NORTH CAROLINA
MARITIME Strategy

# NC Maritime Strategy
## Future Port Infrastructure

**Prepared for the**
**North Carolina Department of Transportation**

**by**

**AECOM**
**in association with URS**

**February 15, 2012**

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# DISCLAIMER

## 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.

# 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 *Future Port Infrastructure* technical report provides a comparison of potential new deepwater container terminal sites or expansions to existing container terminal facilities including costs to dredge to various water depths and to upgrade rail and freeway access at the potential site, if necessary. Terminal size, shape and mode of operation are described, including cargo storage and handling equipment, methods, and productivity. 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. Using this information, cost and capacity for each potential site expansion or new terminal are compared.

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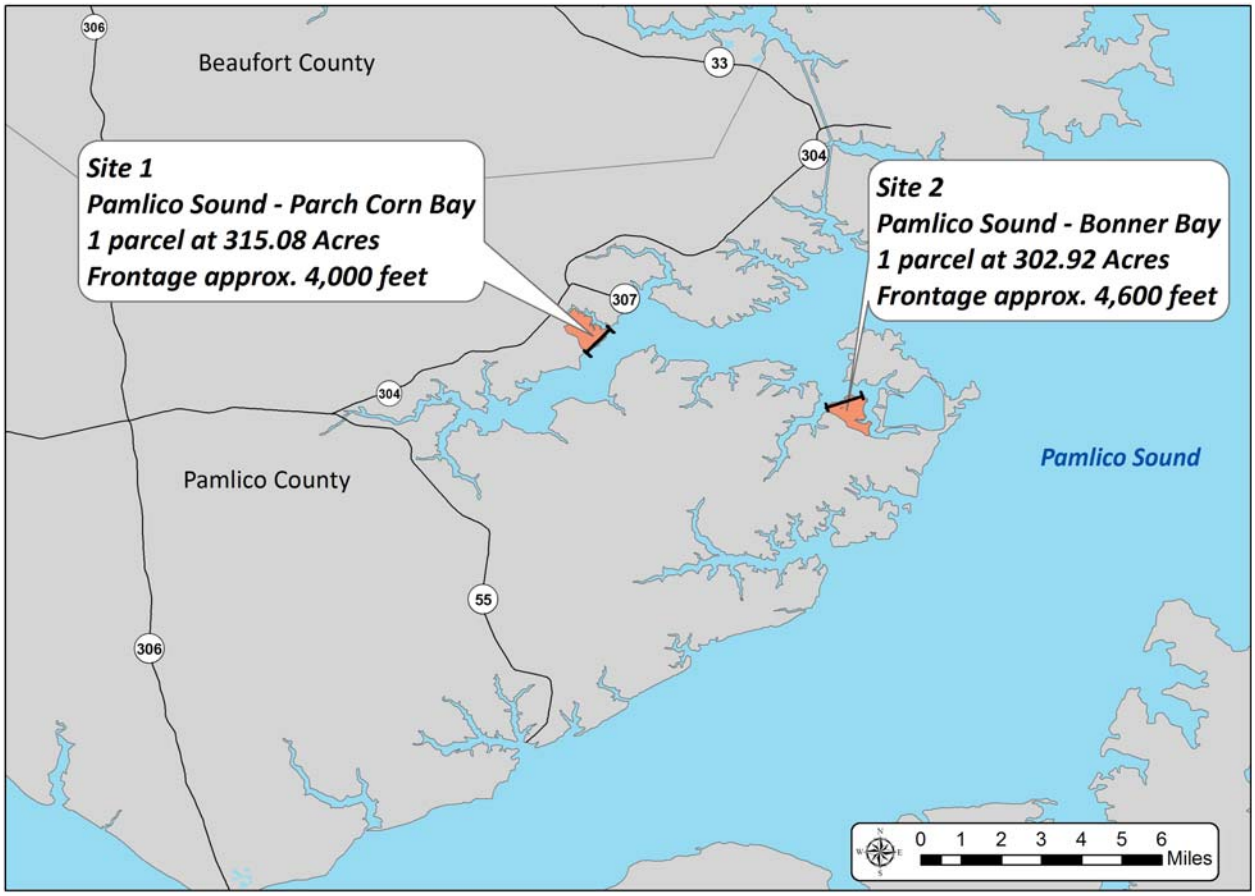
# 1 NORTH CAROLINA FUTURE PORT INFRASTRUCTURE OPTIONS

## 1.1 Container Terminal Site Descriptions

Six potential deepwater port sites were considered for container terminal capacity expansion within North Carolina. Sites were chosen based on a variety of criteria, such as ocean access, land availability and access, dredging requirements, limiting environmental impacts, and ability to meet projected market demands.

**Sites 1 and 2**
Deepwater port Sites 1 and 2 are both located in Pamlico Sound. Figure 1 is a map of the locations considered.

**Figure 1: Deepwater Port Sites 1 and 2**

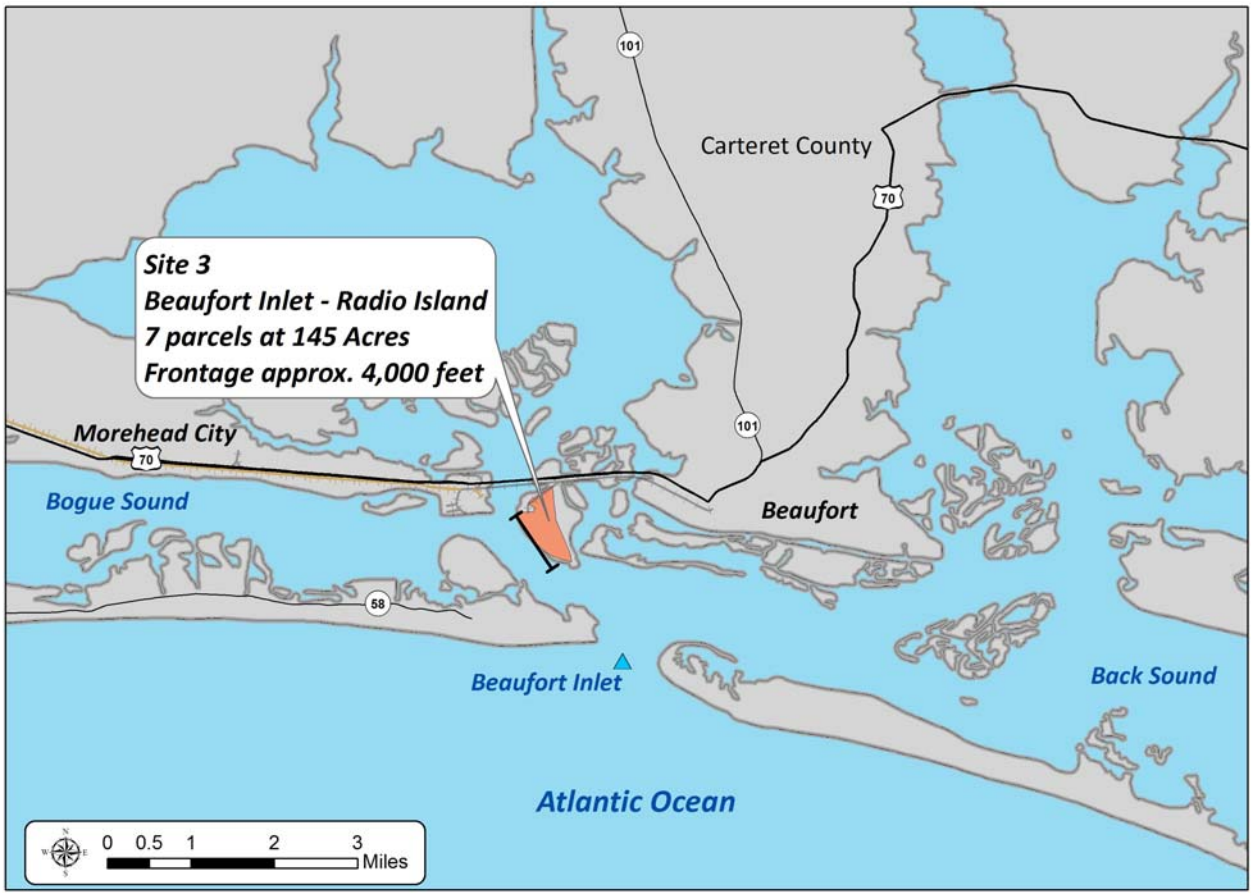



Source: AECOM/URS from ESRI, NCDOT, FAF v3.1, USGS ThematicMapping world borders dataset

Sites 1 and 2 were considered only in the initial phases of cost analysis. Dredging cost analysis revealed these sites to be prohibitively expensive, eliminating them as possibilities in further study.

**Site 3**
Site 3 is located on existing port property at Radio Island, part of the Port of Morehead City. Figure 2 is a map of the site.

**Figure 2: Deepwater Port Site 3**

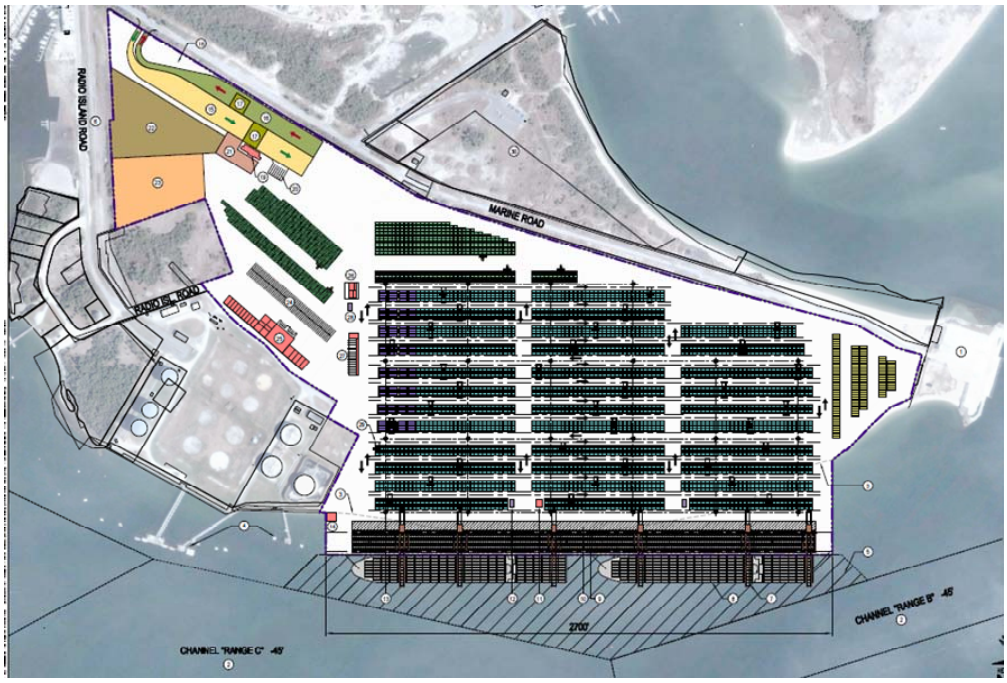



Source: AECOM/URS from ESRI, NCDOT, FAF v3.1, USGS ThematicMapping world borders dataset

Two cases were considered for development at Site 3: a new 2-berth Rubber-Tire Gantry Crane (RTG)-based terminal at an existing water depth of 45', and sensitivity to this option at 51' to allow for the handling of larger containerships. Both cases were analyzed at 80 percent of the current average dwell time of 7 days.

Figure 3 is a map of the RTG-terminal layout considered at both depths.

