay Crane Productivity for Week 52 (ending 06/27/2011)

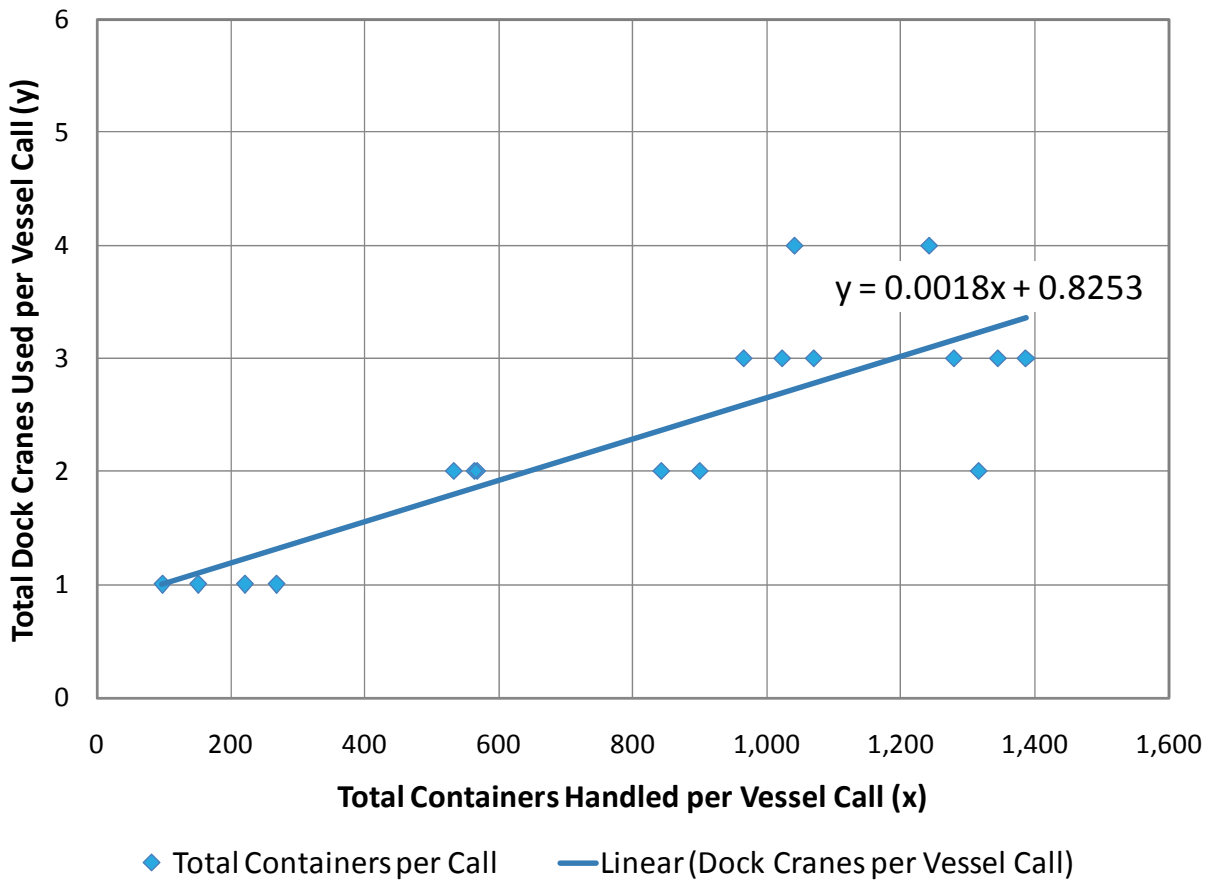
Shipping Line	Vessel	Date	Crane #	S.T.	O.T.	Total Hours	Container Lifts	Container Lifts/ Hour
Hanjin	Hanjin Wilmington	6/21-22	14		7.5	7.50	285	38.0
Hanjin	Hanjin Wilmington	6/21-22	15		7.5	7.50	292	38.9
Hanjin	Hanjin Wilmington	6/21-22	16		8.0	8.00	307	38.4
ICL	Indep. Accord	6/24	14	8.5		8.50	290	34.1
ICL	Indep. Accord	6/24	15	8.0		8.00	302	37.8
Maersk	Roubaix	6/25	15		6.5	6.50	244	37.5
Yang Ming	YM Hamburg	6/26	14		12.5	12.50	477	38.2
Yang Ming	YM Hamburg	6/26-27	15		11.0	11.00	434	39.5
Yang Ming	YM Hamburg	6/26-27	16		15.0	15.00	486	32.4
Hanjin	Han Marseilles	6/27	14	8.0		8.00	342	42.8
Hanjin	Han Marseilles	6/27	15	8.5		8.50	349	41.1
Totals & Avg				**33.0**	**68.0**	**101.00**	**3,808**	**Avg 37.8**

It must be recognized that vessels (ships) come in a variety of sizes (lengths, widths, and depths) translating into different carrying capacities (total number of containers that can be hauled). And berth capacity is mainly dependent on the average number of containers being handled per vessel call and how fast a vessel can be worked.

Based on the data provided in Table 4, a relationship between the number of containers handled per vessel call and the number of dock cranes used at the Port of Wilmington were established, as presented in Figure 10.

The Port of Wilmington has only four dock cranes that can handle larger vessels and as presented in the graph below, as the number of containers per vessel call increases, number of dock cranes used to load/unload the vessel also increases in a linear relationship.

Figure 10: Containers per Vessel Call vs. Dock Cranes Used at Port of Wilmington

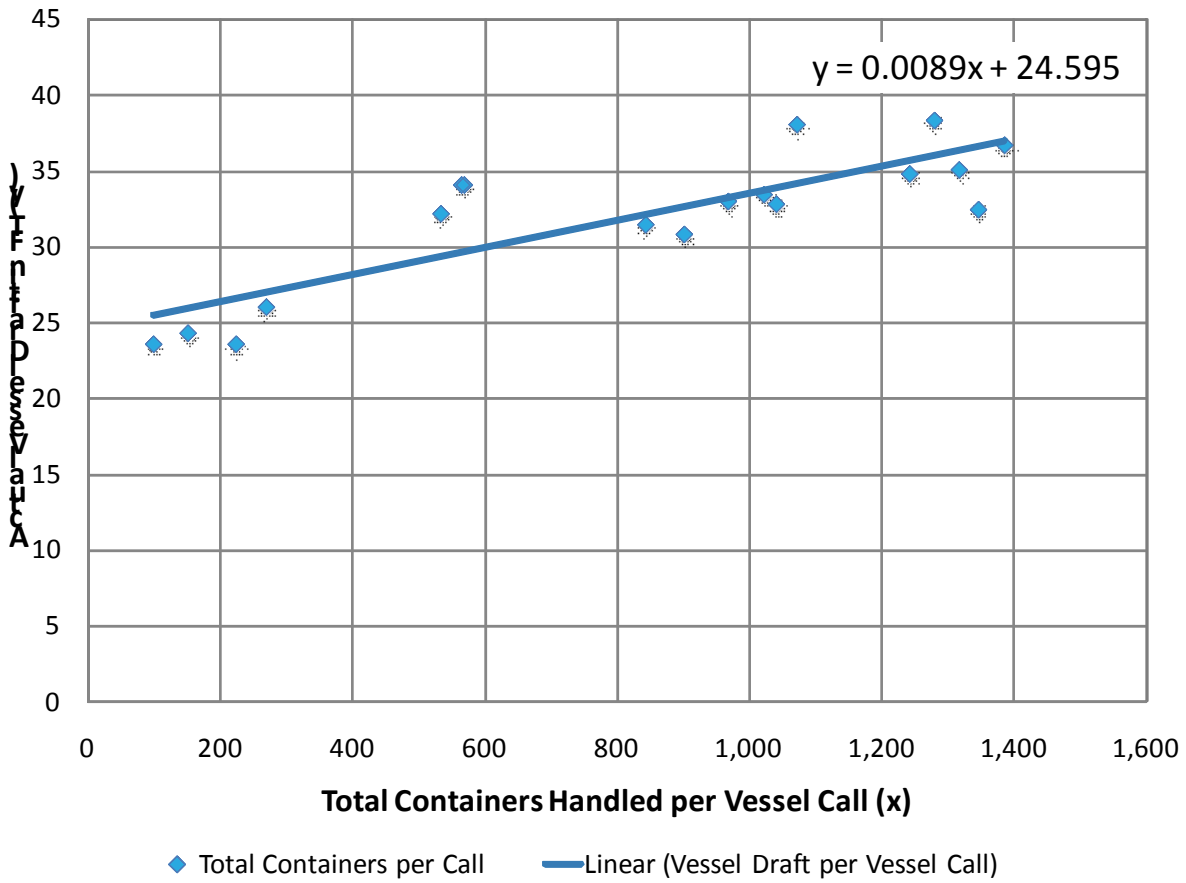


The relationship between the number of containers handled per vessel call and the dock cranes deployed was used for calculating capacity of Port of Wilmington at deeper channel depths.

