GENERAL RE-EVALUATION REPORT
APPENDIX A: ECONOMICS
SAVANNAH HARBOR EXPANSION PROJECT
Chatham County, Georgia and Jasper County, South Carolina

January 2012

US Army Corps
of Engineers
Savannah District
South Atlantic Division

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LIST OF ACRONYMS

ACP	Panama Canal Authority
CD	Circuit Distance
CSPS	Container Shipping Planning Service
EIS	Environmental Impact Statement
FCC	Fully Cellular Container Vessels
GI	HIS Global Insight
GPA	Georgia Ports Authority
GRR	General Reevaluation Report
IWR	Institute for Water Resources
LFA	Load Factor Analysis
LNG	Liquid Natural Gas
LSE	Lloyd’s Shipping Economist
MARAD	Maritime Administration
MPC	Maximum Practicable Capacity
MPD	Maximum Practicable Draft
MPLD	Maximum Practicable Loading Draft
MSA	Metropolitan Statistical Area
MSI	Maritime Strategies International, Limited
MXSLLD	Maximum Summer Load Line Draft
NED	National Economic Development
PDT	Project Delivery Team
PX	Panamax Vessel Class
PPX	Post-Panamax Vessel Class
PPX1	Generation 1 Post-Panamax Vessel Class
PPX2	Generation 2 Post-Panamax Vessel Class
RED	Regional Economic Development
RTG	Rubber-tired Gantries
SHEP	Savannah Harbor Expansion Project
SPX	Sub-Panamax Vessel Class
STS	Ship-to-Shore
TCSM	Transportation Cost Savings Model
TEU	Twenty Foot Equivalent Unit
TPI	Tons per Inch Immersion
UKC	Underkeel Clearance
USACE	United States Army Corps of Engineers
USEC	United States East Coast
WTS	World Trade Service

Terminology Used in the Transportation Cost Model

Applied Cargo	The average weight of cargo per TEU, this includes carriage as well
Cargo Working TPI	This is the tons per inch over the range of immersion for cargo only.
Circuit Distance	The total distance of a trade route, defined as the sum of distances from all ports of call, expressed in nautical miles.
Draft-Restricted	The draft that a ship has available when tides are considered
Draft-Unrestricted	The draft that a vessel can use at anytime regardless of the tide
DWT	Deadweight tons
ECUS	East Coast United States
Empty TEUs	The number of empty TEU containers
FE	Far East
GPA Data	Georgia Ports Authority Data
Lading	Cargo within a TEU
Loaded TEUs	The number of boxes containing cargo
Maximum Practicable Capacity (MPC)	The highest reasonable practicable capacity based on weight and volume that a given vessel can hold assuming a fixed average import and export cargo weight (based on all cargo for a given service), a minimal rate of empty containers for all routes, bunkerage and ballast requirements, 5-feet of usable tide and other considerations. The TCSM does include some calls in which vessels exceeded its MPC, but never more than 15% of the time.
Maximum Practicable Draft	The sailing draft when a vessel is loaded at its MPC
Maximum Practical Load	The highest practicable tonnage capacity based on weight and volume that a given vessel can hold assuming a fixed average import and export cargo weight (based on all cargo for a given service), a minimal rate of empty containers for all routes, bunkerage and ballast requirements, 5-feet of usable tide and other considerations
Maximum Summer Load Line Draft	The maximum draft of a vessel at the summer load line
Project Reference Depth	Also known as the without project depth of -42 feet Mean Low Water
Reference Depth	The TCSM uses this term to define the channel depth at Mean Low Water for each alternative
Underkeel Clearance	The available amount of water beneath the bottom of the vessel (all vessels are required to sail with a level of clearance)

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SAVANNAH HARBOR EXPANSION PROJECT
Economic Evaluations

1. INTRODUCTION

1.1. Document Layout

The following text documents the economic evaluations performed for the Savannah Harbor Expansion Project (SHEP). Initial document sections provide a description of existing conditions at Savannah Harbor. An assessment of future without and with project conditions follows and includes an evaluation and description of forecast trade, the vessel fleet and operations at the harbor. The document concludes with the presentation of National Economic Development (NED) benefits. The NED benefit assessment includes evaluation of project risk and uncertainty utilizing sensitivity analysis.

1.2. Study Purpose and Scope

The Savannah District of the U.S. Army Corps of Engineers (USACE) in conjunction with the Corps' Deep Draft Navigation Center of Expertise has developed the Savannah Harbor General Reevaluation Report (GRR) to determine the feasibility of improvements to the Federal navigation project at Savannah Harbor. The GRR and accompanying Tier II Environmental Impact Study (EIS) have been developed to fulfill the conditions of the conditional authorization granted in 1999. The GRR and Tier II EIS provide documentation of the technical and plan formulation analyses conducted in the development of a recommended plan for navigation improvement and environmental mitigation. The GRR includes a final mitigation plan and an incremental analysis of alternative channel depths from 42 to 48 feet, as required by the conditional authorization.

Potential navigation improvements include deepening and widening of navigational channels, turning basin expansion, and expanded channel wideners. The purpose of these potential improvements is to increase the efficiency of cargo vessel operations and to accommodate larger container ships, which are already calling at the Port and which are projected to use the Port in larger numbers in the very near future. This study identifies and evaluates alternatives that will:

- Accommodate recent and anticipated future growth in containerized cargo and containership traffic;
- Improve the efficiency of operations for containerships within the Savannah Harbor Navigation Project;
- Allow larger and more efficient container ships to use the Port; and
- Reduce vessel congestion in the river channel.

The Deep Draft Navigation Planning Center of Expertise of the USACE and the Institute for Water Resources (IWR) performed analyses contained within this Economic Appendix. In accordance with ER1105-2-100, the Project Delivery Team (PDT) determined the NED benefits of the project, which are defined primarily as the reduction in transportation costs as a result of channel deepening. Transportation costs can be reduced based on two actions on the part of the carriers: (1) a deeper channel allows carriers to load vessels with more cargo destined for Savannah and other ports; and (2) the deeper channel encourages shippers to substitute larger, more efficient vessels that previously were unable to call at Savannah Harbor. The savings increase, generally at a diminishing rate, for each incremental project depth. The NED plan, in turn, is defined as the project that maximizes the net benefits to the national economy. The PDT employed two models in calculating the benefits: (1) a Transportation Cost Savings Model (TCSM) which calculates the waterborne transit costs to and from other world locations to the Savannah Bar Channel and (2) the HarborSym model which uses vessel information generated by the TCSM combined with estimates of sailing drafts within the Savannah Harbor Channel to estimate the costs, delays and transportation savings within the harbor channel itself. The resulting benefits were categorized by transportation cost savings, reduction in meeting area delays and reduction in tidal delay costs. This economic appendix describes the three benefits in order but it should be noted that they are all interdependent.

1.3. Problems and Opportunities

Savannah Harbor is the second largest container port on the US east coast (by twenty foot equivalent unit (TEU) volume) and the fourth largest in the nation. However, Savannah Harbor also has one of the shallowest controlling depths for a major port. With a controlling depth of 42 feet, it is dwarfed by several other major US ports, many of which comprise key legs on Savannah's container voyages. For example, Norfolk and Baltimore Harbors are 50 feet deep whereas the Port of New York and New Jersey is currently being deepened to 50 feet. The problem is expected to worsen once the Panama Canal's expansion is completed in 2014, when an increased number of Post-Panamax vessels are expected to call on east coast ports including Savannah. Moreover, Savannah has been investing heavily to accommodate the forecasted cargo growth and future composition of Post-Panamax containerships, which make up a growing share of the world fleet. Upon its completion in 2020, the Savannah Harbor's Garden City Terminal will be the largest single container handling facility in the U.S. with more than 1,200 acres of storage space, 9,000 feet of berth, 33 post-Panamax size cranes, and two on-site intermodal transfer facilities serviced by two major rail lines. The facility, at full build out, will have an annual throughput capacity of 6.5 million TEUs. From 2017 to 2066 (the period of analysis), the volume of TEUs projected for Garden City Terminal will continue to increase; the vessel fleet calling at Garden City Terminal will continue to shift from predominantly Panamax size to Post-Panamax size; and the Panama Canal and most major ports on the US east coast, Europe, and Asia will be able to accommodate vessels with operating drafts in excess of 46 feet. Finally, continued competition will force carriers to look for ways of achieving transportation cost efficiencies.

Under future without-project conditions, the channel will remain at a controlling depth of 42 feet. Vessels requiring operating drafts of greater than 38 feet (Panamax) and 37.7 feet (Post-Panamax) will continue to be constrained in Savannah Harbor (i.e., due to underkeel clearance requirements). This will create severe transportation cost inefficiencies since Savannah will remain at least eight feet less than controlling depths at the expanded Panama Canal, Norfolk Harbor, Baltimore, the Port of New York and New Jersey, as well as most of the foreign ports that serve Savannah (Figure 1).

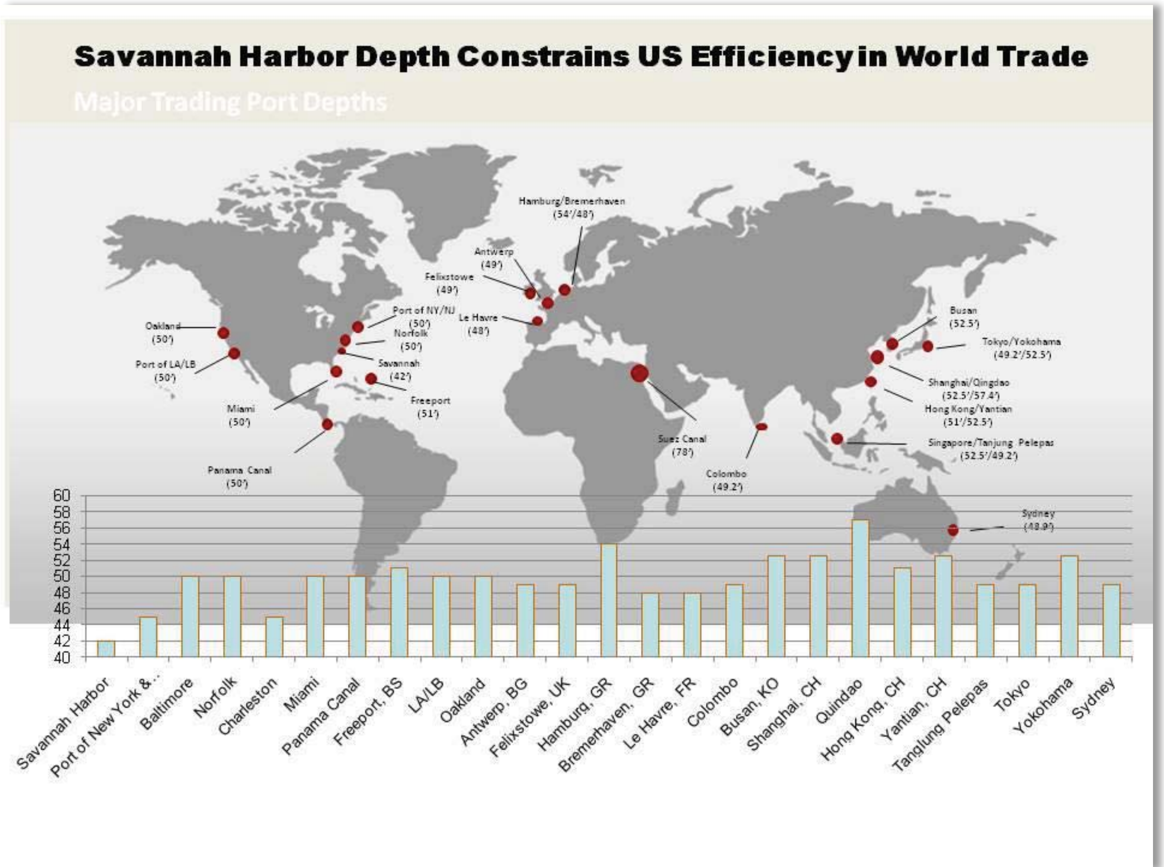

Figure 1: Selected World Harbor Depths Comparison[1]

Over time, these inefficiencies are expected to increase significantly as the volume of cargo continues to grow and as larger vessels comprise a greater share of the world vessel fleet. [2,3]

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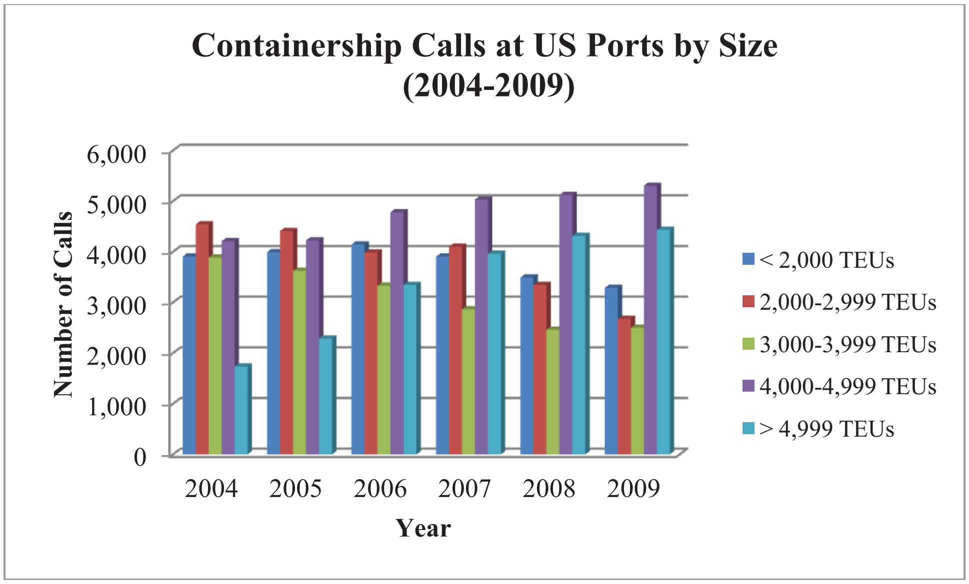
[1] Port of New York and New Jersey scheduled completion date (2014), Miami (2012).

[2] TEU container capacity of some of the containerships calling at U.S. ports is about 9,000 to 10,000 TEUs with vessel drafts of up to 46 feet. Some future forecasts are calling for 12,000 TEU ships with vessel drafts over 49 feet. There are projections of even larger vessels in design having 14,000 TEU-capacity vessels with drafts of 50 feet for entry in the U.S. market by 2020.

[3] CDM and the Tioga Group, *Maritime Transportation System: Trends and Outlooks*, Final Report, Report submitted to the USACE, March 13, 2007.



Source: Department of Transportation's Volpe Center generated chart based on MARAD Data, *U.S. Water Transportation Statistical Snapshot*

Figure 2: Trends in Size of Containerships Calling at U.S. Container Ports, 2004 to 2009

2. EXISTING CONDITIONS

Savannah Harbor is a deep draft harbor on the South Atlantic coast of Georgia. The harbor and deep draft navigation channel comprise the lower 21.3 miles of the Savannah River and 11.4 miles of channel across the bar to the Atlantic Ocean (Figure 3). The Savannah River, along with several of its tributaries, forms the boundary between the States of Georgia and South Carolina along its entire length of 313 miles.

The City of Savannah, Georgia, dominates the mainland on the south side of the river. The city's historic downtown is located on a south bluff approximately 18 miles above the river's mouth. Heavy industry and shipping facilities are located along the south side of the harbor upstream from the city's historic area to the upper limits of the harbor project. Additional heavy industries and a few shipping facilities line the harbor downstream from the city's historic area to the Atlantic Intracoastal Waterway.

From the Intracoastal Waterway to the river's mouth, both sides of the river predominately consist of islands, marshes, dredged material disposal areas, and other undeveloped sites. Land use on the South Carolina side of the Savannah River is basically agricultural, silvicultural (forestry-related), with some recreation. Wetland habitat types found along Savannah Harbor include saltwater aquatic, saltwater coastal flats, saltwater marshes, freshwater aquatic, freshwater flats, and freshwater marsh.

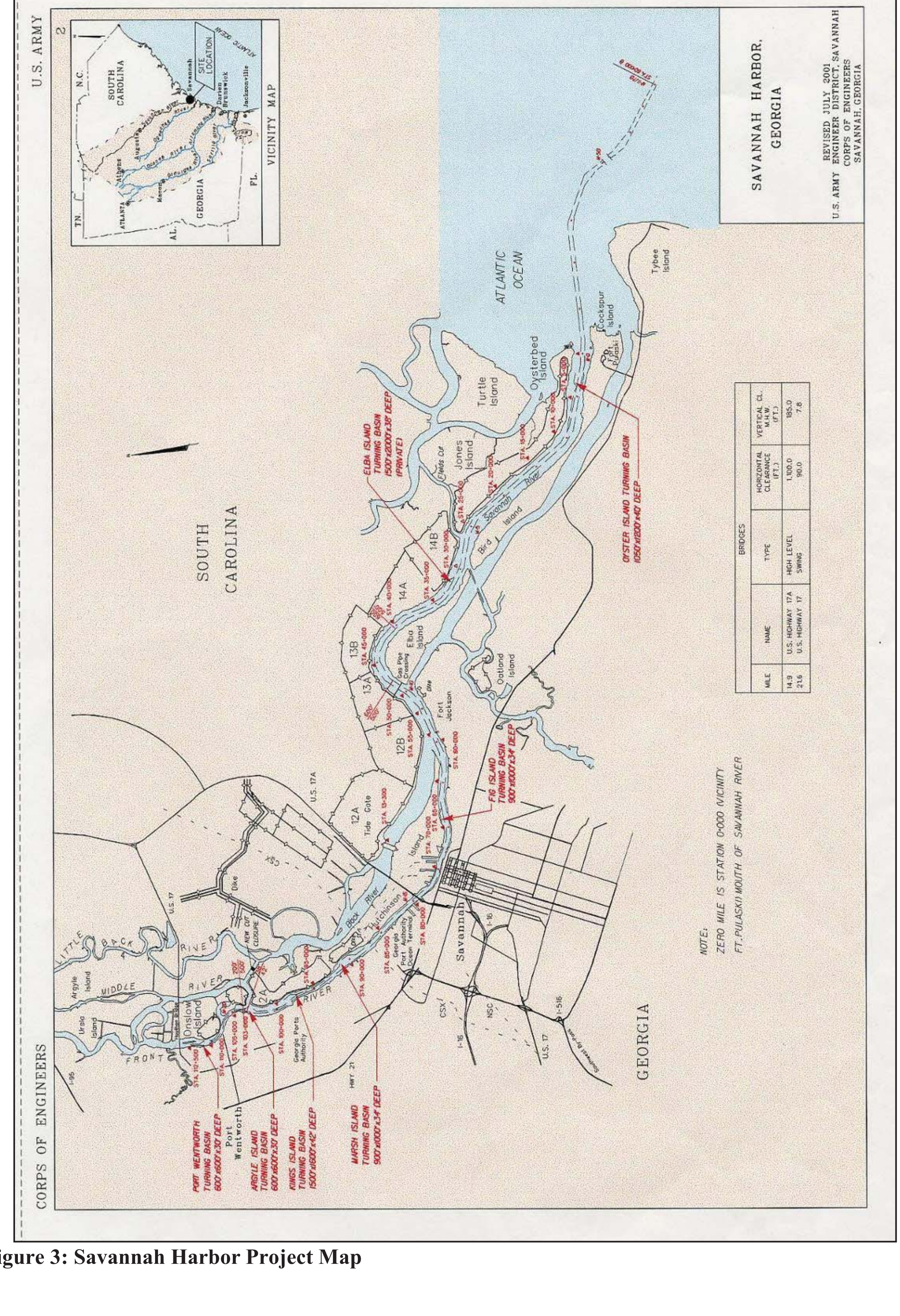


Figure 3: Savannah Harbor Project Map

2.1. Economic Study Area (Hinterland) and Regional Distribution Centers

The Savannah Harbor hinterland includes Birmingham, Atlanta, and Memphis and extends as far west as Dallas, Texas, and as far north as Detroit, Michigan (Figure 4). Savannah Harbor container services calling world regions for containerized imports compete with other major South Atlantic coast ports of Jacksonville, Charleston, and Wilmington, as well as Norfolk for interior U.S. markets. Container ports in South Florida, such as Miami and Port Everglades, are not considered to be competitors to Savannah because of the specificity of their hinterland relative to South Florida and associated transshipment services for the Caribbean and Latin America niche markets. While the majority of Norfolk's hinterland serves the North Atlantic region, it is often viewed as a competitor to Savannah, particularly for cargo to and from the Midwest.

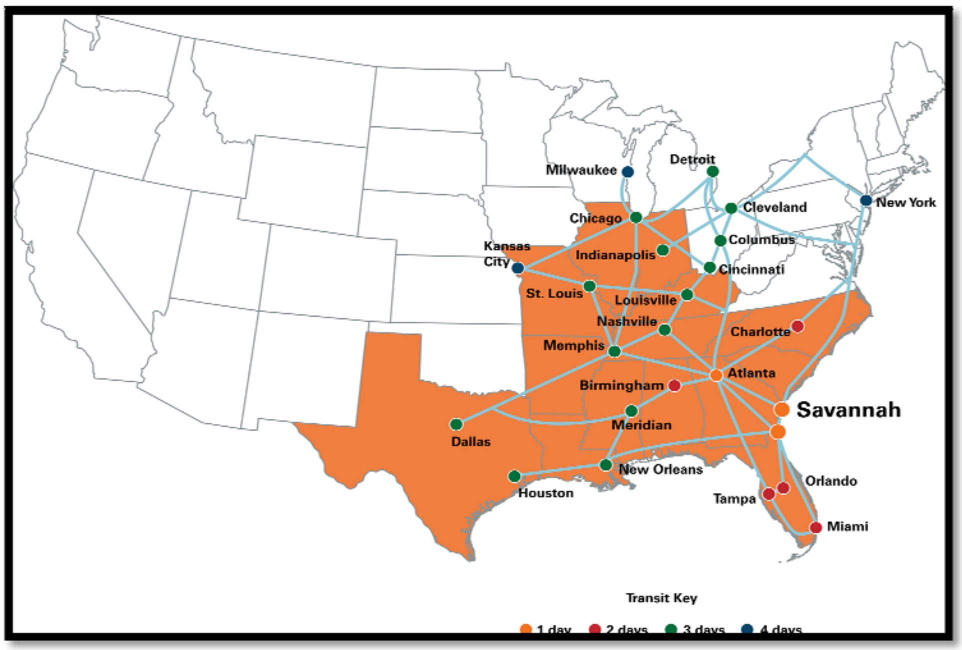


Figure 4: Savannah Harbor Hinterland

Despite low population growth and a minor expansion of the 40-mile "trade radius" around Savannah, Savannah Harbor has been the fastest-growing container port since 1997, experiencing an average annual cargo growth rate of 11.3 percent (MARAD, 2010). The average annual population growth in the Savannah MSA and 40-mile trade radius grew at annual rates of 1 and 2 percent, respectively, over the same period. The large cargo growth is attributable to the port's favorable infrastructure, aggressive marketing, solid transportation network, and new distribution centers that were developed on former farmland in Chatham and surrounding counties. Large scale distribution centers have developed in the area because of the availability of large tracts of undeveloped land and the proximity to road, rail, and waterborne transportation infrastructure.

Distribution centers are typically located within a one-day's drive of the local retail stores with one distribution center potentially supplying inventory for over a dozen local retail stores. The

Distribution centers are typically located within a one-day's drive of the local retail stores with one distribution center potentially supplying inventory for over a dozen local retail stores. The very large distribution centers located near Garden City Terminal also supply regional distribution centers located in the hinterland, which in turn supply local retail stores. Large scale distribution centers reduce the amount of inventory needing to be stored by the local retail stores. The centers also reduce the risk that an inappropriate volume of inventory would be delivered to a local retail store. According to the GPA, Wal-Mart, Kmart/Sears, Dollar Tree, Lowes, IKEA, Pier One Imports, Home Depot and Dick's Sporting Goods are some of the larger distribution centers in the region.

The 24 largest distribution centers using Garden City terminal have a combined warehouse area of 19.7 million square feet (Georgia Ports Authority (GPA), 2007). The Savannah/Chatham County industrial real estate inventory for warehouse/distribution facilities, light manufacturing buildings, and flex/business service space has more than doubled from 1998 to 2007, increasing from 11.0 million square feet in 1998 to 28.3 million square feet in 2007. Additions to the industrial real estate inventory are currently expanding beyond Chatham County into nearby Bryan, Effingham, and Liberty Counties. Build-out of sites acquired and in the planning stage would add an additional 25 million square feet to the inventory (Neely/Dales, 2007).

2.2. Facilities and Infrastructure

2.2.1. Garden City Terminal

The Garden City Terminal is a secured, dedicated container terminal owned and operated by the Georgia Ports Authority (Figure 5). The terminal is the largest single-terminal operation in North America. The facility's single-terminal design allows the port to operate in an environment of maximum efficiency and flexibility, as well as increased security, due to the concentration of all manpower, technology and equipment in one massive container operation.

Figure 5: Garden City Terminal

Garden City Terminal is a gateway to rail and road distribution networks that offer efficient and reliable intermodal access to markets across the U.S. Southeast and Midwest, including those with the fastest-growing populations and capital investments. The James D. Mason Intermodal Container Transfer Facility, upgraded in 2007 to include 2,500 feet of track, moves an average of 17 double stack trains to Atlanta each week. The Mason ICTF is served by CSX and Norfolk Southern Railroad and provides overnight rail service to Atlanta, with two to four day delivery to inland destinations of Charlotte, North Carolina; Chicago, Illinois; Dallas, Texas; and Memphis, Tennessee. Approximately 20% of Garden City Terminal's throughput moves by train.

Additionally, immediate interstate access is available via Interstates 95 (North/ South) within 5.6 miles and 16 (East/ West) within 6.3 miles. Truck traffic is serviced by three separate gates with 37 lanes, 25 of which are pre-check lanes.

The terminal covers approximately 1,200 acres. Its nine container berths provide 9,693 continuous linear feet of waterfront. Garden City Terminal is equipped with 25 container cranes, eight of which are of super Post-Panamax class (the largest of the Post-Panamax vessel) and capable of handling vessels loaded with 22 containers across the vessel's beam. The seventeen remaining cranes are all Post-Panamax class and capable of servicing vessels loaded with 16-18 containers across.

Garden City terminal berths run in a line that parallels the Savannah River navigational channel. The linear berth space is divided into four segments as follows:

- Container Berth 1 – 1,690 feet;
- Container Berths 2 and 3 – 2,358 feet;
- Containers Berths 4, 5, and 6 – 2,369 feet; and
- Container Berths 7, 8, and 9 – 3,276 feet.

2.2.2. Elba Island Natural Gas Facility

The Elba Island Liquid Natural Gas (LNG) terminal and inland pipeline are owned by Southern LNG/E1 Paso Corporation; however, both Shell LNG and British Gas LNG Services have long term leases at the facility, both owning and distributing the product. The LNG brought into the facility is distributed throughout Georgia and in parts of South Carolina. The facility has 4 storage tanks with a total capacity of 350,000 cubic meters.

2.2.3. Ocean Terminal

The Ocean Terminal is a secured, dedicated break-bulk and RoRo facility owned and operated by the GPA. A range of shipments including forest and solid wood products, steel, industrial and farm equipment, automobiles, project shipments and heavy-lift cargoes move through this 208-acre, 10-berth facility every day. The site features 6,674 linear feet of deepwater berthing, 1.5 million square feet of covered storage, and 83 acres of open storage. Ocean Terminal is located 1.2 miles from Interstate 16, 10 miles from Interstate 95, and 1.5 miles from Interstate 516. Norfolk Southern Railroad provides switching services on-terminal. Line-haul services are provided by Norfolk Southern Railroad and CSX Transportation. Additional land is available for future expansion of this facility.

2.2.4. Other Facilities

Other harbor tenants include Willamette Industries, Savannah Electric Power Generating Station – Southern Company, Atlantic Wood Industries, Savannah Food and Industries, Vopak, National Gypsum Company, SIT, Citgo Asphalt Refinery, Georgia Kaolin International, Savannah Steel Corporation, Global Ship Systems, Colonial Oil Industries, Blue Circle Cement, Savannah Marine Services, Crescent Towing Services, Moran Towing, Liberty Terminal, East Coast Terminals/Woodchip Exporting Corporation, Georgia Pacific Gypsum, Nustar, Conoco Phillips, Tronox, and Southern LNG.

2.3. Container Services

This economic analysis focuses primarily on container trade at the Savannah Harbor. This type of trade is the newest and fastest growing and is also very dynamic. Recent trends in the container industry include consolidation of carriers, increases in vessel size, and slot sharing, which is an increasingly common practice that allows multiple companies to share space on a single containership. The impetus for these trends is increased economic efficiency, which is driven by competition among carriers. The major trade lanes and ports are serviced by multiple carriers; therefore, competition on these trade lanes is strong. The baseline presented in this evaluation documents Garden City and vessel operations through calendar year 2007.