**Figure 3: Site 3 at Radio Island (Port of Morehead City); 2-Berth RTG Terminal**

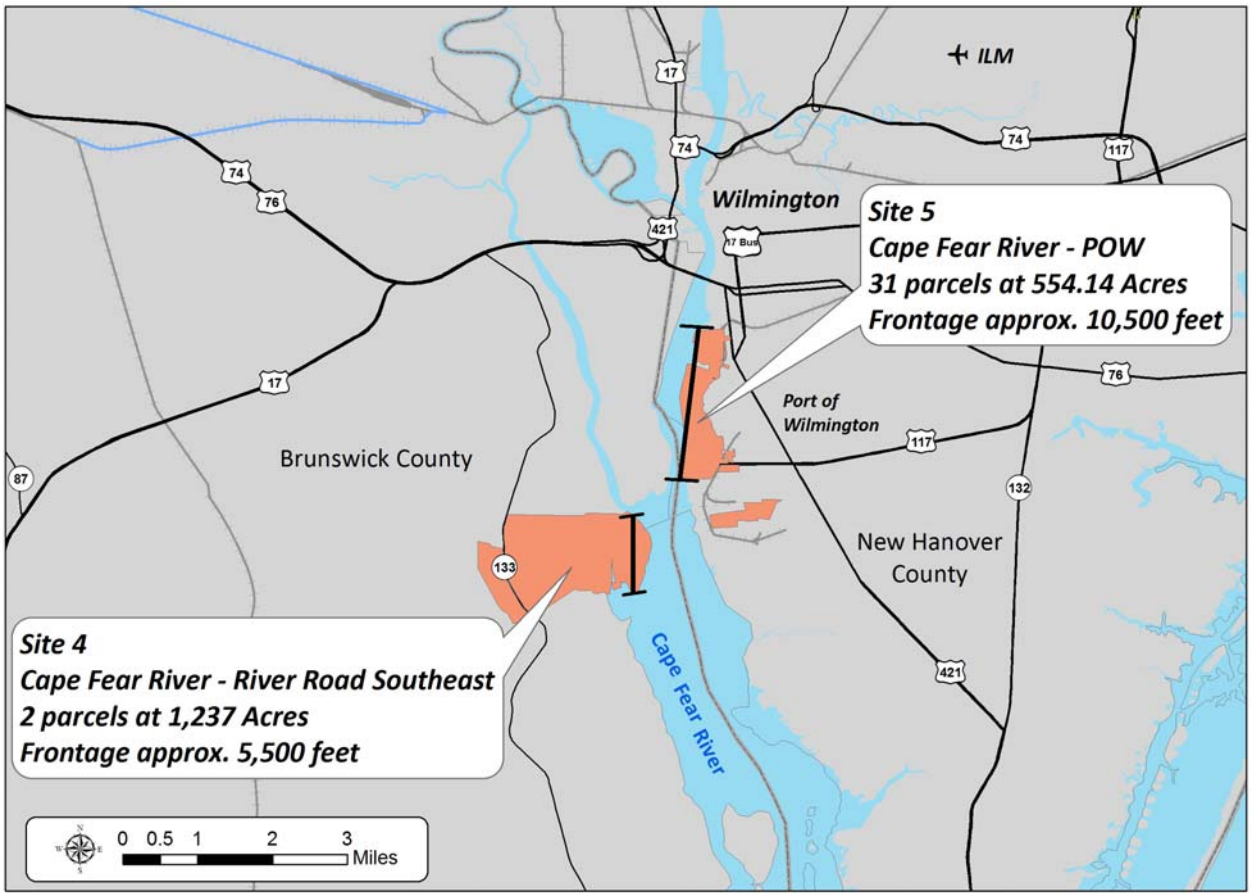



It is important to note that unlike other Sites, Site 3 will have about $410 million of additional cost to upgrade highways in order to allow container trucks to access the Port of Morehead City, along with another $234 million in rail access improvements.

**Sites 4 and 5**

Site 4 is located on Cape Fear River in Brunswick County, while Site 5 is on the opposite bank of the river at the current location of the Port of Wilmington. Sites 4 and 5 are located on Cape Fear River as shown in Figure 4.

**Figure 4: Deepwater Port Sites 4 and 5**

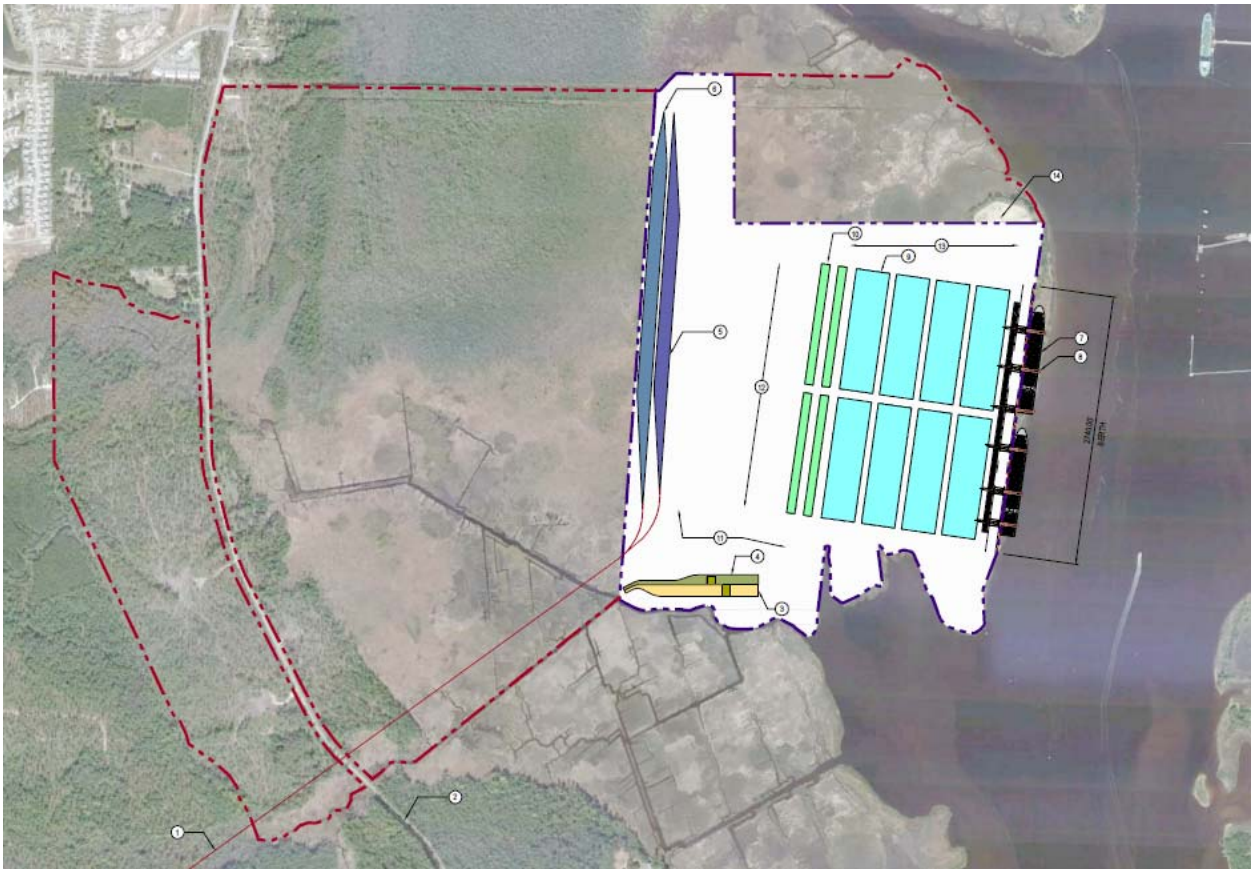



Source: AECOM/URS from ESRI, NCDOT, FAF v3.1, USGS ThematicMapping world borders dataset

For Site 4, where no current facilities exist, two cases were considered: an RTG terminal and an ASC terminal, both at 2 berths and 51' of water depth. No facilities at lower depths were considered for a new facility at Site 4 because lower depths cannot handle the larger containerships in the market today, and the cost of any new facility would be too great to have the water depth be obsolete before it is even built.

Figure 5 shows a conceptual layout of a 2-berth + RTG container terminal serviced by an on-port rail terminal. An ASC layout for Site 4 was not developed due to additional cost of site preparation + environmental mitigation + dredging as compared to Site 6 as described later in this report.

**Figure 5: 2-Berth RTG Container Terminal at Site 4**



For Site 5, a variety of options were considered as incremental improvements to the existing container facility at the Port of Wilmington. Several cases were analyzed at the current channel depth of 42': the existing reachstacker-based 1-berth facility, a 2-berth reachstacker-based terminal, and a 2-berth RTG-based facility. In addition, three other RTG-based facilities were considered: 45' of water depth and an average container dwell time at 80% of the current level, 47' of water depth and 65% of the current dwell time, and 51' and 65% of the current dwell time. Current dwell time is assumed to be 7 days.

As a second alternative to increase container capacity at the Port of Wilmington, a second, denser layout was also prepared as shown in Figure 8. Container movements in this denser layout would use Rubber-Tired Gantry (RTG) cranes to handle containers inside the yard.

As compared to the existing terminal, this layout has following key changes:

- A second berth, with two additional 100' gauge cranes, is added, providing a total berth length (existing Berth 9 plus upgraded Berth 8) of 2,670 ft
- The entry/exit gate has been realigned to provide a more contiguous container storage area by moving the gate out of the middle of the yard to the northeast corner of the port property.
- 37 acres of expanded container storage area
- Old fumigation building, Building SR and Transit shed T7 removed
- New site grading, lighting and utilities

Figure 8 show the 1 berth reachstacker, 2 berth reachstacker, and 2 berth RTG facilities layouts, respectively.

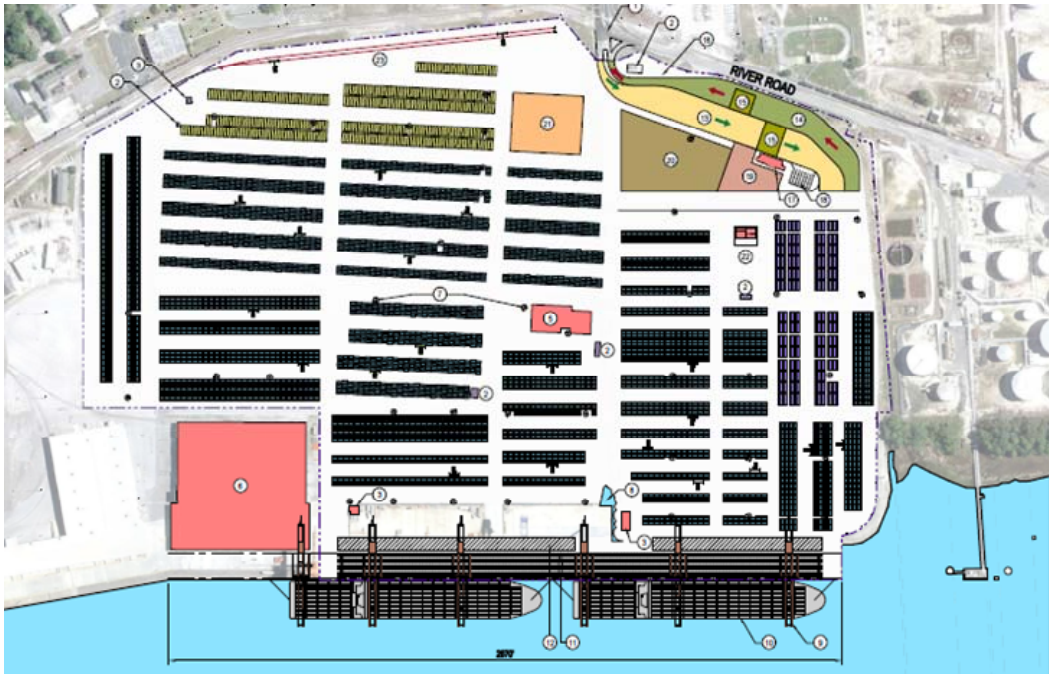
**Figure 6: Existing 1-Berth Reachstacker Facility at the Port of Wilmington (Site 5)**

As shown in Figure 7, the first potential terminal layout increases the gross terminal area dedicated to container use by 26 acres over the existing area. As compared to the existing terminal, this layout has following key features:

- A second berth, with two additional 100' gauge cranes, is added, providing a total berth length (existing Berth 9 plus upgraded Berth 8) of 2,670 ft
- The entry/exit gate has been realigned to provide a more contiguous container storage area by moving the gate out of the middle of the yard to the northeast corner of the port property.
- 26 acres of expanded container storage area
- Old fumigation building, Building SR removed

This layout continues to use Reach Stackers (RS) inside the yard for handling of all containers.

