APPENDIX B

SOCIO-ECONOMICS

FINAL
FEASIBILITY REPORT
AND ENVIRONMENTAL IMPACT STATEMENT
PORT EVERGLADES HARBOR NAVIGATION STUDY
BROWARD COUNTY, FLORIDA

Executive Summary

Port Everglades is a port of national significance, located in heavily-populated southeast Florida. It is the 3rd busiest cruise port in the world, and 2nd in Florida for total tonnage. Port Everglades supplies southeast Florida with nearly all of its liquid petroleum products, such as gasoline, diesel, and jet fuel.

Currently there are navigational constraints, which cause vessel delays and loading inefficiencies. Particularly, there is a blockage of access to the Southport Access Channel for large containerships while large cruise ships occupy adjacent berth spaces. These problems will be exacerbated in the future as volume of cargo throughput and number of vessel calls increase.

The objectives of the project are to improve navigational conditions in the harbor. These improvements are expected to reduce congestion, improve navigational safety, accommodate recent and anticipated future growth in cargo and cruise vessel traffic, improve the efficiency of operations for cargo vessels and cruise ships within the Port complex, and allow for larger cargo vessels to use Port Everglades more efficiently through increased vessel loading.

This economic analysis examined widening and deepening. The HarborSym model was used to determine total transportation costs attributable to the study port. Transportation cost savings were determined based on the difference in total transportation costs between the with- and without-project conditions.

Based on the results of the transportation cost savings analysis, the National Economic Development (NED) plan is to widen and deepen to a project depth of 47 feet. The 48-foot alternative did result in higher net benefits by approximately $400,000, however in accordance with USACE policy guidance ER 1105-2-100 Exhibit G-1 3.c which states “when two cost-effective plans produce no significantly different levels of net benefits; the less costly plan is to be the NED plan” a corporate decision determined that 47 feet was the NED plan. The non-federal sponsor, Broward County, requested and was approved for a locally preferred plan (LPP) of 48-feet. Therefore, the Recommended Plan is the LPP which includes deepening the Federal channel to 48 feet. It provides average annual net benefits of $31,400,000 and has a benefit-cost ratio (BCR) of 2.90:1 at 3.375%.

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1 Introduction

The U.S. Army Corps of Engineers (USACE) Deep Draft Navigation Planning Center of Expertise (DDNPCX) has conducted an economic analysis to determine the feasibility of improvements to the Federal navigation project at Port Everglades Harbor (Port Everglades). Port Everglades is one of the largest multi-purpose cargo and cruise ports on the South Atlantic coast. Port Everglades is Florida's second largest cargo port in terms of total tonnage (Table 1) and the 31st ranked cargo port nationally[1]. Port Everglades is also the third busiest cruise port in the world, as measured by total annual multi-day passengers, with only 2% fewer passengers than the world's largest cruise port (Miami). In addition to supporting international tourism to South Florida, the Port helps to support South Florida's large year-round resident population, and many seasonal residents through the imports of manufactured goods and petroleum products.

Table 1. Port Everglades Rankings for Cargo Tonnage and Cruise Passenger Throughput

Calendar Year 2011 Total Cargo Tonnage (short tons)		
National Ranking	**Florida Port**	**Total Tonnage**
22	Tampa, FL	31,407,913
31	**Port Everglades, FL**	**20,955,921**
38	Jacksonville, FL	16,827,591
61	Miami, FL	7,177,761

Fiscal Year 2012 Multi-day Cruise Passengers		
World Ranking	**Port**	**Multi-day Cruise Passengers**
1	Miami, FL	3,774,452
2	Port Canaveral, FL	3,761,056
3	**Port Everglades, FL**	**3,689,022**

Sources: Tonnage data: AAPA statistics;
Passenger data: Port statistics and bizjournals.com
Notes: Fiscal Year 2012 = 01 Oct 11 through 30 Sep 12;
Passengers counted at embarkation and debarkation.

1.1 Background, Problems and Objectives

The last major improvements to the navigation channels at Port Everglades occurred in the 1980s[2]. Since that time, cargo and cruise traffic at the Port have increased substantially, resulting in increased

[1] More details are provided in Section 1.3 Port Everglades and the South Florida Economy.

[2] More details are provided in Section 3.1 Infrastructure.

congestion. Additionally the world fleet of cargo vessels has become larger than the existing channel dimensions[3] can accommodate, resulting in transportation cost inefficiencies. Potential channel improvements to increase efficiency of port operations include deepening and widening of navigational channels, and channel realignment at the port. The purpose of these potential improvements is to increase the efficiency of cargo vessel operations and to fully accommodate larger cruise ships and containerships, which are already calling at the port, and are projected to use the port increasingly in the future.

This economic analysis evaluated project alternatives that will:

1) reduce congestion,
2) improve navigational safety,
3) accommodate recent and anticipated future growth in cargo and cruise vessel traffic,
4) improve the efficiency of operations for cargo vessels and cruise ships within the Port complex, and
5) allow for larger cargo vessels to use Port Everglades more efficiently through increased vessel loading.

1.2 Location

Port Everglades is located on the southeast coast of Florida in Broward County in the cities of Hollywood, Dania Beach and Fort Lauderdale. The port is approximately 20 nautical miles north of Port Miami, 40 nautical miles south of the Port of Palm Beach, 144 nautical miles south of Port Canaveral, and 270 nautical miles south of Jacksonville Harbor (Figure 1).

Port Everglades lies on 2,190 acres within the urban, eastern section of Broward County (Figure 2). To the east of the Port is a barrier island that contains a U.S. Navy facility, the Nova Southeastern University (NSU) Oceanographic campus, U.S. Coast Guard (USCG) Station Ft. Lauderdale, and John U. Lloyd Beach State Park and adjacent beaches. The Atlantic Intracoastal Waterway runs in a generally north-south direction to the immediate east of the Port and west of the barrier island. The Port's southern boundary is the Dania Cutoff Canal, which is adjacent to an undeveloped coastal ecosystem known as West Lake Park. Immediately west of the Port is the Fort Lauderdale/Hollywood International Airport. North of the Port is a mixture of small craft waterways and commercial and residential development.

[3] More details on existing channel dimensions are provided in Section 3.1, Table 10.

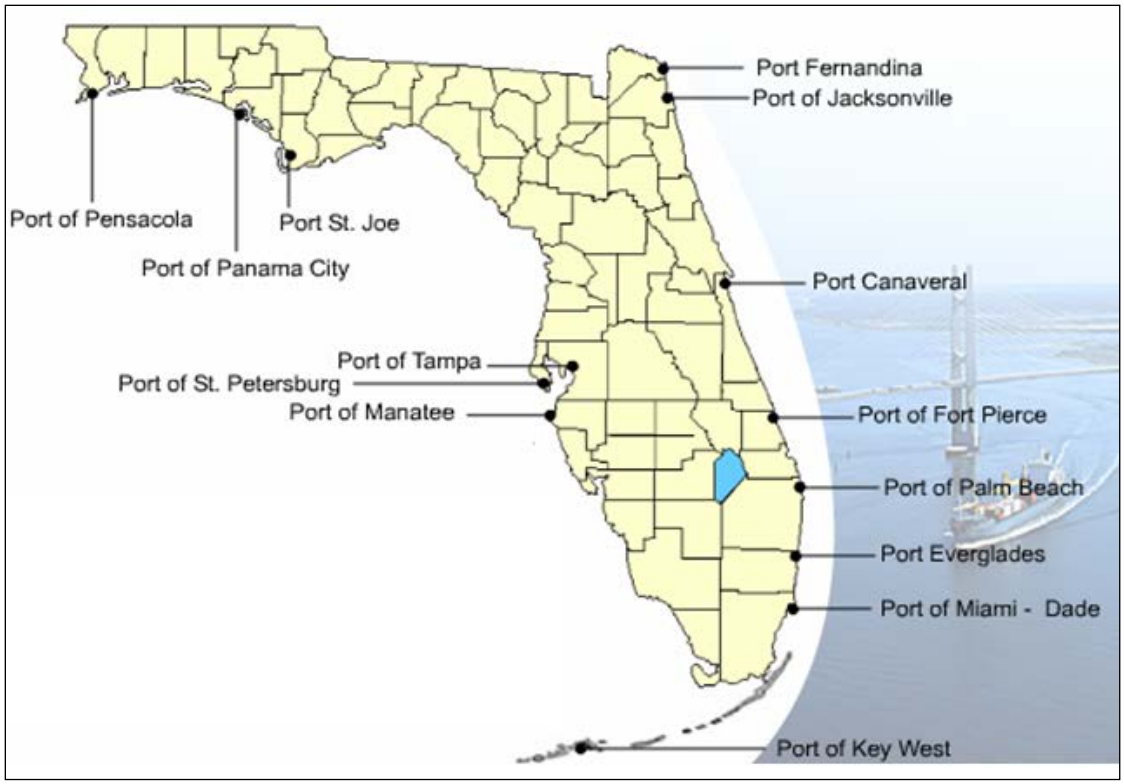

Figure 1. Florida Seaports

Source: *Florida Ports Council (http://www.flaports.org).* Notes: Not to scale. Locations are approximate.

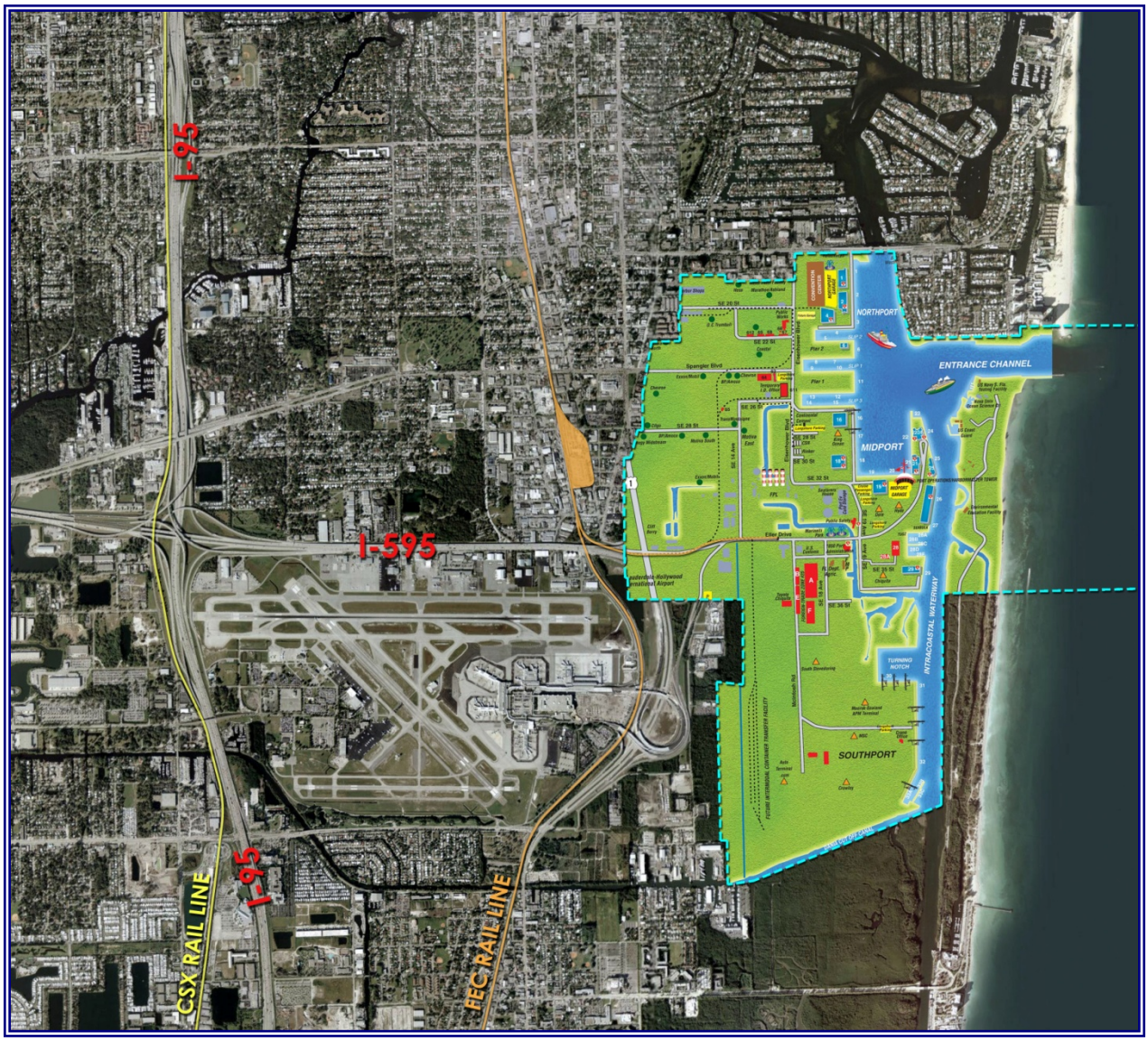

Figure 2. Port Everglades Boundary and Vicinity Map
Source: 2009 Port Everglades Master/Vision Plan

1.3 Port Everglades and the South Florida Economy

Port Everglades is a port of world, national, and regional significance. Port Everglades is the third largest cruise port in the world with only 2% fewer multi-day passengers (Table 1) than the world's largest cruise port (Miami). Port Everglades is the homeport for the world's largest cruise ships, Royal Caribbean International's Oasis Class (*Oasis of the Seas* and *Allure of the Seas*), with lengths of nearly 1,200 feet, passenger capacities of up to 6,300 and a crew of more than 2,000. In Fiscal Year (FY) 2012,

Port Everglades had 838 cruise ship calls (including ferry calls), including 199 calls by cruise ships longer than 1,000 feet, and 344 calls by Post-Panamax beam[4] cruise ships.

As a cargo port, Port Everglades is the second largest Florida port in terms of foreign trade tonnage and domestic trade tonnage (Table 2) and is the largest Florida Atlantic coast port in terms of total tonnage. Port Everglades supplies South Florida with nearly all of its liquid petroleum products (including gasoline, diesel, and jet fuel). In FY 2012, two-thirds of the Port's total cargo tonnage throughput was liquid petroleum (Figure 3).

Table 2. Florida Ports Cargo Tonnage Ranking in 2011

Total Trade		
National Ranking	**Port**	**Short Tons**
22	Tampa, FL	31,407,913
31	**Port Everglades, FL**	**20,955,921**
38	Jacksonville, FL	16,827,591
61	Miami, FL	7,177,761
Foreign Trade		
National Ranking	**Port**	**Short Tons**
32	Tampa, FL	10,451,809
33	**Port Everglades, FL**	**10,375,243**
34	Jacksonville, FL	10,002,705
39	Miami, FL	7,007,219
Domestic Trade		
National Ranking	**Port**	**Short Tons**
15	Tampa, FL	20,956,104
27	**Port Everglades, FL**	**10,580,678**
42	Jacksonville, FL	6,824,886
138	Miami, FL	170,542

Source: Waterborne Commerce Statistics Center

[4] Post-Panamax beam is defined as a beam greater than 106 ft; it is the limiting width of the existing Panama Canal locks.

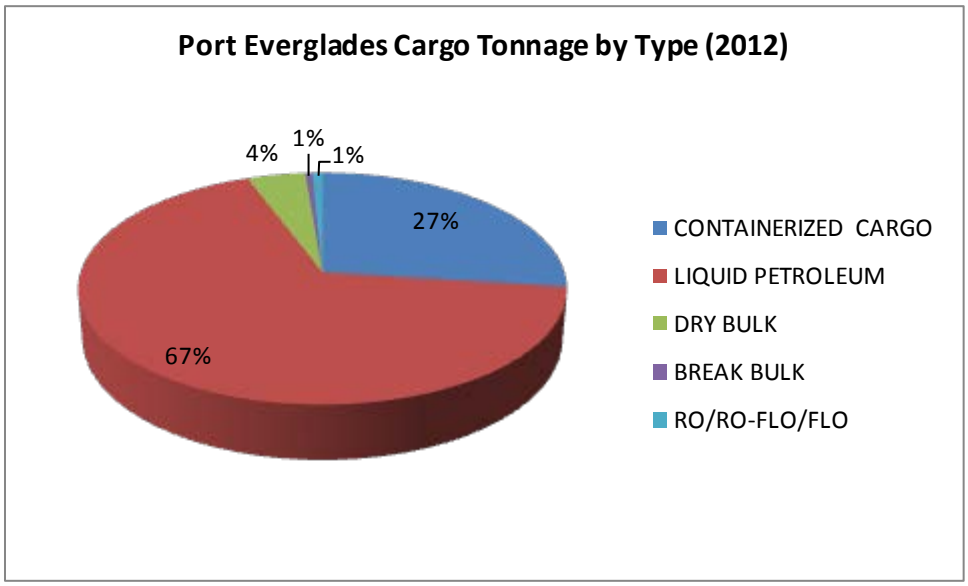

Figure 3. Port Everglades Cargo Tonnage by Type in 2012
Source: Port Everglades Waterborne Commerce Chart 2012

The value of foreign trade exports through Port Everglades in 2012 (nearly $14 billion) was greater than the foreign trade export value of any other Florida port (Table 3). Port Everglades also had the second highest total foreign trade value ($24.3 billion) of all Florida ports in calendar year 2012.

Table 3. Florida Ports Foreign Trade Value in 2012

	Imports	Exports	Total
Port Canaveral	$1,360,901,150	$180,096,311	$1,540,997,461
Port Everglades	**$10,366,436,078**	**$13,981,854,199**	**$24,348,290,277**
Fernandina	$10,987,347	$248,378,801	$259,366,148
Fort Pierce	$13,798,472	$89,244,282	$103,042,754
Jacksonville	$11,379,732,227	$11,713,827,070	$23,093,559,297
Manatee	$370,891,475	$181,823,787	$552,715,262
Miami	$13,456,899,892	$11,861,466,312	$25,318,366,204
Palm Beach	$552,526,002	$1,425,564,468	$1,978,090,470
Panama City	$2,689,495,868	$648,293,768	$3,337,789,636
Pensacola	$1,039,264	$208,732,670	$209,771,934
Tampa	$2,136,164,100	$2,660,699,978	$4,796,864,078

Note: Values are for calendar year 2012;
Source: The Five-Year Florida Seaport Mission Plan (2013 – 2017)

In addition, related port users throughout Florida generate substantial economic activity (Table 4). These include manufacturers and wholesale and retail distribution firms, which use Port Everglades but may also use other ports and therefore are not totally dependent on Port Everglades. These related port users generate:

- 173,300 related user jobs,
- $6.1 billion in personal income,

- $22.8 billion in business activity, and
- $0.57 billion state and local taxes.

Table 4. Port Everglades Regional Economic Impact

Jobs	**Cargo**	**Cruise**	**Total**
Direct	6,211	5,476	11,687
Induced	5,114	3,052	8,166
Indirect	4,392	3,855	8,247
Sub-total	**15,717**	**12,383**	**28,100**
Related Users	173,272	N/A	173,272
Total	**188,989**	**12,383**	**201,372**
Personal Income ($000's)	**Cargo**	**Cruise**	**Total**
Direct	$281,664	$164,173	$445,837
Induced	$632,673	$312,588	$945,261
Indirect	$205,505	$122,369	$327,874
Sub-total	**$1,119,842**	**$599,130**	**$1,718,972**
Related Users	$6,122,998	N/A	$6,122,998
Total	**$7,242,840**	**$599,130**	**$7,841,970**
Business Activity ($000's)	**Cargo**	**Cruise**	**Total**
Business Services	$1,022,151	$1,846,552	$2,868,703
Related User Output	$22,802,366	N/A	$22,802,366
Total	**$23,824,517**	**$1,846,552**	**$25,671,069**
Local Purchases ($000's)	Cargo	Cruise	Total
Local Purchases	$415,990	$170,480	$586,469
State & Local Taxes ($000's)	**Cargo**	**Cruise**	**Total**
Direct, Indirect & Induced	$104,145	$55,719	$159,864
Related User Taxes	$569,439	N/A	$569,439
Total	**$673,584**	**$55,719**	**$729,303**

Source: The Local and Regional Economic Impacts of Port Everglades – FY 2012 Final Report

1.4 Appendix Overview

The remaining sections of this appendix will guide the reader through the economic analysis of the project. By the end of Section 3, a complete picture of all existing conditions will be evident. Section 2 explores the study area and hinterland in more detail. In Section 3, the existing conditions and Port's infrastructure are described. Section 3 also provides more details on existing and historical commodity movements, vessel calls, and growth trends.

Once all of the existing conditions have been described, the appendix moves on to describe the details of future conditions in Section 4 though Section 9. First, in Section 4, Port infrastructure improvements that will be constructed with- or without the project are identified. Section 5 then focuses on the future commodity movements that are forecasted to transit through the Port in the with- and without-project conditions. Section 6 discusses the future without-project conditions, including vessel movements. Then, to address the problems described in the existing conditions and future without-project conditions, Section 7 depicts the project alternatives that were evaluated for their ability to meet the project objectives and provide quantifiable economic benefits from transportation cost savings. The general assumptions used throughout the with-project analysis are identified in Section 8. The results of

applying the commodity forecast to the fleet forecast are described in Section 9. By the end of Section 9, all future with- and without-project conditions have been explained.

The method for evaluation of alternatives and results of the analysis are detailed in Section 11 and Section 12, respectively. The final appendix sections discuss regional economic benefits, sensitivity and scenario analyses and summarize the report findings.

2 Study Area

In this section, the study area and hinterland are explored in more detail. While the footprint of the project is contained within Port Everglades Harbor, the surrounding area that will be most directly affected economically by the project includes a majority of South Florida, particularly Broward, Miami-Dade, and Palm Beach Counties. All Florida counties are shown labeled in Figure 4.

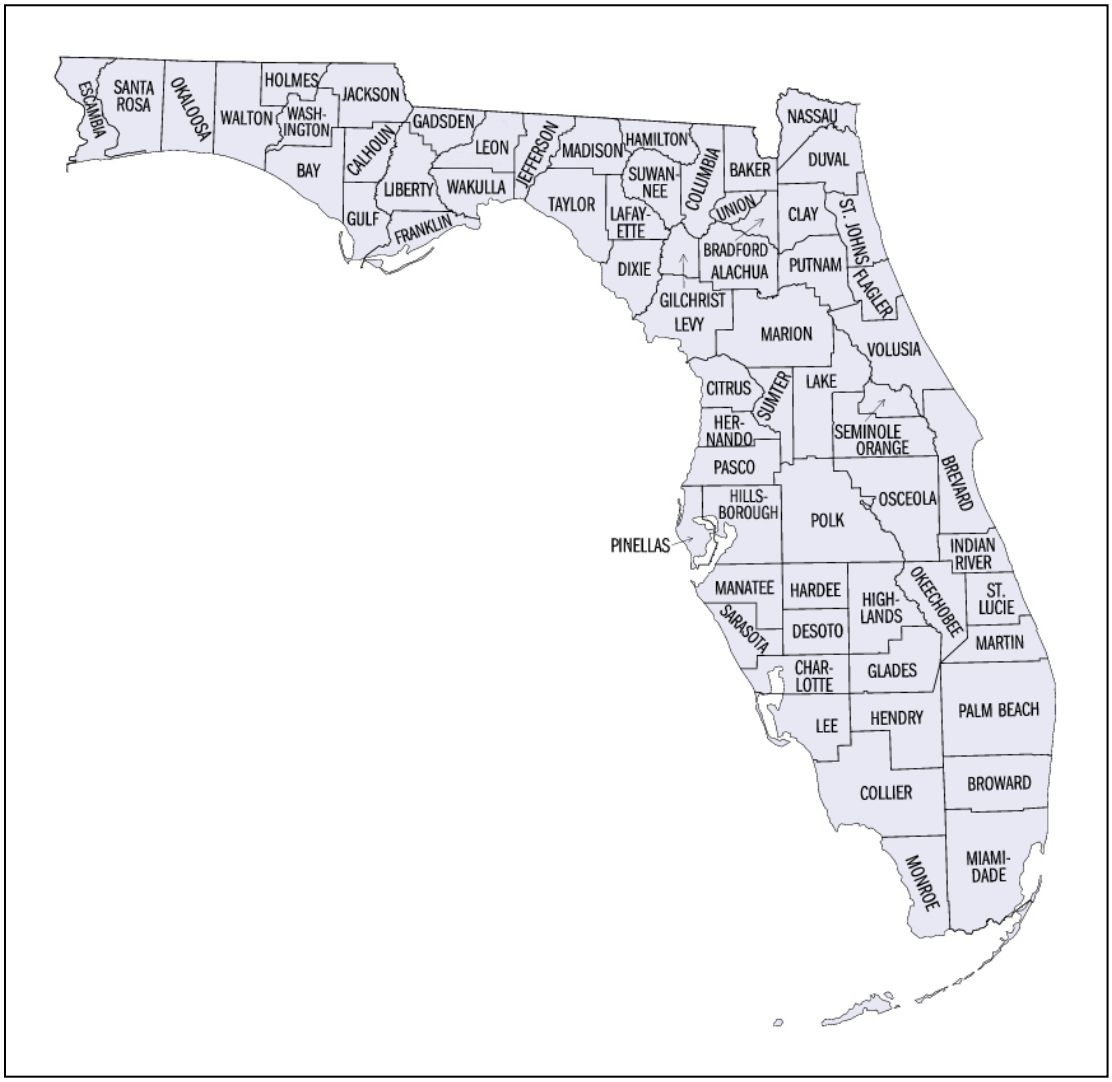

Figure 4. Florida Counties Map
Source: U.S. Census Bureau

2.1 Demographics

Population growth in the area has been rapid since 1950 (Table 5). This growth can be attributed to Florida's ideal climate and historically low property costs, warm climate, and abundant recreation opportunities. Over the last 60 years Broward County population increased from 83,933 in 1950 to 1,748,066 in 2010, an increase of over 2,000%. Due to a more established community, Miami-Dade County achieved less growth than Broward County, or the State as a whole. As seen in Table 5, Florida population grew over 500% in the 60-year span.

Population statistics for the past sixty years for the nine-county South Florida region are presented in Table 5. As a subset of Florida population, the summed total of these nine counties comprises a slowly increasing percentage share of the Florida state population over most of the period. Although the populations of the counties were increasing in absolute numbers from 1970-2000, their share of Florida's population did not change substantially over this period. However, from 2000 to 2010, the South Florida regional share of Florida state population increased to its highest percentage share ever at 40.6%.

Additionally, the proportional share of the population within the nine-county area has changed over the fifty-year period. Miami-Dade County's share of the nine-county population total population has declined from nearly 65% in 1950 to 43.5% in 2010. In contrast, Broward County's share of the regional total has nearly tripled over the sixty-year period (from 10.9% in 1950 to 30.5% in 2010). Palm Beach County's share of the nine-county population has increased by 50% over the last fifty years (from 15% in 1950 to 23% in 2010). While each county has seen an increase in its total population, the most rapid growth in population has been concentrated in Broward, Palm Beach, Martin, and Lee counties. These growth trends clearly illustrate that while Miami-Dade County still has the largest population, its share is declining as Broward and Palm Beach Counties to the north increase their regional share of population. The South Florida region continues to increase its share of State population by outpacing the State population growth rate.

South Florida is also home to the most ethnically diverse populations of the entire state. For the total population of Florida, approximately 17% classify themselves as African Americans while 22.5% classify their heritage as Hispanic or Latino (Table 6). In the nine-county South Florida region, the populations of Miami-Dade and Broward counties contained 49% of the Florida Latino population and 31% of the Florida African American population.

A pattern of median household income increasing with median age is exhibited across the three most populous counties in coastal South Florida (Miami-Dade, Broward, and Palm Beach). When median age is viewed at the county level (Figure 5), median age increases from Miami-Dade County to Broward County to Palm Beach County. Median household income also increases from Miami-Dade County northward (Figure 6). Palm Beach County has the highest median age and household income of the three counties. Miami-Dade County has the lowest median age and household income. Broward County has median ages and household incomes most similar to the national average.

Table 5. Historical Population Growth Statistics for Select South Florida Counties

Area	2010		2000		1990		1980		1970		1960		1950	
Florida	18,801,310		15,982,378		12,937,926		9,746,324		6,789,443		4,951,560		2,771,305	
	Population	%	Population	%	Population	%	Population	%	Population	%	Population	%	Population	%
Glades	12,884	0.2%	10,576	0.2%	7,591	0.2%	5,992	0.2%	3,669	0.1%	2,950	0.2%	2,199	0.3%
Hendry	39,140	0.7%	36,210	0.6%	25,773	0.6%	18,599	0.5%	11,859	0.5%	8,119	0.5%	6,051	0.8%
Lee	618,754	10.8%	440,888	7.7%	335,113	7.2%	205,266	5.7%	105,216	4.3%	54,539	3.3%	23,404	3.1%
Martin	146,318	2.6%	126,731	2.2%	100,900	2.2%	64,014	1.8%	28,035	1.1%	16,932	1.0%	7,807	1.0%
Miami-Dade	2,496,435	43.5%	2,253,362	39.3%	1,937,094	41.8%	1,625,781	45.2%	1,267,792	51.8%	935,047	57.2%	495,084	64.6%
Monroe	73,090	1.3%	79,589	1.4%	78,024	1.7%	63,188	1.8%	52,586	2.1%	47,921	2.9%	29,957	3.9%
Broward	1,748,066	30.5%	1,623,018	28.3%	1,255,488	27.1%	1,018,200	28.3%	620,100	25.3%	333,946	20.4%	83,933	10.9%
Okeechobee	39,996	0.7%	35,910	0.6%	29,627	0.6%	20,264	0.6%	11,233	0.5%	6,424	0.4%	3,454	0.5%
Palm Beach	1,320,134	23.0%	1,131,184	19.7%	863,518	18.6%	576,863	16.0%	348,753	14.2%	228,106	14.0%	114,688	15.0%
County SubTotal	6,494,817	40.6%	5,737,468	35.9%	4,633,128	35.8%	3,598,167	36.9%	2,449,243	36.1%	1,633,984	33.0%	766,577	27.7%

Source: U.S. Census Bureau

Table 6. Population Breakdown by Race and Ethnicity for Select South Florida Counties

County	White	African-American	Other	Total	Hispanic or Latino (of any race)
Florida	77.1%	17.0%	5.9%	100%	22.5%
Glades	72.4%	12.7%	14.9%	100%	21.1%
Hendry	62.1%	14.0%	23.9%	100%	49.2%
Lee	84.8%	9.1%	6.1%	100%	18.3%
Martin	88.6%	5.9%	5.5%	100%	12.2%
Miami-Dade	75.6%	19.9%	4.5%	100%	65.0%
Monroe	91.1%	6.3%	2.6%	100%	20.6%
Okeechobee	79.2%	8.6%	12.2%	100%	23.9%
Palm Beach	75.2%	18.3%	6.5%	100%	19.0%
Broward	65.1%	28.2%	6.7%	100%	25.1%

Source: U.S. Census Bureau, 2010

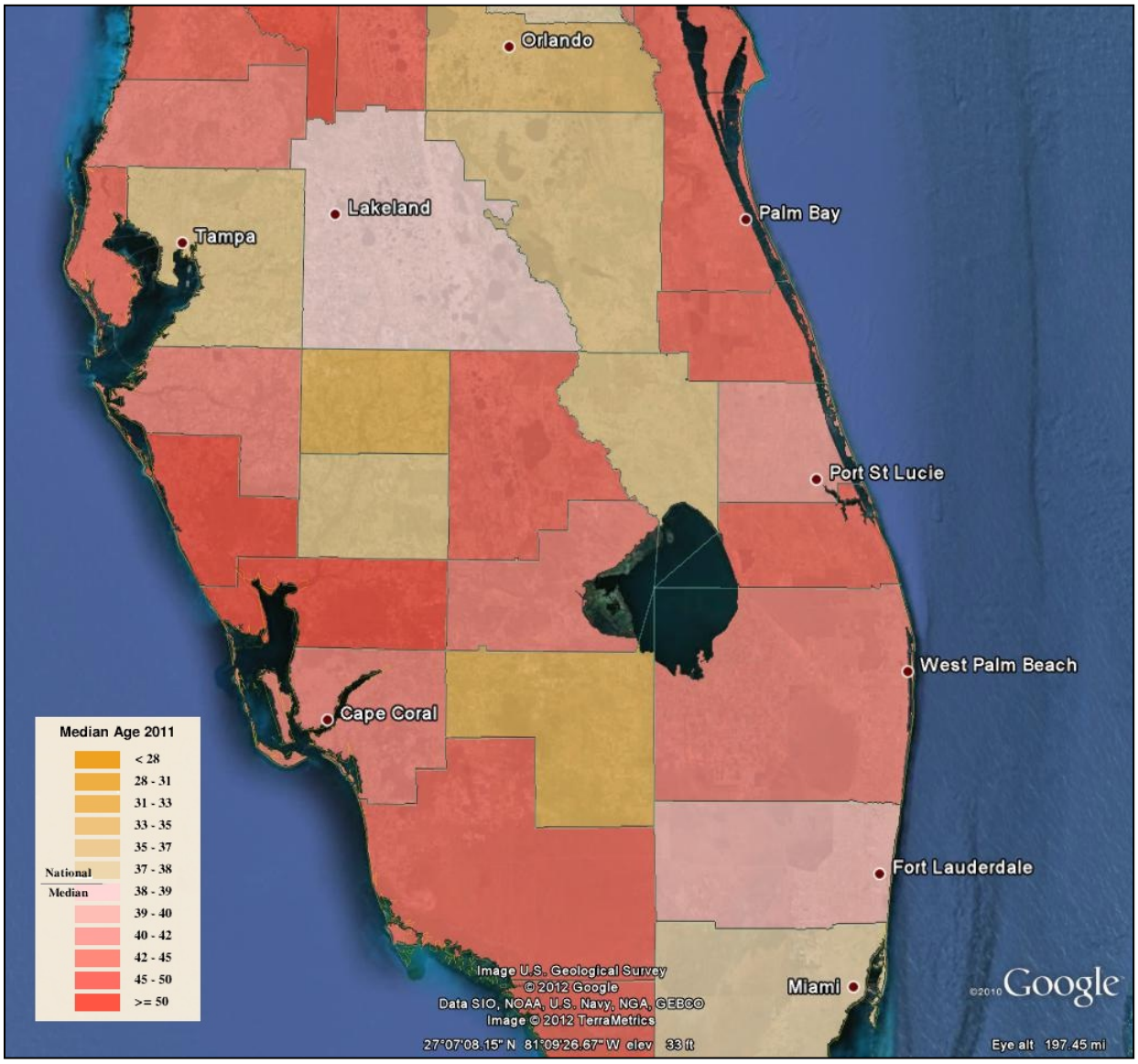

Figure 5. South Florida Median Age by County
Source: The Nielsen Company, 2011

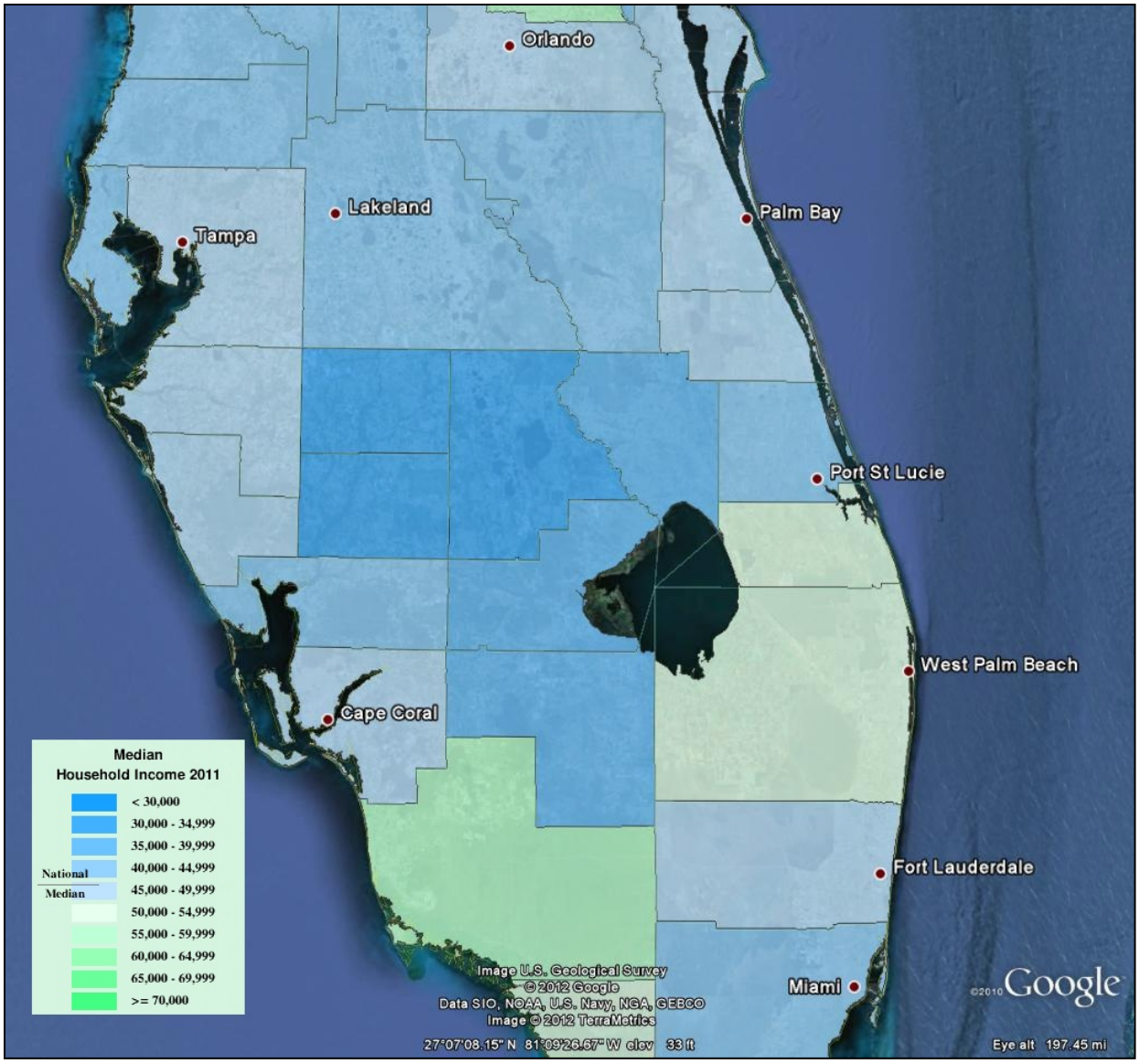

Figure 6. South Florida Median Household Income by County
Source: The Nielsen Company, 2011

In the future, Florida population is projected to grow a slower rate than historical. Population projections (Table 7) for Port Everglades' primary hinterland indicate a slow, but steady growth through 2040 exhibiting a thirty-year compound annual growth rate (CAGR) of 0.88%.