In 2007, more than 50 container ship services included regularly scheduled calls at Garden City Terminal. Some services handled more than 100,000 TEUs at Garden City; others handled only a few hundred TEUs. These containership services are considered liner services which call weekly on a fixed day schedule. Savannah Harbor is typically one of multiple US east coast ports called on by a liner service. Vessels on a liner service are typically of similar size in order to provide a consistent port service. A typical liner service to the US east coast loads goods bound for the US east coast from a number of foreign ports (as few as two or as many as six) then calls at two, three, or more US east coast ports to discharge imports and pick-up exports. The vessel then returns to the same foreign ports-of-call serviced on the in-bound leg.

Liner services may also have more diverse itineraries. Liner services from Asia may stop at US west coast ports before calling at the US east coast. Liner services from the Mediterranean and Europe may call at many ports before arriving at the US east coast, and may also include US Gulf ports in the rotation. Some services from Asia call at the US east coast then continue on to Europe before coming back to the US east coast on the return trip to Asia, thereby connecting Asia, the US east coast, and Europe in a single liner service. Another feature of liner service operations is transshipment, which occurs when a container terminal is used as a transfer point from one liner service to another. For example, MSC uses Freeport, BS (port depth -51 feet) as a transshipment terminal. MSC liner services from Asia to the US east coast and MSC liner services from Europe to the US east coast include a stop at Freeport where European goods bound for Asia and Asian goods bound for Europe can switch liner services. Transshipment terminals are also used for transfer of cargo from larger long haul vessels to smaller feeder vessels.

As mentioned, numerous container services call on the Garden City Terminal. These services are operated by many carriers and have trade routes which originate in various parts of the world. In the interest of protecting proprietary information, services were grouped by the world region that they serve. For example, there are a number of services that call on various ports in the Far East (FE), transit the Panama Canal, proceed to ports along the east coast of the United States (ECUS), and then return to the Far East. Services that represent trade within this world area were grouped and entitled “FE (Panama) ECUS” according to the naming convention described. The economic analysis will focus on Savannah Harbor services utilizing the nomenclature provided in Table 1.

Table 1: Savannah Harbor Container Services

World Region	Acronym
East Coast United States (US) Africa	ECUS Africa
East Coast US Australia Pendulum (PEN)	ECUS AU PEN
East Coast US, West Coast and East Coast South America[4]	ECUS WCSA-ECSA
East Coast US, Europe, Gulf of Mexico, PEN	ECUS EU GULF PEN
East Coast US, Mediterranean	ECUS MED
Far East, East Coast US, Europe Pendulum	FE ECUS EU PEN[5]
Far East, East Coast US, Mediterranean Pendulum	FE ECUS MED PEN
Far East, Panama Canal, East Coast US	FE (Panama) ECUS
Far East, Suez Canal, East Coast US	FE (Suez) ECUS
Round the World	RTW
Australia, East Coast US, Europe Pendulum	AU ECUS EU PEN

Figure 6 and Figure 7 are trade route maps for the FE (Panama) ECUS and FE (Suez) ECUS services, respectively. These maps are provided to illustrate the world areas covered by container services using the nomenclature identified in Table 1.

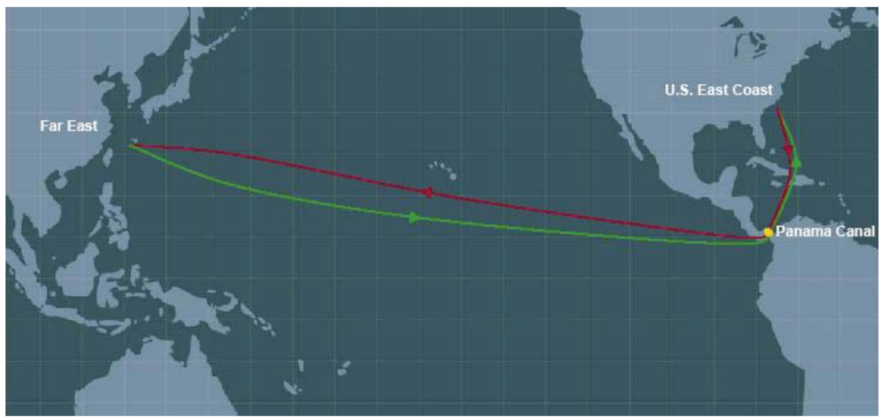


Figure 6: FE (Panama) ECUS Trade Map

As shown in Figure 6, the FE (Panama) ECUS service calls on Far East ports, crosses the Pacific Ocean, and transits the Panama Canal before calling on U.S. East Coast ports. After completing the vessel's ECUS port rotation, the ship returns to the Far East via the Panama Canal. Similarly, the FE (Suez) ECUS service calls on various ports in the Far East and Africa before transiting the Suez Canal and stopping at a Mediterranean port (Figure 7). After its Mediterranean port of call, the vessel crosses the Atlantic and calls on numerous East Coast U.S. ports before returning to the Far East by calling on many of the same ports visited during the first leg of its voyage.

[4] The ECUS WCSA-ECSA is a combined world region service and represents both the ECUS WCSA and ECUS ECSA services. These services were initially analyzed separately (as shown in document text describing the commodity forecast (tonnages)) but were later combined since these services represent a small fraction of total project containerized movements.

[5] "PEN" indicates a pendulum service. In the shipping world, a pendulum service generally involves a trans-oceanic string of ports structured as a continuous loop, much like a pendulum.

Figure 7: FE (Suez) ECUS Trade Map

It should be noted that each trade route contains unique characteristics such as cargo volume, cargo weight, ports of call, vessel types, mix of vessels, etc. and was therefore evaluated separately before being combined as part of the NED analysis. Only eight routes will benefit from channel modifications at Savannah Harbor. However, the non-benefitting routes were still carried forward in the evaluation as the number of future calls will contribute to harbor congestion and will influence other benefit categories outside of the main transportation cost model (i.e., meeting area and tide delay analyses).

Since the inception of containerized cargo in the 1950's, the container shipping industry has been evolving toward greater efficiency. Greater efficiency involves moving more loaded boxes per voyage, which in turn has created incentives to build even larger vessels. However, there are constraints to increased vessel sizes. Perhaps the most obvious constraint is the size of the Panama Canal. Over time, the industry has addressed the physical limitations of the Panama Canal by designing vessels that can accommodate more containers. For example, the Panamax vessel used as the design vessel for the previous Savannah Harbor deepening analysis in 1991 was a 4,000 TEU vessel, which was still under construction at the time. The most recently-built Panamax vessels are rated at just over 5,000 TEUs.

Another limiting factor is the channel depths at other major U.S. container ports. The existing planned, and future controlling depths at these ports are shown in Table 2. Several services, ports such as New York or Norfolk, comprise Savannah's prior or post ports of call.

Table 2: Controlling Depths at US East Coast Ports

Port	Existing[6] (feet)	Planned Depth - Date (feet)
Port of New York and New Jersey	45	50 (2014)
Baltimore	50	50
Norfolk	50	50
Charleston	45	45[7]
Miami	42	50 (2012)
Jacksonville	40	45 (no date)
Port Everglades	44	49 (2012 pending)
Panama Canal Expansion	39	50 (2014)[8]
Savannah	42	???

Much of the Corps' guidance is applicable to bulk-type ports, which serve niche markets and often have regular cargo schedules and predictable loading patterns. Containership ports (with Savannah in particular) are entirely different and are very difficult to evaluate. For one thing, it is nearly impossible for an analyst to track everything that is on the vessel at a given time since many containerships load and offload simultaneously and call at multiple ports during its voyage. Secondly, for each particular voyage, Savannah is seldom the first or final port of call. Third, the total East Coast or other ports of call forecasts by trade route are often unknown, making it difficult to forecast the strings of ports on a voyage. Some vessel strings call at other ECUS ports, and some call at EU and other foreign destinations on their route. Unless Savannah is the first or last port of call on an itinerary, every vessel carries a mix of import and export commodities. For these reasons, the PDT decided to examine sailing drafts (which are available), and relied on averages when determining unit costs. Estimates of vessel loading can be inferred based on the characteristics of the vessel as well as assumptions on loading practices and evolution.

2.4. Historical Commerce

Figure 8 shows historical total commerce at Savannah Harbor as reported in the Waterborne Commerce of the United States. The red squares depict total commodity shipments for each year from 1995 to 2009. While total port commerce has varied over time, the graph clearly illustrates that commerce has increased since 1995, with substantial growth occurring over the last decade. More recent figures show Savannah moving 33.97 million short tons in 2006; 36.5 million short tons in 2007; 35.3 million short tons in 2008, and 32.3 million short tons in 2009. The black line represents the long term trendline for identified commerce.

[6] The existing and planned depths at the identified locations are controlling depths. Note that the tidal variation differs at each location.

[7] Charleston Harbor has begun studies on a harbor deepening project.

[8] Once completed, the expanded Panama Canal will accommodate vessels drafting up to 50' tropical fresh water.

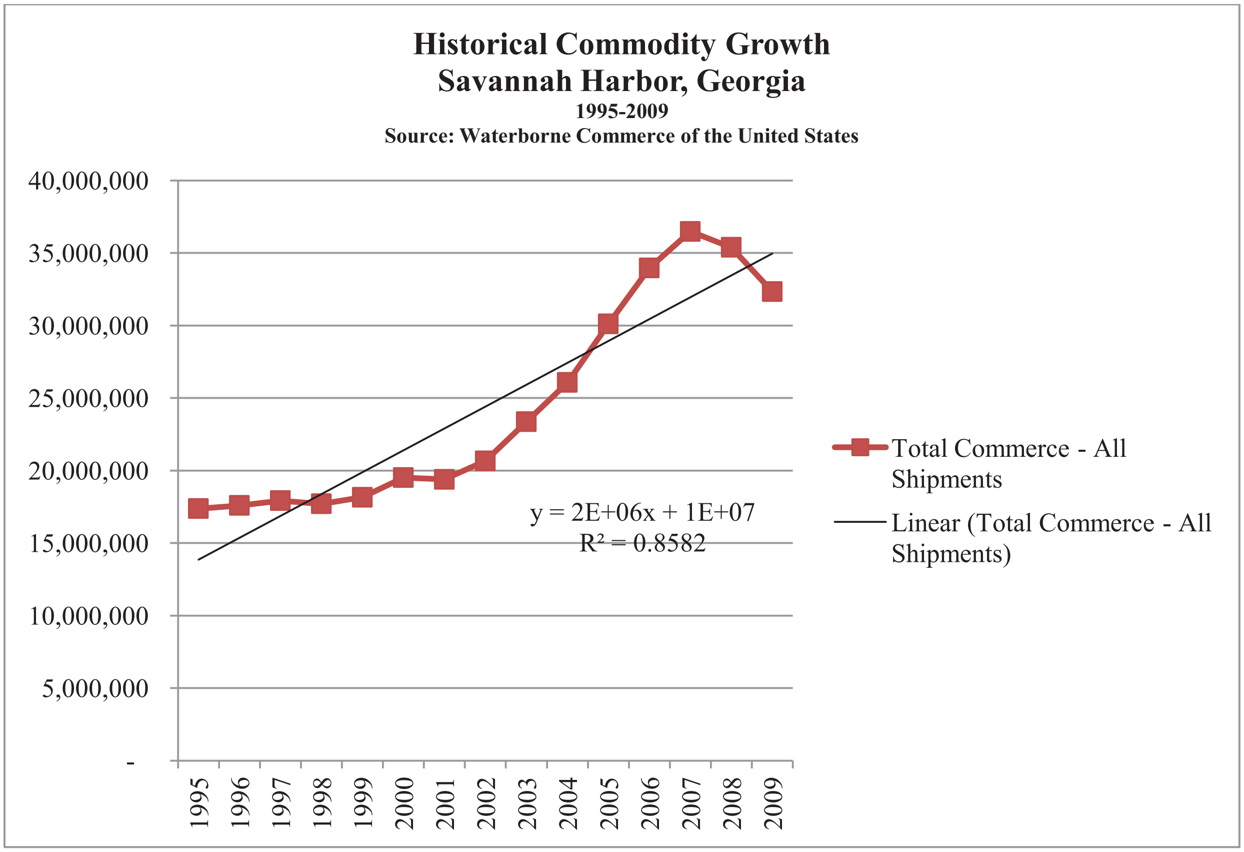


Figure 8: Savannah Harbor Historical Commerce - All Commerce (short tons)

GPA-reported data in Figure 9 illustrates that the number of loaded export and import TEUs at Savannah Harbor grew significantly over the last decade. As indicated by the blue diamonds, export TEUs grew 8 percent between 2007 and 2008, decreased by 5.1 percent during the height of the recession (2008 and 2009), and rebounded to grow by 11.7 percent between 2009 and 2010. Loaded import TEUs (represented by the red squares) rose 0.2 percent between 2007 and 2008, fell by 17.6 percent between 2008 and 2009, and grew by 11.7 percent between 2009 and 2010. By 2010, the GPA reported that 1,144,554 loaded TEUs were exported and 1,050,466 loaded TEUs were imported. Much of Savannah's container growth can be attributed to the availability of affordable land, incentives by local governments to attract distribution centers, congestion at West Coast ports, the distinct hinterland market and the types of commodities transported through Savannah.

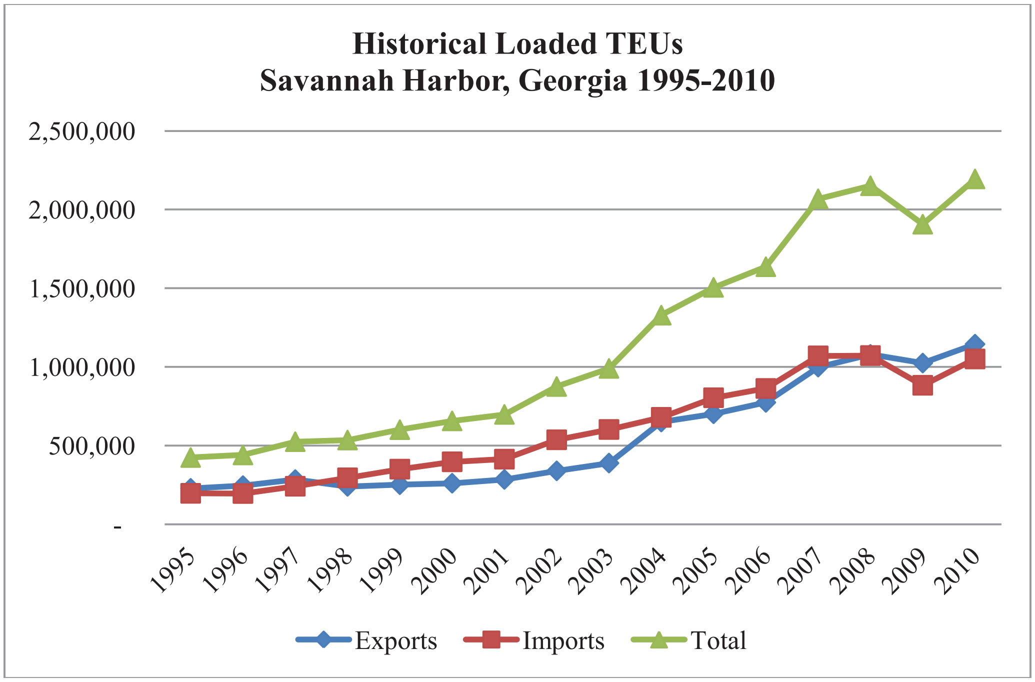


Figure 9: Historical Loaded TEUs

2.5. Existing Fleet

2.5.1. Vessel Classes

It is common practice to separate the containership fleets into TEU bands or classes to analyze supply within the industry. However, due to the evolution of vessel design over time, these TEU bands do not correspond to a breakdown of the fleet by dimensions such as beam or draft. Accordingly, breakdowns in terms of beam and draft straddle different TEU classes. For instance, within the 3.9 k to 5.2 k TEU band, which is generally regarded as the Panamax range, a number of ships fall within that category yet have beams that are too large to pass safely through the current Panama Canal, despite what their name suggests. Conversely, there are many Panamax vessels in the world fleet that fit easily through the Panama Canal while carrying large volumes of TEUs.

The PDT contracted with Maritime Strategies International, Limited (MSI) for information related to the existing and forecast future world fleet of container vessels. MSI is a firm that specializes in vessel forecasting for each shipping sector and provides financial advice to ship owners, shipyards, brokers, investors, insurers and equipment providers.

In the following Table 3, fleet dimensions and TEU ranges used by MSI and the Corps are shown by vessel class. As mentioned, TEU range and vessel dimensions overlap among container vessel classes.

Table 3: Vessel Size Class Definitions

Vessel	TEU Range (TEUs)	Dimension	Feet	
			From	To
Sub-Panamax	100 – 2,900	Beam	34.8	98.2
		Draft	8.2	38.1
		LOA	221.7	813.3
Panamax		Beam	98.4	106.3
		Draft	30.8	44.8
		LOA	572.0	967.5
Panamax Category 1	1,300 – 5,200	Beam	100.1	106.0
		Draft	30.8	38.9
		LOA	572.0	899.0
Panamax Category 2	2,900 – 5,200	Beam	98.4	106.3
		Draft	39.1	44.8
		LOA	899.3	967.5
Post-Panamax	2,900 – 7,600	Beam	106.4	138.8
		Draft	35.4	47.6
		LOA	660.8	1,044.7
Super Post-Panamax	5,200 – 12,000	Beam	138.8	143.9
		Draft	39.4	49.2
		LOA	910.7	1,205.0
Ultra Post-Panamax	7,600 – 12,000+	Beam	144.0	158.1
		Draft	42.7	49.5
		LOA	1,036.7	1,200.8
New Post-Panamax	7,600 – 12,000+	Beam	140.9	185.0
		Draft	50.9	52.6
		LOA	1,140.0	1,304.8

2.5.2. Analysis of Vessel Calls by Prior and Post Port

A useful method of evaluating vessel behavior is to examine the prior and post port of call for vessels calling at Savannah. It is often the case that the first and final ports of call tend to contain vessels carrying the most cargo and subsequently requires the deepest sailing drafts. Figure 10 illustrates that the majority of vessels calling at Savannah (78 percent) had another US port as their prior port of call. Of these, 58 percent were other East Coast ports and 19 percent were Gulf Coast ports. Also it is important to note that 13 percent of the vessels came directly from the Panama Canal. This provides a useful clue that once the Panama Canal's expansion is completed, additional vessels could call at Savannah via the Panama Canal.

Figure 11 displays the next port of call for Savannah traffic. Again, other US ports dominate the figure at 58 percent, split almost evenly between US East Coast and Gulf Coast Ports. The Panama Canal is the next port of call for 24 percent of the vessels. As the Panama Canal has an appointment system, these vessels must schedule their departure from Savannah to ensure arrival at the canal at the scheduled time. Calls at Savannah are expected to generally continue to be the "second in" or "third in" call in US port rotations in the future, due to its location and current liner network practices.

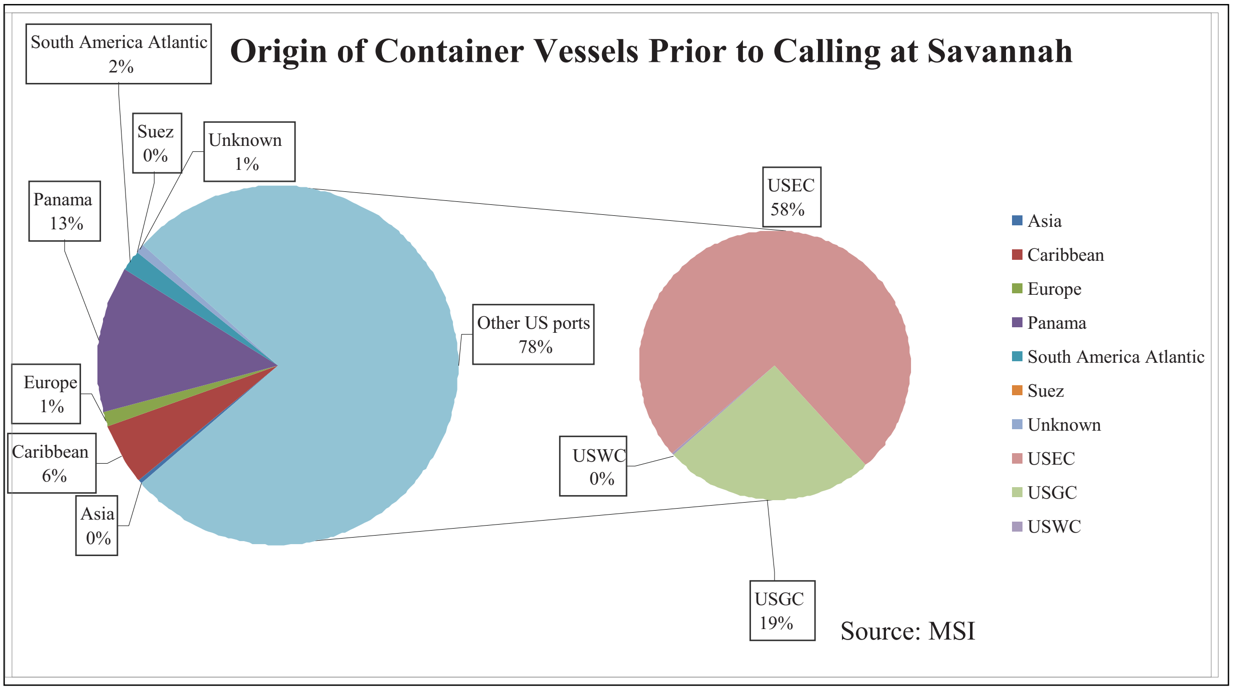


Figure 10: Origin of Container Vessels Prior to Calling at Savannah

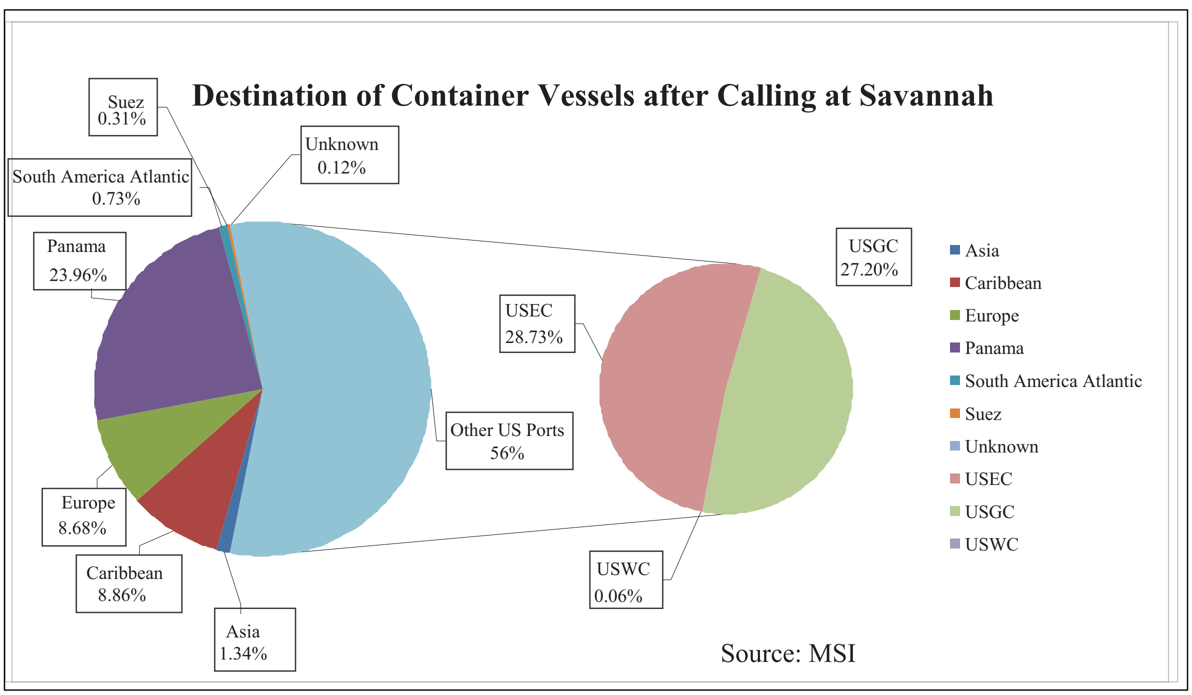


Figure 11: Destination of Container Vessels after Calling Savannah

2.5.3. Trade Balance

The quantity of containerized exports and imports were also examined. A port is said to have "balanced" trade when its exports are equal to its imports. Figure 12 shows Savannah to have larger export traffic (in terms of metric tons) than import traffic for the years 2002 through 2008. This difference is slight, however, and most would categorize Savannah as having a balanced trade. Moreover, this only applies to tonnage, not the number of TEUs, nor the value of the cargo being moved.

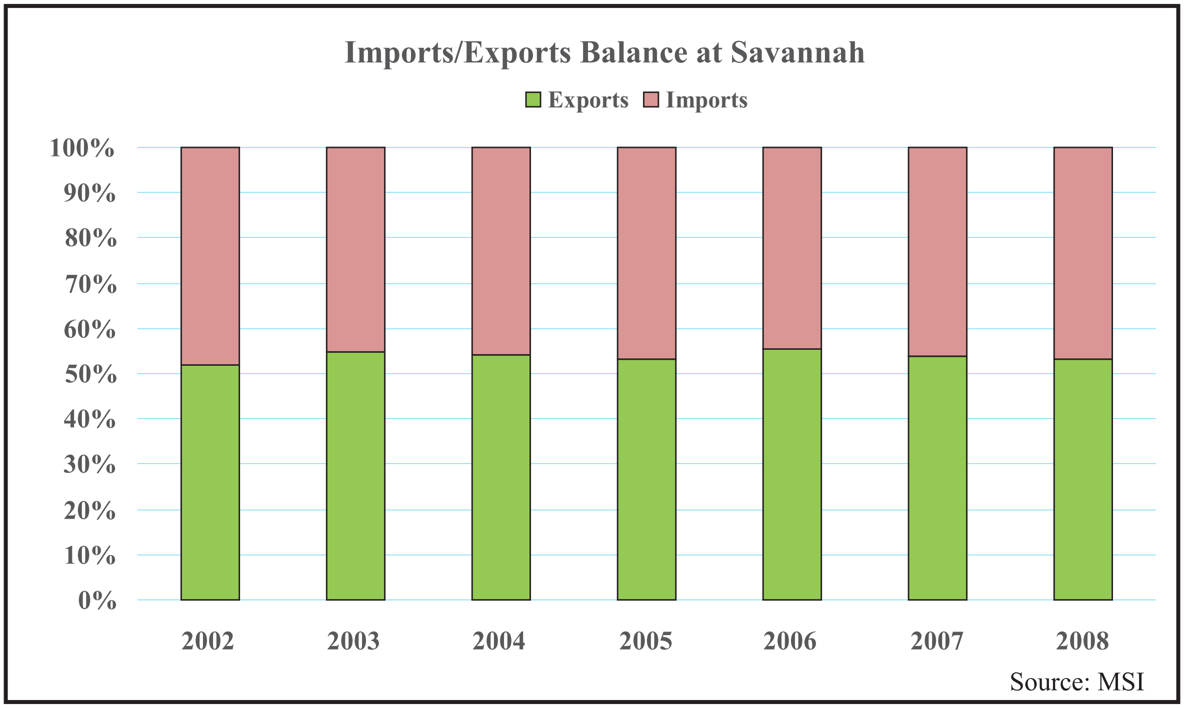


Figure 12: Import/Export Balance of Trade

2.5.4. Historical Calls by Day of Week

Container vessels calling at Savannah have historically been distributed fairly evenly across each day of the week. The peak day has been Mondays with 15 percent of the weekly calls. The low point has been Fridays with an average of 13 percent of weekly calls. Figure 13 displays Waterborne Commerce Statistics data for the years 2002 to 2007 for all vessels calling at Savannah. This analysis was performed as a way of validating whether changes in delivery schedules could be implemented possibly as a non-structural measure of the project. Given that the movements have been evenly distributed, rescheduling does not appear to be a viable non-structural option. Examining the delivery schedule could also be used to estimate the maximum capacity of the port in the future. Much of the vessels originating from Asia tended to call earlier in the week whereas vessels from other world regions called later in the week.

