US Army Corps
of Engineers
Wilmington District®

Wilmington Harbor 403 Letter Report

Wilmington, North Carolina

Attachment 5 – Economic Considerations

09/05/2025

Draft

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Table 5.0. Economic Analysis of Proposed Alternatives (FY25 Price Levels, FY25 Discount Rate 3.0%)

Cost/Benefit	-46 FEET	-47 FEET
AAEQ Benefits	$71,189,000	$83,278,000
AAEQ Costs	$53,561,000	$62,230,000
Incremental AAEQ Costs	$18,174,000	$8,669,000
Net Benefits	$17,628,000	$21,048,000
BCR @ 3.0%	1.3	1.3

Economic Considerations

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ATTACHMENT 5– ECONOMIC CONSIDERATIONS

Section 5.1. Background

The purpose of this economic analysis is to evaluate if the proposed deepening of the Wilmington Harbor navigation channels is economically justified. This analysis is conducted from a National Economic Development (NED) perspective, where NED benefits are defined as the change in value of goods and services that accrue to the nation as a whole from constructing the project and NED costs are defined as the total economic costs of constructing and maintaining the project. The average annual economic benefits of the project are compared to the average annual project costs to provide an estimated benefit-to-cost ratio. A project with a benefit-to-cost ratio greater than 1.0 is considered economically justified. Guidance is contained in U.S. Army Corps of Engineers (USACE) Engineering Regulation (ER) 1105-2-100, as well as recent Economic Guidance Memoranda (EGM's) issued by Headquarters USACE (HQUSACE).

5.1.1. Section 203 Study

The State of North Carolina, acting through the North Carolina State Ports Authority (NCSPA), completed a feasibility study through the authority of Section 203 of the Water Resources Development Act (WRDA) of 1986 (P.L. 99-662), as amended. The study was conducted to determine the feasibility of potential improvements to the Federal Navigation System (FNS) at Wilmington Harbor. The report, recommending deepening the harbor from 42 feet below mean lower low water (MLLW) to 47 feet MLLW, was submitted to the Assistant Secretary of the Army (Civil Works) (ASA(CW)) for review in February 2020.

5.1.2. Section 403 Effort

In May 2020, the 203 study was transmitted to Congress for potential authorization with an Assessment Report that identified unresolved issues and recommendations to perform the following work to resolve those issues:

- Reframe assumptions and the screening of alternatives
- Perform economic analysis for multiple depth alternatives using USACE methodology
- Conduct National Environmental Policy Act (NEPA) analysis including supporting engineering modeling and appropriate sea level change information
- Finalize mitigation and real estate plans,
- Conduct an Independent External Peer Review (IEPR)

Congress conditionally authorized the recommended navigation improvements, at a total cost of $834,093,000, through Section 403 of the Water Resources Development

Act (WRDA) 2020. The conditional authorization included a requirement to address the issues and concerns identified in the ASA(CW) Assessment Report. In 2022, the USACE Wilmington District was tasked with producing a Letter Report and NEPA documentation to address those outstanding issues through a cost-shared effort with the NCSPA.

Section 5.2. Existing Conditions

The existing federal project at Wilmington Harbor (Figure 5-1) consists of the Eagle Island Dredged Material Disposal Site, the New Wilmington Ocean Dredged Material Disposal Site (ODMDS), the Upper and Lower Anchorage basins, and the system of federal channels from the ocean up to the channel's terminus upstream of the Hilton Railroad Bridge. The federal channel extends for approximately 38 miles beginning offshore of the outer ocean bar at the mouth of the Cape Fear River in Brunswick County, NC, and extends upwards to the City of Wilmington in New Hanover County, NC, where it services the Port of Wilmington. The authorized depth of the channel is -44 ft mean lower low water (MLLW) at the ocean bar and entrance channel, then -42 ft for the channel up to the Cape Fear Memorial Bridge.

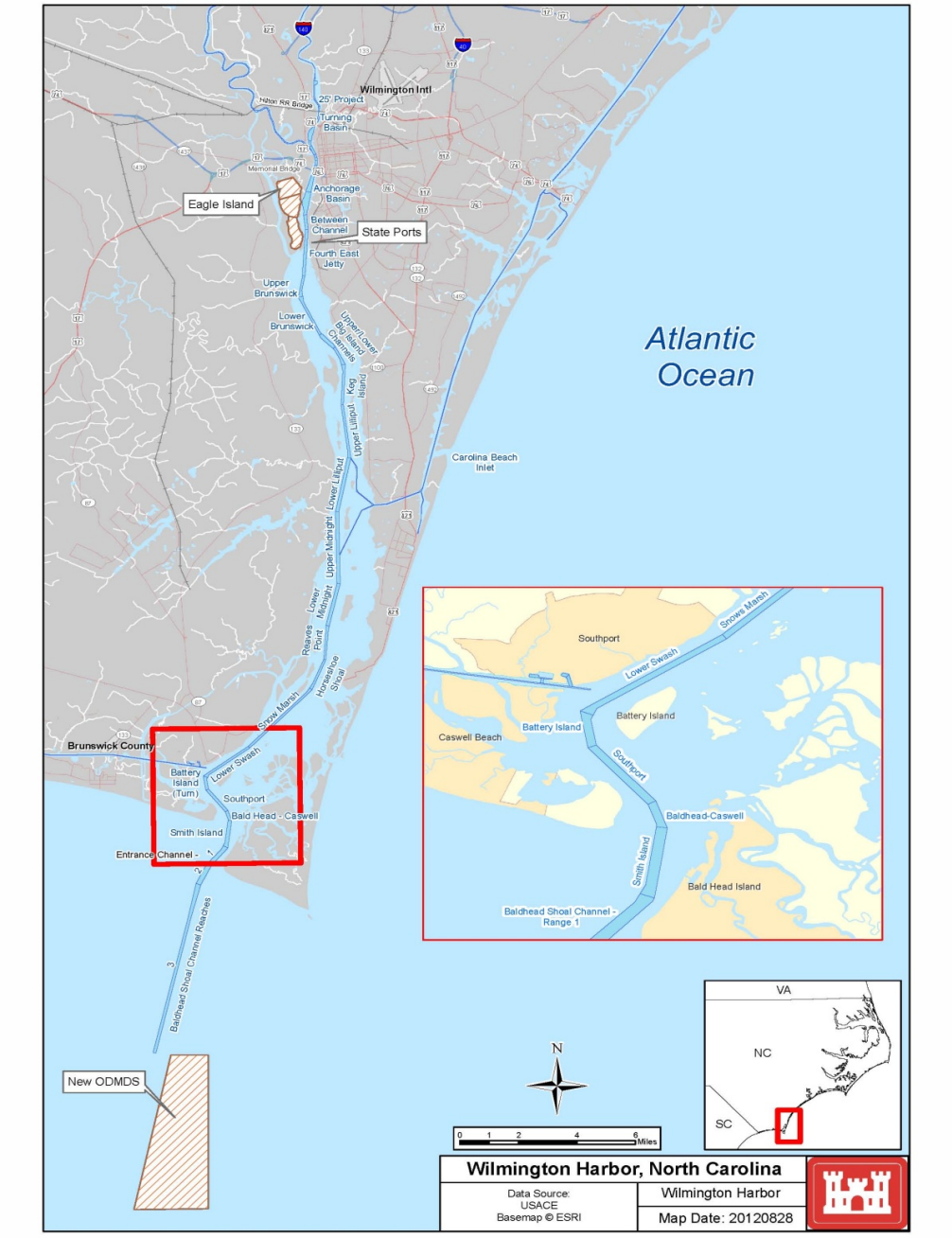


Figure 5-1. Wilmington Harbor Vicinity Map

5.2.1. Port Overview

The Port of Wilmington is in southeastern North Carolina, approximately 28 miles up the Cape Fear River from the Atlantic Ocean. The Cape Fear River borders Brunswick County to the west and New Hanover County to the east. Interstate 40 connects Wilmington with the state capital Raleigh, and to Interstate 95. U.S. highway 74 connects the port to Charlotte, the state's most populous city. The CSX rail system connects the Port of Wilmington directly to intermodal transfer facilities in Charlotte. The

Port of Wilmington is also connected to the CSX Carolina Connector intermodal rain terminal in Rocky Mount, NC. This economic analysis describes and evaluates the existing, future "without" and future "with" project conditions at the port. This section of the report portrays the existing conditions at the port using the latest data available, which is generally from 2022, as available at the time of analysis.

5.2.2. Port Hinterland

The Port of Wilmington's hinterland is primarily within the state of North Carolina. It includes Raleigh, Durham, Greensboro, Fayetteville and, of course, the Wilmington area. The port is connected to the Raleigh-Durham area by Interstate I-40 and to Greensboro by Interstate I-73. The primary Port of Wilmington facilities are approximately 75 miles from Interstate I-95 and 200 miles from Interstate I-85, which are the primary north / south transportation corridors through North Carolina. These highways connect the Port of Wilmington to Charlotte, Greensboro and Raleigh / Durham. Improvements to Interstate I-74 have added vehicle capacity between the port and I-85, which connects to Charlotte, North Carolina.

Landside transportation to and from the Port of Wilmington is primarily by truck. Trucks must pass through residential areas to reach the interstates. They must traverse Burnett Boulevard (two-lane road) to reach I-74, or Shipyard Boulevard and College Road (four lane bi-directional roads) with a series of traffic lights to reach I-40. CSX provides daily rail service to the port via the Queen City and Wilmington Midwest Express services. The rail route is through the City of Wilmington and crosses many of the city's major roads; most crossings within Wilmington are "at-grade."

5.2.3. Port Facilities

The Wilmington Harbor Federal navigation channel provides deep draft access to Military Ocean Terminal Sunny Point (MOTSU), liquid and dry bulk terminals, and to the container terminal at the Port of Wilmington. The following paragraphs describe these terminals in greater detail.

5.2.3.1 North Carolina State Ports Authority

The NCSPA berths 1-9 are located on the east bank of the Cape Fear River at approximately river mile 28. Berths 1-6 handle a wide variety of bulk commodities including shipments of forest products such as lumber, logs, woodchips, pulp, and wastepaper, as well as sulphur, clay, salt, and manufactured equipment and machinery. These docks handle roll-on/roll-off (Ro-Ro) and some limited containerized cargos. Berths 7, 8 and 9 handle containerized shipments primarily and the port has seven modern container cranes, three of which are capable of servicing post-Panamax containerships. Berths 1 and 2 have a total of 1,213 linear feet of berthing area and a width of 300 feet. Berths 3, 4 and 5 have a total of 2,100 linear feet with berth 3 have a width of 60 feet, and berths 4 and 5 a width of 46 feet. Berths 6 and 7 have a total of 1,550 linear feet, with berth 6 being 110 feet wide and berth 7 being 120 feet wide and

berths 8 and 9 have a total of 1,950 linear feet with berth 8 being 300 feet wide and berth 9 being 150 feet wide. According to the Port of Wilmington, the port capacity for the container terminal is 600,000 twenty-foot equivalent units (TEUs) per year.

Depth at the Berths 1 and 2 is -38 feet MLLW, with permits in place to increase to -42 feet MLLW, and depth at Berths 3 – 9 is -42 feet MLLW. Maximum air draft along the approaching channel is restricted to 210 feet above mean higher high water (MHHW) due to electric cable crossing. There are three containership berths providing a total berth length of 2,650 feet:

- Berth 7 – 700 feet;
- Berth 8 – 1,050 feet; and
- Berth 9 – 900 feet.

Currently, containership berths are being rehabilitated to allow simultaneously accommodating one 1,200-foot-long vessel and one 965-foot-long vessel. Vessels over 1,200 feet long routinely call[1] on the port today. The three containership berths are currently serviced by two Panamax ship-to-shore cranes (13- box wide), four post-Panamax ship-to-shore cranes (18-box wide) and three neo-Panamax ship-to-shore cranes (22-box wide).

5.2.3.2 Colonial Oil

Colonial Oil operates a berth located on the east bank of the Cape Fear River 0.5 miles below the Cape Fear Memorial Bridge at approximately river mile 26.5. This berth ships and receives petroleum products and chemicals. It has eight storage petroleum tanks with a total capacity of 406,000 barrels. The facility provides bunkering services. The dock is 720 feet long and depth alongside is -32 feet mean low water (MLW). Colonial Oil Terminals offers storage and distribution of petroleum and liquid chemicals as well as kaolin clays, fertilizer, and other dry bulk commodities by deep-draft vessels and barges.

5.2.3.3 Buckeye

Buckeye Partners operates a wharf located on the east bank of the Cape Fear River 0.7 miles below the Cape Fear Memorial Bridge at river mile 26.3. The facility handles petroleum products such as gasoline, kerosene and jet fuel. This facility has 14 steel storage tanks with 580,000 barrels of storage capacity. The wharf is 550 linear feet long with a depth of -38 feet MLW.

[1] A “call” includes both the inbound and outbound vessel movements, as well as any shifting from dock to dock.

5.2.3.4 Kinder Morgan Terminal

The Kinder Morgan Terminal is immediately north of the Port of Wilmington facility and was recently modified to make room for a larger turning basin. The vessels for this terminal now permanently use Port of Wilmington Berth 1. It is located at approximately river mile 29.5 of the Cape Fear River. The terminal includes significant transportation infrastructure, liquid and heated storage, and custom tank blending capabilities for agricultural and chemical products. It offers a variety of both inbound and outbound services via rail, barge, ship, and truck, and has direct access to two major highways. The facility handles caustic soda, urea-ammonium nitrate solutions, asphalt, methanol, and other liquid chemicals. The depth at this terminal is -32 feet MLW.

5.2.3.5 Apex Oil

Apex Oil Company operates a wharf located on the east bank of the Cape Fear River at approximately river mile 27. The facility handles petroleum and petroleum products, including gasoline, jet fuel, kerosene, petroleum pitches, coke, asphalt, naptha, solvents and other chemicals. It has 17 steel storage tanks with a total capacity of 902,000 barrels. The wharf has a total of 800 linear feet of dock space and water depth is -42 feet MLW alongside. The Apex Oil Terminal accommodates tankers up to Panamax size.

5.2.3.6 Carolina Marine Terminal

Carolina Marine Terminal (CMT) is a bulk handling terminal, which takes vessels up to Panamax size, and ships chromium, salt, and urea. The facility has direct rail access and direct access to I-40 and I-95. The yard has storage capacity of 500,000 tons as well as 50,000 tons of dome storage capacity. The newly constructed concrete dock handles both ship and barge berthing, with 42 feet of available channel depth. Commodity transfer is via a 1,000 ton/hour capacity crane. CMT also maintains a dock at Eagle Island.

5.2.3.7 ChemServe Terminal

This terminal is shared, with multiple users. Vessels calling at this terminal include Articulated Tug Barges (ATBs) and Panamax tankers. The terminal is located on the east bank of the Cape Fear River at approximately river mile 27. This terminal receives asphalt, petroleum products and chemicals. The terminal serves two facilities. The Koch Refining Company, which has five steel petroleum storage tanks with a total capacity of 256,000 barrels, ten chemical storage tanks with a total capacity of 21,300,000 gallons, and seven petroleum-products storage tanks with a total capacity of 363,000 barrels. The Citgo Asphalt Refining Company has five asphalt storage tanks with a total capacity of 273,000 barrels and two petroleum- products storage tanks with a total capacity of 74,000 barrels. The wharf has 700 linear feet of dock space and a depth of -38 feet MLW.

5.2.3.8 Kinder Morgan River Road Terminal

This terminal is immediately north of the National Gypsum Terminal and receives Panamax tankers. It has two berths to accommodate vessel and barge service. The facility handles bulk petroleum products, chemicals, and bio-fuels. The terminal occupies two docks located and is 1.2 miles below the Cape Fear Memorial Bridge. Both docks handle chemicals and related products. The north wharf has a total of 240 linear feet of berthing space and a -24 foot depth MLW. It has seven steel tanks with 1.55 million gallons of storage capacity. The south wharf has a total of 1,010 linear feet of berthing space and a -38 foot depth alongside. This facility has 22 steel tanks with a total storage capacity of 34.1 million gallons.

5.2.3.9 National Gypsum

The National Gypsum Terminal is located on the red side[2] of the channel approximately 1 mile south of the Port of Wilmington Berth 9. This is the first of five private terminals encountered on the red side of the channel for inbound transit immediately south of the Port of Wilmington Berth 9. This terminal is not presently in use but can facilitate up to Panamax class vessels. In the past the facility received gypsum in self-unloading vessels. It is not currently in operation, but there is a possibility that it could resume operations in the future. It had a total storage capacity of approximately 100,000 tons of gypsum and a vessel unloading rate of 1,000 tons per hour. It also handled sand, gravel, stone, rock, limestone, soil, and dredged material. The wharf has a total of 810 linear feet of dock space and water depth is -42 feet MLW.

5.2.3.10 Sunny Point (Military Ocean Terminal)

MOTSU is a large terminal located approximately between river miles 6 to 8. It has five miles of water frontage and over 8,000 acres of property. This terminal handles deep-draft shipments for the Department of Defense. The water depth is -38 feet MLLW in the approach channels and turning basins for the South and Center docks, and -34 feet MLLW in the approach channels and turning basin for the North dock. MOTSU is located on a restricted side channel on the Reaves Point Range.

5.2.3.11 Archer Daniels Midland

The Archer Daniels Midland (ADM) plant located at approximately river mile 5 of the Cape Fear River produces feed ingredients for livestock, equine, poultry, and aquaculture. The facility processes cereal grains and oilseeds into products used in food, beverage, industrial and animal feed markets worldwide. The terminal has a single dock which can handle vessels up to 1,000 feet long.

[2] The red side of a channel corresponds to the starboard bank when traveling upriver or toward a port.