Table 7. Port Everglades Primary Hinterland Population Projections (2010-2040)

	Census	Projections					
	2010	2015	2020	2025	2030	2035	2040
Florida	18,801,310	19,664,972	21,021,643	22,329,543	23,567,010	24,730,724	25,846,980
Broward	1,748,066	1,775,264	1,816,224	1,853,626	1,886,564	1,915,231	1,946,355
Charlotte	159,978	164,784	173,129	181,028	188,302	194,940	201,123
Collier	321,520	341,959	375,585	408,254	439,367	468,770	497,011
Desoto	34,862	35,460	36,709	37,924	39,094	40,214	41,300
Glades	12,884	13,286	14,135	14,953	15,723	16,442	17,127
Hendry	39,140	38,488	39,615	40,665	41,620	42,484	43,279
Indian River	138,028	145,613	158,501	170,931	182,584	193,592	204,134
Lee	618,754	674,992	763,232	847,963	928,484	1,004,503	1,077,279
Martin	146,318	151,590	160,897	169,792	178,093	185,773	193,017
Miami-Dade	2,496,435	2,591,790	2,717,631	2,840,533	2,959,348	3,071,498	3,179,748
Monroe	73,090	72,074	70,863	69,702	68,624	67,633	66,700
Okeechobee	39,996	40,887	42,548	44,133	45,577	46,879	48,157
Palm Beach	1,320,134	1,372,682	1,461,234	1,546,129	1,625,651	1,699,536	1,769,470
Sarasota	379,448	394,783	420,152	444,483	467,286	488,487	508,564
Hinterland Sub-total	7,528,653	7,813,652	8,250,455	8,670,116	9,066,317	9,435,982	9,793,264
5-year CAGR		0.75%	1.09%	1.00%	0.90%	0.80%	0.75%

Source: University of Florida, Bureau of Economic and Business Research, 2013

2.2 Hinterland

The hinterland for the Port is defined by the land transportation costs relative to other ports with similar facilities and services. For refined liquid petroleum products, such as gasoline, diesel, fuel oil and jet fuel, Port Everglades is the primary port of entry for nearly all (over 95%) of these products consumed in south Florida counties (Miami-Dade, Broward, Palm Beach, and Martin) that move via water.

Port Everglades' primary hinterland for containerized cargo includes all of south Florida, where the Port competes with other Florida ports in terms of over-the-road freight costs (Figure 7). As shown (in yellow) Port Everglades offers the least cost truck routing to serve the counties surrounding Lake Okeechobee, and overlaps with Port Miami for both Broward and Miami-Dade Counties (shown in orange). Port Everglades' least-cost truck routing also overlaps with the Port of Tampa in Lee County (shown in orange). The Port of Tampa has the pure truck cost advantage to serve the Tampa and Orlando markets (shown in purple), which is due to the amount of distribution centers along the I-4 Corridor. Additionally, for some cargo destined for or originating from the west and east coasts of South America, Central America, and the Caribbean, for which Port Everglades is the only Southeastern U.S. port on the service, the Port's hinterland can include farther reaching areas of the Southeastern U.S. than shown in Figure 7.

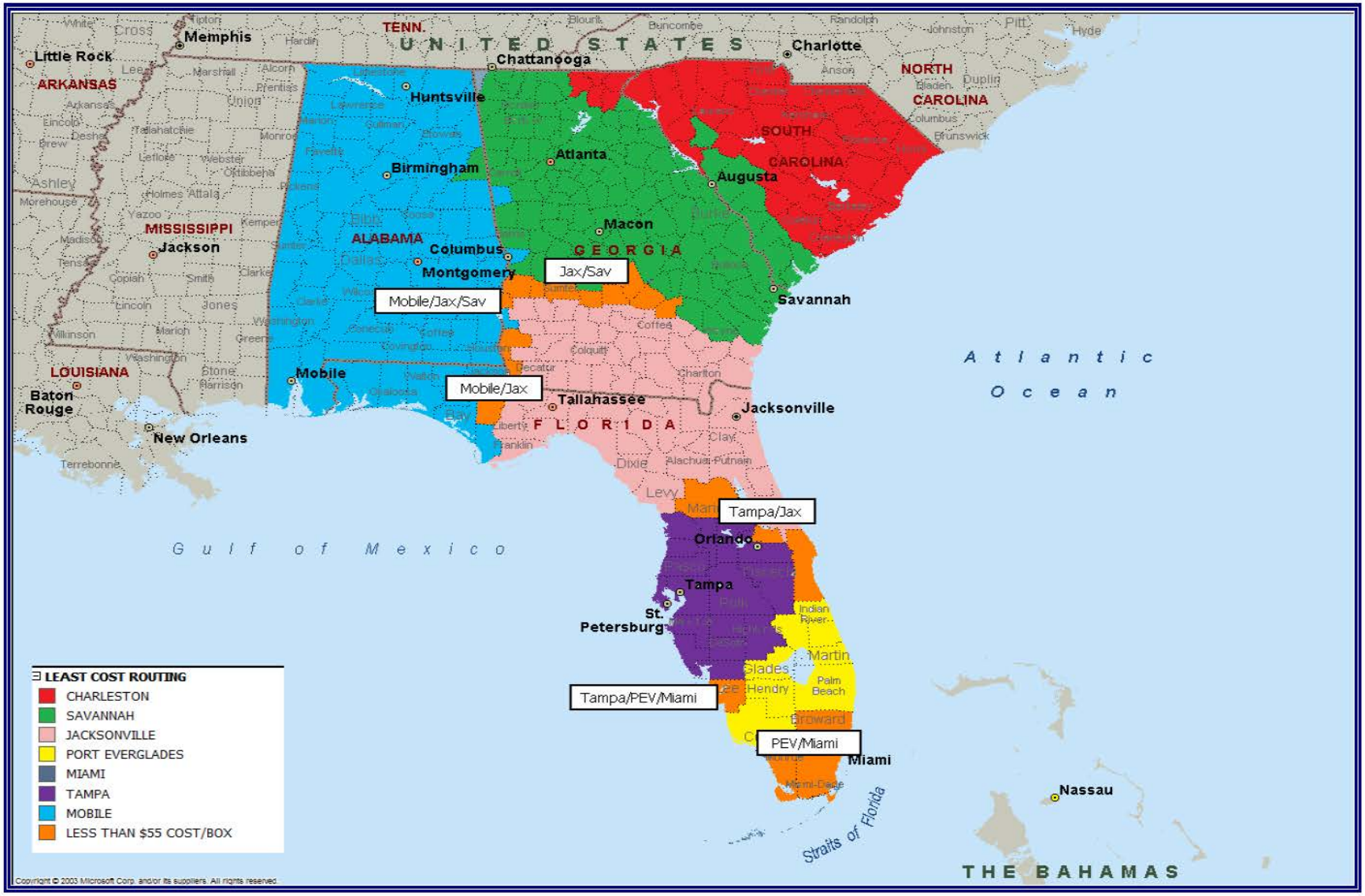

Figure 7. Truck Cost-Effective Hinterland Excluding Rail Competition

Source: Port Everglades Master Plan – Element 2: Market Assessment, 2009

2.2.1 Multi-port Analysis

The closest major ports to Port Everglades are Port of Palm Beach to the north and Port Miami to the south (Figure 1). Further to the north, the next major ports after Palm Beach are Port Canaveral and Jacksonville. Figure 8, below, shows that the Port Everglades is in close proximity to large, deep-draft ports, but Port Everglades has much greater cargo throughput than Miami to the south, and Port of Palm Beach and Port Canaveral to the north. Port Canaveral and Jacksonville generally move similar cargo types as Port Everglades but their hinterlands do not overlap substantially enough to compete for traffic. Port of Palm Beach is more of a niche port with regard to its cargo and vessel types, which means that its cargo does not normally compete directly with other nearby ports. Therefore, growth at the Port of Palm Beach will not affect growth in Port Everglades, which shares the same hinterland. The Port of Miami has significant overlap in hinterland with Port Everglades but its cargo throughput is much less than Port Everglades. This is mainly due to the fact that Port Everglades has facilities for movements of substantial quantities dry bulk and liquid bulk, while Miami does not. Therefore, Port Miami does not compete with Port Everglades for its dry bulk (cement and aggregate) and liquid bulk (refined petroleum products) cargo throughput (due to lack of facilities for these cargo types at this time).

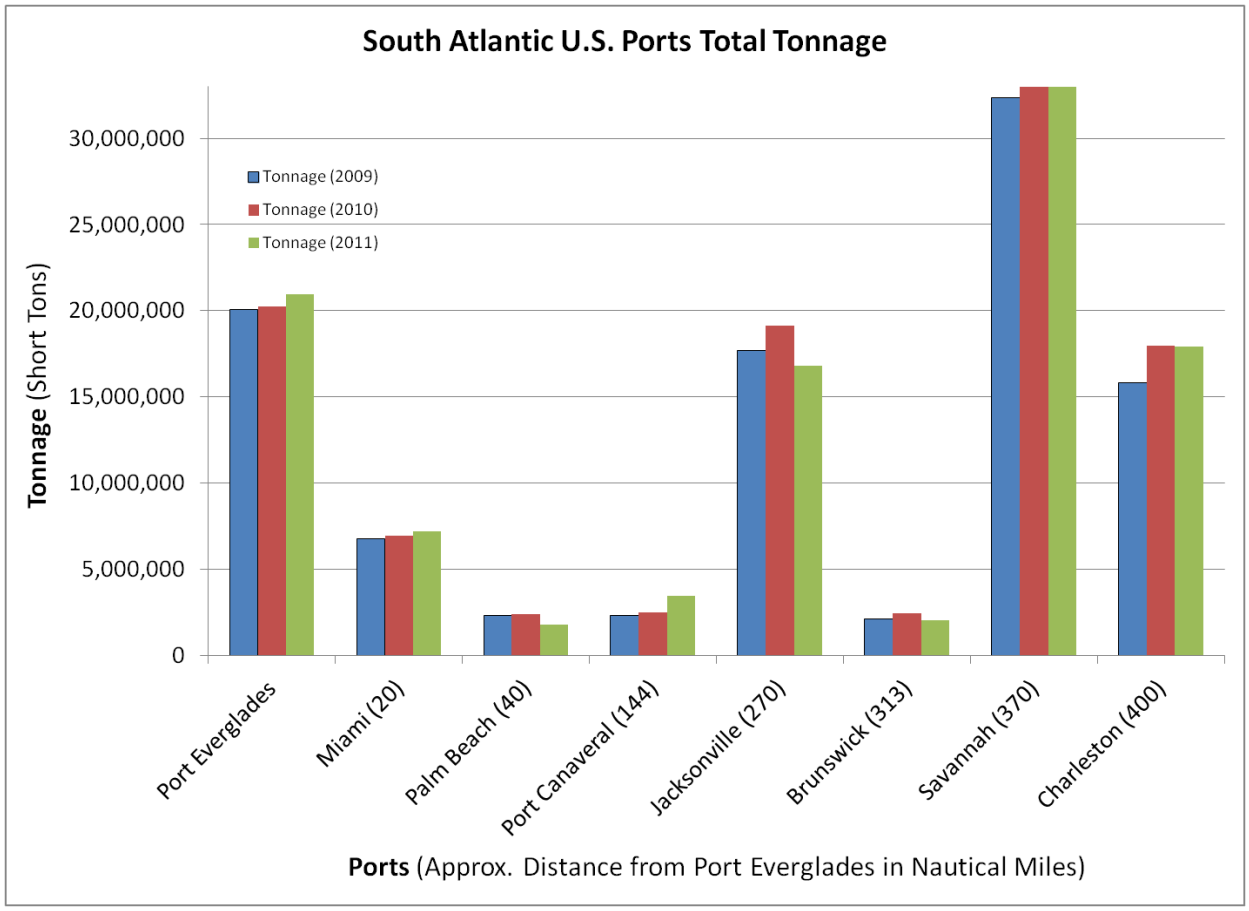

Figure 8. Comparison of South Atlantic U.S. Ports Total Tonnage
Source: USACE, Waterborne Commerce Statistics Center

2.3 Support of Local, State, and National Economy

Generally, tourism, strong wholesale and retail trade, government and service sectors characterize Florida's economy. Florida's warm weather and extensive coastline attracts vacationers and other visitors and helps make the state a significant retirement destination for people all over the country. Agricultural production is also an important sector of the state's economy. Compared to the national economy, the manufacturing sector has played less of a role in Florida, but high technology manufacturing has begun to emerge as a significant sector in the State over the last decade.

Of the nine counties shown in Table 8, the three largest, Broward, Miami-Dade and Palm Beach employ approximately 35% of Florida's work force and account for approximately 33% of state income. Table 9 indicates the importance of relatively low paying employment in the three counties of greatest economic impact. The results coincide with state averages across employment sectors and reflect the relative importance of industries related to tourism (retail, food service), the aged populations of South Florida (health care) and the growth experienced in Florida (construction).

Table 8. Employment as a Percentage of State Employment for Select South Florida Counties

County	Number of Wage & Salary Employees	Annual Wage & Salary Disbursements ($1,000)	Employee Percentage	Annual Salary Percentage
Florida	7,632,084	323,659,342	100%	100%
Glades	1,938	66,153	0.03%	0.02%
Hendry	14,224	418,654	0.19%	0.13%
Lee	208,538	8,238,828	2.73%	2.55%
Martin	59,631	2,378,068	0.78%	0.73%
Miami-Dade	1,038,010	48,445,712	13.60%	14.97%
Monroe	37,959	1,513,204	0.50%	0.47%
Okeechobee	11,016	364,625	0.14%	0.11%
Palm Beach	542,388	25,182,540	7.11%	7.78%
Broward	745,587	33,403,592	9.77%	10.32%
Select Counties Subtotal	2,659,291	120,011,376	35%	37%

Source: U.S. Bureau of Economic Analysis, 2010

Table 9. Employment by Industry for Three Major South Florida Counties

Industry	Broward County	Miami-Dade County	Palm Beach County	Three-County Total	Percentage of Employment by Industry
Health Care & Education	171,463	217,787	123,750	513,000	21%
Retail Trade	112,360	130,845	81,326	324,531	13%
Professional & Administration	108,344	134,619	81,209	324,172	13%
Food Service & Hospitality	86,607	112,057	63,721	262,385	11%
Construction	49,957	74,255	39,760	163,972	7%
Manufacturing	40,905	54,937	22,709	118,551	5%
Major Industry Sub-Total	398,173	506,713	288,725	1,193,611	48%
Total	826,452	1,075,625	577,572	2,479,649	100%

Source: U.S. Bureau of Economic Analysis, 2010

In 2010, the Miami-Fort Lauderdale-Pompano Beach Metropolitan Statistical Area (MSA) accounted for nearly 36% of Florida state real GSP (gross state product). The contributions to Gross Metropolitan Product (GMP) by industry are shown in Figure 9. The real estate industry is the largest contributor, followed by government expenditures and wholesale trade. Other large contributors include finance and insurance industry, retail trade, professional and technical services, and health care and social assistance.

The cruise industry and associated tourism supported by Port Everglades also contributes heavily to the local economy. Broward County accommodates visitors to the region by offering quality tourism infrastructure, comprised of airports, hotels, retail venues, and other entertainment facilities, all within close proximity to Port Everglades via major roadways.

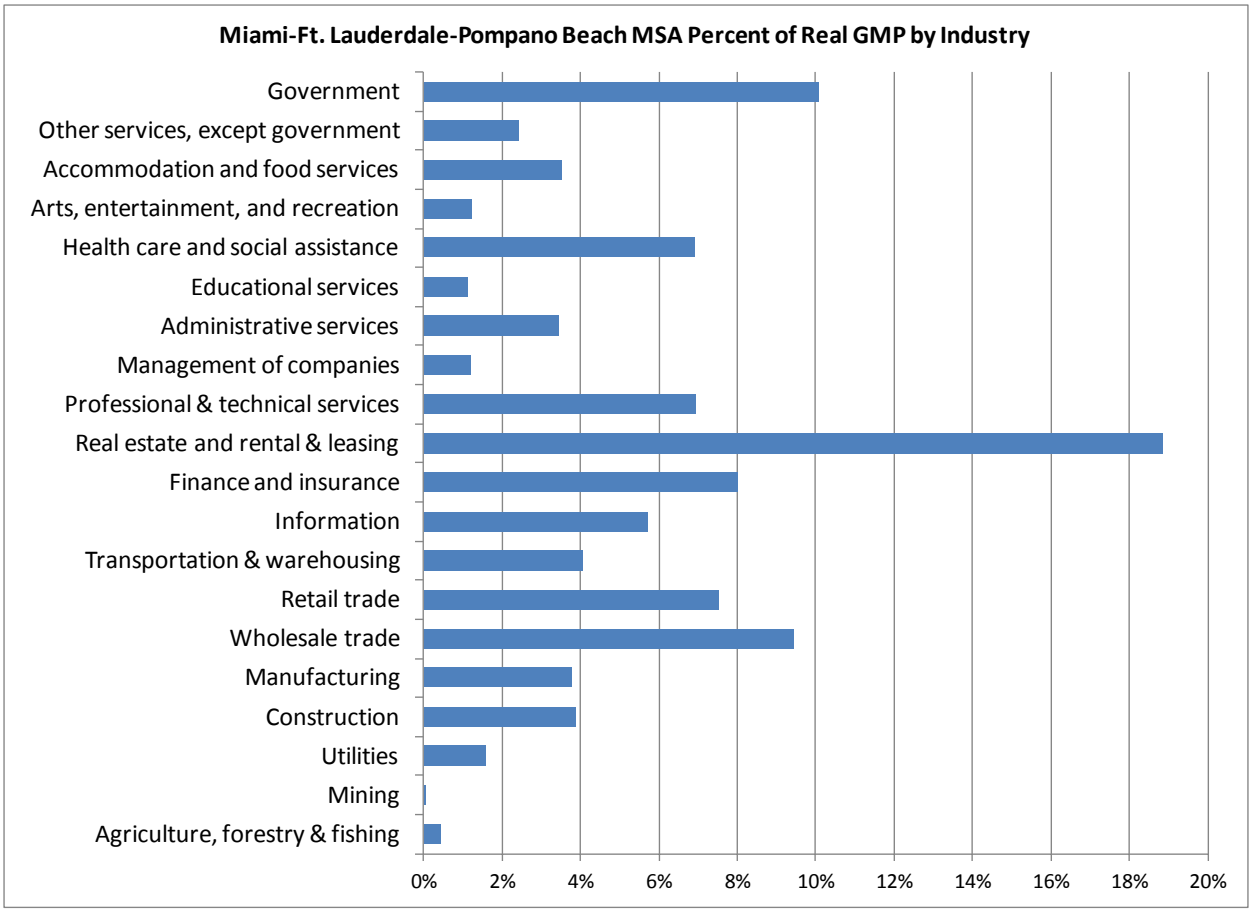

Figure 9. Miami-Ft. Lauderdale-Pompano Beach MSA Percent of Real GMP by Industry, 2010
Notes: MSA = Metropolitan Statistical Area; GMP = Gross Metropolitan Product
Source: U.S. Bureau of Economic Analysis, 2010.

3 Existing Conditions at Port

The purpose of this section is to define how the Port currently functions in serving its hinterland. Particularly, Section 3 conveys how the Port operates to serve demand for freight transport. The section will cover specifics on the Port's infrastructure, transportation networks, cargo types and volumes, and vessels types and number of calls.

3.1 Infrastructure

The current Federal Navigation Project dimensions listed in Table 10 incorporate the most recent Federal and non-Federal improvements. The Federal improvements of the 1970s include modifications to the Outer Entrance Channel (OEC), Inner Entrance Channel (IEC), Main Turning Basin (MTB), and South Turning Basin (STB). The non-federal improvements of the 1980s and 1990s include modifications to the Southport Access Channel (SAC) and the Turning Notch (TN). WRDA 1992 (PL 102-580) Title I, Section 101(9) authorized Federal maintenance of the locally constructed SAC and TN. WRDA 2000 (PL 106-541) Section 515 authorized Federal reimbursement of $15,003,000 to Broward County for the local construction of the SAC and the TN (Figure 10).

Table 10. Existing Federal and Non-Federal Project Dimensions

Existing Port Components	Authorized and Maintained Nominal Depth in feet MLLW[1]	Authorized and Maintained Nominal Width in feet
Outer Entrance Channel (OEC)	45	500
Inner Entrance Channel (IEC)	42	450
Main Turning Basin (MTB)	42	Varies[2]
North Turning Basin (NTB)	31	Varies[3]
South Turning Basin (STB)	31, 36, 37[4]	1,000 X 1,100
Southport Access Channel (SAC)	42	400
Turning Notch (TN)	42	750 X 1,000
Non-Federal Project Features	**Constructed and Maintained Nominal Depth in feet MLLW**	**Constructed and Maintained Nominal Width in feet**
Dania Cut-off Canal (DCC) from SAC to Port Dania	15	Varies (about 100 feet)

[1] *MLLW: Mean Lower Low Water: A tidal datum. The average of the lower low water height of each tidal day observed over the National Tidal Datum Epoch. (NOAA).*

[2] *Basin is irregular shaped that varies in width 800 to 1,100 feet, see* Figure 10*.*

[3] *Basin is irregular shaped. North to South length is 1,200 feet, north side is 500 feet and extends 800 feet on south side. See* Figure 10*.*

[4] *Variable depths by location. See* Figure 10*.*

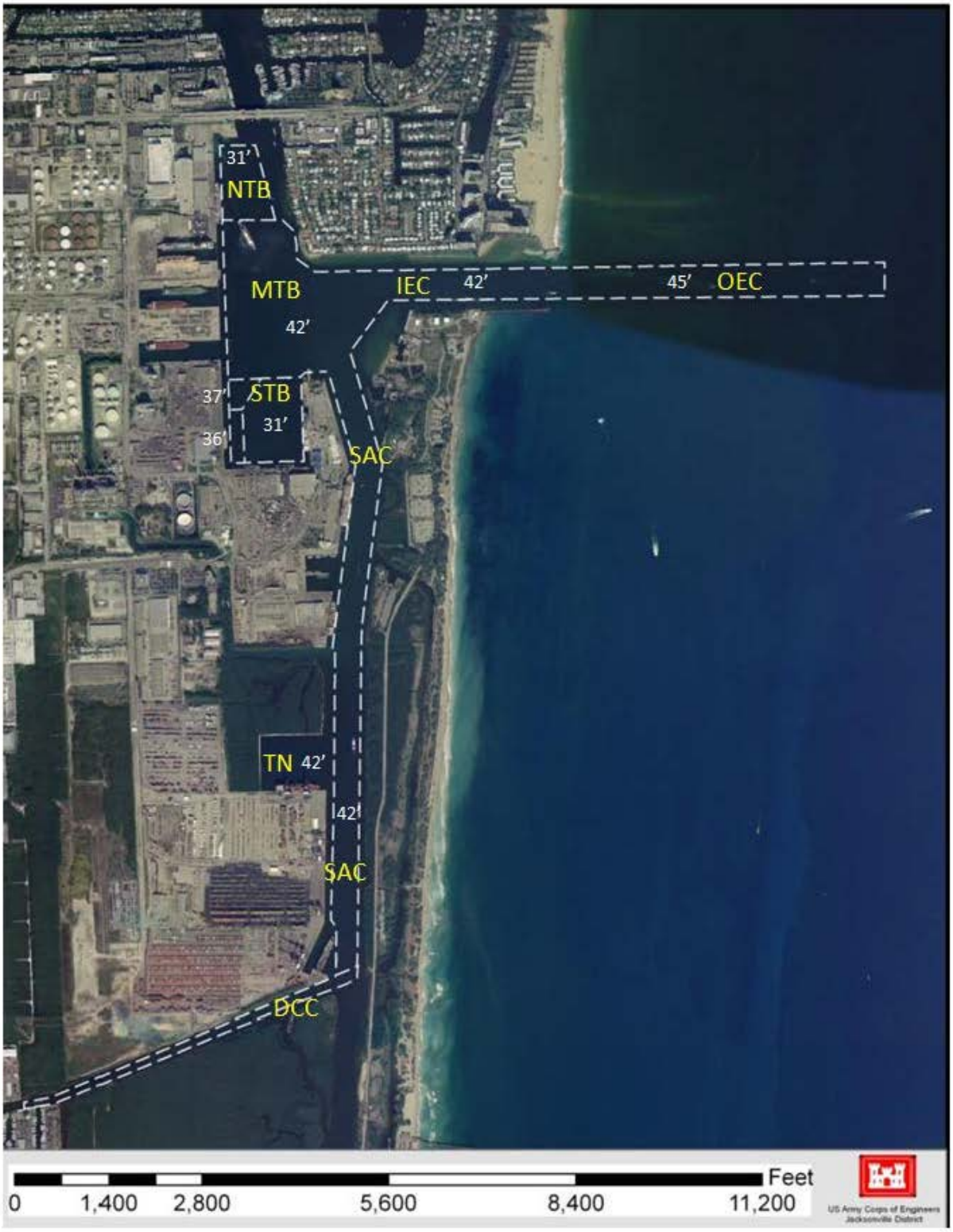

Figure 10. Existing Channel Components

Port Everglades is divided into three port terminal areas: Northport, Midport, and Southport (Figure 11). General land use of the port is shown in Figure 12. The Northport terminal area serves multiple cargoes and vessel types, including cruise operations, liquid bulk unloading (and occasionally loading), small container vessels, general cargo, roll-on/roll-off ("RO/RO") cargo, float-on/ float-off cargo (yachts and other vessels), military berthing, and lay-berth areas. The Northport terminal area includes 22 acres, which are available for container handling operations.

The Midport terminal area serves cruise ships, containerships up to Panamax size, bulk vessels, lift-on/lift-off ("LO/LO") cargo, RO/RO cargo, naval ships, harbor tugboats, and smaller lay-in vessels. One Panamax size gantry crane and a mobile harbor crane are available at berth 16. The Midport terminal area includes 28 acres, which are available for container handling operations. The world's largest cruise ships currently use the Midport terminal area. Large vessels berthed at berths 24 – 29 cause congestion at the port due to "no by-passing" rules observed by the port pilots. Large cruise ships and Post-Panamax container ships may not bypass cruise ships moored at berths 24 – 29. Under both existing and without-project future conditions, the existing scheduling rule of "last-in, first-out" is in effect meaning that a cruise ship scheduled to arrive at berth 29 must arrive before other cruise ships arrive at berths 24 – 27. Also a cruise ship scheduled to depart from berth 29 cannot depart until after the cruise ships moored at berths 24 – 27 have departed.

The Southport terminal area is dedicated to cargo traffic and maintains both lo/lo and ro/ro operations. The Southport terminal area has 235 acres of open yard facilities for container-port operations and includes seven ship-to-shore gantry cranes capable of servicing Panamax-size containerships. These cranes are mounted on a rail which extends from Berth 30 at the Turning Notch to Berth 33 just north of the Dania Cutoff Canal.

The Port has an excellent intermodal transportation network that is undergoing major improvements. The Port Everglades Expressway (Interstate 595) runs directly to the Port (Figure 13), linking the port with Interstate 95 (2.9 miles away), the Florida Turnpike (6 miles away) and Interstate 75 (12 miles away). US Route 1 runs along the western border of the port. The port is also served by the Florida East Coast Railway, which connects directly with the national freight networks of CSX and Norfolk Southern in Jacksonville. The Port's new (completed in 2014) 42.5-acre near-dock intermodal container transfer facility (ICTF) includes 21,000 linear feet of track with the capability of marshalling multiple double stack trains simultaneously. The near-dock ICTF has the capability of processing foreign and domestic cargo. The Florida East Coast Railway projects that the ICTF will transport 110,000 international TEUs (twenty-foot equivalent units) and 55,000 domestic TEUs per year by 2021[5].

[5] See Section 4.1 Intermodal Container Transfer Facility for more information on the ICTF.

Figure 11. Port Everglades Detailed Facilities Map
Source: Port Everglades' Website: http://www.porteverglades.net/includes/media/docs/Port-Map-2009.pdf

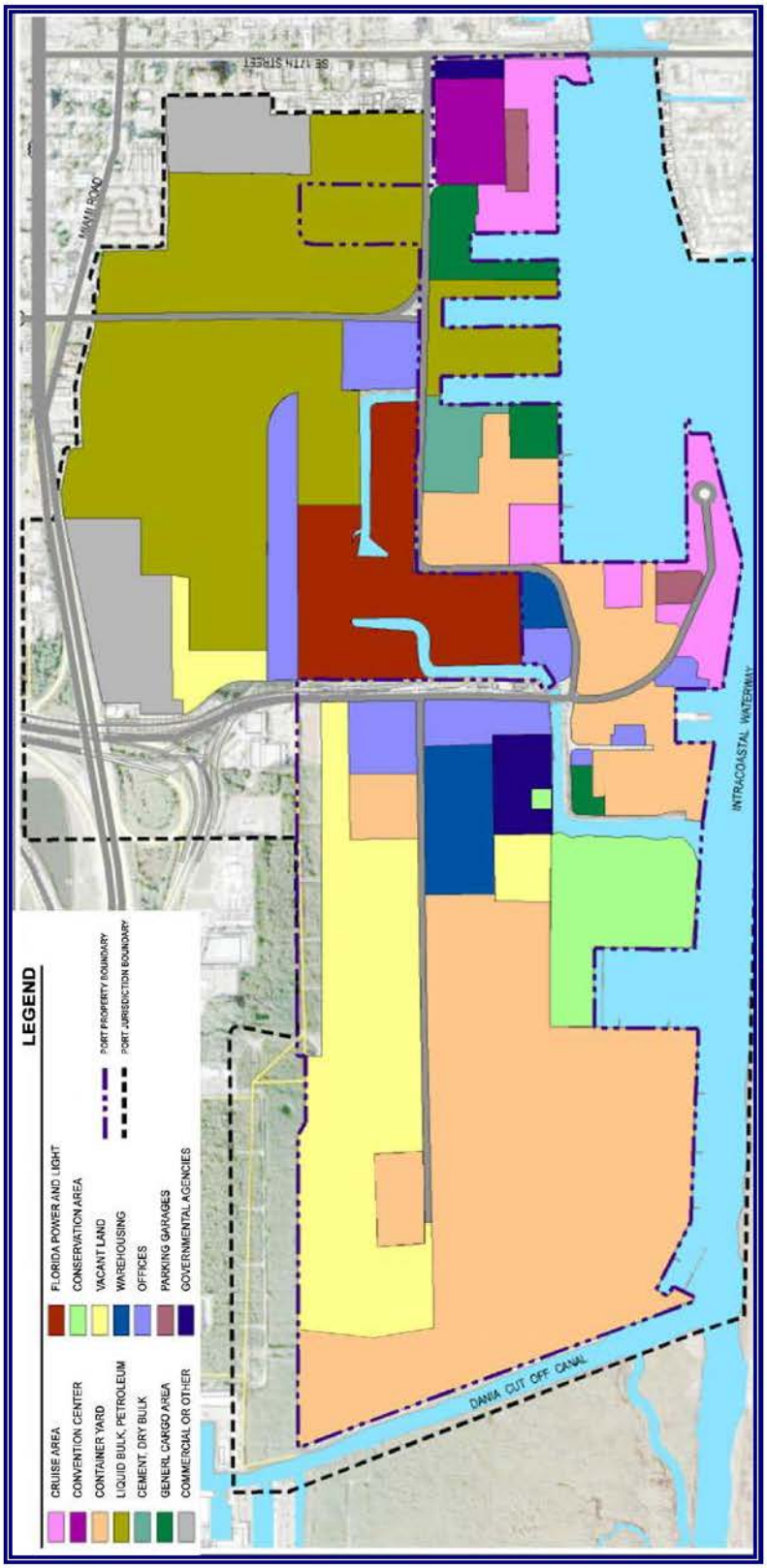

Figure 12. Port Everglades Map of General Land Use
Source: 2009 Port Master Plan

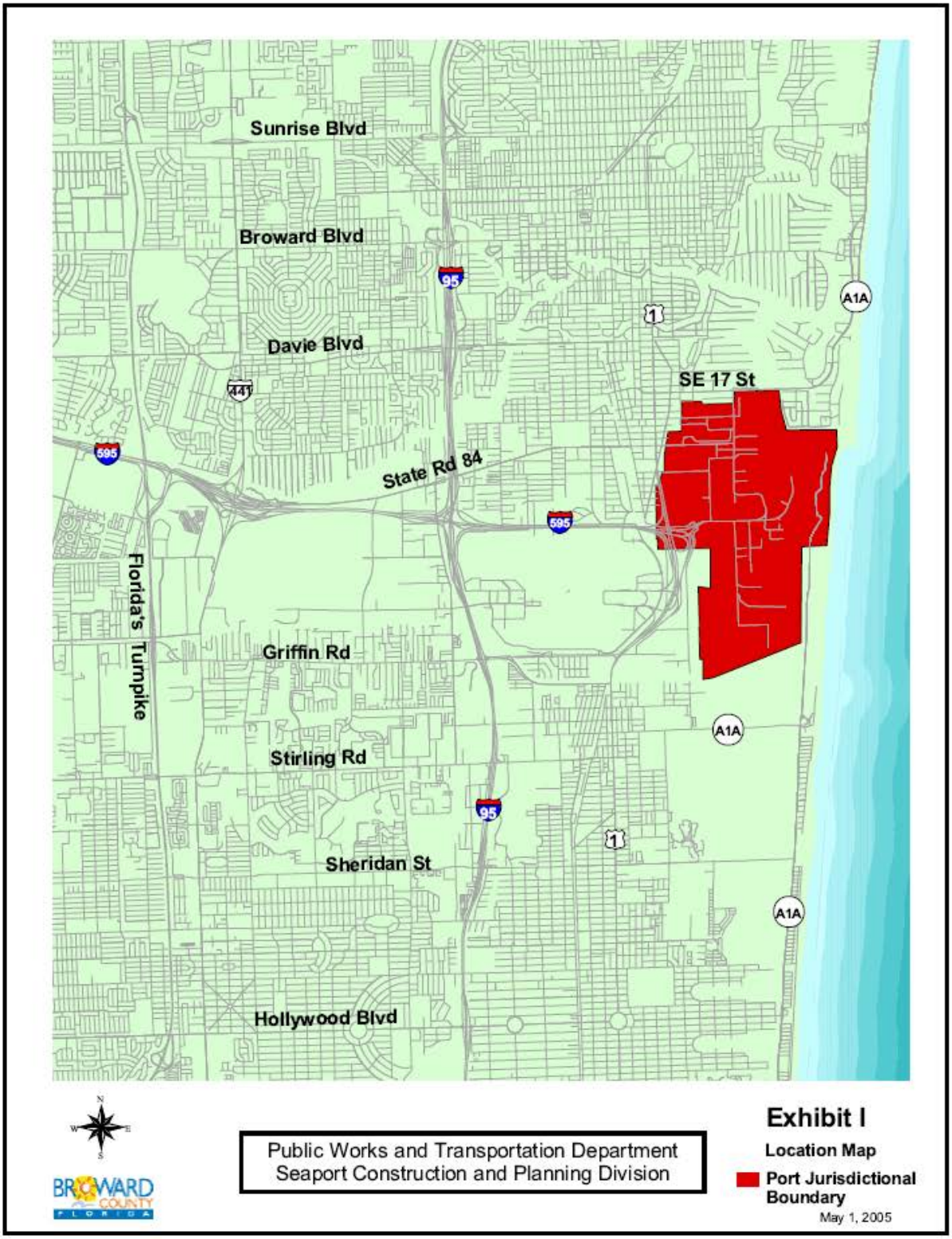

Figure 13. Port Jurisdictional Boundary and Road Connections
Source: Broward County Public Works and Transportation Department

3.2 Commodities and Cargo

Port Everglades handles a wide variety of cargo and vessel types. Port Everglades is one of the world's largest cruise ports and is one of the southeastern US's major cargo ports. The Port's total cruise passengers and waterborne commerce by type are shown in Table 11.

Table 11. Port Everglades Cruise Passengers and Total Tonnage by Type (FY2012)

Total Cruise Passengers	**3,757,320**
Single-day	68,298
Multi-day	3,689,022
Total Containerized Cargo Tonnage	**5,944,513**
TEUs Loaded	655,046
TEUs Total	923,600
Total Petroleum Tonnage	**14,830,384**
Total Bulk Tonnage	**973,191**
Bulk Cement	613,051
Other Dry Bulk	346,976
Liquid Bulk (non-petroleum)	13,164
Total Break Bulk Tonnage	**120,812**
Steel/Coil/Rebar	53,055
Other Break Bulk	67,757
Total Vehicles and Yachts	**166,237**
Total Waterborne Commerce Tonnage	**22,116,275**

Source: Port Everglades Commerce Report FY2012
Notes: Short tons. Cruise Passengers are counted at embarkation and debarkation.