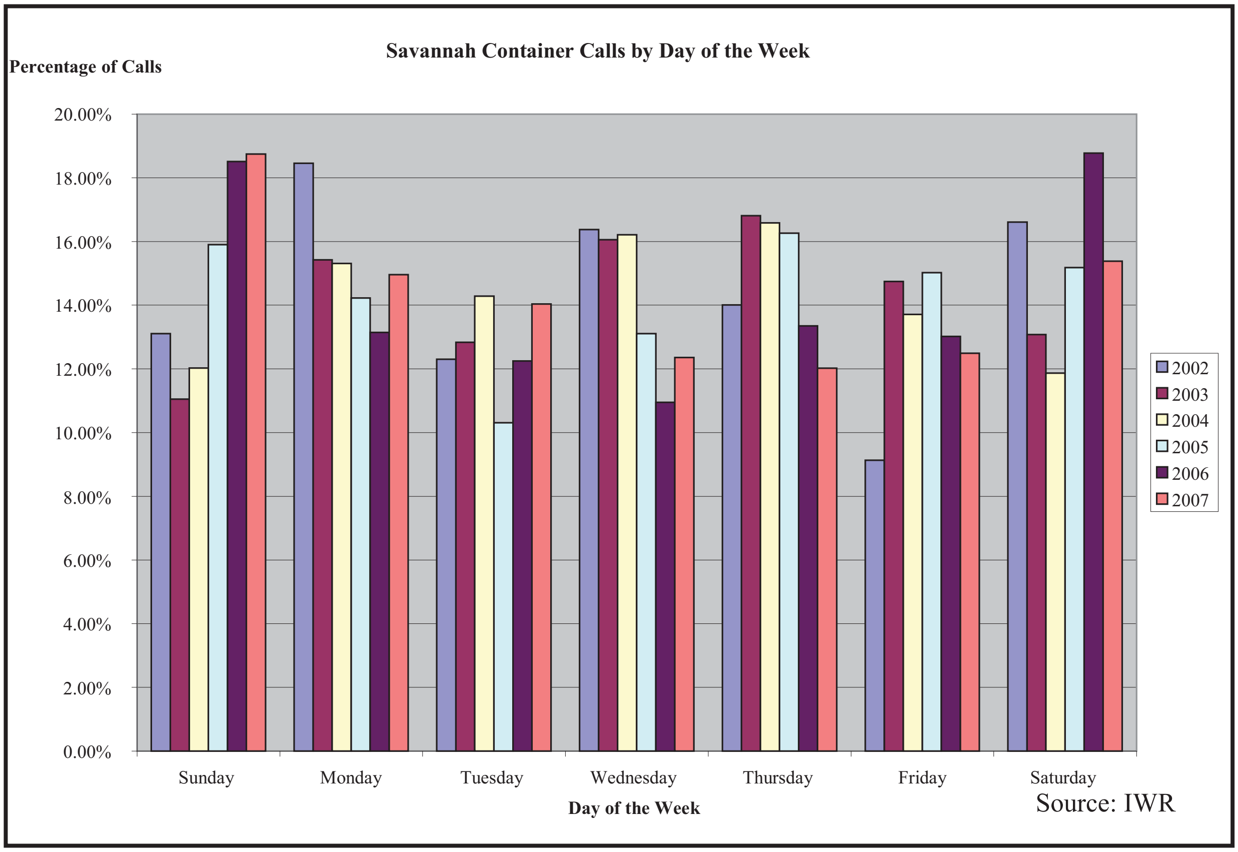


Figure 13: Savannah Container Calls by Day of Week

Table 4 displays this same information in tabular form. For the Garden City Terminal to reach the Georgia Ports Authority's projected future maximum capacity of 6.5 million TEUs per year (estimated to occur in 2030), vessel calls will need to be distributed fairly even across the days of the week similar to historical patterns. Furthermore, round-the- clock operations within the port would need to be abided by to achieve this maximum capacity.

Table 4: Savannah Container Calls by Day of the Week

	2002	2003	2004	2005	2006	2007
Sunday	13.11%	11.05%	12.03%	15.90%	18.51%	18.74%
Monday	18.46%	15.42%	15.31%	14.22%	13.15%	14.96%
Tuesday	12.30%	12.84%	14.29%	10.31%	12.25%	14.04%
Wednesday	16.37%	16.06%	16.22%	13.10%	10.95%	12.36%
Thursday	14.01%	16.81%	16.58%	16.26%	13.35%	12.02%
Friday	9.13%	14.75%	13.71%	15.02%	13.02%	12.50%
Saturday	16.61%	13.08%	11.86%	15.18%	18.77%	15.38%

2.5.5. Liner Services by Region

Competition in liner service can be indicated by the number of operators serving a geographic area. The number of services calling North American ports has doubled from 2001 to 2007. Most of this increase is coming from the Asia to North America trade. The number of services for the Europe to North America has also grown. Figure 14 displays the growth in liner services calling at North American ports by trade regions. The near doubling of the number of services indicates that the environment has become even more competitive for shippers; therefore, further efficiency improvements (slot sharing, consolidations) are likely to be sought by the shipping community.

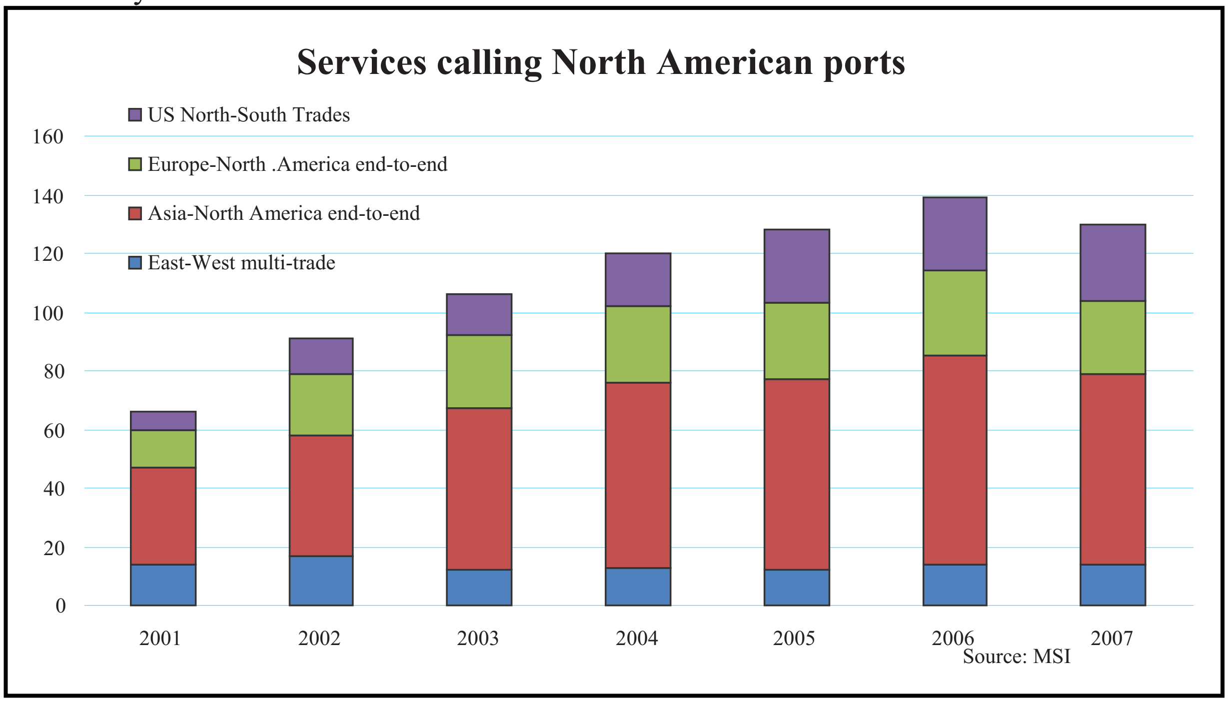


Figure 14: Services Calling North American Ports

2.5.6. Vessel Deployment to North America

By examining the deployment history, reasonable assumptions can be made about deployment in the future. Figure 15 shows total deployment in TEUs by vessel TEU class to the Europe-North America (typically East Coast US) trade from 2000-2007. Vessels above 4,300 TEUs were first introduced to this particular trade in 2002, but in short order these vessels took up an increasing portion of the fleet. Nevertheless this trade deployment continued to feature a large number of smaller class vessels, i.e., including those under 4,300 TEUs over the same time period.

For the Asia to North America route (Figure 16), a different trend emerged as evidenced by the dominance of vessels designed to carry 4,300 TEUs or more. Many of the West Coast ports provide adequate water depths to accommodate such large vessels. Furthermore, many of these vessels do not have to face the limiting constraints of the Panama Canal. MSI and others in the shipping industry, expect that once the Panama Canal expansion is complete in 2014, deployment from Asia to the East Coast will begin to closely resemble the fleet mix calling at the West Coast, which often do not face the limitations of the Panama Canal.

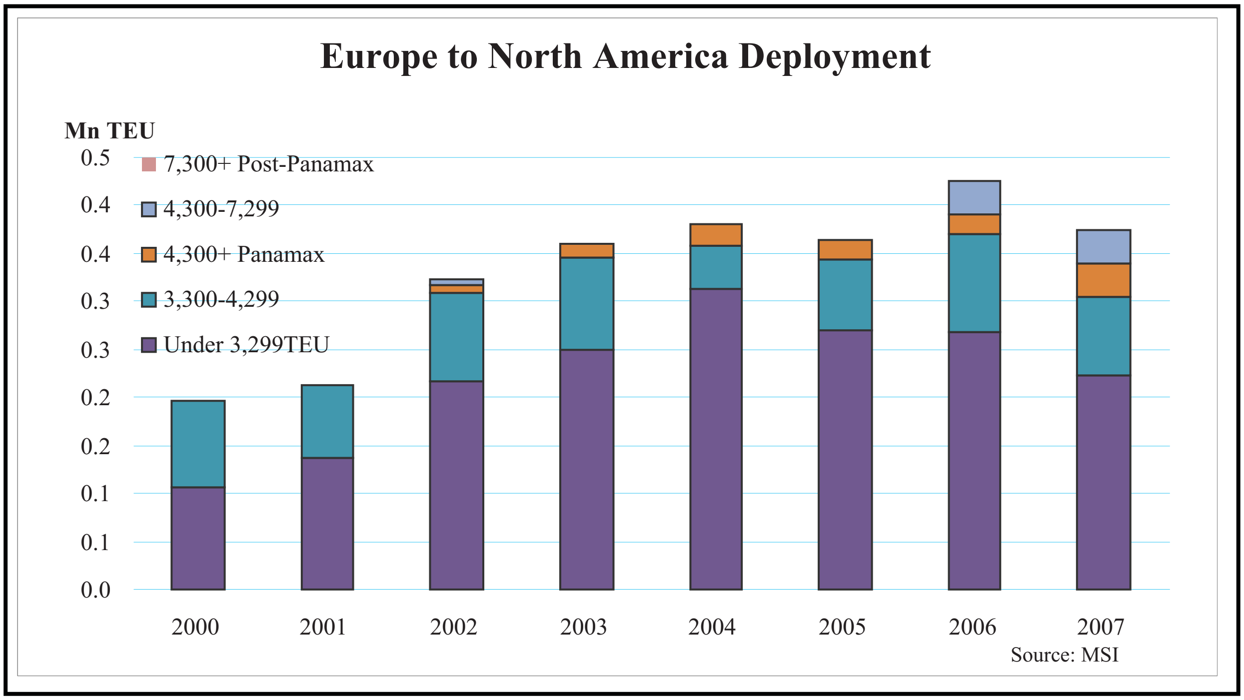


Figure 15: Europe to North America Deployment

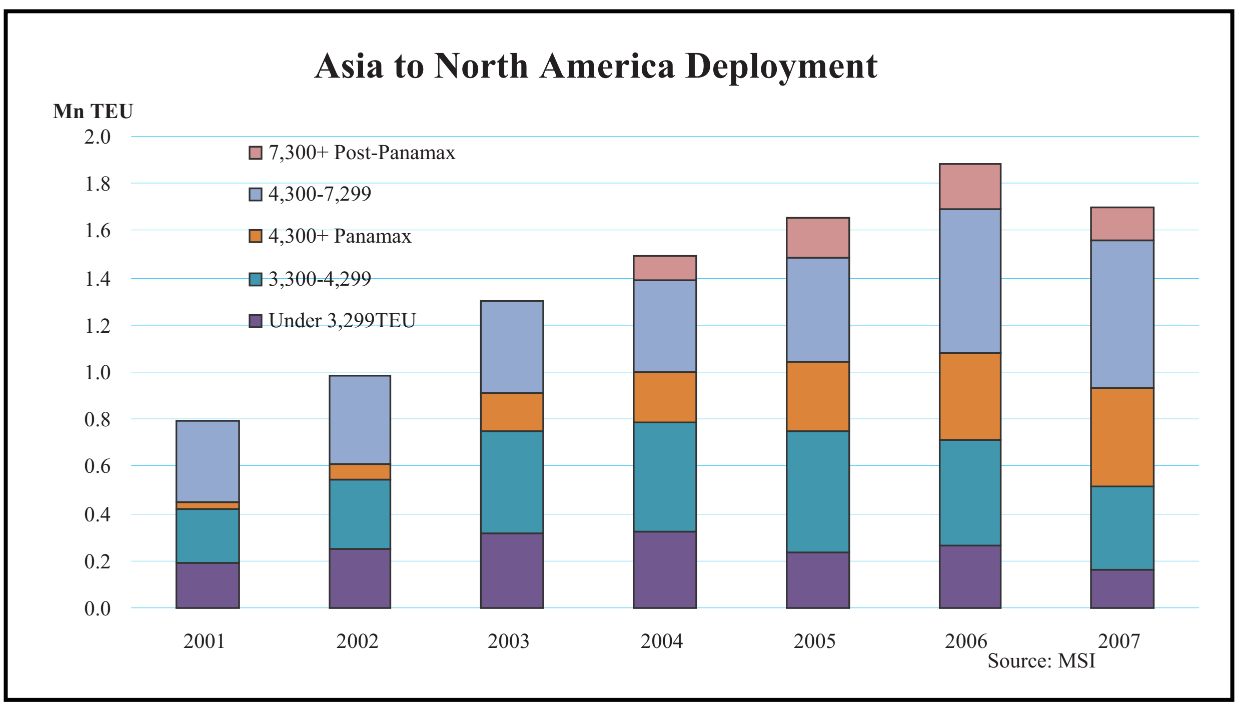


Figure 16: Asia to North America Deployment

2.6. Shipping Operations

Most container vessels calling at Savannah Harbor are part of scheduled liner services that call at multiple East Coast ports in conjunction with Savannah Harbor. Consequently, shippers engage in the practice of "just in time" deliveries of cargo and avoid schedule disruptions whenever possible. There are very few pilot operating restrictions for container traffic transiting the Savannah Harbor. With existing channel dimensions, any container vessel combination (e.g., 2 Post-Panamax or Post-Panamax/Panamax vessels) can pass in the straight channel segments. Container vessels can also pass empty liquid natural gas (LNG) vessels. However, when a loaded LNG vessel is entering the channel, the channel must be clear within 1.5 hours of sailing time or (90,000 feet of a nearby vessel).

2.6.1. Underkeel Clearance

The determination or measure of underkeel clearance (UKC) applied for economic studies is per directive of planning guidance which mandates evaluation of actual vessel operator and pilot practice subject to present conditions with adjustment as appropriate or practical for with-project conditions. Generally, practices for underkeel clearance are determined through review of written pilotage rules and guidelines, interviews with pilots and vessel operators, and analysis of actual past and present practices based on relevant data for vessel movements. With regard to evaluation of data concerning actual practices, typically underkeel clearance is benchmarked or measured relative to measured immersed vessel draft in the static condition (i.e., motionless at dockside). Evaluation of when the vessel is moved or initiates transit relative to immersed draft, tide stage and commensurate water depth allows reasonable evaluation of clearance throughout the course or time of vessel transit within a given waterway. When clearance is measured in the static condition explicit estimation or allowances for squat, trim, and sinkage are unnecessary as the pilot or vessel operator has already accounted for such influences within allowances observed.

Evaluation of all movements renders a distribution of clearance. Evaluation of minimized clearance (i.e., some level of clearance below which operators or pilots will not move a vessel due to concerns for insufficient safety) helps to quantify the window(s) of time each day a given vessel with a specified immersed draft can be moved relative to tide. Given the measurement of clearance in the described manner combined with input from pilots on their practices has revealed that underkeel clearance in Savannah is slightly more than many U.S. coastal ports.

General evaluation of practices for UKC at most coastal ports in the United States has revealed that clearances for all vessel types are often 2.0 to 3.0 feet measured in the static condition for many historical fleets having Panamax or lesser service with an average of approximately 2.7 feet for vessels of Handymax up through about Panamax size. Most coastal ports also have comparatively limited runs or distances between ocean approaches and dock facilities (i.e., less than 20 miles) so loss of tidal advantage during transit is less of a concern compared to Savannah.

Regarding vessel size under with-project conditions, it is understood that most post-Panamax vessels need more clearance depending on blockage factors, currents, and relative confinement of the waterway. As such, most post-Panamax containerships need about 3.3 to 3.6 feet for vessels with breadths of 120 to nearly 150 feet, lengths overall (LOA) approaching 1,150 feet and summer loadline drafts of 46 to approximately 49.0 feet.

At Savannah, the required clearance for vessel sizes of Panamax and up through the first generation of post-Panamax hulls (approximately 123 feet in breadth and up to approximately 1,120 feet in length) based on pilot guidance and actual experience is approximately 4.0 feet. The additional margin above 3.3 to 3.6 feet is due to time for the relatively long run upriver and downriver between the ocean approach and dock facilities (about 25 miles), currents and blockage, and the notable change in salinity and resulting influence for sinkage associated with the more prevalent freshwater environment upriver.

During the course of studies it was discussed with the pilots whether the larger classes of containerships (beyond first generation post-Panamax hulls) would require more clearance and it was indicated that larger hulls would likely require some increase in UKC to maintain an acceptable level of safety though how much had not been determined. Given experience with hydraulics of the waterway, past traffic, and the relative stability in clearance allowances based on size progression from Handymax and Panamax through first generation post-Panamax, it was asked if another quarter of a foot would be sufficient and the pilots indicated this to be acceptable for study purposes with the estimate rounded up to the nearest tenth of a foot (to 4.3 feet) as ultimately applied for analysis of second generation post-Panamax containerships.

As described, container vessels operate with various levels of underkeel clearance (Table 5) accounting for safety, trim, squat and freshwater sinkage. The largest Post-Panamax vessels require more than 4 feet. It is assumed that any Panamax vessel with a reported sailing draft of 38.0 feet or greater and any Post-Panamax vessel with a sailing draft of 37.7 feet or greater are effectively using tide to have sufficient water and clearance to sail at Savannah Harbor.

Table 5: Vessel Underkeel Clearance Requirements

Vessel Class	Total Underkeel Clearance (feet)
Handy Size	3.50
Sub-Panamax	3.75
Panamax	4.00
Post-Panamax Gen 1	4.20
Post-Panamax Gen 2	4.30

2.6.2. Tidal Range

The variability of sea level must be considered when determining the level of water needed for navigation (Figure 17). The Garden City Terminal enjoys a large tide range of 6.9 feet and a wide tide window. Over twenty percent of the Post-Panamax vessels currently calling at Savannah make use of the tide. Currently, Savannah has 100 percent access for vessels drafting

38 feet and less. As larger vessels with potentially deeper sailing drafts call at Savannah in larger numbers, the percent of reliable access depth and the width of the tide window will become a constraint on vessel operations. The following graph shows channel reliability at alternative project depths. The current project depth of 42 feet is 94 percent reliable. That is, it provides at least 42 feet of water 94 percent of the time. The existing condition provides 46 feet of water with 50 percent reliability and 50 feet of water with 5 percent reliability. A project depth of 46 feet would provide 46 feet of water with 94 percent reliability and 50 feet of water with 50 percent reliability. A 48-foot project would provide 50 feet of depth with 68 percent reliability.

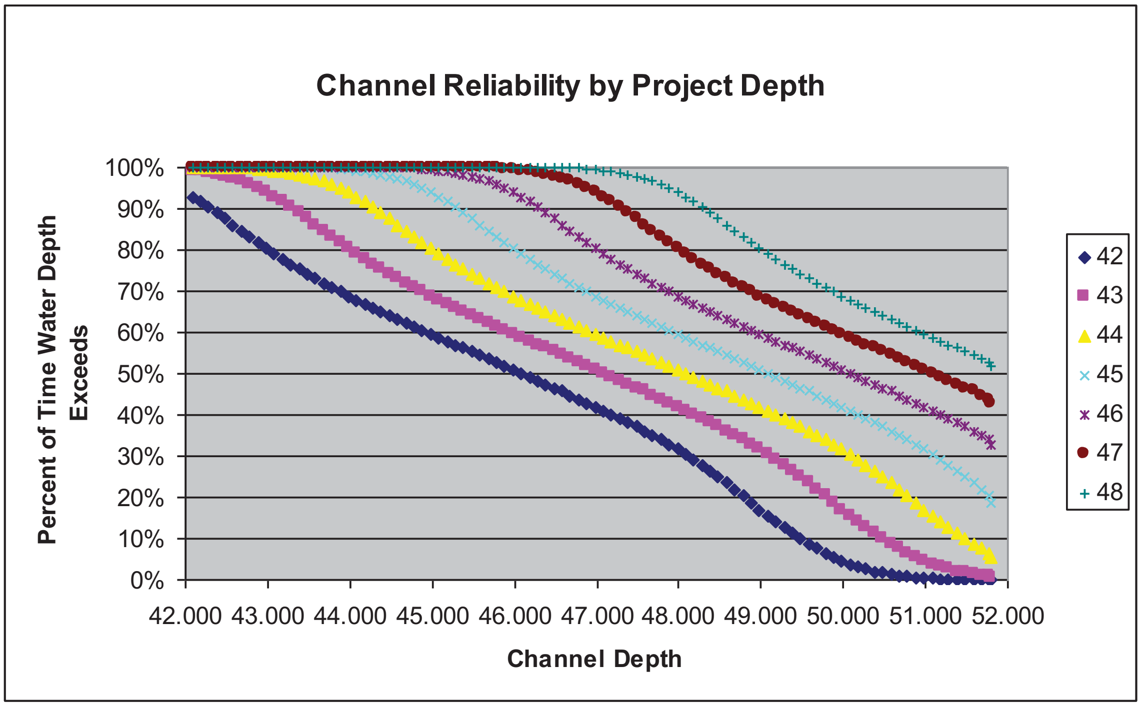


Figure 17: Channel Reliability by Project Depth

2.6.3. Sailing Practices

As shown in Figure 18, the vessel call frequency and sailing drafts grew significantly between 2001 and 2009. At the same time, the number and proportion of larger vessels, i.e., those with operating drafts greater than 35 feet grew at a rapid clip. In the figure below, the purple bars represent vessels drafting 33 to 35 feet, the green bars represent those with a sailing draft of 36 to 38 feet, the orange bars represent vessels sailing at drafts between 39 and 40 feet, and the blue bars indicate those vessels drafting 41 feet or more.

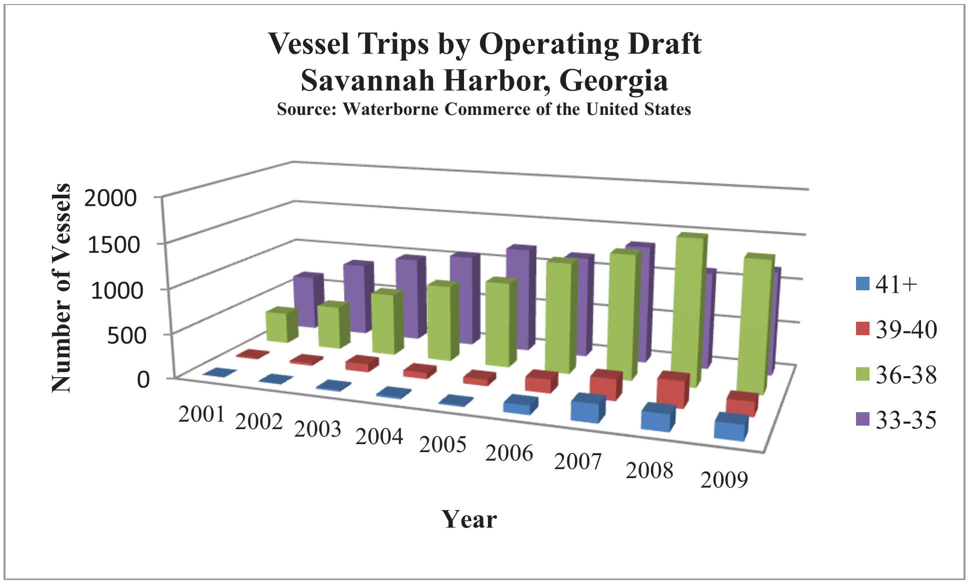


Figure 18: Historical Vessel Sailing Drafts - All Vessels

The recent trend has been even more dramatic. In 2007, there were a total of 2,892 Panamax and Post-Panamax vessel transits at the Garden City Terminal (i.e., 1,446 calls - inbound and outbound). Approximately 45 percent of these transits were on vessels drafting more than 35 feet. Of the total number of transits, approximately 69 percent were by services that transit the Panama Canal: ECUS AU PEN, FE ECUS EU PEN, FE ECUS MED PEN, FE (Panama) ECUS, RTW and AU ECUS EU PEN. As shown in Table 6 many of these vessels typically operated at drafts approaching the depth limitations of the Canal. This suggests that the current dimensions of the canal are a limiting factor when considering the depth at which vessels call on the Savannah Harbor and other U.S. East Coast ports. It should be noted that several of these services have stops at Manzanillo, Panama or Kingston, Jamaica prior to or after calling on Savannah Harbor. These stops are made in effort to redistribute or load more cargo after transiting the canal or to offload cargo before entering the canal[9]. The maximum Panama Canal draft is nearly identical to the existing project at Savannah Harbor with allowance for underkeel clearance. The maximum Canal transit is 39.5 feet Tropical Fresh Water, which is close to the maximum fresh water available at Savannah River upstream near Garden City terminal. Table 7 displays the number of Post-Panamax transits at Savannah in 2007. Since they bypassed the Panama Canal, only two services deployed Post-Panamax vessels, i.e., those on the Far East (Suez) ECUS and the ECUS EU GULF PEN routes.

[9] According to internet sources, Manzanillo, Panama has channel and pier depths of 46 feet. Kingston, Jamaica channel depth is 36-40 feet; however, dredging contracts have been issued to deepen Kingston's navigation channel to 51.5 feet.

Table 6: 2007 Panamax Vessel Transits – Sailing Draft

World Region Service	Vessel Sailing Draft									
	<36	37	38	39	40	41	42	43	44	TOTAL
ECUS Africa	0	0	0	0	0	0	0	0	0	0
AU ECUS EU PEN	14	0	0	0	0	0	0	0	0	14
ECUS WCSA-ECSA	59	7	6	2	2	1	0	0	0	77
ECUS EU GULF PEN	93	1	0	0	0	0	0	0	0	94
ECUS MED	221	20	24	8	7	14	23	1	0	318
FE ECUS EU PEN	82	44	68	49	48	19	3	0	0	313
FE ECUS MED PEN	29	28	41	24	17	23	44	1	0	207
FE (Panama) ECUS	841	241	220	53	27	16	3	0	0	1,401
FE (Suez) ECUS	132	29	32	12	9	5	9	2	0	230
RTW	23	15	17	4	0	0	0	0	0	59
TOTAL	**1,494**	**385**	**408**	**152**	**110**	**78**	**82**	**4**	**0**	**2,713**
PERCENT OF TOTAL	**55%**	**14%**	**15%**	**6%**	**4%**	**3%**	**3%**	**0%**	**0%**	**100%**

Table 7: 2007 Post-Panamax Vessel Transits - Sailing Draft

World Region Service	Vessel Sailing Draft									
	<36	37	38	39	40	41	42	43	44	TOTAL
ECUS Africa	0	0	0	0	0	0	0	0	0	0
AU ECUS EU PEN	0	0	0	0	0	0	0	0	0	0
ECUS WCSA-ECSA	0	0	0	0	0	0	0	0	0	0
ECUS EU GULF PEN	6	6	4	1	2	9	26	0	0	54
ECUS MED	0	0	0	0	0	0	0	0	0	0
FE ECUS EU PEN	0	0	0	0	0	0	0	0	0	0
FE ECUS MED PEN	0	0	0	0	0	0	0	0	0	0
FE (Panama) ECUS	0	0	0	0	0	0	0	0	0	0
FE (Suez) ECUS	96	14	11	1	1	1	1	0	0	125
RTW	0	0	0	0	0	0	0	0	0	0
TOTAL	**102**	**20**	**15**	**2**	**3**	**10**	**27**	**0**	**0**	**179**
PERCENT OF TOTAL	**57%**	**11%**	**8%**	**1%**	**2%**	**6%**	**15%**	**0%**	**0%**	**100%**

Table 8 provides a summary of the total Panamax and Post-Panamax transits by sailing draft. In comparison to other services, the FE (Panama) ECUS service utilized the channel more frequently at depths of 38 feet or more (319 total transits).

Table 8: 2007 Panamax and Post-Panamax Vessel Transits - Sailing Draft

World Region Service	Vessel Sailing Draft (feet)									
	<36	37	38	39	40	41	42	43	44	TOTAL
AU ECUS EU PEN	14	0	0	0	0	0	0	0	0	14
ECUS WCSA-ECSA	59	7	6	2	2	1	0	0	0	77
ECUS EU GULF PEN	99	7	4	1	2	9	26	0	0	148
ECUS MED	221	20	24	8	7	14	23	1	0	318
FE ECUS EU PEN	82	44	68	49	48	19	3	0	0	313
FE ECUS MED PEN	29	28	41	24	17	23	44	1	0	207
FE (Panama) ECUS	841	241	220	53	27	16	3	0	0	1401
FE (Suez) ECUS	228	43	43	13	10	6	10	2	0	355
RTW	23	15	17	4	0	0	0	0	0	59
TOTAL	**1,596**	**405**	**423**	**154**	**113**	**88**	**109**	**4**	**0**	**2,892**
PERCENT OF TOTAL	**55%**	**14%**	**15%**	**5%**	**4%**	**3%**	**4%**	**0%**	**0%**	**100%**

By 2008, the inadequate channel depth caused one carrier to temporarily dropping one of its Savannah legs from its rotation due to the increased demand for cargo moving from the United States to Europe. For many other carriers, it meant loading the vessels light. These types of disruptions can be very costly and illustrate the detrimental impacts that channel depth constraints can have on a port's operations. Moreover, these disruptions are likely to increase in the future as carriers shift to larger, more efficient vessels.