5.2.4. Channel Features

Over 40 topographical features were identified as part of the existing condition for the study. These relate to deep draft navigation in the Cape Fear River. They include a single entry/exit point, one turning basin[3],14 docks and 16 channel reaches. The entry/exit point is located at the sea buoy; the turning basin is located just upstream of the North Carolina State Port Authority docks, on the south side of the channel, between the Vopak and Amerada Hess terminals. The 14 docks associated with deep draft commerce are, beginning with the most downstream, Archer Daniels Midland (ADM), Sunny Point (Military Ocean Terminal), South Wilmington Terminal (SWT), Carolina Marine Terminal (CMT), Invista, Apex Oil, North Carolina State Port Authority (NCSPA) docks 1-9, Vopak, Amerada Hess, Colonial Terminal, and the Kinder Morgan International (KMI) Terminal. Complete dock information is provided in Table 5-1 Wilmington Harbor Docks.

Table 5.1. Wilmington Harbor Docks

ID	Dock	Commodities	Length (feet)	Vessel Capacity	Depth (feet)
1	Archer Daniels Midland	Chemicals	985	1	-42
2	Sunny Point (MOTSU)	Munitions, Military Cargo	6,000	6	-38
3	KM River Road Terminal	Chemicals	815	1	-38
4	Carolina Marine Terminal	Bulk Commodities	700	1	-42
5	ChemServe	Chemicals, Petroleum	850	1	-38
6	Apex Oil	Chemicals, Petroleum	1,040	1	-42
7	NCSPA 7-8-9	Containers	2,645	3	-42
8	NCSPA 3-4-5-6	General Cargo	2,885	4	-42
9	NCSPA 1-2	General Cargo, Ro-Ro	1,212	2	-38
10	Kinder Morgan	Chemicals, Petroleum	1,012	1	-42
11	Buckeye	Chemicals, Petroleum	865	1	-38
12	Colonial Oil	Petroleum	600	1	-32

A total of 25 channel reaches were identified. The length, width, and depth for each reach are provided in Table 5-2.

[3] The turning basin is sometimes referred to as an anchorage; however it is only used to turn vessels and is not used as an anchorage.

Table 5.2. Wilmington Harbor Channel Reaches

ID	Reach	Length (feet)	Width (feet)	Depth (feet)
1	Baldhead Shoal Reach 3	26,658	500	44
2	Baldhead Shoal Reach 2	4,342	900	44
3	Baldhead Shoal Reach 1	4,500	700	44
4	Smith Island	5,100	650	44
5	Baldhead-Caswell	1,912	500	44
6	Southport	5,363	500	44
7	Battery Island	2,589	500	44
8	Lower Swash	9,789	400	42
9	Snows Marsh	15,775	400	42
10	Horseshoe Shoal	6,102	400	42
11	Reaves Point	6,531	400	42
12	Lower Midnight	8,241	600	42
13	Upper Midnight	13,736	600	42
14	Lower Lilliput	10,825	600	42
15	Upper Lilliput	10,217	400	42
16	Keg Island	7,726	400	42
17	Lower Big Island	3,616	400	42
18	Upper Big Island	3,533	510	42
19	Lower Brunswick	8,161	400	42
20	Upper Brunswick	4,079	400	42
21	Fourth East Jetty	4,652	500	42
22	Between Channel	2,827	400	42
23	Memorial Bridge	8,481	450/1,200	42/38
24	CSX RR Bridge	9,573	400	32
25	End of Project	9,277	200/300	32/25

5.2.5. Commodity Movements

Based on Waterborne Commerce of the United States, Wilmington Harbor handled a total of 7.6 million tons[4] of commerce in 2022, including 6.6 million tons of foreign commerce and 1.0 million tons of domestic commerce, making it the 67th largest port in the United States in terms of total tonnage.[5] Foreign imports made up 3.7 million tons while foreign exports accounted for 2.9 million tons. Much of the foreign commerce moving through the port is containerized. In 2022 the port handled 231,000 loaded

[4] All references to commodity shipments in “tons” refer to “short tons” of 2,000 pounds.
[5] Source: Waterborne Commerce of the U.S.; National Summaries. IWR, USACE, Dec 2022.

twenty-foot equivalent units (TEUs)[6] of containers, making it the 21st largest U.S. container port for foreign commerce.[7] Commodity shipments have been highly variable in recent years; total shipments reached a high of nearly 9.5 million tons in 2004 but have declined steadily since that time. The overall decline in shipments appears to be related primarily to petroleum products. Figure 5.2 displays the historic trend in total commerce at Wilmington Harbor between 2002 and 2022. Total commerce includes all foreign and domestic shipments.

Source: Waterborne Commerce of the United States 2002-2022.

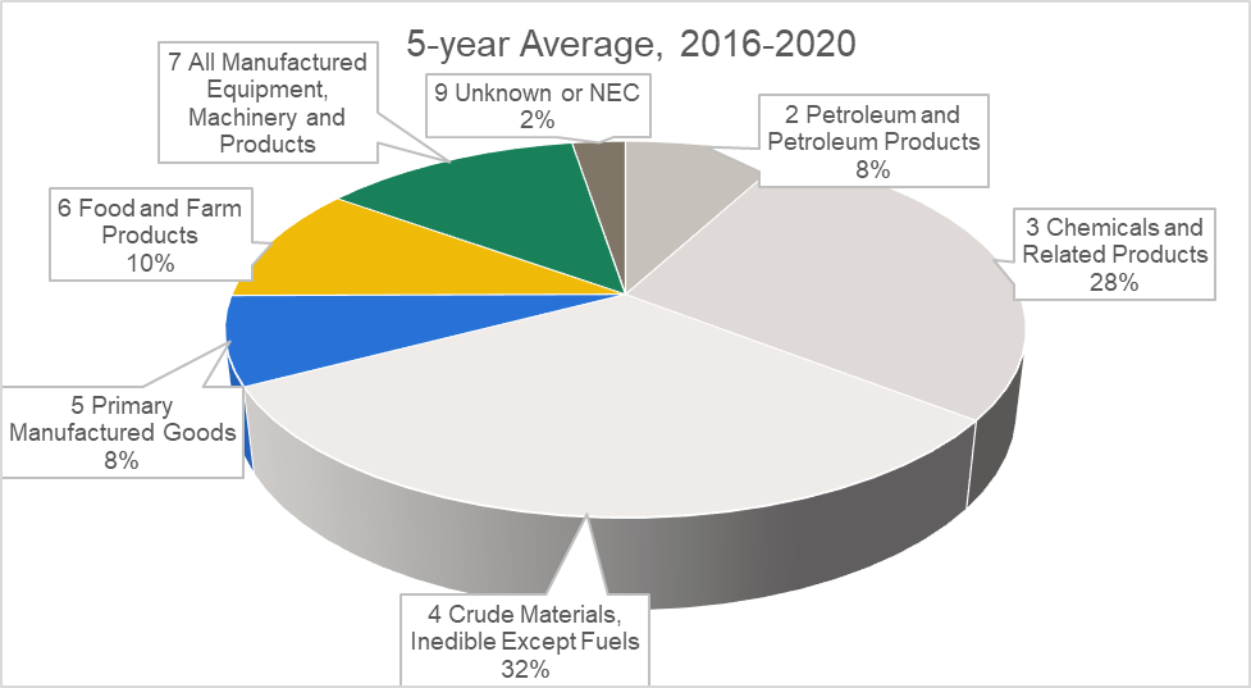
Figure 5.2. Trends in Total Commerce, 2002-2022.

Based on the most recent five years for which data is available (2016 through 2020[8]), total shipments averaged 6.4 million tons per year, varying from a high of almost 6.9 million tons in 2020 to a low of 6.0 million tons in 2017. Coal shipments, which moved by barge, exceeded 1.0 million tons in 2006, but no longer move on the waterway due to the closing of an electric generating facility upstream of the City of Wilmington. Petroleum products averaged about 8% of total shipments, or 500,000 tons. The most significant products in this category were gasoline (26%), kerosene (13%), residual fuel oil (9%), distillate fuel oil (22%), asphalt, tar and pitch (13%) and petroleum coke (14%). The port does not handle crude petroleum. Chemicals averaged 26% of total shipments or 1.78 million tons. The most significant commodities in this category were alcohols (29%), nitrogenous fertilizers (32%) and sodium hydroxide (9%). Crude materials

[6] The TEU, or Twenty-foot Equivalent Unit, is a standard unit of measure in the industry that provides comparability for different sizes of containers.
[7] Source: Waterborne Commerce of the U.S.; Waterborne Container Traffic. IWR, USACE, Dec 2020.
[8] The study generally employs 2020 data, as this was the most recent year for which a complete data set was available; however, some 2022 data has been obtained and is included in the report.

averaged 32% of total shipments or 2.0 million tons. These include fuel wood (43%), wood in the rough (14%), pulp and wastepaper (14%), lumber (5.0%), and gypsum (10%).

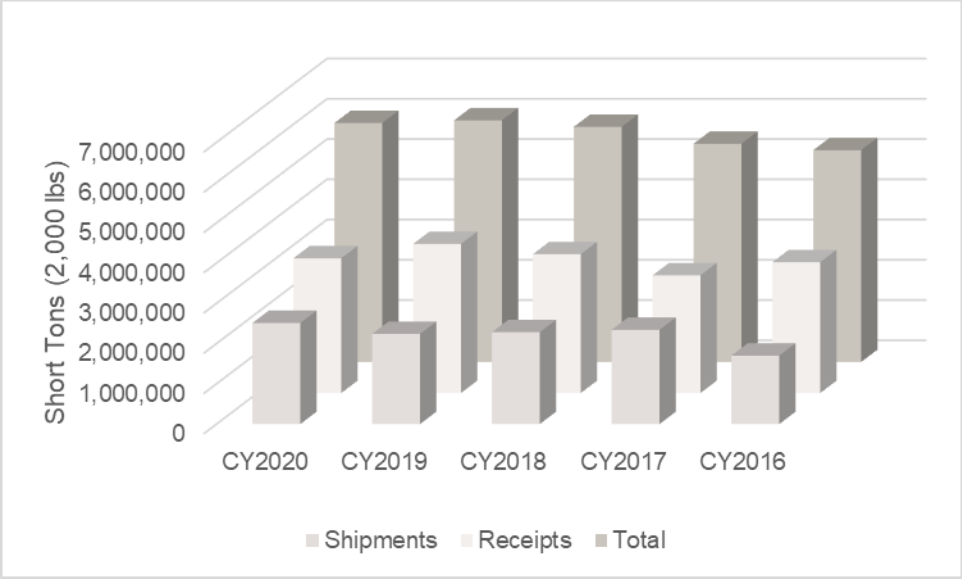
Primary manufactured goods accounted for an average of 8% of total shipments or 489,000 tons over the five-year period. The most significant commodities in this category were paper and paperboard (14%), cement and concrete (15%), misc. mineral products (11%), fabricated metal products (19%), and iron and steel plates and sheets (10%). Food and farm products averaged 9% of the total or 645,000 tons, with soybeans (19%), animal feed (10%), and fresh and frozen meat (38%) being the most significant commodities. Figure 5.3 displays the distribution of commodities at Wilmington Harbor.



Source: WCSC.

Figure 5.3. Wilmington Harbor, Distribution of Commodities.

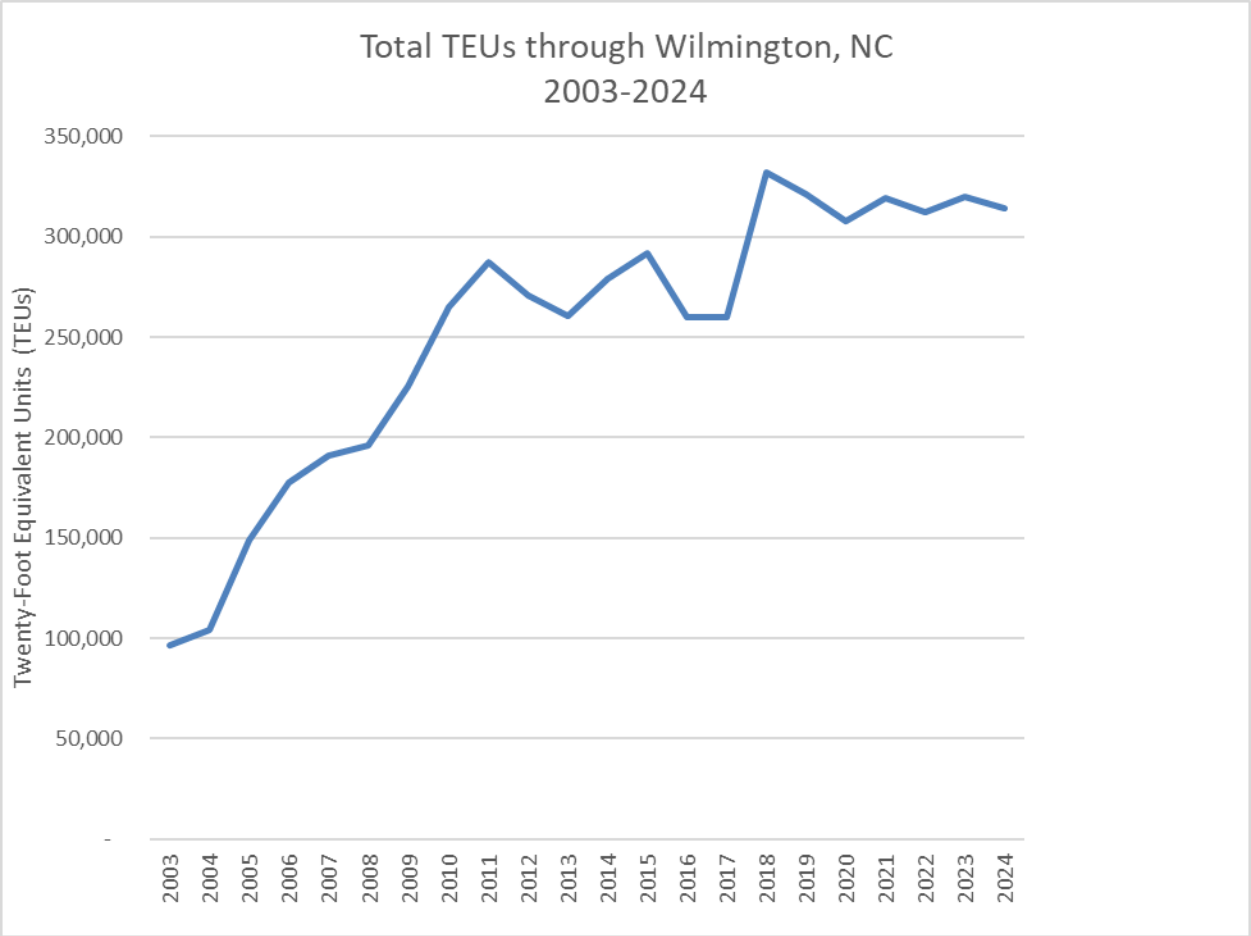
Foreign shipments and receipts made up about 90% of all commodity shipments during the period 2016-2020. Imports account for approximately 60% of the foreign trade at Wilmington Harbor during the period 2016 to 2020, while exports amount to about 40%. Figure 5.4 displays the trend in foreign trade between 2016 and 2020, including imports, exports, and total foreign trade, which has slightly increased overall in recent years.



Source: Waterborne Commerce of the United States 2016-2020

Figure 5.4. Wilmington Harbor Trends in Foreign Commerce 2016-2020.

When measured by volume, containerized cargo represents about 30 percent of the foreign commerce moved through the Port of Wilmington. Containerized cargo includes a great variety of commodities, including raw materials, manufactured products, liquids, agricultural products, and refrigerated goods. The container terminal at the Port of Wilmington moves loaded and empty containers. Filling and emptying containers (stuffing and stripping) also occurs at the Port. The number of containers handled at the Port of Wilmington has increased recently, as shown in Figure 5.5.



Source: AAPA and NCSPA

Figure 5.5. Port of Wilmington Annual TEU Volume 2003-2024

5.2.5.1 Containerization

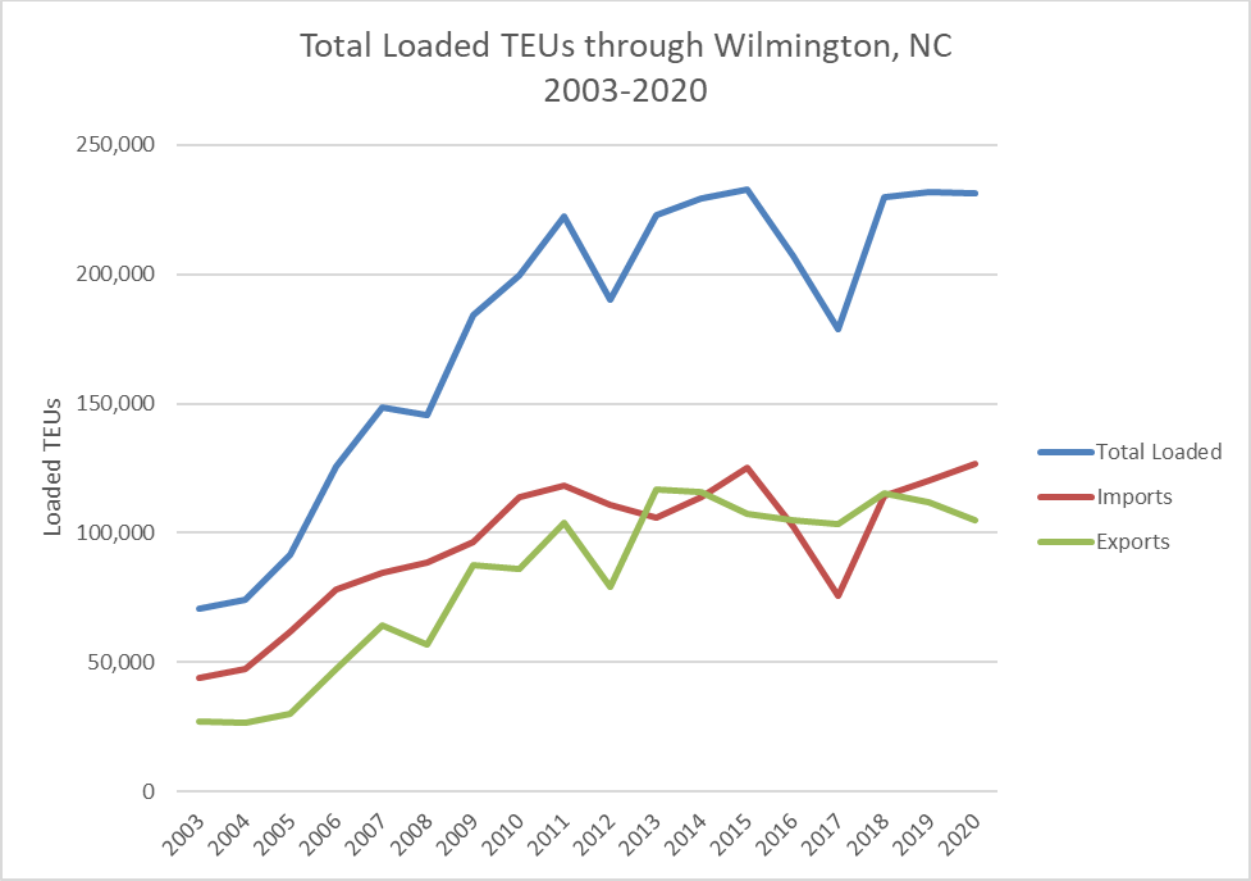
Many waterborne commodities move in containers, which are standardized metal boxes that are typically shipped in specialized vessels called containerships. In 2020, the latest year for which data are available, U.S. ports handled a total of about 41.1 million loaded TEUs, of which 37 million (90%) were imports and 6 million (10%) were exports. TEU is an acronym for twenty-foot equivalent unit, which is a standardized way of measuring containers of different sizes; thus a 40-foot container is 2 TEUs and a 45-foot container is 2.25 TEUs. Containerships also move empty containers, which are not included in the U.S. totals. Approximately 96 % of all loaded U.S. container imports and exports are handled by the 25 largest U.S. ports. Over 230,000 loaded TEUs were handled at Wilmington Harbor in 2020, making it the 21st largest container port in the United States and the 10h largest container port on the U.S. Atlantic coast. Table 5.3 lists the 25 largest container ports in the United States in terms of foreign commerce.