For containerized cargo, Port Everglades handles the largest share (28%) of South and Central American-Caribbean regional[6] cargo (558,032 loaded TEUs in FY2012) as compared to all other southeastern US ports, including Jacksonville, Palm Beach, Miami, Savannah, and Charleston (**Table 12**). However, the Port's total containerized cargo throughput is similar to that of both Jacksonville and Miami (**Table 13**).

For containerized cargo, the top five imports transported through the port were miscellaneous fruits, bananas, vegetables, apparel, and menswear. These imports are driven by consumption by the population or the demand for a product within the hinterland that Port Everglades serves. The top five exports include grocery products, general cargo, paper and paper board, automobiles, and auto parts.

[6] South and Central American-Caribbean regional cargo refers to international trade with nation in the Caribbean, Central America, east coast of South America, north coast of South America, and the west coast of South America

Table 12. South and Central American and Caribbean Regional TEUs

Port	Regional TEUs	% Regional TEUs
Charleston	130,030	7%
Jacksonville	518,069	26%
Miami	426,213	22%
Port Everglades	**558,032**	**28%**
Savannah	175,282	9%
Palm Beach	162,328	8%
Total	1,969,954	100%

Source: Port Everglades Commerce Report 2012
Note: Loaded Import and Export (FY2012)

Table 13. Port Everglades' Share of South Atlantic US Port Containerized Cargo

	Charleston	Jacksonville	Miami	Port Everglades	Savannah	Palm Beach	Total	% Port Everglades
Caribbean	4,114	424,642	154,494	160,295	23,022	160,024	926,591	17.3%
Central America	17,286	4,368	186,029	**251,443**	39,333	50	498,509	50.4%
East Coast of South America	51,321	51,690	16,902	34,607	60,026	43	214,589	16.1%
Mediterranean	35,080	929	957	46,330	194,429	47	277,772	16.7%
Middle East	162,329	5,084	7,059	10,845	242,926	-	428,243	2.5%
North Coast of South America	17,410	30,701	41,212	**62,935**	18,427	2,195	172,880	36.4%
North Europe	435,916	16,080	60,622	17,423	210,341	55	740,437	2.4%
North Far East	301,940	94,689	182,599	22,569	1,037,190	32	1,639,019	1.4%
Other	42,498	5,599	4,812	8,800	142,542	10,181	214,432	4.1%
Southeast Asia	63,473	27,638	29,263	5,444	216,994	-	342,812	1.6%
West Coast of South America	39,898	6,668	27,577	**48,753**	34,473	16	157,385	31.0%
Total	1,171,265	668,088	711,526	669,444	2,219,703	172,643	5,612,669	11.9%
% of Total	21%	12%	13%	12%	40%	3%		

Source: Port Everglades Commerce Report 2012
Note: Loaded Import and Export TEUs (FY2012)

3.3 Vessel Traffic

Port Everglades has a large volume of vessel traffic each year. The Port is homeport to the largest cruise ships in the world and Post Panamax container vessels call on the harbor while servicing the U.S. east coast. The Port also receives Panamax petroleum product tankers and Panamax dry bulk carriers. Each of these operations, including: cruise, containerized cargo, petroleum, and dry bulk operates in a constrained manner at the Port due to the existing dimensions of the Federal navigation channel. The port operates according to a complex set of rules that attempt to minimize the effects of congestion on

the efficient arrival and departure of vessels. Table 14 shows the vessel calls in Fiscal Year 2012 by vessel type. Table 15 shows the percent of vessel movements in each draft range. Due to underkeel clearance requirements, all vessels sailing at 39 ft are the deepest permissible without using tide (in CY2012, 62 transits were greater than 39 feet including two transits at a 42 foot depth). Vessels sailing at greater than 39 ft draft are required to sail at high tide. Vessel movements in the 36 ft to 38 ft sailing draft range may be light-loaded to prevent them from having to wait for tide.

Table 14. Port Everglades Vessel Calls (FY2012)

Total Ship Calls	**4,000**
Cruise ships	838
Containerships	1,867
Cargo Ships	194
Petroleum Tankers/Barges	618
Navy/USCG	16
Other (Bunkers/Tugs)	467

Source: Port Everglades Commerce Report FY2012

Table 15. Port Everglades Movements by Draft (2011)

Draft Range (ft)	**Percent of Movements**
0-14	32.6%
15-29	49.0%
30-35	13.6%
36-38	3.5%
>=39	1.3%

Source: Waterborne Commerce Statistics Center

Note: Movements are counted inbound, outbound, and intra-port. Typically, a vessel call will consist of two movements, one inbound, and one outbound.

3.4 Existing Condition Operations and Navigational Constraints

This chapter describes the existing and projected future navigational problems at Port Everglades. The identification of problems is part of the first step in the six-step planning process described in the Principles and Guidelines[7]. Channel dimension-related problems at Port Everglades occur under existing conditions and are projected to continue to occur and intensify in the future under without-project

[7] The Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, Water Resources Council (February 3, 1983)

conditions as cargo throughput and passenger transfers increase, creating more vessel traffic. The problems identified in this section stem from the fact that the existing Federal navigation channel at Port Everglades was designed in the 1970's for use by sub-Panamax vessels. Under existing conditions, Panamax and Post-Panamax vessels use Port Everglades daily and weekly. Under future conditions, the number and size of Post-Panamax vessels at Port Everglades are projected to increase.

The primary problems at Port Everglades affect container ship and bulk vessel operations in the Federal navigation channel leading to the Southport container terminal (Southport Access Channel), and cruise ship operations in Southport Access Channel (SAC) leading to three of the Port's cruise terminals (berths 24/25, 26/27, and 29). Also, the entrance channel and main turning basin would require improvements to facilitate access to the SAC, and petroleum terminals at berths 7-10. In addressing existing problems and to maintain safe conditions in the harbor, the Port Everglades Pilots have developed operational rules and restrictions, which increase transportation costs for the cargo (compared to an unrestricted condition).

The primary problems identified in this analysis relate to the inefficient operation of containerships, tankers, and cruise ships in the Federal channel at Port Everglades, which affect the Nation's international trade transportation costs and cruise industry operating costs. The following problem statements describe these inefficiencies:

1. Existing cargo shippers are experiencing increased operation costs due to light loading, congestion delays, and tidal delays;
2. Existing ships are experiencing maneuverability problems in the Federal navigation channel associated with restricted access to portions of the Federal navigation channel during typical port operations;
3. 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 and wider channels replace older, smaller ones;

The inefficient operation of cargo vessels and cruise ships at Port Everglades directly results from insufficient depth and width 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. Containership size is also restricted by the existing Federal navigation channel depth (and width). Light-loading and restricted vessel size both increase cargo transportation costs.

The Port Everglades Pilots have developed restrictive operational rules in response to the difficulties associated with navigating a modern fleet in outdated narrow channel conditions. There are by-passing restrictions on vessels transiting the SAC while certain vessels are berthed immediately alongside the channel. The restrictions prevent all Panamax and Post-Panamax beam vessel traffic in the SAC, when Panamax-beam (or greater) vessels are moored alongside berths 24/25, 26/27, or 29. Additional tugs are required for Panamax and Post-Panamax vessels transiting the SAC if sub-Panamax vessels are moored alongside these same berths. Additional tugs are required for all Post-Panamax containerships

with a beam greater than 140 feet. These operational rules increase cargo and cruise ship transportation costs by causing delays, increasing fuel consumption to avoid delays or while waiting at sea or at berth, and by requiring additional tugs. These existing problems are projected to increase as future cargo tonnage, vessel calls, and vessels sizes increase at the Port.

3.4.1 Cruise Ship Operations and Navigational Constraints

In 2012, there were 628 multi-day cruise ship calls at Port Everglades, of which 344 were Post-Panamax vessel calls, 226 Panamax, and 58 sub-Panamax vessel calls. Post-Panamax and Panamax size cruise ships use berths 2/3, 4, 17/18, 19/20, 21/22, 24/25, 26/27, and 29. A selection of the largest cruise ships, which regularly use each berth, is presented in Table 16.

Table 16. Largest Cruise Ships by Berth

Berth	Vessel Name	GRT	LOA (ft)	Beam (ft)
2/3	*Crown Princess*	113,561	947	118
4	*Emerald Princess*	113,561	947	118
17/18	*Allure/Oasis of the Seas*	225,282	1,184	154
19/20	*Carnival Freedom*	110,320	952	116
21/22	*Grand Princess*	108,806	950	118
24/25	*Liberty of the Seas*	154,407	1,112	127
26/27	*Eurodam*	86,273	936	106
29	*Navigator of the Seas*	138,279	1,021	127

Notes: GRT = Gross Registered Tons; LOA = Length Overall.

Cruise ship operations at berths 2/3, and 4, in the Northport area of the Port, and at berths 17/18, 19/20, and 21/22, in the Midport area of the Port, typically do not experience constraints due to the Federal navigation channel, or impact other vessel operations at the Port. Alternatively, cruise ship operations at berths 24/25, 26/27, and 29 have a substantial impact on cruise ship and container ship operations at the Port. A standard operating rule of the Port is that a Panamax or Post-Panamax vessel cannot by-pass a Post-Panamax vessel moored at berths 24/25, 26/27, or 29[8]. This restriction is based on the 400-foot width of the Southport Access Channel (SAC), which does not provide sufficient safety clearance for a Panamax or Post-Panamax vessel to bypass the large cruise vessels typically berthed at berths 24/25, 26/27 and 29.

The navigation restriction at the SAC results in a “last-in, first-out” & “first-in, last-out” set of rules for cruise ships, which requires the cruise ship at berths 24/25 to be the last vessel in and the first vessel out, otherwise cruise ships cannot get to berths 26/27 and 29. Conversely, it also requires the cruise ship at berth 29 to be the first vessel in and the last vessel out. The constraint imposed by the narrow SAC causes congestion delays and imposes additional costs on cruise ship operators. Additional costs include the cost of increased fuel consumption when the vessel increases speed to make up for delays at Port

[8] Pilots Association interview notes 31 Jan 13

Everglades, and the cost of overtime labor when the vessel must arrive early or leave late in order to be the first vessel in or the last out[9].

Panamax and Post-Panamax containerships are also impacted by the Southport Access Channel cruise berth by-pass constraint. Large containerships must arrive before cruise ships arrive at berths 25 – 29 in order to access the Southport container terminal. MSC (Mediterranean Shipping Company) has indicated that their vessels must arrive by 0330 on the days when the cruise ships are scheduled to be in port. If the containership misses this window, then it cannot access the Southport container terminal until 1800 (after all the cruise ships have departed). The operational constraint at the SAC causes increased costs, due to increased fuel consumption, overtime labor costs, and potential rerouting of the vessel to Freeport, BS.[10]

3.4.2 Containership Operations and Navigational Constraints

Containerships calling at Port Everglades in 2012 ranged in size from very small feeder vessels, which service Caribbean islands, to Post-Panamax vessels on trans-Atlantic liner services. As is the case for all major container ports, most of the containerships calling at Port Everglades are sub-Panamax in size. These small vessels, some of which have ship's gear, use many of the Port's berths. Sub-Panamax vessels are not constrained in their operations by channel dimensions at the Port and are therefore not primary contributors to economic benefits of the channel improvement study, except only as they affect overall port congestion.

The larger Panamax and Post-Panamax containerships exclusively use berths 30, 31, and 32 at the Southport container terminal. Containership operations at the Southport container terminal are constrained by the 42-foot controlling depth of the Federal navigation channel and by the narrow width of the Federal navigation channel at the Southport Access Channel (SAC). Two containership lines, MSC and Hamburg-Sud, have indicated that their current and projected future operations are impacted by existing channel conditions.

MSC, the second largest container shipping line in the world, had vessels call Port Everglades in 2012 on three services: 1) North Europe to the U.S. East Coast and Gulf of Mexico (EU-ECUS-GMEX), 2) Mediterranean to the U.S. East Coast and Gulf of Mexico (MED-ECUS-GMEX), and 3) a feeder service to the Bahamas. This discussion focuses on the EU-ECUS-GMEX, and the MED-ECUS-GMEX services, which employ Panamax and Post-Panamax vessels. The feeder service to the Bahamas uses a sub-Panamax vessel.

MSC's Panamax and Post-Panamax vessels operated at maximum allowable drafts (39.0 feet and greater) on 32% of calls (Figure 14). The EU-ECUS-GMEX service consisted of mostly Post-Panamax

[9] Interview notes with Royal Caribbean International 01 Feb 13

[10] Interview with MSC 01Feb13 and interview with Pilots Association 31 Jan 13

vessels, ranging from 5,500 TEUs to 6,700 TEUs capacity with 44 to 47-foot design drafts. The vessels on the EU-ECUS-GMEX service were operating light loaded at Port Everglades due to constraints of the Federal navigation channel. In March 2013, MSC pulled Port Everglades from this service due to operational constraints at the Port. Cargo on this route, which had been serviced by MSC through Port Everglades, is now being routed through other ports. MSC is replacing the North Europe service calls at Port Everglades by adding Port Everglades to the service from Europe to Ecuador and Panama, which uses smaller and less efficient Panamax vessels. This will result in higher transportation costs for TEUs transported to and from Port Everglades under both existing and future without project conditions.

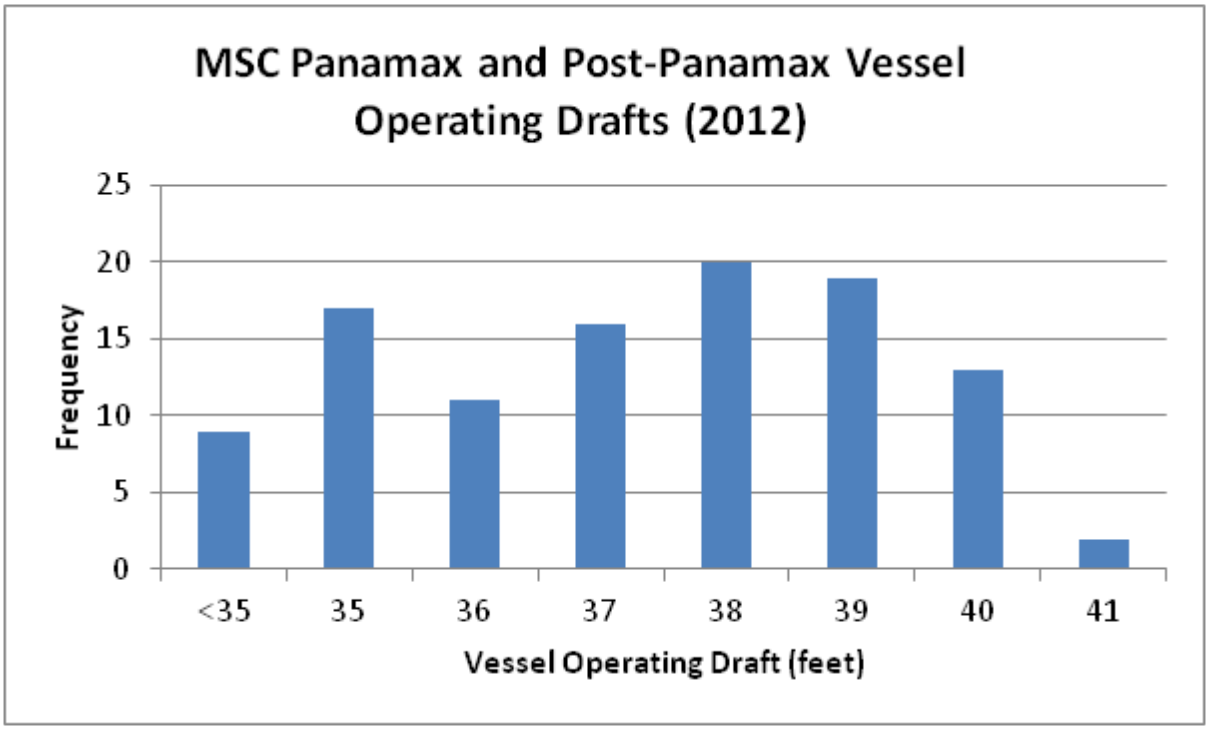

Figure 14. MSC Vessel Operating Drafts at Port Everglades

MSC's MED-ECUS-GMEX service consists of mostly Panamax vessels, but includes some calls by Post-Panamax vessels (5,500 TEUs). The vessels on the MED-ECUS-GMEX service face the same channel constraints as the vessels on the EU-ECUS-GMEX service, but because the MED-ECUS-GMEX service consists mostly of Panamax vessels, this service is not as severely impacted as the EU-ECUS-GMEX service.

The existing channel depth and width constraints limit MSC's ability to bring the new industry-standard Post-Panamax containerships to Port Everglades. MSC has stated that Port Everglades is already too shallow and that it is difficult to maintain existing services at Port Everglades with their rapidly expanding fleet of larger Post-Panamax containerships. MSC is looking to enter the US East Coast to East Coast of South America North-South trade, but would only do so if they could gain a competitive advantage by using their larger Post-Panamax vessels, which cannot cost-effectively call at Port Everglades under existing constrained channel depths. MSC projects that after the Panama Canal

expansion, their vessels will arrive through the Canal with sailing drafts of 47 and 48 feet. These vessels will have to by-pass Port Everglades and go on to transship cargo via Freeport, BS if channel depth constraints at the Port are not alleviated.[11]

Hamburg-Sud operates an east coast of South America to U.S. east coast (ECSA-ECUS) service using five Hamburg-Sud Panamax vessels (4,255 TEUs to 4,616 TEUs capacity) and two CSAV Panamax vessels (3,500 TEUs capacity). These vessels have design drafts of 41 to 44 feet. Hamburg-Sud considers its operations at Port Everglades very constrained by the existing depth of the Federal navigation channel. Hamburg-Sud indicated during an interview that they generally operate with an out-bound (typically deeper than inbound) depth constraint of 11.5 meters (37.7 feet)[12]. The operating data for Hamburg-Sud's ECSA - USEC service indicates that the vessels seldom operate at greater drafts than 37 feet (Figure 15).

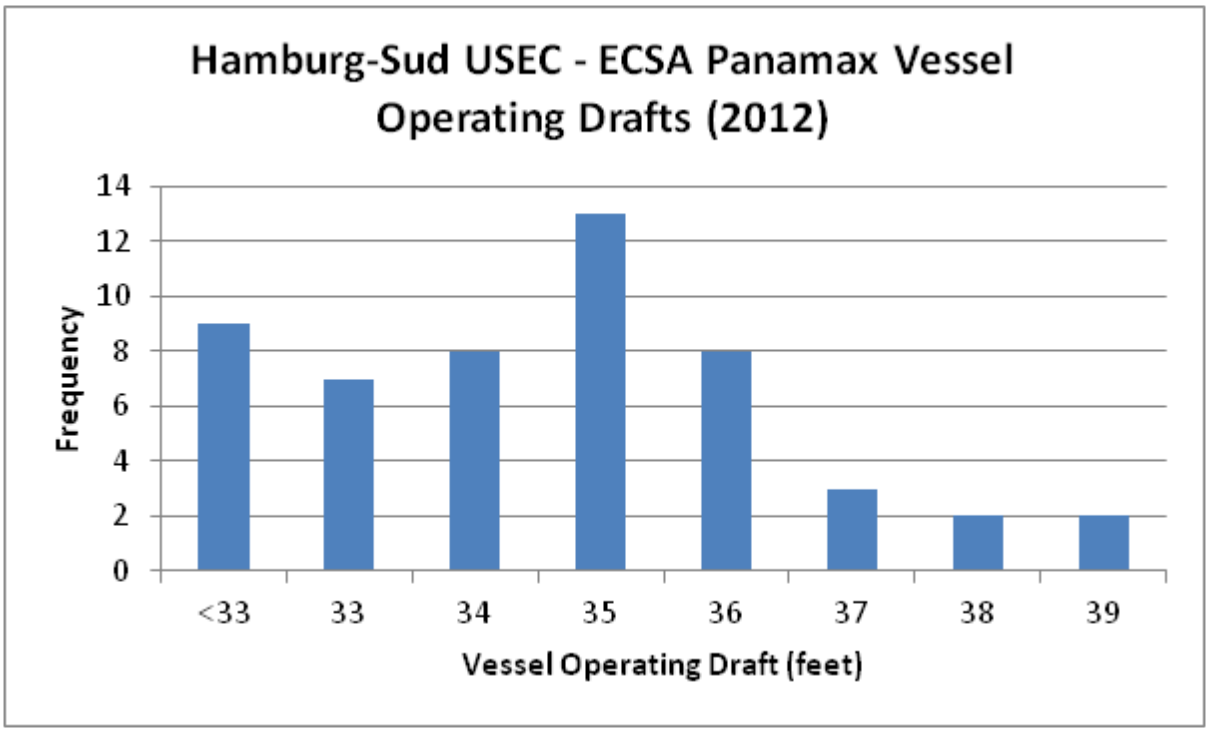

Figure 15. Hamburg-Sud Panamax Vessel Operating Drafts at Port Everglades

Hamburg-Sud's stated strategy is to operate with very high vessel utilization rates, which they consider necessary for survival in a competitive industry[13]. Another component of this competition is being able

[11] MSC interview notes 02 Feb 13

[12] Hamburg-Sud interview notes 02 Feb 13

[13] Ibid.

to operate with larger vessels, which increases productivity and lowers per-unit operating costs[14]. Hamburg-Sud has identified the next generation of vessels for the ECSA-ECUS service as the "Monte Class" of Post-Panamax vessels, which have a TEU capacity of approximately 5,500 TEUs and an operating draft capacity of 43 feet. These vessels would likely not call at Port Everglades unless the Federal navigation channel is deepened. In this case, cargo on the ECSA-ECUS service would be forced to use a different port or continue to use Panamax class vessels, which would likely increase the total transportation costs (landside plus waterside) of this cargo.

3.4.3 Petroleum and Liquid Bulk Vessel Operations and Constraints

Liquid bulk petroleum commodities are delivered to Port Everglades by large tankers and ocean-going barges. The major commodities are categorized as gasoline, jet fuel, diesel, ethanol, and fuel oil. Other liquid bulk commodities such as bio-diesel and crude oil are exclusively transported by barge and not anticipated to benefit from the proposed deepening. Asphalt and tallow are transported by small specialized tankers. Gasoline, jet fuel, and diesel typically use berths 7, 9, and 13. Fuel oil uses berths 5 and 7. Port Everglades has a unique manifold and pipeline system which allows multiple petroleum firms with facilities at Port Everglades to share the contents of a single vessel without the vessel moving to a different berth. Petroleum firms at Port Everglades will "swap" the contents of an arriving vessel based on agreements made while vessels are in transit. They can also transfer inventory from one firm to another's storage tanks at the adjacent landside facilities. The practice of swapping inventory and sharing loads provides cost savings to Port Everglades' petroleum firms because single deliveries can be larger and therefore transported more efficiently. There are no additional tug, pilot, and line-handler costs, which would be associated with moving the vessel from one berth to another in order to split the load, or the additional at-sea transportation costs of bringing separate shipments for each firm.[15]

Tankers often arrive at Port Everglades efficiently loaded, which because of the existing berth depth of 37 ft limits the size of tankers calling at Port Everglades. The larger tankers currently calling at Port Everglades frequently transport gasoline and jet fuel, and arrive at drafts generally ranging from 35 to 38 feet. These tankers are typically Panamax vessels of approximately 45,000 to 60,000 DWT (deadweight tonnes) with lengths from 600 to 620 feet. Less frequently, Panamax tankers of approximately 60,000 to 80,000 DWT with lengths up to 750 feet also call at the port. Smaller tankers and barges, carrying ethanol, fuel oil, asphalt, and tallow typically arrive at Port Everglades with drafts of less than 33 feet. Figure 16 presents tanker arrival drafts at Port Everglades.

[14] Interview with Florida International Terminals 02Feb13

[15] Interview with TransMontaigne 15Feb13

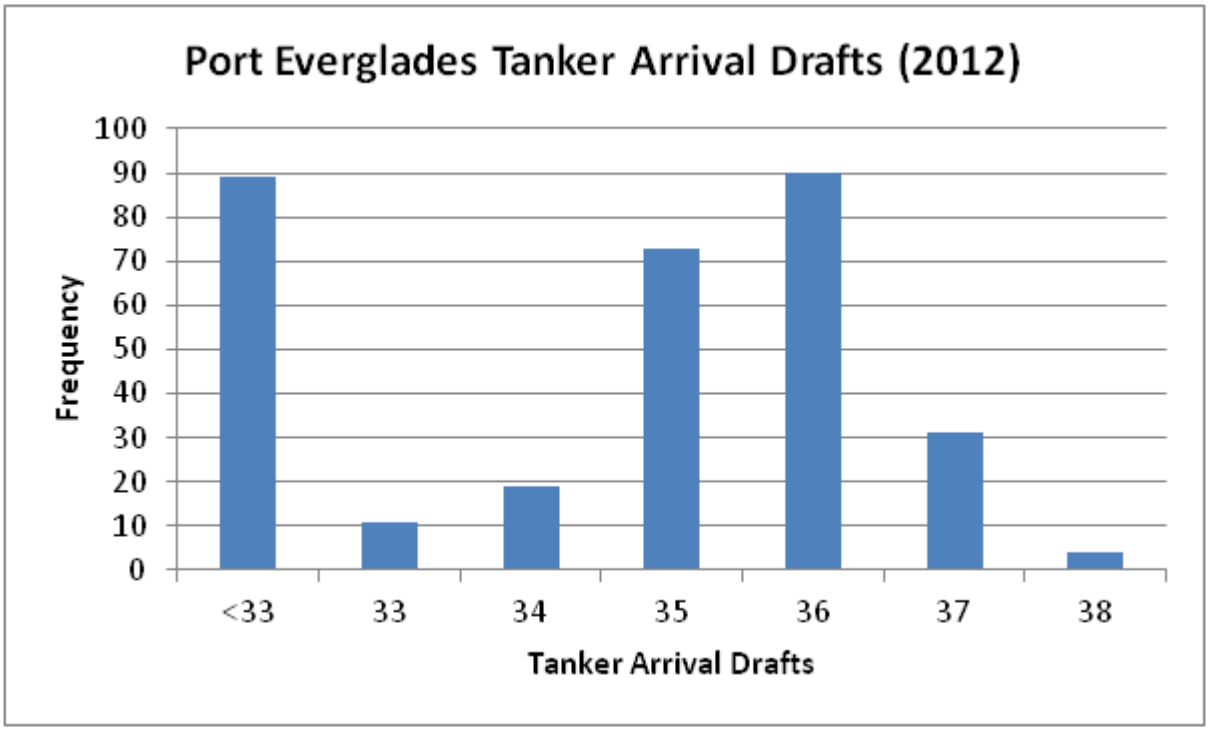

Figure 16. Tanker Arrival Drafts at Port Everglades

Berths 7-10 have not been deepened to date because of the combination of depth restrictions at other U.S. east coast ports and the nature of the market for petroleum products. Interviews with shippers of petroleum products revealed that the petroleum products market is a "spot market," where delivery is taken immediately, and ownership of the cargo can often change hands several times while the vessel is en route. If a foreign shipper knows that a cargo load is headed for the U.S. east coast, but that the specific delivery port may change en route, then they will typically load the vessel to be able to call the Port of New York & New Jersey, since it is such a large market. Many of the petroleum terminals in New York & New Jersey Harbor are located along the Arthur Kill channel, which has a controlling depth of 35 ft, and 6 ft of usable tide. Assuming 3 ft of underkeel clearance, the maximum sailing draft in the Arthur Kill is 38 ft. Therefore, Port Everglades has never deepened its primary petroleum berths past 38 ft because of external market factors, namely the depth restriction at Arthur Kill. However, there is currently part of an authorized project for New York and New Jersey Harbor that is set to begin construction in FY14, which will deepen Arthur Kill to 40 ft MLLW. Given the same tide and underkeel clearances, petroleum vessels will soon be able to call New York and New Jersey Harbor at sailing drafts of up to 43 ft (using high tide). This will cause a shift in the vessel operations for petroleum products tankers calling the U.S. East Coast, which will provide reason for Port Everglades to pursue deepening their petroleum berths[16]. The 2009 Port Everglades Master/Vision Plan details the planned expansion of

[16] In the with project condition, the sailing draft distribution for petroleum tankers takes into account the depth of the terminals located along the Arthur Kill channel. Approximately 90% of all petroleum tankers sail at 43 feet or less. The remaining 10% sails up to a 47 foot depth.

the three slips at Northport in Element 3, Section 3.6.7. In Figure 3.6-27 of that report, the proposed slip dimensions indicate a dredge depth of 42 ft for Slip 1 and Slip 3 (berths 7-10 and 12-15, respectively).

The use of larger, more efficient tankers would reduce transportation costs for the petroleum firms operating at Port Everglades. The load sharing/swapping among petroleum firms at Port Everglades facilitates the efficient loading of tankers, regardless of their size. Larger vessels are not currently used due to the depth constraint of the berths at the port, but those constraints will be removed before the proposed Federal improvement project is constructed (see Section 4), which will leave only the Federal navigation channel as the remaining depth constraint. If greater channel depth were available, Port Everglades petroleum firms would use larger vessels to take advantage of the economies of scale.[17]

3.4.4 Dry Bulk Vessel Operations and Constraints

Historically, Port Everglades had been a major import destination for cement and related dry bulk products, such as gypsum and bauxite, which are cement-production input materials (Table 17). Prior to 2007, when demand was high, cement would often arrive on vessels loaded to or near the Port's un-tide-restricted operating depth of 39 feet[18]. Currently, only vessels carrying bauxite or gypsum arrive at these operating drafts and there are now only a few of these calls per year (3 in 2012).

Table 17. Historical Port Everglades Cement and Dry Bulk Tonnage

	Cement	Dry Bulk	Total
2003	2,164,610	354,444	2,519,054
2004	2,333,142	509,891	2,843,033
2005	2,222,492	607,063	2,829,555
2006	2,465,753	475,084	2,940,837
2007	1,432,837	307,825	1,740,662
2008	494,054	387,383	881,437
2009	306,727	246,988	553,715
2010	264,211	234,068	498,279
2011	375,050	141,189	516,239
2012	613,051	346,976	960,027

Source: Port Everglades Commerce Report FY 2012
Note: Short tons

Operators of the CEMEX and Continental Cement facilities at Port Everglades both indicated that, when demand picks up again, vessels would operate at the Port in a manner similar to vessel operations prior to the economic downturn. Both operators also indicated that, historically and under future conditions of higher demand, vessel size and loading is constrained by depth conditions in the federal navigation channel. CEMEX has a silo capacity of 60,000 tons, but historically has used vessels in the 40,000 to

[17] Interview with TransMontaigne 15 Feb 13

[18] Interview with CEMEX 14 Mar 13

45,000 DWT (deadweight tons) range. If additional depth were available at Port Everglades, CEMEX would use larger vessels. Continental Cement has indicated that under conditions of higher demand and a deeper Federal navigation channel, they would use larger vessels and split shipments between Port Everglades, which they would call first, and Port Canaveral, which also has a Continental Cement facility. Both operators indicated transportation cost savings as the reason for using larger, more deeply loaded vessels if product demand and channel conditions allowed[19].

3.4.5 Tug Operations

Most large cargo vessel arrivals and departures at Port Everglades require tug assistance. Cruise ships require tug assistance far less frequently and are designed specifically to provide the maneuverability required to avoid tug assistance. The narrow conditions of the existing Federal navigation channel and the 105-degree turn required to enter the Southport Access Channel cause additional tugs to be required for large vessels. Additional tugs (a third tug) are required for Panamax and Post-Panamax containerships if they by-pass a vessel moored at berths 24 – 29. Note that no vessels are allowed to by-pass berths 24 – 29 if a Post-Panamax vessel is moored there.[20] Sub-Panamax containerships and other small vessels were moored at berths 24 – 29 on 139 separate occasions. Regardless of vessel operating draft, all containerships with beams greater than 140 feet (Post-Panamax Generation 2 vessels) require a third tug when transiting the Southport Access Channel due to the narrow conditions of the Federal navigation channel.

Cruise ships, which typically do not require tug assistance, sometimes will use tugs to overcome scheduling delays resulting from the last-in, first-out rule. The first-in, last-out rule was developed as a way to accommodate large vessels, which are constrained by the narrow width of the Federal navigation channel. If a vessel at berth 24 or 25 is delayed, cruise ships at berths 26, 27 and 29 may use tugs to carefully by-pass the delayed vessel. Table 18 presents tug use by cruise ships, Panamax container ships, and Post-Panamax containerships at Port Everglades in calendar year 2012.

[19] Interview with CEMEX 14 Mar 13 and interview with Lehigh-Hanson 14Mar13

[20] Interview with Port Everglades Pilots Association 03 Feb 13

Table 18. Tug Use by Vessel Type

Vessel Type	Number of Tugs	Frequency
Cruise Ship	1	91
	2	13
	3	2
Panamax Container Ship	1	1
	2	477
	3	12
Post-Panamax Container Ship	1	0
	2	118
	3	33

Note: Data from 2012 Port Everglades' Harbormaster Records

The use of additional tugs increases existing vessel operating costs for cargo carriers and cruise ships operating at the Port. Under future conditions, with larger vessels operating at the Port, the costs associated with additional tug use are projected to increase. Although not all of the tug use identified in Table 18 would be affected by navigation improvements at the port, the Pilots Association indicates that third tugs would not be required and that cruise ship use of tugs when by-passing vessels at berths 24 – 29 would also not be required under conditions of a wider Federal navigation channel.

4 Planned Infrastructure Improvements

This section describes the planned infrastructure improvements and anticipated changes (compared to Section 3) that are scheduled to be completed by base project year in both the with- and without-project conditions. First, the improvements will be identified and then the expected effects on the Port's capacity for vessel accommodations and cargo throughput will be qualified or quantified. These changes are assumed to be in place throughout analysis. Note that some changes will be necessary to realize full benefits in the with-project condition (even though those improvements will also help in the without-project condition).

The port has a long history of planning and executing infrastructure improvements, which increase the capacity and efficiency of port operations. Port infrastructure planning is conducted over a twenty-year planning period in two five and one ten-year increments. The near-term five-year plan guides the implementation of annual capital plans. The most recently adopted[21] 5-Year Master Plan covers Fiscal Years (FY) 2011 to 2015; the 10-Year Vision Plan covers FY 2016 to 2019, and the 20-Year Vision Plan covers FY 2020 to 2029. Recent improvements constructed by the port, which are identified in the 5-Year Master Plan, include upgrades to Cruise Terminal (CT) 2, CT 19, CT 21, and CT 26 to facilitate use by the world's largest cruise ships and reconfiguration of Berth 28 as a lay berth and tug berth with a

[21] 2009 Port Everglades Master/Vision Plan

mooring dolphin. The port has also conducted a bulkhead study[22], which provides a 20-year schedule of future bulkhead reconstruction based on existing bulkhead conditions and operational requirements. Construction of the Intermodal Container Transfer Facility (ICTF), the Eller Drive overpass, and the reconstruction of interior roadways were all completed in 2014. Table 19 presents the schedule of improvements, excluding those already implemented, identified in the 2009 Master/Vision Plan and 2010 Bulkhead Study.

Planned improvements will affect all aspects of port operations including:

- Cruise ships and terminals;
- Dry bulk cargo;
- Liquid bulk cargo; and
- Containerized cargo.

Planned cruise-related improvements include construction of additional parking and enhanced passenger facilities at CT 4 and CT 18, and a centralized cruise passenger processing facility in the Midport terminal area. Cruise terminals 4, 25, and 29 will be upgraded to accommodate the large size cruise ships currently using the recently improved cruise terminals at the Port, and berth 4 will be extended from 900 to 1150 feet to accommodate larger cruise ships. Dry bulk cargo operation will be improved by bulkhead replacement at the cement ship berths and by construction of a crushed rock aggregate facility. The new crushed rock aggregate facility will be located in the Turning Notch Extension and will be linked to the ICTF through a conveyor system. Rail cars will be able to be loaded with aggregate from storage facilities filled by a conveyor system from the berth. Liquid bulk operations will be improved by the widening of liquid bulk slips to accommodate Aframax-size vessels (80,000 to 120,000 deadweight tons), by bulkhead reconstruction, deepening to existing project depth, and by manifold replacements, which will be concurrent with bulkhead reconstruction. While initially the liquid bulk berths will be deepened from 37 ft to the existing project depth of 42 ft, bulkhead reconstruction will allow for berth depths as deep as 50 feet, to accommodate additional deepening in the future with-project condition.

Containerized cargo handling operations at the port will be greatly improved through a series of planned terminal expansions and equipment upgrades. Berth 30 will be extended from 900 feet to 2,400 linear feet as a part of the Turning Notch Extension[23]. The relocation of the Foreign Trade Zone will provide an additional 23 acres to the Southport container terminals, bringing the total container terminal area to 258 acres. The Southport container terminals are adjacent to the ICTF, which is currently under construction. The ICTF will be able to service double stack trains up to 9,000 feet in length[24]. The

[22] 2010 Bulkhead Study

[23] Environmental mitigation for the Turning Notch Expansion is currently being implemented by the Port.

[24] Additional information on the ICTF is in Section 4.1.

Midport (28 acres) and Northport (22 acres) container handling facilities combined provide an additional 50 container terminal acres.

There are currently 7 ship-to-shore cranes at the Southport container terminal, which are capable of servicing Panamax-size containerships. Five Post-Panamax size cranes (capable of reaching across 22 rows of containers) will be added at Southport for a total of 12 cranes. The first two Post-Panamax cranes are scheduled for delivery in 2015 (Table 19). Throughput capacity at Southport will be enhanced by increased storage density at the terminals. The Port's densification strategy includes a transition from the existing top-pick container handling operations at Southport to a rubber-tire-gantry (RTG) operation, which increases the number of containers that can be stored per acre. Southport throughput capacity will be approximately 2 million TEUs per year, once the densification improvements are in place.