Total U.S. container traffic fell slightly in early 2008. With the dollar's decline in value, U.S. imports were down; however, exports increased. According to an article in Traffic World published on 23 June 2008, the ports of Savannah, Los Angeles, and Long Beach boasted huge first quarter increases in exports over the same timeframe in 2007 – up 25 percent, 23 percent and 19 percent, respectively. However, a big issue facing U.S. ports at that time was an inadequate supply of empty containers given the surge in exports relative to imports and the weak dollar. Savannah Harbor's exported cargo (e.g., frozen poultry, lumber, linerboard, kaolin clay, etc.) typically weighs more than its imported retail products. With one loaded export box taking the place of approximately 6 empty boxes, transport and repositioning of empty boxes to be returned for import products creates problems for ports experiencing channel depth constraints. This issue is currently compounded by the limitations not only imposed by channel depth at Savannah but also by the Panama Canal.

2.7 Design Vessel

The post-Panamax S-class containership, the *Susan Maersk*, was chosen as the design vessel for the Savannah Harbor Expansion Project in September 2001. The *Susan Maersk* is considered the best representation of the vessel of the future considering length, width and draft. Dimensions of the *Susan* or "S" Class Maersk are: 1,138 ft long, 140.4 ft wide, 47.6 ft design draft.

A preliminary channel layout for a 48 ft project depth channel was developed by Savannah District based on EM 1110-2-1613, *Hydraulic Design Guidance for Deep-Draft Navigation Projects*. This guidance states that "the design channel width for navigation projects with maximum currents greater than 3.0 knots should be developed with the assistance of a ship simulator design study". Savannah Harbor routinely experiences currents greater than 3.0 knots. Paragraph 7c of ER 1110-2-1403, *Studies by Coastal, Hydraulic, and Hydrologic Facilities and Others*, 1 January 1998 states that "Hydraulic design studies associated with the planning, design, construction, operation, and maintenance of navigation channels will include a ship or tow simulation investigation unless omission of such an investigation is approved by HQUSACE". Ship simulation was conducted by ERDC for the SHEP and details are documented in the reports titled: 1) *Navigation Study for Savannah Harbor Channel Improvements 2004* 2) *Savannah Harbor Simulations Study 2009* 3) *Savannah Harbor Entrance Channel Simulations 2010 Report* 4) V*ertical Ship Motion Study for Savannah, GA Entrance Channel 2010*. These documents are included in the Engineering Investigations Supplemental Materials and the Channel Design Drawings, including typical sections, are located in Attachment 1 to the Engineering Investigations Appendix.

3. FUTURE CONDITIONS - WITHOUT AND WITH PROJECT

3.1. Garden City Terminal

The GPA's capital improvement plan includes many equipment purchases and upgrades, transportation infrastructure improvements, and container storage area expansions. The plan states that the Garden City Terminal will have 33 ship-to-shore (STS) cranes operational by 2020. GPA plans to purchase 4 cranes in 2013, which will go into operation in 2015. At that time their two oldest cranes will be taken out of service. Therefore, Garden City Terminal will have 25 Post-Panamax and super Post-Panamax STS cranes in operation in 2015. GPA will purchase another 4 super Post-Panamax cranes in 2016 which will be put into service in 2018. This will be followed by purchase of another 4 super Post-Panamax cranes in 2018 which will be put into service in 2020.

The GPA is transitioning from using a combination of top-lifts and rubber-tired gantries (RTG's) to an all RTG operation in the container field. This will allow the port to move the stacks closer together thereby increasing capacity. The total RTG's that will be needed for the container field is 169. Garden City Terminal currently has 71 RTGs in operation with 25 on order. By 2012, they will have 96 RTG's in operation, by 2015 there will be 138, and by 2020 the GPA will have acquired the noted 169.

Planned infrastructure improvements include the construction of a new 8 lane gate on the west side of the terminal at Grange Road. This gate will be completed in 2015. Additionally, expansion of Gate 4 from 15 to 24 lanes will be completed in 2014.

Other improvements include additional rail and automation features to be added to the Chatham Yard ICTF between 2015 and 2019. Further, the Mason ICTF will be expanded in two phases. The first phase will be constructed in 2014 and second phase will be constructed in 2019.

Three areas will be specified at the rear of the container terminal for empties. Each will be complete with rail mounted gantry cranes. The stacks will be more densely configured to create more storage. Each segment of berth will have a designated area, which will be constructed in phases: Container Berth (CB) 7-9 in 2011; CB 4-6 in 2013; and CB 1-2 in 2015.

Personal parking will also be consolidated on the terminal to three separate, distinct areas. These will all be constructed by 2012. Finally, additional reefer racks will be added throughout the terminal. Construction of the racks will be completed in 2015. Each of these improvements will be accomplished within the existing footprint of the Garden City Terminal. It is important to note that all these investments are in the works regardless of whether or not federal navigation improvements are made[10].

[10] The assumptions pertaining to crane capability have been consistently applied to the without and with project conditions.

3.2. Operations

Nine of the top ten carriers at GPA (based upon TEUs for July 2004 through June 2005) were interviewed in May-June 2006 to update information that had previously been provided and confirm assumptions used in the benefits model. Several carriers have been contacted since 2006 for further confirmation. Each of the carriers interviewed were very supportive of channel modification at Savannah Harbor and stated that without a deeper channel, shipping inefficiencies would worsen given the growth in cargo and the increased vessel sizes (Attachment 1 – Carrier Letters). Under future conditions, the ECUS AU PEN, AU ECUS EU PEN and the ECUS WCSA-ECSA services will continue to operate as they have historically. Their respective vessel fleets are comprised of Handysize, Sub-Panamax and/or Panamax vessels which have utilized the existing channel at depths far less than what is available. Interviews with these carriers confirmed that their existing fleet will meet future service needs. As a result, these services were excluded from deepening benefits. However, the total number of calls for services was applied to the meeting area and tidal delay analysis.

In 2006, the Panama Canal Authority (ACP) announced plans for expansion of the Panama Canal. Their announcement came at the end of a multi-year comprehensive study and analysis by the ACP. Panama's president recommended Canal expansion to the National Assembly and it was passed during a national referendum before the Panamanian people at the end of 2006. Design plans include lock chambers of 1,400 feet long, 180 feet wide and 60 feet deep. Accordingly, the expansion will provide the capacity to accommodate vessels up to 1,200 feet long, 160 feet wide and 50 feet deep, or with a cargo volume up to 170,000 DWT and 12,000 TEU. The current project schedule has construction being completed in 2014; however, when interviewed regarding expansion plans, representatives of the ACP noted that the schedule was extremely conservative and construction would likely be completed in 2013, making the expanded canal available for use in 2014. The project is estimated to cost $5.25 billion and will be funded through a variety of sources including existing ACP resources, toll increases, and external sources (e.g., bond, series of bonds, or credit).

The Panama Canal's expansion will pave the way for larger containerships to be deployed to the U.S. East Coast. Presently, the Panama Canal has restricted container traffic shipments to vessels drafting less than 39.5 feet. This essentially prevented any Far East/East Coast US shipments from taking advantage of the economies of scale of loading larger ships to deeper sailing drafts. In the evaluation of without project conditions for the Savannah Harbor Expansion Project, the PDT assumed that the expansion of the Panama Canal would be completed by 2014 and that carriers would begin making adjustments to their fleet soon after, in 2015. This practice has been proven historically (i.e., maximizing vessel size through the canal) and was further supported by the carrier interviews. To back up this claim, the PDT examined new vessel orders and found them to be largely comprised of Post-Panamax vessels. Accordingly, it was assumed that by 2015 the following Panama Canal services will begin to shift their existing vessel fleet, from mainly Panamax vessels, to a mix of Panamax and Post-Panamax vessels: FE ECUS EU PEN, FE ECUS MED PEN, FE (Panama) ECUS, and RTW.

Construction of the Panama Canal expansion is underway and on schedule for opening on its 100th anniversary in 2014.

Both the ECUS MED and ECUS EU GULF PEN services will also begin to shift to a Panamax and Post-Panamax vessel fleet by 2015. These shifts reflect carrier trends to retire older, smaller vessels out of the existing fleet and upgrade with larger vessels which meet the needs of their operations.

The FE (Suez) ECUS service already has an existing fleet comprised of Panamax and Post-Panamax vessels and will continue to replace older, smaller vessels with larger vessels that meet their operational needs.

3.3. Commodity Forecast

3.3.1. Baseline

An essential step when evaluating navigation improvements is to analyze the types and volumes of cargo moving through the port. Detailed cargo history, provided that it is accurate and representative of trends, can offer key insights into a port's long term trade forecast (i.e., the estimated cargo volume upon which future vessel calls are based). Under future with project conditions, the same volume of cargo is assumed to move through Savannah Harbor; however, a deepening project will allow shippers to load their vessels more efficiently or take advantage of larger vessels[11]. This is the main driver of the NED benefits.

In an effort to reduce the impact that any single year or potential anomalies in trade volume may have on the long term forecast, six years of data was utilized in establishing the baseline for the commodity forecast. Data started with 2005 and extended through calendar year 2010. As such, the historical record captured both prosperous port years as well as the economic downturn which occurred in the 2008-2009 timeframe.

Since there was fluctuation in the historical record, a regression analysis of the data was performed to establish the new 2010 starting point for the import and export forecasts (Table 9 and Table 10). It was used for all services with the following exceptions. Over the past 6 years, the ECUS Africa service has called on Savannah Harbor somewhat intermittently. Accordingly, trade on this world region route was averaged and used as its baseline. For the FE ECUS EU PEN, 2010 trade levels actually dropped below that experienced in 2009 and on the FE (Panama) ECUS service, 2010 trade grew only slightly above that of the prior year. Since historically there had been fairly significant growth on these routes, the regression analysis resulted in 2010 estimates that were higher than that realized during the 2010 calendar year. As such, trade on these routes was capped at that which actually occurred in 2010.

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[11] In 2006, a multiport study of various hinterland origins and destinations and various Mid-Atlantic and South Atlantic ports was performed for the SHEP. This study found that with harbor expansion, there would be no substantial changes in origins or destinations of imports and exports to key US markets served by Savannah. Based upon this prior study, a basic assumption in this study effort is that there would not be substantial changes in the hinterland service area and thus no change in overall cargo volume without and with channel improvements at Savannah Harbor.

3.3.1.1. Containerized Imports

Table 9 illustrates historical containerized imports (metric tons) moved through the Savannah Harbor between 2005 and 2010. The table includes the 2010 baseline as determined through methods mentioned in the preceding paragraph.

As shown in Table 9, containerized imports grew from 5.3 million metric tons in 2005 to 7.3 million metric tons in 2010. Trade with Northeast Asia dominated Savannah's import market, followed by Southeast Asia and Northern Europe, respectively. Furniture has been the top import commodity since 2005 (in terms of TEU volume)[12]. Following furniture, Savannah's leading commodities include retail consumer goods; machinery, appliances and electronics; hardware and housewares; food; automotive; apparel; toys; minerals; and rugs, sheets, towels, and blankets. For the new 2010 baseline (last column in the table), imports from all world regions were estimated to total approximately 6.8 million tons. This import trade volume represents the baseline from which forecast commerce was then calculated.

Table 9: Historical Containerized Imports (metric tons)

World Region	World Region Service	2005	2006	2007	2008	2009	2010	2010 Baseline
		(metric tons)						
Africa	ECUS AFRICA	16,857	1,406	-	-	-	-	3,044
Oceania	ECUS AU PEN	45,366	4,548	-	-	137,660	105,682	62,554
Oceania	AU ECUS EU PEN	4,953	175,523	310,910	426,778	66,878	84,803	228,208
ECSA/WCSA	ECUS WCSA-ECSA	131,720	226,075	379,351	364,290	233,909	270,875	318,004
N Europe	ECUS EU GULF PEN	19,546	114,500	145,366	55,173	148,582	464,815	317,883
MED	ECUS MED	281,827	310,637	324,140	200,750	263,771	303,187	269,491
NE Asia	FE ECUS EU PEN	800,447	733,373	767,942	1,309,812	1,033,754	700,211	700,211
NE Asia	FE ECUS MED PEN	613,603	598,308	516,637	557,397	427,819	544,873	484,938
NE Asia	FE (Panama) ECUS	2,608,255	2,723,926	3,266,646	2,837,208	2,247,652	2,277,866	2,277,866
NE Asia	RTW	185,344	233,667	139,354	-	315,103	793,893	502,729
SE Asia	FE (Suez) ECUS	593,443	676,684	1,309,872	1,511,875	1,133,068	1,737,311	1,681,126
Total		**5,301,363**	**5,798,647**	**7,160,219**	**7,263,284**	**6,008,197**	**7,283,516**	**6,846,053**

Source: Georgia Ports Authority

3.3.1.2. Containerized Exports

Containerized exports grew from 7.4 million metric tons in 2005 to 11.8 million metric tons by 2010 (Table 10). As with imports, containerized trade with Northeast Asia dominated the Savannah Harbor's export market with just under one half of Savannah's exports destined for this world region. The new 2010 baseline totaled approximately 11.3 million metric tons. Savannah is one of the few ports in the U.S. in which its exports (expressed in metric tons) have historically exceeded its imports. However, since the cargo weight of exports are considerably higher than that of imports, the number of Savannah's TEU imports has exceeded the number of TEU exports.

From 2005 to 2010, wood pulp was the leading export commodity shipped from Savannah. In 2005 and 2006, clay was the next largest commodity group; however, by 2007, TEU volume for

[12] Georgia Ports Authority website –www.gaports.com

clay had fallen, placing it in fourth after paper and paperboard and food, a trend which continued through 2010. Other leading commodity exports during the 2005 to 2010 timeframe consisted of: retail consumer goods; chemicals; machinery, appliances and electronics; resins and rubber; automotive; fabrics including raw cotton; and other commodities.

Table 10: Historical Containerized Exports (metric tons)

World Region	World Region Service	2005	2006	2007	2008	2009	2010	2010 Baseline
		(metric tons)						
Africa	ECUS Africa	44,216	7,297	-	-	-	-	8,586
Oceania	ECUS AU PEN	112,681	12,018	-	-	392,018	438,094	253,538
Oceania	AU ECUS EU PEN	2,849	209,631	436,210	632,382	115,576	162,630	414,047
ECSA/WCSA	ECUS WCSA-ECSA	191,533	231,437	422,925	414,506	493,857	829,084	713,885
N Europe	ECUS EU GULF PEN	23,321	188,786	263,287	80,319	586,370	802,164	674,327
MED	ECUS MED	587,291	659,080	930,679	787,731	1,241,854	1,272,171	1,272,404
NE Asia	FE ECUS EU PEN	1,037,912	1,122,315	941,704	1,860,804	1,383,200	871,756	871,756
NE Asia	FE ECUS MED PEN	652,515	629,196	617,640	859,299	692,778	875,470	831,662
NE Asia	FE (Panama) ECUS	3,908,159	4,038,746	4,560,683	4,154,449	3,680,376	3,167,768	3,167,768
NE Asia	RTW	158,402	139,044	169,682	-	345,634	709,391	482,623
SE Asia	FE (Suez) ECUS	702,381	828,944	1,834,138	2,261,260	1,784,586	2,672,025	2,619,289
Total		**7,421,260**	**8,066,495**	**10,176,949**	**11,050,751**	**10,716,249**	**11,800,552**	**11,309,885**

Source: Georgia Ports Authority

Table 11 summarizes the 2010 baseline by world region and service route for both imports and exports.

Table 11: Commodity Forecast Baseline

World Region	World Region Service	Imports	Exports
		(metric tons)	
Africa	ECUS Africa	3,044	8,586
Oceania	ECUS AU PEN	62,554	253,538
Oceania	AU ECUS EU PEN	228,208	414,047
ECSA/WCSA	ECUS WCSA-ECSA	318,004	713,885
N Europe	ECUS EU GULF PEN	317,883	674,327
MED	ECUS MED	269,491	1,272,404
NE Asia	FE ECUS EU PEN	700,211	871,756
NE Asia	FE ECUS MED PEN	484,938	831,662
NE Asia	FE (Panama) ECUS	2,277,866	3,167,768
NE Asia	RTW	502,729	482,623
SE Asia	FE (Suez) ECUS	1,681,126	2,619,289
Total		**6,846,053**	**11,309,885**

3.3.2. Trade Forecast

3.3.2.1. Background

The draft Economics Appendix made available for public review in December 2010 utilized a commodity forecast baseline established by determining the weighted average of the historical data (2005-2007). However, during the draft SHEP report public review and comment period, the analysis was updated to extend the historical record to include calendar years 2008-2010. As such, the preceding document section described the evaluation performed to establish the current baseline. The text describes this updated analysis and does not include a description of the prior methodology as the process was revised due to inclusion of a longer period of record for baseline estimation. Document sections that follow include a description of the methodologies utilized to develop the import and export long term trade forecasts for the December 2010 draft report and for this document. Initial sections describe the original analysis as this background is required to understand the relationship and application of the new forecast.

There are several ways to develop a long term trade forecast for a navigation study: the analyst develops the forecast using readily available indices, forecasts are obtained from a reputable firm specializing in the type of forecast required; and/or a combination of the aforementioned methods. The latter method was employed for establishing a commodity forecast for the SHEP.

First, Corps analysts established the forecast baseline from historical trade information. Next, a long term trade forecast for the North Atlantic Region, South Atlantic Region, and the Savannah Harbor was obtained from IHS Global Insight (GI). This first GI forecast was obtained in 2008. In lieu of strictly using the GI trade forecast, the Corps decided that using the Corps' baseline established through empirical data provided by the GPA and applying growth rates calculated from the GI forecast would result in a forecast with less uncertainty than that which is typically present in long term forecasts. The following paragraphs describe the process utilized for developing the long term containerized trade forecasts for Savannah Harbor.

3.3.2.2. IHS Global Insight

In November 2008, containerized trade forecasts were obtained from GI. GI is a well-known consulting firm that provides comprehensive economic and financial information on countries, regions and industries. When making global trade forecasts, GI employs sophisticated macroeconomic models which contain all commodities that have physical volume. The commodities are then grouped into 77 categories derived from the International Standard Industrial Classification. GI tracks 54 major countries then groups the remaining world trade partners into 16 regions according to their geographic location. Accordingly, they forecast 77 commodities among 70 countries or regions and include 270,000 trade flows.

3.3.2.2.1. GI Trade Data Sources. GI obtains trade history data from several sources: Statistics Canada, OECD International Trade by Commodity Statistics, U.S. Customs, and IMF Direction of Trade. The primary data source is the United Nations, information from which is processed and published by Statistics Canada. Custom agencies in United Nations member countries are the origin of these export and import trade statistics.

U.S. Customs data and IMF Direction of Trade data are used to calibrate and supplement that obtained from Statistics Canada. Data is then recorded in different classification systems and units of measurement, converted into thousands of current U.S. dollars and converted into 1997 real commodity value.

GI world trade forecast models utilize its comprehensive macroeconomic history and forecast databases and in particular, data on population, GDP, GDP deflators, industrial output, foreign exchange rates, and export prices by country. These data are used as exogenous variables in the trade forecast models.

3.3.2.2.2. GI Model Structure. The basic structure of the nonlinear, multi-stage switch trade flow models assumes that a country's import from another country '…are driven by the importing country's demand forces, enabled by the exporting country's capacity of exporting (supplying) the commodity, and affected by the exporting country's export price and importing country's import cost for the commodity. A country will import more of a commodity if its demand for this commodity increases. At the same time, the country will import more of this commodity from a particular exporting country if that exporter's capacity to export this commodity is larger and its export price for this commodity is lower than in other exporting countries.' Accordingly, importers purchasing based on delivered cost will import more when the cost decreases. Note that distance between countries is an important factor when determining the scale of trade between countries; therefore, distance as a constant is embedded in GI models to help determine the scale of the base.

3.3.2.2.3. GI Trade Forecasts – 2008. As mentioned, the GI trade forecast for Savannah included 70 countries (e.g., Italy) or region (e.g., Western Africa). To utilize the data for the SHEP, the locations were first grouped by the world region where they are geographically located. The world regions which trade with Savannah Harbor were used for this grouping: Africa, East Coast South America, Mediterranean, Northeast Asia, Europe, Oceania, Southeast Asia and West Coast South America. Table 12 lists the world region applied to the SHEP study and the respective country or blocks of countries that fall within region.

Table 12: Trade Partner and World Region Groupings

SHEP World Region	Global Insight Trade Locations
Africa	Kenya; Other East Africa; Other North Africa; Other Southern Africa; South Africa; Western Africa
East Coast South America	Argentina; Brazil; Caribbean Basin; Mexico; Other East Coast of S. America; Venezuela
Mediterranean	Israel; CIS West; France; Greece; Italy; Other Mediterranean Region; Portugal; Spain; Turkey
Northeast Asia	Taiwan; Hong Kong; China; Japan; Other Asia; South Korea; Canada[13]; Caribbean Basin; Central America
Europe	Baltics; Belgium; Denmark; Finland; Ireland; Norway; Sweden; United Kingdom; Bulgaria; Czech Republic; Hungary; Poland; Romania; Russia; Austria; Germany; Netherlands; Other Europe; Slovak Republic; Switzerland
Oceania	Australia; New Zealand
Southeast Asia	CIS Southeast; Indonesia; Malaysia; Other Asia; Philippines; Singapore; Thailand; Vietnam; Cambodia; India; Other Indian Subcontinent; Egypt; Saudi Arabia; United Arab Emirates; Other Arabian Gulf; Pakistan
West Coast South America	Chile; Colombia; Other West Coast of S. America; Peru

[13] Canada was included in the Northeast Asia world trade region because Savannah Harbor container services calling on Canada originate in Northeast Asia.

3.3.2.2.3.1. GI's Containerized Imports. The GI database obtained for SHEP contained over 181,000 rows of cargo-related data; the following table was developed to summarize pertinent information regarding Savannah's import commodities and associated trade partners. Savannah's top ten import trade regions are identified in Table 13. The first column provides the commodity's country or region of origin (World Trade Service (WTS) Region). The second column (Commodity Description) provides a description of the commodity being imported. For each country or trade region, the top five commodities (in terms of total tonnage) are then displayed, along with their corresponding tonnage and TEU volume. The fifth and sixth columns (Tons-Sum and TEUs-Sum, respectively) identify total tons and TEUs for those leading commodities. The final columns identify total tons and TEUs for all commodities imported from the trade region. For example, imports from China dominated the Savannah Harbor import trade market. The leading commodity group imported from China was furniture and fixtures, accounting for 541,146 tons (123,482 TEUs). The top five commodities imported from China totaled 1.621 million tons (300,340 TEUs) or about 50 percent of total containerized goods imported from China (3.256 million tons or 555,352 TEUs). In 2007, the top ten import trade partners (shown below) accounted for over 71 percent of total Savannah Harbor containerized imports. It should be noted that total tonnages as reported from GI's database vary slightly from the figures reported by the GPA.

Table 13: GI Reported Containerized Commodities - 2007 Imports

WTS Region	Commodity Description	Tons-Sum	TEUs-Sum	Tons-Sum	TEUs-Sum	Total Tons	Total TEUs
		Top five commodities				*All commodities*	
China	Furniture and Fixtures	541,146	123,482				
	Other Manufacturing, nec.	393,846	96,990				
	Metal Products	315,461	36,406				
	Non-Metallic Products, nec.	186,399	16,838				
	Plastic Products, nec.	184,569	26,625	1,621,420	300,340	3,255,760	555,352
Brazil	Non-Metallic Products, nec.	179,507	16,215				
	Textiles	56,575	8,076				
	Iron and Steel	46,702	3,327				
	Cork and Wood	33,951	4,137				
	Wood Products	32,633	3,831	349,368	35,586	447,027	50,061
Italy	Non-Ferrous Metals	639	67				
	Grain	152	18				
	Inorganic Chemicals	1,561	174				
	Iron and Steel	5,943	470				
	Leather and Products	17	3	8,311	732	373,750	41,287
Japan	Iron and Steel	72,887	5,193				
	Machinery and Equipment, nec.	38,689	5,576				
	Special Industrial Machinery	36,172	4,808				
	Parts of Motor Vehicles	31,071	4,315				
	Rubber Products	23,182	4,900	202,002	24,793	335,920	41,108
Germany	Electrical Appliances and Housewares	36,095	6,016				
	Wood Products	35,722	4,659				
	Synthetic Resins	19,205	2,381				
	Petroleum Refineries	18,509	1,699				
	Iron and Steel	16,673	1,320	126,203	16,075	298,840	37,434
Thailand	Natural Rubber	63,111	6,126				
	Wearing Apparel	23,001	4,863				
	Non-Metallic Products, nec.	20,786	1,878				
	Iron and Steel	15,484	1,103				
	Furniture and Fixtures	12,993	2,746	135,374	16,717	265,660	34,695
South Korea	Synthetic Resins	107,348	13,253				
	Special Industrial Machinery	28,200	3,748				
	Textiles	23,459	3,349				
	Metal Products	19,741	2,278				
	Rubber Products	16,915	3,575	195,663	26,203	262,924	34,275
India	Textiles	39,023	5,570				
	Non-Metallic Products, nec.	32,222	2,911				
	Iron and Steel	28,053	1,999				
	Agricultural Machinery	17,298	2,302				
	Wearing Apparel	10,201	2,157	126,797	14,939	196,385	24,350
Taiwan	Metal Products	41,703	4,813				
	Synthetic Resins	23,862	2,946				
	Rubber Products	20,189	4,267				
	Iron and Steel	14,603	1,040				
	Furniture and Fixtures	11,403	2,410	111,760	15,477	192,973	26,932
Indonesia	Natural Rubber	49,570	4,812				
	Wearing Apparel	22,478	4,753				
	Furniture and Fixtures	20,822	4,401				
	Other Food	13,060	1,295				
	Wood Products	10,147	1,191	116,078	16,452	187,081	26,455
SUBTOTAL TOP TEN WORLD REGIONS				**3,251,578**	**493,454**	**5,816,318**	**871,950**
TOTAL IMPORTS						**8,149,133**	**1,159,226**

Source: IHS Global Insight

Table 14 displays GI's imports forecast by world region for selected years occurring over the forecast period. The world region aggregate was developed by combining the tonnages from each country or region identified in Table 12. GI's forecast indicates that Northeast Asia will remain the major source of Savannah Harbor imports, growing to 12.5 million metric tons by 2028. Similarly, Southeast Asia will continue to follow this world region in terms of total import volume (metric tons).

Table 14: GI's Savannah Harbor Containerized Trade Forecast – Imports (metric tons)

SHEP World Region	2015	2020	2025	2026	2027	2028
	(metric tons)					
Africa	30,729	35,155	42,498	43,417	45,647	46,661
ECSA[14]	734,114	881,747	1,109,270	1,145,539	1,207,584	1,252,345
Mediterranean	1,237,171	1,444,858	1,732,464	1,769,677	1,842,109	1,896,237
Northeast Asia	6,460,416	8,271,695	10,761,609	11,229,087	11,934,618	12,466,810
Europe	911,307	1,076,378	1,284,336	1,319,408	1,376,644	1,416,841
Oceania	216,917	259,923	319,663	320,238	332,902	344,123
Southeast Asia	1,740,846	2,125,556	2,678,188	2,805,041	2,954,348	3,092,080
WCSA[15]	210,839	242,562	304,335	310,491	325,478	337,886
Total Imports	**11,542,339**	**14,337,875**	**18,232,363**	**18,942,898**	**20,019,330**	**20,852,983**

Source: IHS Global Insight

The import forecast rate of change between each year is shown in Table 15. The rate of change was calculated from the annual commodity forecast developed by GI. The data illustrates that economic conditions are cyclical and that the fastest growth will take place in developing countries.

Table 15: GI's Savannah Harbor Containerized Import Metric Tons - Rate of Change

SHEP World Region	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Africa	-1%	5%	9%	-1%	4%	3%	10%	-2%	-4%	13%	2%	5%	4%	3%	0%	7%	5%	2%	5%	2%
ECSA	3%	6%	7%	4%	4%	6%	11%	-1%	-1%	11%	4%	5%	7%	2%	4%	4%	6%	3%	5%	4%
Mediterranean	3%	4%	5%	4%	4%	5%	8%	0%	1%	7%	4%	4%	6%	1%	4%	2%	5%	2%	4%	3%
NE Asia	8%	4%	7%	7%	7%	5%	9%	3%	3%	8%	6%	5%	7%	4%	5%	5%	6%	4%	6%	4%
Europe	4%	2%	4%	5%	4%	3%	5%	2%	3%	5%	4%	4%	5%	2%	4%	3%	4%	3%	4%	3%
Oceania	-1%	7%	7%	2%	4%	4%	5%	3%	3%	5%	3%	4%	4%	3%	5%	2%	7%	0%	4%	3%
SE Asia	7%	0%	4%	6%	5%	5%	9%	1%	1%	8%	5%	5%	6%	4%	4%	5%	5%	5%	5%	5%
WCSA	6%	2%	4%	6%	2%	8%	14%	-4%	-2%	12%	4%	5%	8%	0%	5%	3%	6%	2%	5%	4%

Source: IHS Global Insight

3.3.2.2.3.2. GI's Containerized Exports. China led world trade regions as the top recipient of Savannah Harbor exports in 2007 (approximately 2.2 million metric tons or 230,308 TEUs) (Table 16). Leading exports to this trade region were comprised of meat/dairy/fish requiring refrigeration (44,168 TEUs), followed by stone, clay and other crude minerals (23,575 TEUs), pulp (26,855 TEUs), scrap (19,581 TEUs), and synthetic resins (29,592 TEUs). The top ten export trade partners accounted for nearly 64 percent of containerized export trade tonnage in 2007 (62 percent of export TEUs).