Table 5.3. Twenty-five Largest U.S. Container Ports in 2020 (Loaded TEUs)

#	Port	State	Inbound Loaded TEUs	Outbound Loaded TEUs	Total Loaded TEUs
1	Los Angeles	CA	5,031,295	1,419,301	6,450,596
2	Long Beach	CA	4,271,951	1,419,859	5,691,810
3	New York (NY and NJ)	NY	4,185,679	1,253,380	5,439,059
4	Savannah	GA	2,364,792	1,336,505	3,701,297
5	Houston	TX	1,342,994	1,184,512	2,527,506
6	Port of Virginia	VA	1,319,670	852,613	2,172,284
7	Oakland	CA	1,035,089	880,916	1,916,005
8	Charleston	SC	1,084,467	736,681	1,821,148
9	Tacoma	WA	804,941	721,750	1,526,691
10	Seattle	WA	671,381	479,767	1,151,148
11	San Juan Harbor	PR	702,056	200,250	902,306
12	Jacksonville	FL	334,312	547,769	882,081
13	Miami	FL	504,249	295,371	799,620
14	Honolulu	HI	490,807	294,205	785,013
15	Baltimore	MD	524,498	205,487	729,985
16	Port Everglades	FL	302,291	321,385	623,677
17	Philadelphia	PA	435,516	95,423	530,940
18	New Orleans	LA	142,898	277,447	420,345
19	Anchorage	AK	290,028	92,081	382,110
20	Mobile	AL	221,338	132,666	354,005
21	Wilmington	NC	126,586	104,867	231,452
22	Wilmington	DE	196,269	18,188	214,457
23	Boston	MA	143,510	69,453	212,963
24	South Jersey Port District	NJ	110,638	50,423	161,061
25	Gulfport	MS	79,059	58,478	137,537

Source: WCSC

Imports at Wilmington accounted for almost 127,000 loaded TEUs (55%) and exports accounted for about 105,000 loaded TEUs (45%). Empty containers account for an additional 30% of containers at Wilmington. Historically, exports have increased at a faster pace than imports. In 2005, exports made up only about 33% of total shipments. Even though commodity shipments have been relatively flat at Wilmington Harbor, both import and export container shipments have displayed significant growth since 2003. However, TEU volumes have plateaued since 2011 at around 220,000 loaded TEUs.



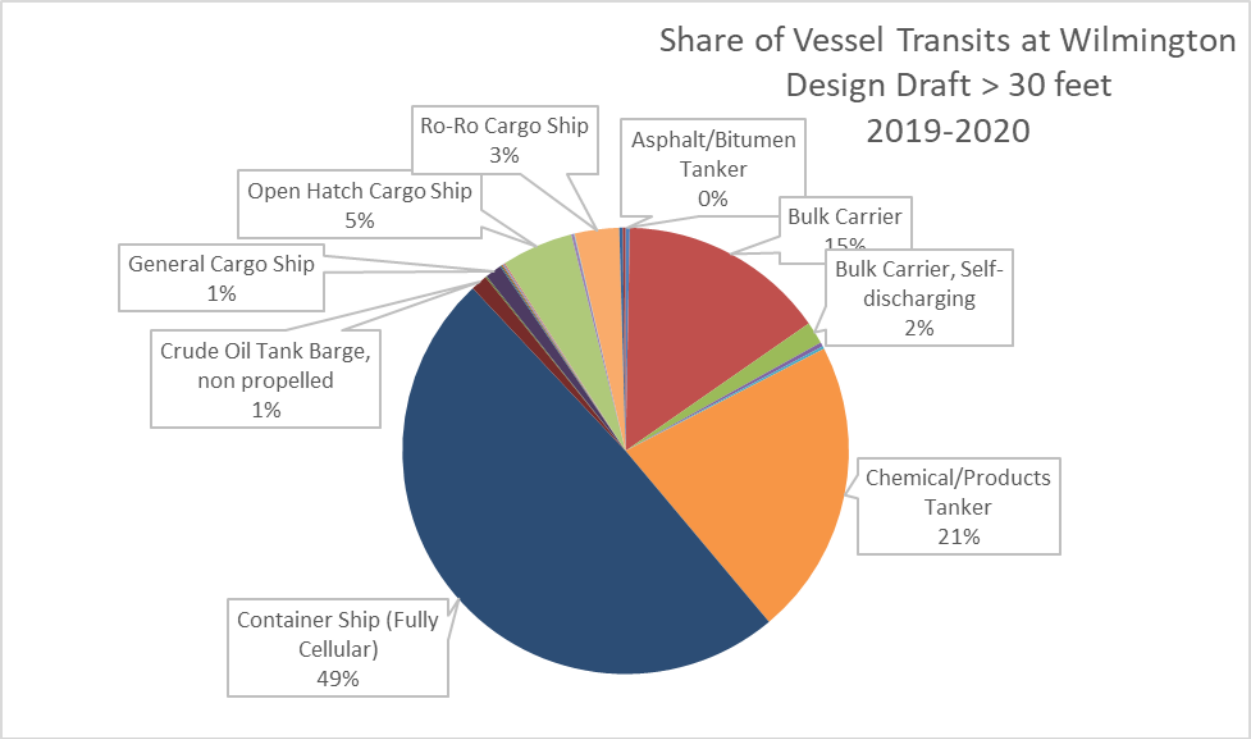
Source: Waterborne Commerce of the U.S. 2003-2020

Figure 5.6. Total Loaded Container Volumes through Wilmington, in TEUs, 2003-2020

5.2.6. Vessel Fleet Characteristics

Based upon data contained in Waterborne Commerce of the United States, there were a total of 8,236 commercial vessel transits[9] of Wilmington Harbor in 2020. This is a sharp decline from the 80,374 commercial vessel transits that occurred in 2005. Most of the vessel transits were tugs and barges with drafts of less than 10 feet. Of the 2020 total, 6,948 transits (84%) were vessels with drafts of less than 10 feet, while the 2005 there were 78,826 vessel transits (98%) with drafts of less than 10 feet. The decline in vessel transits between 2005 and 2020 is primarily related to vessels drafting less than 10 feet, which are presumably tugs and barges that are not constrained by the channel. Figure 5.7 shows the distribution of vessel types calling Wilmington Harbor with a Design Draft greater than 30 feet. The resulting distribution is approximately 50% containerships, 25% tankers, and 25% general cargo vessels.

[9] A “transit” is a single vessel movement in or out of a channel. A “call” includes both the inbound and outbound vessel movements, as well as any shifting from dock to dock.



Source: WCSC.

Figure 5.7. Share of Vessel Transits at Wilmington, Vessels with Design Draft greater than 30 feet, 2019-2020.

The distribution of vessel transits by sailing draft for the period 2016 to 2020 is presented in Figure 5.8. There was a total of 1,301 vessel transits with drafts at 10 feet or greater in 2020; of these approximately 1,266 transits were in vessels drafting greater than 14 feet. The total number of transits for vessels drafting greater than 10 feet has varied over the period 2016 to 2020 from a high of 1,351 transits in 2018 to a low of 1,268 transits in 2016. In 2020, there were a total 113 vessel transits in the 36-foot to 38-foot sailing draft range. This number varied from a low of 112 vessel transits in 2016 to a high of 202 vessel transits in 2018. 63 vessels with sailing drafts greater than 38 feet were reported in 2020; reinforcing harbor pilots' reports that vessels have occasionally transited the channel with drafts of up to 41 feet utilizing high tide. The data suggests that there is an increasing trend to fully utilize the existing channel depth at Wilmington Harbor.

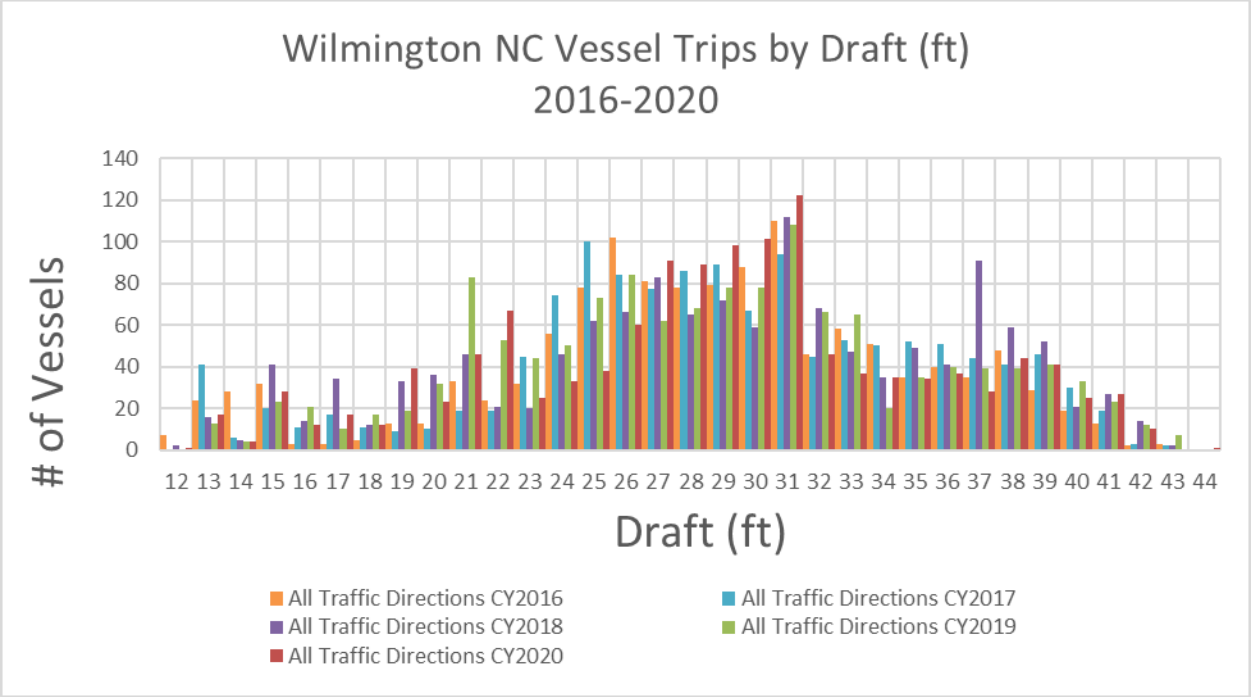


Figure 5.8. Wilmington Vessel Trips by draft (feet), 2016-2020. Source: WCSC.

5.2.7. Port Operations

The Port of Wilmington is the largest terminal complex at Wilmington Harbor. The Port handles break bulk and bulk commodities and is the only container terminal at Wilmington Harbor. The project depth at Wilmington Harbor is -42 feet MLLW. Historically, the maximum sailing draft is -41 feet, which is confirmed through pilot interviews and pilot log data. Vessels with drafts greater than 38 feet are required to transit using tidal advantage. Up to four feet of tidal advantage is available, but vessels very seldomly load to 42 feet because of the infrequency of such a high tide.

5.2.7.1 General Operational and Navigational Constraints

This section describes the existing and projected future navigational constraints at Wilmington. Channel dimension-related problems occur under existing conditions and are projected to continue to occur and intensify in the future under without-project conditions as cargo throughput increases, creating more vessel traffic. The constraints identified in this section stem from the fact that the existing Federal navigation channel was designed for use by sub-Panamax vessels. Under existing conditions, Panamax and Post-Panamax vessels use Wilmington daily and weekly. Under future conditions, the number and size of Post-Panamax vessels at the port are projected to increase.

The primary constraints at Wilmington affect bulk and container ship operations in the Federal navigation channel leading to their respective terminals. The primary constraints identified in this analysis relate to the inefficient operation of containerships, tankers, and bulkers in the Federal channel at Wilmington, which affect waterborne

transportation costs nationwide. The following problem statements describe these inefficiencies:

- Existing cargo shippers are experiencing increased operating costs due to light loading, congestion delays, and tidal delays;
- Light loading, congestion delays, and tidal delays will increase as present harbor users increase their annual tonnage throughput and as larger ships that require deeper channels replace older, smaller ones;

The inefficient operation of cargo vessels at Wilmington directly results from insufficient depth of the Federal channel at the Port. The existing channel depth constraint causes some carriers to light-load vessels and restricts the efficient vessel size utilized by carriers. Examples of light loading are exhibited in containership operations. Restrictions on efficient vessel size are exhibited by liquid bulk and dry bulk operations, which have the landside capacity to use larger vessels, but the existing channel depth restricts the efficient use of these larger vessels. Light-loading and restricted vessel size both increase cargo transportation costs. The existing channel depth restricts efficient vessel size in the dry bulk cargo route. Shippers and terminal operators have confirmed that they would utilize larger vessels with a deeper channel.

5.2.7.2 Petroleum and Liquid Bulk Vessel Operations and Constraints

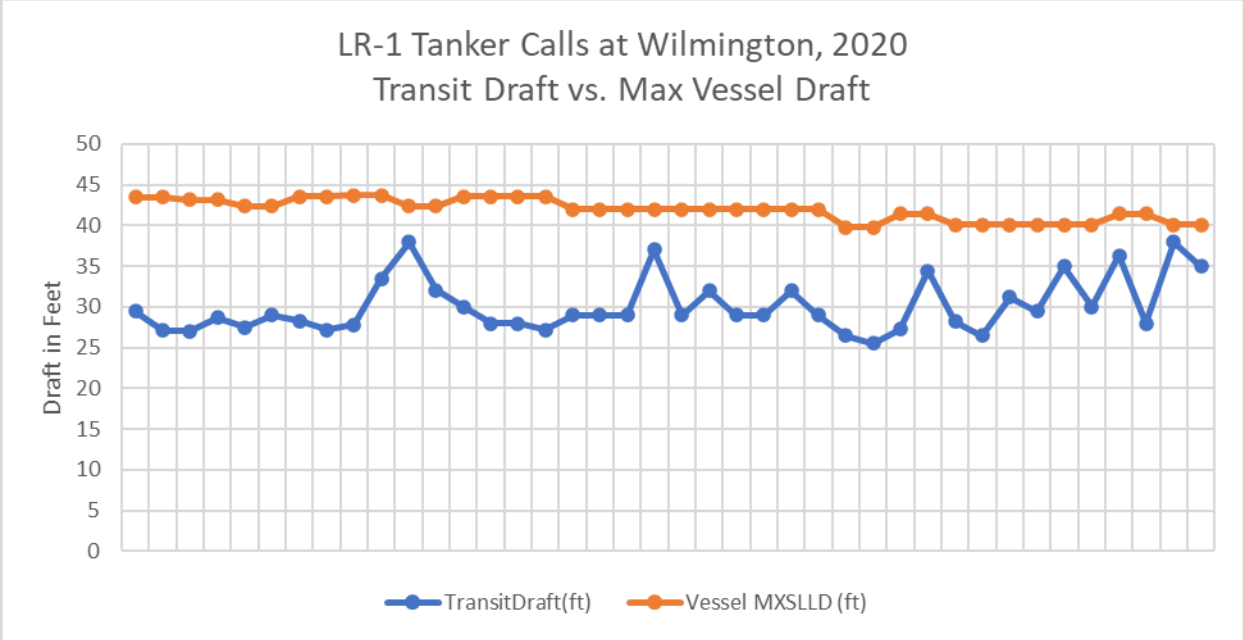
Liquid bulk commodities are delivered to Wilmington by small- and medium-sized tankers. Although most of the world fleet of tankers is Aframax and larger classes (80-120k deadweight tons (DWT), these have not called on Wilmington, given the decrease in petroleum products tonnage over the last 10 years. Only 8% of the port's total cargo remains petroleum products. The major petroleum commodities are categorized as gasoline, kerosene, residual fuel oil, distillate fuel oil, asphalt, tar and pitch and petroleum coke. The port does not handle crude petroleum. Chemicals averaged 26% of total shipments or 1.78 million tons from 2016-2020. The most significant commodities in this category were alcohols, nitrogenous fertilizers, and sodium hydroxide. These commodities were hauled by small- and medium-sized products tankers.