Based on the data provided in Table 4, a relationship between the number of containers handled per vessel call and average vessel draft that called at the Port of Wilmington was also established, as presented in Figure 11.

Port of Wilmington's channel is dredged to 42' M.L.L.W and can only accept vessels with draft less than that. As shown in the graph below, the maximum vessel draft during the sample period was 38.5'. The relationship between the number of containers handled per vessel call vs. the actual vessel draft is also linear.

Figure 11: Containers per Vessel Call vs. Vessel Draft at Port of Wilmington



The relationship between the number of containers handled and a vessel's draft was used as a reference to derive an estimate of the maximum vessel load that can be brought in recognizing the 42' channel depth limitations. It should be noted that a minimum of 2' under keel clearance is required in the channel, so the maximum vessel draft that can transit the channel at Port of Wilmington is limited to 40'. Keeping that in mind, based on the formula presented in Figure 11, the average number of containers that can be handled per each vessel call was calculated to be 1,442, which is used in the capacity analysis presented in the next section.

2.3 NCSPA Container Operations Capacity Analysis

Based on existing operations data and discussions with the NCSPA, the Port of Wilmington existing container terminal capacity was determined, which is calculated as the minimum of two key capacity elements, capacity to handle containers over the berth and capacity to handle containers inside the yard. Landside access usually is not a constraint due to relatively low cost solutions for increasing modern terminal gate capacity and that rail cargo can be trucked to off-site yards. So, an assumption was made that landside access capacity can be increased in line with the overall terminal capacity.

Berth Capacity – the potential maximum throughput of containers handled over the berth (measured in twenty-foot equivalent units or TEUs), is primarily dependent on the following factors:

Number of Available Berths: The number of berths on the facility which are operational and provide access to 100' gauge cranes required to service typical size container vessels arriving at the Port. Currently, the Port of Wilmington has only one berth that meets this criterion. Although the Port of Wilmington has many other berths, the existing crane rail gauge is less than 50' and those cranes do not provide sufficient reach to handle the larger container vessels. Berth capacity resulting from the use of other berths has not been accounted for in this exercise based on discussions with the NCSPA that they rarely use any other berth for container handling operations.

Container Moves per Vessel Call: As discussed in the previous section, based on the actual data and prorating based on the relationship between containers per vessel call and vessel draft, 1,442 container moves per vessel call was used as the maximum average number of containers carried per vessel call at the Port of Wilmington for the existing channel depth of 42 ft.

Dock Cranes Assigned per Vessel: As described in the previous section, based on the actual data from the NCSPA, we used an average maximum of 3 dock cranes per vessel call. It should be noted that as a maximum, the Port has used all four cranes on a single vessel call, and on a smaller vessel, only 1 crane was used. Hence, an average use of 3 dock cranes per vessel call also allows for consideration of crane maintenance and downtime.

Productivity per Dock Crane: As described in the previous section, based on the actual data from the NCSPA, we have used 37 moves per hour as the net productivity for dock cranes.

Maximum Practical Berth Utilization: This is the key subjective variable in a berth capacity analysis. No berth can effectively run at 100 percent full. With a typical vessel schedule that includes a peak period, most facilities cannot operate much above 60 percent without vessel queuing. In some locations, especially in Asia where feeder vessels will in fact queue for berth space, terminals can operate at berth occupancy up to 80 percent. Longer contiguous berths allow for greater occupancy than shorter berths. The maximum value we have implemented from past experience is 65 percent for more than 2 contiguous berths. For a single berth, it varies from 50 to 60 percent. At the Port

of Wilmington, due to the availability of Berth 7 and part of Berth 8 for vessel waiting while another ship is being worked at Berth 9, we have set the maximum practical berth utilization at 55 percent.

Unproductive Time at Berth: It accounts for ship tie-up and untie time, which represents time where the berth is physically occupied by a vessel (i.e. no other vessel can be in that berth position) but there is no crane activity, excluding breaks which are captured by the work hours per day input. This activity includes mooring, line fastening, unlashing prior to first container move, administrative clearance, and so forth.

Peak/mean Week Seasonal Demand: It is assumed that a peak week demand of a berth will be 20 percent higher than the average weekly demand to account for changes in seasonal demand and to adjust peak week berth capacity down to an average week berth capacity for calculation of the annual berth capacity.

Table 10 describes the step-by-step calculations of annual berth capacity for the Port of Wilmington Existing Container Terminal. The right column provides formulas for the calculations done.

With one berth of 1,250' length that accommodates four 100' rail gauge dock cranes, the NCSPA can handle approximately 530,000 TEU over the berth. In FY2010, the NCSPA handled approximately 250,000 TEU at the Port of Wilmington. In essence, they operated the berth at approximately 47 percent of capacity.

Another important factor in the capacity of a container terminal is the size and operation of the container yard. Ideally, the capacity of the berth and the container yard should be balanced to achieve maximum throughput from the terminal as a whole.

Table 10: Existing Container Berth Capacity at Port of Wilmington

1 Berth Existing Max 42' Channel	
5,000	Typical max vessel class size, TEUs
1,442	Container moves (lifts) per vessel call [a]
3.0	Dock cranes assigned per vessel [b]
37.0	Productivity per dock crane (mv/hr) [c]
111.0	Vessel productivity(mv/hr) [d=b*c]
13.0	Work hours per vessel call [e=a/d]
3	Unproductive time at berth (hrs) [f]
16.0	Total vessel time at berth (hrs) [g=e+f]
20.0	Work hours per day [h]
1.20	Calendar hrs/ work hour [i=24/h]
19.2	Total vessel hrs at berth [j=g*i]
168	Calendar hrs per week [k]
8.75	Vessel calls per week at 100% berth utilization [l=k/j]
55%	Maximum practical peak week berth utilization [m]
4.82	Maximum practical vessel calls per week [n=l*m]
6,944	Peak week berth capacity (moves) [o=n*a]
1.2	Peak/mean week seasonal demand factor [p]
5,786	Mean week throughput capacity (moves) [q=o/p]
301,000	Annual unit berth capacity (moves) [r=q*52]
1.75	TEU per container [s]
530,000	Annual unit berth capacity (TEU) [t=r*s]
1	Number of berths (100' gauge crane) [u]
530,000	**Annual total berth capacity (TEU) [v=t*u]**
100,333	Annual lifts per dock crane [w=r/b]
1,250	Total berth length (feet)
420	Annual berth capacity per unit berth length (TEU/feet)

Note: Inputs shaded in blue, desired outputs shaded in pink.

Container Yard Capacity – the potential maximum throughput of containers handled inside the container yard (measured in twenty-foot equivalent units or TEU), is primarily dependent on the following factors:

Mean Dwell Time: The number of days a container sits inside the container terminal (dwell), which varies by import vs. export vs. empty container. For the capacity calculation, an average of 7 days was used, based on feedback provided by the NCSPA.

TGS Capacity: Represents the static storage capacity in terms of the total number of twenty-foot ground slots (TGS) or net acres available to store those containers. As discussed in previous section, currently the Port of Wilmington has approximately 6,000 TGS.

Mean Storage Height: With reach stackers being used for all container yard operations, loaded containers can be stored up to three high, and empties up to five high. A mean storage height was calculated which takes into account the peak stacking height of the machine and various utilization factors than can be applied. It simply represents the maximum overall desired height for grounded operations. Most operators feel that 70 to 80 percent of the peak theoretical capacity is a reasonable level for planning purposes. We used 2.5 as an average stacking height for capacity calculations.

Seasonal Peaking Factor: It is assumed that a peak week demand of the container yard will be 20 percent higher than the average week demand to account for changes in seasonal demand and adjust peak week container yard capacity down to an average week berth capacity for calculation of the annual container yard capacity.

Weekly Inventory Peaking Factor: During a week, when a vessel arrives or departs, there is a sudden surge of inventory of containers that needs to be handled in the container yard, based on the size of the vessel and number of containers handled per vessel call. This factor is applied to account for this surge assuming the ratio of peak week inventory is 20 percent higher than the average week inventory.

Table 11 describes the calculation of container yard capacity and the formulas used to derive it.