[14] East Coast South America
[15] West Coast South America

Table 16: GI Reported Containerized Commodities - 2007 Exports

WTS Region	Commodity Description	Tons-Sum	TEUs-Sum	Tons-Sum	TEUs-Sum	Total Tons	Total TEUs
		Top Five Commodities				*All Commodities*	
China	Meat/Dairy/Fish requiring Refrigeration	387,524	44,168				
	Stone, Clay and Other Crude Minerals	316,983	23,575				
	Pulp	283,064	26,855				
	Scrap	239,761	19,581				
	Synthetic Resins	207,418	29,592	1,434,749	143,770	2,160,922	230,308
Japan	Stone, Clay and Other Crude Minerals	1,164,794	86,628				
	Pulp	171,522	16,272				
	Oil Seeds	51,609	3,590				
	Synthetic Resins	37,145	5,299				
	Organic Chemicals	33,980	2,735	1,459,050	114,525	1,580,172	129,342
Turkey	Cotton	233,642	29,619				
	Paper and Paperboard and Products	176,460	18,455				
	Pulp	102,753	7,936				
	Meat/Dairy/Fish requiring Refrigeration	26,830	3,058				
	Stone, Clay and Other Crude Minerals	10,452	777	550,137	59,845	594,060	64,851
Taiwan	Stone, Clay and Other Crude Minerals	249,205	18,534				
	Paper and Paperboard and Products	33,684	4,323				
	Pulp	29,540	2,802				
	Waste Paper	27,973	3,540				
	Synthetic Resins	27,506	3,924	367,908	33,123	471,868	44,460
South Korea	Stone, Clay and Other Crude Minerals	146,084	10,864				
	Synthetic Resins	78,280	11,168				
	Pulp	46,004	4,364				
	Waste Paper	27,466	3,476				
	Paper and Paperboard and Products	20,418	2,620	318,251	32,493	469,304	48,493
Italy	Pulp	114,276	9,806				
	Paper and Paperboard and Products	75,317	8,752				
	Stone, Clay and Other Crude Minerals	58,466	4,348				
	Waste Paper	25,346	3,564				
	Synthetic Resins	6,698	934	280,102	27,405	325,986	32,985
Australia	Beverages	29,479	2,631				
	Paper and Paperboard and Products	27,729	3,558				
	Rubber Products	25,834	5,461				
	Synthetic Resins	20,789	2,966				
	Organic Chemicals	19,236	1,549	123,066	16,164	265,363	34,809
Brazil	Pulp	86,740	8,229				
	Synthetic Resins	42,678	6,089				
	Stone, Clay and Other Crude Minerals	21,747	1,617				
	Paper and Paperboard and Products	19,443	2,495				
	Organic Chemicals	11,990	965	182,598	19,396	235,358	25,581
Indonesia	Cotton	53,940	5,868				
	Stone, Clay and Other Crude Minerals	40,746	3,030				
	Synthetic Resins	28,165	4,018				
	Animal Feed	25,131	2,652				
	Pulp	19,930	1,891	167,912	17,459	217,929	23,410
United Kingdom	Pulp	64,016	5,493				
	Paper and Paperboard and Products	48,112	5,032				
	Stone, Clay and Other Crude Minerals	21,108	1,570				
	Chemical Products, nec.	16,168	1,804				
	Textiles	7,888	1,472	157,292	15,371	214,647	22,033
SUBTOTAL TOP TEN WORLD REGIONS				**5,041,065**	**479,551**	**6,535,610**	**656,272**
TOTAL EXPORTS						**10,261,389**	**1,066,812**

Source: IHS Global Insight

Northeast Asia is forecast to receive nearly half of the exports shipped from Savannah Harbor (Table 17). Exports to this region were forecast to total 8.2 million metric tons in 2015, growing to 11.2 million metric tons by 2028. Southeast Asia and the Mediterranean are forecast to continue their relative importance in the overall commodity forecast, receiving approximately 3.3 million and 2.6 million metric tons, respectively, by 2028.

Table 17: GI's Savannah Harbor Containerized Trade Forecast – Exports (metric tons)

SHEP World Region	2015	2020	2025	2026	2027	2028
	(metric tons)					
Africa	191,997	224,634	253,220	261,651	268,826	275,806
ECSA	634,830	765,961	884,058	918,848	948,735	978,433
Mediterranean	1,995,832	2,262,243	2,470,427	2,540,529	2,595,571	2,645,603
Northeast Asia	8,229,779	9,222,053	10,431,617	10,619,153	10,886,165	11,150,995
Northern Europe	1,377,283	1,594,610	1,758,081	1,807,166	1,848,966	1,887,184
Oceania	466,315	551,593	635,367	654,845	674,433	693,632
Southeast Asia	2,311,052	2,692,970	3,022,767	3,109,093	3,196,722	3,266,979
WCSA	280,886	328,916	369,946	382,784	393,326	403,415
Total Exports	**15,487,974**	**17,642,979**	**19,825,482**	**20,294,069**	**20,812,744**	**21,302,048**

Source: IHS Global Insight

The export forecast rates of change are shown in the following table. As illustrated, the rate of change varies by trade region and year. The volatility of exports appears to be less pronounced than that of the forecasted imports. Also, the rate of change in exports is lower than that of imports.

Table 18: GI's Savannah Harbor Containerized Export Metric Tons - Rate of Change

SHEP World Region	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Africa	3%	5%	5%	2%	5%	2%	2%	4%	4%	2%	2%	4%	3%	2%	2%	3%	2%	3%	3%	3%
ECSA	2%	7%	6%	3%	6%	2%	3%	5%	5%	2%	3%	4%	4%	3%	2%	4%	2%	4%	3%	3%
Mediterranean	2%	5%	4%	2%	4%	2%	2%	3%	3%	2%	1%	3%	3%	1%	1%	2%	1%	3%	2%	2%
Northeast Asia	8%	2%	3%	5%	3%	3%	7%	0%	3%	4%	3%	3%	5%	0%	2%	2%	3%	2%	3%	2%
Europe	1%	7%	5%	1%	5%	0%	0%	5%	6%	-1%	2%	3%	2%	2%	1%	3%	1%	3%	2%	2%
Oceania	4%	3%	5%	2%	5%	2%	2%	4%	5%	2%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Southeast Asia	2%	7%	5%	3%	5%	2%	2%	4%	4%	2%	2%	3%	3%	2%	2%	3%	2%	3%	3%	2%
WCSA	1%	6%	5%	2%	5%	2%	2%	4%	4%	2%	2%	4%	3%	2%	2%	3%	2%	3%	3%	3%

Source: IHS Global Insight

The rates of change developed from the 2008 Global Insight forecast over the period 2010 to 2028 were used to populate the long term forecasts for both imports and exports (i.e., applying the rates of change to the baseline). Since Global Insight forecasts were only developed through 2028, data for the last five years of the forecast, for each respective service, were averaged to establish the growth rate that would be used beyond 2028.

3.3.2.2.4. GI Trade Forecasts – 2010. As previously mentioned, a new South Atlantic containerized trade forecast was obtained from GI during the fall of 2010. Since the GI forecast was for the South Atlantic region only, the relationship between the region and Savannah Harbor trade had to be established. Accordingly, it was assumed that for each forecast year, each respective Savannah world region route would comprise the same share of total South Atlantic commerce as had been assumed for each route in the 2008 forecast. For example, if in the original GI forecast, the ECUS MED world region route comprised 4% of imports forecast for the South Atlantic region in forecast year 2016, then in year 2016 of the updated forecast, it was assumed that the ECUS MED service would again comprise 4% of total South Atlantic imports. The same assumption was made for exports based upon each respective route's percent share, by year, in the original export forecast. The following table illustrates the South Atlantic 2010 forecasts obtained from GI and the import and export forecasts estimated for Savannah Harbor utilizing the methodology described above.

Table 19: 2010 Containerized Imports and Exports Forecasts

	2010	2015	2017	2020	2025	2028
	(metric tons)					
Savannah Harbor Imports:						
ECUS Africa	18,064	23,988	22,547	27,658	33,996	37,790
ECUS AU PEN	6,217	8,050	8,482	9,722	12,157	13,250
AU ECUS EU PEN	124,544	161,280	169,916	194,774	243,556	265,448
ECUS WCSA-ECSA	519,133	737,651	717,136	884,562	1,130,811	1,287,894
ECUS EU GULF PEN	553,022	711,386	743,771	846,851	1,027,402	1,147,469
ECUS MED	716,602	965,763	974,452	1,136,756	1,385,880	1,535,721
FE ECUS EU PEN	588,462	861,347	912,171	1,111,511	1,470,334	1,724,456
FE ECUS MED PEN	431,702	631,893	669,178	815,416	1,078,652	1,265,079
FE (Panama) ECUS	2,289,050	3,350,541	3,548,238	4,323,648	5,719,427	6,707,935
RTW	136,201	199,361	211,124	257,261	340,312	399,129
FE (Suez) ECUS	983,708	1,358,943	1,386,919	1,672,302	2,142,410	2,504,209
Total Savannah Imports	**6,366,706**	**9,010,203**	**9,363,934**	**11,280,462**	**14,584,936**	**16,888,380**
Total South Atlantic Imports	**19,846,974**	**26,359,171**	**28,796,971**	**33,225,999**	**41,497,960**	**47,204,816**
	2010	**2015**	**2017**	**2020**	**2025**	**2028**
Savannah Harbor Exports:						
ECUS Africa	141,113	184,584	199,719	216,962	250,359	277,784
ECUS AU PEN	29,120	38,087	41,521	45,261	53,369	59,351
AU ECUS EU PEN	313,643	410,225	447,215	487,494	574,821	639,256
ECUS WCSA-ECSA	662,632	880,363	963,482	1,057,485	1,239,839	1,391,761
ECUS EU GULF PEN	1,065,229	1,324,110	1,469,546	1,540,151	1,738,221	1,900,722
ECUS MED	1,502,017	1,918,777	2,033,789	2,184,982	2,442,520	2,664,581
FE ECUS EU PEN	963,731	1,322,089	1,348,630	1,488,360	1,723,414	1,876,678
FE ECUS MED PEN	596,281	818,005	834,426	920,881	1,066,313	1,161,141
FE (Panama) ECUS	4,057,216	5,565,871	5,677,605	6,265,859	7,255,411	7,900,639
RTW	150,223	206,083	210,220	232,001	268,640	292,530
FE (Suez) ECUS	1,702,678	2,221,828	2,409,426	2,600,999	2,988,620	3,290,415
Total Savannah Exports	**11,183,884**	**14,890,022**	**15,635,579**	**17,040,435**	**19,601,526**	**21,454,860**
Total South Atlantic Exports	**22,513,608**	**29,902,537**	**31,873,150**	**35,137,493**	**41,134,349**	**45,109,858**

Next, the rate of change between forecast years was determined for each world region route for both imports and exports (Table 20).

Table 20: Savannah Harbor Containerized Imports and Exports- Rate of Change (2010 update)

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Rate of Change - Imports																		
Africa	11%	1%	4%	4%	10%	-2%	-4%	13%	3%	6%	5%	3%	1%	7%	5%	3%	6%	3%
Oceania	9%	3%	4%	5%	6%	3%	3%	5%	4%	5%	5%	3%	5%	3%	8%	1%	4%	4%
ECSA&WCSA	8%	6%	4%	7%	12%	-2%	-1%	11%	5%	6%	8%	2%	5%	4%	6%	3%	6%	4%
Europe	5%	6%	5%	4%	6%	2%	2%	5%	4%	4%	5%	2%	4%	4%	5%	3%	5%	3%
Mediterranean	7%	6%	4%	5%	8%	0%	1%	7%	4%	5%	6%	2%	5%	3%	5%	3%	4%	3%
Northeast Asia	8%	9%	8%	6%	9%	3%	3%	8%	6%	6%	7%	4%	5%	5%	7%	5%	7%	5%
Southeast Asia	6%	7%	6%	5%	9%	1%	1%	8%	5%	6%	6%	4%	5%	5%	5%	5%	6%	5%
Rate of Change - Exports																		
Africa	9%	5%	7%	4%	3%	4%	4%	2%	2%	4%	4%	2%	2%	4%	2%	4%	3%	3%
Oceania	9%	5%	7%	4%	3%	4%	5%	2%	3%	4%	3%	3%	3%	4%	3%	4%	4%	3%
ECSA&WCSA	9%	5%	8%	4%	3%	5%	5%	2%	3%	4%	4%	3%	3%	4%	3%	4%	4%	4%
Europe	8%	4%	8%	2%	1%	5%	6%	0%	2%	3%	2%	3%	1%	4%	2%	3%	3%	3%
Mediterranean	8%	5%	7%	3%	3%	3%	3%	2%	2%	4%	3%	2%	2%	3%	2%	3%	3%	3%
Northeast Asia	6%	7%	6%	5%	8%	-1%	3%	4%	3%	3%	6%	0%	3%	3%	4%	2%	3%	3%
Southeast Asia	8%	5%	7%	4%	3%	4%	4%	2%	3%	3%	3%	3%	2%	4%	3%	3%	3%	3%

3.3.3. SHEP Long Term Trade Forecast – Metric Tons

3.3.3.1. SHEP Containerized Import Trade – Metric Tons

The respective world region route import rates of change were applied to the 2010 baseline (Table 11) to estimate the SHEP long term import trade forecast. Note, port capacity was forecast to be reached in 2030; therefore, the long term forecast was constrained at that point. As shown in Table 21, it is forecast that Northeast Asian trade will continue to dominate Savannah Harbor imports over the forecast period, growing from approximately 4 million metric tons in the 2010 baseline to just under 13 million metric tons in 2030. Imports from Southeast Asia will likewise grow from 1.7 million metric tons to 4.7 million metric tons in 2030.

Table 21: SHEP Containerized Trade Forecast - Import Metric Tons

World Region	World Region Service	2010 Baseline	2015	2017	2020	2025	2030
Africa	ECUS Africa	3,044	4,042	3,799	4,660	5,728	6,972
Oceania	ECUS AU PEN	62,554	81,005	85,343	97,828	122,330	143,580
Oceania	AU ECUS EU PEN	228,208	295,519	311,345	356,893	446,277	523,802
ECSA&WCS	ECUS WCSA-ECSA	318,004	451,862	439,295	541,855	692,699	865,792
N Europe	ECUS EU GULF PEN	317,883	408,912	427,527	486,779	590,561	712,110
MED	ECUS MED	269,491	363,192	366,460	427,497	521,184	620,286
NE Asia	FE ECUS EU PEN	700,211	1,024,916	1,085,391	1,322,585	1,749,548	2,291,526
NE Asia	FE ECUS MED PEN	484,938	709,816	751,698	915,970	1,211,667	1,587,020
NE Asia	FE (Panama) ECUS	2,277,866	3,334,170	3,530,901	4,302,522	5,691,481	7,454,598
NE Asia	RTW	502,729	735,857	779,276	949,575	1,256,120	1,645,244
SE Asia	FE (Suez) ECUS	1,681,126	2,322,391	2,370,200	2,857,911	3,661,311	4,748,979
TOTAL IMPORTS		**6,846,053**	**9,731,681**	**10,151,235**	**12,264,074**	**15,948,907**	**20,599,909**

3.3.3.2. SHEP Containerized Export Trade – Metric Tons

The export tons forecast is shown in Table 22. Exports to Northeast Asia are forecast to grow from 5.4 million metric tons in 2010 to 11.1 million metric tons in 2030. As with imports, the FE (Panama) ECUS world region service is forecast to lead all other Savannah Harbor services in total trade volume.

Table 22: SHEP Containerized Trade Forecast - Export Metric Tons

World Region	World Region Service	2010 Baseline	2015	2017	2020	2025	2030
Africa	ECUS Africa	8,586	11,231	12,151	13,200	15,232	18,054
Oceania	ECUS AU PEN	253,538	331,611	361,513	394,073	464,665	554,566
Oceania	AU ECUS EU PEN	414,047	541,547	590,379	643,551	758,833	905,648
ECSA&WCS	ECUS WCSA-ECSA	713,885	948,457	1,038,005	1,139,279	1,335,738	1,612,215
N Europe	ECUS EU GULF PEN	674,327	838,207	930,273	974,968	1,100,353	1,276,659
MED	ECUS MED	1,272,404	1,625,454	1,722,883	1,850,964	2,069,132	2,380,355
NE Asia	FE ECUS EU PEN	871,756	1,195,915	1,219,922	1,346,318	1,558,939	1,799,535
NE Asia	FE ECUS MED PEN	831,662	1,140,912	1,163,815	1,284,397	1,487,239	1,716,770
NE Asia	FE (Panama) ECUS	3,167,768	4,345,685	4,432,924	4,892,217	5,664,833	6,539,108
NE Asia	RTW	482,623	662,084	675,375	745,351	863,062	996,262
SE Asia	FE (Suez) ECUS	2,619,289	3,417,916	3,706,505	4,001,209	4,597,500	5,389,006
TOTAL EXPORTS		**11,309,885**	**15,059,018**	**15,853,747**	**17,285,528**	**19,915,526**	**23,188,179**

3.3.3.3. SHEP Containerized Trade – TEU Equivalents

Since cargo movements and container vessel capacities are often expressed in TEUs and not tons, the PDT converted these tonnage forecasts into their TEU equivalents. As previously mentioned, the weight of containers can vary widely by trade route and by haul direction. For example, major products destined for the Mediterranean are heavier pulp and kaolin clay whereas imports from the Far East involve lighter manufactured goods and textiles. For each service, the historical average weight per TEU was calculated and used for this conversion. Table 23 presents the average weights, which were derived from historical data provided by the GPA (2005-2010).

The historical percent of empty containers was applied as a means of forecasting the number of empty containers moving through Savannah Harbor. It is important to account for empty containers when determining future loading practices and draft requirements. According to a Drewry Consulting report, if Savannah is among the final port calls in a service’s rotation, vessels may be carrying a larger proportion of empties inbound, but have fewer empties for exports as vessels load up for the return voyage. The FE ECUS EU PEN shows percentages of 47% and 16%, for empty imports and exports, respectively. The average weight of an empty container is approximately 2 metric tons and was factored into the vessel loading and estimated draft requirements.

Table 23: Average Container Box Weight and Empty Percentages by Service

Route	Metric Tons per TEU

	Imports	Exports	Percent Empties to Loaded Imports	Percent Empties to Loaded Exports
ECUS AU PEN	10.98	8.67	62.11%	3.94%
AU ECUS EU PEN	10.73	8.94	62.11%	3.94%
ECUS WCSA-ECSA	10.10	10.14	76.62%	14.84%
ECUS EU GULF PEN	8.77	9.64	34.55%	7.31%
ECUS MED	9.67	10.56	81.64%	8.11%
FE ECUS EU PEN	7.12	9.83	15.31%	13.01%
FE ECUS MED PEN	6.37	10.54	7.61%	29.74%
FE (Panama) ECUS	5.78	10.84	7.88%	56.53%
RTW	6.65	10.58	9.62%	99.45%
FE (Suez) ECUS	7.76	10.08	18.28%	27.18%

Table 24 shows the resulting TEU forecast for Savannah Harbor.

Table 24: TEU Forecast for Selected Years

Year	Loaded Export TEUs	Loaded Import TEUs	Total Loaded TEUs	Total Exports (loaded and empty)	Total Imports (loaded and empty)	Total TEUs
2005	701,857	803,693	1,505,550	989,295	864,668	1,853,963
2006	774,056	862,763	1,636,819	1,186,311	953,299	2,139,610
2007	998,516	1,070,018	2,068,534	1,397,723	1,196,065	2,593,788
2008	1,079,421	1,072,075	2,151,496	1,386,329	1,224,470	2,610,799
2009	1,024,279	883,013	1,907,292	1,243,873	1,109,222	2,353,095
2010	1,101,836	983,434	2,085,270	1,446,361	1,158,350	2,604,711
2017	1,544,968	1,470,981	3,015,949	2,028,305	1,722,487	3,750,792
2020	1,683,960	1,780,666	3,464,626	2,214,037	2,082,314	4,296,351
2025	1,940,501	2,324,044	4,264,545	2,552,885	2,710,699	5,263,584
2030	2,260,378	3,013,260	5,273,638	2,970,714	3,503,311	6,474,025

3.4. Vessel Fleet

3.4.1. World Fleet

In addition to a commodity forecast, an accurate forecast of the future fleet is required when evaluating navigation projects. To develop projections of the future fleet calling at Savannah, the study team obtained a World Fleet forecast of containerships developed by Maritime Strategies Inc, (MSI) and a general methodology to forecast total capacity calling at Savannah Harbor and a breakdown of the capacity calling into containership size and TEU classes. The general methodology developed by MSI was then modified and linked to the commodity forecast developed by the PDT.

By combining information from the commodity forecast with MSI's forecasted fleet *capacity*, the PDT was able to allocate a number of Post-Panamax (PPX), Panamax (PX) and Sub-Panamax vessels calls (SPX) to Savannah's fleet. The number of transits, particularly those made by larger vessels, is a key variable in calculating the transportation costs.

MSI's forecasting technique begins with performing a detailed review of the current world fleet and how it is deployed on the trade routes of the world. Forecasting of the world fleet was made possible through MSI's proprietary Container Shipping Planning Service (CSPS) model, which applies historical and forecasted time series data from 1980 to 2030 for:

- Macroeconomic and trade variables including:
    - Annual GDP growth rates by region
    - Industrial Production
    - Population Growth
    - Inflation and Interest Rates
    - Currency Exchange
- Global container trade and movements in TEU lifts by region including:
    - Primary Lifts
    - Transshipment Lifts
    - Loaded/Empty Lifts

- Sector-specific fleet dynamics including:
    - Fleet nominal capacity by vessel size and age
    - Contracting, order book, deliveries, cancellations, slippage and scrapping
    - Container fleet by size

- Sector-specific supply/demand balances

- Time charter rates and vessel operating costs

- Freight rates including:
    - Headhaul rates
    - Backhaul rates

- New building, second-hand (by age) and scrap prices for standard sizes

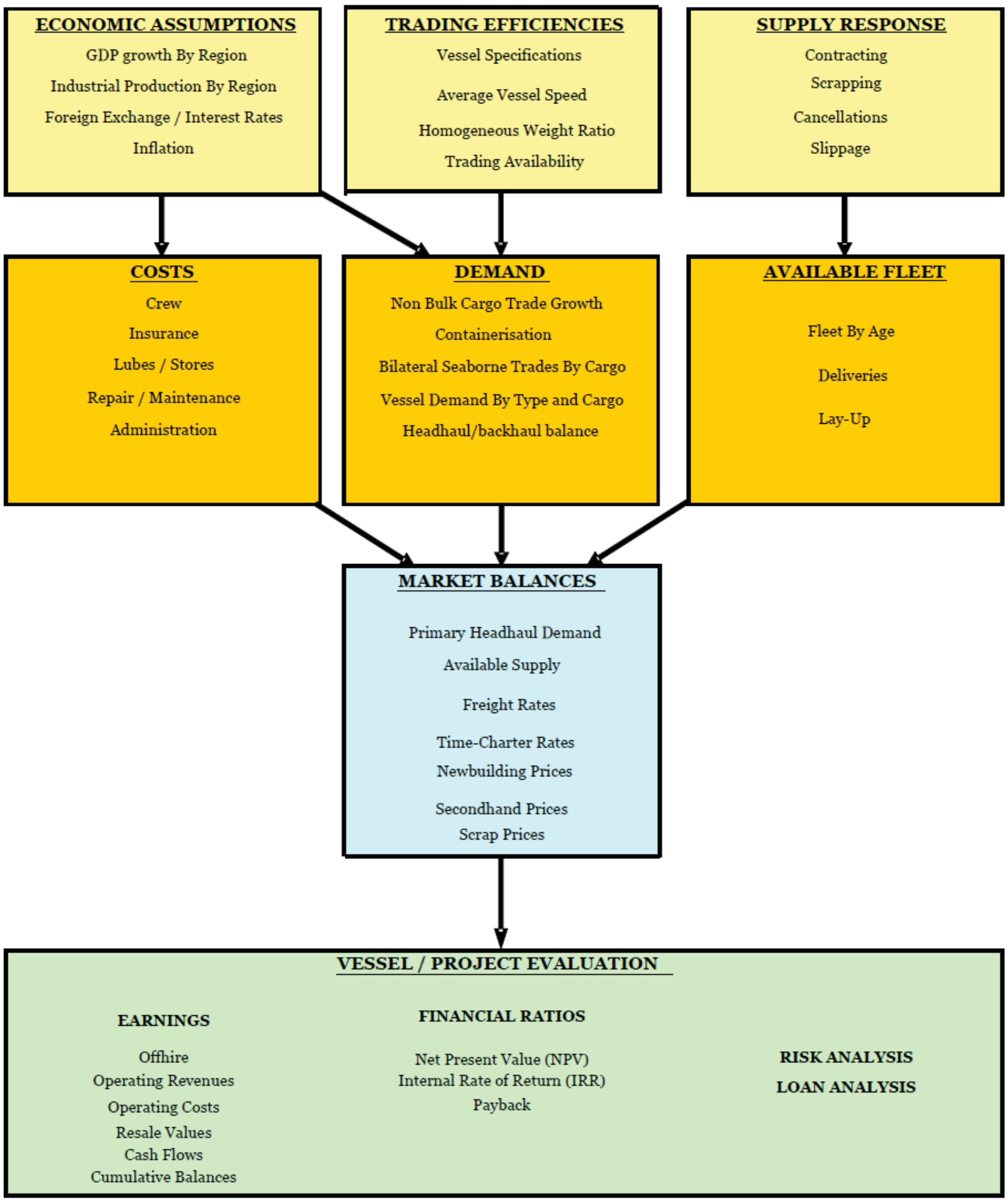


Figure 19: Schematic Overview of the CSPS Model

Data sources for the CSPS model include:

- Macroeconomics: Oxford Economics, leading investment banks;
- World Trade: UNCTAD, Drewry Shipping Consultants, Containerization International;
- Fleet Supply: LR-Fairplay, Worldyards, Howe Robinson; and
- Charter Rates, Freight Rates and Vessel Prices: Drewry Shipping Consultants, Howe Robinson, Clarksons and various contacts at shipping lines.

When evaluating data on vessel composition, vessel age, and container markets, MSI then considered the “order book” to estimate new deliveries to the fleet into the future. Vessel scrapping is accounted for based on historical scrapping rates by vessel class and age. Containerships, particularly the largest ones, are relatively new, so widespread scrapping is not expected to take place until well in the future. Likewise, when economies are strong, vessel owners are more likely to hold onto their existing vessels (or build new ones) and less likely to scrap them. The forecasted world fleet provides a frame of reference to verify the validity of the Savannah fleet forecast and is provided as background information.

There is a strong relationship between the economic condition of a port and its total nominal vessel capacity. As an economy grows, exports from the port often increase (from the increased output) or demand for imports increase (from increased consumer purchasing power). Vessels respond accordingly to satisfy this increased level of trade. MSI examined the empirical relationship between the nominal capacity of the fleet calling Savannah and the historical tonnages moving through Savannah and found the variables to be highly correlated, having an R-squared value of 0.967. This statistical relationship was then applied to the forecasted tonnages in order to estimate future nominal TEU vessel capacity calling Savannah. As the tonnage in Savannah grows over time, the nominal TEU vessel capacity, i.e., the total number of available container slots, grows. Capacity is adjusted by operators to match demand. Once the forecasted nominal TEU vessel capacity at Savannah was determined, the future containers were allocated to various vessel classes (PPX, PX and SPX). The allocation to vessel classes was based on MSI’s examination of historical utilization of Panamax vessels, current trends in vessel design and orders and the world wide redeployment of vessels affected by the expansion of the Panama Canal.

3.4.1.1. World Fleet End of Period 2010

A projection of the World Fleet provides the necessary background for evaluating the future fleet forecast for Savannah. The starting point for this projection was the world fleet by vessel class as extracted by MSI from the Lloyds Register (LR)-Fairplay database for the year 2010[16]. The 2010 fleet is shown by TEU bands in the following table.

Table 25: World Feet by TEU Band - 2010

TEU Band	Count
0.1 k to 1.3k TEU	1,622
1.3 k to 2.9 k TEU	1,437
2.9 k to 3.9 k TEU	356
3.9 k to 5.2 k TEU	703
5.2 k to 7.6 k TEU	454
7.6 k to 12 k TEU	256
12 k TEU +	36
Total	**4,864**

[16] LR Fairplay maintains the largest maritime databases covering ships, movements, owners and managers, maritime companies, ports & terminals.