Tankers often arrive at Wilmington light-loaded, given the existing berth depth of 42 ft. The larger tankers currently calling at the port frequently transport gasoline, kerosene, and various chemicals and arrive at drafts generally ranging from 15 to 38 feet. These tankers are typically Large Range 1 (LR-1) classes of vessels of approximately 45,000 to 60,000 DWT with lengths from 600 to 640 feet. Smaller tankers and barges, carrying asphalt, bitumen, and various other chemicals arrive with drafts of less than 35 feet. Table 5.4 presents a breakdown of vessel transits by liquid bulk class from 2016-2021. Figure 5.9 presents tanker calls at Wilmington and compares their transit drafts (in feet) to their maximum summer Loadline drafts (MXSLLD in feet) for 2020.

Table 5.4. Tanker Transits by Class at Wilmington, 2016-2021

Tanker Class*	Size (DWT)	MXSLLD Range (feet)	2016	2017	2018	2019	2020	2021	Grand Total
General Purpose (GP)	10,000-24,999	22.2-33.5	52	55	34	76	86	108	411
Medium Range (MR)	25,000-44,999	30.2-44.0	145	103	88	113	107	101	657
Large Range 1 (LR-1)	45,000-79,999	39.5-43.9	44	68	22	41	38	48	261
Grand Total			**241**	**226**	**144**	**230**	**231**	**257**	**1,329**

Note:
*Average Freight Rate Assessment (AFRA) Scale. Source: "Scaling the Tanker Market". Surveyor (American Bureau of Shipping) (4): 5–11



Source: WCSC.

Figure 5.9. Tanker Arrival Drafts (feet) at Wilmington.

Table 5.5 presents the average percentage of tonnage for liquid bulk products on tankers by vessel class. Approximately 39 percent of the liquid bulk volume is carried on MR or LR-1 tankers. Over the past 5 years, tonnage has begun to shift from smaller to larger tankers.

Table 5.5. Wilmington Liquid Bulk Percentage of Tonnage by Vessel Class, 2016-2020

Vessel Class	2016	2017	2018	2019	2020	Average
GP	67	50	65	72	61	62
MR	33	50	35	26	27	35
LR-1	0	0	0	2	12	3
Total	100	100	100	100	100	100

Source: USACE, WCSC 2023.

The more efficient use of larger LR-1 class tankers (60,000-80,000 DWT) would reduce transportation costs for the petroleum firms operating at Wilmington. Larger vessels are not frequently used due to the depth constraint of the Federal navigation channel. If greater channel depth were available, petroleum firms would likely increase the shift of cargo onto larger vessels already in the fleet of vessels calling to take advantage of the economies of scale.

5.2.7.3 Dry Bulk Vessel Operational Constraints

Wilmington's fleet of bulk carriers consists of foreign flag vessels with a variety of sizes. Table 5.6 provides the characteristics in which bulk carriers were classified for the analysis.

Table 5.6. Wilmington Bulk Carrier Fleet Classification Characteristics

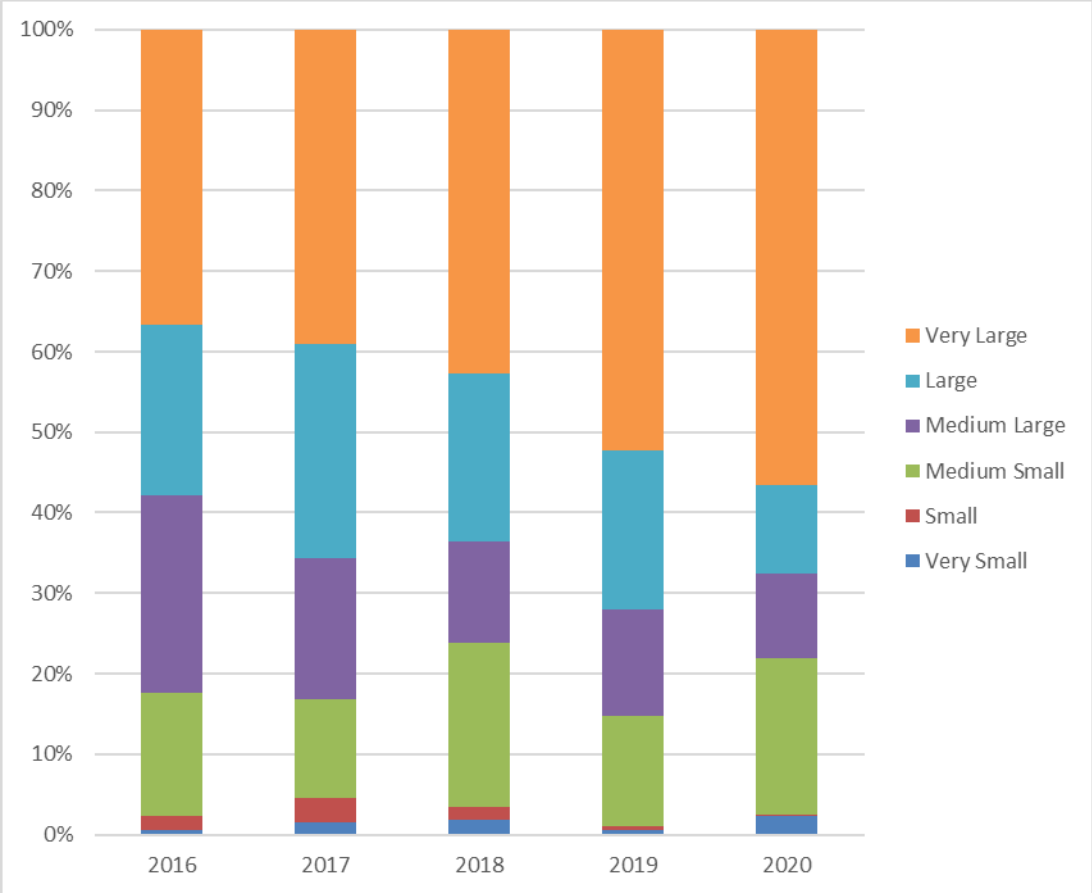
Bulker Size	Capacity Range (DWT)	Design Draft Range (feet)	Beam Range (feet)	LOA Range (feet)
Very Small	3,000–20,000	25–30	60–75	400–480
Small	20,001–30,000	31–35	76–90	481–550
Medium Small	30,001–40,000	36-–37	91–95	551–590
Medium Large	40,001-–50,000	38–40	96–103	591–620
Large	50,001–60,000	41–43	104–106	621–700
Very Large	60,001–105,000	44–50	107–140	701–800

On average, 78 percent of the cargo tonnage transported by bulk carriers through the port was on Medium Large or larger bulk carriers. Table 5.7 presents the average percentage of tonnage for dry bulk cargo on bulkers by vessel DWT. The average for 2016–2020 is more than 47 percent of volume carried on very large bulkers. As shown in Figure 5.10, over the past 5 years, tonnage has shifted towards being carried on very large bulkers.

Table 5.7. Wilmington Percentage of Dry Bulk Tonnage by Vessel DWT.

DWT Range	2016	2017	2018	2019	2020	Average
0–19,999	1	1	2	1	2	**1**
20,000–29,999	2	3	2	0	0	**1**
30,000–39,999	15	12	20	14	19	**16**
40,000–49,999	24	18	12	13	10	**15**
50,000–59,999	21	27	21	20	11	**19**
60,000+	37	39	43	52	57	**47**
Total	**100**	**100**	**100**	**100**	**100**	**100**

Source USACE, NDC detailed unpublished data, 2016-2020



Source: USACE, NDC detailed unpublished data 2016-2020.

Figure 5.10. Percentage of Dry Bulk Tonnage on Various Size Bulkers, 2016-2020.

The Very Large Bulkers that have called on Wilmington represent the smaller half of the vessel class, as the largest ones to call on the port are less than 85,000 DWT, with a

design draft of 48 feet. Bulkers over 100,000 DWT with a design draft of greater than 50 feet, have yet to call. However, the expanded Panama Canal will support calling from the Pacific, and it is reasonable to think shippers will transition to them eventually.

For dry bulk volumes, the fleet composition for 2016–2020 has shown a trend towards vessels with larger DWT ranges. Medium Large and larger bulk carriers have a deeper design draft and a greater average shipment size.

Table 5.8 presents the average world bulker fleet as of 2017. As shown, the Large and Very Large bulkers have been built most recently and with greater design drafts. It is assumed that the world fleet will continue this trend, especially as vessels are replaced.

Table 5.8. Bulker World Fleet Characteristics.

Size	Number of Vessels	Average Design Draft (Feet)	Average Year Built
Very Small	1,617	16.9	1996
Small	967	32	2001
Medium Small	1,728	33	2010
Medium Large	643	37	2001
Large	1,999	41	2009
Very Large	3,492	45	2010

Source: IHS Maritime, 2017.

5.2.7.4 Containership Operations and Constraints

Containerships made up nearly 50% of the deep-draft vessels calls at Wilmington Harbor in 2019-2020. Data for the container fleet was obtained from USACE's Waterborne Commerce Statistics Center. From 2016 to 2020, a variety of different container ships called on the Port of Wilmington. These ships are classified for this study as Sub-Panamax (SPX), Panamax (PX), Post-Panamax Generation 1 (PPX1), Post-Panamax Generation II (PPX2), Post-Panamax Generation III (PPX3), and Post-Panamax Generation IV (PPX4), depending on their capacity. The vessels are distinguished based on physical and operational characteristics, including lengths overall (LOA), design draft, beam, speed, and TEU capacity. It is common practice to separate the containership fleet in TEU bands or classes to analyze supply within the industry. However, due to the evolution of vessel design over time, these TEU bands do not correspond to a breakdown of the fleet by dimensions such as beam or draft. Accordingly, breakdowns in terms of beam and draft straddle different classes. To minimize the overlap, the beam band or range was used to distinguish container vessels into six vessel classes as shown in Table 5.9.

Table 5.9. Containership Fleet Subdivisions and Dimensions

Vessel Fleet Subdivision (Containerships)	Measurement	From	To
Sub Panamax	**Beam**		98
	Draft	8.2	38.1
	LOA	222	813.3
	TEUs		2,800
Panamax	**Beam**	98	106
	Draft	30.8	44.8
	LOA	572	970
	TEUs	2,801	4,800
Post-Panamax Generation I (Post-Panamax)	**Beam**	106	138
	Draft	35.4	47.6
	LOA	661	1045
	TEUs	4,801	6,800
Post-Panamax Generation II (Super Post-Panamax)	**Beam**	138	144
	Draft	39.4	49.2
	LOA	911	1,205
	TEUs	6,801	9,900
Post-Panamax Generation III (New Panamax, or Ultra Post-Panamax)	**Beam**	144	168
	Draft		51.2
	LOA	Up to	1220
	TEUs	9,901	15,000
Post-Panamax Generation IV (New Post-Panamax)	**Beam**	168	200
	Draft		52.5
	LOA	1,295	1,315
	TEUs	15,000	23,000

SPX and PX, generally 4,800 TEUs and below, refer to those vessels that fit through the Panama Canal locks prior to its redesign. Post-Panamax Generation I and II, generally 9,900 TEUs and below, refer to those vessels that were too large to fit through the original Panama Canal. Post-Panamax Generation III, generally 15,000 TEUs and below, refers to the “New Panamax” vessels that were designed to fit through the expanded Panama Canal locks, which opened in 2016. Finally, Post-Panamax Generation IV refers to those vessels that are too large (beam > 168.5 ft[10]) to fit through the expanded Panama Canal (i.e., the “new” Post-Panamax vessels), with capacities

[10] Panama Canal Authority, 2022

above 15,000 TEUs. All vessel classes listed in Table 5-10 regularly call at the Port, except for the Post-Panamax Generation IV.

Table 5-10 shows vessel calls at the Port of Wilmington from 2016-2020, broken down by vessel class, based on data collected by the USACE. Over this period, the use of Panamax vessels at the port is trending downward while the use of larger vessels is trending upward. Most Post-Panamax vessel calls have shifted from PPX Generation I in 2016 to PPX Generation III by 2020. This shift can be attributed to smaller vessels (i.e., Panamax, PPX1) being replaced with larger vessels that carry more tonnage on a single voyage, as evidenced by the increase in cargo tonnage and TEUs, and decrease in vessel calls, since 2016. This trend in voyage reduction is an effort to realize economies of scale in the container shipping market.

Table 5.10. Container Vessel Fleet Port Calls by Class, 2016-2021.

Year	Sub-Panamax	Panamax	PPX1	PPX2	PPX3	Total
2016	173	43	51	6	3	276
2017	185	64	43	17	16	325
2018	140	62	28	21	19	270
2019	120	37	4	25	69	305
2020	162	32	1	4	85	284
2021	163	73	1	1	83	321

Source: USACE 2022.

Finally, Figure 5.11 shows the progression of containerships calling U.S. ports from 1955 to present day.

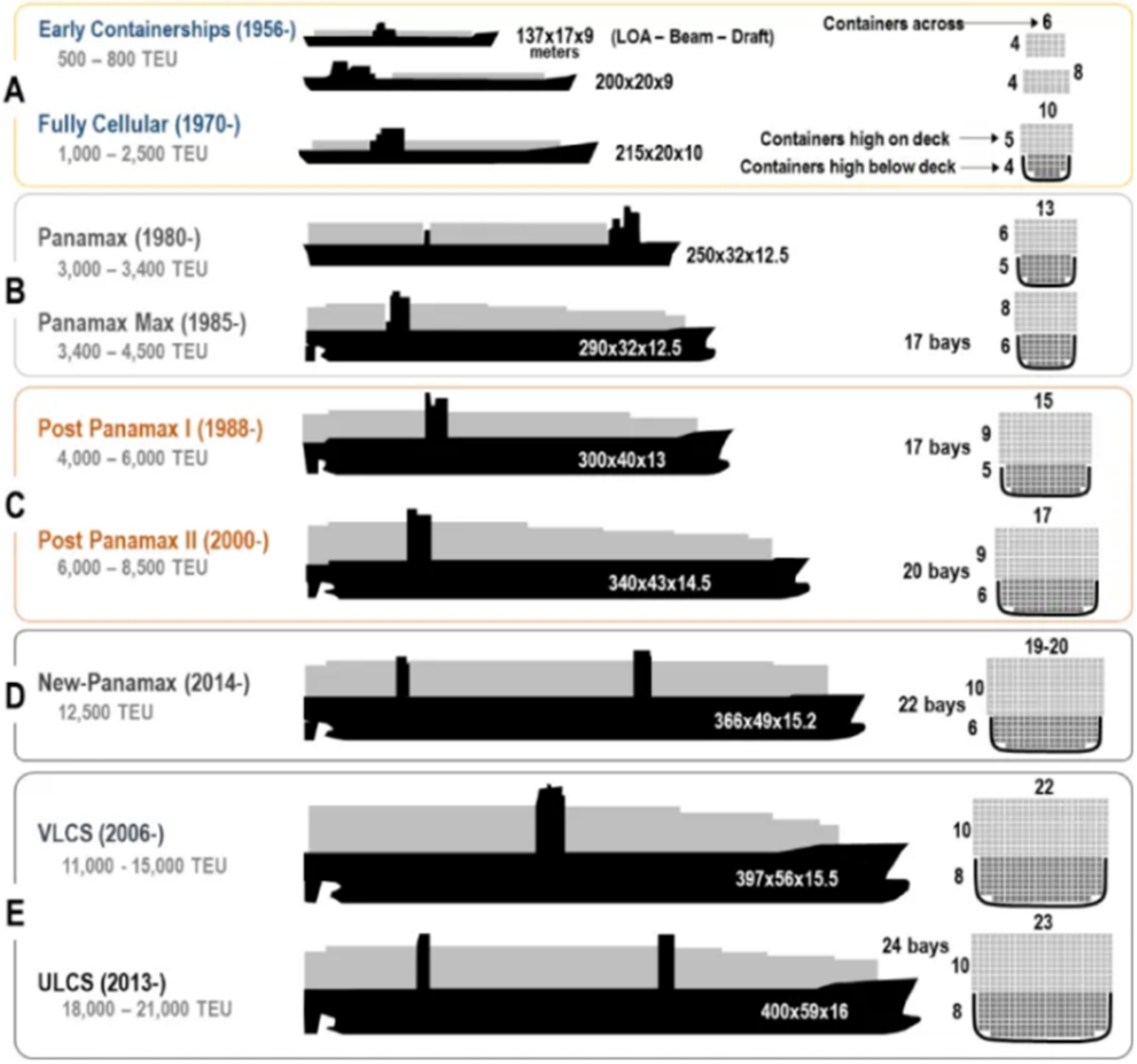


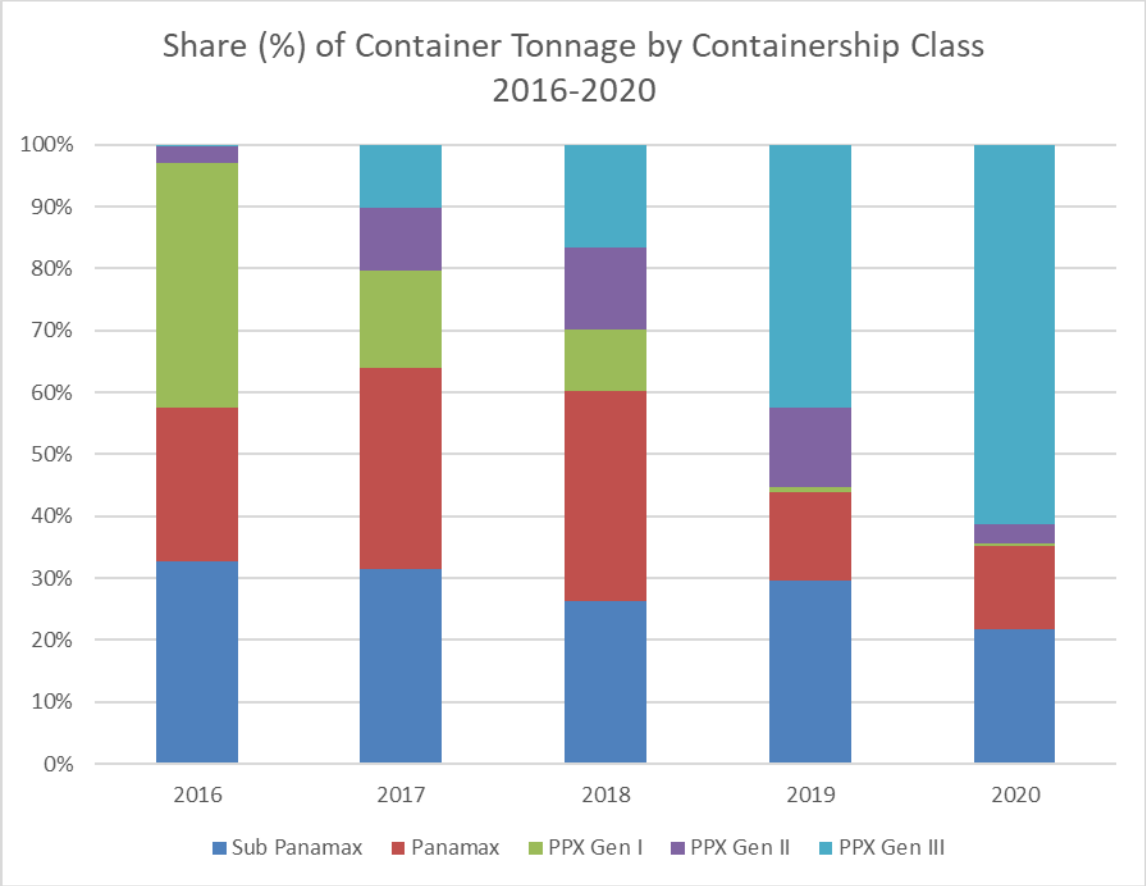
Figure 5.11. Containership Growth at U.S. Ports, 1955-present

Wilmington is already handling a significant number of Post-Panamax ships. From 2016 through 2020, about 30 percent of all calls were Post-Panamax calls. Table 5.11 and Figure 5.12 display percent cargo by vessel class for years 2016 to 2020. Total cargo movements on PPX Generation II or larger containerships grew from 3 percent in 2016 to 64 percent in 2020.