The existing bulkheads at the Southport container terminal (berths 31 and 32) and the new bulkhead along the Turning Notch Extension (berth 30) will all be able to accommodate depths as deep as 50 feet. However, due to existing FAA flight surface restrictions that affect air draft and crane height on the western end of the Extension, the current USACE project would only deepen the eastern 1,300 feet of the Turning Notch to the new project depth, with the remaining 1,100 feet to the west, staying at the existing depth of 42 feet.

Table 19. Port Everglades Existing and Planned Future Port Configuration

Berth	Cargo	Existing Length	Planned Improvements
1a	Yachts, lay	180	
1b	Yachts, lay	220	
1	Ro-Ro		
2	cruise	1,601	2019/20 – new bulkheads
3	cruise		
4	Multi cargo & cruise	900	2014/5 – berth extend to 1150 ft; improvements to CT 4 for large cruise ships 2019/20 – CT 4 parking garage (multi-level)
5	Multi cargo & asphalt	900	2027 – new bulkheads
6	Multi cargo & diesel load	380	2029 – reduced to 330 feet
7	Petroleum products		2017 – new tank farm
8	Petroleum products & asphalt	1,200	2021 – Slip 1 (berths 7&8) widened to the north from 425 to 475 feet; new bulkheads
9	Petroleum products		2016 – Slip 1 (berths 9&10) widened to the south from 300 to 425 feet to allow Aframax-size vessels; new bulkheads; deepened to project depth
10	Petroleum products & FPL	1,200	
11	Propane, lay	500	2015 – reduced to 375 feet; 2029 – no longer a berth
12	Petroleum products & FPL	1,226	2034 – new bulkheads;
13	Petroleum products		
14	Multi cargo & cement	1,226	2023 – new bulkheads;
15	Multi cargo & cement		
16	Small container ships	1,648	2019 –CT 18 parking garage
17	cruise		2019 – new bulkheads

Berth	Cargo	Existing Length	Planned Improvements
18	cruise		
19	Multi cargo & cruise	1,300	Ship's gear only – no cranes 2022/25 – centralized cruise processing center/intermodal facility 2024 – new bulkheads
20	Multi cargo & cruise		
21	Cruise & lay	1,475	2019 – new bulkheads
22	Cruise & lay		
23	Lay, USCG	240	2025 – new bulkheads
24	Cruise & lay	1,369	2017 – improvements to CT 25 for large cruise ships
25	Cruise & lay		2025 – new bulkheads
26	Cruise & lay	1,337	
27	Cruise & lay		
28a	Tugs & lay	480	
28b/e	Tugs & lay	550	
28f	Tugs & lay	400	
29	Cruise & multi cargo	800	Ship's gear only – no cranes 2017 – improvements to CT 29 for large cruise ships 2036 – new bulkheads
30	Containers	900	2016 – additional 23 acres added to container yard (former FTZ) 2017 – lengthen berth to 2400 ft; 2017/18 – third 22-wide crane (10 cranes total) 2020/21 - fifth 22-wide crane (12 cranes total)
31	Containers	2,000	2015 - first & second 22-wide crane (9 cranes total)
32	Containers		2018/19 – fourth 22-wide crane (11 cranes total) 2039 – new bulkheads
33a	Containers & RO/RO	800	2020 – lengthen to 1100 ft
33b	Containers & RO/RO	400	2020 – no longer functional
33c	Containers & RO/RO	400	2020 – no longer functional
ICTF	Double stack containers	21,000 LF	2014 - Service trains up to 9,000 LF; double track spur to mainline
New	Crushed rock aggregate	1,000	2017 – north side turning basin first year of operation
New	Containers & RO/RO	1,000	2017 – north side turning basin first year of operation
New	Ferry	600	2017 – west side turning basin first year of operation

Source: 2009 Port Everglades Master/Vision Plan, Element 5: Final Plan; and 2010 Bulkhead Study.

The Port's current Capital Improvement Plan includes a number of projects, currently under construction or in the design phase, which will substantially improve cargo operations at the Port. Each of these improvements will be completed and operational between 2014 and 2017 (Table 20). Three projects: the ICTF, the McIntosh Road Realignment, and the Eller Drive Over-pass are a part of the Port's integrated intermodal transportation network improvements. The McIntosh Road Realignment and the Eller Drive Overpass will enhance operation of the ICTF by removing on-grade railroad crossings outside of the Port, separating truck and rail traffic at the Port. Container cargo operations will be enhanced by the Turning Notch Expansion, which will allow the largest Panamax and Post-Post Panamax vessels that currently call the Port to use berth 30, which will be extended from 900 feet to 2,400 feet. The first two Super Post-Panamax cranes, each with a reach of 22 containers across, will resolve the weight and reach restrictions currently associated with the Ports existing cranes (16 containers across reach).

Table 20. Selected Ongoing Port Infrastructure Improvement Projects

Project	Year Operational	Cost (millions)
ICTF	2014	$72
Eller Drive Overpass	2014	$42
McIntosh Road	2014	$8
Turning Notch Expansion	2017	$122
22-Wide Cranes (2)	2015	$24
Total		$268

Source: Port Everglades

4.1 Intermodal Container Transfer Facility

Construction of the new Intermodal Container Transfer Facility (ICTF) was completed in 2014. The ICTF is a rail terminal for Florida East Coast (FEC) railway that is located adjacent to the Southport Container Terminal (see planned location in Figure 11). It is expected to further expand Port Everglades' rail-accessed hinterland to include cost-effective access to markets as far as Jacksonville, Atlanta, Charlotte, and Nashville[25]. For example, an analysis conducted by the Port Everglades Department[26] indicates that cargo using rail from Port Everglades to Atlanta will be cost and time competitive with cargo that spends additional time on a container vessel, unloaded in Savannah, and is then trucked from Savannah to Atlanta.

5 Commodity Forecast

The purpose of this section is to show how future commodity growth was forecasted. The details of the assumptions and methods used to determine the forecast are described. The primary benefitting commodities in this study are those moving on the largest cargo vessels that call the Port: containerized cargo, liquid petroleum products, and dry bulk. The containerized cargo that will benefit the most from channel deepening and widening is cargo moving on trans-Atlantic and North America-South America trade. The liquid petroleum products that will benefit the most from deepening are gasoline, diesel, and jet fuel moving on foreign-flagged tankers. The dry bulk commodities that will benefit the most from channel expansion are cement, cement-production input materials, and aggregate. An increase in domestic production could impact the benefits associated with dry bulk commodities, therefore, a sensitivity analysis will be conducted to evaluate the significance of the dry bulk good benefits to the proposed project. Other cargo types (such as break-bulk and non-containerized general cargo) moving on smaller vessels will receive incidental benefits through reduced congestion and delays in the harbor. The forecast for primary benefitting commodities was given the most consideration in the following sub-sections. A breakdown of benefits by commodity type is included in section 11.5.

[25] FEC interview notes 1 February, 2013

[26] Port Everglades Master Plan – Element 2: Market Assessment, 2009

5.1 Commodity Forecast Methods and Assumptions

For the purposes of this analysis, commodities were grouped into "trade concepts." A trade concept is a grouping of commodities by the manner in which freight is unitized, loaded and unloaded from a vessel so that it can be traded. Commodity growth rates over the period of analysis were specified by trade concept. Applying growth rates at this lower level of detail allowed the forecast to be simplified. The trade concepts identified for this are:

- Liquid bulk[27]
- Dry bulk, non-containerized general cargo, and break-bulk
- Containerized Cargo

The primary foreign commodity forecast used in this analysis for near-term growth (2015-2029) was based on a growth forecast for the south Atlantic U.S., obtained from IHS Global Insight (now renamed IHS Economics & Country Risk), a data and consulting firm. The Port Everglades' share of southeast U.S. cargo was determined based on historical averages. The Port Everglades cargo share percent was then applied to the regional IHS forecast to calculate future tonnages. The following is a description of how IHS Global Insight forecasts are produced:

The primary input used to derive the Port's commodity forecasts is IHS Global Insight's World Trade Service (WTS). The WTS relies on several key sources of information within the development of its forecast, including IHS Global Insight's economic forecasting model of the U.S. economy and IHS Global Insight's International Models. IHS Global Insight's Regional state economic models provided additional information that factored into the forecast.

The IHS Global Insight world trade forecasting system provides detailed forecasts of international commodity trade to assist decision makers involved with international commodity transportation. The world trade forecasts include all commodities that have physical volume; they exclude trade in services or commodities without physical volume, such as electricity. The trade forecasts are produced with a system of linked world trade commodity models collectively called the World Trade Model (WTM). The commodity forecasts are grouped into IHS Global Insight's own categories derived from the International Standard Industrial Classification (ISIC) and cover 88 ISIC categories. For all trade partners in the world, the WTM has 66 major countries individually and groups the rest of the world into 12 regions according to their geographic location. Therefore, IHS Global Insight forecast 88 commodities traded among 78 country/regions. This is a framework of 77 by 78 by (78-1), or 528,528 potential trade flows.

Because not every country trades every commodity with every other country, they include about 365,000 trade flows in their forecasts. The forecasts of world trade, in both nominal and real commodity value, are converted to physical volume by transportation mode using standard formulas. Primary modes of transportation include air, overland, and maritime transport, all measured in metric

[27] Foreign liquid bulk and domestic liquid bulk were forecasted separately.

tons as well as in value. Container trade is measured in twenty-foot equivalent units (TEUs) as well as metric tons.

IHS Global Insight's flagship model of the U.S. economy integrates modern economic theory and behavior in an analytical tool that is widely used in forecasting, assessing derivative risks, and evaluating policy alternatives. The model embodies major properties of the Neoclassical growth models developed by Robert Solow; thus ensuring that short-run cyclical developments will converge to robust long-run equilibrium.

In growth models, the expansion rate of technological change (or adoption of technology), the labor force, and the capital stock determine the productive potential of an economy. As a result, monetary and fiscal policies will influence both the short- and the long-term characteristics of such an economy through their impacts on national saving and investment. A modern model of output, prices, and financial conditions is melded with the growth model to present the detailed, short-run dynamics of the economy.

The IHS Global Insight Model captures the full simultaneity of the U.S. economy, forecasting over 1,400 concepts spanning final demands, aggregate supply, prices, incomes, international trade, industrial detail, interest rates, and financial flows.

In the IHS Global Insight regional forecasting approach, each area is modeled individually and then linked into the national system. Thus, the models do not forecast regional growth as simple proportions of U.S. totals, but focus on internal growth dynamics and state-specific business cycle response. This approach is referred to as "top-down bottom-up." Unlike pure share (top-down) models and models that are not linked to a national macroeconomic model (bottom-up), the IHS Global Insight model includes both approaches.

A primary objective is to project how regional activity varies, given an economic environment as defined by macroeconomic and industry forecasts. Important regional issues are addressed using information about detailed industrial mix, inter-industry and interregional relationships, productivity and relative costs, and migration trends. IHS Global Insight maintains separate models for 50 states and for Washington, DC, as well as for 318 metropolitan areas. The state models have two fundamental characteristics: (1) Each state is modeled individually, with different model structures specified according to the characteristics of the state; and (2) national policy is explicitly captured from the output of the U.S. macro model.

For long-term growth (2029-2060), and domestic petroleum shipments (non-benefitting), several related forecasts were used as proxy rates for the long-term growth rate forecast of cargo at Port Everglades. These sources and the rates used are detailed throughout this section and the estimated tonnages are displayed in Table 26. Due to the uncertainty of forecasting over 40 years into the future, and to keep the assumptions as conservative as possible, no additional cargo growth was assumed after 2060. Cargo throughput in 2060 was held constant through the end of the period of analysis.

Near-term Liquid Bulk, Dry Bulk, Break Bulk, and Non-containerized General Cargo: The forecast for foreign bulk and general cargo movements over the near-term period from 2015-2029 was based on the IHS Global Insight south Atlantic U.S. regional forecast. The method used to apply the regional forecast to Port Everglades was to first determine the historic share of Port Everglades' import and export tonnages for each commodity group from the total regional forecast of South Atlantic ports. Then the average historic Port Everglades' cargo share percentages (by commodity category) were applied to the future regional tonnage forecast from IHS Global Insight.

Below is an overview of the steps taken to determine the Port Everglades forecast for foreign liquid bulk, dry bulk, break bulk, and non-containerized general cargo:

1. Waterborne Commerce Statistics Center commodity movement tonnage data was assembled for all South Atlantic region ports[28] for years 2003-2010
    a. Level of detail included 4-digit commodity code as well as category totals
    b. Domestic and foreign trade were separated
    c. Inbound and outbound cargo were separated
2. For foreign trade only, commodity tonnages were totaled at the general category level separately for imports and exports for all South Atlantic ports over the historical period
3. For each commodity category, the annual share of commodities transiting through Port Everglades was derived as a percent of the total South Atlantic tonnage
4. The average share of Port Everglades' import and export tonnage for each commodity category was derived from the historical record over the period 2003-2010 (Table 21 and Table 22)
5. These percent shares, broken down by commodity category and import/export, were then applied to the IHS Global Insight commodity forecast for bulk commodities and non-containerized cargo (for forecast period through 2029)[29]
    a. This assumes that the average historical share of bulk and non-containerized cargo commodities would remain the same throughout the forecast period

[28] The south Atlantic U.S. ports included were: Wilmington, NC, Charleston, SC, Savannah, GA, Brunswick, GA, Fernandina, FL, Jacksonville, FL, Canaveral, FL, Palm Beach, FL, Port Everglades, FL, and Miami, FL.

[29] After reviewing the results of applying the Port Everglades proportion to the IHS forecast, crude petroleum movements and petroleum product exports were both reduced to be more in line with low historic levels.

Table 21. Port Everglades Historical Percent Share of South Atlantic Imports by Commodity Type

Port Everglades Imports Percent Share of South Atlantic Imports by Commodity Category	2003	2004	2005	2006	2007	2008	2009	2010	Import Share Average
All Commodities	14.76%	16.66%	16.10%	15.80%	15.65%	13.66%	13.41%	12.94%	14.87%
Total Chemicals and Related Products	2.00%	2.41%	3.50%	2.43%	5.90%	8.28%	7.92%	2.16%	4.32%
Total Coal,Lignite and Coal Coke	2.83%	4.21%	0.22%	0.01%	0.01%	0.01%	0.18%	0.01%	0.93%
Total Crude Materials, Inedible Except Fuels	4.02%	5.37%	4.57%	4.08%	4.67%	5.54%	4.27%	3.46%	4.50%
Total Food and Farm Products	15.99%	20.09%	21.50%	23.48%	26.71%	27.61%	25.32%	23.91%	23.08%
Total All Manufactured Equipment, Machinery	6.10%	6.30%	7.64%	7.04%	6.91%	5.87%	4.87%	4.78%	6.19%
Total Petroleum and Petroleum Products	25.85%	30.63%	29.84%	28.21%	28.28%	27.58%	24.13%	26.42%	27.62%
Total Primary Manufactured Goods	22.92%	23.14%	20.07%	21.72%	19.49%	12.00%	10.23%	10.01%	17.45%
Total Unknown or Not Elsewhere Classified	3.05%	5.32%	5.21%	3.54%	4.45%	6.16%	5.31%	9.93%	5.37%

Source: Waterborne Commerce Statistics Center, New Orleans, LA

Table 22. Port Everglades Historical Percent Share of South Atlantic Exports by Commodity Type

Port Everglades Exports Percent Share of South Atlantic Exports by Commodity Category	2003	2004	2005	2006	2007	2008	2009	2010	Export Share Average
All Commodities	8.62%	8.92%	9.95%	10.63%	10.44%	10.26%	9.26%	9.33%	9.67%
Total Chemicals and Related Products	4.99%	3.73%	4.16%	4.72%	4.19%	4.91%	5.19%	4.42%	4.54%
Total Coal,Lignite and Coal Coke	2.55%	3.96%	1.82%	3.67%	3.72%	6.32%	17.25%	9.54%	6.10%
Total Crude Materials, Inedible Except Fuels	1.59%	1.31%	2.23%	2.67%	3.00%	3.51%	3.97%	4.50%	2.85%
Total Food and Farm Products	7.93%	7.85%	9.59%	9.79%	9.22%	10.03%	8.43%	8.15%	8.87%
Total All Manufactured Equipment, Machinery	15.64%	17.42%	18.67%	18.84%	18.56%	17.79%	16.53%	14.73%	17.27%
Total Petroleum and Petroleum Products	43.32%	40.72%	41.82%	38.48%	59.06%	20.18%	23.42%	21.57%	36.07%
Total Primary Manufactured Goods	9.39%	9.87%	9.67%	10.51%	8.43%	9.57%	8.57%	9.32%	9.42%
Total Unknown or Not Elsewhere Classified	23.68%	31.09%	36.73%	39.90%	38.47%	23.75%	24.48%	22.31%	30.05%

Source: Waterborne Commerce Statistics Center, New Orleans, LA

The following figure provides the historical and forecasted tonnage through 2029 for Dry Bulk and General Cargo. After 2029, an annual 0.8% growth rate was applied.

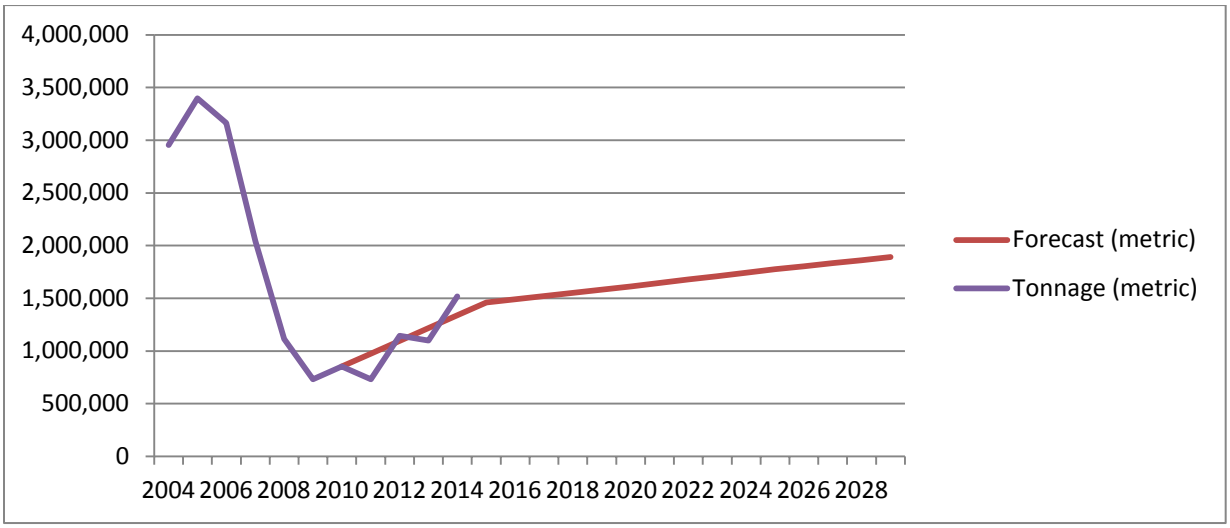

Figure 17. Dry Bulk/General Cargo Historical/Forecasted Commodity Growth

Figure 18. Historical and Forecasted Tonnage (through 2029) for Liquid Bulk transported through Port Everglades

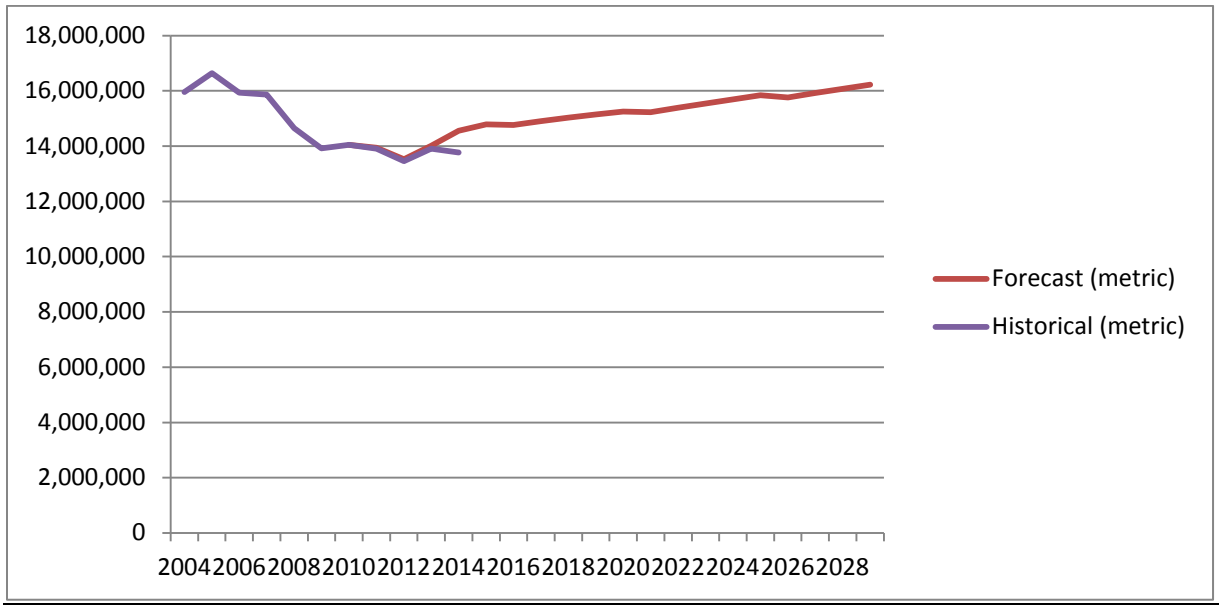

Figure 18. Historical and Forecasted Tonnage (through 2029) for Liquid Bulk transported through Port Everglades

Near-term Containerized Cargo: The containerized cargo forecast over the near-term period (2015-2029) applied the Port Everglades historical share of south Atlantic containerized cargo throughput to the south Atlantic regional IHS forecast. PIERS (Port Import Export Reporting Service) data was used to derive the port's share and incorporate the correct share of regional trade partners with Port Everglades into the containerized cargo forecast. Port Everglades' share of south Atlantic containerized cargo by foreign trade region was then applied to the IHS Global Insight forecast of containerized cargo for the region.

Below is an overview of the steps that were taken to determine the Port Everglades forecast for foreign containerized cargo:

1. PIERS containerized cargo tonnage data was assembled for south Atlantic region major container ports[30] for years 2008-2011
    a. Level of detail included the world region's trade with each port
    b. All tonnages were based on foreign traffic only

[30] The south Atlantic U.S. major container ports included were:

c. Imports and Exports were combined

2. Containerized cargo tonnages were totaled at the trade-region level for all South Atlantic ports over the historical period
3. For each trade region, the annual share of containerized cargo tonnage transiting through Port Everglades was derived as a percent of the total South Atlantic tonnage
4. The average share of Port Everglades' containerized cargo tonnage for each trade region was derived from the historical record
5. These percent shares, broken down by trade region, were then applied to the Global Insight commodity forecast for containerized cargo (forecast period through 2029)
    a. This assumes that the average historical share of containerized cargo commodities by trade region would remain the same throughout the forecast period

Table 23. Port Everglades Historical Percent Share of South Atlantic Containerized Cargo by Region[31]

Region	2008	2009	2010	2011	Average
ASIA	2.65%	2.31%	1.62%	2.24%	**2.20%**
CARIBBEAN	18.56%	16.74%	15.10%	15.45%	**16.46%**
CENTRAL AMERICA	51.58%	49.68%	49.39%	50.56%	**50.30%**
EUROPE	1.66%	2.16%	3.20%	2.78%	**2.45%**
MEDITERANEAN	11.32%	10.18%	10.55%	13.07%	**11.28%**
MIDEAST	1.98%	4.62%	5.45%	5.18%	**4.31%**
EAST COAST SOUTH AMERICA	33.31%	27.24%	14.78%	13.27%	**22.15%**
WEST COAST SOUTH AMERICA	18.08%	19.60%	23.84%	24.01%	**21.38%**
NORTH COAST SOUTH AMERICA	36.36%	36.03%	33.63%	34.92%	**35.24%**
AFRICA/OCEANIA/NORTH AMERICA/OTHER	2.63%	2.63%	2.37%	2.67%	**2.58%**
Overall Share	**12.02%**	**11.56%**	**10.54%**	**10.99%**	**11.28%**

[31] The East Coast United States – East Coast South America trade land for containerized tonnage consists of approximately 14 percent of total projected containerized tonnage

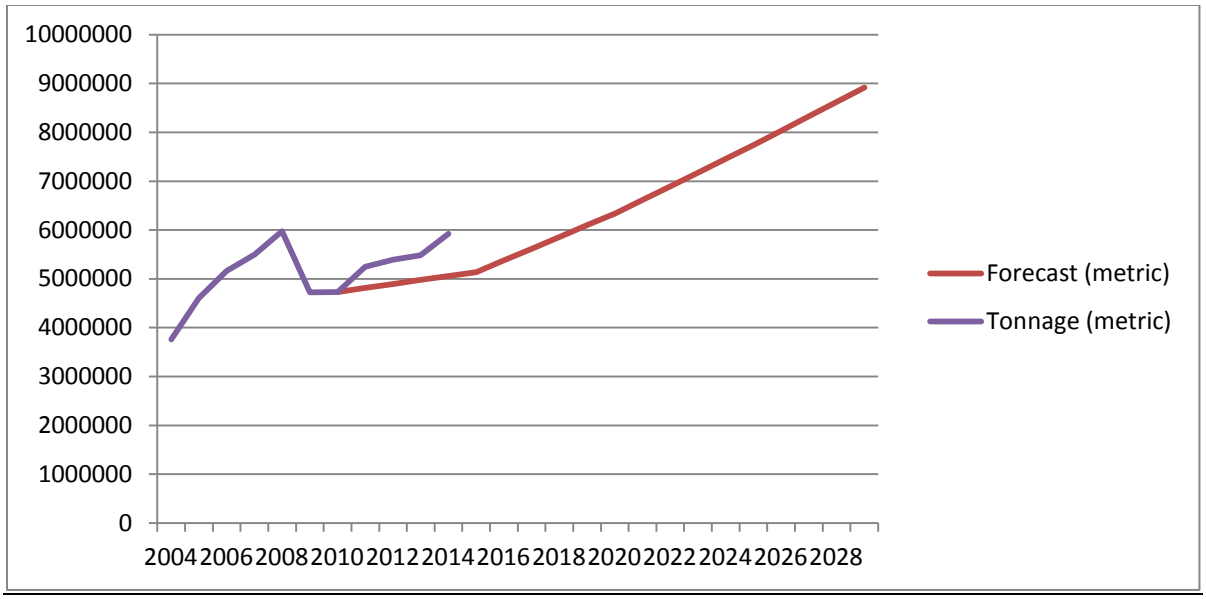

Figure 19. Historical and forecasted tonnage for Containerized Cargo (through 2029)

Long-term dry bulk and general cargo[32]: For the long-term forecast period from 2029 to 2060, dry bulk and general cargo imports and exports were associated with the long term population growth estimates (2030-2040) for South Florida counties[33] at 0.8% annually. This growth rate was based on the results from the Florida Demographic Estimating Conference, February 2013 and UF, BEBR, Florida Population Studies, Volume 46, Bulletin 165, March 2013 medium-growth county projections. The projected long-term growth in population was used as a proxy for long-term foreign dry bulk and general cargo throughput at the Port.

The following figure displays the projected long term commodity growth for Dry Bulk/General Cargo. As shown, Dry Bulk/General Cargo is anticipated to reach approximately 2.4 million tonnes by 2060.

[32] General cargo includes break-bulk. Over the entire forecast period, general cargo was estimated as a fixed percentage (10.8%) of the total dry bulk and general cargo forecast. This percent was based on historical averages.

[33] South Florida Counties included Broward, Indian River, Martin, Miami-Dade, Orange, Osceola, Palm Beach, and St. Lucie.

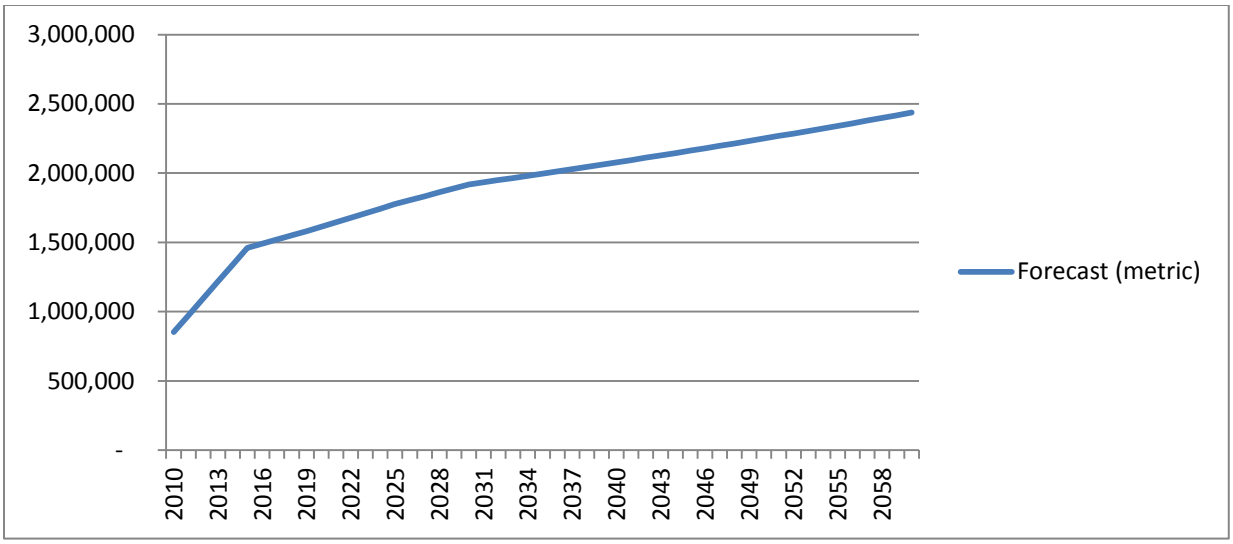

Figure 20. Projected Long-Term Commodity Growth for Dry Bulk/General Cargo

Long-term Liquid Bulk: For the long-term forecast period from 2029 to 2060 liquid bulk imports were associated with the U.S. Energy Information Administration Annual Energy Outlook 2012 forecast for demand for liquid petroleum products for the transportation sector at 0.2% annually. The projected growth in demand for liquid petroleum products in the transportation sector was used as a proxy for long-term foreign liquid bulk cargo throughput growth at the Port. No growth was assumed after 2060 for any commodities.

Displayed in **figure 21** below is the total tonnage projected for Liquid Bulk for the period of analysis. As shown, the forecast is anticipated to reach about 17.3 million tonnes in 2060.

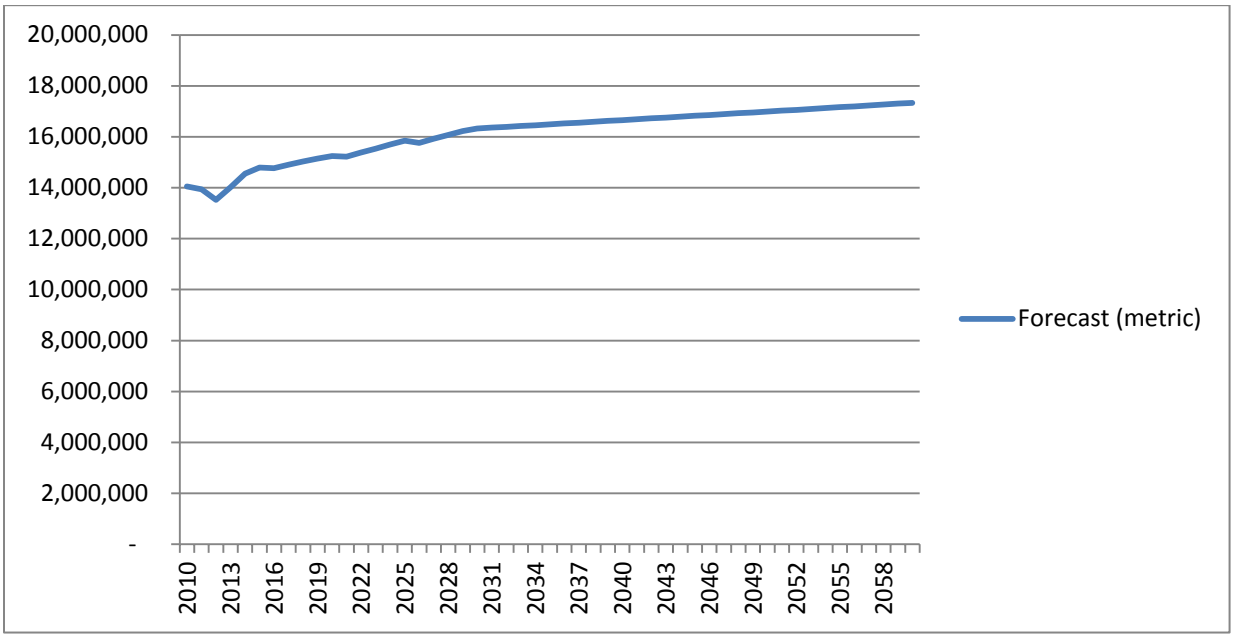

Figure 21. Total Tonnage Projected for Liquid Bulk

The forecast for Domestic liquid bulk was forecast using the transportation sector of the U.S. Energy Information Administration Annual Energy Outlook 2012. It is forecasted to grow at 0.2% annually throughout the period of analysis and reach just over 9 million tonnes in 2060.

Medium-term Containerized Cargo: For the medium-term forecast period from 2029 to 2040 containerized cargo imports and exports were associated with IHS Global Insight & U.S. Energy Information Administration Annual Energy Outlook 2012 economic activity growth rates at 2.5% annually. This rate was applied to all trade routes over this period except for Caribbean basin traffic, which was forecasted to remain constant after 2030. The projected growth of economic activity was used as a proxy for medium-term containerized cargo throughput growth at the Port.

Long-term Containerized Cargo: For the long-term forecast period from 2040 to 2060 containerized cargo imports and exports were associated with long-term South Florida counties population growth estimates (2030-2040) at 0.8% annually. The projected long-term growth in population was used as a proxy for long-term containerized cargo throughput growth at the Port. No growth was assumed after 2060. The results of the foreign containerized cargo forecast are shown in Section 5.2.Domestic Liquid Bulk: For the entire forecast period from 2015 to 2060 domestic coast-wise liquid bulk receipts were forecasted with a growth rate based on the U.S. Energy Information Administration Annual Energy Outlook 2012 forecast for demand for liquid petroleum products for the transportation sector at 0.2% annually. The projected growth in demand for liquid petroleum products in the transportation sector was used as a proxy for domestic liquid bulk cargo throughput at the Port. No growth was assumed after 2060. The results of the domestic liquid bulk forecast are shown in Section 5.2. The following **Figure 22** displays the containerized tonnage forecast for the period of analysis. Containerized tonnage is anticipated to increase to 11.6 million tonnes in 2060.

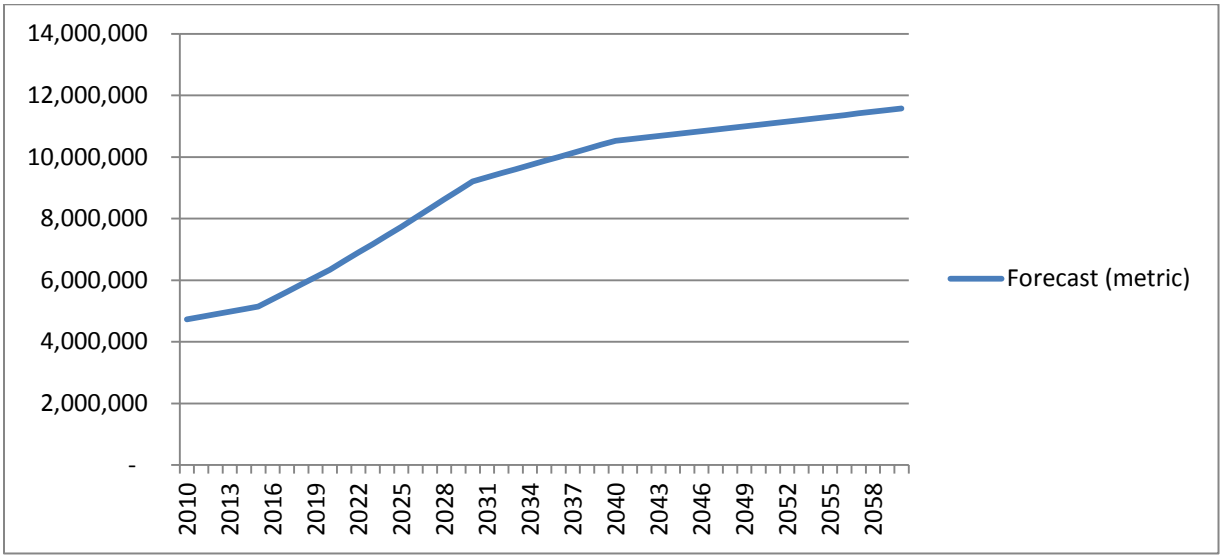

Figure 22. Containerized Tonnage Forecast

The results of the foreign liquid bulk, dry bulk, and general cargo forecast are shown in Section 5.2.

5.2 Commodity Forecast Results

The resulting growth rates for the short-term total foreign cargo forecast are shown in Table 24, below. The results of the total domestic and foreign cargo forecasts, over the entire forecast period from 2015 to 2060, using the growth rates and sources detailed above, is summarized in Table 26, and shown graphically in Figure 23. Finally, historical containerized cargo tonnages are compared to the forecasted tonnages in Figure 24. The annual growth rates (forecasted and historical where available) are provided as well.

Table 24. Growth Rates for Near-term Foreign Trade Forecast by Trade Concept

Growth Rates for Total Foreign Trade Forecast by Trade Concept				
	2015-2020	**2020-2025**	**2025-2029**	**2015-2029**
Dry Bulk / General Cargo	2.00%	1.95%	1.75%	1.91%
Liquid Bulk	1.13%	1.45%	1.27%	1.28%
Container	4.27%	4.07%	3.81%	4.07%
Total	**2.50%**	**2.65%**	**2.50%**	**2.56%**

Note: Based on IHS Global Insight projections. Percentages represent compound annual growth.