Table 11: Existing Container Yard Capacity Calculation at Port of Wilmington

RS Existing POW 100% Dwell	
6,000	TGS capacity available [a]
2.5	Mean storage height (containers) [b]
15,000	TEU static capacity [c=a*b]
7.0	Mean dwell time (days) [d]
52.14	Turnovers per year per TEU static capacity [e=365/d]
782,143	TEU capacity without peaking [f=c*e]
1.20	Seasonal throughput peak factor [g]
1.20	Weekly inventory peak factor [h]
540,000	**Annual CY capacity (TEUs, rounded) [i=f/g/h]**
106	Gross terminal area (including wharf, acres)
5,100	Annual TEUs per gross acre

Note: Inputs shaded in blue, desired outputs shaded in pink.

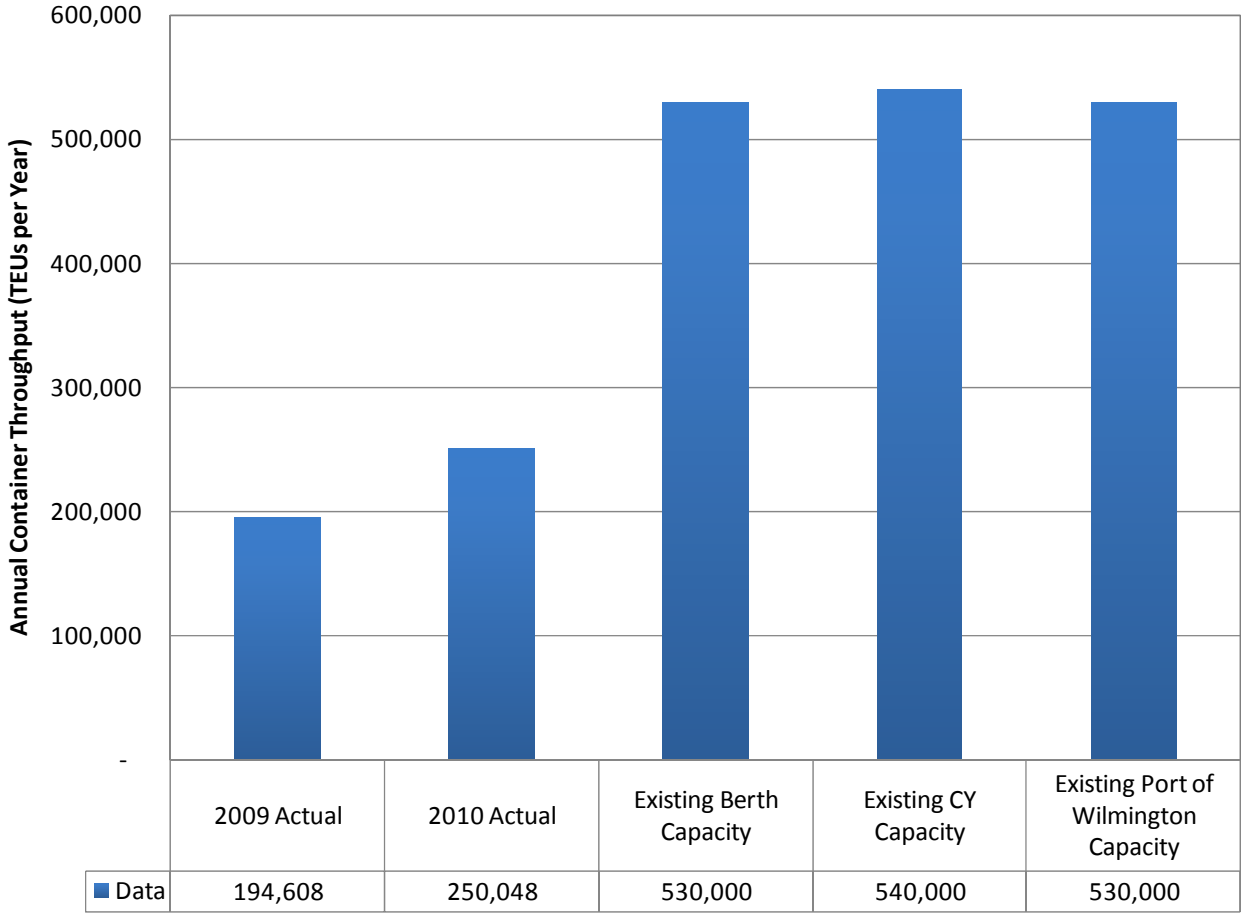
The current reach-stacker (RS) based operation at the Port of Wilmington offers a maximum container yard capacity of 540,000 TEU/year.

Port of Wilmington Container Terminal Capacity – the overall terminal capacity is given as the minimum of the berth and container yard capacities. Therefore, AECOM assessed the existing container terminal capacity at the Port of Wilmington to be approximately 530,000 TEU.

In 2009, the Port handled total of 194,608 TEU, which is approximately 37 percent of the Port's capacity and in 2010, the Port handled 250,048 TEU which is approximately 47 percent of the Port's capacity.

Figure 12 provides a summary of the Port of Wilmington's existing container handling capacity as compared to the actual throughput handled in 2009 and 2010.

Figure 12: Port of Wilmington Existing Container Terminal Capacity



This page intentionally blank

3 NCSPA NON-CONTAINER OPERATIONS CAPACITY ANALYSIS

Annual berth and storage capacities were calculated for some major bulk commodities handled at both the Port of Wilmington and the Port of Morehead City.

3.1 Port of Wilmington Bulk/ Breakbulk Capacity

Berth capacity calculations are detailed in Table 13 for the Port of Wilmington. The values provided in green shaded cells are inputs and non-shaded white cells are formulas. The formulas are described in the first column of the table.

There are 7 berths at the Port of Wilmington used for bulk handling. All berth utilizations are split among multiple commodities as detailed in Table 12.

Table 12: Port of Wilmington Berths Sharing for Bulk/Breakbulk Commodities

	Grains (animal feed)	Machinery	Cement	Metal Products (coils)	General Merchandise/ Misc.	Lumber/ Forest Products	Fertilizer	Wood Pulp	Wood Chips	Sum
Throughput Base	371,014	117,077	147,528	128,026	140,112	355,273	50,000	208,021	88,014	
Max Product Utilization by Berth:										
1				39%					26%	**65%**
2				39%					26%	**65%**
3	49%	16%								**65%**
4			14%		13%	33%	5%			**65%**
5					17%	42%	6%			**65%**
6					12%	31%	4%	18%		**65%**
7								65%		**65%**
Average	**49%**	**16%**	**14%**	**39%**	**14%**	**35%**	**5%**	**41%**	**26%**	

Note: Throughput Base volume is tonnage as reported by NCSPA at the time of analysis. Generally, 2010 tonnages are used; however, for some commodities a more representative Throughput Based was applied. Not all commodities and tonnages are listed.

Table 13 summarizes berth capacity calculations for major commodities at the Port of Wilmington.

Table 13: Port of Wilmington Berth Capacity Calculations for Bulk/Breakbulk Commodities

	Port of Wilmington Bulk Berth Capacity	Grains (animal feed)	Cement	Metal Products (coils)	Lumber/ Forest Products	Fertilizer	Wood Pulp	Wood Chips
	Berths used	3	4	1,2	4,5,6	4,5,6	6,7	1,2
a	Number of berths available	1	1	2	3	3	2	2
b	Ship work rate (hours/day)	24	24	24	24	24	24	24
c	Max work days/week	7	7	7	7	7	7	7
d	Max practical berth utilization	49%	14%	39%	35%	5%	41%	26%
e=a*b*c*d	Effective total berth-hours per week	83.01	23.25	129.42	178.62	25.14	139.35	88.98
f	Mean cargo handled per vessel call (tons)	45,000	12,000	6,000	5,000	8,000	3,455	44,000
g	Mean loading/ unloading rate (tons/hour)	500	300	400	300	350	200	800
h=f/g	Mean ship work time (hrs)	90.0	40.0	15.0	16.7	22.9	17.3	55.0
I	Non-work hours at berth	4.0	4.0	4.0	4.0	4.0	4.0	4.0
j=h+i	Mean berth occupancy time per ship (hrs/call)	94.0	44.0	19.0	20.7	26.9	21.3	59.0
k=e/j	Potential ship calls per week	0.9	0.5	6.8	8.6	0.9	6.6	1.5
l=k*f	Weekly throughput capacity (tons)	39,737	6,341	40,871	43,214	7,488	22,630	66,355
m	Weekly peaking factor	110%	110%	110%	110%	110%	110%	110%
n=l*52/m	**Annual berth capacity (tons)**	**1,878,000**	**300,000**	**1,932,000**	**2,043,000**	**354,000**	**1,070,000**	**3,137,000**

Note: Inputs shaded in green, desired outputs bolded.