Table 5.11. Percent Cargo by Vessel Class, 2016-2020.

Containership	2016	2017	2018	2019	2020
Sub Panamax	33%	32%	26%	30%	22%
Panamax	25%	32%	34%	14%	13%
PPX Generation I	39%	16%	10%	1%	0%
PPX Generation II	3%	10%	13%	13%	3%
PPX Generation III	0%	10%	17%	42%	61%

Source: USACE 2022



Source: USACE 2022.

Figure 5.12. Total Percentage of Tonnage by Vessel Class, 2016-2020.

The largest vessels that call at Wilmington Harbor at the present time are Post-Panamax Gen III containerships of 14,220 TEUs. These vessels travel between Far East ports such as China and Korea, and the East Coast of the United States, calling at the North Carolina State Port Authority docks 7, 8 and 9. They are around 1,200 feet long, 168 feet in beam and have design drafts of 51 feet. Their actual sailing drafts were

38 feet or less when calling at Wilmington Harbor in 2020; however, some instances of deeper arrival drafts using high tide did occur. Containerships always maintain an underkeel clearance of at least 10 percent of sailing draft in the channel. There were 89 calls at the port for this sub-class of vessel in 2020. They can carry up to 14,200 TEUs, however they generally transfer around 1,000 TEUs[11] at the port, which are split between imports and exports.

Other shippers also employ Panamax containerships on Far East routes. These vessels are generally about 965 feet long, 106 feet wide, and have design drafts of about 44 feet. They can carry up to about 5,000 TEUs. There were 3 Panamax vessel calls in 2020.

Both Sub-Panamax and Panamax classes are employed on the European and Central/South American routes. These vessels are generally between 10,000 DWT and 60,000 DWT. They are typically 458 to 965 feet in length, with beams ranging from 73 to 106 feet and design drafts between 25 and 45 feet. They can carry up to approximately 5,000 TEUs. There were 194 vessel calls to Wilmington Harbor by these classes in 2020.

5.2.7.4.1 Far East-East Coast Containership Routes

According to the Port, in summer 2021, there were four different Far East container services at Wilmington. Table 5.12 below details services that were considered for the economic evaluation, including the carrier(s), service name, vessel route, and ship sizes at that time. Wilmington is typically a third port of call for several of the Asian – East Coast U.S. routes, usually after stops in Savannah, Charleston, New York, or Norfolk. All services call from Asia via trans-Pacific routes through the Panama Canal, which has limiting depths of 40 feet for Panamax vessels and 50 feet for Post-Panamax vessels.[12]

[11] 2020 average, WCSC 2022.
[12] Panama Canal Authority, 2022.

Table 5.12. Asia-East Coast U.S. Services at Wilmington

Ocean Carrier	Service Name	Vessel Class	Route
The Alliance – Hapag-Lloyd, ONE, Yang Ming, HMM			
Hapag-Lloyd	EC2	Panamax – PPX3	Qingdao-Ningbo-Yangshan-Busan-Cartagena-New York-Norfolk-Wilmington-Savannah-Charleston
2M Alliance – Maersk, MSC			
Maersk	TP10	Panamax – PPX3	Qingdao-Ningbo-Shanghai-Busan-Kingston-Savannah-Charleston-Wilmington-Jacksonville
MSC	Amberjack	Panamax – PPX1	Tianjin-Qindao-Ningbo-Shanghai-Busan-Kingston-Savannah-Charleston-Wilmington-Jacksonville
Non-Alliance			
ZIM	ZCP	PPX1 – PPX3	Qingdao-Ningbo-Shanghai-Busan-Panama-Kingston-Savannah-Wilmington-Jacksonville

A total of 198,102 TEUs were exported to the Far East through Wilmington Harbor in 2020.[13] Of these, 143,622 TEUs were loaded, with a total cargo weight of 804,171 tons or 12.7 tons of cargo per loaded export TEU.[14] The remaining 54,480 TEUs, or 27.5% of the total export TEUs, were empty. Imports amounted to a total of 98,328 TEUs were imported from the Far East through Wilmington Harbor in 2020. Of these, 77,215 were loaded, with a total cargo weight of 540,620 tons, or 6.9 tons per loaded import TEU.[15] Tare or empty container weights vary significantly depending on whether the containers are 20-foot, 40-foot, or some other length. An estimate of 2 tons per TEU was used in this report.

5.2.7.4.2 Other Containership Routes

According to the Port, in summer 2021, there were four different non-Far East container services at Wilmington: three serving Central/South America and one Northern European service. Table 5.13 below details services that were considered for the economic evaluation, including the carrier(s), service name, vessel route, and ship sizes at that time.

[13] Port of Wilmington data, Feb 2023.
[14] Source: WCSC, USACE 2022.
[15] Source: WCSC, USACE 2022.

Table 5.13. European and Central/South American Container Services at Wilmington

Ocean Carrier	Service Name	Vessel Class	Route
2M Alliance – Maersk, MSC			
Sealand	South Atlantic Express	Sub-Panamax - Panamax	Norfolk-Philadelphia-Wilmington-Savannah-Port Everglades-Santo Tomas-Puerto Cortes-Manzanillo
Sealand	North Atlantic Express	Sub-Panamax	Philadelphia-Wilmington-Savannah-Port Everglades-Cartagena-Turbo-Manzanillo-Puerto Moin
Non-Alliance			
Independent Container Line (ICL)	Trans-Atlantic	Sub-Panamax – Panamax	Antwerp-Southampton-Cork-Chester PA-Wilmington-Antwerp
Crowley Maritime	Centr. Amer. Northern Zone & Cuba	Sub-Panamax	Wilmington-Jacksonville-Mariel-Port Everglades-Puerto Cortes-Santo Tomas-Port Everglades

5.2.7.4.3 TEU Weight by Container

TEU weight data was obtained by USACE and confirmed with the Port to determine weight per TEU. Data was obtained at a country and region level for calendar years 2016 through 2020 and were grouped into world regions and eight services. Table 5.14 presents loaded TEU weights, including the box weight of approximately 2 metric tons per box, for each world region. Table 5.15 presents loaded TEU weights by route group. Wilmington's export commodities (mostly agricultural products and wood chips) typically weigh more than imports and is reflected in the weight/TEU observations to its major trading partners.

Table 5.14. Wilmington Average Weight (metric tons) per Loaded TEU, Import and Export.

World Region	Import – Average Weight per Loaded TEU (MT)	Export – Average Weight per Loaded TEU (MT)	Imports and Exports – Average Weight per Loaded TEU (MT)
Asia	6.9	12.9	9.9
Europe	8.4	8.5	8.4
Latin America & Caribbean	7.8	8.8	8.3

Table 5.15. Average Weight (metric tons) per Loaded TEU by Service

Service	Import - Average Weight per Loaded TEU (MT)	Export - Average Weight per Loaded TEU (MT)	Imports and Exports - Average Weight per Loaded TEU (MT)
AMBERJACK	7.5	13.3	10.4
EC2	6.9	13.3	10.1
TP10	6.8	12.5	9.7
ZCP	7.2	12.5	9.9
TRANS-ATLANTIC	8.4	8.5	8.4
CENTRAL AMERICA NORTHERN ZONE	6.7	8.4	7.6
NORTH ATLANTIC EXPRESS	10.2	8.8	9.5
SOUTH ATLANTIC EXPRESS	6.7	9.1	7.9
Overall Average Weight per Loaded TEU	**7.6**	**10.8**	**9.2**

Source: NDC unpublished data 2022.

Section 5.3. Future Conditions – Without and With a Project

5.3.1. Future Without-project Conditions

The purpose of this section is to show how future cargo movements would affect existing identified constraints without changing the channel configuration. The section discusses how commodity growth results were applied to the anticipated without-project vessel fleet. It also identifies assumptions on the future without-project fleet and provides details on the effect of the future fleet on pre-existing problems.

Total cargo throughput is expected to continue to increase in the future. Cargo volumes have been steadily increasing since 2015. Without a project, volumes will continue to increase, according to the overall economic trends visible at this point. A detailed description of the increase of each commodity type over the study period is available in the Commodity Forecast section.

The Port of Wilmington will see an increase in vessel traffic to accommodate this increase in volume. Current vessel loading practices, including light-loading, are assumed to persist without a project in place. To accommodate this increase in volume, expansion projects at the port will be completed as planned. The NCSPA terminal improvement program continues to increase the efficiency and throughput capacity of the Port of Wilmington container terminal to 750,000 TEUs at the completion of the projects underway and to 1.1 million TEUs by 2035. An update on completed, underway and scheduled projects include:

Completed Projects:

- Turning Basin Phase II expansion to 1,524’
- Reefer Phase I (524 plugs)
- Container Berth Expansion to 2,650’
- Air Draft Clearance upgrade to 212’
- Southgate Container Gate upgrade to 1.2M annual TEU capacity
- New Terminal Operating System (TOS) and Gate Operating System to increase efficiency and throughput
- Battery Island Turn
- Resurfacing and upgrade of Area F East to Rubber-Tired Gantry (RTG) crane capable (5 acres)

Projects Underway:

- Resurfacing and upgrade of Area L (old gate, 8 acres additional laydown capacity)
- Reefer Phase II (704 additional plugs)
- On-dock Intermodal Yard Redesign to double daily rail capacity (4 x 1,250’ working track)
- Resurfacing and upgrade of Area F West

Projects Scheduled:

- Resurfacing and upgrade Area H, Area K, and Area A to RTG capable
- Berth 9 Crane upgrade to Neo-Panamax capability

These without-project condition terminal improvements enhance current terminal operations and efficiency independent of improvements to the federal channel. The

NCSPA is currently realizing the benefits of larger and faster cranes, improved mooring facilities, and yard configuration.

Due to the current channel's configuration, light loading practices continue as the least-cost alternative to intermodal shifts in cargo. Vessels will continue to call Wilmington in an inefficient manner, as opposed to shifting their cargo to an alternate port nearby, such as Charleston, SC or Norfolk, VA, to access their hinterlands via landside transport. Historically, those users of other alternative modes of transportation are usually only marginally more expensive and prefer truck or rail for other beneficial reasons that are not captured by costs alone. If a deeper channel reduces movement costs to reach either current or new destinations, it is unlikely that the resulting cost savings would be substantial. In the existing equilibrium without a project, they were already using another mode, so the cost reductions with a project would have been significant to see large benefits between the two planning scenarios.

5.3.1.1 Commodity Forecast

An important step when evaluating navigation improvements is to analyze the types and volumes of cargo moving through the port. Cargo history can offer key insight into a port's long term trade forecast which is the estimated cargo volume upon which future vessel calls are based. In the without and in the future with project conditions, **the same volume of cargo is assumed to move through Wilmington Harbor**; however, channel modifications will allow for more efficient vessel use.

To minimize the impacts of potential anomalies in trade volumes on long-term forecasts, five years of data were employed to establish the baseline for the commodity forecast. Empirical data from 2016 to 2020 were used to develop a baseline, allowing the forecast to capture both economic prosperity and downturn which occurred over that timeframe.

5.3.1.1.1 Container Forecast

Table 5.16 illustrates historical containerized receipts moved through the Port of Wilmington from 2016 to 2020. Since 2016, overall receipts have fluctuated but increased overall from 700,000 tons to over 900,000 tons by 2020. Trade with the Far East, primarily China and South Korea, makes up most of Wilmington's market, accounting for nearly 60 percent of tonnage. A high percentage of Wilmington receipts are either consumer goods or raw or intermediate goods that will become consumer goods after going through a manufacturing process. Average receipts from all World regions were estimated to total 725,000 tons. Because this tonnage is lower than 2020 tonnage, the 2020 tonnages were used to represent the baseline form which forecasted commerce was conducted. However, the weight per loaded TEU by route group presented in the previous section was applied for loading vessels with the container loading tool (CLT), which is based on the average weight per TEU from 2016 to 2020.

Table 5.16. Historical Containerized Receipts (metric tons).

Route Group	2016	2017	2018	2019	2020	Average 2016-2020
Far East	429,667	257,763	299,649	413,039	536,937	387,411
Europe	226,493	239,452	192,801	288,184	271,293	243,645
Caribbean	81,717	55,960	78,622	151,605	102,152	94,011
Total	737,877	553,175	571,072	852,828	910,382	725,067

Source: NDC Unpublished data, 2022.

Table 5.17 displays historical containerized shipments moved through the Port of Wilmington from 2016 to 2020. Since 2016, overall shipments have increased slightly from 1.0 million in 2016 to over 1.1 million in 2020. It should be noted that TEU peaked in 2018, even though tonnage decreased, due to a surge in empty container exports that year (over 100,000). Typically, empty container exports make up about 31 percent of overall container volumes. Trade with the Far East accounts for nearly 70 percent of shipment tonnage. The top containerized exports are typically food and farm products and wood products. Average exports from all World regions were estimated to total 1.0 million tons. Because this average shipment tonnage is lower than 2020 tonnage, the 2020 tonnages were used to represent the baseline from which forecasted commerce was conducted. However, the weight per loaded TEU by route group presented in the previous section was applied for loading vessels with the container loading tool (CLT), which is based on the average weight per loaded TEU from 2016 to 2020.

Table 5.17. Historical Containerized Shipments (metric tons).

Route Group	2016	2017	2018	2019	2020	Average 2016-2020
Far East	619,240	696,832	562,459	675,281	804,171	671,597
Europe	267,413	286,146	250,684	228,646	209,446	248,467
Caribbean	155,874	133,544	113,897	219,614	143,209	153,228
Total	1,042,527	1,116,522	927,040	1,123,541	1,156,826	1,073,291

Source: NDC Unpublished data

Table 5 18 summarizes the baseline for both receipts and shipments by World region and service route.

Table 5.18. Wilmington Harbor Baseline Containerized Forecast (metric tons)

Route Group	Receipts	Shipments	Total
Far East	536,937	804,171	1,341,108
Europe	271,293	209,446	480,739
Caribbean	102,152	143,209	245,361
Total	910,382	1,156,826	2,067,208

From the containerized baseline, future volumes of containerized cargo were projected over the forecast period using long-term growth rates established by S&P Global (formerly IHS Global Insight) for international seaborne trade by World region. To validate that these growth rates were appropriate for the Port of Wilmington, forecasted containerized cargo for 2022 using these rates was compared to actual 2022 containerized volumes provided by the NCSPA. The forecasted rates of change between each year are shown in Table 5.19.

Table 5.19. Wilmington Harbor Container Forecast Rates of Change (%)

Route Group	2023	2025	2030	2035	2040	2045	2050	2055
Imports								
Far East	3%	3%	3%	3%	3%	3%	3%	3%
Europe	2%	2%	2%	2%	2%	2%	2%	2%
Caribbean	3%	3%	3%	3%	3%	3%	3%	3%
Exports								
Far East	4%	4%	4%	4%	4%	4%	4%	4%
Europe	2%	2%	2%	2%	2%	2%	2%	2%
Caribbean	3%	3%	3%	4%	4%	4%	4%	4%

The last step of the forecast calculation is implementing qualitative factors, like COVID-19 impact factors, tariffs, infrastructure developments, and export/import restrictions. The area surrounding the Port of Wilmington is seeing significant growth in landside facilities. Over $10.0 Billion in new or upgraded manufacturing and processing facilities are planned over the next 10 years, as well as $523 Million in the construction of 10 new storage and distribution facilities. In discussions with the NCSPA, these improvements are either permitted for construction, or currently under construction; therefore, the PDT assumed that all would be operational by the base year of the analysis. The NCSPA provided estimated annual TEU volumes associated with each improvement, based on discussions with the respective facility. These estimates of new volumes were further grouped into their appropriate World region and direction (import/export) and added to the initial forecast.