**Figure 7: 2-Berth Reachstacker Facility at the Port of Wilmington (Site 5)**



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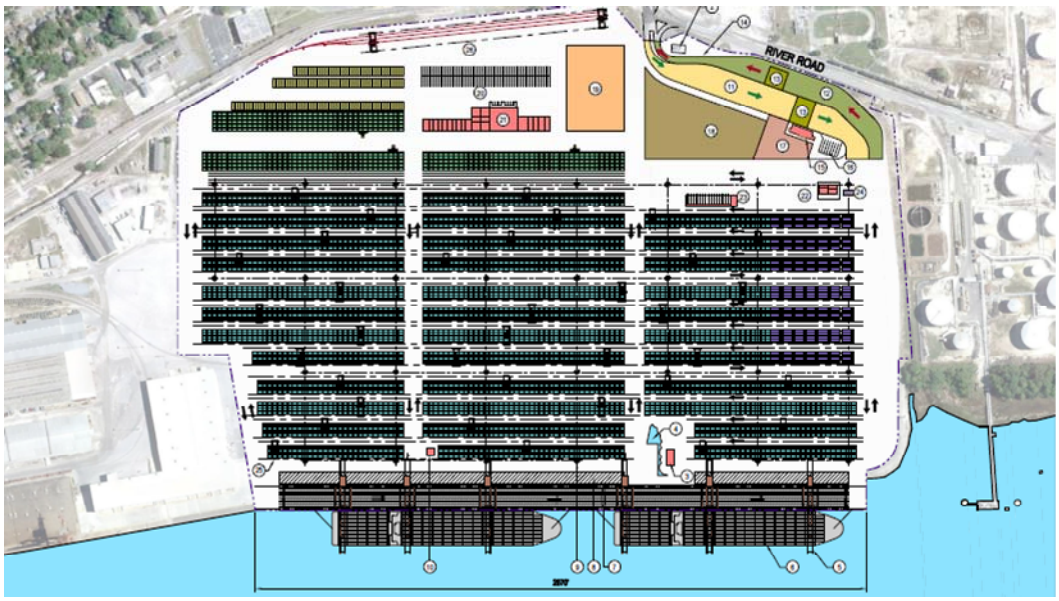
- 37 acres of expanded container storage area
- Old fumigation building, Building SR and Transit shed T7 removed
- New site grading, lighting and utilities

**Figure 8: 2-Berth RTG Facility at the Port of Wilmington (Site 5)**

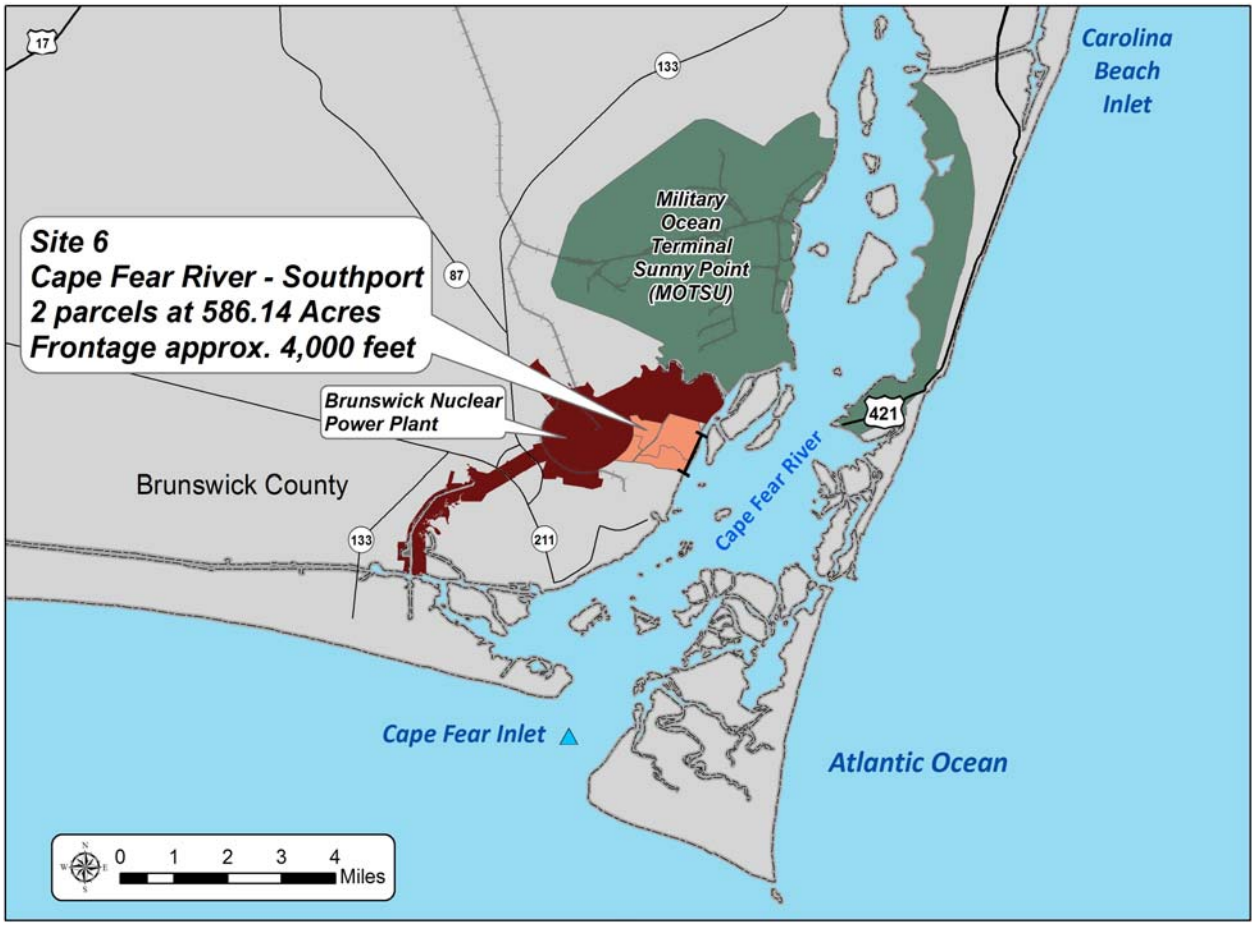



Lower depths were considered at Site 5 because facilities are already in place at the Port of Wilmington, so the incremental cost to improve the existing infrastructure may be low enough to justify improvements even at lower depths.

**Site 6**

Site 6 is also on Cape Fear River, closer to open ocean than Sites 4 and 5 at a location known as Southport as shown in Figure 9.

**Figure 9: Deepwater Port Site 6**




Source: AECOM/URS from ESRI, NCDOT, FAF v3.1, USGS ThematicMapping world borders dataset

Like Site 4, since Site 6 would be an entirely new facility with no existing infrastructure, only two cases were considered: RTG or ASC-based 3-berth facilities, both at 51' of channel depth.

Figure 10 shows a conceptual layout of a 3 berth + RTG container terminal serviced by an on-port rail terminal. It should be noted that Site 6 allows for additional undeveloped area for future development of ancillary facilities near the container terminal such as warehouses and CFS on the West side of the proposed intermodal rail yard.

**Figure 10: 3-Berths RTG Container Terminal at Site 6**

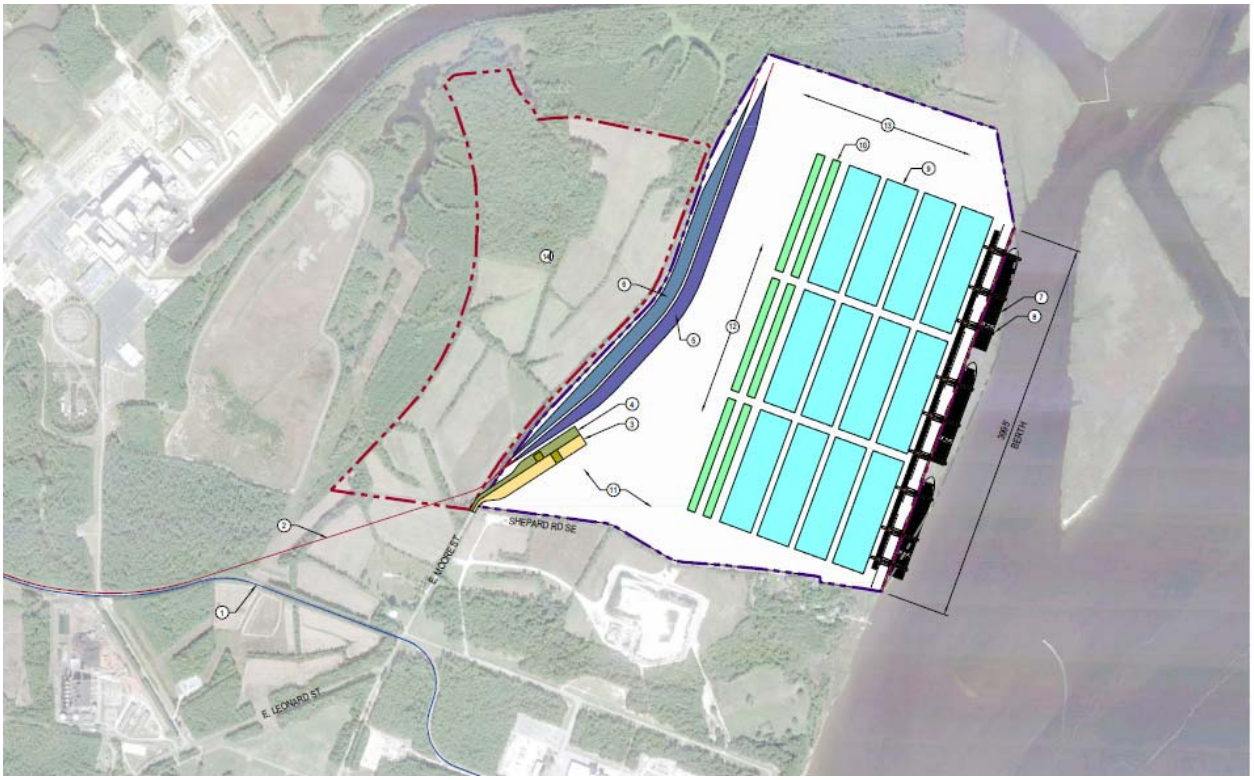
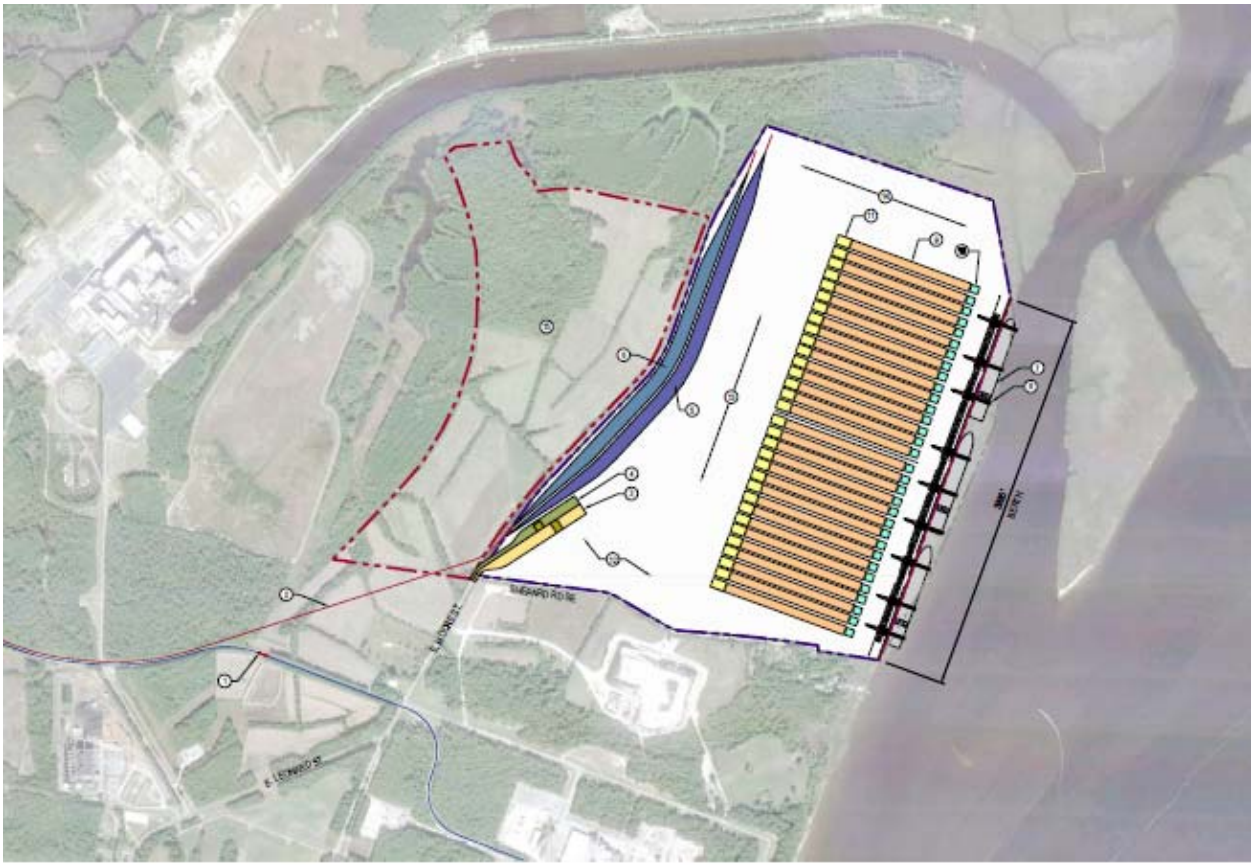


Figure 11 shows a conceptual layout of a 3 berth + ASC container terminal serviced by an on-port rail terminal. It should be noted that Site 6 allows for additional undeveloped area for future development of ancillary facilities near the container terminal such as warehouses and CFS on the West side of the proposed intermodal rail yard.

**Figure 11: 3-Berths ASC Container Terminal at Site 6**



## 1.2 Container Terminal Sites Summary

Table 1 summarizes all deepwater sites considered and the facility types and depths analyzed at each location. Case labels are used for reference in cost charts.

**Table 1: Container Terminal Sites Summary**

| 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’ |

# 2 FUTURE CONTAINER TERMINAL CAPACITY ANALYSIS

## 2.1 Capacity Analysis Methodology

In order to calculate capacity of various container terminal development options summarized in Table 1, a detailed capacity analysis was conducted. Detailed methodology for calculating the berth and CY capacity is discussed in the NC Existing Port Infrastructure Technical Memorandum.