3.4.1.2. The “Order Book”

The “order book” is short hand for the vessels that have been contracted to be built by ship builders around the world. Vessel deliveries are primarily a function of new building contracting. These contracts can take several forms. There are firm contracts for vessels that are under construction. There are also option contracts that secure the capacity of the ship yard but do not require the buyer to exercise the option to construct the vessel. Some contracts have financing that is committed, others do not. There are several other nuances and the challenge is to translate the number of vessels and types of contracts into future vessels coming on line at a specific time. This requires knowledge and expertise of this market and this process. Forecasts must be made for future contracts, vessel scrapping and vessel deliveries[17]. Over the long term, new building investment tends to equate to the incremental demand for new tonnages to meet cargo growth or replacement of aged or obsolete ships.

A historical breakdown of contracting by TEU band was accomplished using a widely recognized fleet database provided by LR-Fairplay. The breakdown was expressed as a percentage of ships for each TEU band size band. These percentages were used as a baseline for forecasting future contracting. The following figure depicts historical contracting by TEU bands for fully cellular *container (FCC) vessels*[18].

[17] Factors such as economic conditions, price of steel, exchange rates, and a host of others can influence the forecasted world fleet.
[18] The term, “fully cellular” refers to vessels that are purpose built to carry ocean containers. The containers are generally stored in vertical slots on the ship.

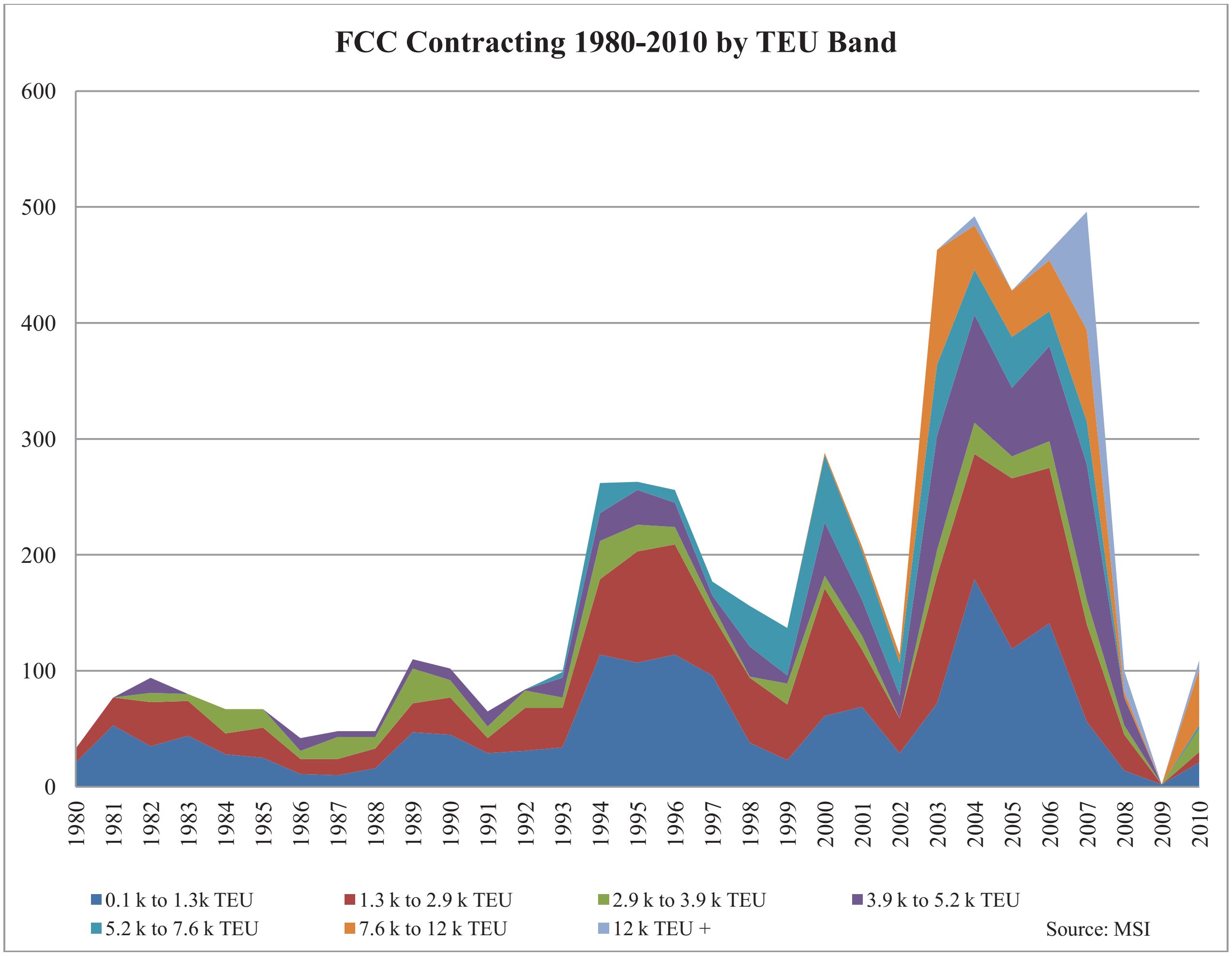


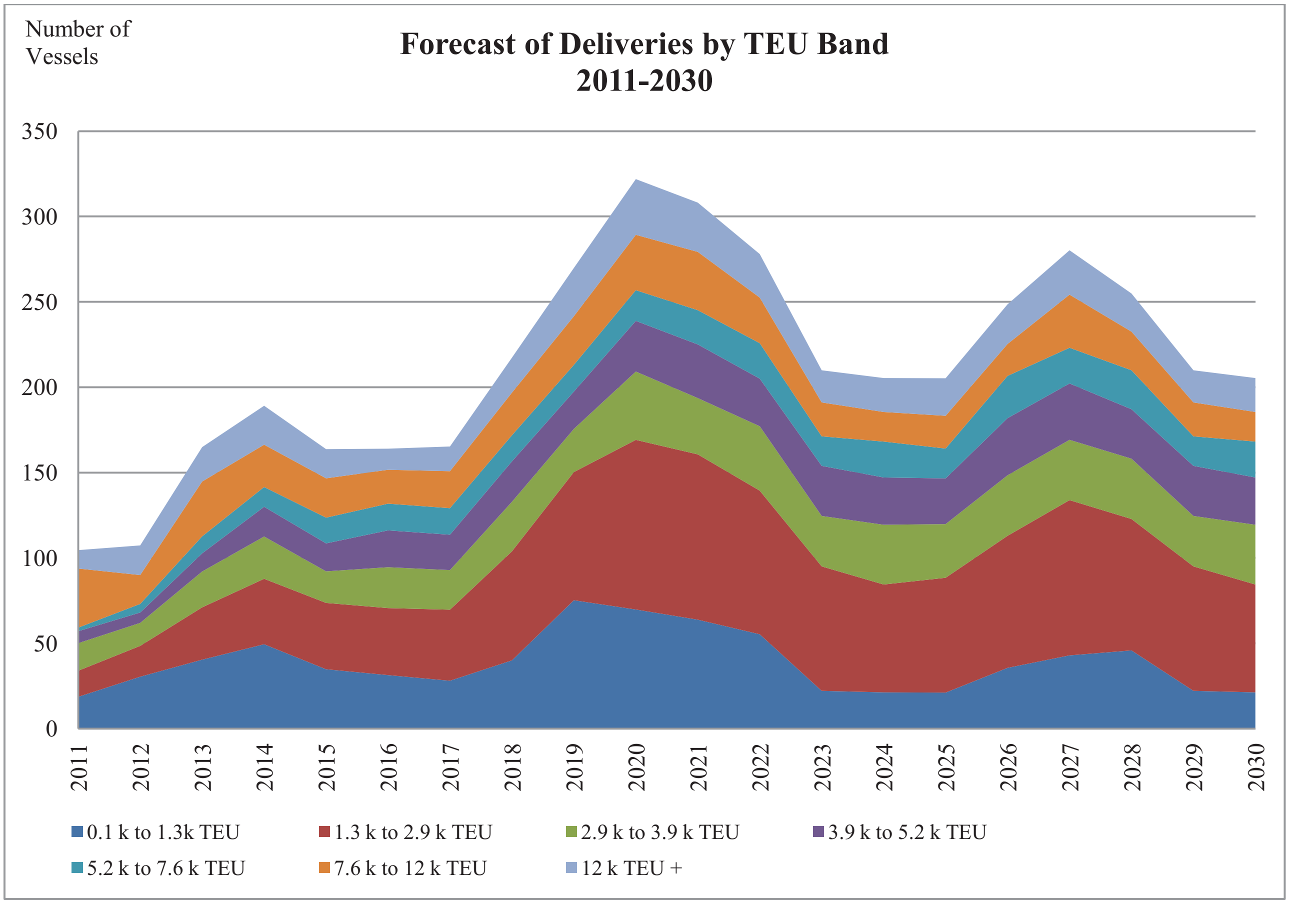
Figure 20: FCC Contracting 1980-2010

The steep economic contraction that occurred in 2009 led to an almost zero ordering that year. Cancellations and slippage produced a considerable change to the order book profile and the pace of deliveries to the fleet. Going forward MSI perceives there to be an over-supply in containerships. This had material impacts on both expected deliveries and scrapping of vessels in the future.

3.4.1.3. Deliveries and Scrapping Assumptions

The perceived over-supply in containerships is expected to bear heavily on investors' sentiment, resulting in deliveries falling from historical expectations. Conversely, the deletions are expected to occur in excess of historical expectations. Long-term, container fleet growth expectations have been significantly reduced. However, it must be stressed that the ship classes that have suffered most from the fleet re-orientation were those with a capacity below 5.2 k TEU.

MSI modeled the relationship between annual contracting and annual deliveries. They estimated this relationship by TEU band. The forecast of deliveries by TEU band are depicted in the following figure. The number of new vessel deliveries is expected to increase each year until a 2020 peak, and then taper off to the end of the forecast period, with an upward bounce in 2027.



Source: MSI

Figure 21: Forecast of Deliveries by TEU Band 2011-2030

An estimate of annual scrapping was accomplished by examining the LR-Fairplay database for the world fleet each year and noting which vessels drop out each year. This was done by TEU band and transformed into a scrapping profile for each band. **Figure 22** shows the estimated scrapping by TEU band class. The surge in vessel scrapping in 2009 (210 vessels) was not expected to be repeated until 2022, when many vessels reach the end of their useful lives.

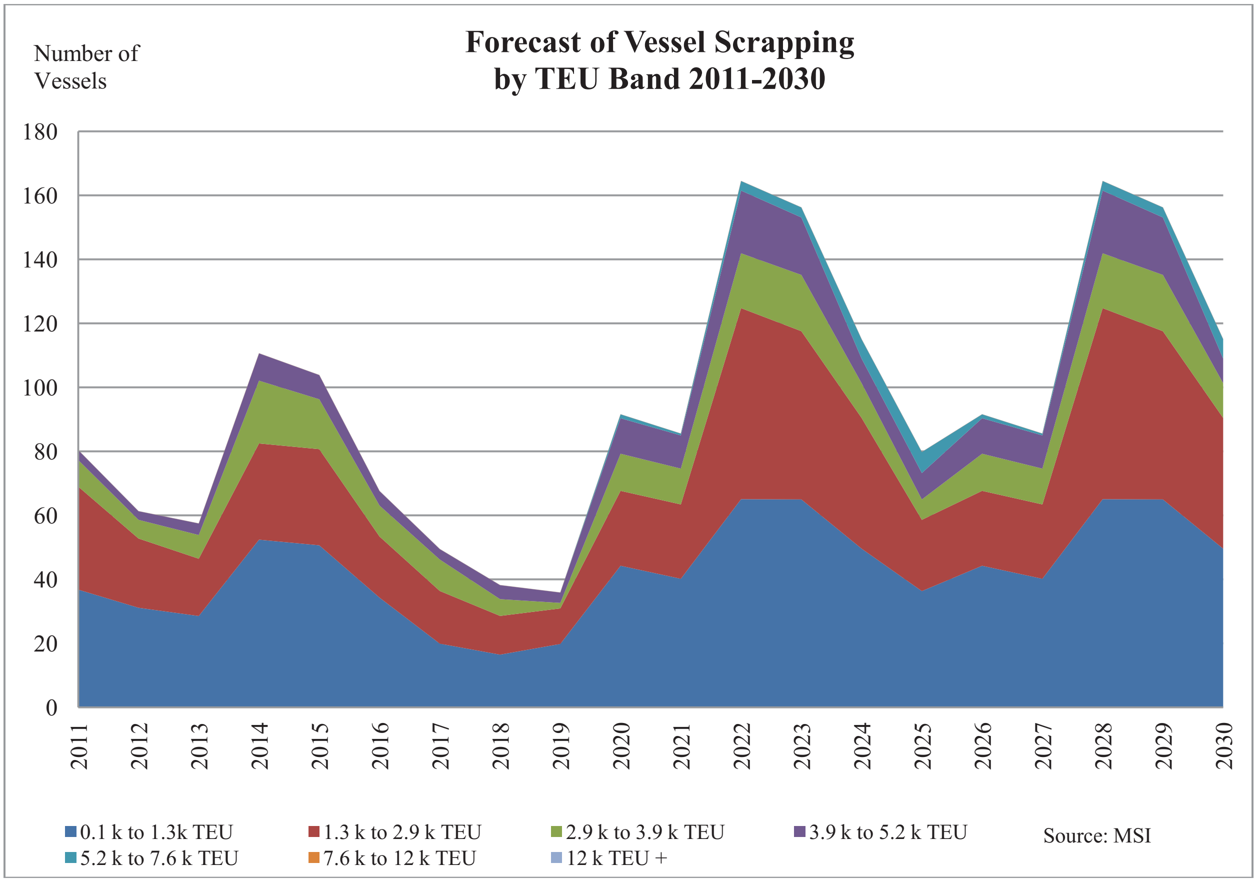


Figure 22: Forecast of Vessel Scrapping by TEU Bands 2011-2030

3.4.1.4. World Fleet Forecast

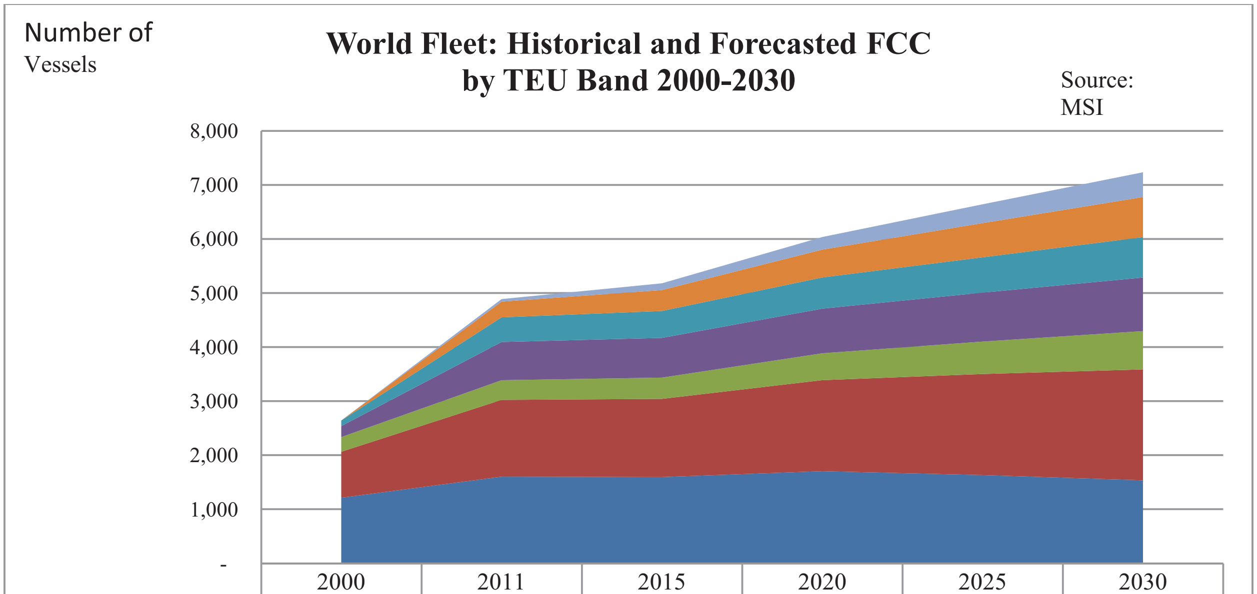
With data for deliveries, scrapping and the 2010 fleet calculated, forecast of the fleet for the end of each forecast year was estimated using the following equation:

Equation 1: Fleet End of Period

Fleet EoP (Year) = Fleet EoP (Year-1) + Deliveries (Year) – Scrapping (Year)

EoP = End of period

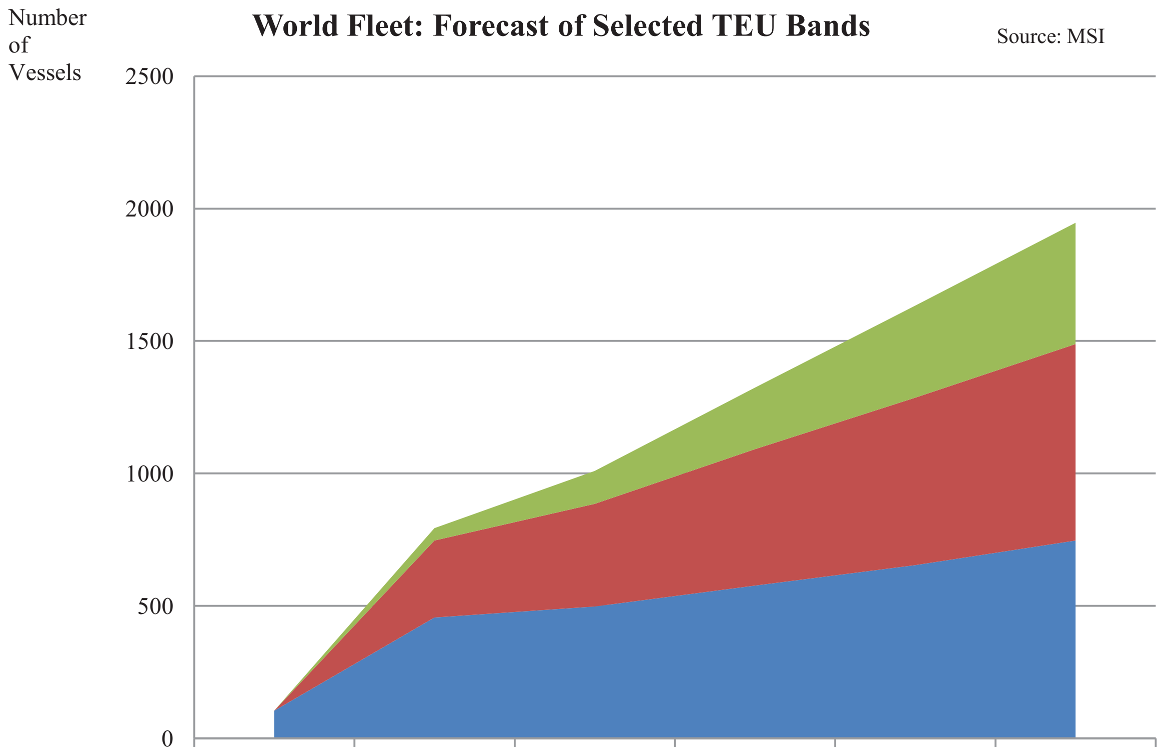
Figure 23 displays the world fleet fully cellular *container* forecast by TEU band through 2030.



	2000	2011	2015	2020	2025	2030
12 k TEU +	-	47	124	232	348	458
7.6 k to 12 k TEU	-	291	388	515	632	742
5.2 k to 7.6 k TEU	104	456	498	577	654	747
3.9 k to 5.2 k TEU	203	707	735	826	905	991
2.9 k to 3.9 k TEU	272	364	393	497	600	708
1.3 k to 2.9 k TEU	850	1,420	1,446	1,684	1,869	2,051
0.1 k to 1.3k TEU	1,214	1,604	1,596	1,706	1,633	1,537

Figure 23: World Fleet: Historical and Forecasted FCC by TEU Band 2000-2030

Figure 24 shows the growth in selected Post-Panamax TEU bands. These types of vessels are a key factor in the evaluation of port deepening studies like Savannah Harbor.



	2000	2011	2015	2020	2025	2030
12 k TEU +	0	47	124	232	348	458
7.6 k to 12 k TEU	0	291	388	515	632	742
5.2 k to 7.6 k TEU	104	456	498	577	654	747

Figure 24: World Fleet: Forecast of Selected TEU Bands

3.4.2. Container Vessels Calling at Savannah

3.4.2.1. Trade Through North America and Savannah Vessel Capacity

The Lloyd's Shipping Economist (LSE) is an annual publication that details the fleet deployment on most containership service routes. The report details the number of vessels deployed on each service by TEU-band. MSI had access to these publications since 2000, and used those as an indicator of deployment for the year prior to publication.

The TEU bands used by LSE do not specify vessel capacity. MSI used LR Fairplay data to calculate the average vessel size within the LSE size bands for each year. This capacity estimate was used to estimate the nominal capacity deployed on each route. For the purpose of this study all the services calling North American ports were aggregated.

The capacity deployed on each trade route was compared to the annual container volumes for the US using a simple regression technique. The fit showed a very high R-squared of 94 percent against the observed data. This close relationship demonstrates how capacity is adjusted by operators to match demand. Figure 25 shows this relationship.

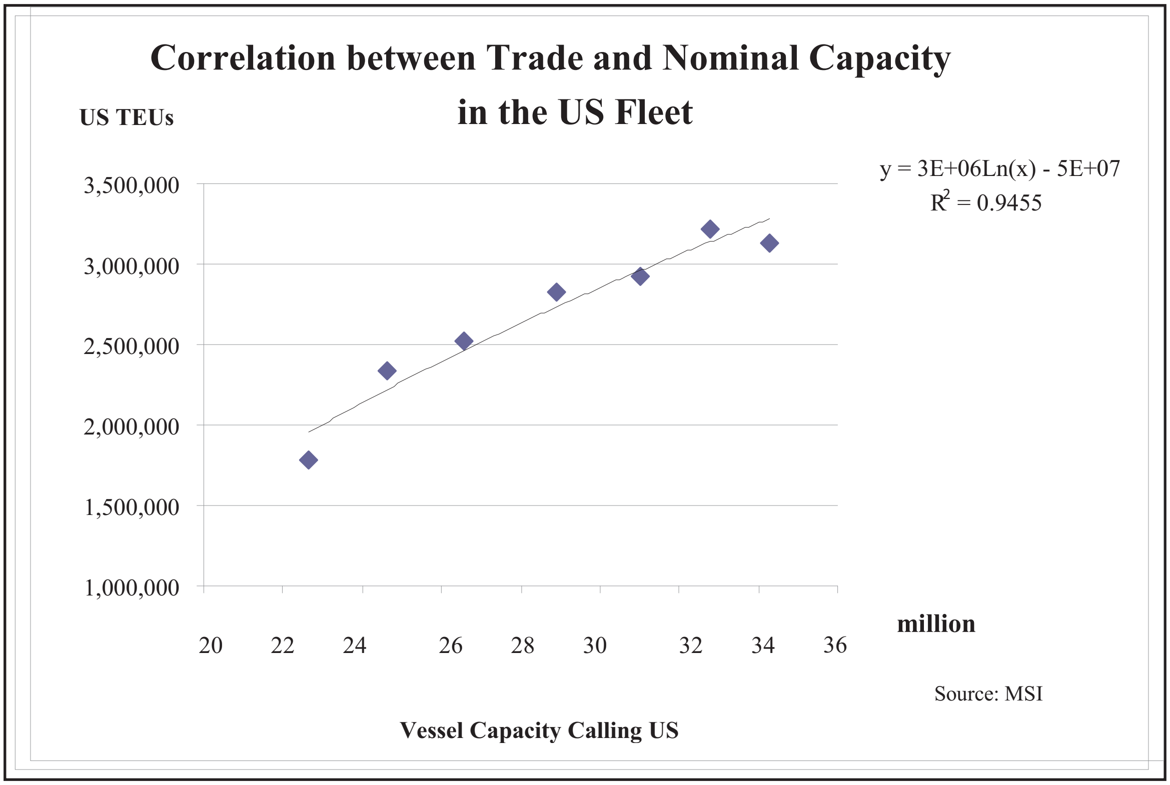


Figure 25: Correlation Between Trade and Nominal Capacity in the US Fleet

Similarly, MSI preformed an analysis of port throughput at Savannah. TEU capacity of vessels calling at Savannah in each of the years between 2000 and 2010 was compared to TEUs at Savannah. Again, the R-squared value is very high at .967 percent, confirming that forecasted trade volumes could be used to forecast capacity deployed on services calling at Savannah in the future. Figure 26 displays this result.

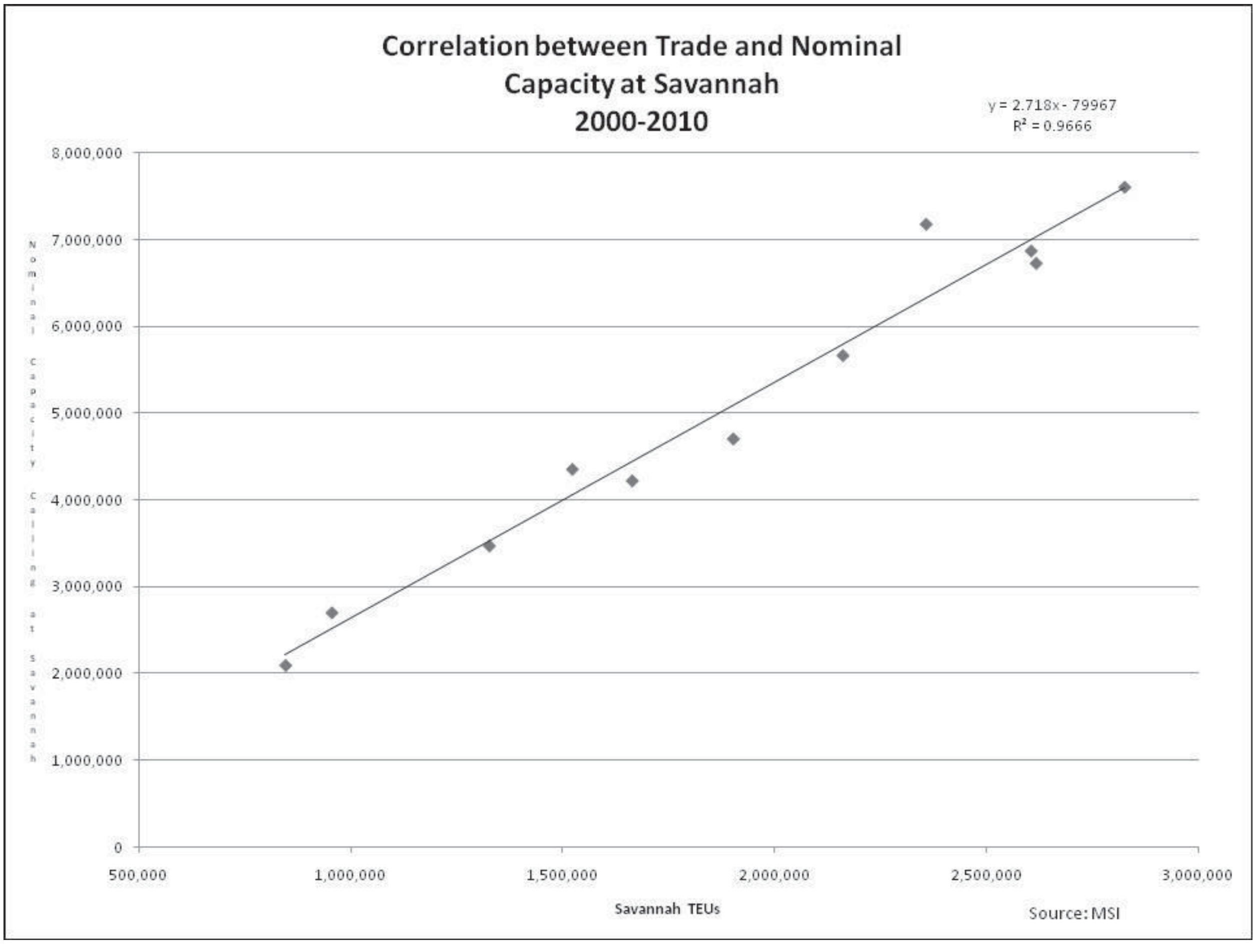


Figure 26: Correlation between Trade and Nominal Capacity at Savannah

Table 26 and Table 27 show the historical calls at Savannah by TEU band and the percent share of the calls.