Machinery and general merchandise are included in Table 12 to incorporate their effect on the berth capacity of other commodities, though their berth capacity is not determined. Blank cells indicate that the commodity does not use the berth in question. A nominal 50,000 tons is used for fertilizer due to low volumes in recent years.

It is important to note that distribution is only one nominal way of determining the impact of berth sharing on each commodity. Overall berth capacity will be fluid depending on the priority of the commodity. For instance, if wood chips were no longer handled, metal products could have a berth utilization of 65 percent at Berths 1 and 2 and a correspondingly higher capacity.

Table 13 indicates that for most commodities, berth capacity is much higher than historical throughput volumes even with most berths split among multiple commodities. The limiting factor to overall capacity is more likely to be storage capacity as discussed below.

Table 14 determines storage capacity for each commodity for the Port of Wilmington.

Table 14: Port of Wilmington Storage Capacity Calculations for Bulk/Breakbulk Commodities

	Port of Wilmington Bulk Storage Capacity	**Grains (animal feed)**	**Cement**	**Metal Products (coils)**	**Lumber/ Forest Products**	**Fertilizer**	**Wood Pulp**	**Wood Chips**
	Static storage capacity (tons)	55,000	25,000	30,000	43,000	104,000	89,000	70,000
	Static capacity/ mean ship capacity	1.2	2.1	5.0	8.6	13.0	25.8	1.6
a	Nominal annual throughput (tons/year)	100,000	100,000	100,000	100,000	100,000	100,000	100,000
b=a/52	Mean week vessel volume (tons)	1,923	1,923	1,923	1,923	1,923	1,923	1,923
c	Cargo dwell time (days)	30.0	30.0	45.0	30.0	30.0	30.0	30.0
d	Average volume of cargo in storage (tons)	8,242	8,242	12,363	8,242	8,242	8,242	8,242
e	Peak/ mean inventory	150%	150%	125%	125%	125%	125%	150%
f=d*e	Demand for storage (tons)	12,363	12,363	15,453	10,302	10,302	10,302	12,363
g	Total storage available (tons)	55,000	25,000	30,000	43,000	104,000	89,000	70,000
h=g/f*a	**Annual storage capacity (tons)**	**445,000**	**202,000**	**194,000**	**417,000**	**1,009,000**	**864,000**	**566,000**

Note: Inputs shaded in green, desired outputs bolded.

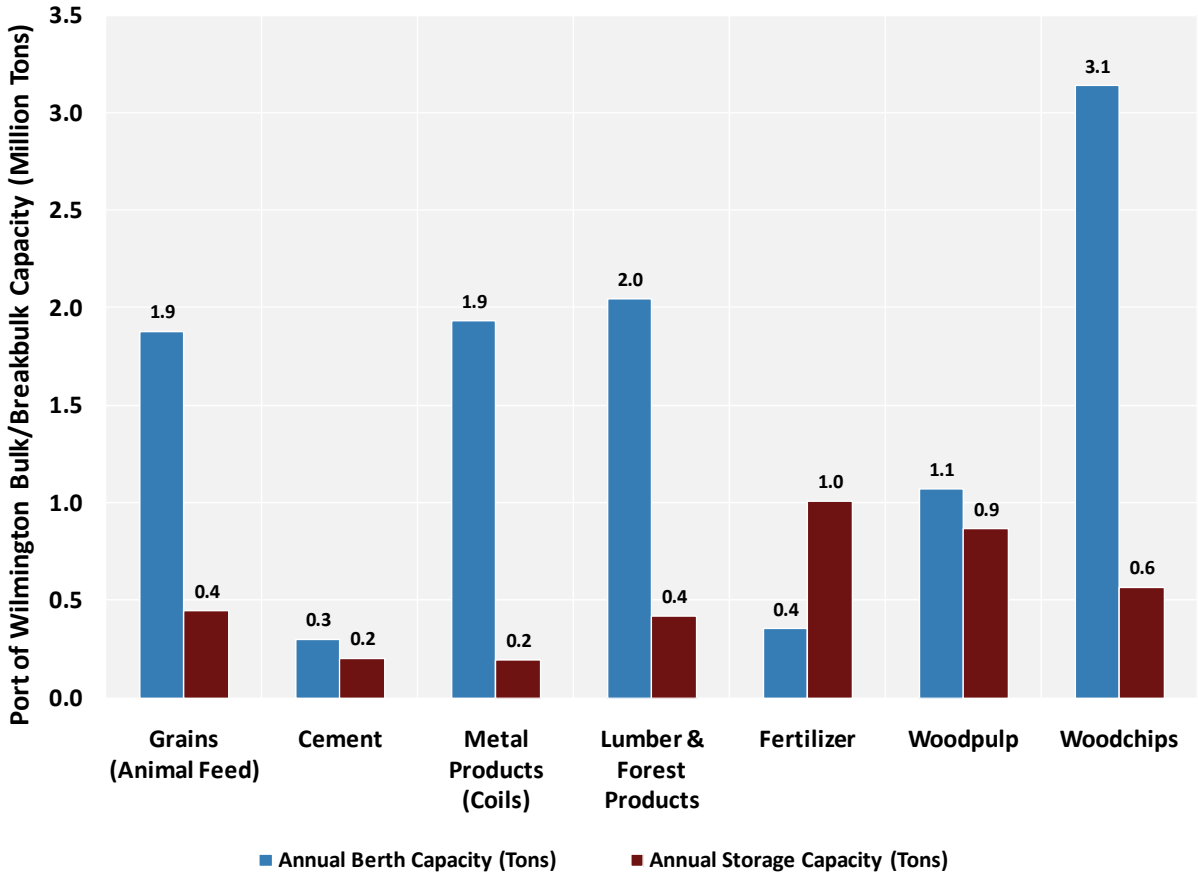
Static storage capacity for each commodity was provided by the NCSPA. Static Capacity / Mean Ship Capacity is determined using Row f in Table 13 (Mean Cargo Handled per Vessel Call). This value is used to determine Row e, Peak/Mean Inventory. If the ratio of storage capacity to average vessel tonnage is high, then a single vessel does not impact storage utilization heavily, reducing inventory peaking (as with fertilizer); 125 percent is used for e in this case. However, if a single vessel uses most of a commodity's available storage (as with grains or cement), then inventory peaking will be high; 150 percent is used in this case.

Cargo dwell time is the average time a unit of cargo spends on the port before exiting via truck, rail, or barge. In lieu of other data, 30 days is used for most commodities at the Port of Wilmington. Note that dwell times are heavily impacted by demand; if demand increases, dwell times can reduce significantly and thus will allow more throughput.

A dwell time of 30 days is used for all commodities analyzed at the Port of Wilmington with the exception of Metal Products, as indicated by the Port based on historical throughputs.

Figure 13 provides overall berth and storage capacities for the commodities analyzed at Port of Wilmington in chart form for comparison.