In Section 5.3.1, the Port's landside capacity in the future without-project condition was estimated at 1.1 million TEUs per year, based on their planned facility upgrades as of the time of this report. As a result of the estimated additional volumes reported by the NCSPA as part of this forecast, that 1.1 million TEU capacity may be reached as soon as 2042. Therefore, container growth was capped at the year 2042 for the remainder of the forecast period ending in 2056.

Table 5.20 displays the imports forecast in metric tons for select years occurring over the forecast period using both S&P's growth estimates and these qualitative adjustments.

Table 5.20. Wilmington Containerized Trade Forecast – Import Tons

Route Group	2025	2030	2036	2042	2046	2056
Imports						
Far East	625,485	728,635	2,840,505	3,411,517	3,411,517	3,411,517
Europe	300,392	328,418	474,337	524,823	524,823	524,823
Caribbean	118,998	138,622	232,789	279,585	279,585	279,585
Total	1,044,875	1,195,676	3,547,631	4,215,925	4,215,925	4,215,925

The containerized export tonnage forecast is shown in Table 5.21. As with imports, exports to Asia are forecast to dominate Wilmington export trade over the forecast period, growing from 800,000 tons in 2020 to 1.9 million tons by 2042.

Table 5.21. Wilmington Containerized Trade Forecast – Export Tons

Route Group	2025	2030	2036	2042	2046	2056
Exports						
Far East	985,946	1,205,332	1,557,351	1,925,507	1,925,507	1,925,507
Europe	233,466	253,997	327,796	358,427	358,427	358,427
Caribbean	168,606	196,411	301,452	374,879	374,879	374,879
Total	1,388,018	1,655,740	2,186,599	2,658,812	2,658,812	2,658,812

Using the containerized trade forecast for imports and exports and the average weight per loaded container (in terms of twenty-foot equivalent units, or TEUs), a loaded container forecast was developed. Table 5.22 provides the loaded import and export TEU forecast, along with the weight per loaded container for each route group.

Table 5.22. Wilmington Loaded TEU Forecast – Import and Export

Route Group	Weight per Loaded Import TEU	2030	2036	2042
Far East	6.9	105,599	411,667	494,423
Europe	8.4	39,097	56,469	62,479
Caribbean	7.8	17,772	29,845	35,844
Total Loaded Imports		**162,469**	**497,981**	**592,746**
Far East	12.9	93,437	120,725	149,264
Europe	8.5	29,882	38,564	42,168
Caribbean	8.8	22,319	34,256	42,600
Total Loaded Exports		**145,638**	**193,545**	**234,032**

From the loaded TEU forecast, empty TEU volumes were developed. The percentage of total empty TEUs was derived from historical data obtained by the NCSPA. These percentages were used to forecast empties to 2042. The total number of TEUs, included loaded and empty containers, by import and export, and route group, are shown in Table 5.23.

Table 5.23 Wilmington Total TEU Forecast for Receipts and Shipments

Totals	2025	2030	2036	2042
Total Loaded Receipts (TEU)	141,667	162,469	497,981	592,746
Total Loaded Shipments (TEU)	123,056	145,638	193,545	234,032
Total Empty TEU	82,064	95,513	214,373	256,301
Total Overall TEU	346,788	403,620	905,899	1,083,079

5.3.1.1.2 Liquid Bulk Forecast

Petroleum products (not crude oil) and chemicals comprise the liquid bulk shipments at the Port of Wilmington. They account for approximately 30% of total tonnage at the port and are carried by vessel fleet mix that would benefit from a deeper channel. To minimize the effect of volatility in the market on the forecast, a baseline amount of tonnage was calculated for each of the two liquid commodities, for both receipts and shipments, using empirical data from 2016-2020.

Table 5.24 shows historical receipts of liquid bulk cargo.

Table 5.24. Historical Liquid Bulk Receipts (short tons 2,000 lbs) 2016-2020

Commodity	2016	2017	2018	2019	2020	Average 2016-2020
Petroleum Products	547,393	428,627	360,928	414,981	421,140	434,614
Chemicals	1,143,050	1,362,164	1,380,105	1,287,384	1,479,174	1,330,375

Source: USACE WCSC 2022

Table 5.25 shows historical shipments of liquid bulk cargo.

Table 5.25. Historical Liquid Bulk Shipments (short tons 2,000 lbs) 2016-2020

Commodity	2016	2017	2018	2019	2020	Average 2016-2020
Petroleum Products	12,009	11,400	1,337	2,107	40,503	13,471
Chemicals	104,630	94,596	89,250	89,988	90,271	93,747

Source: USACE WCSC 2022

From the baseline, future volumes of liquid bulk cargo were projected over the forecast period using a linear regression of the empirical data from 2016-2020. In the cases of petroleum products receipts and chemical shipments, trends in tonnage were negative. In these cases, tonnages were held constant from the baseline over the forecast period. The forecasted tonnages for select years over the forecast period and their respective rates of change are shown in Table 5.26 and Table 5.27.

Table 5.26. Baseline and Projected Liquid Bulk Receipt Tonnages (short tons)

Commodity	Baseline	2026	2036	2046	2056	CAGR
Petroleum Products	434,614	434,614	434,614	434,614	434,614	0.0%
Chemicals	1,330,375	1,473,906	1,668,085	1,846,031	2,023,958	1.0%

Table 5.27. Baseline and Projected Liquid Bulk Shipment Tonnages (short tons)

Commodity	Baseline	2026	2036	2046	2056	CAGR
Petroleum Products	13,471	35,597	76,077	111,987	148,068	5.8%
Chemicals	93,747	93,747	93,747	93,747	93,747	0.0%

5.3.1.1.3 Dry Bulk Forecast

The final category of benefiting cargo to be forecast was dry bulk materials. This category included cargo of wood pellets, gypsum, cement and concrete, manufactured metal products, soybeans, and animal feed. Again, to minimize the volatility in volumes over the five-year dataset, an average was used to represent the baseline tonnage for shipments and receipts going forward. The historical volumes and resulting baseline average volume for the four major dry bulk categories is in the tables below; separated by receipts and shipments.

Table 5.28. Historical Dry Bulk Receipts (short tons)

Commodity	2016	2017	2018	2019	2020	Average 2016-2020
Crude Materials	435,975	343,041	785,226	668,880	728,573	592,339
Primary Manufactures	345,224	304,443	354,211	316,604	389,358	341,968
Food and Farm Products	651,936	287,436	153,251	525,811	179,304	359,548
Machinery and Products	529,978	360,443	531,975	589,655	634,542	529,319

Source: USACE, WCSC 2022

Table 5.29. Historical Dry Bulk Shipments (short tons)

Commodity	2016	2017	2018	2019	2020	Average 2016-2020
Crude Materials	954,266	1,669,306	1,517,690	1,338,167	1,710,223	1,437,930
Primary Manufactures	147,543	133,699	130,491	83,551	88,890	116,835
Food and Farm Products	183,413	170,262	252,677	349,480	373,306	265,828
Machinery and Products	273,114	199,866	230,122	337,660	241,669	256,486

From the baseline, future volumes of dry bulk cargo were projected over the forecast period using a linear regression of the empirical data from 2016-2020. Given the movements in Food and Farm receipts and Primary Manufacture shipments resulted in a negative trend over the five-year empirical period, those commodity growth rates were held constant over the forecast period. The forecasted tonnages for select years over the forecast period and their respective rates of change are shown in Table 5.30.

Table 5.30. Projected Dry Bulk Cargo Tonnages (short tons) by direction

Dry Bulk Cargo	Baseline	2026	2036	2046	2056	CAGR
Receipts	1,823,173	2,287,893	2,866,998	3,429,721	3,990,502	1.6%
Shipments	2,077,079	2,523,208	3,075,468	3,596,290	4,117,026	1.4%

5.3.1.2 Vessel Fleet Forecast

In addition to a commodity forecast, a forecast of the future fleet is required when evaluating navigation projects. To develop projections of the future fleet calling at Wilmington, the study team developed a world fleet forecast for benefiting vessel types, a methodology to forecast total capacity calling at Wilmington Harbor based on previous

USACE studies at other East Coast ports and future throughput capacity at the port, and a breakdown of that capacity calling into vessel type and classes.

The methodology was then linked to the commodity forecast data for the port. Even though the commodity forecast was constrained, based on landside capacity, the fleet forecast model was unconstrained in respect to inter-port competition on the U.S. East Coast. This means that forecasted commodity totals were not adjusted based on effects from nearby ports. Therefore, volumes were not increased or decreased based on movements to substitute ports in the region. Further, the study team did not consider land-based infrastructure as a limiting factor in its projections of the World Fleet. In the without-project condition, the overall vessel fleet is assumed to remain much the same as it is today, burdened by the same set of problems and navigational constraints.

5.3.1.2.1 Container Vessel Fleet Forecast

Section 0 outlined the different classes and TEU capacities of the container vessel fleet currently calling on Wilmington. The containership fleet is expected to expand to accommodate the significant influx of Far East imports from electric vehicle manufacturers in Central North Carolina. Since this will require more vessels than only a single class of container vessel can provide, the amount of liner services may increase from the two currently scheduled, and the fleet mix of vessels may grow to mirror those calling on other U.S. East Coast ports. Significantly more PPX1 and PPX2 vessels would be required to fulfill the commodity forecast without a project.

In the meantime, the world container fleet will continue its shift towards larger vessels. Over time, more new builds of post-Panamax container vessels are expected to come into service. These vessels will be deployed on strings that call Wilmington, as they do now, in a draft-constrained condition, without being able to fully utilize vessel capacity. However, a smaller share of the cargo is shifted to the light-loaded, larger, vessel fleet, resulting in smaller vessels continuing to call on Wilmington more often than they would with a deeper channel. Additionally, container liners are not anticipated to deploy as many Generation 3 Post-Panamax vessels onto strings that service Wilmington in the future without-project condition. Generation 4 Post-Panamax vessels are not anticipated to be placed in service to Wilmington at all without a project, given the beam limitations of the Panama Canal.

By combining information from the commodity forecast with forecasted fleet capacity and Wilmington’s average share of cargo on a containerized vessel, the study team was able to allocate several post- Panamax, Panamax, and sub-Panamax vessels calls to Wilmington’s fleet. The number of transits, particularly those made by larger vessels, is a key variable in calculating the transportation costs. The study team’s forecasting technique begins with performing a detailed review of the current world fleet and how it is deployed on the trade routes of the world.

When evaluating data on vessel composition, vessel age, and container markets, the study team considered the “order book” to estimate new deliveries to the fleet into the

future. Vessel scrapping is accounted for based on historical scrapping rates by vessel class and age. Containerships, particularly the largest ones, are relatively new, so widespread scrapping is not expected to take place until well in the future. Likewise, when economies are strong, vessel owners are more likely to hold onto their existing vessels (or build new ones) and less likely to scrap them. The forecasted world fleet provides a frame of reference to verify the validity of the Wilmington fleet forecast and is provided as background information.

As new larger vessels become a greater percentage of the world fleet and are deployed to Wilmington, they replace smaller vessels which are redeployed to shorter routes, which may utilize the smaller vessels more efficiently.

There is a strong relationship between the economic condition of a port and its total nominal vessel capacity. As an economy grows, exports from the port often increase (from the increased output) or demand for imports increase (from increased consumer purchasing power). Vessels respond accordingly to satisfy this increased level of trade. As the tonnage in Wilmington grows over time, the nominal TEU vessel capacity, i.e., the total number of available container slots, grows. Capacity is adjusted by operators to match demand. Once the forecasted nominal TEU vessel capacity at Wilmington was determined, the future containers were allocated to various vessel classes (post-Panamax, Panamax, and sub-Panamax). The allocation to vessel classes was based on the examination of historical utilization of all container vessels, current trends in vessel design and orders, and the worldwide redeployment of vessels affected by the expansion of the Panama Canal.

5.3.1.2.1.1 World Fleet as of Spring 2023

A projection of the world fleet provides the necessary background for evaluating the future fleet forecast for Wilmington. The starting point for this projection was a share of the world fleet by vessel class as extracted from the S&P Global database for the years 2013, 2017, and 2023. As shown in Table 5.31, larger vessels are quickly becoming a higher percentage of the world fleet. In 2013, container vessels larger than 12,000 TEUs made up just under 3 percent of the world fleet while vessels greater than 7,600 TEUs totaled around 10.5 percent. As of 2023, 12,000+ TEU vessels have increased to about 9.9 percent of the world fleet and vessels greater than 7,600 TEUs now make up about 21 percent.

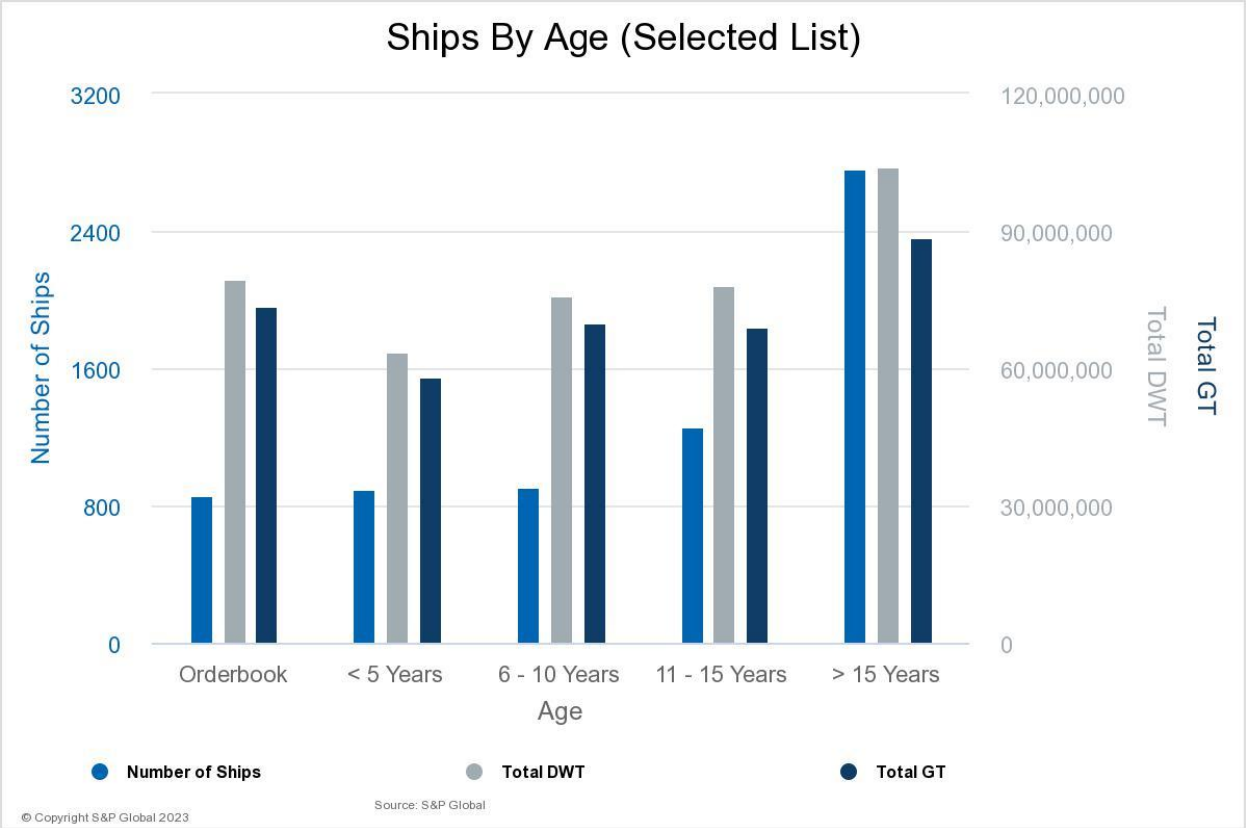
Table 5.31. World In-Service Container Fleet by TEU band, 2013-2023

TEU Band	2013	2017	2023
0.1 - 1.3 k TEU	1,600	1,553	1,497
1.3 - 2.9 k TEU	1,352	1,476	1,634
2.9 - 3.9 k TEU	303	271	294
3.9 - 5.2 k TEU	762	656	643
5.2 - 7.6 k TEU	519	468	447
7.6 - 12 k TEU	379	670	665
12 k TEU +	151	422	570
TOTAL	**5,066**	**5,516**	**5,750**

Source: S&P Global, 2023

5.3.1.2.1.2 The “Orderbook”

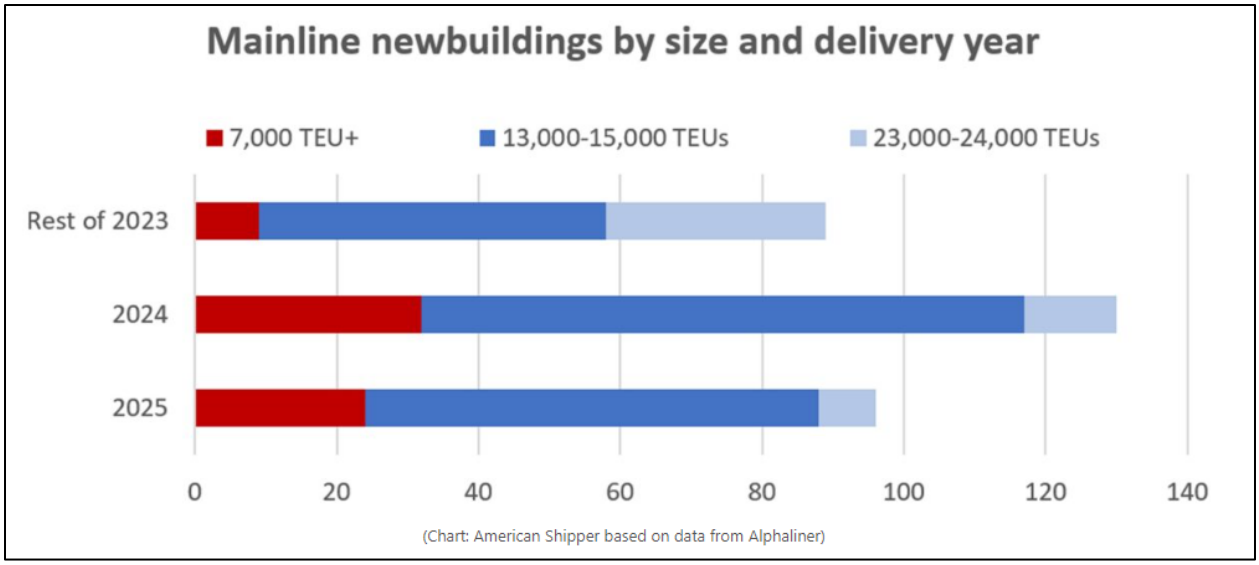
The “order book” is shorthand for the vessels that have been contracted to be built by ship builders around the world. Vessel deliveries are primarily the function of new building contracting. These contracts can take several forms. There are firm contracts for vessels that are under construction. There are also option contracts that secure the capacity of the shipyard but do not require the buyer to exercise the option to construct the vessel. Some contracts have financing that is committed; others do not. There are several other nuances and the challenge is to translate the number of vessels and types of contracts into future vessels coming online at a specific time. Forecasts must be made for future contracts, vessel scrapping, and vessel deliveries. Over the long term, new building investment tends to equate to the incremental demand for new tonnages to meet cargo growth or replacement of aged or obsolete ships. In Figure 5.13 below, the world fleet of containerships, according to the S&P Global data, is broken down by age; including those in the “orderbook.”