Berth capacity was calculated for each option based on the number of berths and the channel depth as summarized in Table 2. Deeper channels allow for larger ships that carry more TEUs per ship call and, therefore, offer a more efficient use of each berth.

Existing berth capacity of Port of Wilmington (Site 5), at 55% maximum practical berth utilization, will be 530,000 TEUs/year (Column 1), using the single premium berth (Berth 9 + part of Berth 8) for container handling operations. With the addition of a second 100' gauge container berth, the overall berth capacity at Port of Wilmington (Site 5) can increase to approximately 1,240,000 TEUs/year at existing 42' deep channel (Column 2). This is based on the assumption of 5% increase in berth utilization with a 2nd berth and 5% reduction in QC productivity due to more congestion in the terminal as actual volumes approach maximum theoretical capacity. Berth capacity was calculated for channel depths of 45', 47', and 51' to evaluate the effect of dredging. Capacities of up 1.42 million, 1.46 million, and 1.64 million TEUs/year could be achieved for these respective water depths (Columns 3, 4, and 5) at Site 5.

**Table 2: Berth Capacity Analysis**

| Existing 1 Berth Max 42' Channel | 2 Berth Max 42' Channel | 2 Berth Max 45' Channel | 2 Berth Max 47' Channel | 2 Berth Max 51' Channel | |
|---|---|---|---|---|---|
| 5000 | 5000 | 5000 to 7000 | 5000 to 8000 | 8000 | Typical Max Vessel Class Size TEUs |
| 1,450 | 1,450 | 1,650 | 1,860 | 2,060 | Container moves per vessel call [a] |
| 3.0 | 3.5 | 4.0 | 4.0 | 4.5 | Dock cranes assigned per vessel [b] |
| 37.0 | 35.2 | 35.2 | 35.2 | 35.2 | Moves per hour per dock crane [c] |
| 111.0 | 123.0 | 140.6 | 140.6 | 158.2 | Vessel productivity (moves/hr) [d=b*c] |
| 13.1 | 11.8 | 11.7 | 13.2 | 13.0 | Work hours per vessel call [e=a/d] |
| 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | Unproductive time at berth (hrs) [f] |
| 16.1 | 14.8 | 14.7 | 16.2 | 16.0 | Total vessel time at berth (hrs) [g=e+f] |
| 20 | 20 | 20 | 20 | 20 | Work hours per day [h] |
| 1.20 | 1.20 | 1.20 | 1.20 | 1.20 | Calendar hrs/ work hour [i=24/h] |
| 19.3 | 17.7 | 17.7 | 19.5 | 19.2 | Total vessel hrs at berth [j=g*i] |
| 168 | 168 | 168 | 168 | 168 | Calendar hrs per week [k] |
| 8.72 | 9.47 | 9.50 | 8.63 | 8.74 | Vessel calls per week at 100% berth utilization [l=k/j] |
| 55% | 60% | 60% | 60% | 60% | Maximum practical peak week berth utilization [m] |
| 4.79 | 5.68 | 5.70 | 5.18 | 5.24 | Maximum practical vessel calls per week [n=l*m] |
| 6,951 | 8,237 | 9,406 | 9,627 | 10,800 | Peak week berth capacity (moves) [o=n*a] |
| 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | Peak/mean week seasonal demand factor [p] |
| 5,793 | 6,865 | 7,838 | 8,023 | 8,999 | Mean week throughput capacity (moves) [q=o/p] |
| 301,000 | 357,000 | 408,000 | 417,000 | 468,000 | Annual unit berth capacity (moves) [r=q*52] |
| 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | TEUs per container [s] |
| 530,000 | 620,000 | 710,000 | 730,000 | 820,000 | Annual unit berth capacity (TEUs) [t=r*s] |
| 1.0 | 2.0 | 2.0 | 2.0 | 2.0 | Number of berths (100' gauge crane) [u] |
| .53 | 1.24 | 1.42 | 1.46 | 1.64 | Annual total berth capacity (TEUs, Millions) [v=t*u/1,000,000] |

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 needs to be balanced but it is not the case always.

The number of days a container sits inside the container terminal (dwell time), the total number of twenty feet ground slots (TGS) or net acres available to store those containers, and the type of equipment used to handle those containers are the primary drivers of the annual container yard capacity.

Table 3 shows annual container yard capacity for reach stacker (RS) and rubber-tired gantry (RTG) operations at the Port of Wilmington (Site 5) and the Port of Morehead City's (Site 3) Radio Island based on the alternative layouts shown in Chapter 1. The dwell time (100% or 80%) is expressed as a percentage of an average 7-day dwell of containers in the yard. Seven

(7) days is typical industry average for truck-based operations. If near-dock intermodal rail service is provided, dwell time can be reduced to 80% of this average (5.6 days) or up to 65% of the average (4.5 days), depending on the frequency of rail service and amount of cargo coming in and going out of the terminal by rail vs. truck.

The current reach-stacker (RS) based operation at Port of Wilmington (Site 5) offers a maximum container yard capacity of 540,000 TEUs/year. This can be increased to 750,000 TEUs/year by expanding the storage area and realigning the gate, but still using reach stacker (RS) operations (as shown in Figure 7). If RTGs are used as shown in Figure 8, a total container yard capacity of 1,070,000 TEUs/year can be achieved.

By adding intermodal rail service – and reducing container dwell time on average by 20% to 5.6 days – the capacity of the RTG container yard alternative at Site 5 can be increased to 1.33 million TEUs/year. If dwell times can be reduced by an average of 35% to 4.5 days, the CY capacity can be increased to 1.66 million TEUs/year.

The proposed RTG terminal on Radio Island at the Port of Morehead City (Site 3, Figure 3) offers a container yard capacity of 960,000 TEUs/year with 7 days of average dwell time, which can be increased to 1.2 million TEUs/year with 20% reduction in the average dwell times.

**Table 3: CY Capacity Analysis Summary**

| RS Existing POW 100% Dwell | RS Future POW 100% Dwell | RS Future POW 80% Dwell | RTG Future POW 100% Dwell | RTG Future POW 80% Dwell | RTG Future POW 65% Dwell | RTG Future POM 100% Dwell | RTG Future POM 80% Dwell | |
|---|---|---|---|---|---|---|---|---|
| 6,000 | 8,300 | 8,300 | 9,400 | 9,400 | 9,400 | 8,500 | 8,500 | TGS capacity available [a] |
| 2.5 | 2.5 | 2.5 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | Mean storage height (containers) [b] |
| 15,000 | 20,750 | 20,750 | 28,200 | 28,200 | 28,200 | 25,500 | 25,500 | TEU static capacity [c=a*b] |
| 7.0 | 7.0 | 5.6 | 7.0 | 5.6 | 4.5 | 7.0 | 5.6 | Mean dwell time (days) [d] |
| 52.14 | 52.14 | 65.18 | 52.14 | 65.18 | 81.11 | 52.14 | 65.18 | Turnovers per year per TEU static capacity [e=365/d] |
| 0.78 | 1.08 | 1.35 | 1.47 | 1.84 | 2.29 | 1.33 | 1.66 | TEU capacity without peaking, millions [f=c*e/10^6] |
| 1.20 | 1.20 | 1.20 | 1.20 | 1.20 | 1.20 | 1.20 | 1.20 | Seasonal throughput peak factor [g] |
| 1.20 | 1.20 | 1.20 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | Weekly inventory peak factor [h] |
| **0.54** | **0.75** | **0.94** | **1.07** | **1.33** | **1.66** | **0.96** | **1.2** | **Annual CY Capacity in Million TEUs [i=f/g/i]** |
| 106 | 132 | 132 | 143 | 143 | 143 | 136 | 136 | Gross terminal area (including wharf) |
| 5,100 | 5,700 | 7,100 | 7,500 | 9,300 | 11,600 | 7,100 | 8,800 | Annual TEUs per gross acre |

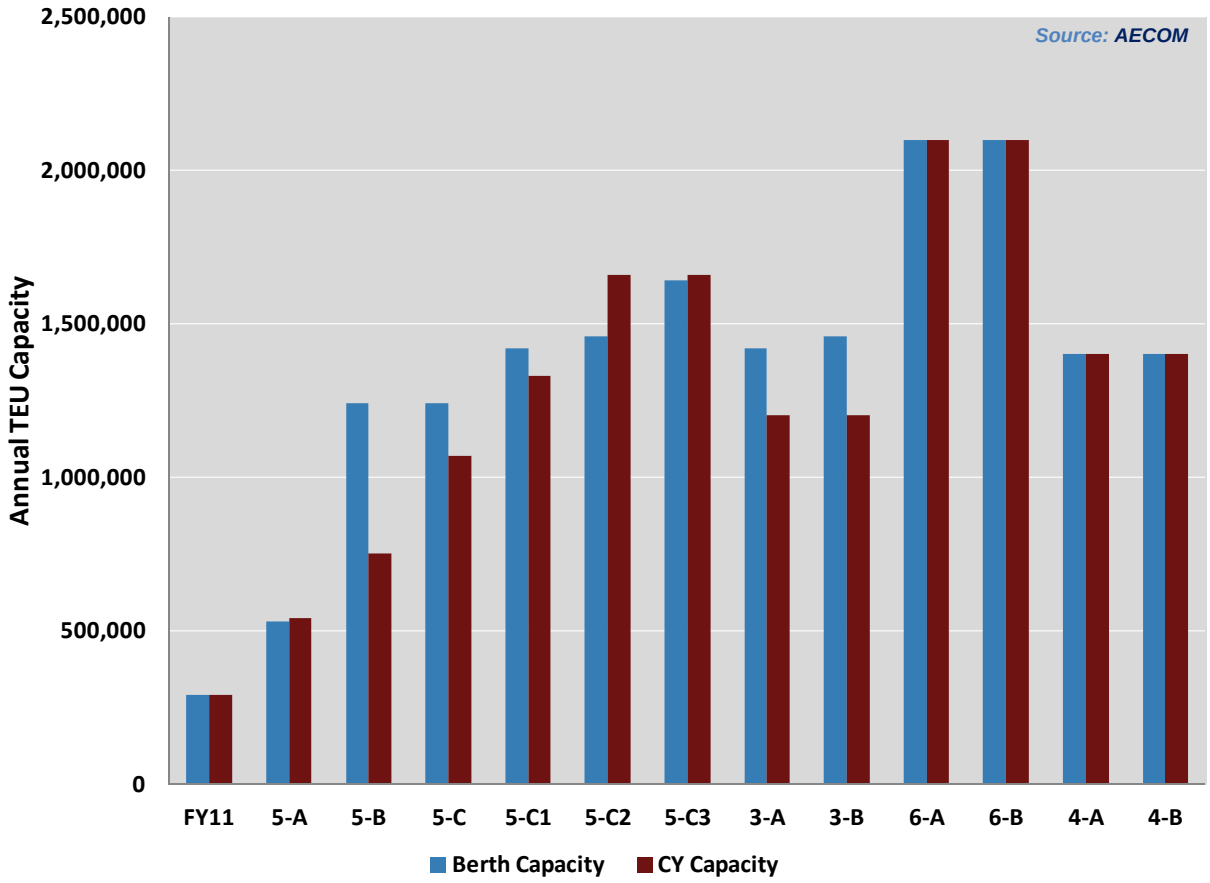
Container yard dwell times can most effectively be reduced by providing intermodal rail service, which speeds the turnover of containers through the yard. Other alternatives may include a container pricing strategy that includes demurrage as a disincentive to long storage periods. Careful consideration of market conditions and price sensitivity is required to ensure that business is not lost due to increased cost to shippers.

Near-dock intermodal container transfer facilities can also be used to move containers off the terminal and reduce dwell. The total need for storage area may be not be reduced under this scenario, but a portion of the required acreage is moved from off the dock. Additional handling costs would need to be considered under this alternative.

## 2.2 Future Container Terminal Capacity Summary

Figure 12 is a chart of the estimated capacity for each of the facilities listed in Table 1 in annual twenty foot equivalent units (TEUs).

**Figure 12: Annual Container Terminal Capacity**




FY11 refers to the fiscal year 2011 ending June 2011 at the Port of Wilmington (Site 5), which operated at about half its estimated capacity, or about 300,000 TEUs. 5-A is the current facility at capacity. In 5-B berth capacity is extended due to the addition of a second berth, resulting in a container yard (CY)-constrained facility due to the low-density RS based layout (see Figure 7). 5-C addresses this issue by upgrading to a higher-density RTG-based CY. In 5-C1, 5-C2, and 5-C3, berth capacity is incrementally increased through channel dredging, while CY capacity is increased in parallel though dwell time reductions. Average dwell time was assumed to be 7 days; this can be reduced through use of intermodal rail service and empty container management techniques using inland ports.