Table 26: Historical Vessel Calls at Savannah by TEU Band 2000-2010

Vessels Calling Savannah by TEU Band 2000-2010											
TEU Bands	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
0.1 - 1.3 k TEU	1	2	4	35	34	79	86	58	42	87	124
1.3 - 2.9 k TEU	256	323	284	286	274	315	325	444	321	217	227
2.9 - 3.9 k TEU	319	311	411	364	231	194	212	195	134	153	171
3.9 - 5.2 k TEU	114	228	346	552	627	723	819	1,028	1,101	1,145	1,096
5.2 - 7.6 k TEU	1	1		3			77	76	67	126	212
7.6 - 12.0 k TEU											5
12.0 k TEU +											
TOTAL	**691**	**865**	**1,045**	**1,240**	**1,166**	**1,311**	**1,519**	**1,801**	**1,665**	**1,728**	**1,835**

Table 27: Historical Share of Nominal Vessel Capacity Calling Savannah by TEU Band

Share by TEU Band of Nominal Vessel Capacity Calling Savannah 2000-2010											
TEU Bands	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
0.1 - 1.3 k TEU	0.1%	0.1%	0.1%	0.9%	0.9%	1.8%	1.7%	1.0%	0.7%	1.3%	1.7%
1.3 - 2.9 k TEU	26.5%	25.1%	17.5%	15.1%	14.7%	15.0%	12.7%	14.5%	11.3%	6.9%	6.7%
2.9 - 3.9 k TEU	49.5%	37.5%	38.6%	28.2%	19.2%	14.6%	13.0%	10.0%	6.9%	7.3%	7.9%
3.9 - 5.2 k TEU	23.7%	37.1%	43.8%	55.3%	65.2%	68.6%	64.8%	68.1%	75.4%	74.1%	66.0%
5.2 - 7.6 k TEU	0.3%	0.2%	0.0%	0.4%	0.0%	0.0%	7.9%	6.5%	5.8%	10.4%	17.1%
7.6 - 12.0 k TEU	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.6%
12.0 k TEU +	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
TOTAL	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

3.4.2.2. Forecasted Vessel Capacity Calling Savannah

The SHEP TEU forecast (see section "Commodity Forecast") was used to estimate total annual nominal capacity calling at Savannah for the years 2011-2030. The forecast was developed using the linear regression equation from above, solving for x (nominal capacity), with "y" being the forecasted number of TEUs at Savannah.

$$y = 2.718\,x - 79967\text{ TEU}$$

Once the study team determined the total annual nominal capacity over the period of analysis, they then allocated the estimated capacity into TEU bands since this demand is likely to be satisfied by a range of vessels. The allocation was based on TEU band shares developed by MSI's CSPS model.

3.4.2.3. Forecasted Post-Panamax Share of Vessel Capacity

The forecasted capacity calling at Savannah was allocated to SHEP Post-Panamax vessel classes according to MSI's forecast of capacity share.

Table 28: Forecasted Post-Panamax Share of Vessel Capacity

Approximate SHEP Vessel Classes	**Forecasted Share by TEU Band of Nominal Vessel Capacity at Savannah**					
	TEU Bands	**2011**	**2017**	**2020**	**2025**	**2030**
Gen I	5.2 - 7.6 k TEU	17.7%	21.4%	25.5%	20.2%	23.9%
Gen II	7.6 - 12.0 k TEU	6.5%	22.5%	39.9%	45.9%	51.9%
Gen III	12.0 k TEU +	0.0%	0.0%	0.0%	0.0%	0.0%
Total TOTAL		**24%**	**44%**	**65%**	**66%**	**76%**

Source: MSI

The largest share of forecasted vessel capacity is in the 7.6 – 12.0 k TEU band. The vessels in this band vary significantly in physical dimensions and include vessels that will not be able to call at Savannah due to size constraints (width and air draft). Table 29 shows a detailed breakdown of the TEU band, first by vessel width, then by design draft. Vessels named Ultra Post-Panamax are not expected to call at Savannah because of size limitations. These vessels have widths in excess of 144 feet. The Savannah channel modification is designed for a maximum width of 144 feet. The vessel class named Super Post-Panamax more closely fit the design dimensions of the channel and are less likely to have air draft concerns with the Talmadge Memorial Bridge which provides a vertical clearance of 185-feet. In this vessel class 85% of the vessels have a design draft of less than 48 feet. While there are 15% that have design drafts greater than 48 feet it is expected that this share will decline over time as they are not as economically efficient as the similarly drafted Ultra Post-Panamax vessels and which have other size dimensions which take greater advantage of the new Panama Canal locks.

Within the Super Post-Panamax vessel class, by far the most common design draft is in the 47.5 to 48.0 foot range.

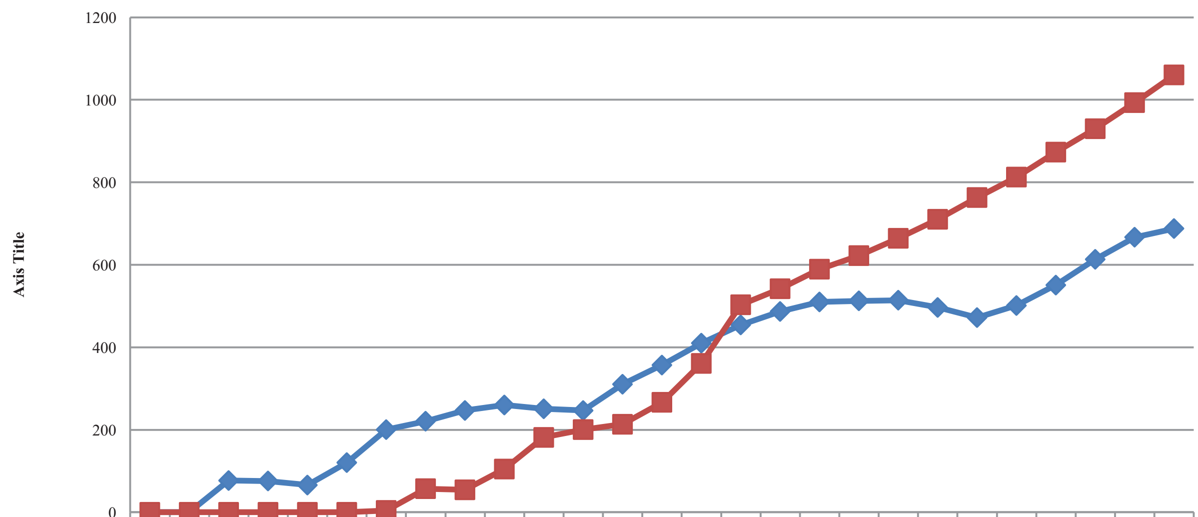
Table 29 – World Fleet: Detailed View of 7.6 - 12.0 TEU Band

Detailed View of 7.6 to 12.0 k TEU Band							
Vessel Widths	**Vessel TEU Capacity**	**Vessel Size Class**	**Draft brackets**	**Number in World 2010**	**Number in Order book End of Period 2010 for ships of known dimensions**	**Number with Combined World Feet and Order Book**	**Percent of Class**
139 - 144 ft	7,600 - 12,000	Super Post-Panamax	Under 47 feet Draft	49	30	79	25.40%
			47.0 to 47.5	1		1	0.32%
			47.5 to 48.0	159	26	185	59.49%
			48.0 to 48.5	**5**	**13**	**18**	**5.79%**
			49.0 to 49.5	**25**	**3**	**28**	**9.00%**
144 - 158 ft	7,600 - 12,000	Ultra Post-Panamax	Under 47 feet Draft	16	38	54	39.42%
			47.5 to 48.0	32	6	38	27.74%
			49.0 to 49.5	28	13	41	29.93%
			49.5 to 50.0	4		4	2.92%

3.4.2.4. Initial Forecast of Post-Panamax Vessel Calls at Savannah

At this point, the PDT focused on development of an initial forecast of Post-Panamax Vessel calls at Savannah since it is these vessels where most of the project benefits will accrue. The Post-Panamax vessels were represented by TEU bands 5.2 k to 7.6 k (PPX1) and 7.6 k to 12 k (PPX2). The forecasted vessel calls for the Post-Panamax vessels was developed by applying the regression equation in paragraph 3.4.2.2. to the TEU forecast for Savannah in Table 24 to derive total capacity calling. Then, the percent of total capacity calling by PPX1 and PPX2 vessels (shown in Table 28) was applied to derive capacity calling by Post-Panamax vessel classes. PPX1 and PPX 2 capacity calling was then divided by the average TEU capacity of the respective vessel classes (6,146 for PPX1 and 8,653 for PPX2) to estimate number of calls by

Post-Panamax vessels. The initial forecast of Post-Panamax vessels through the year 2030 is depicted in Figure 27. Notice that the larger, Generation 2 Post-Panamax vessel becomes the more dominant type of vessel calling at Savannah from the year 2019 onward.



	1998	1999	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
PPX1	0	0	77	76	66	120	200	221	247	260	251	247	310	357	410	454	487	510	513	514	497	472	501	551	613	667	688
PPX2	0	0	0	0	0	0	5	57	55	105	182	201	213	267	361	503	542	589	622	664	710	763	813	873	930	993	1060

Figure 27: Initial Forecast of Post-Panamax Vessels Calling at Savannah

3.4.3. Initial Allocation of Post-Panamax Vessel Calls by Service

Once the number of Post-Panamax vessel calls was determined, these calls were then allocated to specific Savannah trade routes. The share for each route was based on the historical averages from 2005 to 2007 and increased over time by the route specific growth rates reflected in the commodity forecast. Some trade routes particularly those originating from the Far East would receive a larger allocation of vessels to meet the high demand. Other trade routes such as the AU ECUS EU PEN, ECUS AU PEN, and ECUS WCSA-ECSA do not expect any Post-Panamax vessels to deploy at all throughout the study period. Indeed, a large portion of cargo would still be moved on smaller, Sub-Panamax vessels and so the study team excluded Sub-Panamax vessels from the transportation cost savings analysis, but included them in the ultimate number of vessel calls to account for total vessel calls. However, the Sub-Panamax vessel class share of capacity calling at Savannah is expected to decline over time, as it has historically, and shift to Panamax vessels. Therefore, one adjustment was made to the historic values to account for this decline in Sub-Panamax shares. Table 30 shows the historic sub-Panamax share of capacity calling Savannah, while Table 31 shows the sub-Panamax share as forecast by MSI. The average sub-Panamax share for the 2005/07 historic years was 28 percent. By 2017 the sub-Panamax share of capacity calling Savannah is expected to decline to about 19%, or about 67% of the historic capacity calling in the period analyzed. While the forecast shows a continued decline through 2030, the Savannah analysis simply assumes a 33% reduction.

Table 30: Percentage of Sub-Panamax Vessel Capacity at Savannah ((Historically)

Composition of capacity calling at Savannah (Forecast)											
Vessel Class	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
A 0.1k - 1.3k TEU	0%	0%	0%	1%	1%	2%	2%	1%	1%	1%	2%
B 1.3K - 2.9K TEU	26%	25%	17%	15%	15%	15%	13%	15%	11%	6.9%	6.7%
C 2.9k - 3.9k TEU	49%	37%	39%	28%	19%	15%	13%	10%	7%	7.3%	7.9%
Total -SPX Vessels	**76%**	**63%**	**56%**	**44%**	**35%**	**31%**	**27%**	**25%**	**19%**	**16%**	**16%**

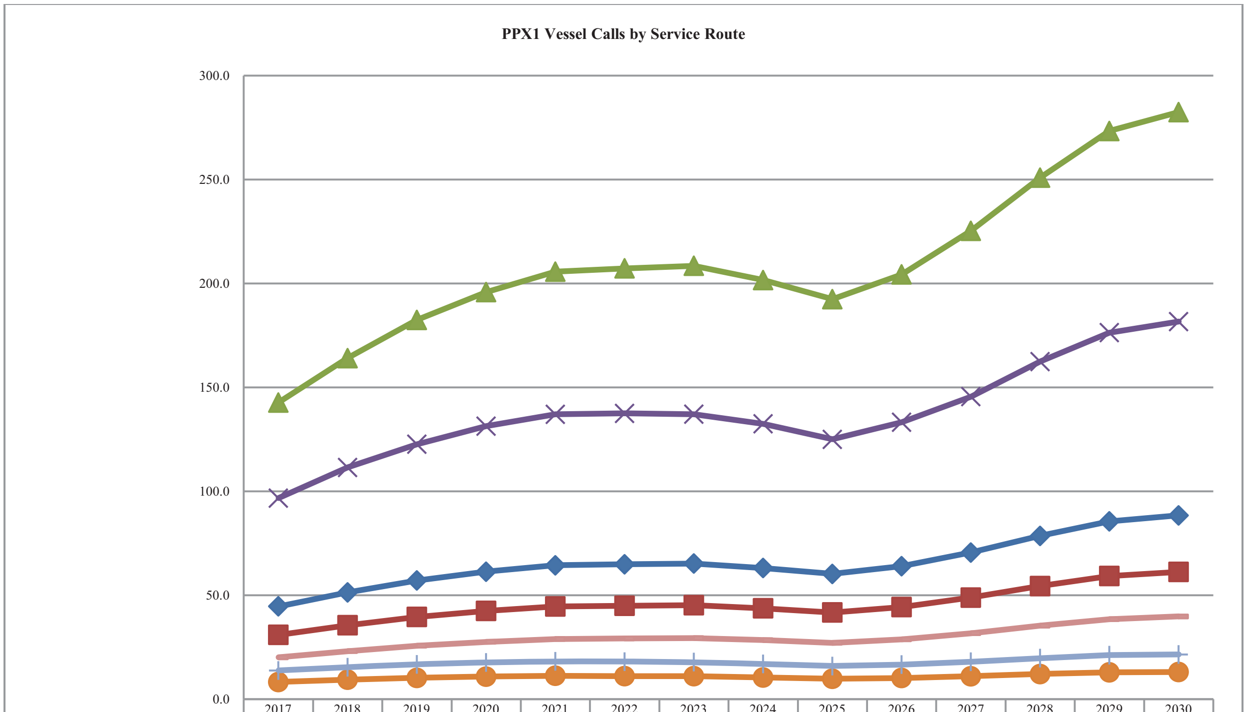
Table 31: Forecast Percentage of Sub-Panamax Vessel Capacity

Composition of capacity calling at Savannah (Forecast)											
Vessel Class	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
A 0.1k - 1.3k TEU	1.2%	1.3%	1.3%	1.3%	1.2%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%
B 1.3K - 2.9K TEU	8.0%	8.8%	9.6%	10.1%	10.1%	9.5%	8.7%	8.3%	7.8%	7.3%	6.8%
C 2.9k - 3.9k TEU	8.1%	8.3%	8.5%	8.7%	8.9%	9.2%	9.4%	9.7%	9.9%	10.2%	9.5%
Total -SPX Vessels	**17%**	**18%**	**19%**	**20%**	**20%**	**20%**	**19%**	**19%**	**19%**	**19%**	**18%**

Post-Panamax vessel calls (shown in Figure 28) were then allocated to the benefiting trade routes based on each route's share of total Import cargo not expected to be carried by SPX vessels. Table 32 shows the allocations over time for the pertinent trade routes. Vessel calls by route service are depicted in Figure 28 and Figure 29 . This forecast assumed vessels have sufficient channel depth to call at Savannah.

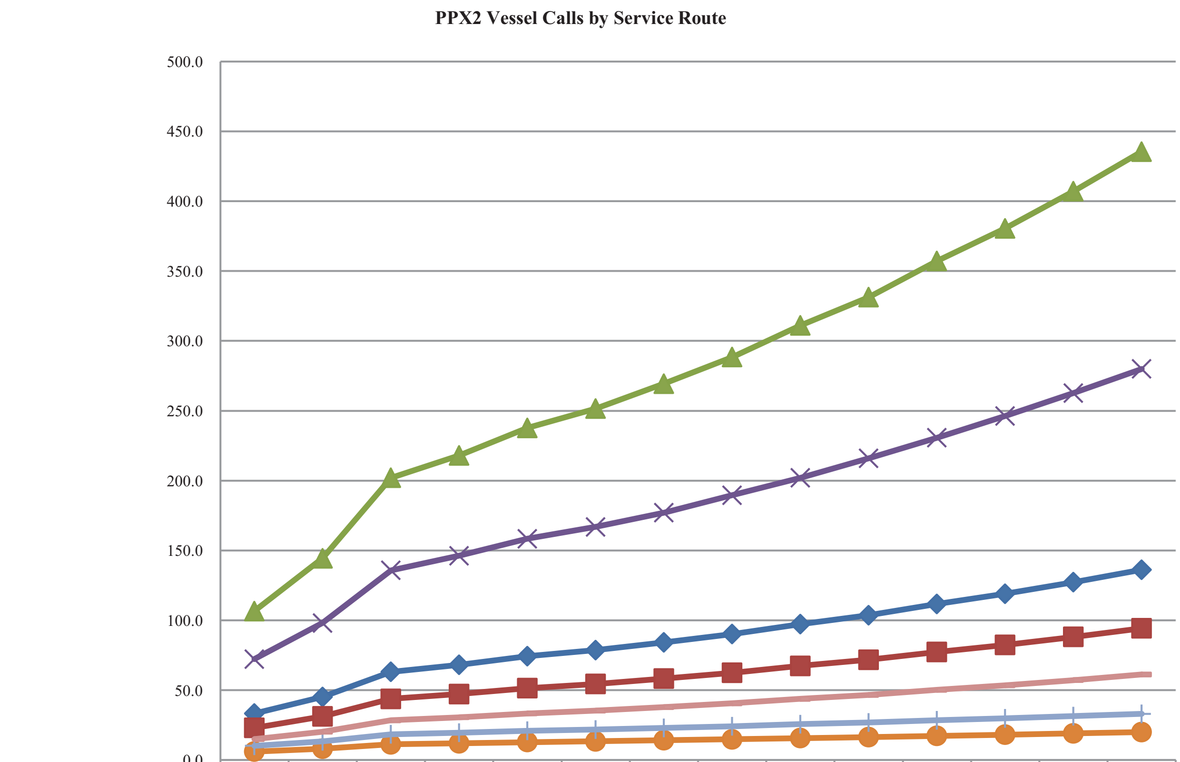
Table 32: Route Percent Share of Forecast PX and PPX Tonnes

SHEP Services	2015	2020	2025	2030	2032
FE ECUS EU PEN	12.4%	12.6%	12.8%	12.9%	12.9%
FE ECUS MED PEN	8.6%	8.7%	8.8%	8.9%	8.9%
FE (Panama) ECUS	39.5%	40.2%	40.8%	41.1%	41.3%
FE (Suez) ECUS	27.8%	27.0%	26.5%	26.4%	26.3%
ECUS MED	2.4%	2.2%	2.1%	1.9%	1.8%
ECUS EU GULF PEN	3.9%	3.6%	3.4%	3.1%	3.0%
RTW	5.6%	5.7%	5.7%	5.8%	5.8%
Total	**100%**	**100%**	**100%**	**100%**	**100%**



	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
FE ECUS EU PEN	44.6	51.3	57.1	61.3	64.4	64.9	65.2	63.1	60.2	63.9	70.5	78.5	85.5	88.4
FE ECUS MED PEN	30.9	35.5	39.5	42.4	44.6	44.9	45.2	43.7	41.7	44.3	48.8	54.4	59.2	61.2
FE (Panama) ECUS	142.7	164.1	182.5	195.9	205.7	207.3	208.5	201.6	192.5	204.4	225.3	250.9	273.4	282.5
FE (Suez) ECUS	96.7	111.4	122.7	131.3	137.0	137.5	137.1	132.5	125.0	133.2	145.6	162.4	176.4	181.6
ECUS MED	8.2	9.3	10.2	10.8	11.2	11.0	11.0	10.4	9.8	10.2	11.0	12.0	12.9	13.0
ECUS EU GULF PEN	13.7	15.3	16.7	17.6	18.2	18.0	17.8	16.9	15.9	16.6	18.0	19.7	21.1	21.4
RTW	20.1	23.1	25.7	27.6	28.9	29.2	29.3	28.4	27.1	28.8	31.7	35.3	38.5	39.7

Figure 28: PPX1 Calls by Route Service



	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
FE ECUS EU PEN	33.4	45.2	63.2	68.2	74.4	78.7	84.3	90.3	97.3	103.7	111.8	119.0	127.4	136.2
FE ECUS MED PEN	23.1	31.3	43.8	47.2	51.5	54.5	58.4	62.5	67.4	71.8	77.4	82.4	88.2	94.3
FE (Panama) ECUS	106.6	144.4	202.1	218.1	237.7	251.6	269.4	288.5	311.1	331.3	357.2	380.5	407.1	435.4
FE (Suez) ECUS	72.2	98.1	135.9	146.2	158.4	166.8	177.1	189.5	202.0	216.0	230.7	246.3	262.7	280.0
ECUS MED	6.1	8.2	11.3	12.0	13.0	13.4	14.2	14.8	15.8	16.5	17.4	18.3	19.2	20.1
ECUS EU GULF PEN	10.3	13.5	18.5	19.6	21.0	21.8	23.0	24.2	25.7	26.9	28.5	29.9	31.4	33.1
RTW	15.0	20.3	28.4	30.7	33.4	35.4	37.9	40.6	43.8	46.6	50.3	53.5	57.3	61.3

Figure 29: PPX2 Calls by Route Service

Following this allocation by trade route of Post Panamax vessels, the study team moved on to allocate all vessels calls by alternative channel depth through use of a Load Factor Analysis and a Transportation Cost model.

3.4.4. Load Factor Analysis and Unit Cost Estimation

One of the biggest challenges when undertaking a containership study is estimating the total volume of cargo stored on a vessel at a given time. Unlike bulk ports which generally serve niche markets, container ports are very dynamic. A useful way of thinking of the container trade is to consider the analogy of bus lines which make multiple stops on a particular route. Cargo is often loaded and unloaded simultaneously before calling at a string of other ports. As mentioned previously, the weight of cargo can vary greatly by trade route, whereas vessel operators can also carry large numbers of empty containers or sail with vacant slots. What further complicates matters is that as vessel operators share cargo, they may be carrying a wide mix of cargo boxes, each with entirely different weights.

A vessel load factor analysis (LFA) helps to capture valid relationships and parameters for estimating the disposition of cargo and non-cargo components of vessel loading which in turn helps to better estimate the amount of cargo on a ship at a given time. The basic methodology and logic of the load factor analysis is based on long-established practices which have been historically applied to Corps-sponsored economic evaluations of deep draft waterway improvements. A better snapshot of the cargo aids in identifying requirements for vessel immersion and draft. Cargo components of an LFA include carried tonnages, the containers that store the cargo as well as empty containers. Some of the non-cargo components that are considered in an LFA include allowances for ballast, bunkerage, vacant slots and any other load factor significant to reasonably estimating hull immersion and draft.

Once the commodity forecast and the initial PPX vessel call forecast by trade route were completed, a Load Factor and Vessel Cost analysis was undertaken. The Load Factor Analysis is described through the remainder of the benefit analysis and provides the rationale for deployment decisions associated with the potential economic efficiencies of channel deepening.

3.4.4.1. Load Factor Analysis

An LFA explores the various relationships between a ship's physical attributes, considerations for operations, and attributes of a trade route's cargo. In doing so, it allows the analyst to identify the unit costs and operating efficiencies of vessel classes for alternative sailing drafts, which are also inferred to alternate project depths.

The ships physical characteristics used in the LFA are:

- Aggregate Maximum Summer Load Line Draft (MXSLLD), which is the primary load line of a vessel;
- Deadweight Tonnage Rating at MXSLLD, this is the entire weight of the ship, including ballast, fuel and other non-cargo related items;
- Maximum Tonnage for Cargo at MXSLLD, this is the maximum amount of cargo that is practicable to be carried for that particular vessel;
- Nominal TEU Rating, this describes the maximum TEU capacity of the vessel; and
- Working Tons Per Inch Immersion (this helps describe the overall density of the ship). Larger vessels typically have higher immersion rates than smaller vessels.

The load factor tabs in the Savannah Transportation Cost Model characterize approximately 45 different classes of vessels which represent the world fleet expected to potentially call at Savannah. Information on the physical characteristics of the ships was taken from Lloyd's Registry of Ships and stored in an Excel spreadsheet (3).

Table 33: Screen shot of vessel information taken from Lloyd's Registry of Vessels and used in the LFA

Vessel Class Designator	General Vessel Group	General Vessel Sub-Grouping	General Vessel Class	Aggregate MXSLLD Draft (Feet)	Underkeel Clearance (UKC) Requirement (Feet)	For Sinkage Where Applicable (Feet)	Requirement for Vessel UKC Clearance (Feet)	DWT Tonnage Rating MXSLLD (DWT; Metric)	Max DWT Utilization Max Cargo Transit Draft	Working TPI (Metric Tonnes)	TEU Rating Nominal
4	SPX	- Ag	CL 4	26.23	2.70	0.70	3.40	11,726.3	10,013.6	59.200	907.3
10	SPX	- Ag	CL 10	34.57	2.70	0.90	3.60	24,812.3	19,551.9	96.300	1,778.2
17	PX	- Ag	CL 4	41.22	2.80	1.10	3.90	50,070.4	40,446.1	162.700	3,841.1
18	PX	- Ag	CL 5	42.53	2.80	1.10	3.90	56,791.8	43,684.1	176.700	4,125.2
19	PX	- Ag	CL 6	43.41	2.80	1.20	4.00	54,884.5	42,272.0	170.400	3,992.5
27	PPX	Gn I	5.50	46.05	3.00	1.20	4.20	74,069.5	64,599.0	222.300	6,185.8
41	PPX	Gn II	10.50	47.64	3.00	1.30	4.30	103,816.8	90,538.5	291.500	8,669.6

The LFA progresses by having the user input information on vessel operations. This information includes:

- Vessel operating speed at sea;
- Assumptions for ballast stored on each vessel;
- Allowances for bunkerage and fuel storage; and
- Hourly operating cost at sea.

Information on vessel operating speeds, assumptions for ballast and allowances for bunkerage were derived from industry publications and consultation with industry experts. Furthermore, the estimates, relationships, and potential range of parameters have been shared and discussed with industry analysts repeatedly throughout the study. The framework for the calculations was also vetted with the U.S. Naval Academy, Lloyd's Register-Fairplay. Vessel operating costs were based on HQUSACE published vessel operating cost estimates.

Attributes of each trade route are also required for the LFA and include:

- Allowance for empty containers;
- Allowance for unused or vacant slots;
- Average cargo weight in each container; and
- Average weight of an empty container.

The weight of the container itself is around 2.0 metric tons and was derived from published industry trade journals. Allowances for minimum empties and vacant slots were based on expert elicitation and a Drewry Consultant report prepared specifically for the Savannah study. The percentages assigned for vacant slots vary by trade route. For example, Panama Canal transits are limited by the size of the locks, line of sight restrictions and the seasonal depth of water in the lakes. Likewise, high cube containers and other non-standard cargo, including those that are gaseous or volatile, may result in vessels having large numbers of unused container slots.

The LFA mechanics of the calculation are as follows. For a given sailing draft, a calculation using vessel specific Tons per Inch Immersion (TPI) was made to determine capacity utilization at that sailing draft, i.e., to determine how much space of the vessel was occupied by cargo, stores and other items having weight. This capacity utilized figure (metric tonnes) is then allocated to several factors. An estimate of ballast weight is accounted for on a variable scale. Empty container weight (carriage weight) is accounted for by applying a historical percentage of empty containers for each vessel on a particular trade route[19]. Container (lading) weight is accounted for, and finally the cargo itself. The remainder is the empty space on the vessel.

Initially, the PDT used historical averages for cargo weights based on GPA and PIERS data and estimated minimum percentages for empty containers and vacant slots, which seemed appropriate since vessels contain mixes of imports and exports plus the fact that Savannah is rarely the first or final port of call. However, when using these average cargo weights for imports and exports, and initial uniform estimates for all trade routes for minimum empties and vacant, the PDT discovered that for some of the trade routes, a large percentage of calls ended up exceeding their maximum practicable sailing drafts (MPD) more than 15 percent of the time. This lead the PDT to believe that the initial estimates of minimum empties and vacants, and average import and export cargo weights do not adequately capture the affects of port rotations on the amounts of import and export cargo carried on some vessels when they call Savannah Harbor. Therefore the model was then calibrated and rerun using estimated cargo weights and minimum empty and vacant slots which resulted in maximum practicable sailing drafts that were not exceeded 85 percent of the time. Table 344 presents the variables employed in the LFA, after calibrating the model.

Table 34: Variables Used in LFA upon Model Calibration

Trade Route	Avg. Cargo Weight (Tons/TEU)	Minimum % Empty Containers	Minimum % Unused (Vacant) Slots
AU ECUS EU PEN	10.35	4.36%	7.65%
ECUS AU PEN	9.72	1.30%	7.65%
ECUS EU GULF PEN	9.17	2.02%	4.65%
ECUS MED	10.33	10.5%	4.65%
ECUS WCSA-ECSA	10.50	30.24%	6.15%
FE (Panama) ECUS	7.98	6.46%	7.65%
FE (Suez) ECUS	8.46	8.74%	4.65%
FE ECUS EU PEN	8.71	11.38%	7.65%
FE ECUS MED PEN	8.48	2.45%	7.65%
RTW	10.32	14.91%	7.65%

By assembling this information in the LFA, the analyst can:

- Estimate the quantity of cargo on the vessel for any given sailing draft;
- Calculate the unit cost of operation for a given distance (This is a key variable in determining the voyage costs used in the transportation cost model);
- Calculate the draft at which a vessels "cubes out" (i.e., runs out of available space on the vessel) when carrying light boxes; and

[19] Ports do not usually record the weights of containers but they generally keep good records of the number of containers (loaded and empty), which can be used to derive the total weight carried on a ship.