Table 25. Trade Concept Growth Rates

	Petroleum		Containerized		Dry Bulk/General Cargo	
	Historical	Forecasted	Historical	Forecasted	Historical	Forecasted
2010	0.96%		0.24%		16.47%	
2011	-1.02%	-0.79%	10.95%	1.72%	-14.05%	14.27%
2012	-3.23%	-2.98%	2.70%	1.69%	56.07%	12.49%
2013	3.37%	3.60%	1.70%	1.66%	-3.89%	11.10%
2014	3.65%	3.87%	5.86%	1.63%		9.99%
2015		1.64%		1.61%		9.08%
2016		-0.13%		4.65%		2.08%
2017		0.92%		4.45%		2.04%
2018		0.83%		4.26%		2.00%
2019		0.75%		4.08%		1.96%
2020		0.70%		3.92%		1.92%
2021		-0.14%		4.42%		2.03%
2022		1.04%		4.23%		1.99%
2023		1.01%		4.06%		1.95%
2024		0.98%		3.90%		1.92%
2025		0.97%		3.75%		1.88%
2026		-0.50%		3.81%		1.61%
2027		0.99%		3.67%		1.58%
2028		0.96%		3.54%		1.56%
2029		0.94%		3.42%		1.53%
2030		0.61%		3.31%		1.51%
2031		0.20%		1.43%		0.80%
2032		0.20%		1.41%		0.80%
2033		0.20%		1.39%		0.80%
2034		0.20%		1.37%		0.80%
2035		0.20%		1.36%		0.80%
2036		0.20%		1.34%		0.80%
2037		0.20%		1.32%		0.80%
2038		0.20%		1.30%		0.80%
2039		0.20%		1.29%		0.80%
2040		0.20%		1.27%		0.80%
2041		0.20%		0.49%		0.80%
2042		0.20%		0.49%		0.80%
2043		0.20%		0.49%		0.80%
2044		0.20%		0.49%		0.80%
2045		0.20%		0.49%		0.80%
2046		0.20%		0.48%		0.80%
2047		0.20%		0.48%		0.80%
2048		0.20%		0.48%		0.80%
2049		0.20%		0.48%		0.80%
2050		0.20%		0.47%		0.80%
2051		0.20%		0.47%		0.80%
2052		0.20%		0.47%		0.80%
2053		0.20%		0.47%		0.80%
2054		0.20%		0.46%		0.80%
2055		0.20%		0.46%		0.80%
2056		0.20%		0.46%		0.80%
2057		0.20%		0.46%		0.80%
2058		0.20%		0.46%		0.80%
2059		0.20%		0.45%		0.80%
2060		0.20%		0.45%		0.80%

Table 26. Total Port Everglades Foreign and Domestic Cargo Throughput Forecast

Trade Concept (metric tons)	**2005**	**2010**	**2015**	**2020**	**2023**	**2025**	**2030**	**2040**	**2060**
Dry Bulk / General Cargo	3,396,909	852,270	1,460,315	1,612,202	1,710,471	1,775,983	1,918,548	2,077,678	2,436,625
Foreign Liquid Bulk	7,357,786	5,009,209	6,506,815	6,883,369	7,124,892	7,395,750	7,792,705	7,949,969	8,274,083
Container	4,605,283	4,732,678	5,139,336	6,335,324	7,175,075	7,734,909	9,208,759	10,528,196	11,570,013
Total Foreign Cargo	**15,359,977**	**10,594,157**	**13,106,466**	**14,830,895**	**16,010,438**	**16,906,642**	**18,920,013**	**20,555,842**	**22,280,721**
Domestic Liquid Bulk	9,278,682	9,037,653	8,281,138	8,364,281	8,414,668	8,448,259	8,533,080	8,705,286	9,060,193
Total Cargo	**24,638,659**	**19,631,810**	**21,387,603**	**23,195,176**	**24,425,106**	**25,354,901**	**27,453,093**	**29,261,129**	**31,340,915**

Note: Metric Tons

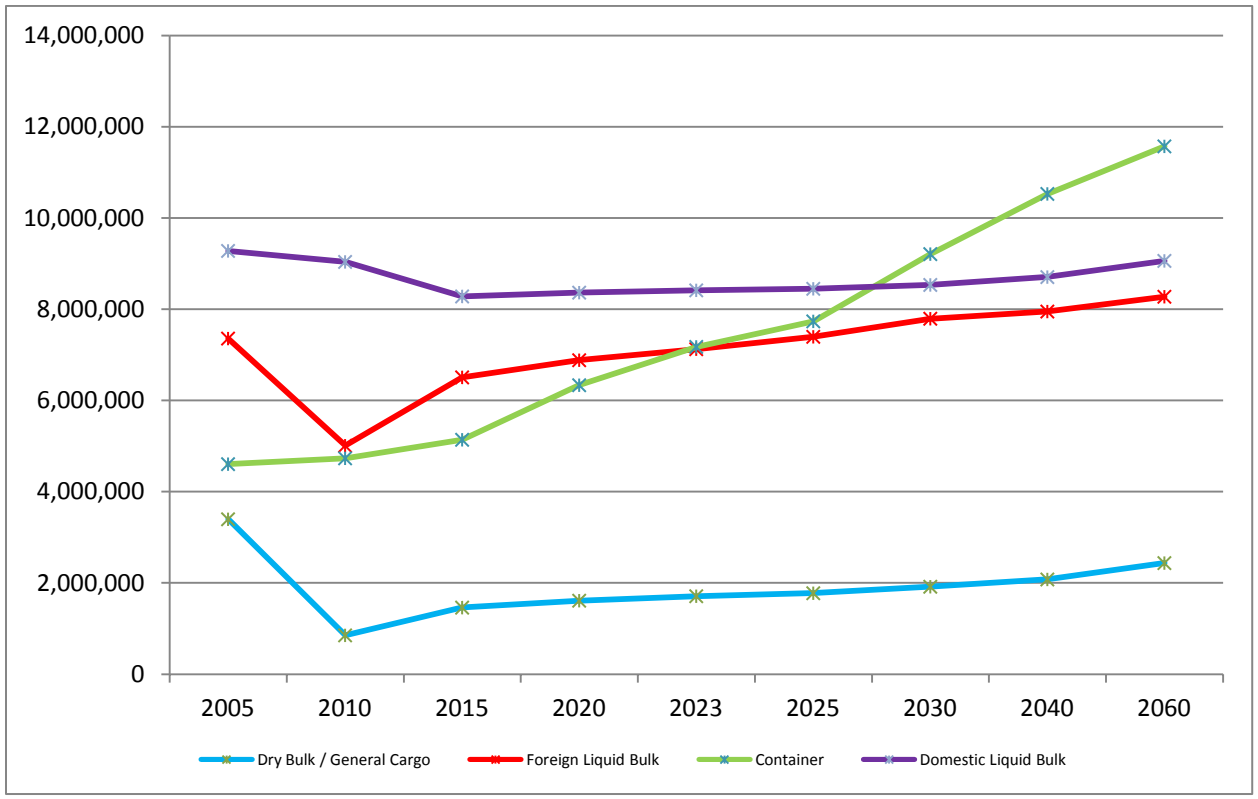

Figure 23. Graph of Total Port Everglades Cargo Throughput Forecast (Metric)

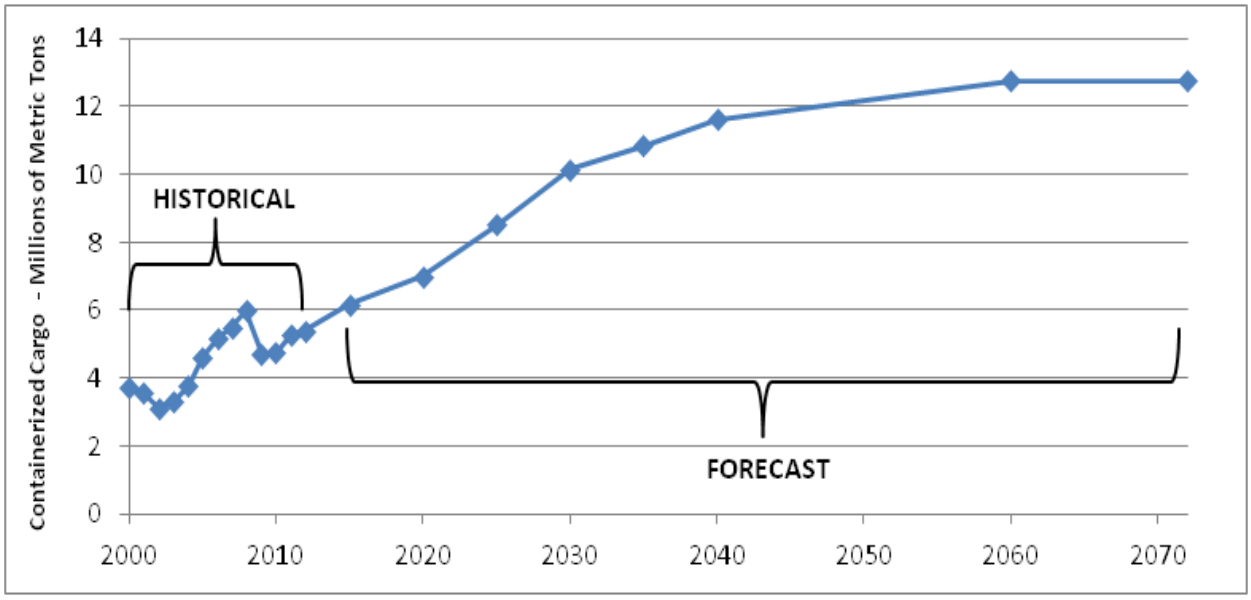

Figure 24. Graph of Historical and Forecasted Port Everglades Containerized Cargo Tonnage[34]

6 Future Without-Project Conditions

The purpose of this section is to show how future cargo movements will affect existing identified problems (see Section 3) with no changes to the channel configuration. The section will discuss how commodity growth results were applied to the anticipated without-project vessel fleet. It will also identify assumptions behind the future without-project fleet, and provide details on the effect of the future fleet on pre-existing problems.

6.1 Future Without-Project Vessel Fleet

In the without-project condition the overall vessel fleet will remain much the same as it is today, burdened by the same set of problems and navigational constraints. The fleet for bulkers and foreign-flagged liquid petroleum tankers will not experience any shift in vessel sizes. The domestic fleet of petroleum tankers and barges will not experience any shift in the without-project condition. The cruise vessel fleet is assumed to remain unchanged as well. This is a conservative assumption because the cruise fleet may increase in size in the future. However, since cruise vessels are not primary drivers of transportation cost savings, the assumption of no change in fleet was considered sufficient for this analysis.

The containership fleet is expected to 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

[34] Historic tonnage provided by the Port is in short tons, therefore, Figure 24 forecasted tonnage is shorts tons as well

that call Port Everglades, as they do now, in a draft-constrained condition, without being able to fully utilize vessel capacity. Additionally, container liners would not be able to fully utilize the vessel fleets that will be available to them. The liners are not anticipated to deploy as many Generation 2 Post-Panamax vessels[35] onto strings that service Port Everglades in the future without-project condition.

6.2 Future Without-Project Vessel Movements

Table 27 shows the forecasted number of vessel calls in the future without-project condition, projected for the years 2023, 2030, and 2060.

[35] Generation 2 Post-Panamax vessels are characterized by having a beam greater than 140 ft, and being able to load approximately 8,000 to 10,000 TEUs.

Table 27. Future Without-Project Vessel Calls

Vessel Class	2023	2030	2060
Sub-Panamax Containership 1 (SPX1)	1,433	1,773	1,773
Sub-Panamax Containership 2 (SPX2)	194	240	240
Panamax Containership 1 (PX1)	308	386	520
Panamax Containership 2 (PX2)	172	206	304
Post-Panamax Containership 1 (PPX1)	194	294	475
Post-Panamax Containership 2 (PPX2)	5	7	10
Tank Barge	152	154	164
Tanker 20k DWT	37	40	42
Tanker 25k-45k DWT	38	41	43
Tanker 45k-60k DWT	300	316	336
Tanker 60k-80k DWT	15	16	17
Tanker 110k DWT	0	0	0
Bulker 15k DWT	11	12	16
Bulker 25k DWT	11	12	16
Bulker 40k DWT	27	30	39
Bulker 60k DWT	5	6	7
Bulker 80k DWT	0	0	0
General Cargo Ship-15k DWT	32	36	46
General Cargo Ship-15k-25k DWT	40	45	57
General Cargo Ship-25-35k DWT	18	21	26
General Cargo Ship-35-40k	15	17	22
Ferry Ship	221	221	221
Cruise Ship-Luxury - 400 passengers	53	59	59
Cruise Ship-Small - 1200 passengers	58	64	64
Cruise Ship-Contemporary - 2600 passengers	498	552	552
Cruise Ship-Large - 4000 passengers	50	56	56
Cruise Ship-Oasis Class - 5400 passengers	132	147	147
Total	4,019	4,751	5,252

Note: More details for each vessel class are shown in Section 11.3.1, Table 45.

6.3 Future Without-Project Condition Summary

In conclusion, vessel calls will continue to increase into the future, while still being affected by the navigational constraints described earlier in Section 3.4.

7 Project Alternatives

The intent of this section is to introduce the options available that were studied and considered to alleviate problems, and meet project objectives. It also details the planning-level economic costs of proposed alternatives.

7.1 Description of Final Array of Alternatives

The structural project alternatives considered deepening and widening to address the problems present in the harbor. Widening the channel in strategic locations would alleviate the existing navigational

constraints in the channel due to the rules against passing at the knuckle (berths 24-27). Widening would also allow for larger vessels transit more safely when fully laden. Once the widening features had been identified, deepening the channel at 1 ft incremental depths from 43' to 51' was evaluated in conjunction with widening in this analysis. The primary planning objectives were stated as:

1. Decrease costs associated with vessel delays (due to congestion, channel passing restrictions, and berth deficiencies) through the end of the period of analysis.
2. Decrease transportation costs by increasing economies of scale for cargo and petroleum vessels through the end of the period of analysis.
3. Increase channel safety and maneuverability for large vessels that are calling now and ones that are expected to call through the end of the period of analysis.

A summary of the management measures that were examined and combined to form alternative widening plans is shown in Table 28. Plan 2 was selected based on its ability to meet the most objectives while being anticipated to provide the most economic benefits. The features of Plan 2 are shown in relation to the existing project footprint in Figure 25.

Table 28. Table of Management Measures by Plan

Management Measures	Plan 1	**Plan 2**	Plan 3	Plan 4	Plan 5	Plan 6
Light-loading Vessels (widening at existing 42 ft project depths)						X
Widen OEC	X	**X**			X	X
Deepen OEC/Deepen IEC	X	**X**			X	
Deepen MTB	X	**X**			X	
Deepen STB	X			X	X	
Widener – Shoaling Area Removal		**X**			X	X
Widen SAC		**X**			X	X
Deepen SAC		**X**			X	
Widen TN		**X**			X	X
Deepen TN		**X**			X	
DCC TB			X		X	X
Widen and Deepen DCC			X		X	X
Notes: Plan 6 does not have any deepening. Plans 1-5 examine the existing and greater depths incrementally.						

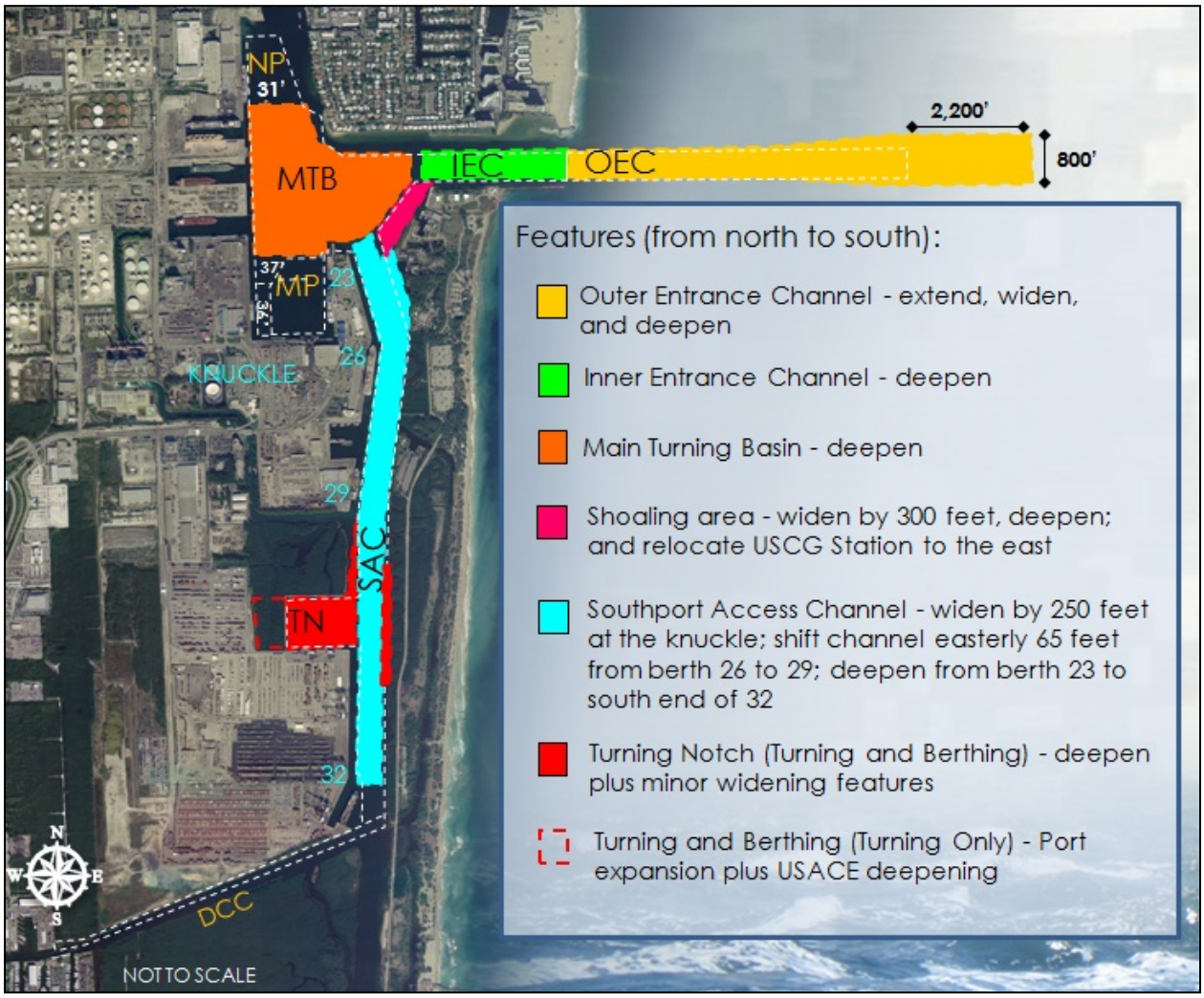

Figure 25. Features of Plan 2

7.2 Planning-level Costs

Once the final array was established as Plan 2 plus deepening at incremental depths, planning-level costs for these alternative plans were estimated. Table 29 shows the planning-level costs that were used in evaluation of the final array of alternatives.

Table 29. Planning-Level Cost Estimates Used in Economic Analysis

Project Depth (ft) +Widening	Project First Cost	Duration (days)	IDC Est. based on mid-month uniform payments	Total Investment Cost Including IDC	Average Annual Cost
42	$ 297,000,000	638	$ 8,805,585	$ 305,805,585	$ 13,037,627
43	$ 298,500,000	1,162	$ 16,745,834	$ 315,245,834	$ 13,440,099
44	$ 311,000,000	1,266	$ 19,122,309	$ 330,122,309	$ 14,074,339
45	$ 323,500,000	1,371	$ 21,646,324	$ 345,146,324	$ 14,714,868
46	$ 336,000,000	1,475	$ 24,316,928	$ 360,316,928	$ 15,361,647
47	$ 352,000,000	1,646	$ 28,639,271	$ 380,639,271	$ 16,228,064
48	$ 370,000,000	1,816	$ 33,468,003	$ 403,468,003	$ 17,201,338
49	$ 387,500,000	1,998	$ 38,843,182	$ 426,343,182	$ 18,176,591
50	$ 405,000,000	2,179	$ 44,607,715	$ 449,607,715	$ 19,168,445
51	$ 422,500,000	2,361	$ 50,768,319	$ 473,268,319	$ 20,177,184

Notes: IDC = Interest During Construction; IDC was calculated at 3.75% interest rate. Average Annual Costs were calculated at 3.5% discount rate. Costs for project alternatives at 43', 45', and 49' depths were linearly interpolated.

8 Future With-Project General Methods and Assumptions

This section describes the general methods of analyzing project alternatives versus the without-project condition. It then details the assumptions of the changes that are expected to take place in the future with-project condition.

8.1 Transportation Cost Savings

The Planning Guidance Notebook, Engineer Regulation 1105-2-100, gives specific details of what can be considered a NED benefit for deep-draft navigation improvement projects. The NED benefits for the Port Everglades Harbor feasibility study were determined using the transportation cost reduction method. Transportation cost reductions, in the most basic terms, are calculated by subtracting the total cost of moving all of the goods through the port over the period of analysis in the with-project condition from the total cost in the without-project condition.

Transportation cost savings benefits in the study were derived from increased efficiencies in the movement of cargo. For the purposes of this study, all benefits from reductions in transportation costs were assumed to have the same origin, destination, and harbor with and without the project. For the sake of simplification of the analysis, it was assumed that increased efficiencies would reduce transportation costs without affecting the demand for import and export of goods through the harbor. This means that the commodity tonnages forecast to be transited through Port Everglades are expected to move with or without the proposed improvements. There will be no expected shift in origin, destination, mode of transportation, or any induced movement of cargo due to the proposed navigation improvements. Transportation cost savings will result primarily from the use of larger, more efficient

vessels, more efficient use of large vessels that are currently transiting the harbor, and reduced congestion in the harbor.

8.2 Assumptions on Changes in With-Project Condition

Below are the general assumptions on changes in the with-project condition that will lead to transportation cost savings:

Fleet transition to larger vessels / more efficient use of existing fleet: The primary driver of transportation cost savings will be the transition to larger cargo vessels and more efficient use of existing fleet. A majority of the transportation costs accrue while the vessel is transiting at-sea. When larger vessels are utilized or the existing fleet can be utilized more efficiently by increasing loading, the cost per ton per mile of cargo drops significantly. Furthermore, the increases in efficiencies are often so great that the number of vessel calls per year can be reduced (compared to moving a similar amount of cargo in the without-project condition).

Reduced congestion and wait times: Widening features will eliminate the passing restrictions in the Southport Access Channel (SAC) while large cruise vessels are at Berths 24-27. With a greater availability for use of the SAC, congestion and wait times will be reduced, resulting in transportation cost savings. Also, the fleet transition and more efficient use of vessels will reduce the number of vessel calls required to move the forecasted cargo throughput. The reduction in number of vessel calls will also contribute to reducing congestion and wait times.

Reduced tidal delays: As the channel gets deeper, vessels that were previously tide-constrained (i.e. were so fully loaded that they could only transit at high tide) become less constrained by the need to wait for high tide. Alleviation of this constraint reduces tidal delays and transportation costs.

Finally, with a wider and deeper channel the following existing conditions will be addressed and channel users will experience improved safety[36]:

i. Outer Entrance Channel (OEC) existing dimensions and strong unpredictable cross currents combine to make entrance transit difficult under conditions of increased winds, waves, and currents. Pilots must increase vessel speed to negotiate the currents and compensate under crabbed conditions to remain aligned within the channel;
ii. The “Knuckle” area configuration restricts maneuverability and passing operations, especially when vessels are at Berths 24-25 and 26-27;
iii. The shoal in the area of the USCG facility restricts maneuverability and passing operations for transit down the Southport Access Channel (SAC), especially when vessels are at Berths 24 and 25;

[36] For more information on vessel safety problems and opportunities, see Section 4 of the Main Report.

9 Future With-Project Fleet Forecast

The fleet forecast in the future with-project condition was analyzed for each vessel type, and, in the case of containerships, by each trade route. The primary benefitting vessel types are foreign-flagged petroleum tankers and containerships. There is also expected to be some shift in the dry bulk fleet. For general cargo, domestic petroleum products, and cruise ships, no shift in vessel fleet was forecasted.

9.1 Containership Future With-Project Fleet Forecast

The total world containership fleet has been shifting towards larger Post-Panamax container vessels in recent years. Figure 26 shows that the TEU capacity of sub-Panamax and Panamax containerships has remained fairly constant over the past 15 years, while Post-Panamax containership capacity has increased dramatically from around 6,500 TEUs in 1998 to over 9,000 TEUs in 2010. This increase in capacity is also reflected in the overall dimensions of the vessels.

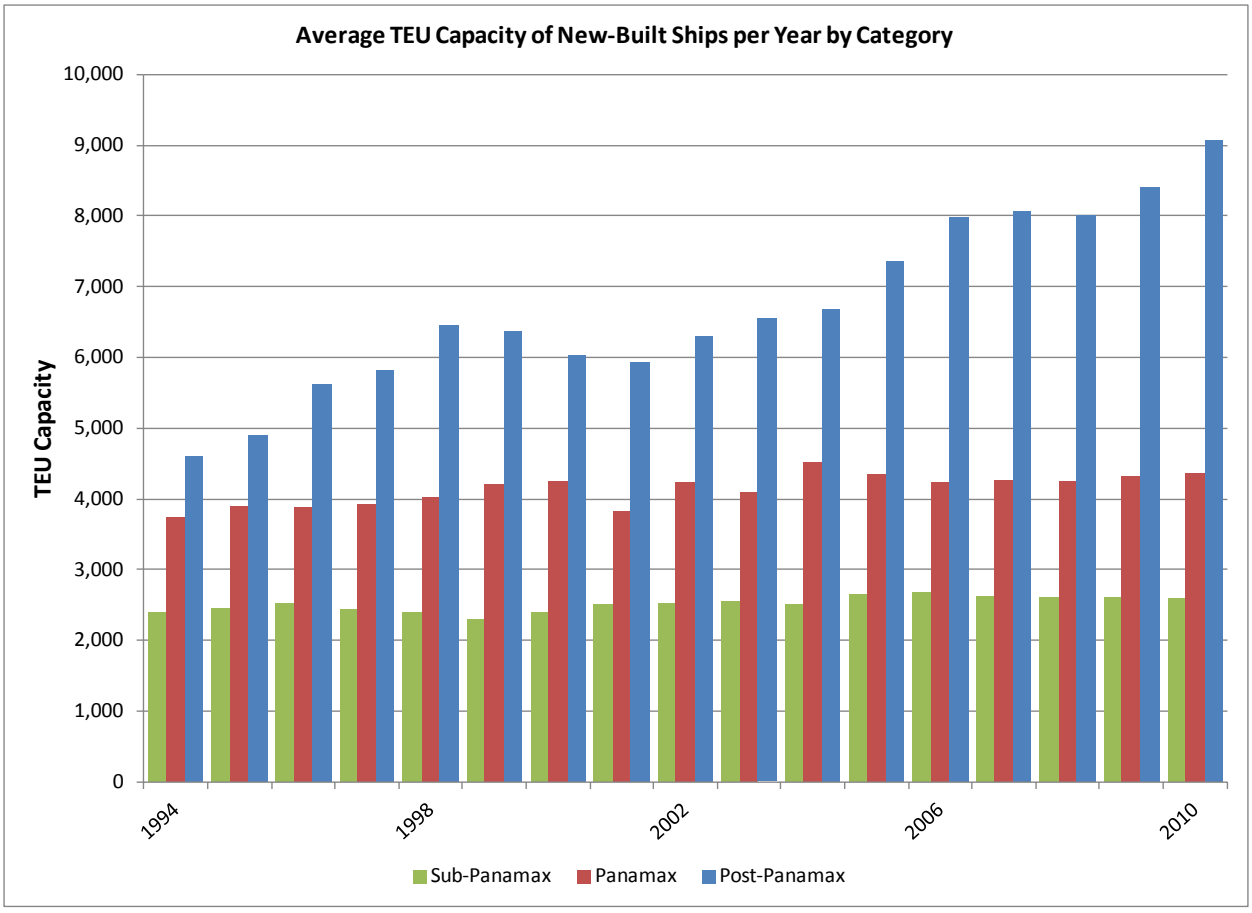

Figure 26. Average TEU Capacity of Newly Built Container Ships per Year by Category
Source: IHS Sea-web

In addition to the increasing capacity and size of Port-Panamax vessels, the number of new builds has also increased in recent years (Figure 27). With fewer than 30 new builds per year before 2000, the number of new builds reached 96 in 2010. At the same time the average design draft of all vessels built each year increased from 46.1 feet in 1998 to 47.6 feet in 2010. These increases reflect the shift from the "Generation 1" Post-Panamax containerships to the "Generation 2" Post-Panamax ships.

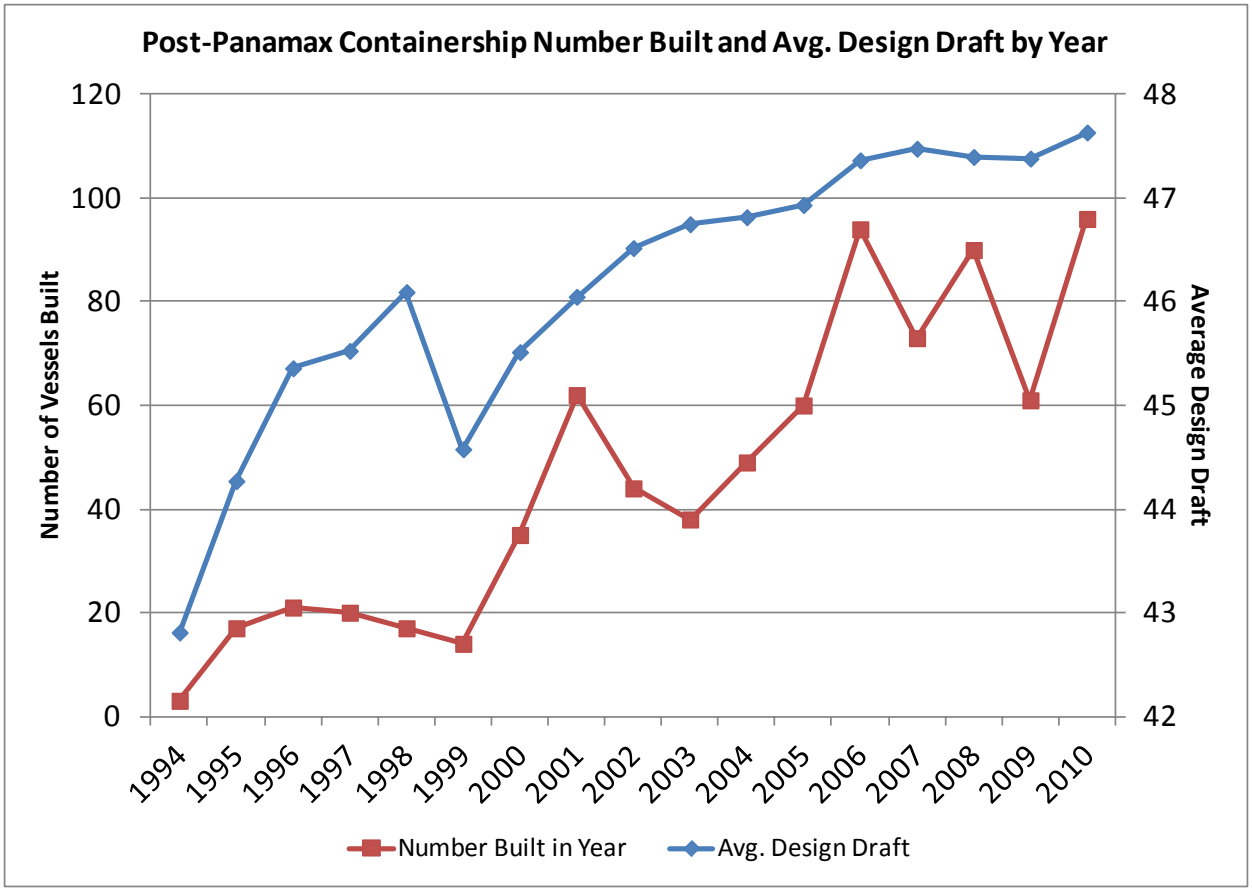

Figure 27. Number of Post-Panamax Vessels Built by Year and Average Design Draft
Source: IHS Sea-web

The addition of larger Post-Panamax containerships has contributed to changing the distribution of cargo capacity of the world containership fleet. Smaller "feeder" category ships still account for the greatest number of vessels in the world fleet (Figure 28), but Post-Panamax containerships now account for over 40% of total TEU capacity (Figure 29).

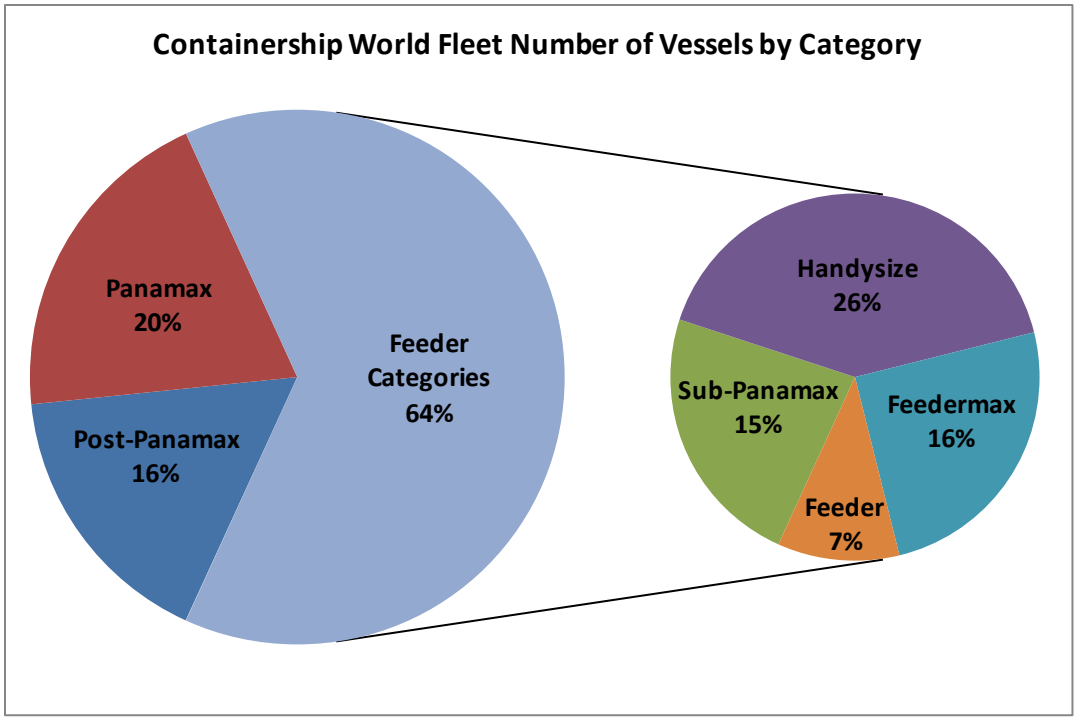

Figure 28. Percent of Number of Vessels in Containership World Fleet by Category
Source: IHS Sea-web, 2011

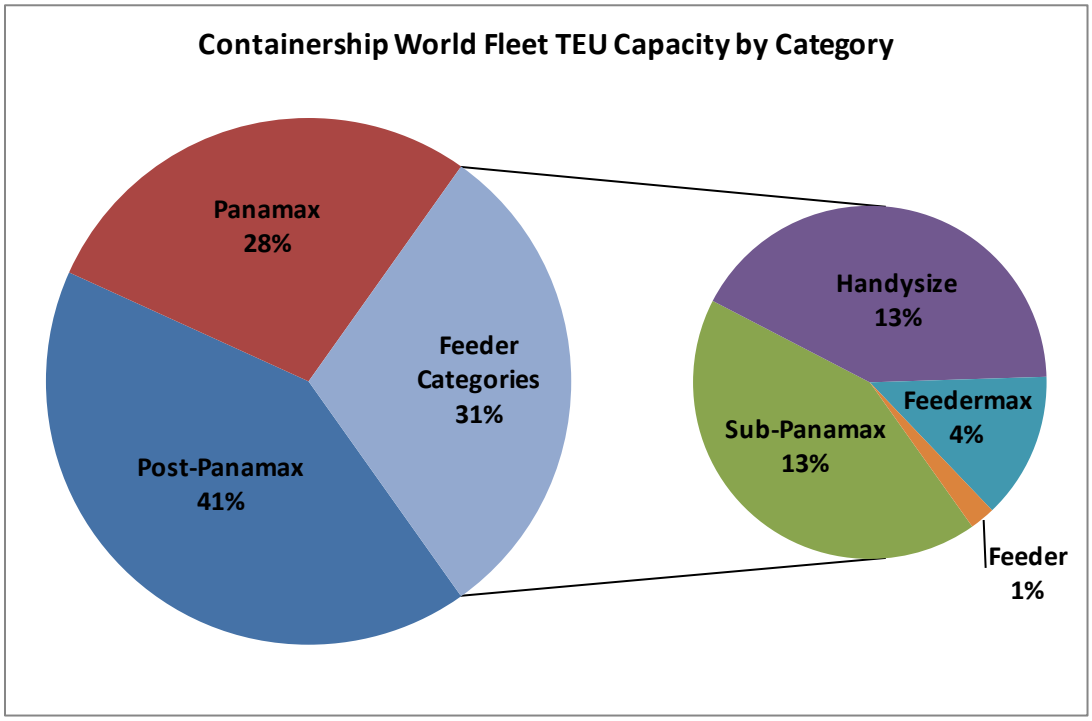

Figure 29. Percent of Total TEU Capacity in Containership World Fleet by Category
Source: IHS Sea-web, 2011

Post-Panamax containerships are already calling Port Everglades in significant numbers, and that trend is expected to increase into the future. The largest containerships that call the port are deployed on the longest trade routes, where the carriers are most able to take advantage of the economies of scale of a larger ship. The longest trade routes that currently service Port Everglades are the Europe and Mediterranean to East Coast U.S. and Gulf of Mexico pendulum route, East Coast South America to East Coast U.S. pendulum route, and West Coast South America to East Coast U.S. pendulum route. Separate fleet forecasts were used for each of these primary benefitting trade routes.