At Site 3 (the Port of Morehead City), in Case 3-A berth capacity is assumed to be 1.4M annual TEUs, the same as Case 5-C1 as both are two berth facilities at 45' of water depth. However, CY capacity is only 1.2M annual TEUs due to limited storage availability behind the berth. Additional dredging to 51' (Case 3-B) increases berth capacity slightly, but will not improve CY capacity.

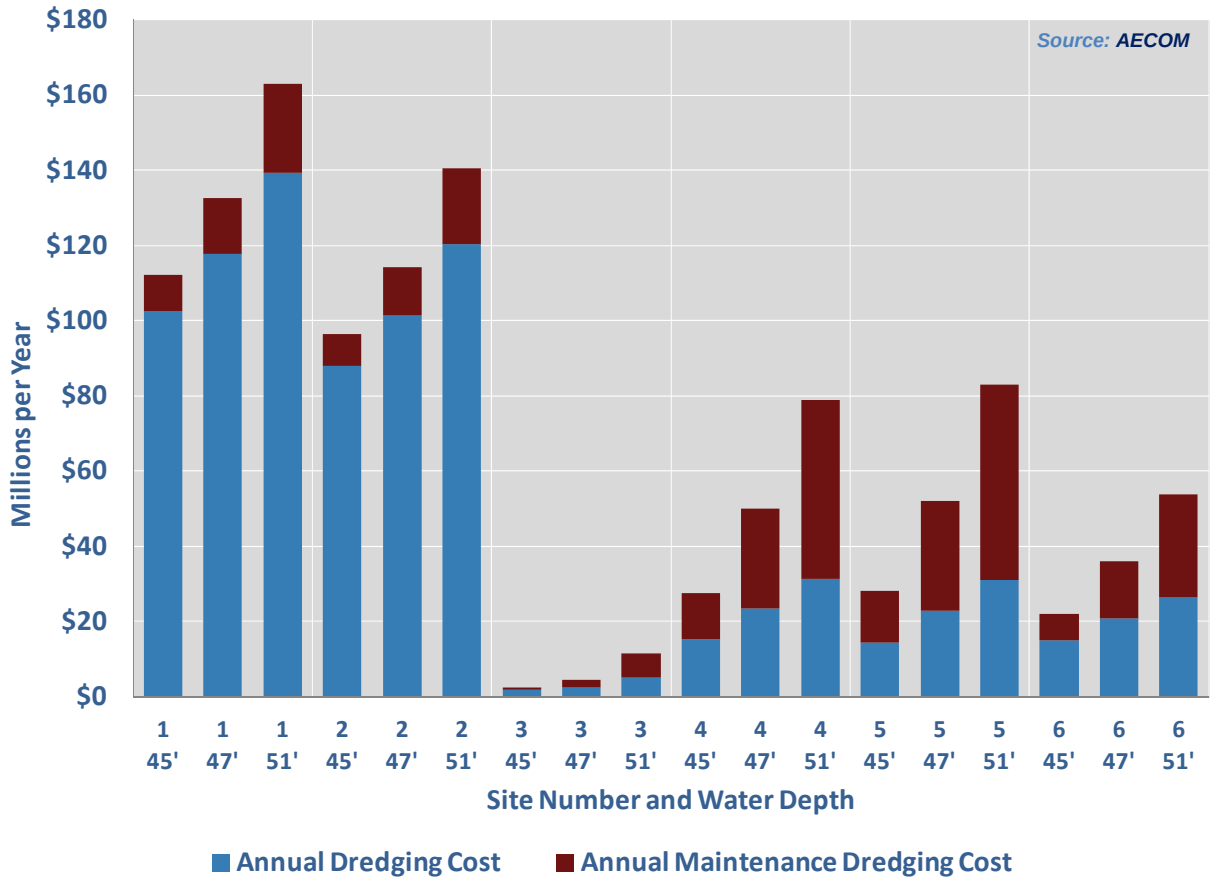
At Sites 4 and 6, capacity is assumed to be about 400,000 annual moves per berth for both RTG and ASC facilities. At Site 4, a 2 berth terminal is planned where as a 3 berth terminal is planned at Site 6, depending on the available water frontage. Being a Greenfield site, it was assumed that berth and CY capacity would be in balance and the terminal will be planned accordingly.

# 3 Cost Analysis

## 3.1 Dredging Cost

Preliminary dredging costs were determined for each of the six sites under consideration. Both the capital cost for initial dredging to the desired water depth and annual maintenance dredging costs were included. Figure 13 is a chart of both costs, with the initial dredging expense annualized over 30 years at 6% interest.

**Figure 13: Annual Dredging Costs**




Sites 1 and 2 in Pamlico County have a very high dredging cost as they are located away from open ocean and would need to have an entirely new channel dredged to access them. They were eliminated as possibilities based on this in further analysis. Site 3 at Radio Island at the Port of Morehead City has the least dredging required. Sites 4 and 5 have similar costs due to being located fairly close together on opposite banks of the Cape Fear River. Site 6 at Southport is also located on the Cape Fear River, but closer to the open ocean, resulting in less dredging costs than at Sites 4 and 5.

Annual cost of channel deepening and maintenance dredging estimates do not differentiate between the funding sources.

## 3.2 Capital Upgrades

For most of the cases in Table 1, either some upgrades to existing infrastructure or entirely new development costs will be required. Table 4 summarizes cost estimates for upgrades to facilities at the Ports of Wilmington and Morehead City (Sites 5 and 3 respectively).

**Table 4: Capital Upgrades at Sites 5 and 3**

| | WILMINGTON: REDEVELOPMENT REACH STACKER LAYOUT | | WILMINGTON: REDEVELOPMENT RTG LAYOUT | | MOREHEAD CITY: RADIO ISLAND TERMINAL RTG LAYOUT | |
|---|---|---|---|---|---|---|
| | 200-Foot-Wide Wharf Costs | | 200-Foot-Wide Wharf Costs | | | |
| | Total Package Minimum Cost | Total Package Maximum Cost | Total Package Minimum Cost | Total Package Maximum Cost | Total Package Minimum Cost | Total Package Maximum Cost |
| Demolition | $232,250 | $278,700 | $1,159,723 | $1,391,667 | $383,856 | $460,627 |
| Civil Site Work | $8,236,602 | $9,883,922 | $21,297,032 | $25,556,439 | $52,433,936 | $62,920,723 |
| Wharves | $43,512,500 | $52,215,000 | $43,512,500 | $52,215,000 | $83,830,000 | $100,596,000 |
| Electrical | $4,382,893 | $5,259,472 | $32,880,150 | $39,456,180 | $31,819,000 | $38,182,800 |
| Utilities | $2,703,359 | $3,244,030 | $5,730,378 | $6,876,453 | $17,389,748 | $20,867,698 |
| Gates | $2,915,000 | $3,498,000 | $2,915,000 | $3,498,000 | $2,915,000 | $3,498,000 |
| Buildings | $2,785,000 | $3,342,000 | $14,104,000 | $16,924,800 | $18,199,000 | $21,838,800 |
| MOBILIZATION / DEMOBILIZATION | $3,240,000 | $3,890,000 | $4,870,000 | $6,210,000 | $6,210,000 | $7,460,000 |
| **ESTIMATED TOTAL CONSTRUCTION COST** | **$68,007,603** | **$81,611,124** | **$126,468,782** | **$152,128,539** | **$213,180,540** | **$255,824,648** |
| ESTIMATED SOFT COSTS (15%) | $10,201,141 | $12,241,669 | $18,970,317 | $22,819,281 | $31,977,081 | $38,373,697 |
| **ESTIMATED TOTAL COST** | **$78,208,744** | **$93,852,793** | **$145,439,100** | **$174,947,819** | **$245,157,621** | **$294,198,346** |

Development costs in Table 4 are based on the layouts in Figure 7, Figure 8 and Figure 3 respectively. Cost per acre for a new container terminal development was determined for the RTG layout at Morehead City (Case 3-B) to be about $2.16M. This value was used to estimate development at Site 4 (375 total acres) and Site 6 (402 total acres). In addition cost of wetland mitigation was added for Site 4 and Site 6. Also, the cost of filling the marsh land was added for Site 4. Figure 14 compares development costs on an annualized basis over 30 years at 6% interest.

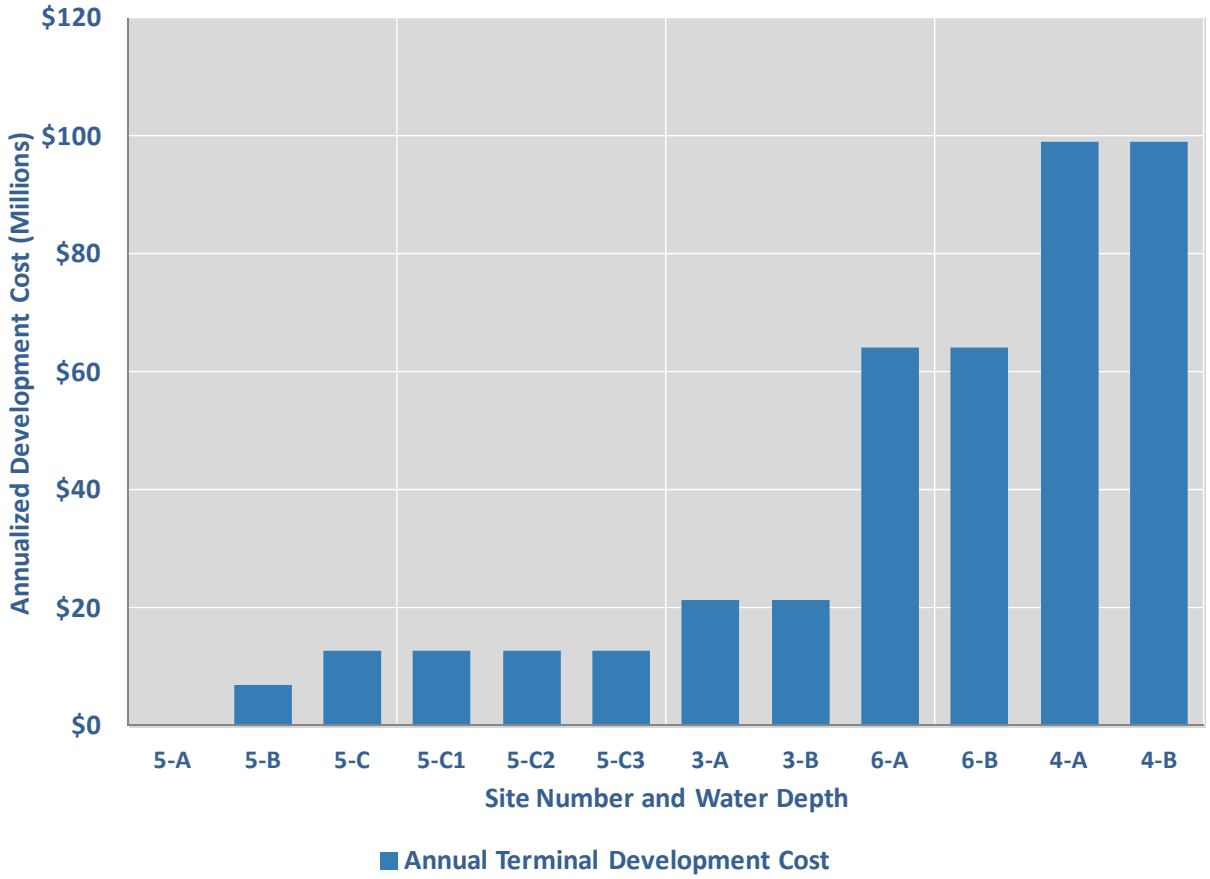
For Site 6, it was estimated that for approximately 77 acres of coastal wetlands onsite, additional cost of mitigation was calculated to be 77 acres x $157,627 per acre = $12,137,279. For Site 4, for approximately 287 acres of coastal wetlands onsite, the cost for mitigation was calculated to be approximately 287 acres x $157,627 per acre = $45,238,949. It should be noted that these estimates of coastal wetlands were based on preliminary GIS data available,

and that in order to obtain an accurate estimate of wetlands, a field delineation using USACE guidelines would be required

Developing a container terminal at Site 4 requires filling of the existing marsh area with good structural soil that would be brought in from an inland location. Potential use of the dredged material was not an option due to poor quality of the material. It was estimated that it would cost approximately $1.5M per acre for filling and site preparation at Site 4 in addition to the $2.1M per acre for container terminal development cost and the wetlands mitigation costs discussed earlier.

This results in annualized development cost for Site 4 being the highest at approximately $100M per year vs. approximately $65M per year for Site 6 and $21M per year for Site 3.

**Figure 14: Annual Terminal Development Cost**




## 3.3 Landside Access Improvements

In addition to development costs on the terminals themselves, most of the sites will require some upgrades to their highway or rail networks to allow sufficient access by trucks and trains. Table 5 summarizes the highway and rail access upgrade costs for each of the four sites under consideration.