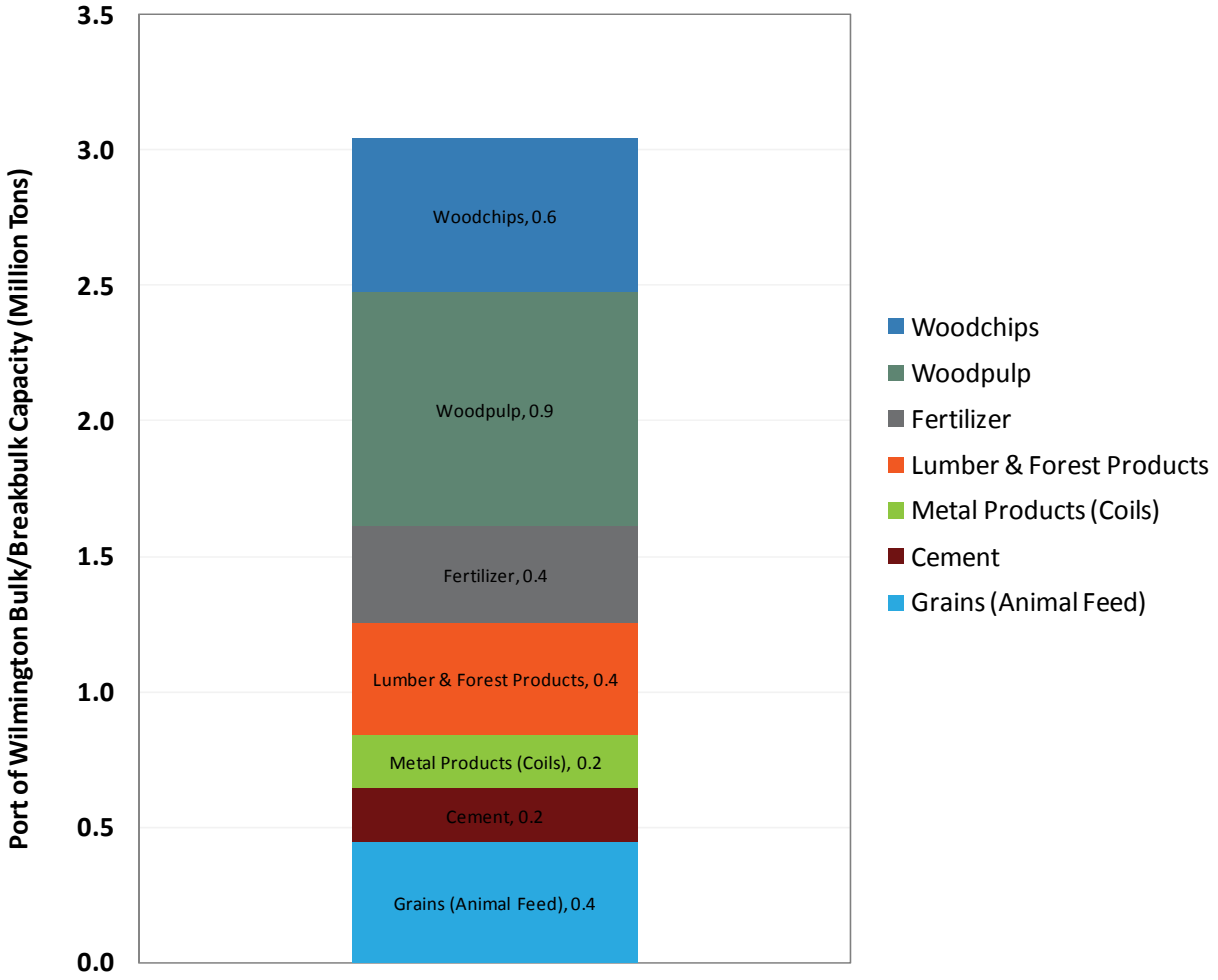
Figure 13: Port of Wilmington Bulk/Breakbulk Berth vs. Storage Capacity Chart



As expected, storage capacity is the limiting factor for most commodities. The only exception is fertilizer, which is based on nominal berth sharing; however, since Lumber & Forest products share with fertilizer and are unlikely to utilize their full berth capacity due to market demand and storage limitations, it is unlikely fertilizer will be limited by berth access in practice. Which means throughput of all commodities will be limited by the storage capacity and not by the berth.

Figure 14 summarizes the total bulk/breakbulk capacity at the Port of Wilmington by commodity type. Based on the assumptions used in this report, the total bulk/breakbulk handling capacity at the Port of Wilmington is approximately 3.1 million tons.

Figure 14: Port of Wilmington Bulk/Breakbulk Capacity Summary



3.2 Port of Morehead City Bulk/Breakbulk Capacity

Berth capacity calculations are detailed in Table 15 for the Port of Morehead City. The values provided in the green shaded cells are inputs and non-shaded white cells are formulas. The formulas are described in the first column of the table.

Table 15: Port of Morehead City Berth Capacity Calculations for Bulk/Breakbulk Commodities

	Port of Morehead City Bulk Berth Capacity	**Natural Rubber**	**Sulphur**	**Ore, Mica, Schist**	**Aggregate**	**Forest Products**	**Metal Products**	**Phosphate**
	Berths used	5 - 9	Radio Is.	8,9	1	8,9	5 - 9	2,3
a	Number of berths available	5	1	2	1	2	5	2
b	Ship work rate (hours/day)	24	24	24	24	24	24	24
c	Max work days/week	7	7	7	7	7	7	7
d	Max practical berth utilization	35%	50%	5%	50%	14%	17%	65%
e=a*b*c*d	Effective total berth-hours per week	291.97	84.00	15.68	84.00	47.06	141.42	218.40
f	Mean cargo handled per vessel call (tons)	6,000	14,000	12,000	40,000	6,000	7,000	40,000
g	Mean loading/ unloading rate (tons/hour)	275	1,100	350	4,000	300	400	750
h=f/g	Mean ship work time (hrs)	21.8	12.7	34.3	10.0	20.0	17.5	53.3
I	Non-work hours at berth	4	4	4	4	4	4	4
j=h+i	Mean berth occupancy time per ship (hrs/call)	25.8	16.7	38.3	14.0	24.0	21.5	57.3
k=e/j	Potential ship calls per week	11.3	5.0	0.4	6.0	2.0	6.6	3.8
l=k*f	Weekly throughput capacity (tons)	67,852	70,304	4,916	240,000	11,764	46,042	152,372
m	Weekly peaking factor	110%	110%	110%	110%	110%	110%	110%
n=l*52/m	**Annual berth capacity (tons)**	**3,208,000**	**3,323,000**	**232,000**	**11,345,000**	**556,000**	**2,177,000**	**7,203,000**

Note: Inputs shaded in green, desired outputs bolded.

There are 9 total berths at Morehead City for bulk handling, plus additional facilities on Radio Island for sulphur. Berth 4 is currently inoperative. Information in the green cells indicates data inputs, most of which were provided by the NCSPA, with the exception of Rows d, i, and m. Non-work hours at berth (d) refers to non-loading time where a vessel occupies a berth per vessel call, such as tie-up and untie time; 4 hours is used as an average industry factor. The Weekly Peaking Factor (m) is used to incorporate the effects of non-uniform cargo volumes throughout the year and account for peaking that may occur during busy seasons.

Typically, AECOM uses a Maximum Practical Berth Utilization (Row d in Table 15) of 65 percent for multi-berth facilities and 50 percent for single berths based on industrial experience. However, this will be less for commodities on shared berths. The first line of the chart lists the berths typically used for each of the commodity types. For some products, berths must be shared. For example, Berths 8 and 9 can be used to handle rubber, ore, forest products, and metal products, so no single product will have a 65 percent utilization of those particular berths.

Table 16 shows how maximum berth utilization by a particular commodity was determined for shared berths.

Table 16: Port of Morehead City Berth Sharing for Bulk/Breakbulk Commodities

	Natural Rubber	Scrap Metal	Ore, Mica, Schist	Forest Products	Metal Products	Sum
Throughput Base	108,280	75,773	23,830	71,496	52,445	331,824
Max Product Utilization by Berth:						
5	44%				21%	**65%**
6	44%				21%	**65%**
7	44%				21%	**65%**
8	21%	15%	5%	14%	10%	**65%**
9	21%	15%	5%	14%	10%	**65%**
Average	**35%**	**15%**	**5%**	**14%**	**17%**	

Note: Throughput Base volume is tonnage as reported by NCSPA at the time of analysis. Generally, 2010 tonnages are used; however, for some commodities a more representative Throughput Based was applied. Not all commodities and tonnages are listed.

Most commodities are calculated using 2010 throughputs; however, for commodities with disproportionately low 2010 throughputs, the maximum throughput since 2005 is used. The formula for each cell is (base throughput of commodity / total throughput of all commodities using that particular berth) * 65 percent. For instance, berth 5 handles rubber and metal products, for a total of 160,725 tons, of which 108,280 was rubber. Thus the berth 5 utilization by rubber is 108,280/160,725 * 65 percent = 44 percent. This value is then averaged in the final line over each berth used by the commodity. Blank cells indicate that the commodity does not use the berth in question.

Scrap metal is included in the berth sharing calculations to include its effect on other commodities, but an overall capacity for it is not included. Sulphur, aggregates, and phosphate are also not listed in Table 16 as they do not share berths with other commodities.

Note that this is just a nominal way to distribute the capacity of a shared berth among multiple products based on historical usage. Overall annual berth capacity will be fluid depending on the relative market share of each commodity.

Table 15 indicates that for most commodities, berth capacity is much higher than historical throughput volumes – even with most berths split among multiple commodities. The limiting factor to overall capacity is more likely to be storage capacity, which is determined in Table 17 for the Port of Morehead City.

Table 17 determines storage capacity for each commodity at the Port of Morehead City included in Table 15.