9.1.1 South America Trade Routes

East Coast South America to East Coast U.S. pendulum route (ECSA-ECUS) and West Coast South America to East Coast U.S. pendulum route (WCSA-ECUS) both used the same fleet forecast for the future with-project condition and the future without-project condition. The regional fleet forecast was derived from data provided by a consultant, and was adapted to coincide with existing fleet characteristics at Port Everglades. The existing fleet at Port Everglades does not employ any sub-Panamax vessels on the ECSA-ECUS trade route; the forecast does not include any sub-Panamax vessels on either the ECSA-ECUS or WCSA-ECUS routes.

The South America containership fleet calling Port Everglades is expected to transition to Generation 1 Post-Panamax (PPX1)[37] container vessels by the base-year (2023). This trend is expected to continue throughout period of analysis for with- and without-project conditions. There is no increase in PPX1 vessel deployment expected with increased channel depths for this trade route; efficiency is gained only from more efficient loading and increased cargo capacity as channel depths increase. A transition to larger Generation 2 Post-Panamax (PPX2) container vessels is not expected on this trade route. The amount of cargo expected to be carried by each container vessel class throughout the period of analysis is shown in Table 30.

Table 30. Forecast of South America Container Trade Routes Distribution of Cargo by Vessel Class

Vessel Class	TEU Capacity	2023 Cargo Percent	2030 Cargo Percent	2060 Cargo Percent
Panamax 1	3,500	39%	35%	30%
Panamax 2	4,800	32%	28%	27%
Post-Panamax Gen 1	6,500	29%	37%	43%

[37] See Table 45 in Section 11.3.1 for standard dimensions of vessel sizes used in the analysis.

9.1.2 Europe and Mediterranean Trade Routes

The Europe and Mediterranean to East Coast U.S. and Gulf of Mexico pendulum route (EU-MED-ECUS-GMEX) is made up of several services that each have different ports of call, but similarly sized ships, container weights, and load factors. This is the trade route with the largest vessels calling on the most frequent basis, and is the one most likely to transition to greater use of Post-Panamax Generation 2 (PPX2) vessels as the channel depth becomes deeper in the future with-project condition. The regional fleet forecast was derived from data provided by a consultant, and was adapted to coincide with existing fleet characteristics at Port Everglades. Europe and Mediterranean trade routes were combined because they both had similar vessel sizes, U.S. ports of call, and carried similar cargo. No Sub-Panamax vessels are on this trade route.

The fleet transition to Post-Panamax Generation 1 (PPX1) and Generation 2 (PPX2) container vessels is forecasted to occur by base-year (2023), and continue throughout period of analysis. Some transition to larger vessels is expected to occur in the without-project condition as the world fleet of containerships shifts towards larger vessels. However, a greater level of deployment is expected to occur in the future with-project condition, as Port Everglades channel depth is more able to accommodate larger and more fully-laden PPX2 ships. The amount of Port Everglades cargo expected to be carried by each container vessel class throughout the period of analysis by each project depth is shown in Table 31.

Table 31. Forecast of Europe and Mediterranean Trade Routes Distribution of Cargo by Vessel Class

Channel Depth	Vessel Class	TEU Capacity	2023 Cargo Percent	2030 Cargo Percent	2060 Cargo Percent
42 ft. WOP	Panamax 1	3,500	24%	24%	24%
	Panamax 2	4,800	15%	15%	15%
	Post-Panamax 1	6,500	58%	58%	58%
	Post-Panamax 2	8,700	3%	3%	3%
44 ft.	Panamax 1	3,500	17%	14%	14%
	Panamax 2	4,800	13%	11%	11%
	Post-Panamax 1	6,500	58%	58%	58%
	Post-Panamax 2	8,700	12%	17%	17%
46 ft.	Panamax 1	3,500	13%	10%	10%
	Panamax 2	4,800	13%	11%	11%
	Post-Panamax 1	6,500	61%	61%	61%
	Post-Panamax 2	8,700	13%	18%	18%
47 ft.	Panamax 1	3,500	13%	10%	10%
	Panamax 2	4,800	13%	11%	11%
	Post-Panamax 1	6,500	61%	61%	61%
	Post-Panamax 2	8,700	14%	19%	19%
48 ft.	Panamax 1	3,500	13%	10%	10%
	Panamax 2	4,800	13%	11%	11%
	Post-Panamax 1	6,500	61%	61%	61%
	Post-Panamax 2	8,700	14%	19%	19%
50 ft.	Panamax 1	3,500	13%	10%	10%
	Panamax 2	4,800	13%	11%	11%
	Post-Panamax 1	6,500	61%	61%	61%
	Post-Panamax 2	8,700	14%	19%	19%

Note: Not all depths shown.

9.1.3 Caribbean Sea and Gulf of Mexico Regional Trade

Nearly half of all the containerized cargo that transits through Port Everglades is on shorter regional trade routes in the Gulf of Mexico and Caribbean Sea. Most of this trade is on smaller “feeder” class vessels which are sub-Panamax in size. There is no fleet shift expected over time, or in response to increased channel depths in the with-project condition. Therefore, the historical fleet mix was used throughout all alternatives over entire period of analysis. Approximately 83% of cargo on this trade route moves on sub-Panamax 1 class vessels that have an average capacity of about 600 TEUs, 16% of the cargo moves on sub-Panamax 2 vessels that have a 2,200 TEU capacity, and the remaining 1% of cargo on this route moves on Panamax 1 vessels with a 3,500 TEU capacity.

9.1.4 Containership Sailing Draft Distributions and Load Factors

Containership sailing drafts (particularly arrival and departure drafts at the study port) are critical to the economic analysis of channel deepening. Sailing drafts are dependent on the amount and weight of cargo on board the ship, as well as the vessel dimensions (design draft) and immersion rate (how many tons of cargo must be loaded for the vessel to sink 1 inch in the water).

The amount of cargo and weight of cargo on board the ship at arrival is not directly observable; therefore the arrival draft of the ship is not directly calculable using empirical data. So, arrival drafts for containerships by vessel class were applied based on best-available data. Departure drafts were calculated by the HarborSym model, based on cargo tonnage transferred and the vessel characteristics. The arrival drafts were applied as a distribution, based on empirical data. The sailing draft distribution for Sub-Panamax and Panamax 1 vessel classes was based on USACE Waterborne Commerce Statistics Center's "Entrances and Clearances" data from 2007-2010 for those vessel classes at all U.S. Ports. The sailing draft distribution for Panamax 2 and Post-Panamax vessel classes was based on arrival draft information provided by MSC (Mediterranean Shipping Company) for years 2010-2012 at the ports of Charleston, Norfolk, New York-New Jersey, and Long Beach. These data sets were used to determine the mean and standard deviation of the arrival draft distributions by vessel class. The arrival draft distributions were then based on a truncated normal distribution centered on a mean with upper and lower limits. The upper limit was the lower value of either the upper limit of the sailing drafts in the dataset or the channel depth. The mean, standard deviation, and upper and lower limits for each vessel class are shown in Table 32. Arrival draft distributions for containerships are shown in Figure 30 through Figure 33. Note that these figures show arrival draft distributions for the 2060 forecast year; not all project depths are included in the figures.

Table 32. Containership Sailing Draft Distribution Characteristics by Trade Route and Vessel Class

Trade Route	Vessel Class	Min. Arrival Draft (ft)	Mean Arrival Draft (ft)	Max. Arrival Draft (ft.)	Standard Deviation (ft)
ECUS-MED-EU-GMEX	Panamax 1	29.3	32.6	41.0	3.3
	Panamax 2	34.9	39.7	43.3	2.4
	Post-Panamax 1	34.1	40.2	45.0	1.9
	Post-Panamax 2	35.6	42.3	47.4	2.2
ECUS-WCSA & ECUS-ECSA	Panamax 1	28.6	31.9	41.0	3.3
	Panamax 2	34.9	39.7	43.3	2.4
	Post-Panamax 1	34.1	40.2	45.0	1.9

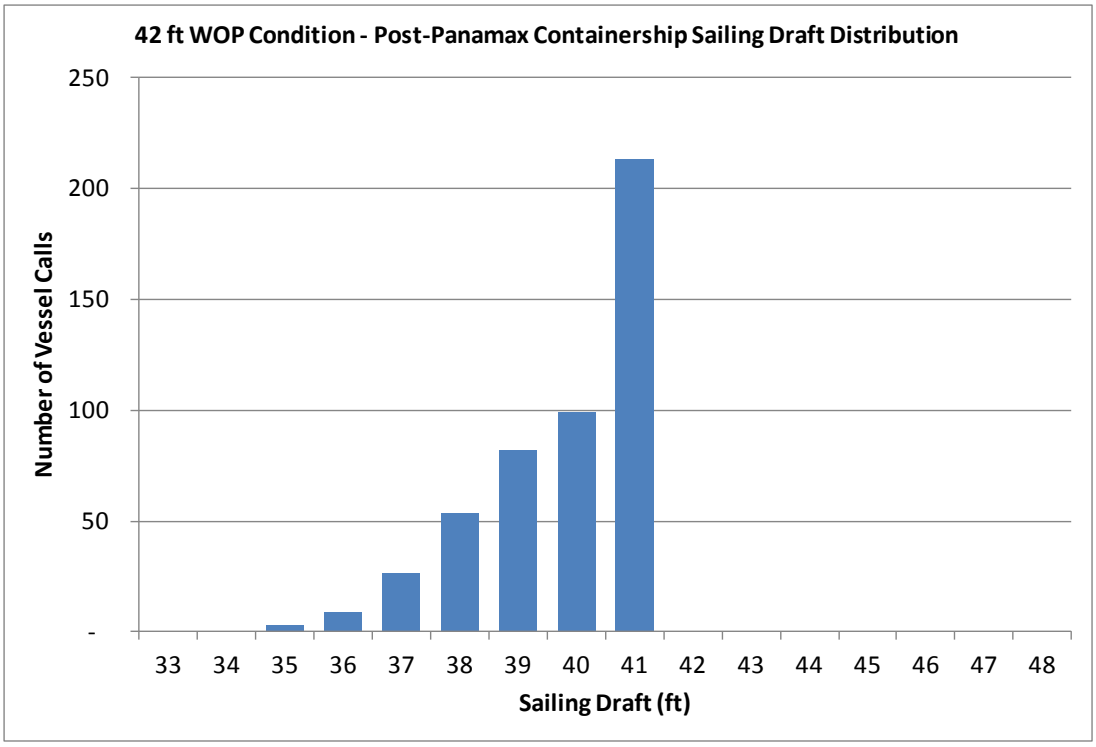

Figure 30. Post-Panamax Containership Arrival Drafts by Depth for 42 ft WOP Condition

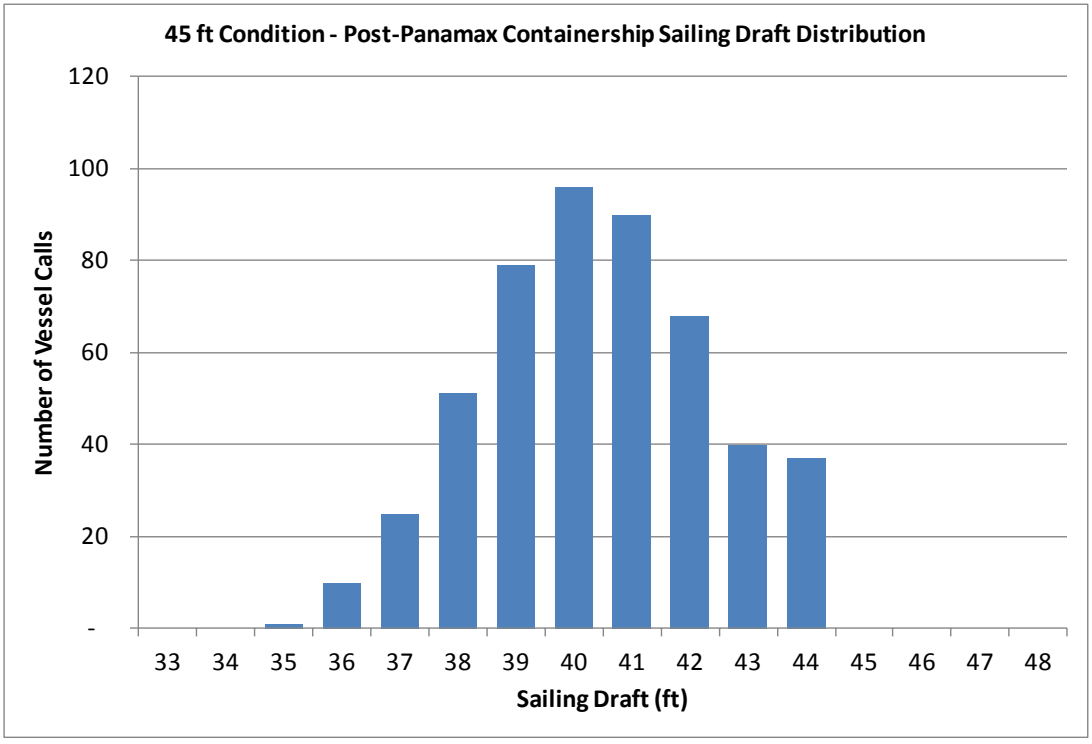

Figure 31. Post-Panamax Containership Arrival Drafts by Depth for 45 ft Condition

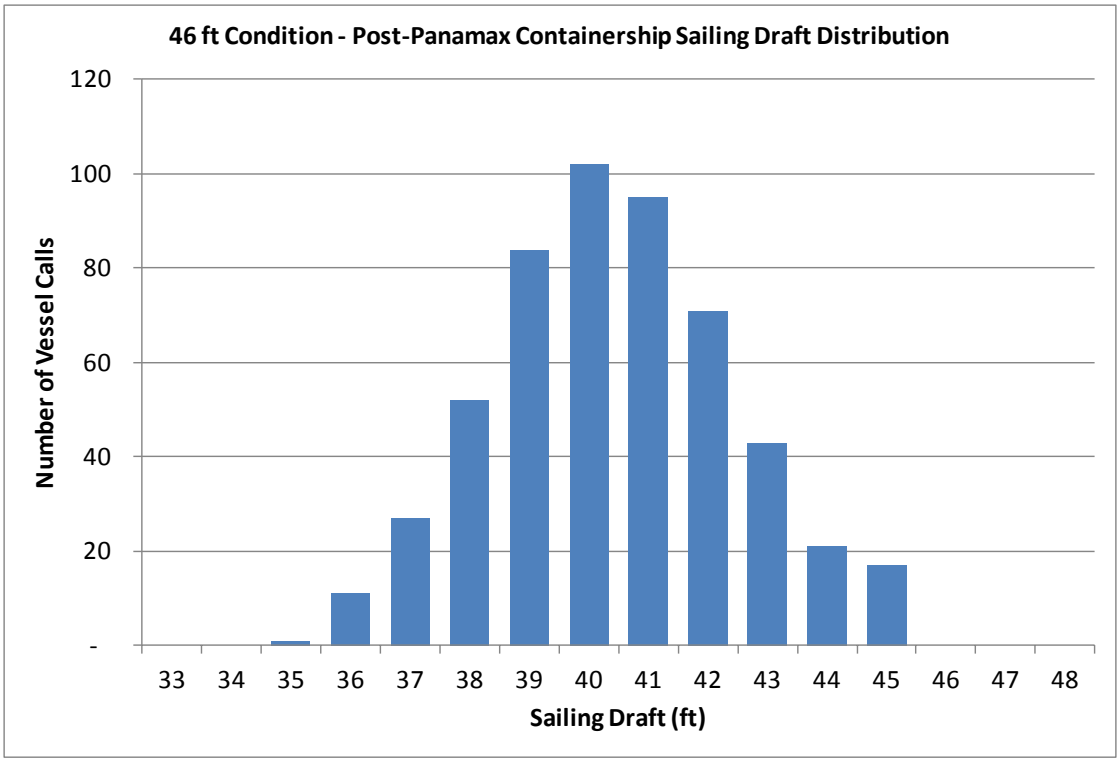

Figure 32. Post-Panamax Containership Arrival Drafts by Depth for 46 ft Condition

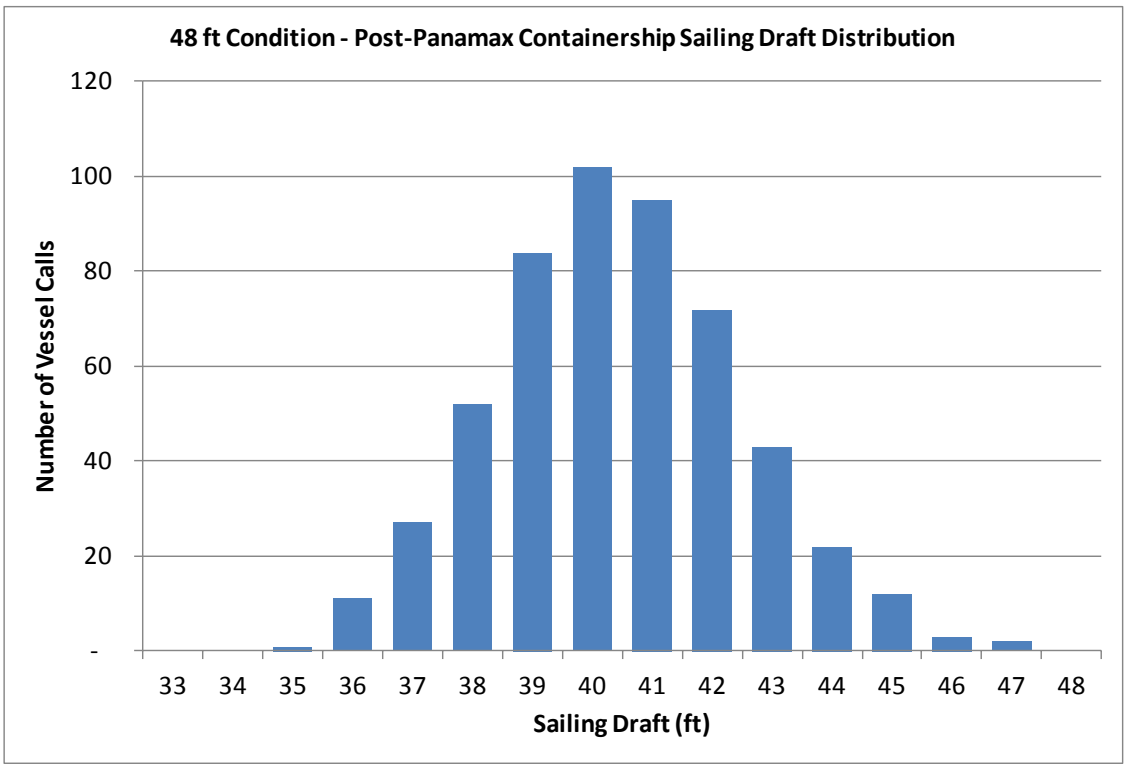

Figure 33. Post-Panamax Containership Arrival Drafts by Depth for 48 ft Condition

Containership load factors are another critical component of economic analysis of channel deepening. Load factors include: average weight per loaded TEU, percentage of loaded vs. empty TEUs, percentage of imports vs. exports, and percent vacant slots. These factors are used to determine the total tonnage of TEUs that are loaded and unloaded per call, as well as the associated change in sailing draft, and what percent of total trip cargo is actually unloaded at the port (to determine the transportation cost allocation). Load factors were determined using Port Everglades Harbormaster's data and regional data from other south Atlantic U.S. ports. A summary of the load factors used in the analysis for the primary benefitting container trade routes is shown in Table 33.

Table 33. Containership Load Factors by Trade Route

Trade Route	Laden TEU Weight (metric tons)	Percent Empties	Percent Vacant Slots	Import Percent	Export Percent
ECUS-MED-EU-GMEX	10.31	18.9%	4.65%	73%	27%
ECUS-ECSA	7.57	23.2%	6.15%	58%	42%
ECUS-WCSA	8.31	24.7%	6.15%	57%	43%

9.2 Liquid Bulk and Dry Bulk Fleet Forecast

Liquid bulk makes up the largest proportion of total cargo throughput at Port Everglades, approximately two-thirds annually. Foreign-flagged petroleum tankers are currently limited in size by channel depth, berth depth, and manifold height. The berth depth and manifold height will be addressed by improvements in the future without-project condition[38]. In the future with-project condition, as channel depth increases, larger tankers will be able to call Port Everglades, offering greater levels of efficiency.

Dry bulk vessels make up a relatively small proportion of total cargo throughput at Port Everglades, less than 5% annually. However, the largest of the dry bulk vessels that are currently calling are draft constrained in the future without-project condition, and a larger bulker could be utilized for greater efficiency in the future with-project condition.

Throughout this forecast, all bulkers and tankers are expected to load to either their full capacity or the limits of the channel depth in each with-project condition (accounting for underkeel clearance and tide-riding behavior).

9.2.1 Tanker World Fleet

The world fleet of petroleum tankers includes some of the largest ships in the world. However, the largest tankers are usually reserved for carrying crude petroleum only. Since there are no refineries in South Florida, all petroleum must be brought in already refined as "products." The fleet of vessels that

[38] See Section 4.

are suited to carry petroleum products is a subset of the world fleet of tankers. Some tankers are designed to carry both products and crude, depending on their route, and to minimize empty backhauls. For this analysis, both products tankers and products/crude tankers were included in the world fleet of tankers that could service Port Everglades in the future with-project condition. Both of these vessel types are referred to as "products tankers" throughout this section.

Tankers are grouped into sizes based on classes that were created to standardize oil contracts. The two main classification systems in use today are the Average Freight Rate Assessment (AFRA) scale and the Flexible Market scale (Table 34). The largest products tankers calling the port in the existing condition, and projected to call in the future without-project condition are 60,000 DWT to 80,000 DWT tankers, which fall in the Large Range 1 (LR-1) or Panamax class of ships. In the future with-project condition, it is expected that Large Range 2 (LR-2) or Aframax tankers would be utilized, particularly vessels in the 100,000 DWT to 120,000 DWT size range.

Table 34. Tanker Classification Scales

Fixed AFRA Scale		Flexible Market Scale	
General Purpose (GP)	10,000-24,999 dwt	Product Tanker	10,000-60,000 dwt
Medium Range (MR)	25,000 - 44,999 dwt	Panamax	60,000-80,000 dwt
Large Range 1 (LR-1)	45,000 - 79,999 dwt	Aframax	80,000-120,000 dwt
Large Range 2 (LR-2)	80,000 - 159,999 dwt	Suezmax	120,000-200,000 dwt
VLCC	160,000 - 319,999 dwt	VLCC	200,000-315,000 dwt
ULCC	320,000 - 549,999 dwt	ULCC	320,000-550,000 dwt

Source: "Scaling the Tanker Market". Surveyor (American Bureau of Shipping) (4): 5–11

In the world fleet of products tankers, there are nearly 1650 vessels in-service from 45,000 DWT to 120,000 DWT. LR-1 tankers outnumber Aframax tankers about 3.5:1, but they only represent a 1.8:1 ratio of capacity (Table 35). Within the Aframax fleet however, larger ships are more prevalent: 100,000 DWT to 120,000 DWT tankers outnumber 80,000 to 100,000 DWT tankers by a ratio of nearly 4.8:1. This large difference is the result of a shift towards larger vessels in recent years. While the total number of Aframax products tankers has not changed substantially from 2011 to 2013 (359 to 363 vessels), the number of 100,000-120,000 DWT tankers has increased by 41 ships, over a 15% increase, and the number of 80,000-100,000 DWT tankers has decreased by 37 ships, a 37% decrease (Table 36). Additionally, nearly all new builds (over 93% of vessels on-order or under construction) are in the 100,000 DWT to 120,000 DWT size range. The trend towards building more of the larger Aframax products tankers resulted in a sub-class of 100,000-120,000 DWT vessels that is 10-years newer than the 80,000-100,000 DWT vessels on average.

Table 35. Products Tankers World Fleet Composition

	45k-80k DWT Products Tanker Class (LR1)	80k-120k DWT Products Tanker Class (Aframax)	Total	Ratio of LR1 to Aframax
Number of Vessels	1,283	363	1,646	3.5
Total Capacity (DWT)	70,148,227	38,979,887	109,128,114	1.8
Percent of Total Vessels	78%	22%		
Percent of Total Capacity	64%	36%		

Source: IHS Sea-web.

Note: "Total vessels" refers to total LR1 and Aframax products tankers; "Total capacity" refers to total LR1 and Aframax products tankers capacity.

Table 36. Comparison of Aframax Products Tanker Fleet from 2011 to 2013

Aframax Products Fleet as of January 2011	Sub-Class		
	80,000 DWT to 100,000 DWT	100,000 DWT to 120,000 DWT	Total
Number of Vessels In-Service/ Launched	100	259	359
Number of Vessels On-Order/ Keel Laid / Under Construction	0	38	38
Number of Vessels Laid up/Rebuilding	0	5	5
Number of Vessels to be Broken up	0	0	0
Total	100	302	402
Average Build Year of Vessels In-Service / Launched	1994	2006	2002
Aframax Products Fleet as of June 2013	Sub-Class		
	80,000 DWT to 100,000 DWT	100,000 DWT to 120,000 DWT	Total
Number of Vessels In-Service/ Launched	63	300	363
Number of Vessels On-Order/ Keel Laid / Under Construction	3	41	44
Number of Vessels Laid up/Rebuilding	2	2	4
Number of Vessels to be Broken up	2	0	2
Total	70	343	413
Average Build Year of Vessels In-Service / Launched	1996	2006	2005

Source: IHS Sea-web.

9.2.2 Foreign-Flagged Tanker Fleet Forecast

Foreign petroleum imports make up approximately one-third of all petroleum receipts at Port Everglades. A majority of these petroleum products are gasoline, diesel fuel, and jet fuel. The historical fleet composition was used as a basis for the future without-project fleet forecast. About two-thirds of

the foreign-flagged petroleum tankers in the existing fleet of vessels calling Port Everglades are products tankers on the smaller side of the LR-1 class, approximately 45,000 to 60,000 DWT. These tankers have a near-Panamax beam, and design drafts of about 41 ft. They are very well represented in the world fleet of products tankers, and will continue to carry the largest proportion of cargo with the most vessel calls in the future without- and with-project conditions.

However, as the channel depth increases, larger and deeper-drafting vessels will become more cost-effective to transport liquid petroleum products. Considering the greater prevalence and average lower age of the 100,000-120,000 DWT Aframax products tanker vessels compared to the smaller 80,000-100,000 DWT sub-class, as well as the relative cost savings over the LR-1 class, the expected transition in the fleet of vessels calling Port Everglades will be from Medium Range (MR) tankers to LR-1 and from LR-1 to 100,000-120,000 DWT Aframax tankers. The expected transition of cargo carried by each vessel class for each project depth is shown in Table 37 and Figure 34.

Table 37. Distribution of Cargo for Foreign-Flagged Petroleum Tanker Fleet by Project Depth

Tanker Class	42 ft WOP	44 ft	45 ft	46 ft	47 ft	48 ft	49 ft	50 ft
20k DWT	8.1%	8.1%	8.1%	8.1%	8.1%	8.1%	8.1%	8.1%
25-45k DWT	14.5%	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%
45-60k DWT	66.4%	43.9%	36.2%	35.8%	35.5%	35.3%	35.2%	35.2%
60-80k DWT	10.9%	18.8%	19.0%	19.1%	19.2%	19.2%	19.2%	19.2%
100k-120k DWT	0.0%	21.9%	29.4%	29.7%	29.9%	30.1%	30.2%	30.2%

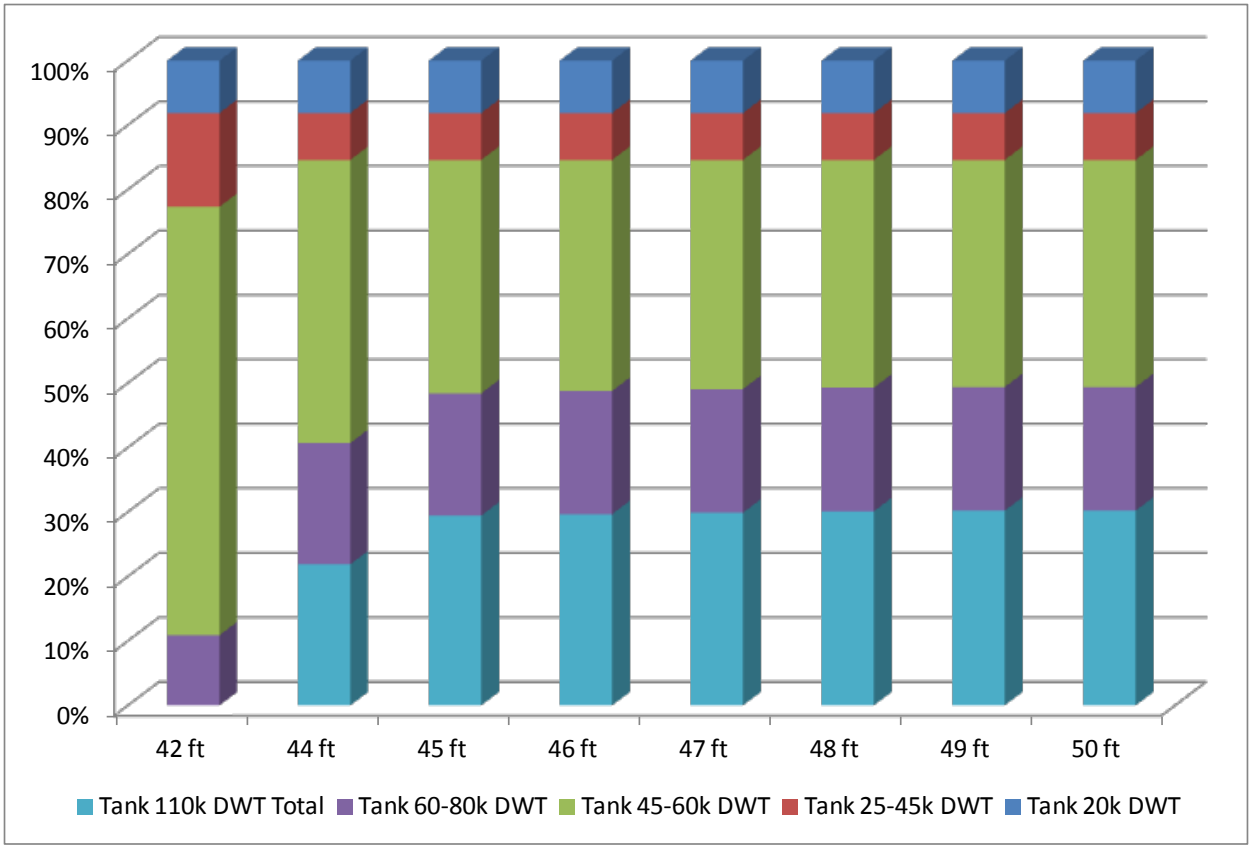

Figure 34. Distribution of Cargo for Foreign-Flagged Petroleum Tanker Fleet by Project Depth

The expected fleet transition for foreign-flagged products tankers shows that 100,000 – 120,000 DWT tankers can be employed efficiently at project depths as shallow as 44 feet, even though these large Aframax tankers have average design drafts of 49 feet. This is due to the relatively light weight of refined petroleum products being carried by these tankers. It was important to determine what specific petroleum products are moving through Port Everglades; their physical qualities and properties, including, cargo density or weight per unit of volume versus volumetric capacity of vessels as applied for the fleet forecasts. Correspondingly, the analysis needed to account for carrying capacity (limited either by weight or volume) of respective cargo type (in this case gasoline, diesel oils, and jet fuels) with immersed draft and calculate need for depth accordingly.

Refined liquid petroleum products vary considerably in density. Crude oil and residual fuels are the heaviest by volume, while “light distillates” such as gasoline and diesel are the lightest by volume (Table 38). As tankers increase in size, their hulls are designed to accommodate a large range of product densities. Since petroleum products are traded by volume and not weight, the vessels are designed to carry a specific volume of product, while accounting for the densest cargo possible. The vessels will only draw their maximum design draft when loaded with the densest products. Therefore, when loaded with any lighter products, the vessel will not draw full draft.

Table 38. Comparison of Liquid Densities

Water	Crude Oil (Mexican crude)	Marine Diesel	Jet Fuel (Jet A) / On-Highway Diesel (ULSD)	Gasoline
1,000 kg/m^3	973 kg/m^3	880 kg/m^3	820 kg/m^3	737 kg/m^3

The 100,000 – 120,000 DWT vessel class is represented in the analysis by an average sized vessel of approximately 110,000 DWT. The 110,000 DWT sized representative vessel has a design draft of 49.1 ft. and liquid volume capacity of 120,315 cubic meters, which is the average volumetric capacity for the class. This volumetric capacity, when loaded with gasoline at 737 kg/ m^3, specifies that the vessel will be fully loaded (volumetrically) with only 88,672 metric tons of gasoline. Using the vessel's dimensions and immersion rates, and after accounting for underkeel clearance and tide-riding behavior, the vessel can load to nearly 97% of volumetric capacity with a 44 ft. channel depth. When loaded with diesel fuel or jet fuel, the vessel requires a 47 ft. deep channel to reach 96% loading.

9.2.3 Dry Bulk Fleet Forecast

The dry bulk forecast assumed that the next larger size bulker vessel would enter the fleet when it could be utilized at greater than 90% capacity. For dry bulk, an 80,000 DWT bulker enters the fleet at the 46 ft project depth (Table 39).

Table 39. Distribution of Cargo for Dry Bulk Vessel Fleet by Project Depth

Vessel Class	42 ft WOP	44 ft	45 ft	46 ft	47 ft	48 ft	49 ft	50 ft
Bulk 15k DWT	9%	9%	9%	8%	8%	8%	8%	8%
Bulk 25k DWT	15%	15%	15%	13%	13%	13%	13%	13%
Bulk 40k DWT	59%	58%	58%	52%	52%	51%	51%	51%
Bulk 60k DWT	17%	18%	18%	16%	16%	16%	16%	16%
Bulk 80k DWT	0%	0%	0%	11%	11%	12%	12%	12%

The annual forecasted vessel calls, based on the methods and assumptions described in the previous sections, was forecast for without- and with-project conditions. A sampling of the vessel fleet forecast at 42, 44, 46, 47, 48, and 50 ft for 2023, 2030, and 2060 is shown in Table 40,

Table 41, and Table 42. These tables also display the estimated fleet transition over the period of analysis for each channel depth.

Table 40. Without-Project (WOP) and With-Project Vessel Call Forecast for 2023

10 Class	42 ft WOP Calls	44 ft + widening Calls	46 ft + widening Calls	47 ft + widening Calls	48 ft + widening Calls	50 ft + widening Calls
Sub-Panamax Containership 1 (SPX1)	1,433	1,433	1,433	1,433	1,433	1,433
Sub-Panamax Containership 2 (SPX2)	194	194	194	194	194	194
Panamax Containership 1 (PX1)	308	270	256	254	254	254
Panamax Containership 2 (PX2)	172	159	159	159	159	159
Post-Panamax Containership 1 (PPX1)	194	188	193	193	193	193
Post-Panamax Containership 2 (PPX2)	5	18	20	21	21	21
Tank Barge	152	152	152	152	152	152
Tanker 20k DWT	37	37	37	37	37	37
Tanker 25k-45k DWT	38	20	20	20	20	20
Tanker 45k-60k DWT	300	248	230	229	228	228
Tanker 60k-80k DWT	15	25	25	25	25	25
Tanker 110k DWT	0	20	27	27	27	27
Bulker 15k DWT	11	11	10	10	10	10
Bulker 25k DWT	11	11	10	10	10	10
Bulker 40k DWT	27	27	24	24	23	23
Bulker 60k DWT	5	6	5	5	5	5
Bulker 80k DWT	0	0	3	3	3	3
General Cargo Ship-15k DWT	32	32	32	32	32	32
General Cargo Ship-15k-25k DWT	40	40	40	40	40	40
General Cargo Ship-25-35k DWT	18	18	18	18	18	18
General Cargo Ship-35-40k	15	15	15	15	15	15
Ferry Ship	221	221	221	221	221	221
Cruise Ship-Luxury - 400 passengers	53	53	53	53	53	53
Cruise Ship-Small - 1200 passengers	58	58	58	58	58	58
Cruise Ship-Contemporary - 2600 passengers	498	498	498	498	498	498
Cruise Ship-Large - 4000 passengers	50	50	50	50	50	50
Cruise Ship-Oasis Class - 5400 passengers	132	132	132	132	132	132
Total	4,019	3,936	3,915	3,913	3,911	3,911

Note: More details for each vessel class are shown in Section 11.3.1, Table 45.