Source: S&P Global, 2023.

Figure 5.13. World Containership Fleet by Age.

A more focused breakdown of the Post-Panamax newbuild containerships contained in the "order book" was outlined in American Shipper, according to data collected by the data firm Alphaliner, and is shown in Figure 5.14 below. The emphasis was on the significant share of Post-Panamax Generation III orders (13,000-15,000 TEU) that made up 60 percent of Post-Panamax newbuilds scheduled for delivery between now and 2025. This growth in Post-Panamax Generation III vessels is predicted to impact the Trans-Pacific trade (23-24,000 TEU vessels would impact the Asia to Europe trade, by contrast), and should provide significant additional capacity for services between the Far East and U.S. East Coast, such as the services currently calling the Port of Wilmington.



Source: American Shipper, 2023.

Figure 5.14 Post-Panamax Containership Orderbook by size and delivery year

This additional capacity suggests that there could be additional services available to move increased forecasted container cargo through Wilmington over the next ten years.

5.3.1.2.1.3 Port of Wilmington Containership Capacity

The study team used the historical fleet deployment and capacity listed in Section 5.3.1.2.1 as a baseline for forecasting the future fleet. Then, the TEU forecast listed in Section 5.3.1.1.1 was used to estimate total annual nominal capacity calling at Wilmington for the years 2036 to 2056. The forecast assumed that existing nominal capacities would persist throughout the forecast period, given that the fleet will have adjusted with additional services and a more diverse fleet mix to allocate the appropriate TEU volumes. Once the study team determined the total annual nominal capacity over the period of analysis, the estimated capacity was allocated into each class since this demand is likely to be satisfied by a range of vessels.

The forecasted capacity calling at Wilmington was allocated to container vessel routes and classes according to the forecast of capacity share, as shown in Table 5-32 .The forecasted capacity share at Wilmington was estimated by considering changes to the available fleet and the forecasted tonnage for the port. Different routes did not shift their share of vessel capacity in the same way. Routes with smaller volumes of cargo shipped, such as the Caribbean route, didn't fully utilize the largest containership classes because they weren't estimated to require the larger capacity ships to maintain their call frequency and meet the increased demand in volumes forecasted. By the same rationale, European routes didn't utilize the largest classes of vessels in the same way as the Far East routes.

Table 5.32. FWOP Forecasted Shares of Container Vessel Capacity

Route	Class	2036	2056
Far East	PPX1	24%	24%
Far East	PPX2	26%	26%
Far East	PPX3	50%	50%
Europe	SPX	53%	53%
Europe	PX	47%	47%
Caribbean	SPX	50%	50%
Caribbean	PX	50%	50%

The study team developed the FWOP fleet forecast using the previously mentioned projections as well as an analysis of historical calls. Namely, the study team used the forecasted share of capacity by vessel class to distribute forecasted tonnage. The PDT then used historical average percent empty containers, arrival drafts, and box weights to determine the number of calling vessels. The FWOP forecast of containerized vessels through the year 2056 is depicted in Table 5.33. These values were input into HarborSym's Container Loading Tool (CLT), which built a year's worth of vessel traffic using these total call inputs.

Table 5.33. FWOP Forecast of Containerized Vessels through 2056

Route Group	Vessel Class	Without Project Year 2036	Without Project Year 2056
Far East	PPX1	237	289
Far East	PPX2	157	186
Far East	PPX3	103	124
Europe	SPX	30	36
Europe	PX	102	111
Caribbean	SPX	29	34
Caribbean	PX	64	78
Total		**722**	**858**

5.3.1.2.2 Bulker and Tanker Fleet Forecasts

Sections 5.2.7.2 and 5.2.7.3 outlined the different sizes and capacities of the bulker and tanker fleets that call on the Port of Wilmington. Using existing loading data from 2016-2020, the study team developed an average tonnage per vessel, categorized by vessel class. For the bulker fleet, loading practices were separated by commodity type; specifically crude materials (including wood pellets) from the rest of the dry bulk commodities, to accurately project future loading patterns for the bulker fleet. The average cargo size per bulker class, based on historical information, is shown in Table 5.34 below.

Table 5.34. Average Bulker Load per call at Wilmington (metric tons)

Commodity Type	Crude Materials		Other Dry Bulk Cargo	
Vessel Class	Receipts	Shipments	Receipts	Shipments
Very Small	9,792	0	10,338	0
Small	0	0	6,000	0
Medium	11,151	11,732	15,390	21,946
Large	0	27,394	19,844	27,394
Very Large	28,314	43,318	29,759	43,318

Given the small size and sporadic nature of these bulk loading patterns, it is reasonable to assume that they will continue those patterns in the without-project condition; therefore, they were used to estimate the number of bulker vessel calls expected to move the forecasted levels of bulk commodities.

A similar loading analysis was completed for the tanker fleet calling on Wilmington, with one notable difference: only receipts were used in determining the number of vessel calls effected by the depth of the channel. Any outbound tanker shipments are very small, domestic movements using the Atlantic Intracoastal waterway, and therefore are not modeled in this scenario. Existing loading data from 2016-2020 was used to estimate an average liquid cargo size per vessel class and is displayed in Table 5-35.

Table 5.35. Tanker Vessel average tonnage per call and projected without-project cargo share by vessel class

Vessel Class	2016-2020 Avg Receipts per call (metric tons)	Share of liquid bulk cargo by vessel class		
		2020 (existing)	2036	2056
GP	6,353	18%	18%	18%
MR	15,990	49%	42%	32%
LR-1	29,085	33%	40%	50%

Additionally, the estimated share of liquid bulk cargo for each tanker vessel class was adjusted over the forecast period from its existing share in 2020. This assumes that shippers and cargo owners will continue to take advantage of available economies of scale in shipping by using an increasing share of LR-1 tankers to move their cargo. Given that most of the existing liquid cargo uses smaller, Medium Range tankers today, the most likely shift would be to the next larger class of Long-Range 1 tankers, and not all the way to Aframax class tankers, even with most of the world fleet containing Aframax tankers. This is reflected in the slight shift in cargo share reflected in Table 5.35 in the without-project condition.

Using these anticipated loading patterns in the without-project condition, the study team used the Bulk Loading Tool (BLT) in HarborSym's Suite of Tools to estimate the number of tanker and bulker vessel calls needed to satisfy the commodity forecast, over the forecast period of 2036-2056. The results are shown in Table 5.36.

Table 5.36. Future Without-project condition Tanker and Bulker Vessel Calls

Vessel Class	2036	2056
General Purpose Tanker	49	57
MR Tanker	49	44
LR-1 Tanker	26	38
Very Small Bulker	9	13
Small Bulker	1	1
Medium Bulker	71	93
Large Bulker	12	13
Very Large Bulker	71	97
Total Bulk Vessel Calls	**288**	**356**

5.3.1.2.3 Combined Without-Project Fleet Forecast

In the without-project condition, the overall vessel fleet is assumed to remain much the same as it is today, burdened by the same set of problems and navigational constraints. The fleet for bulkers will shift towards larger sub-classes of Very Large Bulker vessels but remain draft constrained. The fleet of chemical tankers will shift cargo towards the larger classes of LR-1 tankers, away from smaller classes. The largest classes of chemical tankers will continue to light-load because of the current channel depth.

The containership fleet is expected to expand to accommodate the significant influx of Far East imports from electric vehicle manufacturers in Central North Carolina. Since this will require more vessels than only a single class of container vessel can provide, the amount of liner services may increase from the two currently scheduled, and the fleet mix of vessels may grow to mirror those calling on other U.S. East Coast ports. Significantly more PPX1 and PPX2 vessels would be required to fulfill the commodity forecast without a project. In conclusion, vessel calls will continue to increase into the future, while still being affected by the navigational constraints described earlier.

Table 5.37 shows all the vessel classes and their attributes that were used to represent the fleet of vessels that are expected to call Wilmington in the future with- and without-project conditions.

Table 5.37. Vessel Classes and Dimensions Used in HarborSym

Vessel Type	Vessel Class Name	Classification Category	Classification Criteria	Typical Max Cargo Capacity	Typical LOA (ft)	Typical Beam (ft)	Typical Design Draft (ft)	Typical DWT	Underkeel Clearance (ft)
Sub-Panamax Container	SPX1	DWT	0-12,500 DWT	600 TEU	433.0	70.6	25.2	9,500	2
Sub-Panamax Container	SPX2	Capacity	12,501-42,999 DWT	2,800 TEU	669.2	93.5	36.8	31,900	2
Panamax Container	PX	Draft	>= 42 ft	4,800 TEU	935.3	106.4	43.6	65,000	3
Post-Panamax Container	PPX1	Beam	107-139 ft	6,800 TEU	1,027.0	131.5	45.7	80,700	3
Post-Panamax Container	PPX2	Beam	140-150 ft	9,900 TEU	1,119.1	143.5	48.1	103,000	3.5
Post-Panamax Container	PPX3	Beam	150 ft +	15,000 TEU	1,202.0	154.0	49.0	117,000	3.5
Tanker	GP	Capacity	<25k DWT	18,000 DWT	518.6	80.2	32.3	20,000	3
Tanker	MR	Capacity	25k-44.9k DWT	32,200 DWT	575.2	91.3	35.5	35,000	3
Tanker	LR	Capacity	45k-79.9k DWT	55,200 DWT	662.9	108.4	40.6	60,000	3.5
Bulker	Very Small	Capacity	0-20k	13,500 DWT	510.0	78.8	29.6	15,000	2
Bulker	Small	Capacity	20-30k	23,000 DWT	549.9	84.7	32.3	25,000	2
Bulker	Medium	Capacity	30-50k	36,800 DWT	607.0	93.1	36.2	40,000	2
Bulker	Large	Capacity	50-60k	55,000 DWT	698.4	105.9	42.1	55,000	2.5
Bulker	Very Large	Capacity	60-105k	100,000 DWT	778.5	124.5	48.2	88,000	3

Table 5.38 shows the forecasted number of benefiting vessel calls in the future without project condition projected for the years 2021, 2036, and 2056.

Table 5.38. Combined Without-Project Fleet Forecast

Vessel Class	2021	2036	2056
Sub-Panamax Containership (SPX)	163	59	70
Panamax Containership (PX)	73	166	189
Post-Panamax Containership 1 (PPX1)	1	237	289
Post-Panamax Containership 2 (PPX2)	4	157	186
Post-Panamax Containership 3 (PPX3)	83	103	124
GP Chemical Tanker	43	49	57
MR Chemical Tanker	54	49	44
LR Chemical Tanker	19	26	38
Very Small Bulker	5	9	13
Small Bulker	1	1	1
Medium Bulker	38	71	93
Large Bulker	12	12	13
Very Large Bulker	38	71	97
Total	**534**	**1,010**	**1,214**

5.3.2. Future With Project Condition

The following section describes the anticipated condition at Wilmington assuming that a project has been constructed. The anticipated changes in the operating procedures at the port are the basis for the economic analysis.

5.3.2.1 Assumptions

Both bulk and container vessels would experience a time savings “with” project in the form of the reduction in transit time delays. Another source of savings would be the elimination of voyages over the year by loading the existing fleet deeper with a deeper channel in place. The ability to load deeper allows the existing fleet to move the same volume of cargo in fewer trips. This would result in cost savings to the shippers and nationwide benefits. Other costs and practices, such as land side costs, would not change because of the project and are assumed to remain constant.

The period of analysis is 50 years, beginning with the base year of 2036, the project effective date, to 2085. The FY 2025 Federal discount rate of 3.0 percent is used to discount benefits and costs. The report uses methodology from Engineering Regulation 1105-2-100, transportation savings accruing to deep draft vessels.

5.3.2.2 Project Alternatives

For this project, a total of five different alternatives are being evaluated in this analysis along with the existing/without project condition. These alternatives call for channel

depths of 44, 45, 46, 47, and 48 feet. All alternatives also contained widening in specific reaches (not the entire channel length) to accommodate the PPX Gen III containership. Discussions with the Cape Fear Marine Pilots indicated that a project would not change their traffic management practices. So, one vessel movement at a time was not assumed to change in any alternative.

5.3.3. Transportation Cost Savings Benefits Analysis

In Wilmington Harbor, navigation benefits would be generated with the reduction in costs from more efficient use of existing vessels and reductions in transit time. By allowing the vessels to arrive and depart closer to their maximum draft, large cargo vessels can minimize the number of voyages to overseas ports each year. Reducing the number of these voyages will be a significant cost savings to the shippers. Also, reducing the number of delays waiting for conditions to improve at the bar would make existing voyages faster and more efficient, incurring fewer operating costs over the year as well. NED benefits were estimated by calculating the reduction in transportation cost at each alternative using the HarborSym Modeling Suite of Tools (HMST) developed by IWR. The HMST reflects USACE guidelines on transportation cost savings analysis.[16]

5.3.3.1 Methodology

Channel improvement modifications result in reduced transportation cost by creating fewer delays when traversing the port, and more efficient loading of the forecasted fleet. The HMST was designed to allow users to model these benefits.

To begin, HarborSym was setup with the basic required variables. To estimate cost saving benefits, the Bulk Loading Tool (BLT) and Container Loading Tool (CLT), modules within the HMST, were used to generate a vessel call list based on the commodity and fleet forecasts at the Port of Wilmington for a given year, under the various alternatives. The resulting vessel traffic was simulated using HarborSym, producing average annual vessel transportation costs. The transportation costs saving benefits were then calculated for each additional project alternative.

5.3.3.1.1 HarborSym Model

IWR developed HarborSym as a planning level, general-purpose model to analyze the transportation costs of various waterway modifications within a harbor. HarborSym is a Monte Carlo simulation model of vessel movements at a port for use in economic analyses. While many harbor simulation models focus on landside operations, such as detailed terminal management, HarborSym instead concentrates on specific vessel movements and transit rules on the waterway, fleet and loading changes, as well as incorporating calculations for both within harbor costs and costs associated with the ocean voyage.

[16] HarborSym, the Container Loading Tool (CLT), and the Bulk Loading (BLT) are USACE certified planning models

HarborSym represents a port as a tree-structured network of reaches, docks, anchorages, and turning areas. Vessel movements are simulated along the reaches, moving from the bar to one or more docks, and then exiting the port. Features of the model include intra-harbor vessel movements, tidal and current influence, the ability to model complex shipments, and incorporation of turning areas and anchorages. The driving parameter for the HarborSym model is a vessel call at the port. A HarborSym analysis revolves around the factors that characterize or affect a vessel movement within the harbor.

5.3.3.1.2 Model Behavior

HarborSym is an event driven model. Vessel calls are processed individually and the interactions with other vessels are considered. For each iteration, the vessel calls for an iteration that fall within the simulation period are accumulated and placed in a queue based on arrival time. When a vessel arrives at the port, the route to all the docks in the vessel call is determined. This route is comprised of discrete legs (contiguous sets of reaches, from the entry to the dock, from a dock to another dock, and from the final dock to the exit). The vessel attempts to move along the initial leg of the route. Potential conflicts with other vessels that have previously entered the system are evaluated according to the user-defined set of rules for each reach within the current leg, based on information maintained by the simulation as to the current and projected future state of each reach. If a rule activation occurs, such as no meeting allowed in each reach, the arriving vessel must either delay entry or proceed as far as possible to an available anchorage, waiting there until it can attempt to continue the journey. Vessels move from reach to reach, eventually arriving at the dock that is the terminus of the leg.

After the cargo exchange calculations are completed and the time the vessel spends at the dock has been determined, the vessel attempts to exit the dock, starting a new leg of the vessel call; rules for moving to the next destination (another dock or an exit of the harbor) are checked in a similar manner to the rule checking on arrival, before it is determined that the vessel can proceed on the next leg. As with the entry into the system, the vessel may need to delay departure and re-try later to avoid rule violations and, similarly, the waiting time at the dock is recorded. For Wilmington, one rule was implemented based on the harbor pilot’s restrictions on larger vessels:

1. There is no meeting of vessels when the combined beam width of the two meeting vessels is greater than 135 feet.

A vessel encountering rule conflicts that would prevent it from completely traversing a leg may be able to move partially along the leg, to an anchorage or mooring. If so, and if the vessel can use the anchorage (which may be impossible due to size constraints or the fact that the anchorage is filled by other vessels), then HarborSym will direct the vessel to proceed along the leg to the anchorage, where it will stay and attempt to depart periodically, until it can do so without causing rule conflicts in the remainder of the leg. The determination of the total time a vessel spends within the system is the

summation of time waiting at entry, time transiting the reaches, time turning, time transferring cargo, and time waiting at docks or anchorages. HarborSym collects and reports statistics on individual vessel movements, including time in system, as well as overall summations for all movements in an iteration.