Table 17: Port of Morehead City Storage Capacity for Bulk/Breakbulk Commodities

	Port of Morehead City Bulk Storage Capacity	**Natural Rubber**	**Sulphur**	**Ore, Mica, Schist**	**Aggregate**	**Forest Products**	**Metal Products**	**Phosphate**
	Static storage capacity (tons)	66,319	30,000	20,000	60,000	21,000	14,000	180,000
	Static capacity/ mean ship capacity	11.1	2.1	1.7	1.5	3.5	2.0	9.0
a	Nominal annual throughput (tons/year)	100,000	100,000	100,000	100,000	100,000	100,000	100,000
b=a/52	Mean week vessel volume (tons)	1,923	1,923	1,923	1,923	1,923	1,923	1,923
c	Cargo dwell time (days)	30.0	15.0	30.0	30.0	30.0	30.0	30.0
d	Average volume of cargo in storage (tons)	8,242	4,121	8,242	8,242	8,242	8,242	8,242
e	Peak/ mean inventory	125%	150%	150%	150%	150%	150%	125%
f=d*e	Demand for storage (tons)	10,302	6,181	12,363	12,363	12,363	12,363	10,302
g	Total storage available (tons)	66,319	30,000	20,000	60,000	21,000	14,000	180,000
h=g/f*a	**Annual storage capacity (tons)**	**644,000**	**485,000**	**162,000**	**485,000**	**170,000**	**113,000**	**1,747,000**

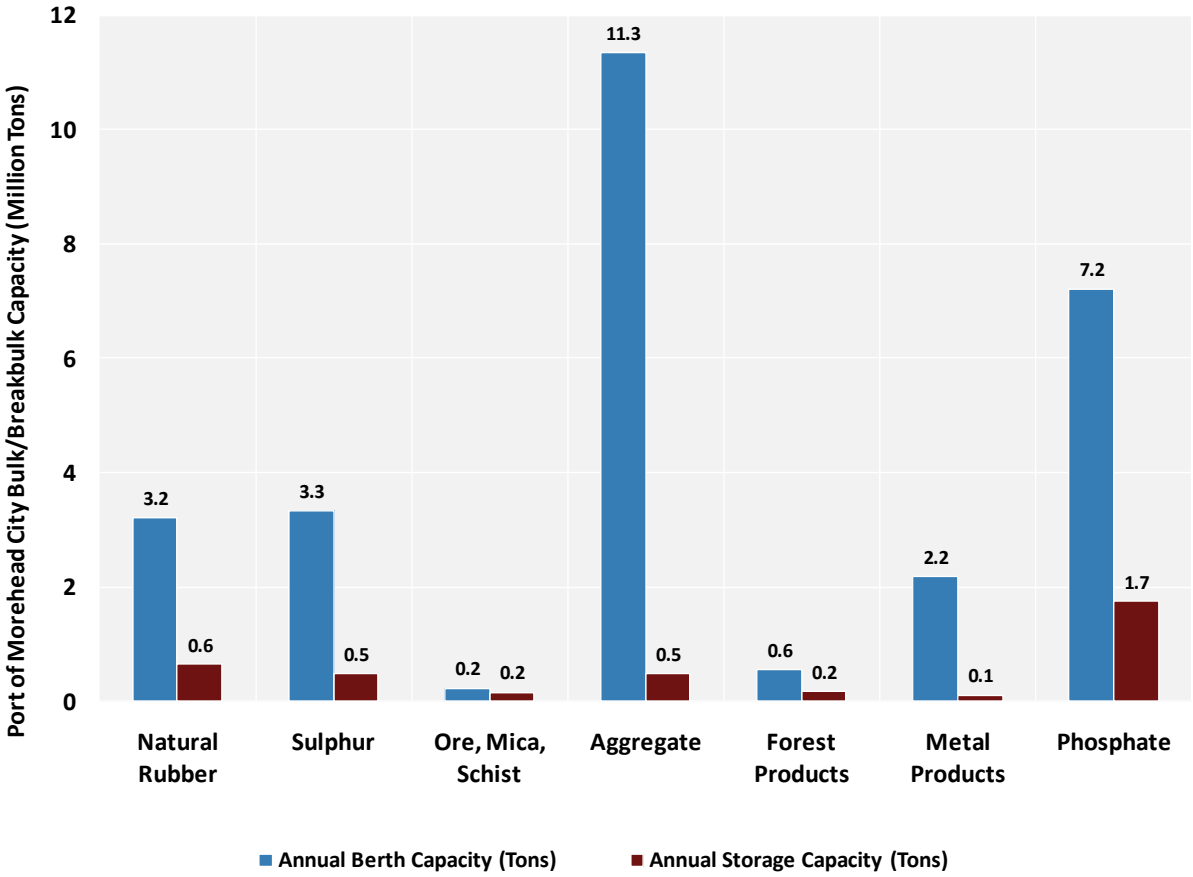
Note: Inputs shaded in green, desired outputs bolded.

Static storage capacity for each commodity was provided by the NCSPA. Static Capacity / Mean Ship Capacity is determined using Row f in Table 15 (Mean Cargo Handled per Vessel Call). This value is used to determine Row e, Peak/Mean Inventory. If the ratio of storage capacity to average vessel tonnage is high, then a single vessel does not impact storage utilization heavily, reducing inventory peaking (as with natural rubber); 125 percent is used for e in this case. However, if a single vessel uses most of a commodity's available storage (as with aggregates), then inventory peaking will be high; 150 percent is used in this case.

Cargo dwell time is the average time a unit of cargo spends on the port before exiting via truck, rail, or barge. In lieu of other data, 30 days is used for most commodities, with the exception of sulphur, which uses 15 days as indicated by historical throughputs. Note that dwell times are heavily impacted by demand; if demand increases, dwell times can reduce significantly and thus will allow more throughput.

Figure 15 provides overall berth and storage capacities for the commodities analyzed at the Port of Morehead City in chart form for comparison.

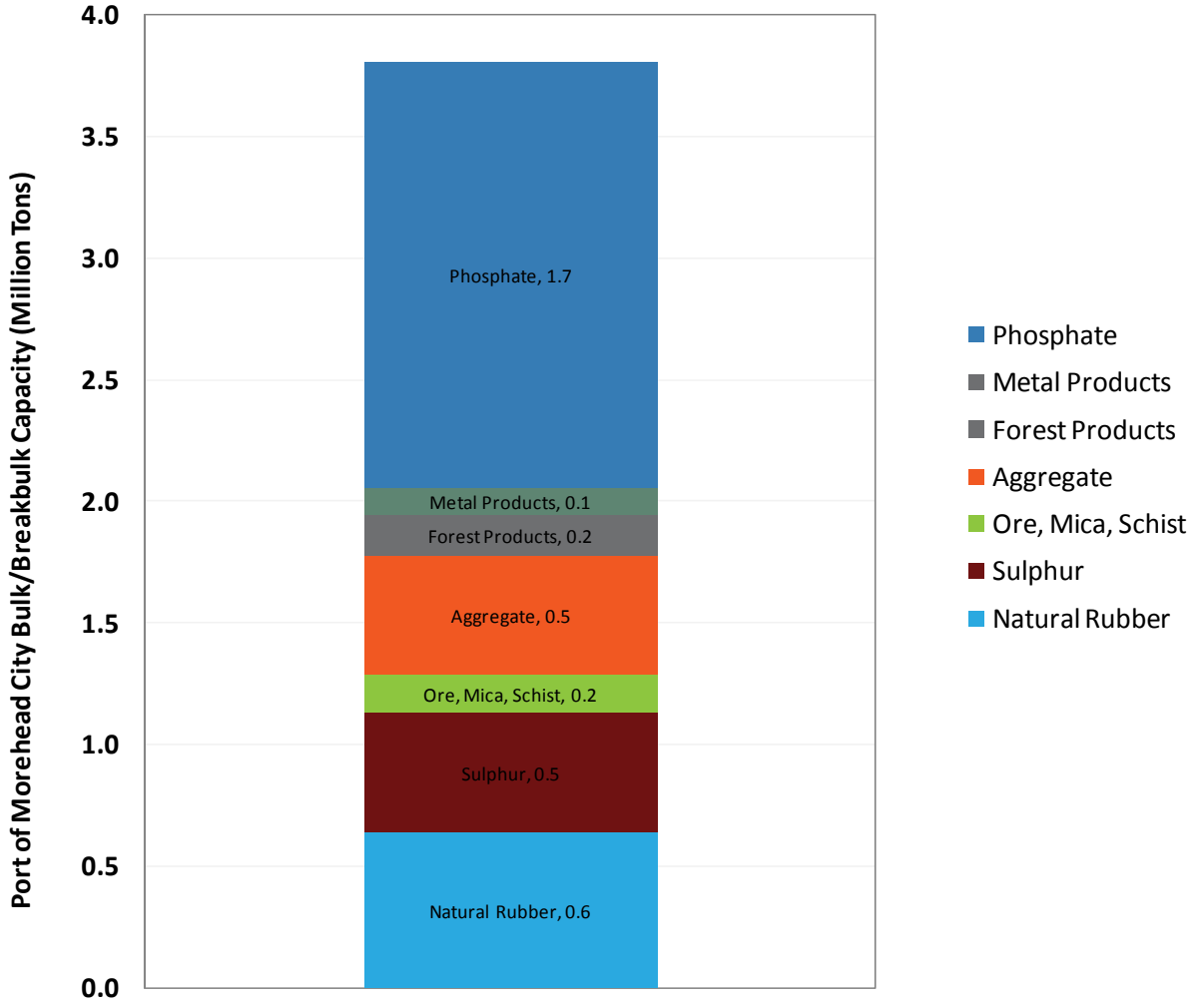
Figure 15: Port of Morehead City Bulk/Breakbulk Berth vs. Storage Capacity Chart