Table 41. Without-Project (WOP) and With-Project Vessel Call Forecast for 2030

Class	42 ft WOP Calls	44 ft + widening Calls	46 ft + widening Calls	47 ft + widening Calls	48 ft + widening Calls	50 ft + widening Calls
Sub-Panamax Containership 1 (SPX1)	1,773	1,773	1,773	1,773	1,773	1,773
Sub-Panamax Containership 2 (SPX2)	240	240	240	240	240	240
Panamax Containership 1 (PX1)	386	320	300	297	297	297
Panamax Containership 2 (PX2)	206	184	182	181	181	181
Post-Panamax Containership 1 (PPX1)	294	283	290	290	290	290
Post-Panamax Containership 2 (PPX2)	7	35	38	39	39	39
Tank Barge	154	154	154	154	154	154
Tanker 20k DWT	40	40	40	40	40	40
Tanker 25k-45k DWT	41	21	21	21	21	21
Tanker 45k-60k DWT	316	259	239	238	237	237
Tanker 60k-80k DWT	16	27	27	27	27	27
Tanker 110k DWT	0	22	28	28	28	28
Bulker 15k DWT	12	12	11	11	11	11
Bulker 25k DWT	12	12	11	11	11	11
Bulker 40k DWT	30	30	27	26	26	26
Bulker 60k DWT	6	6	6	5	5	5
Bulker 80k DWT	0	0	3	3	3	3
General Cargo Ship-15k DWT	36	36	36	36	36	36
General Cargo Ship-15k-25k DWT	45	45	45	45	45	45
General Cargo Ship-25-35k DWT	21	21	21	21	21	21
General Cargo Ship-35-40k	17	17	17	17	17	17
Ferry Ship	221	221	221	221	221	221
Cruise Ship-Luxury - 400 passengers	59	59	59	59	59	59
Cruise Ship-Small - 1200 passengers	64	64	64	64	64	64
Cruise Ship-Contemporary - 2600 passengers	552	552	552	552	552	552
Cruise Ship-Large - 4000 passengers	56	56	56	56	56	56
Cruise Ship-Oasis Class - 5400 passengers	147	147	147	147	147	147
Total	4,751	4,636	4,608	4,602	4,601	4,601

Note: More details for each vessel class are shown in Section 11.3.1, Table 45.

Table 42. Without-Project (WOP) and With-Project Vessel Call Forecast for 2060

Class	42 ft WOP Calls	44 ft + widening Calls	46 ft + widening Calls	47 ft + widening Calls	48 ft + widening Calls	50 ft + widening Calls
Sub-Panamax Containership 1 (SPX1)	1,773	1,773	1,773	1,773	1,773	1,773
Sub-Panamax Containership 2 (SPX2)	240	240	240	240	240	240
Panamax Containership 1 (PX1)	520	423	393	389	389	389
Panamax Containership 2 (PX2)	304	272	269	268	268	268
Post-Panamax Containership 1 (PPX1)	475	456	467	467	467	467
Post-Panamax Containership 2 (PPX2)	10	53	57	59	59	59
Tank Barge	164	164	164	164	164	164
Tanker 20k DWT	42	42	42	42	42	42
Tanker 25k-45k DWT	43	23	23	23	23	23
Tanker 45k-60k DWT	336	275	253	253	252	252
Tanker 60k-80k DWT	17	29	29	29	29	29
Tanker 110k DWT	0	23	31	31	31	31
Bulker 15k DWT	16	15	14	14	14	14
Bulker 25k DWT	16	15	14	14	14	14
Bulker 40k DWT	39	38	34	34	33	33
Bulker 60k DWT	7	8	7	7	7	7
Bulker 80k DWT	0	0	4	4	4	4
General Cargo Ship-15k DWT	46	46	46	46	46	46
General Cargo Ship-15k-25k DWT	57	57	57	57	57	57
General Cargo Ship-25-35k DWT	26	26	26	26	26	26
General Cargo Ship-35-40k	22	22	22	22	22	22
Ferry Ship	221	221	221	221	221	221
Cruise Ship-Luxury - 400 passengers	59	59	59	59	59	59
Cruise Ship-Small - 1200 passengers	64	64	64	64	64	64
Cruise Ship-Contemporary - 2600 passengers	552	552	552	552	552	552
Cruise Ship-Large - 4000 passengers	56	56	56	56	56	56
Cruise Ship-Oasis Class - 5400 passengers	147	147	147	147	147	147
Total	5,252	5,099	5,064	5,061	5,059	5,059

Note: More details for each vessel class are shown in Section 11.3.1, Table 45.

11 Evaluation of Alternatives via HarborSym

To determine transportation cost savings, total transportation costs must first be determined. Total transportation costs were calculated using the Corps-certified HarborSym simulation model[39].

11.1 Model Overview

The Corps-developed HarborSym model was used to calculate transportation costs for entire routes and time in port for all vessel calls projected throughout the period of analysis. HarborSym was created by CDM-Smith (under contract) to serve as the primary economic model for deep draft navigation projects. For this study HarborSym version 1.5.5 was used for all final production modeling, and total transportation cost calculations. The HarborSym Model has been certified for use on all deep draft navigation studies in accordance with Engineering Circular 1105-2-412, Assuring Quality of Planning Models.

HarborSym performs data-driven Monte Carlo simulations of vessel transits through harbors, based on user input. The model incorporates uncertainty through randomizing parameters over multiple model iterations, based on a user-inputted range for parameters such as vessel speed through a specified area (reach), loading and unloading times at docks, docking and undocking times, at-sea distances, etc.

The simulations are based upon vessels moving through reaches from the harbor entrance to their destination dock. At each time increment (step) the model determines if each vessel can move from one node to the next, without violating transit rules. If a transit rule would be violated by a vessel entering a reach, such as passing another vessel when the channel width is too narrow, then the vessel waits until the next time step. This waiting continues until the rule is no longer violated and the vessel resumes its journey.

HarborSym records and accumulates the total time and cost of vessel transits through the harbor and at sea. Since many variations of events can occur over a total voyage, many iterations of the simulation were run to obtain the average values for time in the harbor, time waiting, and total operating costs of vessels in the harbor and at sea.

11.2 Modeling Assumptions

Assumptions that were included in the development of the HarborSym model and limitations of using the model are described in the following lists. The limitations of the model were not considered significant for the purposes of this study.

[39] The HarborSym model estimates a subset of total transportation costs, bound by the limitations of the model. There are some additional transportation costs that are not captured by the model, such as tug assists, dockage fees, etc. The limitations of the model are listed in Section 11.2.

HarborSym Model limitations:

- Tug use and tug costs are not included.
- Wind is not simulated.
- Loading/unloading costs at the port of origin/destination (for imports/exports respectively) are not included.
- Additional handling fees at the study port or foreign port are not included.
- Pilotage costs and other terminal fees for the study port are not included.
- Hinterland transportation costs are not included.
- Ability to account for other fixed costs is not included.

Assumptions in model:

- HarborSym predefined assumptions:
    - All vessels can be classified into classes of similar representative vessels which exhibit similar operating costs and other characteristics.
    - All vessels of a similar type will have a similar commodity transfer rate for a specific commodity at a specific dock.
    - "Priority" vessel arrival times will not be randomized
    - Arrival times for non-priority vessels will vary randomly within a 24 hour window of the originally designated arrival time.
    - Costs external to the port are the same for all conditions.
- Study-specific assumptions:
    - All vessels are foreign flagged except U.S. flagged tankers and barges
    - Vessels in a vessel class for a specific commodity have the same commodity loads transferred and sailing drafts for a specific project alternative and year.
    - Dry Bulk, Liquid bulk and General Cargo vessels are assumed to load to full capacity (when channel depth allows)
    - Dry Bulk and General Cargo are assumed to have similar loads per vessel call within a class
    - Safety Zone active for all vessel types:
        - 2000 ft fore and aft for petroleum and cruise
        - 1000 ft fore and aft for all other vessel types
    - No passing or overtaking in any of the reaches from entrance channel inward to harbor

Vessel loading assumptions:

- Usable Tide: 1.5 ft
- % Empties & Vacant slots, Laden TEU weights by Benefitting Containership Trade Route are shown in Table 43.

Table 43. Containership Loading Assumptions by Trade Route

Route	Avg. Laden TEU Weight	% Empty TEUs	% Vacant Slots
ECUS-MED-EU-GMEX	10.31	18.9%	4.65%
ECUS-ECSA	7.57	23.2%	6.15%
ECUS-WCSA	8.31	24.7%	6.15%

Source: Port Everglades 2012 Harbormaster's Detailed Vessel Call Data

11.3 Model setup & calibration

HarborSym is a data-driven model. All port features, vessel types, vessel movements, and their associated parameters must be manually entered into the model, or otherwise supplied by the modeler. Data sources for this information included the USACE Waterborne Commerce Statistics Center (WCSC), USACE Institute for Water Resources, GIS mapping tools, local sponsor, port shippers, port tenants, port cargo-handlers, and harbor pilots. Figure 35 shows an example of all the necessary input data to make HarborSym function properly.

The first data entered into the model are various settings that define the location of the port, simulation parameters, and parameters to define the limits of acceptable user-inputted data. Figure 36 shows the main screen of HarborSym used to input data and set up simulation runs.

Validation settings are used to help the modeler determine the reasonableness of the data inputs. Each project alternative can be individually "validated" before performing simulation runs to check for potential input values that are outside of a normal range. For this study, only the vessel speed in reach validation settings were adjusted to better match the speeds of Port Everglades. The validation settings have no impact on the model performance.

Simulation settings are used to fine tune some of the parameters that apply to all simulation runs. These parameters can affect model performance and several values were adjusted to better represent the actual system. Only adjusted values are discussed below; other parameters were left as default.

Vessel Leg Wait Limit Count = 432

The "Vessel Leg Wait Limit Count" parameter specifies the number of time steps that a vessel should wait at any node before the vessel is "deleted" from the system, meaning that the model assumed it was stuck and could not move. This parameter was adjusted to better represent the system because the default parameter was *50*, and with a 10 minute time step, that meant that each vessel would only wait for 8.33 hours before being deleted. Since the Port Everglades has significant amounts of congestion in the future without-project condition, and arrival times were randomized, the value was increased to 437, which equates to a 3-day maximum wait time. Also, the Port has bulk commodities that move very slowly, such as aggregate and fuel oil, and the maximum wait time assumes that a ship would wait for

nearly the entire maximum load or unload time of two other ships in port at its intended berth before turning away.

Hours Added to Priority Simulation = 150

This value was changed from 50 to 150 hours to allow "priority" vessels additional time to complete their vessel calls at the end of the simulation. This ensures that all priority vessels remain in the call list, and are not left stuck in the system at the end of the simulation. Only cruise vessels were considered to be priority vessels for this project.

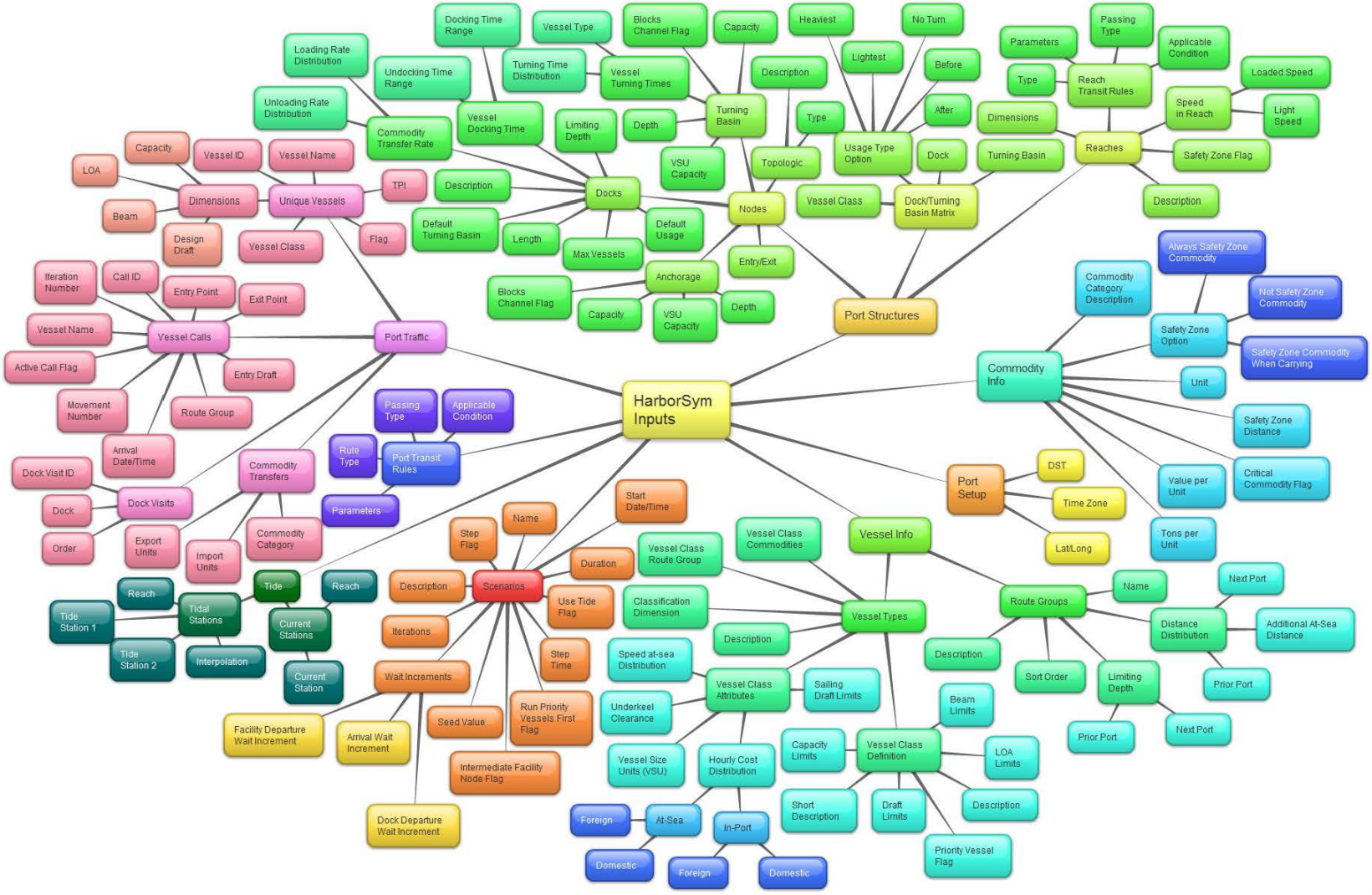

Figure 35. HarborSym Input Diagram

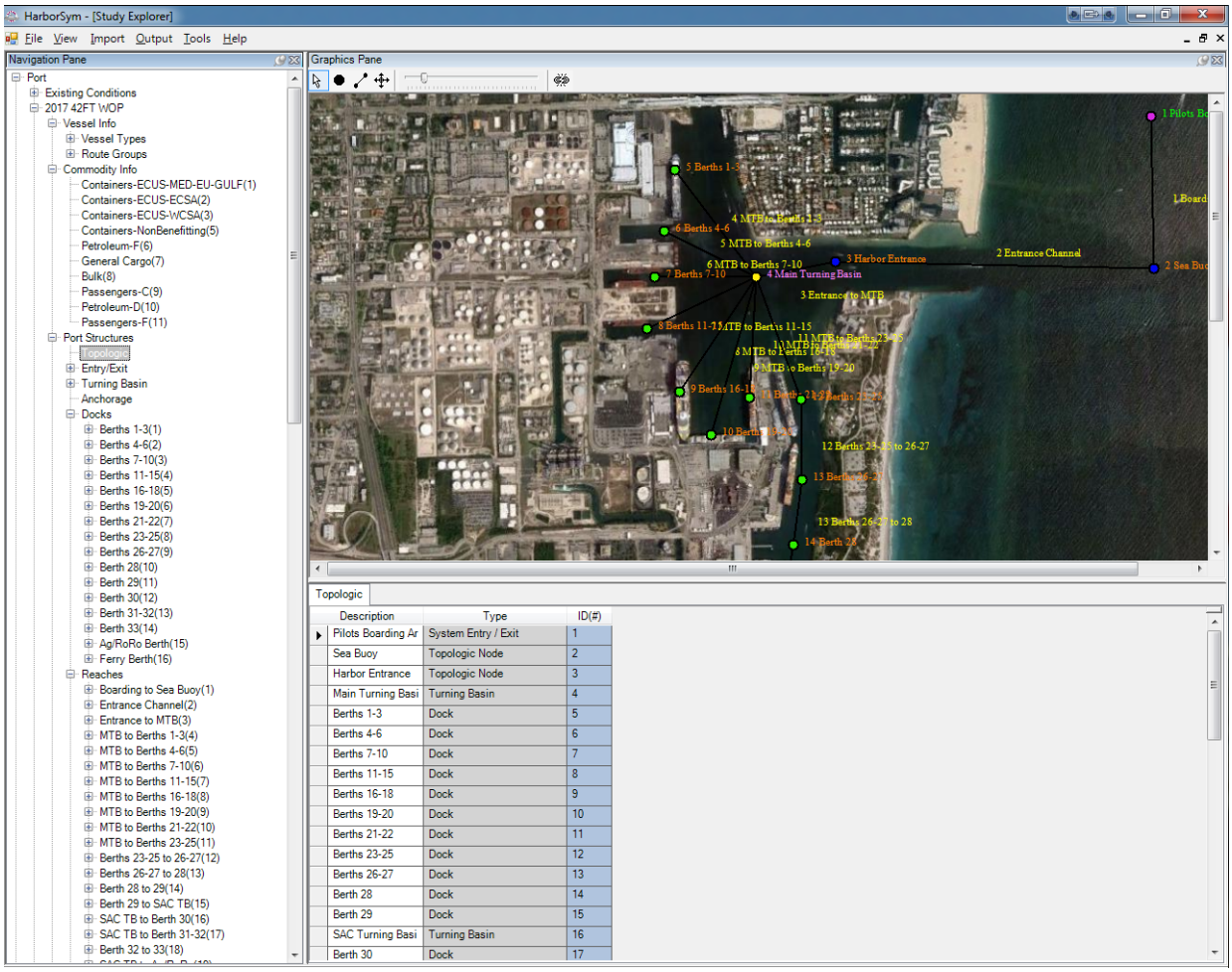

Figure 36. Example HarborSym Screen Shot

Tide and current stations are used in the model to facilitate vessel transit rules based on tide and current conditions. For this project, IWR Tide Tool (version 1.1.0) was used to determine the correct tide stations to use. No current stations were used because no transit rules were dependent on current conditions. IWR Tide Tool is a separate software program that allows the user to view tide and current station data from all over the world that has been calculated based on harmonics equations which were observed from actual data. HarborSym can then load these virtual stations into the model to be used during the simulation runs.

IWR Tide Tool contained two appropriate tide stations that were used in the model:

- Port Everglades, Turning Basin, Fort Lauderdale, FL
- South Port Everglades, ICWW, Fort Lauderdale, FL

All of the reaches from the entrance channel, to the inner channel, to the main turning basin, and the Southport Access Channel (SAC) to berths 24-25 referenced the *Port Everglades, Turning Basin* tide station. The reaches in the SAC from berths 26-27 southward used the *South Port Everglades, ICWW* tide

station. The reach from berths 24-25 to berths 26-27 used an average value of the tides from both stations.

Once all inputs are entered into the HarborSym model, it must be calibrated and the inputs adjusted to ensure that the model behaves as closely as possible to actual conditions. Existing conditions (42FT project depth and no widening features), and vessel fleet from 2012 Harbormaster's data, and 2010 Waterborne Commerce Statistics Center detailed data were used to calibrate the model. Output files that detailed the times that each vessel spent doing different activities in the port (waiting, transiting, loading/unloading, etc.) were analyzed. Numerous adjustments were then made to vessel loading times, rules, and dock capacities and dimensions. Vessel call lists that were originally provided by the harbor pilots were cleaned to match the vessel sizes used in HarborSym and vessels were set to call the correct docks with correct commodity categories. After each set of inputs were adjusted, the simulation was run again and results were compared to the previous results. This process was repeated until all model inputs satisfactorily represented real-world conditions as closely as possible.

Existing condition data was used to calibrate the model for vessel times in system, loading rates, time at dock, dock distribution for calls by vessel type, commodity transfer rates, and dock capacities. Once the future conditions were simulated, some of these parameters were recalibrated to account for changes in port infrastructure and changes in the vessel fleet. If any remaining deleted vessel calls occurred after the final calibration, then these were attributed to "noise" in the system from random arrival dates and these calls would be manually rescheduled to ensure the vessel would not be deleted.

11.3.1 Vessel Types

Vessels are defined in the HarborSym model at the type-level, and then at the class-level, a subset of vessel types. Vessel types and classes must be set up carefully because other parameters of the model are defined at either only the type-level or class-level. For example, vessel speeds in reaches and docking/undocking times are both defined at the vessel class level of detail, while turning times and commodity transfer rates are defined at the vessel type level of detail. The goal is to make vessel types and classes broad enough to encompass a large number of vessels in the fleet with similar traits, but narrow enough to have separate features compared to another class to more accurately represent the system.

Vessel types are specified manually in the vessel call list, but vessel classes are automatically classified by HarborSym based on a specific attribute (dimension) when vessels are loaded into HarborSym from a vessel call list. The vessel types and attribute upon which automatic classification is based is shown in Table 44. The classification option dimension is used to separate vessel classes within a vessel type. For example, if *Beam* is selected as the classification option, then in the vessel class definition settings each class will be given a discrete range of lengths that vessels in a class will fall into, such as 107 ft to 139 ft.

Table 44. HarborSym Vessel Types and Classification Options

Vessel Type		Classification Options			
Type	Description	LOA	Beam	Draft	Capacity
Sub-Panamax	Sub-Panamax Containerships	☐	☐	☐	☑
Barge	US-Flag Tank Barge	☐	☐	☐	☑
Tanker	Tanker Ship	☐	☐	☐	☑
Bulker	Bulker Ship	☐	☐	☐	☑
Gen Cargo	General Cargo Ship	☐	☐	☐	☑
Ferry	Ferry Ship	☐	☐	☐	☑
Cruise	Cruise Ship	☐	☐	☐	☑
Panamax	Panamax Containership	☐	☐	☑	☐
Post-Panamax	Post-Panamax Containerships	☐	☑	☐	☐

One of the main assumptions of HarborSym is that the fleet of vessels calling the study port can be represented by a fleet of vessels that fall into definitive categories, or classes, which exhibit similar characteristics in transit speeds, loading rates, and other maneuvering times. Many of the vessel classes were separated to correspond with actual clusters of vessel sizes calling Port Everglades and/or were based on Corps'-published Vessel Operating Cost tables from Engineering Guidance Memorandum (EGM) 11-05, developed by the Institute for Water Resources. Vessel class attributes define the Vessel Size Units[40] (VSUs), underkeel clearance, speeds at sea, sailing draft limits, and hourly operating costs for each vessel class. Table 45 shows all of the vessel classes and their attributes that were used to represent the fleet of vessels that are expected to call Port Everglades in the future with- and without-project conditions.

[40] VSU is further described below in Section 11.3.2

Table 45. 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	2,200 TEU	669.2	93.5	36.8	31,900	2
Panamax Container	PX1	Draft	< 42 ft	3,500 TEU	797.9	106.4	40.4	46,400	2.5
Panamax Container	PX2	Draft	>= 42 ft	4,800 TEU	935.3	106.4	43.6	65,000	3
Post-Panamax Container	PPX1	Beam	107-139 ft	6,500 TEU	1,027.0	131.5	45.7	80,700	3
Post-Panamax Container	PPX2	Beam	140 ft +	8,700 TEU	1,119.1	143.5	48.1	103,000	3.5
Barge	US Tank Barge	Capacity	20k DWT	18,000 DWT	630.0	86.0	33.1	20,000	3
Tanker	Tank 20k DWT	Capacity	<25k DWT	18,000 DWT	518.6	80.2	32.3	20,000	3
Tanker	Tank 25-45kDWT	Capacity	25k-44.9k DWT	32,200 DWT	575.2	91.3	35.5	35,000	3
Tanker	Tank 45-80kDWT	Capacity	45k-79.9k DWT	55,200 DWT	662.9	108.4	40.6	60,000	3.5
Tanker	Tank 90kDWT	Capacity	80k+	82,800 DWT	757.5	127	46.2	90,000	4
Tanker	Tank 110kDWT	Capacity	110k DWT	109,900 DWT	806.8	140.3	49.1	101,000	4
Bulker	Bulk 15kDWT	Capacity	0-20k	13,500 DWT	510.0	78.8	29.6	15,000	2
Bulker	Bulk 25k DWT	Capacity	20-30k	23,000 DWT	549.9	84.7	32.3	25,000	2
Bulker	Bulk 40k DWT	Capacity	30-50k	36,800 DWT	607.0	93.1	36.2	40,000	2
Bulker	Bulk 60k DWT	Capacity	50-70k	55,200 DWT	677.7	103.8	41.0	60,000	2.5
Bulker	Bulk 80k DWT	Capacity	70-100k	73,600 DWT	742.2	113.9	45.3	80,000	3
Gen Cargo	GC-15k	Capacity	<15 k DWT	9,900 DWT	433.2	65.5	26.4	11,000	2
Gen Cargo	GC 15-25k	Capacity	15k-25k DWT	18,000 DWT	520.6	78.8	32.0	20,000	2
Gen Cargo	GC 25-35k	Capacity	25-35k DWT	27,000 DWT	587.9	89.2	36.1	30,000	2
Gen Cargo	GC 37.5k	Capacity	35k+	33,750 DWT	635.1	96.5	39.0	37,500	2.5
Ferry	Ferry	Capacity	400-500 pass.	500 pass	241.5	85.3	9.5	197	2
Cruise	Cruise-400	Capacity	200-600 pass.	600 pass	650.2	85.3	20.9	5,000	2
Cruise	Cruise-1200	Capacity	600-1,400 pass.	1,400 pass	719.1	101.1	25.3	7,637	2
Cruise	Cruise-2600	Capacity	1,800-3,200 pass.	2,600 pass	949.9	118.2	27.9	8,418	2
Cruise	Cruise-4000	Capacity	3,600-4,400 pass.	4,400 pass	1,111.9	126.6	28.9	10,600	2
Cruise	Cruise-5400	Capacity	5,400 pass.	5,400 pass	1,184.4	154.2	30.5	15,000	2

11.3.2 Port structures

The port structures entered into HarborSym provide a framework for simulated vessel movements to interact in the harbor. They are supposed to represent the actual structures and features of the port, but they are sometimes consolidated or adjusted in the model for the purposes of simplification or to work around limitations of the model. Figure 37 shows the nodes and reaches, which make up the visual representation of the harbor channel and detailed port/dock layout as they appear in HarborSym. Note that some reaches may not be to scale.

Port Everglades only has one direct connection to the ocean. Therefore, only one Entry/Exit feature was included in the model with the name "Pilots Boarding Area". The entry/exit point is also the point where arriving vessels will wait until the channel is clear for them to transit through to their designated dock.

The Atlantic Intracoastal Waterway (AIWW) also intersects with the main turning basin in Port Everglades Harbor. However, no cargo vessels use this route when arriving at or departing from the port. Therefore, the AIWW entry/exit was not included in the model. Expansion of the Dania Cutoff Canal (DCC) was dropped from the analysis and therefore it was not included in the model either.

Port Everglades Harbor has two turning basins that were evaluated in the analysis. Both were included in the model. The parameters for these turning basins in the model are shown in Table 46 below.

Table 46. HarborSym Turning Basin Parameters

Description	Vessel Capacity	Limiting Depth	Blocks Channel?	VSU Capacity
Main Turning Basin	1	42 ft	NO	185
SAC Turning Basin	1	42 ft	YES	160

Note: Limiting Depth shown is for existing conditions. Limiting depth increases with project depth for with-project simulations.

Vessel size units (VSUs) are an arbitrary measure of vessel sizes that are used to determine maximum capacity of nodes such as turning basins, anchorages, and docks. For this study, VSUs were calculated as LOA * Beam / 1000, rounded to the nearest 5. Then, VSU capacities for docks and the turning basin were adjusted to put realistic limits on these nodes. For the main turning basin, since only one vessel could occupy it at a time, 185 VSU maximum capacity would not restrict any vessel from using the turning basin, as the largest VSU value for any ship is 185. For the SAC Turning Basin, the largest vessel that would use it has a VSU rating of 160.

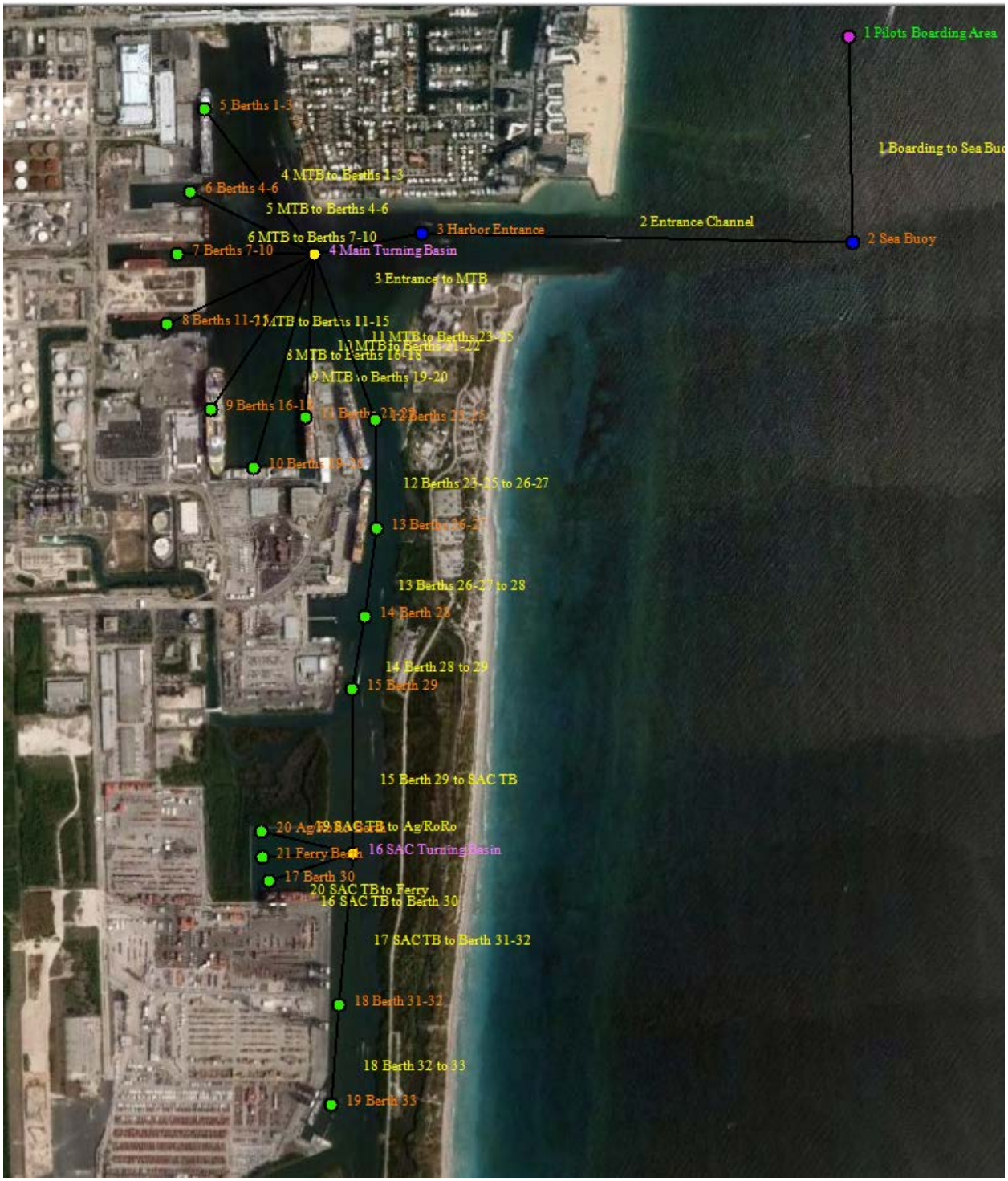

Figure 37. HarborSym Linked Node Network

Every ship must turn before or after docking. While the use of the turning basin before or after docking is determined at the dock level, the turning basin times are specified for the turning basin by vessel

type. Table 47 shows the turning-times for each vessel type that were used in the model. The same times were used for all vessel types and for both turning basins.

Table 47. HarborSym Turning Basin Times by Vessel Type

	Turning Time (hrs)		
Vessel Type	Min	Most Likely	Max
Sub-Panamax	0.25	0.3	0.4
Barge	0.25	0.3	0.4
Tanker	0.25	0.3	0.4
Bulker	0.25	0.3	0.4
Gen Cargo	0.25	0.3	0.4
Ferry	0.25	0.3	0.4
Cruise	0.25	0.3	0.6
Panamax	0.25	0.3	0.6
Post-Panamax	0.25	0.3	0.6

In the HarborSym model, “docks” are designated to represent the berthing areas of the port. For simplification purposes, several berths can be combined into a single dock in the model. For this study, some single berths were designated as a single dock, while some combinations of multiple berths were combined into a single dock. The parameters specified for each dock are description, length, limiting depth, maximum number of vessels, default turning basin to use, default time or condition to use turning basin, and vessel size unit (VSU) capacity. VSUs were discussed above in this section. The dock parameters used for each project condition are shown in Table 48, below.

Table 48. HarborSym Dock Parameters

Dock Description	Length (ft)	Limiting Depth (ft)	Max Vessels	Default Turning Basin	Default Usage	VSU Capacity
Berths 1-3	1601	31	4	Main Turning Ba	After	170
Berths 4-6	1150	46	5	Main Turning Ba	Before	145
Berths 7-10	1200	46	4	Main Turning Ba	Before	220
Berths 11-15	1226	46	4	Main Turning Ba	Before	170
Berths 16-18	1648	38	2	Main Turning Ba	After	190
Berths 19-20	1300	36	2	Main Turning Ba	Before	150
Berths 21-22	1475	36	2	Main Turning Ba	Before	150
Berths 23-25	1369	46	2	Main Turning Ba	Lightest	190
Berths 26-27	1337	46	2	Main Turning Ba	Lightest	150
Berth 28	550	46	5	Main Turning Ba	NoTurn	35
Berth 29	800	46	2	SAC Turning Bas	After	145
Berth 30	2400	46	4	SAC Turning Bas	Before	280
Berth 31-32	2000	46	4	SAC Turning Bas	Before	260
Berth 33	1100	46	3	SAC Turning Bas	Before	130
Ag/RoRo Berth	1000	46	2	SAC Turning Bas	Before	90
Ferry Berth	600	46	1	SAC Turning Bas	Before	25

Note: Limiting Depth shown is for existing conditions. Limiting depth increases with project depth for with-project simulations.

Each dock also allows for specification of vessel docking and undocking times by vessel class (Table 49). All vessel docking and undocking times were based on information supplied by the harbor pilots and port tenants. Docking/undocking times remained the same for all docks across all project conditions.

Table 49. HarborSym Docking and undocking times

Docking Time (hrs)		Undocking Time (hrs)	
Min	Max	Min	Max
0.5	0.75	0.333	0.5

Reaches in HarborSym represent the channel lengths that vessels must travel from the ocean to reach their docks. Each reach has the parameters of length, width, depth, description, and a flag of whether or not the safety zone is active (Table 50).

Table 50. HarborSym Reach parameters

Length (ft)	Width (ft)	Depth (ft)	Description
12152	1000	60	Boarding to Sea Buoy
10633	450	42	Entrance Channel
1216	1200	42	Entrance to MTB
2387	1200	31	MTB to Berths 1-3
1682	1200	42	MTB to Berths 4-6
1373	1200	42	MTB to Berths 7-10
1435	1200	42	MTB to Berths 11-15
1961	1200	38	MTB to Berths 16-18
2330	1200	36	MTB to Berths 19-20
1590	1200	36	MTB to Berths 21-22
1645	400	42	MTB to Berths 23-25
1532	400	42	Berths 23-25 to 26-27
855	400	42	Berths 26-27 to 28
659	400	42	Berth 28 to 29
2154	400	42	Berth 29 to SAC TB
1075	400	42	SAC TB to Berth 30
1455	400	42	SAC TB to Berth 31-32
1136	400	42	Berth 32 to 33
1500	400	42	SAC TB to Ag/RoRo
1800	400	42	SAC TB to Ferry

Each reach has parameters for vessel speed by vessel type and transit rules. Vessel speeds were provided by the harbor pilots, and are shown in Table 51 below.

Table 51. HarborSym Speeds in reaches

Reach	Light Speed (knots)	Loaded Speed (knots)
Boarding to Sea Buoy	12	11
Entrance Channel	7	6
Entrance to MTB	5	4
MTB to all berths in MTB (berths 1-22)	2	1
MTB to SAC	3	2
SAC	3	2
SAC TB to all berths in Southport (berths 30-33)	2	1

11.3.3 Commodity Types

Commodities in HarborSym require several parameters in their definition: Description, Unit, Tons per unit, Value per unit, Critical Commodity, Safety Zone Type, and Safety Zone Distance. The primary parameters for each commodity used in this study are shown in Table 52. The commodity units must be selected from either tons, passengers, containers, or automobiles. Commodity units and tons per unit will affect commodity transfer rates, which are specified in commodity units per hour, commodity loads, which are specified in commodity units, and vessel tones per inch (TPI) immersion rates, which are specified in metric tons per inch. All of the bulk cargoes are specified as the "Tons" unit, and their "Tons per unit" are all 1. The "passengers" unit was used for passengers, and the "containers" unit was used for containers.

Table 52. HarborSym Commodity Types and Tons per Unit

Description	Unit	Tons Per Unit
Containers-ECUS-MED-EU-GULF	Containers	10.36
Containers-ECUS-ECSA	Containers	7.81
Containers-ECUS-WCSA	Containers	8.26
Containers-NonBenefitting	Containers	9.22
Petroleum-F	Tons	1
General Cargo	Tons	1
Bulk	Tons	1
Passengers-C	Passengers	0.1
Petroleum-D	Tons	1
Passengers-F	Passengers	0.1

11.3.4 Rules

In HarborSym, vessel transit rules govern the way vessels interact with each other and how they move in the system. Transit rules may be created to better simulate actual conditions and practices, or they may represent rules that restrict movements which are imposed by the harbor pilots. For this study, rules were created for both of these reasons.