**Table 5: Landside Access Improvement Costs**

| Site Number | Site Name | Highway Improvement Cost (M) | Rail Improvement Cost (M) | Site Total (M) | Annual cost @ 30yr life and 6% interest (M) |
|---|---|---|---|---|---|
| 3 | Port of Morehead City | $410.0 | $233.8 | $643.8 | $46.8 |
| 4 | River Road | $111.0 | $33.2 | $144.2 | $10.5 |
| 5 | Port of Wilmington | $0 | $14.9 | $14.9 | $1.1 |
| 6 | Southport | $201.0 | $20.0 | $221.0 | $16.1 |

The Port of Morehead City has the largest landside access cost by far due to its rural location and limited current highway access. The existing Port of Wilmington facility has the lowest requirement for landside access improvements due to the ability to use existing infrastructure.

## 3.4 Labor Cost

Annual labor costs were estimated for each facility based on detailed discussions with the NCSPA on existing labor practices at the Port of Wilmington.

Table  summarizes the hourly dock crane labor staffing and rates at the Port of Wilmington used for calculation in all cases.

**Table 6: Dock Crane Gang Structure and Labor Cost (in US$)**

| Job Name | # of persons | Wage Cost per person | Wage cost per category |
|---|---|---|---|
| Crane driver | 2.0 | $35 | $70 |
| Electrician | 1.0 | $35 | $35 |
| Crane mechanic | 1.0 | $35 | $35 |
| Standby mechanics | 1.0 | $35 | $35 |
| Crane supervisor | 0.5 | $40 | $20 |
| Checkers | 3.0 | $70 | $210 |
| Lashers | 7.0 | $70 | $490 |
| Cone Handlers | 6.0 | $70 | $420 |
| ILA Supervisors | 2.0 | $35 | $70 |
| Total | 23.5 | $425 | $1,385 |

Table  summarizes estimated hourly labor cost per equipment type based on current wage and staffing rates and expected staffing rates based on similar facilities in existence for new equipment types, such as ASCs.

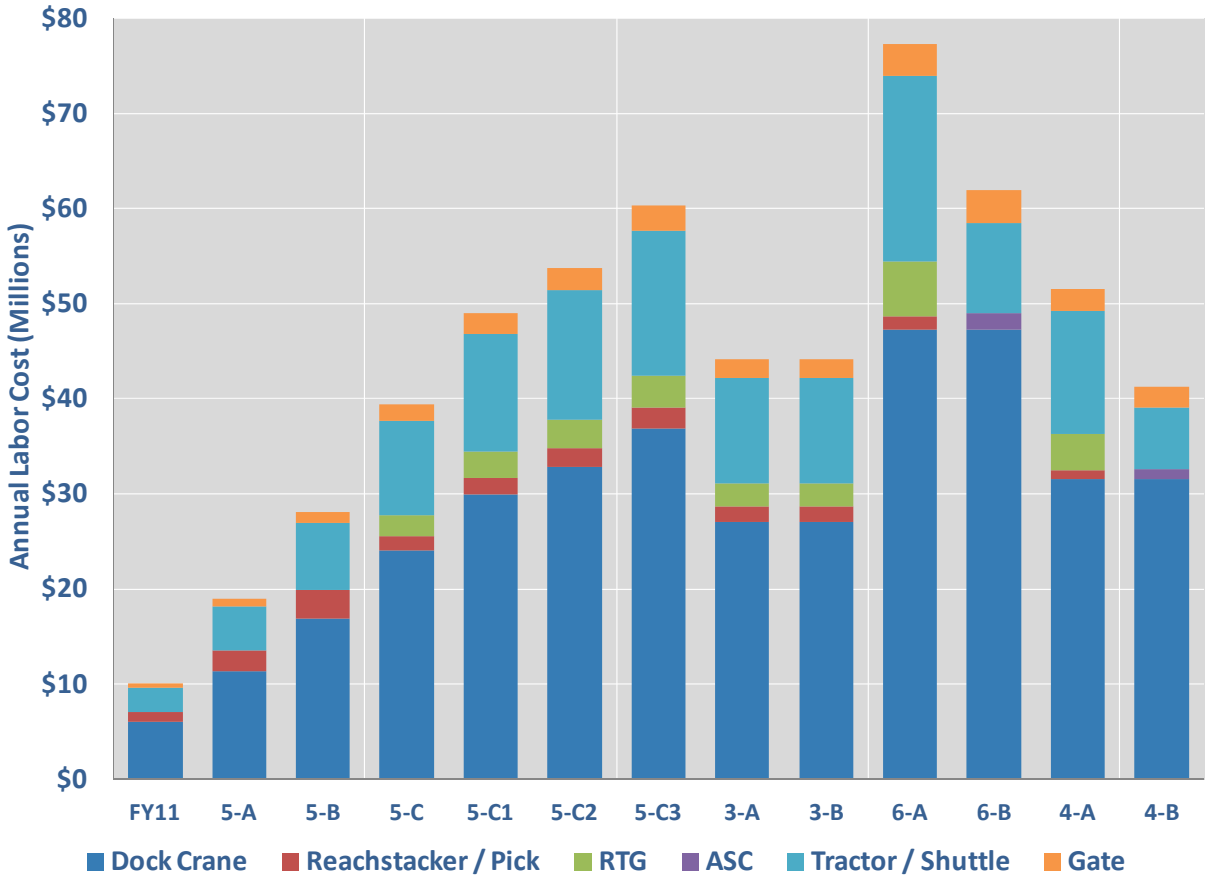
**Table 7: Staffing and Hourly Labor Rates by Equipment Type**

| All Included Cost/hr | $70 | $27 | $30 | $27 | |
|---|---|---|---|---|---|
| | UTR Driver | TP Driver | RTG Driver | Clerk | Machine labor cost/hr |
| Dock Crane | | | | | $1,385 |
| Vessel TP/RS driver | | 1.50 | | 0.50 | $54 |
| Gate TP/RS driver | | 1.25 | | 0.50 | $47 |
| CY Top-pick for rail | | 1.25 | | 0.50 | $47 |
| Vessel RTG | | | 1.25 | 0.50 | $51 |
| Gate RTG | | | 1.25 | 0.50 | $51 |
| Vessel ASC | | | 0.10 | | $3 |
| Gate ASC | | | 0.50 | | $15 |
| Tractor | 1.17 | | | | $82 |
| Shuttle | 1.33 | | | | $93 |

There is also an estimated $2.90 cost for gate management per annual vessel lift based on current rates at the Port of Wilmington.

Figure 15 charts annual labor cost for all equipment types for all cases considered based on annual hours to support the capacity shown in Figure 12.

**Figure 15: Annual Labor Cost**




## 3.5 Equipment Capital Cost

A variety of equipment will need to be purchased for the cases considered. At Site 5 locations (Port of Wilmington), fewer dock cranes will need to be purchased than other cases due to the currently existing 4 cranes. Otherwise it is assumed than one dock crane will be required per 100,000 vessel lifts worth of terminal capacity.

For terminals with side picks and reachstackers in use, it is assumed that 1 side pick will be required and 1 reachstacker will be required per dock crane, except in Cases 5-A and 5-B, where 2.5 reachstackers are needed per dock crane. For RTG terminals, two RTGs are required per dock crane, while ASC-based facilities will need 5 ASCs per dock crane as they will be used for both stevedoring and gate operations.

For all cases except 4-B and 6-B (the ASC terminals), yard tractors and bombcarts are needed at about 7 tractors per dock crane, plus 25% additional bombcarts for miscellaneous usage. In 4-B and 6-B, 3 shuttles are estimated per dock crane for an ASC case.

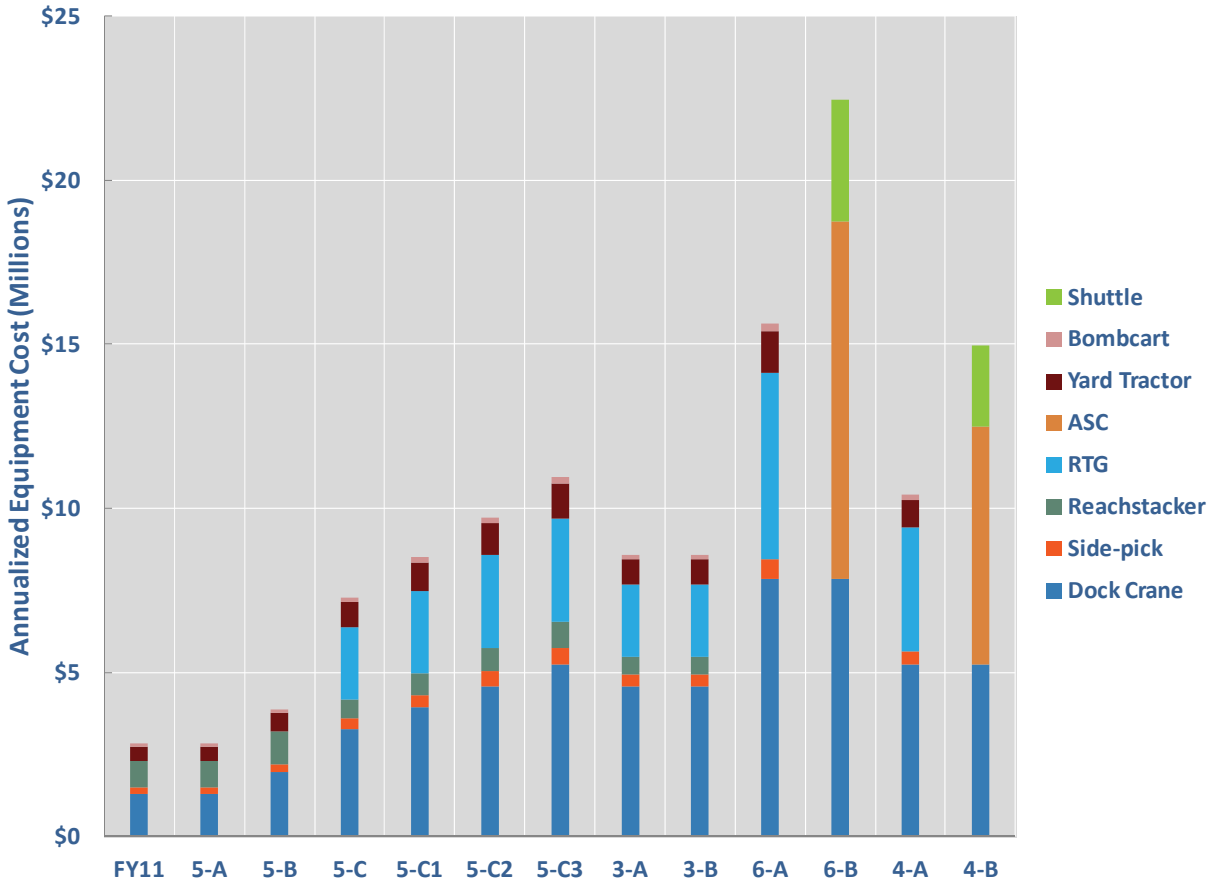
In addition to all the base equipment required to be in operation, most equipment types will also have a fleet of spares to allow for maintenance. Table  summarizes the percent spares required for each machine type, initial purchase cost, and machine life assumed for annualized cost calculations.

**Table 8: Equipment Characteristics**

| Equipment Type | Purchase Price | Lifespan (Yrs) | % Spares |
|---|---|---|---|
| Dock Crane | $9,000,000 | 30 | - |
| Side-pick | $400,000 | 13 | 10% |
| Top-pick | $650,000 | 13 | 10% |
| RTG | $1,500,000 | 17 | 10% |
| ASC | $2,500,000 | 30 | - |
| Yard Tractor | $87,000 | 9 | 20% |
| Bombcart | $24,000 | 20 | 10% |
| Shuttle | $750,000 | 12 | 15% |

Figure 16 summarizes annual equipment cost using the assumptions listed in Table 8 and 6% annual interest.

**Figure 16: Annual Equipment Cost**




## 3.6 Energy Cost

The following hourly energy consumption rates were assumed for each type of equipment. For diesel equipment, the rate is in gallons/hr, while for electric equipment the rate is kW-hr.