As expected, storage capacity is the limiting factor for most commodities. In general, most commodities have an excess of berth capacity in comparison to storage capacity. For any given commodity, if dwell time can be reduced significantly, the annual cargo handling capacity can be increased inversely by an equal amount.

Figure 16 summarizes the total bulk/breakbulk capacity at the Port of Morehead City by commodity type. Based on the assumptions used in this report, the total bulk/breakbulk handling capacity at the Port of Morehead City is approximately 3.8 million tons.

Figure 16: Port of Morehead City Bulk/Breakbulk Capacity Summary

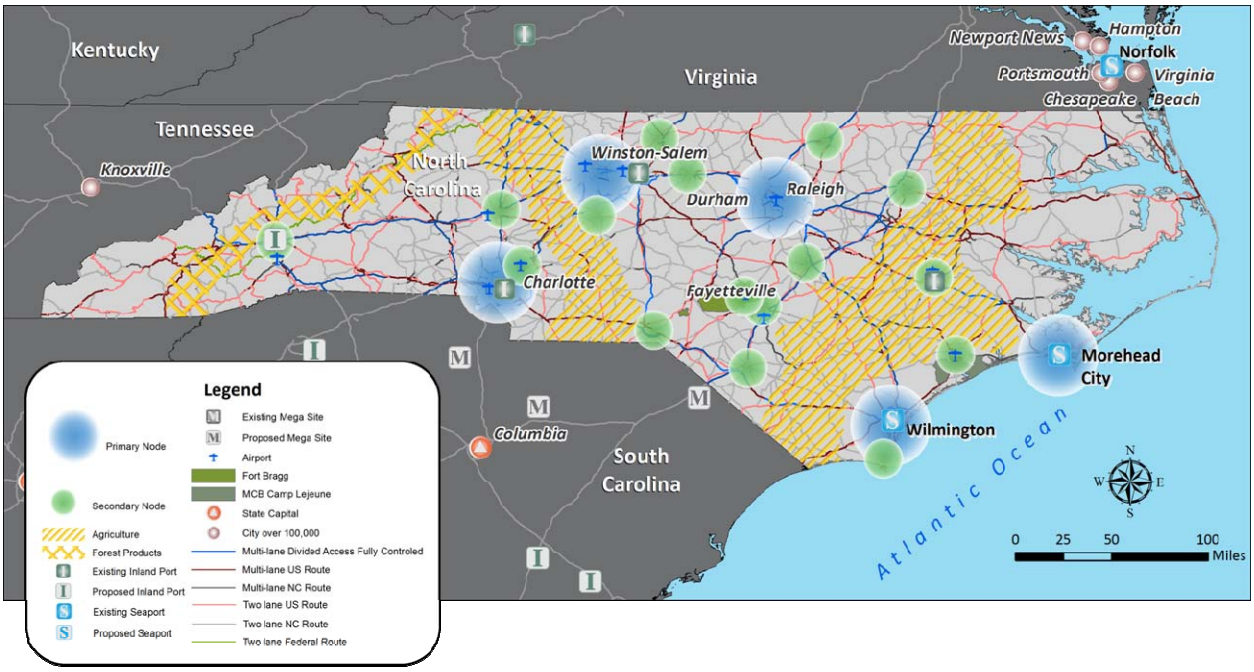


4 ROAD AND RAIL ACCESS

The ports of Wilmington and Morehead City are accessible by both roadways and railways; barging is also heavily used at Morehead City. However, the flavor of access to each is distinct. Summary descriptions for existing and planned facilities are provided here with full details available in the *Highway Infrastructure Assessment* and *Rail Infrastructure Assessment* technical reports.

4.1 Road Network

Figure 17: North Carolina Freight Nodes and Facilities



Source: AECOM/URS from ESRI, NCDOT, NCDA, and USGS ThematicMapping world borders dataset
Agricultural production exists across the state; the areas of dense agricultural production illustrated are intended to be representative

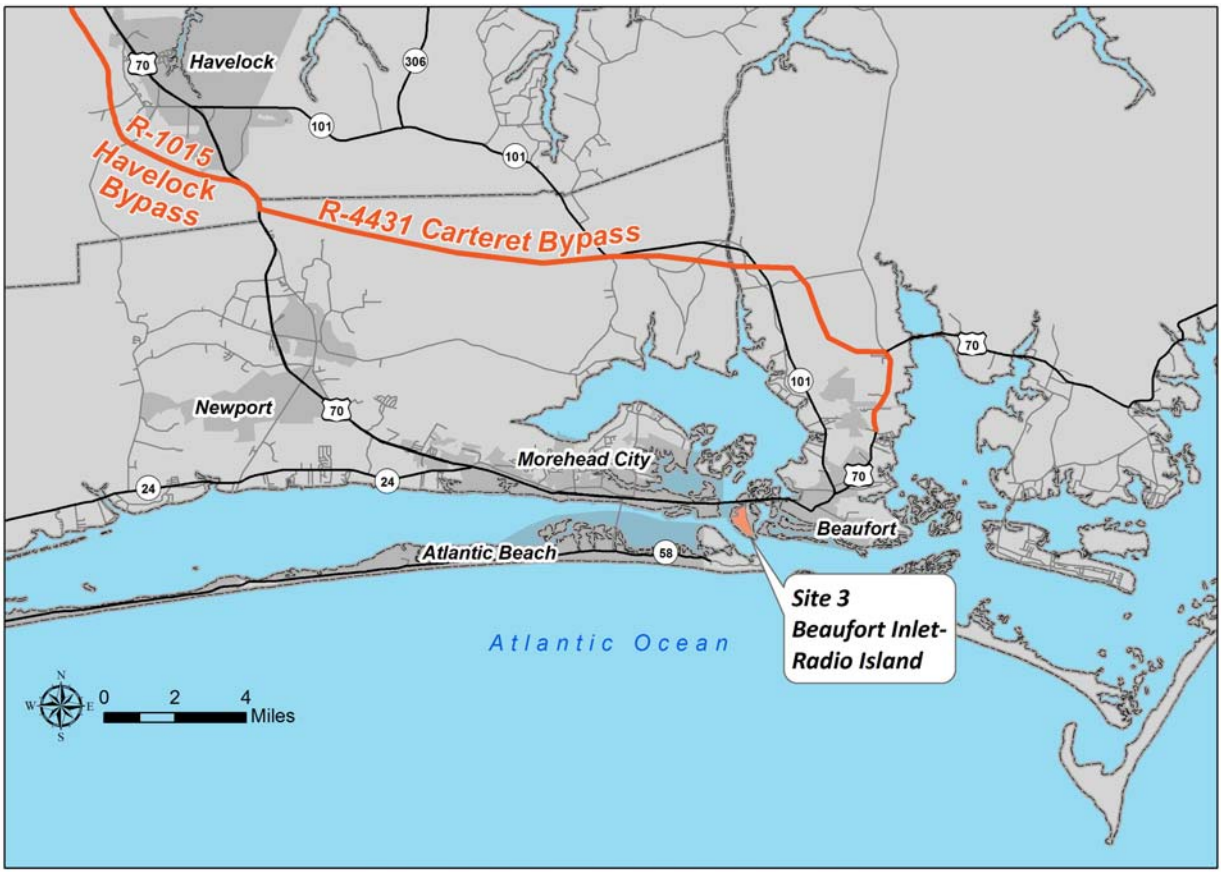
Port of Wilmington. Improvements to Interstate I-40, the Wilmington Bypass, have improved connectivity from POW to the Raleigh-Durham region and the construction of Interstate 73 has increased connectivity from the port to Greensboro. POW is approximately 75 miles from Interstate 95 and 200 miles from Interstate 85. These two large interstates serve as the primary transportation corridors for both passengers and freight in a north-south direction through North Carolina. They connect the largest population centers within the state (Charlotte, Greensboro and Raleigh/Durham).