The model calculates receipt and shipment tons, receipt and shipment value, and receipt and shipment allocated cost. This information allows for the calculation of total tons and total cost, allowing for the derivation of the desired metrics at the class and total level. The model can thus deliver a high level of detail on individual vessel, class, and commodity level totals and costs.

Either all or a portion of the at-sea costs are associated with the subject port, depending on whether the vessel call is a partial or full load. The at-sea cost allocation procedure is implemented within the HarborSym Monte-Carlo processing kernel and utilizes the estimate total trip cargo (ETTC) field from the vessel call information along with receipt tonnage and shipment tonnage. In all cases the ETTC is the user's best estimate of total trip cargo.

5.3.3.1.3 Data Requirements

The data required to run HarborSym are separated into six categories, described below. Key data for the Wilmington Harbor study are provided.

- Simulation Parameters

  Parameters include start date, the duration of the iteration, the number of iterations, the level of detail of the result output, and the wait time before rechecking rule violations when a vessel experiences a delay. These inputs were included in the model runs for the study. The base year for the model was 2036. A model run was performed for the following years: 2036 and 2056. After 2056, the forecast cargo volume was held constant until the end of the period of analysis. Each model run consisted of 100 iterations.

- Physical and Descriptive Harbor Characteristics

  These data inputs include the specific network of Wilmington Harbor such as the node location and type, reach length, width, and depth, in addition to tide and current stations. This also includes information about the docks in the harbor such as length and the maximum number of vessels the dock can accommodate at any given time. Figure 5.15 displays the Node network used for Wilmington Harbor. Note that the reach dimensions are not to scale but are accurately reflected in the model.

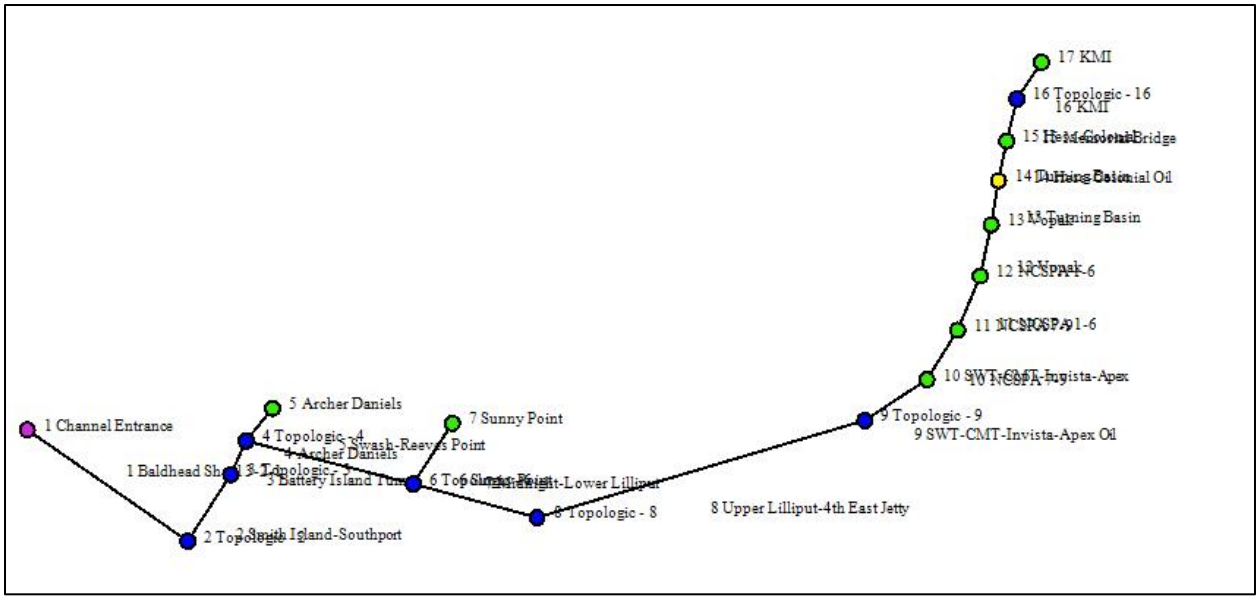


Figure 5.15. Wilmington Harbor HarborSym Node Network

- General Information

  General information used as inputs to the model include specific vessel and commodity classes, commodity transfer rates at each dock, and specifications of turning area usage at each dock within the harbor.

- Vessel Speeds and Operations

  The speed at which vessels operate in the harbor, by vessel class both loaded and light loaded, were determined for each channel segment by verifying with the pilots. Hourly operating costs while in-port and at-sea were determined for both domestic and foreign flagged vessels from the Institute for Water Resources (IWR) Vessel Operating Cost spreadsheets and Economic Guidance Memorandum (EGM) 25-03 (dated 25 November 2024), Deep-Draft Vessel Operating Costs FY 2022 Price Levels, Supplemental Guidance. Vessel operating costs and speeds at sea are entered as a triangular distribution (minimum, most likely, maximum). Vessel operating costs are not shown as some or much of the information integral to the estimates is considered sensitive or proprietary by commercial sources and is protected from open or public disclosure under Section 4 of the Freedom of Information Act.

- Reach Transit Rules

  Vessel transit rules for each reach reflect restrictions on meeting in particular segments of Wilmington Harbor and are used to simulate actual conditions in the reaches. For the channel deepening analyses, vessel widths were used to determine if a vessel can enter the system, as previously discussed.

- Vessel Calls

  The vessel call lists consist of forecasted vessel calls for a given year as generated by the BLT and CLT. Each vessel call list contains the following information: arrival date, arrival time, vessel name, entry point, exit point, arrival draft, receipt/shipment, dock name, dock order, commodity, units, origin/destination, vessel type, Lloyds Registry, net registered tons, gross registered tons, dead weight tons, capacity, length overall, beam, draft, flag, tons per inch immersion factor, ETTC, and the route group for which it belongs.

5.3.3.2 Forecasted Synthetic Vessel Call Lists

For the simulation years of 2035 and 2056, the commodity levels remained the same as in the FWOP, but the load factors for the benefiting vessels were updated to reflect their ability to load deeper with a project. In the BLT, this was accomplished using the available depth of each respective alternative, the maximum loaded draft of each bulk vessel class, the load factor percentage of each class, and their resulting increased capacity per their tons per inch immersion factor. The BLT adjusts the available capacity of the fleet in each alternative scenario, then loads the largest vessel class completely, down to the smallest class, until the forecasted commodity volumes are satisfied. The BLT load factor values for the FWOP and the three simulated FWP alternatives are listed in Table 5.39 below.

Table 5.39. Future Bulk Vessel Load Factors With- and Without-Project

Vessel Class	FWOP Load factor Min/ML/Max	44 feet Load Factor	46 feet Load Factor	48 feet Load Factor
GP Tanker	10/50/90	10/55/90	10/55/90	10/55/90
MR Tanker	10/50/90	10/75/91	10/75/92	10/75/92
LR-1 Tanker	10/50/90	10/75/91	10/75/92	10/75/92
Very Small Bulker	63/71/90	63/75/91	63/75/91	63/75/91
Small Bulker	20/40/90	20/40/92	20/40/92	20/40/92
Medium Bulker	20/50/90	20/50/92	20/50/92	20/75/92
Large Bulker	20/40/90	20/55/90	20/55/92	20/75/92
Very Large Bulker	20/35/50	23/38/53	25/40/55	30/45/60

As the channel gets deeper, the load factors are increased for all vessels. However, they are increased more significantly for the larger classes that have more spare capacity in the without-project condition. These load factor changes result in a different fleet mix that is needed to satisfy the commodity forecast in the BLT. This change in required vessel calls is illustrated in Table 5.40 below.

Table 5.40. FWP BLT Vessel Calls

Vessel Class	FWOP	44 feet	46 feet	48 feet
2036 Vessel Calls				
GP Tanker	49	8	6	6
MR Tanker	49	49	49	49
LR-1 Tanker	26	26	26	26
Very Small Bulker	9	9	9	9
Small Bulker	1	1	1	1
Medium Bulker	71	59	59	53
Large Bulker	12	12	11	11
Very Large Bulker	71	71	68	68
Grand Total	**288**	**235**	**229**	**223**
2056 Vessel Calls				
GP Tanker	57	2	1	1
MR Tanker	44	44	44	44
LR-1 Tanker	38	38	38	38
Very Small Bulker	13	13	13	13
Small Bulker	1	1	1	1
Medium Bulker	93	80	74	73
Large Bulker	13	13	13	5
Very Large Bulker	97	97	97	97
Grand Total	**356**	**288**	**281**	**272**

As the channel gets deeper, smaller vessel call numbers are reduced because of the larger vessel calls handling more cargo, becoming more efficient.

By allowing the BLT to fulfill the commodity forecast for future with-project conditions and eliminate calls at the same time, HarborSym will compute the benefits of loading larger ships more deeply.

The CLT generates a vessel call list by first generating a synthetic vessel fleet based on user inputs using existing fleet data. Each vessel in the fleet is randomly assigned physical characteristics based on parameters provided by the user.

Then, arrival draft adjustments are made for each generated vessel based on user-provided cumulative distribution functions (CDFs). The maximum allowable arrival draft is determined as the minimum of:

1. Prior port limiting depth,
2. Design draft, and
3. Limiting depth at the dock + underkeel clearance + sinkage adjustment + tidal availability + sea level change.

Next, the CLT conducts a Loading Factor Analysis (LFA) given the physical characteristics of each generated vessel and the estimated total trip cargo (ETTC) for the Port of Wilmington. LFA explores the relationships between a ship's physical attributes, considerations for operations and attributes of the trade route cargo to evaluate the operating efficiencies of vessel classes at alternative sailing drafts. The CLT works to load each vessel available to carry the commodity on the given route until the forecast is satisfied or the available fleet is exhausted. Just like the BLT, the CLT adjusts the load factors as the channel gets deeper, based on how much capacity is available on each containership class.

Containership vessel Calls by Route Group and vessel class are shown in Table 5.41 below. These are a result of the CLT loading algorithm, the containerized forecast for the Port of Wilmington, the available vessel fleet by service and the LFA data inputs.

Table 5.41. CLT Containership Vessel Calls by Route Group and Class FWOP and FWP, 2036 and 2056

CLT Vessel Calls	Without	With44	With46	With48
2036				
Europe SPX	30	15	5	0
Europe PX	102	102	102	99
Far East PPX1	237	201	148	115
Far East PPX2	157	157	157	157
Far East PPX3	103	103	103	103
Caribbean SPX	29	20	16	8
Caribbean PX	64	64	64	64
Total	**722**	**662**	**595**	**546**
2056				
Europe SPX	36	20	3	0
Europe PX	111	111	111	110
Far East PPX1	289	245	185	143
Far East PPX2	186	186	186	186
Far East PPX3	124	124	124	124
Caribbean SPX	34	22	11	5
Caribbean PX	78	78	78	78
Total	**858**	**786**	**698**	**646**

Table 5.42 shows the combined vessel call total from the BLT and CLT for the FWOP and 3 simulated alternative depths.

Table 5.42. Combined BLT and CLT vessel call totals, FWOP and FWP, 2036 and 2056

Year	Depth	BLT	CLT	Total
2036	FWOP	288	722	1,010
	44ft	235	662	897
	46ft	229	595	824
	48ft	223	546	769
2056	FWOP	356	858	1,214
	44ft	288	786	1,074
	46ft	281	698	979
	48ft	272	646	918

5.3.3.3 Transportation Cost Savings

Transportation cost benefits were estimated by summarizing and annualizing HarborSym results from multiple simulations. The transportation costs from various model run output files were collected and the transportation cost reduction for all project years was calculated, then annualized to produce an Average Annual Equivalent (AAEQ).

Transportation costs were estimated for a 50-year period of analysis for the years 2036 through 2085. Transportation costs were estimated using HarborSym for the years 2036 and 2056. Commodity and transportation cost growth is held constant after 20 years following the base year (2036) due to the uncertainty surrounding such long-term forecasts. However, benefit levels remain constant through the remaining period of analysis (2056-2085) as well. The net present value (NPV) was estimated by interpolating between the modeled years. Transportation costs were annualized to determine AAEQ cost savings by discounting the cost stream from year 2036 to 2085 at the current FY 2025 Federal Discount rate of 3.0 percent. Estimates were determined for each measure and alternative. The Total and AAEQ transportation cost saving benefits are provided in Table 5.43.

Table 5.43. Transportation Cost Savings Benefits by Alternative (in thousands $)

Alternative/Depth	Total Benefits (NPV) ($1,000s)	AAEQ Benefits ($1,000s)
Without Project	$0	$0
44 feet	$959,859	$39,170
45 feet	$1,352,151	$55,180
46 feet	$1,744,443	$71,189
47 feet	$2,040,667	$83,278
48 feet	$2,336,890	$95,635

5.3.3.4 Benefit Cost Analysis

Parametric costs for the preliminary array of alternatives were annualized using the discount rate of 2.75 percent and at FY 23 price level, the effective rates at the time of the preliminary analysis. The costs include all economic costs such as project first costs (construction cost) for the Federal project, interest during construction, and annual operations and maintenance (O&M) dredging expenses associated with maintenance of those alternatives. Results are presented in Table 5.44, below.

Table 5.44. Economic Analysis of Proposed Alternatives (August 2023)

Economic Parameter	44 Feet Alternative	45 Feet Alternative	46 Feet Alternative	47 Feet Alternative	48 Feet Alternative
AAEQ* Benefits	$31,767,000	$44,742,000	$57,718,000	$67,521,000	$77,323,000
AAEQ* Costs	$26,057,000	$33,591,000	$42,060,000	$51,647,000	$60,797,000
Incremental AAEQ* Costs		$7,534,000	$8,469,000	$9,857,000	$9,150,000
Average Annual Net Benefits	$5,710,000	$11,151,000	$15,658,000	$15,874,000	$16,526,000
BCR** @ 2.75%	1.2	1.3	1.4	1.3	1.3

Alternative depth designations represent inner harbor depths but include widening where needed.
*AAEQ: Average Annual Equivalent
**BCR: Benefit-to-cost ratio

Following alternative screening, the final array of alternatives underwent detailed analysis, including full consideration of environmental impact as presented in the Draft EIS. Alternative costs for the final array of alternatives are presented in Table 5-45, including interest during construction (IDC), operations and maintenance cost assumptions. Estimated first costs include the cost to construct the alternative, Real Estate costs, relocation costs, environmental mitigation costs, Preconstruction, Engineering and Design (PED) and Construction Management (CM) costs; presented at

current price levels (FY 25). Interest during construction is based on the estimated construction duration for each alternative. Total economic costs include project first costs, interest during construction, and annual O&M costs.

Table 5.45. Final Alternative Costs (FY25 Prices, 3.0% Discount Rate)

Costs	-46 Feet	-47 Feet
Project First Cost (FY25 Price Levels)	$ 965,199,000	$ 1,140,270,000
Duration (mos.)	61	61
IDC	$76,318,000	$89,882,000
Economic Cost	$1,044,517,000	$1,230,152,000
Annual O&M	$ 12,965,000	$ 14,420,000
AAEQ Cost	$53,561,000	$62,230,000

Note: Annualized using the 3.0% FY25 Federal Discount Rate

The results of the origin-destination (OD) transportation cost saving benefit analysis are displayed in Table 5.46. As shown, the 47-foot alternative maximizes net NED benefits, but all alternatives are justified at this time. At the time of this analysis in June 2025, no local service facility costs were anticipated for any alternatives. Construction costs of the proposed alternative are $1.1 billion, with a total economic cost of approximately $1.23 billion after interest during construction, and associated O&M costs of $14,420,000 every year.

Table 5.46. Benefit Cost Analysis (FY 25 Prices, 3.0% Discount Rate)

Benefit/Cost	-46 Feet	-47 Feet
AAEQ Benefits	$71,189,000	$83,278,000
AAEQ Costs	$53,561,000	$62,230,000
Incremental AAEQ Costs	$18,174,000	$8,669,000
Net Benefits	$17,628,000	$21,048,000
BCR @ 3.0%	1.3	1.3

Section 5.4. Multiport Analysis

Multiport competition was assessed qualitatively for this study as it relates to shifting of cargo from one port to another port based on factors such as deepening of a harbor.

The recommended plan includes an expanded channel to operate larger vessels more efficiently. Larger vessels alone do not drive growth for the harbor. Many factors may influence the growth of a particular harbor: landside development and infrastructure, location of distribution centers for receipts, source locations for shipments, population and income growth and location, port logistics and fees, business climate and taxes, carrier preferences, labor stability and volatility, and business relationships. Harbor dimensions are just one of many factors involved in determining growth and market share for a particular port.

Market share between the Port of Wilmington and nearby regional ports like Charleston and Savannah is multi-faceted and very dynamic. Specific business relationships that drive the fluctuation of market share between them are the manufacturer-to-shipper relationships, shipper-to-port, or port-to-processor relationships. Some companies only ship to one port, others may ship to and from all three, depending on those involved. Given the relative closeness of these three ports geographically, it is likely that the market share will continue to fluctuate between the ports as capital improvements are made and the demand for goods change.

Shipper input has also revealed that modifications to the channel framework at Wilmington alone will not be sufficient to cause changes in the vessel fleet servicing the U.S. (such as a shift to larger vessels). As mentioned previously, carriers visit multiple ports in the U.S. on a typical voyage. In general, East Coast and Gulf Coast ports are upriver ports, meaning vessels need to navigate up a river system to reach their respective terminals. Conversely, West Coast ports are more coastal and require shorter transits through deeper, wider approaches. Even though the ports of Savannah and Charleston have completed large channel dredging projects in the last 20 years, more comprehensive change to the East Coast/ Gulf Coast port system as a whole would be needed to result in changes to the fleet.

Ultimately, this economic analysis was conducted with the historical Wilmington cargo share remaining the same in both the future without-project and future with-project conditions. To restate the multiport considerations in another way, justification of the recommendation for this study is not based on the assumption that cargo will shift to Wilmington with deepening alone. The analysis assumes Wilmington receives the same share of regional cargo volumes with or without the modification of the waterway.