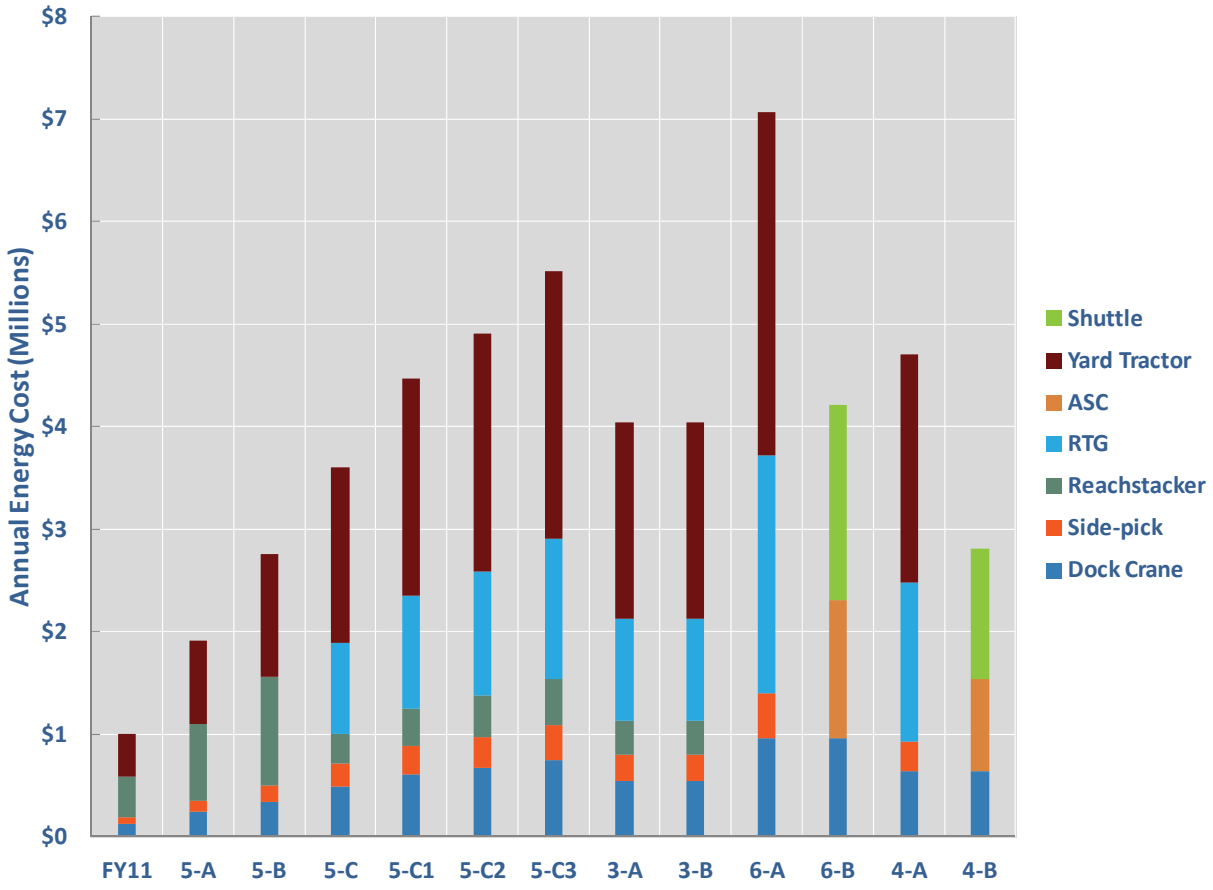
**Table 9: Hourly Equipment Energy Consumption**

| | |
|---|---|
| Dock Crane (kW-hr) | 200 |
| Side Pick (gal/hr) | 3.9 |
| Reachstacker (gal/hr) | 5.2 |
| RTG (gal/hr) | 5.2 |
| ASC (kW-hr) | 70.0 |
| Yard Tractor (gal/hr) | 3.5 |
| Shuttle (gal/hr) | 4.7 |

The cost of diesel is estimated to be $4.00 per gallon, while electricity costs are calculated using $0.12/kW-hr.

Using these assumptions, annual energy costs for each type of equipment was calculated based on the estimated annual hours required to support the capacity shown in Figure 12.

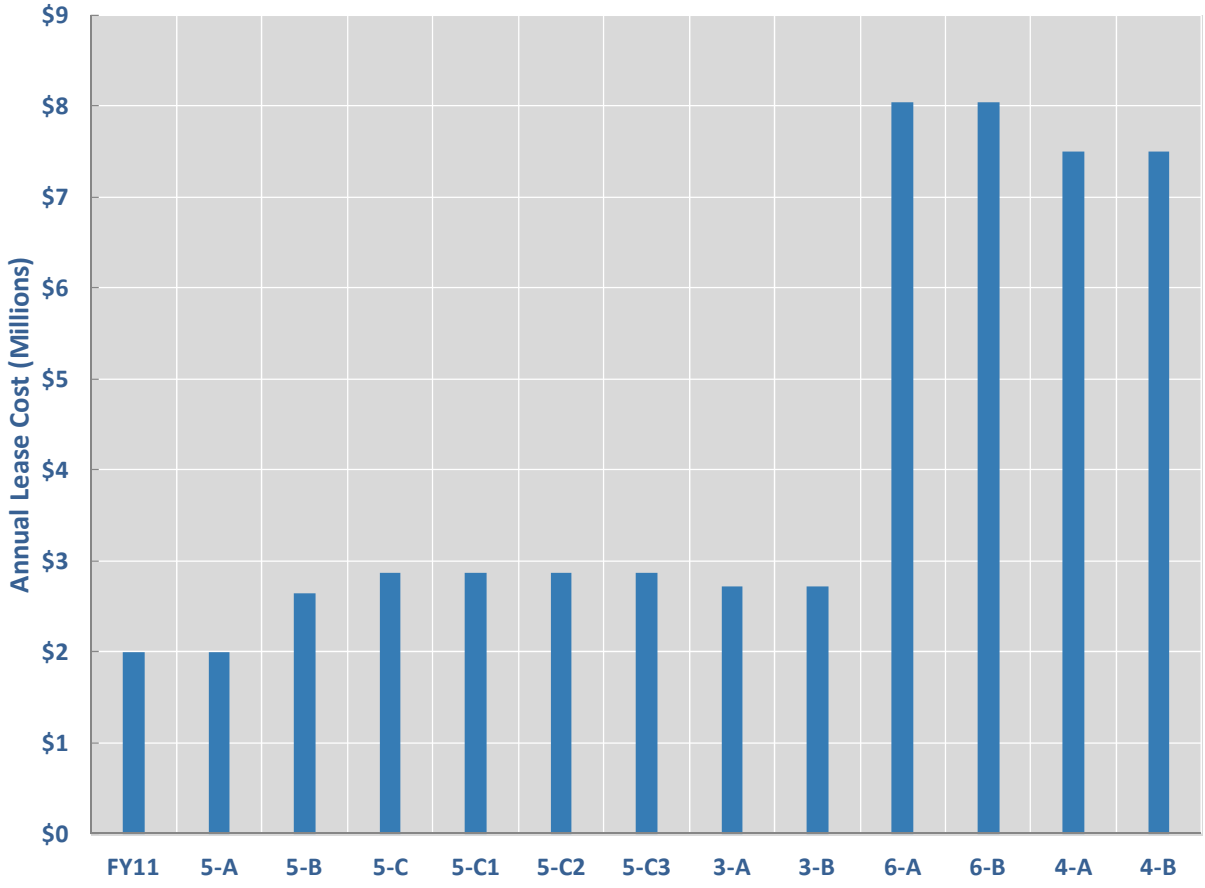
**Figure 17: Annual Energy Cost at Capacity**




## 3.7 Terminal Lease Cost

Terminal lease costs were roughly estimated using a figure of $20,000 per acre per year for each case.

**Figure 18: Annual Terminal Lease Cost**




For Figure 18, the average lease rate per acre is the same for all options; only the size of the facilities varies.

## 3.8 Relative IT Cost

There are two types of cost for IT systems: initial system purchase price, and annual IT maintenance. For reachstacker and RTG-based facilities, initial purchase price is assumes to be $1,000,000, with a system life of 15 years. Maintenance cost is estimated at $1/annual vessel move.

For ASC-based facilities, initial system cost is estimated at $5,000,000 with a life of 15 years, while annual maintenance cost is assumed to be 10% of the system purchase price per year, or $500,000 annually.

## 3.9 Cost Summary

Figure 19 is a summary of annual cost for all costs under analysis at capacity. All costs have been annualized at 6% interest where applicable.

**Figure 19: Relative Total Annual Cost at Capacity**

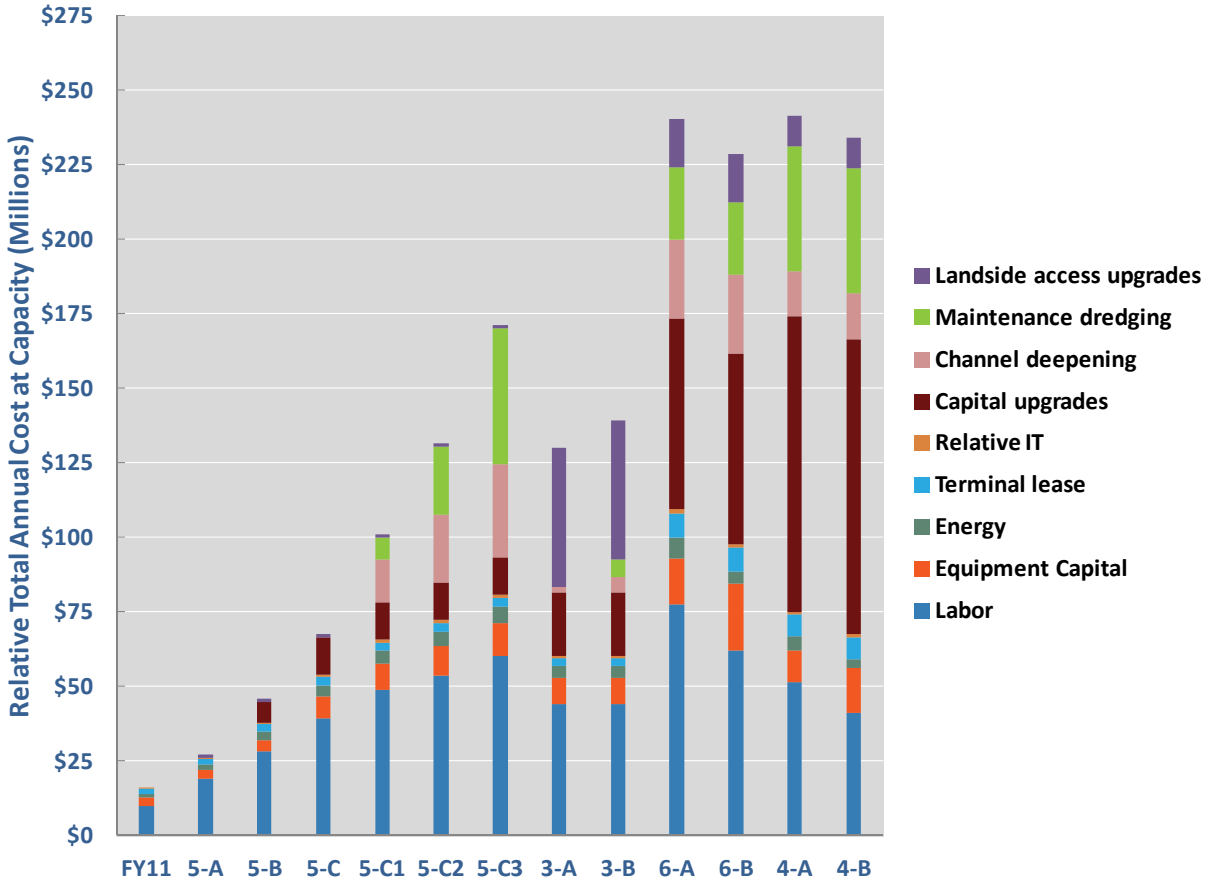



Figure 19 includes only direct variable costs required to operate the terminal at capacity and annualized costs for required capital and landside access upgrades and dredging. Indirect costs such as port management, administration, and security are not included.

Note that the annualized cost of building a new two-berth RTG-based container facility with 51' of water depth at Morehead City (Case 3-B) is more than adding a 2nd berth at the Port of Wilmington and converting the facility to an RTG-layout (case 5-C2) due to significant landside access upgrade costs. In addition, the cost of building an entirely new 3-berth RTG facility at Site 6 with 51' water depth (6-A) is less than the cost of building a new 2-berth RTG facility at Site 4 with same 51'' water depth due to additional cost of site preparation incurred at Site 4.

Figure 20 summarizes the costs in Figure 19 per vessel move at capacity.