Transit rules may be defined at the port level and at the reach level. Port-level rules will apply to all "projects" (alternative scenarios) within the model (Table 53). These rules are best suited for transit restrictions that will *not* change from the without-project to the with-project condition. Reach-level rules are specific to each reach and are contained within an individual project. These rules are best suited to transit restrictions that will change from the without-project to the with-project condition, and those that will change across different project depths.

Table 53. HarborSym Port-Level Transit Rules

Active	Rule Type	Applicable Condition	Vessel Passing Type
☑	Maintain Safety Zone	Always	Not Applicable
☑	Draft Exceeds Depth Using Tide / Underkeel	Always	Not Applicable

The "Maintain Safety Zone" rule at the port-level is meant to simulate a normal transit distance between all vessels in the channels. The safety zone was set to 2000 ft fore and aft of all cruise vessels and petroleum-carrying vessels, and 1000 ft fore and aft of all other vessel types. The "Draft Exceeds Depth Using Tide/Underkeel" rule activates the underkeel clearance parameters and use of tide for each vessel transiting throughout the harbor.

11.3.5 Routes

Route groups represent the distances that vessels travel outside the study port to other ports along their respective routes. For this study, most of the route groups that were included apply to cargoes and vessel types that will benefit from channel deepening. Other vessel types and commodities that will not benefit from channel deepening were assigned to the "Default Route Group," "CARIB-Non-Benefitting," "FF-Incidental," or "DF-Incidental" routes, which only have a placeholder insignificant distance of 1 nautical mile for each leg of the journey. Route group distances are summarized in Table 54.

Table 54. HarborSym Route Groups[41]

		Prior Port			
Name	Description	Min Distance	Most Likely	Max Distance	Limiting Depth
Default RtGrp	Default route group created by HarborSym	1	1	1	85
ECUS-MED-EU-GMEX	Container route for US East Coast, Gulf Coast, Mediterranean and Europe	380	513	779	85
ECUS-ECSA	Container route for US East Coast & East Coast South America	302	302	411	85
ECUS-WCSA	Container route for US East Coast & West Coast South America	411	777	1143	85
CARIB-Non-Benefitting	Containerized cargo on non-benefitting Caribbean trade	1	1	1	85
PetroleumRoute	Foreign-flagged petroleum tanker routes	180	3223	9827	85
DryBulk Route	Foreign-flagged dry bulker routes	78	995	9896	85
FF-Incidental	Other cargo & passengers on non-benefitting foreign-flagged vessels	1	1	1	85
DF-Incidental	Other cargo on non-benefitting domestic-flagged vessels	1	1	1	85

	Next Port					Additional Sea Distance		
Name	Limiting Depth	Min Distance	Most Likely	Max Distance	Limiting Depth	Min	Most Likely	Max
Default RtGrp	85	1	1	1	85	1	1	1
ECUS-MED-EU-GMEX	85	78	1881	4536	85	6604	9390	12176
ECUS-ECSA	85	3015	3015	3815	85	9305	9795	10285
ECUS-WCSA	85	945	1044	1143	85	7304	7688	8072
CARIB-Non-Benefitting	85	1	1	1	85	1	1	1
PetroleumRoute	85	78	840	8972	85	1	1	1
DryBulk Route	85	180	730	9896	85	1	1	1
FF-Incidental	85	1	1	1	85	1	1	1
DF-Incidental	85	1	1	1	85	1	1	1

11.4 Model runs

Once the model was fully set up and calibrated, the with- and without-project conditions were simulated by loading each project condition with its corresponding fleet of vessel calls and commodity transfers. Since simulating every single depth and every model year would have been an enormous task, only a representative sample of model years and project depths were simulated, with other values interpolated (Table 56). The interpolations between depths and years were a standard linear interpolation.

[41] The limiting depth of 85 feet is the default depth input in the HarborSym model. The default input was used in the analysis based on the assumption that the limiting port on each trade route is Port Everglades at 42 feet. Vessels were not allowed to sail inbound/outbound greater than the limitations of Port Everglades at each alternative depth.

Table 55. Management measure descriptions and short name reference

Management Measures	Short Name
Outer Entrance Channel (OEC) Deepening & Widening	OEC
Inner Entrance Channel (IEC) Deepening	IEC
Main Turning Basin (MTB) Deepening	MTB
"Widener" - Widening of turn to Southport Access Channel; shoaling area	Widener
Southport Access Channel (SAC) Widening	SAC
Turning Notch Deepening	TN

Table 56. Matrix of model runs

	Depths									
Project Alternatives	**42 ft**	**43 ft**	**44 ft**	**45 ft**	**46 ft**	**47 ft**	**48 ft**	**49 ft**	**50 ft**	**51 ft**
Without Project	✓									
OEC + IEC + MTB + Widener + SAC + TN + Deepening (43'-51')			✓		✓	✓	✓		✓	

Notes: Simulation years were 2017, 2030, 2040, and 2067. After running 46 ft, 47 ft, 48 ft, and 50 ft depth alternatives it became evident that 44 ft alternative would not be justified, and therefore it was dropped from the modeling.

11.5 Model Outputs

The primary output of the model used to determine transportation cost savings is total transportation costs[42] for each alternative by year. These total transportation cost values were determined based on the averages of multiple iterations of model runs. In this case, 100-iteration model runs were used to determine the average total transportation costs. Initial runs were conducted for 10 iterations, and the average total transportation cost per year per condition varied from the 100 iteration runs by less than 0.1%. The results were interpolated over the period of analysis and across project depths and then annualized and present-valued. Table 57 and The figures below display the benefits by commodity type. As can be seen, at a 47 foot project depth, containerized cargo and petroleum make up approximately 97% of the total benefits. At a 48 foot project depth, these two trade concepts generate about 95% of the total benefits.

[42] "Total transportation costs" in this context refers only to the total transportation costs that are calculated by the HarborSym model. The model does not account for all costs as mentioned in Section 11.2.

Table 57. Total Transportation Costs by Project Condition for Each Model Year

Year	W/O-Project Transportation Costs	45 FT Project Transportation Costs	46 FT Project Transportation Costs	47 FT Project Transportation Costs	48 FT Project Transportation Costs	49 FT Project Transportation Costs	50 FT Project Transportation Costs
2023	$ 591,119,605	$ 560,784,822	$ 557,710,241	$ 554,016,717	$ 553,502,629	$ 553,495,814	$ 553,488,999
2024	$ 606,890,797	$ 575,605,692	$ 572,116,664	$ 568,617,269	$ 567,852,876	$ 567,845,010	$ 567,837,143
2025	$ 622,661,988	$ 590,426,562	$ 586,523,087	$ 583,217,821	$ 582,203,123	$ 582,194,206	$ 582,185,288
2026	$ 638,433,180	$ 605,247,432	$ 600,929,510	$ 597,818,373	$ 596,553,370	$ 596,543,401	$ 596,533,432
2027	$ 654,204,371	$ 620,068,302	$ 615,335,934	$ 612,418,925	$ 610,903,618	$ 610,892,597	$ 610,881,577
2028	$ 669,975,563	$ 634,889,172	$ 629,742,357	$ 627,019,478	$ 625,253,865	$ 625,241,793	$ 625,229,721
2029	$ 685,746,754	$ 649,710,042	$ 644,148,780	$ 641,620,030	$ 639,604,112	$ 639,590,989	$ 639,577,866
2030	$ 701,517,946	$ 664,530,913	$ 658,555,203	$ 656,220,582	$ 653,954,359	$ 653,940,185	$ 653,926,011
2031	$ 706,836,128	$ 669,552,105	$ 663,552,990	$ 661,303,582	$ 659,078,553	$ 659,064,261	$ 659,049,970
2032	$ 712,154,310	$ 674,573,297	$ 668,550,777	$ 666,386,582	$ 664,202,747	$ 664,188,338	$ 664,173,930
2033	$ 717,472,492	$ 679,594,490	$ 673,548,564	$ 671,469,582	$ 669,326,941	$ 669,312,415	$ 669,297,889
2034	$ 722,790,675	$ 684,615,682	$ 678,546,351	$ 676,552,583	$ 674,451,135	$ 674,436,492	$ 674,421,848
2035	$ 728,108,857	$ 689,636,874	$ 683,544,137	$ 681,635,583	$ 679,575,329	$ 679,560,569	$ 679,545,808
2036	$ 733,427,039	$ 694,658,067	$ 688,541,924	$ 686,718,583	$ 684,699,523	$ 684,684,645	$ 684,669,767
2037	$ 738,745,221	$ 699,679,259	$ 693,539,711	$ 691,801,583	$ 689,823,717	$ 689,808,722	$ 689,793,727
2038	$ 744,063,404	$ 704,700,451	$ 698,537,498	$ 696,884,583	$ 694,947,911	$ 694,932,799	$ 694,917,686
2039	$ 749,381,586	$ 709,721,644	$ 703,535,285	$ 701,967,584	$ 700,072,105	$ 700,056,876	$ 700,041,646
2040	$ 754,699,768	$ 714,742,836	$ 708,533,071	$ 707,050,584	$ 705,196,299	$ 705,180,952	$ 705,165,605
2041	$ 760,017,950	$ 719,764,028	$ 713,530,858	$ 712,133,584	$ 710,320,493	$ 710,305,029	$ 710,289,565
2042	$ 765,336,133	$ 724,785,221	$ 718,528,645	$ 717,216,584	$ 715,444,688	$ 715,429,106	$ 715,413,524
2043	$ 770,654,315	$ 729,806,413	$ 723,526,432	$ 722,299,584	$ 720,568,882	$ 720,553,183	$ 720,537,484
2044	$ 775,972,497	$ 734,827,605	$ 728,524,219	$ 727,382,585	$ 725,693,076	$ 725,677,259	$ 725,661,443
2045	$ 781,290,679	$ 739,848,798	$ 733,522,005	$ 732,465,585	$ 730,817,270	$ 730,801,336	$ 730,785,403
2046	$ 786,608,861	$ 744,869,990	$ 738,519,792	$ 737,548,585	$ 735,941,464	$ 735,925,413	$ 735,909,362
2047	$ 791,927,044	$ 749,891,182	$ 743,517,579	$ 742,631,585	$ 741,065,658	$ 741,049,490	$ 741,033,321
2048	$ 797,245,226	$ 754,912,375	$ 748,515,366	$ 747,714,585	$ 746,189,852	$ 746,173,566	$ 746,157,281
2049	$ 802,563,408	$ 759,933,567	$ 753,513,153	$ 752,797,585	$ 751,314,046	$ 751,297,643	$ 751,281,240
2050	$ 807,881,590	$ 764,954,760	$ 758,510,939	$ 757,880,586	$ 756,438,240	$ 756,421,720	$ 756,405,200
2051	$ 813,199,773	$ 769,975,952	$ 763,508,726	$ 762,963,586	$ 761,562,434	$ 761,545,797	$ 761,529,159
2052	$ 818,517,955	$ 774,997,144	$ 768,506,513	$ 768,046,586	$ 766,686,628	$ 766,669,873	$ 766,653,119
2053	$ 823,836,137	$ 780,018,337	$ 773,504,300	$ 773,129,586	$ 771,810,822	$ 771,793,950	$ 771,777,078
2054	$ 829,154,319	$ 785,039,529	$ 778,502,087	$ 778,212,586	$ 776,935,016	$ 776,918,027	$ 776,901,038
2055	$ 834,472,502	$ 790,060,721	$ 783,499,873	$ 783,295,587	$ 782,059,210	$ 782,042,104	$ 782,024,997
2056	$ 839,790,684	$ 795,081,914	$ 788,497,660	$ 788,378,587	$ 787,183,404	$ 787,166,180	$ 787,148,957
2057	$ 845,108,866	$ 800,103,106	$ 793,495,447	$ 793,461,587	$ 792,307,598	$ 792,290,257	$ 792,272,916
2058	$ 850,427,048	$ 805,124,298	$ 798,493,234	$ 798,544,587	$ 797,431,792	$ 797,414,334	$ 797,396,875
2059	$ 855,745,231	$ 810,145,491	$ 803,491,021	$ 803,627,587	$ 802,555,987	$ 802,538,411	$ 802,520,835
2060	$ 861,063,413	$ 815,166,683	$ 808,488,807	$ 808,710,588	$ 807,680,181	$ 807,662,487	$ 807,644,794
2061	$ 861,063,413	$ 815,166,683	$ 808,488,807	$ 808,710,588	$ 807,680,181	$ 807,662,487	$ 807,644,794
2062	$ 861,063,413	$ 815,166,683	$ 808,488,807	$ 808,710,588	$ 807,680,181	$ 807,662,487	$ 807,644,794
2063	$ 861,063,413	$ 815,166,683	$ 808,488,807	$ 808,710,588	$ 807,680,181	$ 807,662,487	$ 807,644,794
2064	$ 861,063,413	$ 815,166,683	$ 808,488,807	$ 808,710,588	$ 807,680,181	$ 807,662,487	$ 807,644,794
2065	$ 861,063,413	$ 815,166,683	$ 808,488,807	$ 808,710,588	$ 807,680,181	$ 807,662,487	$ 807,644,794
2066	$ 861,063,413	$ 815,166,683	$ 808,488,807	$ 808,710,588	$ 807,680,181	$ 807,662,487	$ 807,644,794
2067	$ 861,063,413	$ 815,166,683	$ 808,488,807	$ 808,710,588	$ 807,680,181	$ 807,662,487	$ 807,644,794
2068	$ 861,063,413	$ 815,166,683	$ 808,488,807	$ 808,710,588	$ 807,680,181	$ 807,662,487	$ 807,644,794
2069	$ 861,063,413	$ 815,166,683	$ 808,488,807	$ 808,710,588	$ 807,680,181	$ 807,662,487	$ 807,644,794
2070	$ 861,063,413	$ 815,166,683	$ 808,488,807	$ 808,710,588	$ 807,680,181	$ 807,662,487	$ 807,644,794
2071	$ 861,063,413	$ 815,166,683	$ 808,488,807	$ 808,710,588	$ 807,680,181	$ 807,662,487	$ 807,644,794
2072	$ 861,063,413	$ 815,166,683	$ 808,488,807	$ 808,710,588	$ 807,680,181	$ 807,662,487	$ 807,644,794

Notes: Orange-shaded cells are actual model results. Blue-shaded cells were interpolated based on surrounding depths. Un-shaded cells were linearly interpolated between years, or held constant from year 2060 on. Widening-only, 44 ft., and 51 ft. results are not shown.

The figures below display the benefits by commodity type. As can be seen, at a 47 foot project depth, containerized cargo and petroleum make up approximately 97% of the total benefits. At a 48 foot project depth, these two trade concepts generate about 95% of the total benefits. These two project alternatives are presented since 47 feet is the NED plan, and 48 feet is the LPP (see section 12).

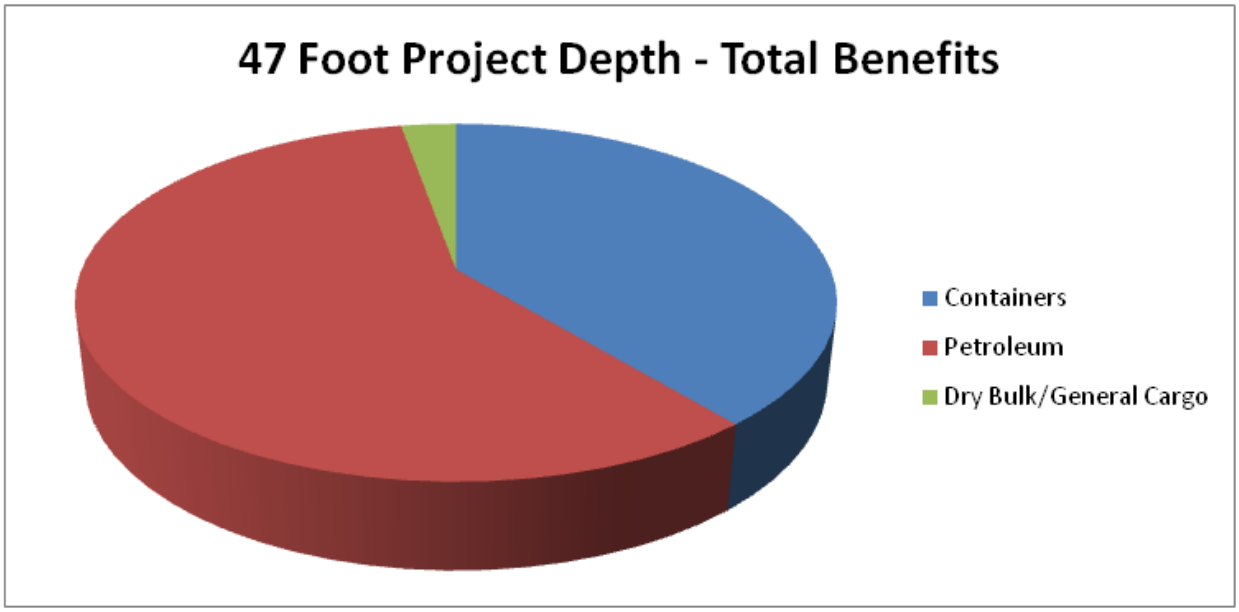

Figure 38. 47-Foot Project Depth – benefits by trade concept

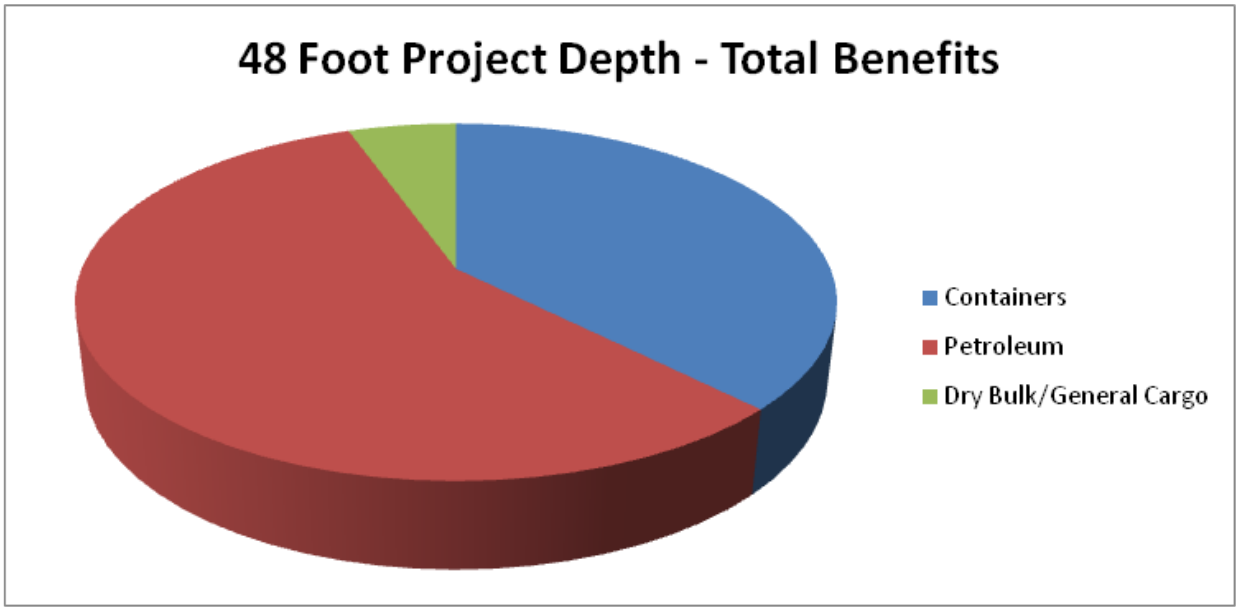

Figure 39. 48-Foot Project Depth – benefits by trade concept

Table 58. Total Present Value and Average Annual Benefits

Project (Depth)	44'+Widening	45'+Widening	46'+Widening	47'+Widening	48'+Widening	49'+Widening	50'+Widening	51'+Widening
Sum of Present-Value Benefits	$785,000,000	$921,000,000	$1,056,000,000	$1,097,000,000	$1,130,000,000	$1,130,000,000	$1,131,000,000	$1,131,000,000
Annualized Cost Savings	$33,500,000	$39,300,000	$45,000,000	$46,800,000	$48,200,000	$48,200,000	$48,200,000	$48,200,000

*numbers have been rounded to the nearest thousand

Additionally, HarborSym model runs produce many other outputs which can measure changes from the without-project condition, such as wait time reduction (Table 59).

Table 59. Wait-Time Reduction Summary by Vessel Class for 48 ft Project

	Average Vessel Wait Time Reduction (hrs)		
	2023	2030	2060
Panamax 1 (3,500 TEU)	-1.0	-1.9	-1.8
Panamax 2 (4,800 TEU)	-3.0	-3.0	-4.1
Post-Panamax 1 (6,500 TEU)	-2.2	-2.5	-3.0
Post-Panamax 2 (8,700 TEU)	-3.4	-5.5	-5.1
Weighted Average for All Vessels	-0.3	-0.5	-0.9
Total Wait Time Reduction for all Vessels	-1,073	-2,491	-4,398

12 National Economic Development Benefits

The purpose of this section is to compare the benefits based on HarborSym model outputs to project costs, to determine net benefits. National Economic Development (NED) benefits are based on differences in total transportation costs[43] between with the future with-project condition and the future without-project condition. Average annual benefits were compared to average annual costs to determine average annual net benefits. Based on the results of the transportation cost savings analysis, the National Economic Development (NED) plan is to widen and deepen to a project depth of 47 feet. The 48-foot alternative did result in higher net benefits by approximately $400,000, however in accordance with USACE policy guidance ER 1105-2-100 Exhibit G-1 3.c which states "when two cost-effective plans produce no significantly different levels of net benefits; the less costly plan is to be the NED plan" a corporate decision determined that 47 feet was the NED plan. The non-federal sponsor, Broward County, requested a locally preferred plan (LPP) of 48-feet. Therefore, the Recommended Plan

[43] "Total transportation costs" in this context refers only to the total transportation costs that are calculated by the HarborSym model. The model does not account for all costs as mentioned in Section 11.2.

is the LPP which includes deepening the Federal channel to 48 feet. It provides average annual net benefits of $31,380,000 and has a benefit-cost ratio (BCR) of 2.90:1 at 3.375%. (Table 60). The results of the net benefits and BCR analysis are shown graphically in Figure 40 and Figure 41.

Table 60. Summary of National Economic Development Benefits Compared to ROM Costs

Project (Depth)	44'+Widening	45'+Widening	46'+Widening	47'+Widening	48'+Widening	49'+Widening	50'+Widening	51'+Widening
Total First Cost	$311,000,000	$323,000,000	$335,000,000	$353,000,000	$371,000,000	$388,000,000	$405,000,000	$422,000,000
Interest During Construction (IDC)	$18,420,000	$20,820,000	$23,350,000	$27,660,000	$32,310,000	$37,440,000	$42,930,000	$48,790,000
Total Investment Costs (incl. IDC)	$329,420,000	$343,820,000	$358,350,000	$380,660,000	$403,310,000	$425,440,000	$447,930,000	$470,790,000
Average Annual Costs incl. IDC	$13,730,000	$14,330,000	$14,940,000	$15,860,000	$16,810,000	$17,730,000	$18,670,000	$19,620,000
Avg. Ann. Increased O&M Costs	$55,500	$55,500	$55,500	$55,500	$55,500	$55,500	$55,500	$55,500
Total Avg. Ann. Costs	$13,780,000	$14,380,000	$14,990,000	$15,910,000	$16,860,000	$17,780,000	$18,720,000	$19,670,000
Sum of Total Present Value Benefits	$804,000,000	$943,000,000	$1,083,000,000	$1,124,000,000	$1,157,000,000	$1,158,000,000	$1,158,000,000	$1,159,000,000
Average Annual Benefits	$33,520,000	$39,320,000	$45,120,000	$46,860,000	$48,240,000	$48,260,000	$48,270,000	$48,280,000
Avg. Ann. Net Benefits	$19,740,000	$24,940,000	$30,130,000	$30,950,000	$31,380,000	$30,480,000	$29,550,000	$28,610,000
BCR	2.40	2.70	3.00	2.90	2.90	2.70	2.60	2.50

Notes: Costs and benefits annualized at 3.375%. Total first cost, and sum of total present value benefits rounded to nearest $1,000,000. All other cost and benefit numbers rounded to nearest $10,000. Finalized costs will be presented in the Main Report

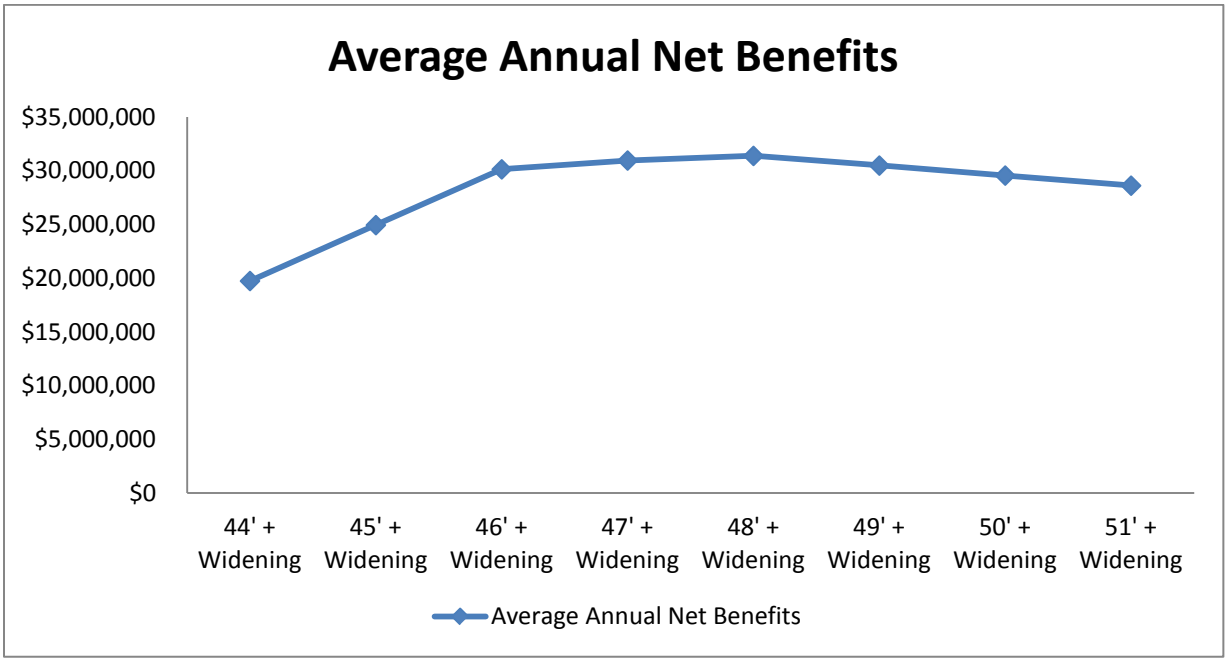

Figure 40. Graph of Average Annual Net Benefits by Project Depth

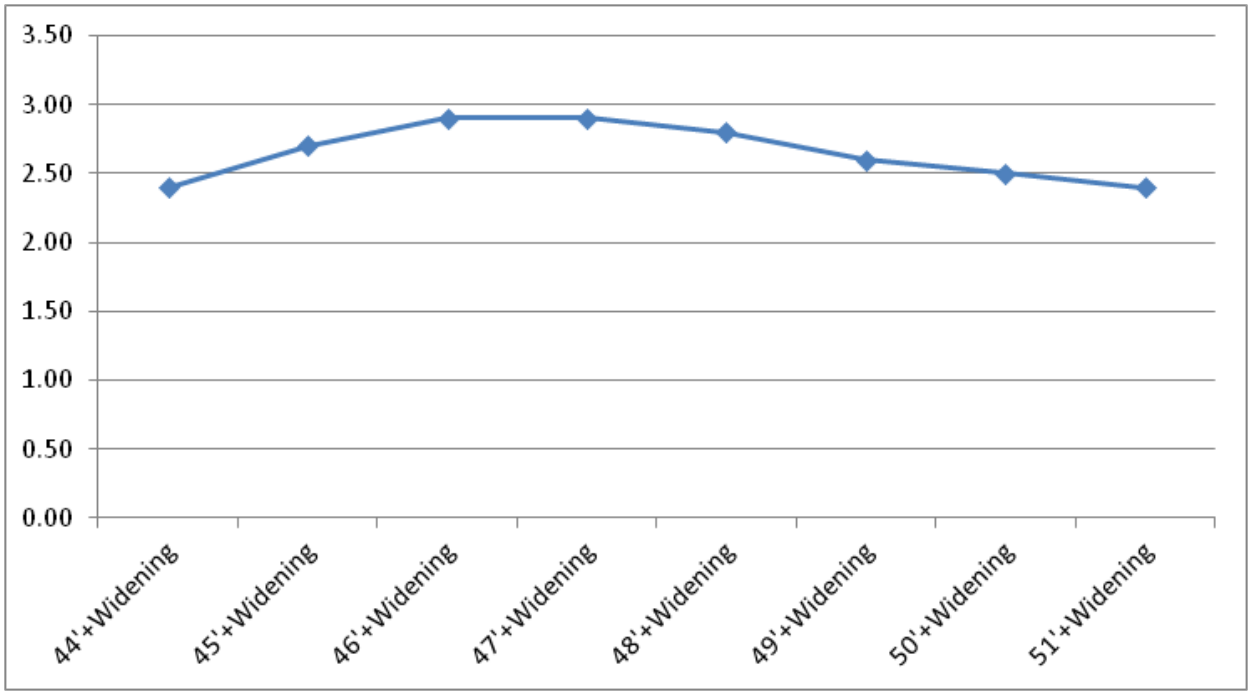

Figure 41. Graph of Benefit-Cost Ratios by Project Depth

13 Regional Economic Development Benefits

The main difference between Regional Economic Development (RED) and National Economic Development (NED) benefits is that RED benefits are associated with the local or regional economy, whereas NED benefits accrue to the entire Nation.

The U.S Army Corps of Engineers (USACE) Institute for Water Resources, the Louis Berger Group and Michigan State University has developed a regional economic impact modeling tool called RECONS (Regional ECONomic System) to provide estimates of regional and national job creation, and retention and other economic measures such as income, value added, and sales. This modeling tool automates calculations and generates estimates of jobs and other economic measures, such as income and sales associated with USACE's ARRA spending, annual Civil Work program spending and stem-from effects for Ports, Inland Water Way, FUSRAP and Recreation. This is done by extracting multipliers and other economic measures from more than 1,500 regional economic models that were built specifically for USACE's project locations. These multipliers were then imported to a database and the tool matches various spending profiles to the matching industry sectors by location to produce economic impact estimates. The tool is a means to document the performance of direct investment spending of the USACE. The Tool also allows the USACE to evaluate project and program expenditures associated with the annual expenditure by the USACE.

The total project cost would include expending approximately $371,000,000. Of this total project expenditure around $206,000,000 will be captured within the regional impact area. The rest will be leaked out to the state or the nation. The expenditures made for various services and products are

expected to generate additional economic activity in that can be measured in jobs, income, sales and gross regional product as summarized in the following table and includes impacts to the region, the State impact area, and the Nation.

Table 61 displays the input assumptions (Spending and LPC's) that were calculated using RECONS.

Table 62 shows the results of applying these assumptions to the total first cost of construction of the project.

Table 61. Regional Economic Development Spending Assumptions

Category	Spending (%)	Spending Amount	Local LPC (%)	State LPC (%)	National LPC (%)
Dredging Fuel	4%	$14,469,000	37%	42%	90%
Metals and Steel Materials	10%	$35,245,000	14%	27%	90%
Textiles, Lubricants, and Metal Valves and Parts (Dredging)	2%	$5,565,000	8%	24%	65%
Pipeline Dredge Equipment and Repairs	4%	$12,985,000	15%	28%	100%
Aggregate Materials	5%	$17,066,000	53%	65%	97%
Switchgear and Switchboard Apparatus Equipment	1%	$4,081,000	11%	34%	80%
Hopper Equipment and Repairs	2%	$7,420,000	1%	5%	97%
Construction of Other New Nonresidential Structures	17%	$61,586,000	63%	100%	100%
Industrial and Machinery Equipment Rental and Leasing	12%	$43,036,000	46%	91%	100%
Planning, Environmental, Engineering and Design Studies and Services	5%	$17,066,000	39%	94%	100%
USACE Overhead	4%	$13,356,000	44%	99%	100%
Repair and Maintenance Construction Activities	3%	$11,501,000	50%	100%	100%
Industrial Machinery and Equipment Repair and Maintenance	8%	$27,825,000	66%	86%	100%
USACE Wages and Benefits	7%	$26,712,000	75%	100%	100%
Private Sector Labor or Staff Augmentation	18%	$68,264,000	100%	100%	100%
Dredging Food and Beverages	1%	$4,823,000	12%	42%	90%
Total	**100%**	**$371,000,000**	-	-	-

Table 62. Regional Economic Development Benefits from Construction Expenditures

Impact Areas Impacts		Regional	State	National
Total Spending		$371,000,000	$371,000,000	$371,000,000
Direct Impact				
	Output	$206,102,764	$295,902,712	$361,865,062
	Job	3,515.71	4,296.01	4,539.75
	Labor Income	$127,959,087	$167,779,578	$186,242,068
	GRP	$146,809,011	$198,125,601	$224,085,332
Total Impact				
	Output	$300,039,972	$599,284,185	$973,379,490
	Job	4,374.39	6,587.84	8,210.73
	Labor Income	$157,464,092	$273,425,182	$385,829,877
	GRP	$201,982,676	$381,638,366	$568,350,438

14 Sensitivity and Scenario Analyses

Since many assumptions go into conducting an economic analysis of a Federal navigation improvement project, risk and uncertainty can be addressed through sensitivity and scenario analysis. This section describes the performance of the NED plan throughout a range of more conservative assumptions and possible futures to address risk and uncertainty.

Multiple sensitivities were conducted on the 48 foot project alternative based on the results of the HarborSym model runs (Table 63). First, in the "7% Discount Rate" sensitivity analysis, future benefits and costs were discounted at a higher rate than the FY14 discount rate of 3.375% by using a 7% discount rate. With the "7% Discount Rate" the commodity and vessels fleet forecasts remain consistent with the base growth scenario which used the IHS Global Insight forecast provided for the South Atlantic. This rate is often used by the Office of Management and Budget to compare the results of different studies across different years. Second, in the "No Growth After 20 years" sensitivity analysis, the vessel traffic, commodity movements, and the shift in the vessel fleet was held constant after 20 years from the base year (2023 to 2042). After 20 years the commodity throughput and the vessel fleet were held constant. Third, a "No Growth after Base Year" sensitivity analysis was modeled. In the no growth scenario, there is no growth it the total tonnage transported through the harbor after the base year of the analysis (2023). This scenario assumes the lowest level of commodity growth analyzed. These three scenarios were developed to demonstrate the level of risk associated with the construction of the project.

Table 63. Sensitivity Analysis Results

Sensitivity	Avg. Ann. Net Benefits	Benefit-Cost Ratio
7% Discount Rate	$14,550,000	1.50
No Growth after 20 years (@ 3.375%)	$30,280,000	2.80
No Growth after Base year (@ 3.375%)	$20,760,000	2.20

Additional scenarios were developed as well to more fully investigate the risk associated with modifying Port Everglades to a depth of 48 feet. The benefits by commodity were evaluated to determine how reliant the project justification is on each specific trade concept. In these scenarios, each trade concept is assumed to be the only benefiting commodity. Also, the "No growth after Base year" scenario was adjusted to assume lower growth in the tonnage being transported through the harbor up to 2023. In this scenario, the tonnage assumed at the harbor in 2023 is just over 23.8 million tonnes (In the base forecast, this tonnage is forecasted to become over 26.9 million tonnes). Petroleum makes up approximately 16.4 million of those tonnes and Containerized cargo consists of an additional 6.2 million tonnes. Dry Bulk and General Cargo is another 1.6 million tonnes. In FY2013, the Port Everglades reported over 22.4 million tonnes. The adjusted "No growth after Base year" assumes a compound annual growth rate of 0.58% between 2013 and 2023 opposed to the 1.82% compound annual growth currently assumed in the base analysis.

Table 64. Additional Sensitivity Analysis

	Avg. Ann. Net Benefits	Benefit-Cost Ratio
Petroleum Tonnage Only (Base Analysis)	$ 10,200,000	1.59
Containerized Tonnage Only (Base Analysis)	$ 616,000	1.04
Dry Bulk/General Cargo Tonnage Only (Base Analysis)	$ (14,600,000)	0.16
Reduced Commodity Growth to Base Year (2023)	$ 22,900,000	2.33

15 Summary

In conclusion, the analysis presented in this appendix has been robust, with consideration given to nearly every aspect of economic activity at the port. Based on the results of the transportation cost savings analysis, the National Economic Development (NED) plan is to widen and deepen to a project depth of 47 feet. The 48-foot alternative did result in higher net benefits by approximately $400,000 annually, however in accordance with USACE policy guidance ER 1105-2-100 Exhibit G-1 3.c which states "when two cost-effective plans produce no significantly different levels of net benefits; the less costly plan is to be the NED plan" a corporate decision determined that 47 feet was the NED plan. The non-federal sponsor, Broward County, requested a locally preferred plan (LPP) of 48-feet. Therefore, the Recommended Plan is the LPP which includes deepening the Federal channel to 48 feet. It provides average annual net benefits of $31,400,000 and has a benefit-cost ratio (BCR) of 2.90:1 at 3.375%. The selected plan is a reasonable, beneficial, and cost-effective alternative that meets the project objectives to improve navigational conditions in the harbor. These improvements are expected to reduce congestion, improve navigational safety, accommodate recent and anticipated future growth in cargo and cruise vessel traffic, improve the efficiency of operations for cargo vessels and cruise ships within the Port complex, and allow for larger cargo vessels to use Port Everglades more efficiently through increased vessel loading.