Upgrading of an existing road to interstate standards to create Interstate I-74 has added vehicle capacity between the port and I-85 connecting to Charlotte; however, there are many gaps in the highway connection between the port and this major population center.

The majority of freight arrives and leaves the port by truck. A challenge for the port is that trucks must pass through residential areas to connect to the interstates from POW. They must traverse Burnet Boulevard (two-lane road) to reach I-74, or Shipyard Boulevard and College Road (four-lane bi-directional roads) with a series of stop lights to reach I-40. Figures 2 and 3 show the local infrastructure.

Port of Morehead City. Road accessibility to Morehead City is a concern because trucks must pass through the middle of Morehead City to reach the port. This route during the summer months, with the tourism associated with the Outer Banks coastal regions, makes the more than six-miles from the port to beyond the intersection of NC 24 difficult, which is the only way out of Morehead City to access US 70. NCDOT has a number of initiatives underway to mitigate this conflict. The Gallants Channel Bridge project that is now underway will provide an alternative route to US 70. However, until the Northern Carteret Bypass and Havelock Bypass are completed, this link would not be a viable alternative route to and from Morehead City. Interstate 95 (I-95) is approximately 120 miles from Morehead City along US 70. After construction of the Gallants Channel Bridge, there would be an opportunity to follow NC 101 but this roadway is a rural two-lane road and would not effectively reduce travel time. In the meantime, all traffic would have to continue through Morehead City. Figures 8 and 9 show the local infrastructure and Figure 18 shows the planned bypasses.

Figure 18: North Carteret Bypass and Havelock Bypass

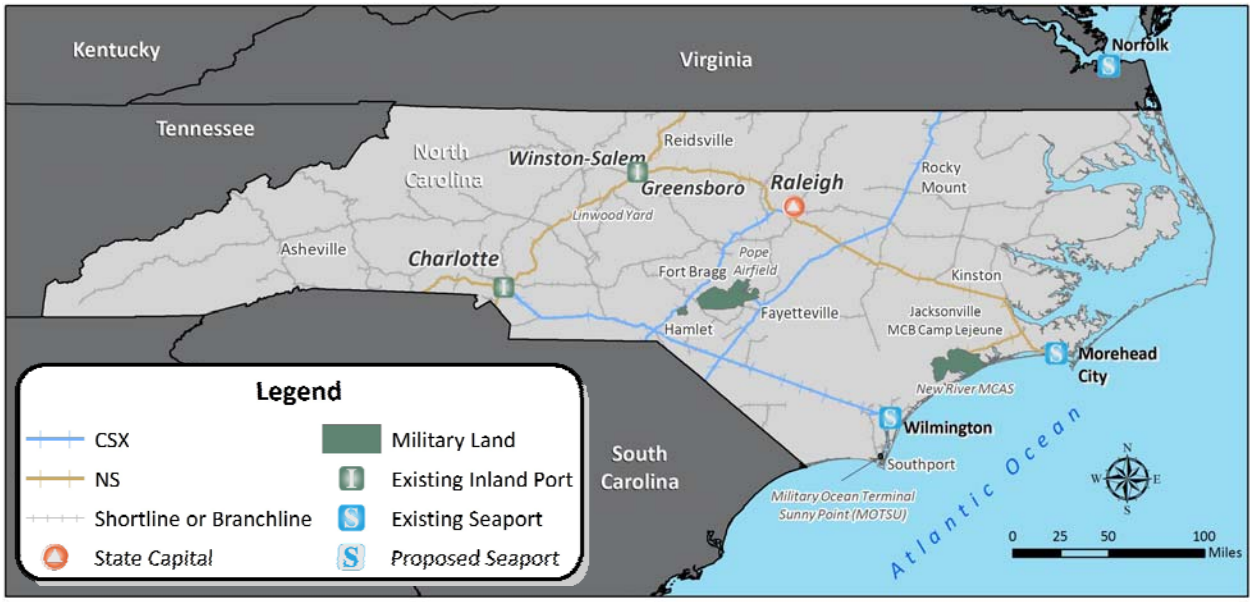


Source: AECOM/URS from ESRI, NCDOT, USDOT FAF 3.1, and USGS ThematicMapping world borders dataset, Seamap-SA, 2001 and Moser and Taylor, 1995.

4.2 Rail Network

Rail Network. Within the state of North Carolina, the freight rail network comprises more than 3,200 miles of rail trackage owned by 22 railroads. Two Class I[1] railroad companies, CSX and Norfolk Southern (NS), operate approximately 77 percent of the state's rail system[2]. Short lines and switching companies operate on the remainder of the system. Two railroads own tracks but are not currently operating within the state. One railroad no longer transports freight but provides passenger excursion service. The US Military also has a rail connection to its munitions depot in the Southport area (MOTSU).

Figure 19: Railroads in North Carolina



Source: AECOM/URS from ESRI, NCDOT, FAF 3.1, and USGS ThematicMapping world borders dataset

Port of Wilmington. CSX operates in both an east-west and north-south direction within North Carolina. CSX serves the Port of Wilmington and has a direct east-west rail route to Charlotte from the port that passes through Pembroke and Hamlet. It has major rail yards at Hamlet on the east-west route and at Rocky Mount on the north-south, I-95 corridor route. CSX has an intermodal terminal at Charlotte and bulk transfer terminals at Charlotte, Raleigh, Wilmington and Winston-Salem.

CSX provides daily service to the port. The speed of rail services to the port is impacted by the route through the City of Wilmington. Most crossings within the city are at-grade and the trackage follows a route that crosses many of the city's major thoroughfares.[3]

---

[1] A Class I railroad carrier is defined as a railroad with annual operating revenues (based on 2005 statistics) over $319.2 million.
[2] 2006 North Carolina Waybill Analysis Executive Summary
[3] Moffatt and Nichol (2006). North Carolina State Ports Authority Equipment Analysis: Wilmington Terminal, pg. 3. (In Appendix E of their Port of Wilmington Container Yard Improvements Report, 2006)

Port of Morehead City. Norfolk Southern (NS) operates in both an east-west and north-south direction, as well. NS serves the Port of Morehead City and has a direct east-west rail route over the North Carolina Railroad to Charlotte. It has a major classification yard at Linwood (Spencer Yard). NS has intermodal facilities at Greensboro and Charlotte as well as two bulk transfer terminals located just south of Charlotte, and east of Winston-Salem. In addition, there is an auto distribution terminal west of Winston-Salem. The Norfolk Southern north-south route follows the I-81 corridor.

The port is served by Norfolk Southern (NS), which runs three trains per week into the port. Rail freight passes through the center of Morehead City with numerous at-grade crossings that slow train speeds and create numerous traffic bottlenecks throughout the day. Carolina Coastal Railroad Company provides switching service within the port limits.

5 OTHER PORT FACILITIES

In addition to the marine ports, the North Carolina State Ports Authority (NCSPA) operates inland terminals in Charlotte and in the Piedmont Triad region in Greensboro. These port facilities are profiled briefly below; further details can be found in the *Inland Ports* technical report. NCSPA also owns a small boat harbor in Southport, NC.

5.1 Charlotte Inland Terminal

Source: Google Maps, 2011

Managed by NCSPA, the Charlotte Inland Terminal (CIT) is a 16-acre site that is C-TPAT certified and bonded by US Customs and Border Protection. The facility provides storage space for approximately 400 stacked containers and 300 containers on chassis. NCSPA offers “Sprint” container service via truck to and from the Port of Wilmington, Charlotte, and beyond. CIT has access to I-77 and I-85 for trucking. CIT is not directly accessible by rail. The CSX Charlotte intermodal terminal is approximately one mile away and the new NS intermodal facility is approximately eight miles from CIT.

5.2 Piedmont Triad Inland Terminal

Source: Google Maps, 2011

The Piedmont Triad Inland Terminal (PTIT) is located in Greensboro NC. It is an existing site that is currently dormant. CSX and NS have terminals approximately six miles from PTIT; however, there are rail spurs within one mile.

This page intentionally blank