**Figure 20: Relative Cost per Vessel Move at Capacity**

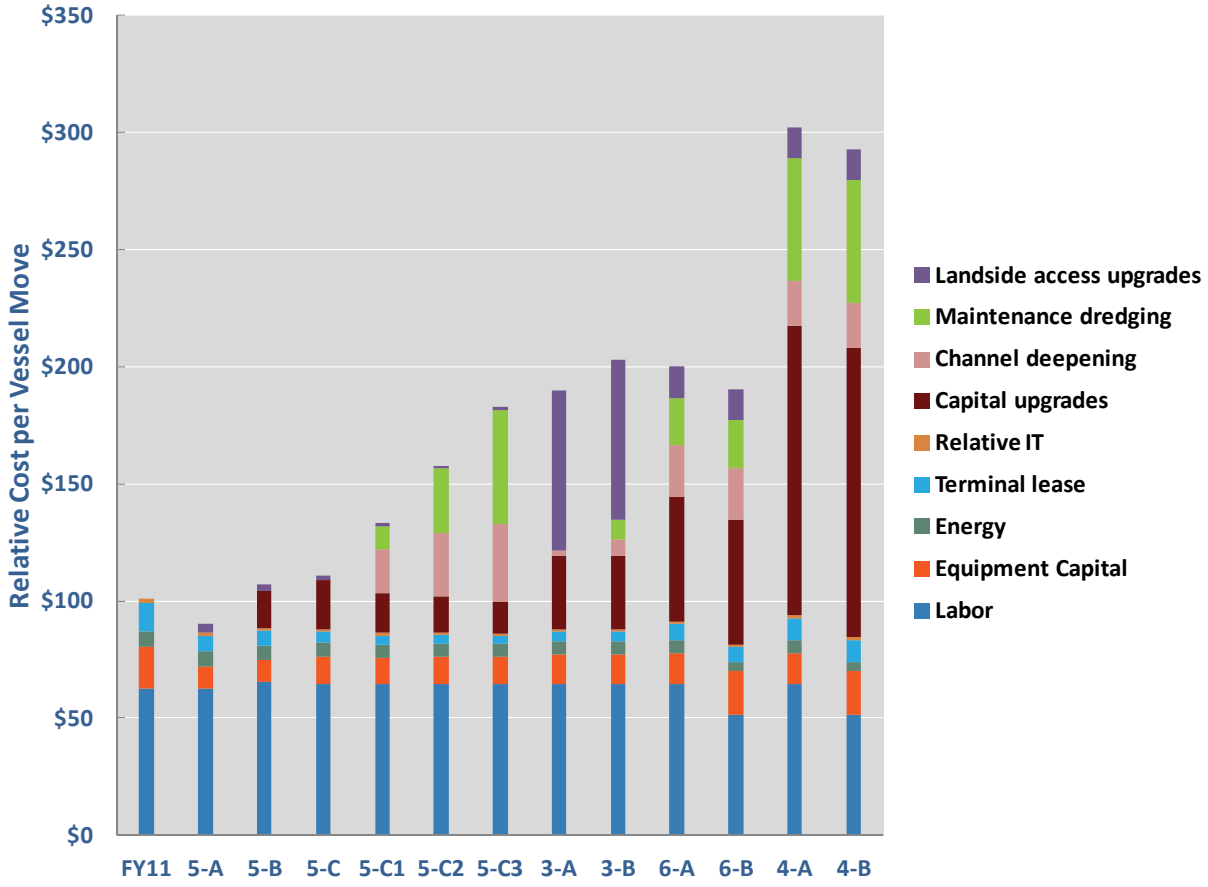


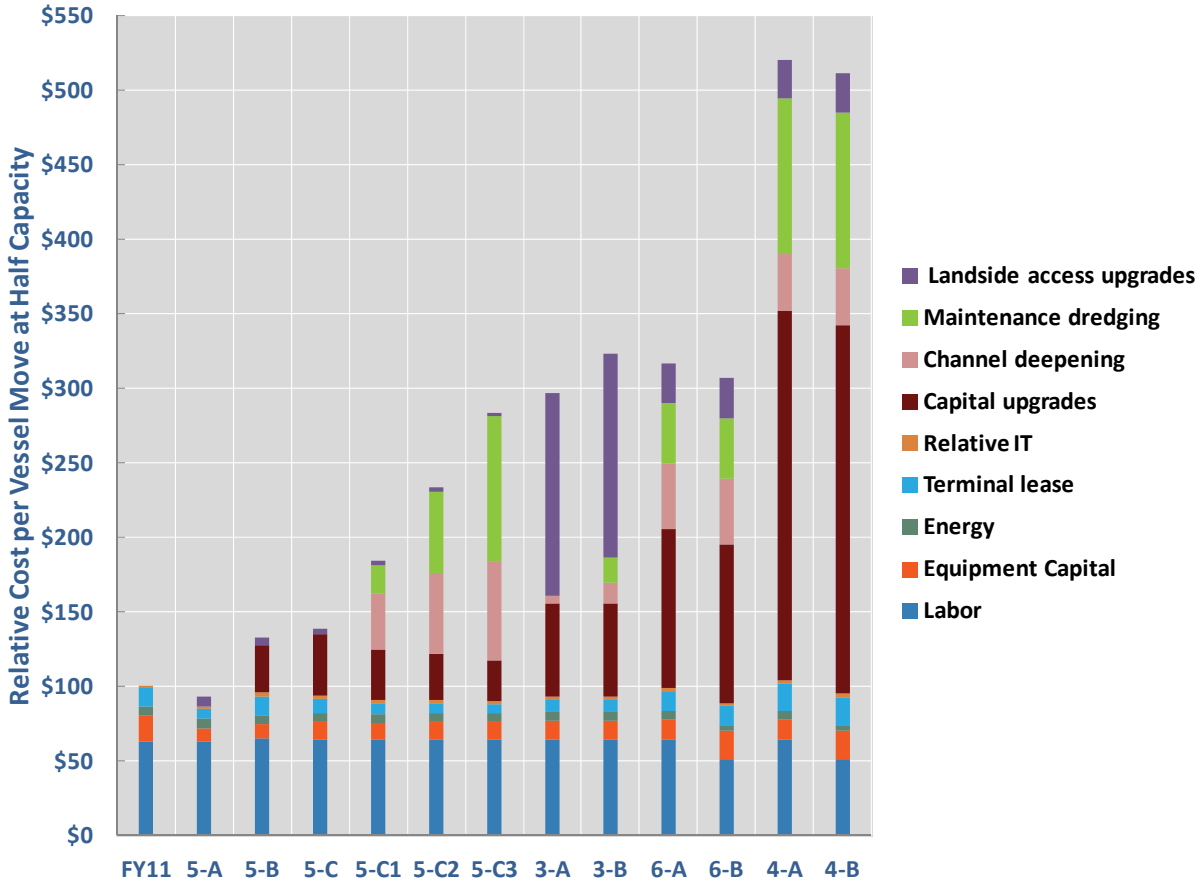

Figure 20 shows that the most cost-effective expansion of container capacity in North Carolina is maxing out the capacity of the current facility (5-A), followed by upgrades to the same site including dredging. Since 5-B and 5-C have similar costs per move and involve only upgrading from a reachstacker-based to an RTG-based facility, 5-C will allow for increase capacity at the Port of Wilmington without significant increases in cost per move. Any dredging options at Wilmington (5-C1, 5-C2, and 5-C3) will lead to significant increases in cost per move without significant upgrades to capacity.

A new 3 berth RTG terminal at Southport (6-A) will be about the same cost per move as building a 2-berth RTG terminal at Morehead City (3-B), with both facilities at 51' of water depth. Using ASCs at Southport (6-B) instead of RTGs will reduce this cost slightly, but overall expansion at Morehead is more cost-effective, notwithstanding potentially required costs for landside access improvement at Morehead.

Site 4 at River Road Southeast has the highest cost per move due to large dredging costs to support a two-berth facility, as well as very high additional cost of filling the site and cost of wetland mitigation as compared to Site 6.

It is important to note that Figure 20 determines costs at capacity, where cost per move will be most favorable. Figure 21 analyzes the same values at half capacity.

**Figure 21: Relative Cost per Vessel Move at Half Capacity**



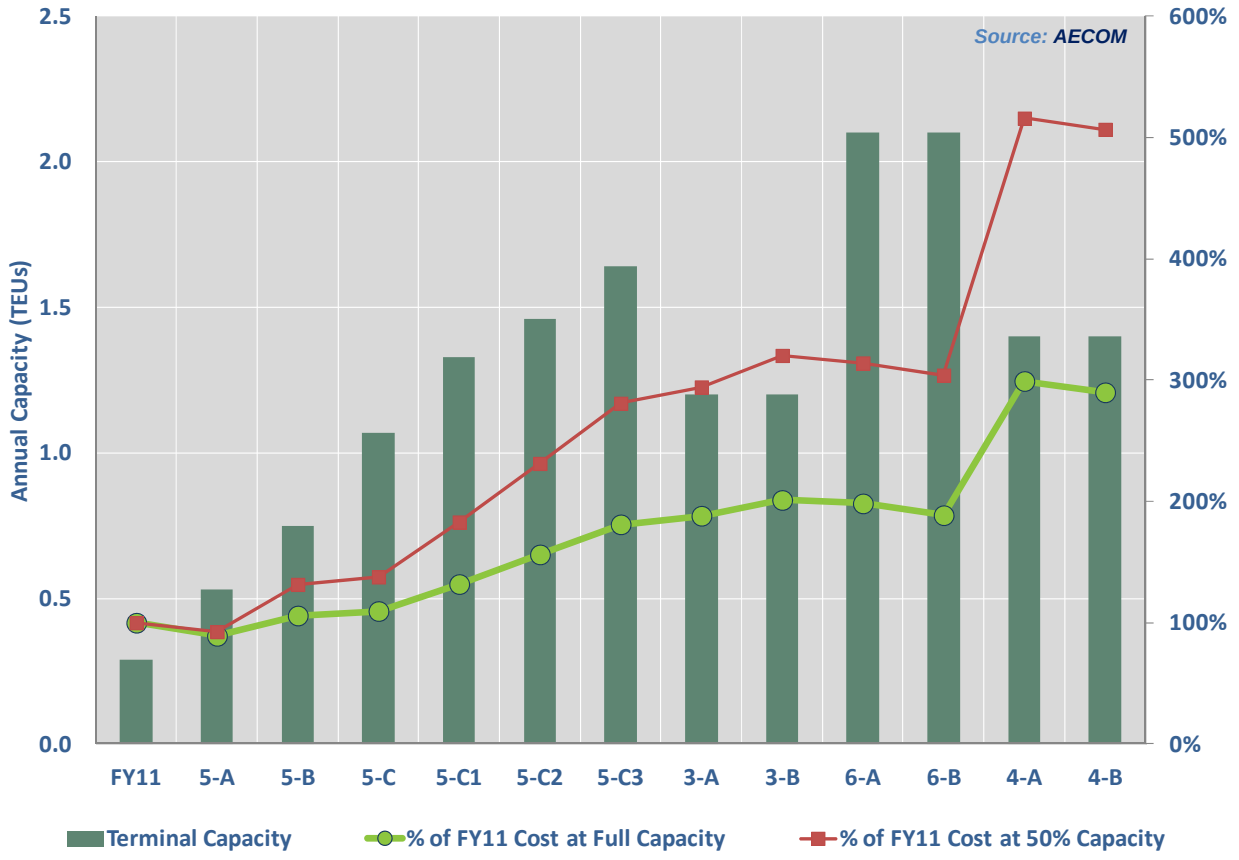

Note that in Figure 20, the vertical axis reaches $350 per vessel move, while in Figure 21 it reaches $550. This is because for fixed costs such as terminal lease, capital improvements landside access, and dredging, cost per move will be higher when the facility operates at a lower volume. Typically new terminals will not operate at capacity immediately after opening.

Figure 21 shows that even for case 5-C with no dredging at Wilmington, there will be a significant increase in cost per move when operating at less than capacity due to having high costs offset by a very low increase in volume. A similar issue occurs with dredging options at Morehead City (3-A and 3-B), resulting in costs up to 50% to 75% more than FY11 levels.

Both the new terminal facilities at Southport and River Road Southeast (Sites 6 and 4 respectively) will have very high costs per move when operating at half capacity due to significant dredging expenses and required capital expenditures to build entirely new facilities. There is a significant risk to building a new facility if the market demand does not support it.

Figure 22 present the cost data of the previous two charts in percentage form along with the annual terminal capacity from Figure 12.

**Figure 22: Terminal Capacity vs. Cost per Move**




The right axis in Figure 22 is percent of FY11 costs. The optimal case in Figure 22 will have a high capacity bar, but low lines for cost as a percentage of the current mode of operation at Wilmington. The most promising development options overall are maxing out the capacity of Wilmington without dredging (5-A, 5-B, and 5-C), followed by building a new facility at Morehead (3-A or 3-B).

Overall, economies of scale result in higher cost effectiveness as volume increases. In order to provide a total annual capacity of approximately 1M TEUs for North Carolina, the most cost effective option is maxing out the current facility at the Port of Wilmington at its existing water depth. If the goal is to build up to 2M TEU capacity in North Carolina, it would be most cost effective to build additional container terminal capacity at Morehead City after maxing out the existing terminal capacity at Wilmington. However, it is important to note that location of Morehead may result in it being a less desirable destination for shippers compared to other sites due to high distances from population centers. It should be also noted that Southport (Site 6) allows for additional capacity of up to 2.2M TEUs and room for additional growth, should the demand exist for North Carolina ports. It is clear that Site 4 at River Road Southeast would still

likely be more expensive than Morehead or Site 6.

For new terminals, ASC facilities will also be more cost-effective than RTGs, but the difference in costs between manual and automated terminals relatively small compared to the differences in dredging, landside access, and terminal development between the site options considered.