- Calculate the number of boxes on board and empty slots when the vessel "weights out" (i.e., can no longer carry additional weight).

3.4.4.2. Maximum Practicable Loading Draft and Capacity

For the SHEP study, the Maximum Practicable Loading Draft (MPLD) was applied since it provides a realistic measure of the vessel behavior, as opposed to the maximum design draft. Container vessels carry *empty boxes*, which can cause the vessel to "volume out" or "cube out" before reaching its maximum design draft. Containers are also not always uniform in size. There are "high lift" containers and 50-foot containers. These size irregularities create *unused spaces or "slots*" on the vessel. Some vessels have "*line of sight*" requirements which restrict operators from using the entire number of slots on a vessel. The *bunkerage on a vessel* can fluctuate and is rarely 100% full. Most importantly, the average weight of the cargo in each box can be less than the weight required to reach the maximum design draft.

The MPLD may approach the vessel's maximum design draft or be less if the vessel "volumes out" or "cubes out" due to the presence of empty boxes. On the other hand, if a channel is not deep enough, carriers may not be able to load to their vessels to their MPLDs, after accounting for underkeel clearance requirements and examining the availability of tide. Finally, at the MPLD, the capacity of the vessel is reached and is termed the Maximum Practicable Capacity (MPC) of the vessel. The MPC is useful in describing the volume of cargo that could reasonably be loaded onto each vessel.

3.4.4.3. Utilization of the LFA in SHEP

3.4.4.3.1. Vessel Deployment. Since the ultimate product of the SHEP benefits analysis is the transportation costs (and reduction of transportation costs for each project depth), the unit cost estimates based on the MPC of various classes of container ships for each trade route at various channel depths were used to inform the deployment decisions. As a channel is deepened, the relative economic efficiency between the vessel classes can change giving one class an economic advantage over another. A comparison of unit costs of Panamax, PPX1, and PPX2 vessels derived from the LFA is used to predict the cost breakpoints in which it makes more economic sense to switch from one vessel to another. This unit cost information is used to inform the deployment decision in the SHEP analysis.

3.4.4.3.2. Savannah Share of Vessel Capacity. Using 2005 and 2007 vessel call data for Savannah for Panamax and Post-Panama vessels, the LFA was used to estimate the percent share of Savannah cargo that would be carried on average by Post-Panamax vessel calls. The LFA was used to estimate the MPC for each class of vessel for each trade route with the existing channel. The Savannah share of vessel capacity utilization was based on actual Savannah cargo carried, and the estimated total vessel cargo at MPD. In other words, actual Savannah cargo is used as the numerator, and vessel capacity at MPD is used as the denominator.

Equation 2: Percent of Cargo Transferred at Savannah

$$\frac{Laden\ Cargo\ Transferred\ \ Savannah\ (historical)}{Total\ Cargo\ on\ the\ Ship\ (at\ MPC)} = \%\ of\ Cargo\ Transferred\ at\ Sav.$$

The PDT assumed that Savannah's share of vessel capacity for alternate project depths would be the same as the share observed for the 42 ft deep channel and that additional project depths would not lead to rerouting of cargo from other ports. The vessel's MPC was then multiplied by the estimated share for Savannah as a means of deriving the quantity of cargo moved at Savannah for each vessel call. For larger vessels that are restricted by the channel, the quantity carried can increase with project depth because the MPLD (and thus MPC) increases as the channel restriction is eased.

3.4.4.4. Savannah Share of Route Costs

The LFA was used to estimate the percent share of each trade routes total circuit distance operating costs attributable to Savannah cargo. This share is calculated similar to the Savannah's share of vessel capacity, but includes the weight of the containers carried, both laden and empty, and is based on the actual observed operating drafts from the 2005 and 2007 vessel call data. In this calculation, total Savannah cargo plus laden and empty container weight is used in the numerator and total estimated vessel tonnage (cargo and container weight) carried for all vessels calls in 2005 and 2007 is used as the denominator.

3.4.4.5. Illustrated Example

Figure 30 depicts a LFA capacity allocation for the PPX2 vessel weighing a total of 103,800 DWT and with a design draft of 47.6 feet. The figure reveals how the allocation of capacity changes with vessel's sailing draft. The capacity is assigned to ballast, cargo, allocation for operations, weight of containers (empty and laden), and unallocated capacity. As this vessel loads more fully, its sailing draft increases. The amount of available deadweight tonnage (as indicated by the orange-colored wedge) begins to shrink while the cargo tonnage and carriage (blue, purple and maroon-colored areas) increase. Weight for operations and crew appear to be fairly uniform whereas ballast weight rises slowly and maxes out at about 12,000 DWT.

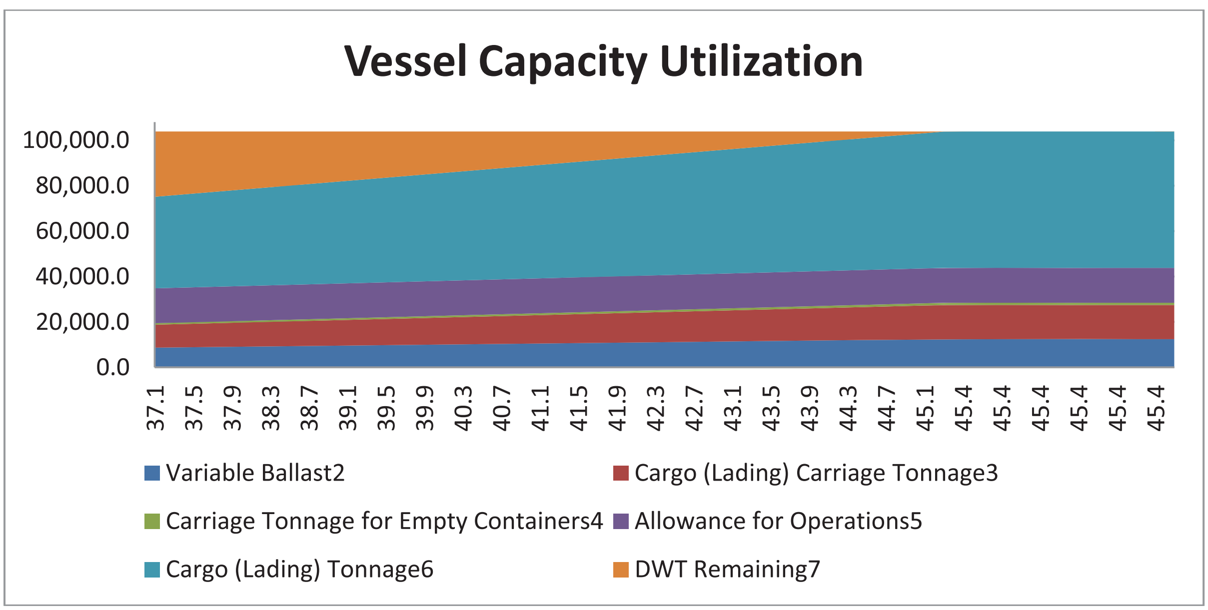


Figure 30: Illustration of Load Factor Capacity Allocation

The equivalent information in tabular form is presented below (Table 35).

Table 35: Vessel Capacity Utilization

MXSLLD (Feet):	47.64	47.64	47.64	47.64	47.64	47.64	47.64	47.64	47.64	47.64	47.64
Draft1	37	38	39	40	41	42	43	44	45	45.4	45.4
Variable Ballast2	8,699.8	9,153.4	9,607.0	10,060.7	10,514.3	10,967.9	11,421.5	11,875.1	12,328.7	12,427.0	12,427.0
Cargo (Lading) Carriage Tonnage3	10,092.3	10,694.6	11,296.9	11,899.2	12,501.5	13,103.8	13,706.1	14,308.4	14,910.7	15,041.1	15,041.1
Carriage Tonnage for Empty Containers4	652.0	690.9	729.8	768.7	807.6	846.5	885.4	924.3	963.2	971.7	971.7
Allowance for Operations5	15,363.0	15,363.0	15,363.0	15,363.0	15,363.0	15,363.0	15,363.0	15,363.0	15,363.0	15,363.0	15,363.0
Cargo (Lading) Tonnage6	40,268.3	42,671.5	45,074.6	47,477.8	49,881.0	52,284.2	54,687.4	57,090.5	59,493.7	60,014.1	60,014.1
DWT Remaining7	28,741.5	25,243.5	21,745.5	18,247.5	14,749.5	11,251.5	7,753.5	4,255.5	757.5	0.0	0.0
Deadweight Tonnage (DWT); Rating (Maximum at MXSLLD) 8	103,816.8	103,816.8	103,816.8	103,816.8	103,816.8	103,816.8	103,816.8	103,816.8	103,816.8	103,816.8	103,816.8

[1] Draft refers to the actual loaded draft of the particular vessel.

[2] Variable ballast is used to describe the amount of ballast used to trim or balance the vessel and to provide sufficient draft to maneuver the vessel. As vessels are loaded more fully, they often require additional ballast water.

[3] Cargo (lading) carriage tonnage refers to the aggregate weight of the containers that are carrying cargo inside them.

[4] Carriage tonnage refers to the aggregate weight of the empty containers.

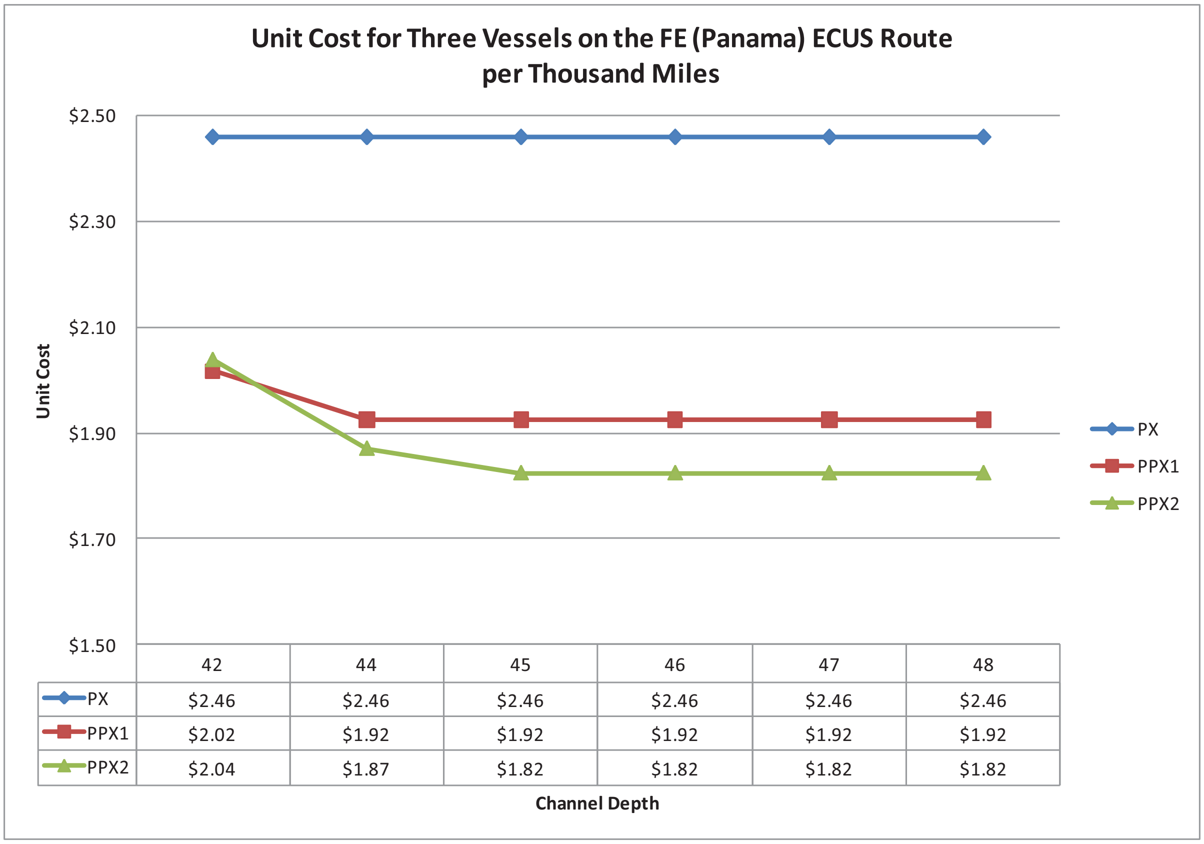
[5] Operations includes the weight for crew, equipment, stores, fuel (bunkerage), and other non-cargo related items on a vessel.

[6] Cargo (lading) tonnage refers to the aggregate weight of all the cargo (and excluding the weight of the containers themselves). Most ports only compile the weight of the cargo itself.

[7] DWT remaining refers to the amount of available weight left on the vessel. As vessels are loaded more fully, the remaining available DWT drops until it approaches the vessel's maximum deadweight tonnage

[8] This refers to the maximum DWT tonnage allowable on the vessel. It is calculated as the sum of the previous items on the vessel.

The final step in this process is to calculate the unit cost per metric ton. The vessel operating cost for a 1,000-mile journey is estimated by considering the vessel speed and its hourly vessel operating cost. The cargo weight previously calculated for each sailing draft is then divided into the voyage cost, yielding a cost per metric ton (unit cost) at each sailing draft.



	42	44	45	46	47	48
PX	$2.46	$2.46	$2.46	$2.46	$2.46	$2.46
PPX1	$2.02	$1.92	$1.92	$1.92	$1.92	$1.92
PPX2	$2.04	$1.87	$1.82	$1.82	$1.82	$1.82

Figure 31: Unit Cost by Sailing Draft

Figure 31 compares the changes in unit costs for PX, PPX1 and PPX2 vessels. It is apparent from Figure 31 that as a channel is deepened, vessel operators are able to load more cargo, which reduces the unit cost per ton. At some point, the gains in efficiency level off, since the vessels are no longer constrained by the channel or are unable to load any more cargo onto them. For the Panamax vessel, the unit costs are minimized at 42 feet on this route; for the Post-Panamax vessels, unit costs are minimized at 45 feet and beyond. This provides useful insight as to deployment decisions.

3.4.5. Deployment by Channel Depth

The PDT then evaluated the impact project depths would have on unit costs and ultimately vessel deployment. In doing so, the team factored under keel clearance requirements for each vessel class as well as the available tide.

3.4.5.1. Maximum Practicable Sailing Draft

The MPD is a concept that describes a vessel's *expected* deviation from design draft during operations. A vessel will only sail at its design draft when it has reached its capacity for bunkerage, cargo, ship's stores and other incidentals. Vessels rarely sail with full bunkerage and for container vessels, the maximum cargo weight can be limited by the weight of each container.

As mentioned previously, a LFA was conducted for each vessel class by service route and by haul direction. The LFA considered average box weight, loaded container weight; percent empty boxes, slot vacancies, bunkerage and ballast, which were based on empirical data and/or expert elicitation. This analysis identified the cargo weight carried at each sailing draft as well as the MPD for each vessel class on each route service.

All vessels on all routes, including the largest ones, reach their MPD with a 47-foot channel. At channel depths shallower than 47 feet, some vessel's MPDs are restricted by inadequate water depth when considering tide and under keel requirements. Changes in the MPD across project depths can be seen on the routes services that have heavier average container box weight.

Table 36 displays the results of the LFA, which provide the maximum practicable sailing drafts by type of vessel, trade route and channel depth. The results can vary significantly, largely as a result of the varying cargo weights but also as a result of percent empties and unused slots. For example, the PPX1 vessels on the FE (Panama) ECUS route reach their MPD with a channel depth of 42 feet. This is because the route's relatively light average container box weight causes the vessel to "volume out" ("cube out") at 42.5 feet. That same vessel on the RTW service reaches a MPD of 46.05 feet simply because its average box weight is greater. This is particularly important for this study as the majority of forecasted commodities are on the FE (Panama) ECUS route service. The PPX1 vessels on the FE (Panama) ECUS route service are not restricted at any project depth.

Table 36: Maximum Practicable Sailing Draft (feet) by Project Depth Alternative

World Region Service	Vessel Class	Sailing Draft (feet)					
		42	44	45	46	47	48
FE (Suez) ECUS	PX	40.51	40.51	40.51	40.51	40.51	40.51
	PPX1	42.80	44.80	45.40	45.40	45.40	45.40
	PPX2	42.70	44.70	45.70	46.70	46.94	46.94
ECUS MED	PX[20]	43.00	44.02	44.02	44.02	44.02	44.02
	PPX1	42.80	44.80	45.80	46.05	46.05	46.05
	PPX2	42.70	44.70	45.70	46.70	47.64	47.64
FE (Panama) ECUS	PX	39.20	39.20	39.20	39.20	39.20	39.20
	PPX1	42.80	43.91	43.91	43.91	43.91	43.91
	PPX2	42.70	44.70	45.35	45.35	45.35	45.35
FE ECUS EU PEN	PX	39.90	39.90	39.90	39.90	39.90	39.90
	PPX1	42.80	44.71	44.71	44.71	44.71	44.71
	PPX2	42.70	44.70	45.70	46.20	46.20	46.20
FE ECUS MED PEN	PX	40.90	40.90	40.90	40.90	40.90	40.90
	PPX1	42.80	44.80	45.80	45.84	45.84	45.84
	PPX2	42.70	44.70	45.70	46.70	47.41	47.41
RTW	PX	42.42	42.42	42.42	42.42	42.42	42.42
	PPX1	42.80	44.80	45.80	46.05	46.05	46.05
	PPX2	42.70	44.70	45.70	46.70	47.64	47.64
ECUS EU GULF PEN	PX	43.00	43.21	43.21	43.21	43.21	43.21
	PPX1	42.80	44.80	45.80	46.05	46.05	46.05
	PPX2	42.70	44.70	45.70	46.70	47.64	47.64

[20] It should be noted that a sizable number of vessels that fall under the "Panamax" category in the world fleet have design drafts greater than the depth of the Panama Canal itself. These vessels are often categorized by their length and breadth, which are not easily adjustable (in contrast to draft). Also note that many of these larger Panamax vessels are dedicated to routes that bypass the Canal.

3.4.5.2. Operating Cost per Thousand Miles

Unit costs were calculated based on a hypothetical 1,000-nautical mile route, which is a commonly-used metric used to measure unit costs in manageable terms for navigation studies. The costs per thousand nautical miles were based on USACE-published vessel operating costs and adjusted for vessel operating speeds of 17 knots. Table 37 shows the vessel operating cost per 1,000 nautical miles as well as the adjusted hourly at sea operating cost.

Table 37: Vessel Operating Costs for Three Vessel Classes

Vessel Class	Operating Cost per Thousand Nautical Miles	Vessel Speed (knots)	Operating Cost at Sea per hour
Panamax	$101,999	17	$1,733.98
PPX1	$104,391	17	$1,774.64
PPX2	$138,722	17	$2,358.27

3.4.5.3. Unit Cost in Tonnes per Thousand Miles

Unit costs in tonnes per thousand nautical miles were calculated by dividing the operating cost per a thousand nautical miles by the tonnes carried. The load factor analysis calculates capacity available for cargo at each sailing draft. Table 38 shows the estimated unit cost by vessel class by channel depth. Entries shaded in yellow identify the breakpoints or depth where it makes economic sense for a shipper to deploy a larger vessel to the route.

Table 38: Unit Cost in Tonnes per Thousand Miles

World Region Route	Vessel Classes	Channel Depths (feet)					
		42	44	45	46	47	48
FE (Suez) ECUS	PX MPD	$ 2.31	$ 2.31	$ 2.31	$ 2.31	$ 2.31	$ 2.31
	PPX1 MPD	$ 2.02	$ 1.85	$ 1.81	$ 1.81	$ 1.81	$ 1.81
	PPX2 MPD	$ 2.04	$ 1.87	$ 1.80	$ 1.73	$ 1.72	$ 1.72
ECUS MED	PX MPD	$ 2.07	$ 1.99	$ 1.99	$ 1.99	$ 1.99	$ 1.99
	PPX1 MPD	$ 2.02	$ 1.85	$ 1.78	$ 1.76	$ 1.76	$ 1.76
	PPX2 MPD	$ 2.04	$ 1.87	$ 1.80	$ 1.73	$ 1.67	$ 1.67
FE (Panama) ECUS	PX MPD	$ 2.46	$ 2.46	$ 2.46	$ 2.46	$ 2.46	$ 2.46
	PPX1 MPD	$ 2.02	$ 1.92	$ 1.92	$ 1.92	$ 1.92	$ 1.92
	PPX2 MPD	$ 2.04	$ 1.87	$ 1.82	$ 1.82	$ 1.82	$ 1.82
FE ECUS EU PEN	PX MPD	$ 2.38	$ 2.38	$ 2.38	$ 2.38	$ 2.38	$ 2.38
	PPX1 MPD	$ 2.02	$ 1.86	$ 1.86	$1.86	$ 1.86	$ 1.86
	PPX2 MPD	$ 2.04	$ 1.87	$ 1.80	$ 1.76	$ 1.76	$ 1.76
FE ECUS MED PEN	PX MPD	$ 2.27	$ 2.27	$ 2.27	$ 2.27	$ 2.27	$ 2.27
	PPX1 MPD	$ 2.02	$ 1.85	$ 1.78	$ 1.78	$ 1.78	$ 1.78
	PPX2 MPD	$ 2.04	$ 1.87	$ 1.80	$ 1.73	$ 1.69	$ 1.69
RTW	PX MPD	$ 2.07	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00
	PPX1 MPD	$ 2.02	$ 1.85	$ 1.78	$ 1.76	$ 1.76	$ 1.76
	PPX2 MPD	$ 2.04	$ 1.87	$ 1.80	$ 1.73	$ 1.67	$ 1.67
ECUS EU GULF PEN	PX MPD	$ 2.07	$ 2.06	$ 2.06	$ 2.06	$ 2.06	$ 2.06
	PPX1 MPD	$ 2.02	$ 1.85	$ 1.78	$ 1.76	$ 1.76	$ 1.76
	PPX2 MPD	$ 2.04	$ 1.87	$ 1.80	$ 1.73	$ 1.67	$ 1.67

3.4.5.4. Considerations for Deployment

In terms of model results, the deployment scenario is a very sensitive decision made by the economics team. The unit cost estimates provide the strongest empirical rationale supporting the deployment scenario[21]. Shippers are assumed to follow the cost advantage indicated by the unit cost analysis when making their deployments on every route. Recently, beginning in the fall of 2010, PPX 2 vessels began to call in limited numbers at Savannah. In early 2011, Maersk announced plans to begin deploying PPX2 vessels at Savannah, in spite of the apparent slight increase in unit costs shown by the Load Factor Analysis. This supports the argument that carriers base their deployment decisions over an entire route and rarely on a port-by-port basis. In addition, carriers may not have the choice or availability of a PPX 1 versus PPX 2 vessel given "just in time delivery" practices and a large number of port calls per rotation. In summary, the economic evaluation recognizes and therefore projects that both PPX1 and PPX 2 vessels will call Savannah in the without (42 foot channel) condition. However, because of the cost advantages of PPX1 vessels in the 42 foot channel, the PDT assumed that 50% of the PPX 2 vessels in an unconstrained condition will be deployed on all benefiting trade routes in the without project condition.

The final consideration in the deployment scenario was determining the number of PPX2 vessels to replace the PPX1 vessels. Initially, the PDT assumed that the total number of Post-Panamax vessel calls (PPX1 and PPX2s) would remain the same, but the number of PPX2 vessel calls that were forecasted in MSI's unconstrained condition would replaced by the same number of PPX1 vessel calls. However, as PPX 1 and 2 vessels are both less expensive on a per TEU and tonnage basis, and upon discussion with reviewers the PDT changed the assumption by applying a 140 percent replacement ratio of PPX1 vessels. The 140 percent a TEU capacity equivalency derived by dividing the TEU capacity of the PPX2 vessels by the TEU capacity of the PPX1 (8700/6200).

Table 39 shows the final PPX vessel call forecast for the FE (Panama) ECUS route service. It depicts how at the 42-foot channel depth (the without project condition), both PPX1 and PPX2 vessels call in the without project donation. However, beyond 42 feet, there are expected to be greater numbers of PPX2 calls and fewer PPX1 calls. For this particular route, PPX2 deploy to their full allocation at 44 feet. The vessels could load a little deeper in a 45-foot channel and the Transportation Cost Savings Model picks that up and calculates a "deepening" benefit using the same number of trips but more Savannah cargo. Table 40 and Table 41 show the PPX vessel calls for the ECUS MED and FE (Suez) ECUS services respectively.

[21] To avoid over-claiming benefits, the PDT assumed that vessel operators would only deploy to the threshold of vessels determined by MSI in their vessel forecast for Savannah Harbor, even if the cost analysis shows it clearly advantageous to replace an entire fleet with Post-Panamax vessels.

Table 39: FE (Panama) ECUS Vessel Calls by Class by Year (with 140% replacement ratio)

Vessel Class – Project Depth	2017	2020	2025	2030
PPX1-42	153	349	410	587
PPX2-42	40	109	156	218
PPX1-44	97	196	192	282
PPX2-44	79	218	311	435
PPX1-45	97	196	192	282
PPX2-45	79	218	311	435
PPX1-46	97	196	192	282
PPX2-46	79	218	311	435
PPX1-47	97	196	192	282
PPX2-47	79	218	311	435
PPX1-48	97	196	192	282
PPX2-48	79	218	311	435

Table 40: ECUS MED Vessel Calls by Class by Year

Vessel Class – Project Depth	2017	2020	2025	2030
PPX1-42	13	19	21	27
PPX2-42	3	6	8	10
PPX1-44	8	11	10	13
PPX2-44	6	12	16	20
PPX1-45	8	11	10	13
PPX2-45	6	12	16	20
PPX1-46	8	11	10	13
PPX2-46	6	12	16	20
PPX1-47	8	11	10	13
PPX2-47	6	12	16	20
PPX1-48	8	11	10	13
PPX2-48	6	12	16	20

Table 41: FE (Suez) ECUS Vessel Calls by Class by Year

Vessel Class – Project Depth	2017	2020	2025	2030
PPX1-42	147	234	266	368
PPX2-42	36	73	101	137
PPX1-44	97	122	124	165
PPX2-44	72	137	200	255
PPX1-45	97	118	120	160
PPX2-45	72	132	192	246
PPX1-46	97	116	117	156
PPX2-46	72	129	188	241
PPX1-47	97	116	115	154
PPX2-47	72	129	188	238
PPX1-48	97	116	115	154
PPX2-48	72	129	188	238

3.4.5.5. The Transportation Cost Savings Model

The TCSM combines inputs from the LFA, as well as the cargo and vessel forecasts in determining the total transportation costs (sum of all voyages for all years in the period of analysis) for each project depth.

In running the TCSM, the PDT needed to first disaggregate tonnages carried on Sub-Panamax vessels from the model, though these vessels would not be significantly impacted by any channel deepening. The number of vessel calls required to carry this allocated amount was based on 67% of the historical utilization of Panamax vessels of Savannah's share of vessel capacity for this class.

Next, the PDT allocated the forecasted Post-Panamax cargo volumes to the forecasted Post-Panamax fleet using the forecast of the number of Post-Panamax calls in an unconstrained channel. At certain depths it becomes economically advantageous to switch from a PPX1 vessel to a PPX2 vessel. The number of PPX calls that was predicted by MSI for its unconstrained channel could then be applied. For the 42 foot without condition channel depth, 50% of the unconstrained PPX2 vessels were deployed at Savannah for all benefiting trade routes. In the 42 foot channel, they were replaced by 1.4 PPX 1 vessels as discussed above to account for comparable capacity.

Table 42 shows the average tonnage of Savannah cargo allocated to each Post-Panamax vessel call for the FE (Panama) ECUS and the ECUS EU GULF PEN trade routes by project depth. The average tonnages allocated per call were based on the maximum practicable capacity by vessel class by channel depth (based on the MPD) and the historical share of vessel capacity used for Savannah cargo by vessels calling at Savannah. For most services, the Post-Panamax vessels are able to carry more cargo as the channel depth increases until the vessel capacity is no longer constrained by channel depth. Thus, a PPX2 vessel on the FE-(Panama)-ECUS trade route reaches its maximum average *share* of capacity[22] (10,293 tonnes for imports) at a 45-foot channel depth while on the ECUS-EU-GULF route the maximum share of capacity is not reached until 47 feet. This reflects the differences in trade weight per TEU.

Table 42: Average Metric Tons Carried per Call by Channel Depth - Imports

Vessel Type	Draft (feet)					
	42	44	45	46	47	48
Route: FE-(Panama)-ECUS						
PPX1	6,978	7,344	7,344	7,344	7,344	7,344
PPX2	9,214	10,039	10,293	10,293	10,293	10,293
Route: ECUS-EU-GULF						
PPX1	2,629	2,866	2,984	3,020	3,020	3,020
PPX2	3,472	3,783	3,938	4,093	4,233	4,233
Route: FE (Suez) ECUS						
PPX1	8,557	9,328	9,577	9,577	9,577	9,577
PPX2	11,300	12,311	12,817	13,322	13,423	13,423

The total tons allocated to the PPX class of vessels are then estimated by multiplying the ton per vessel class by the number of the calls per vessel class. This is repeated for each channel depth and for each route service.

The residual forecasted tonnages left after allocation to the Sub-Panamax and PPX vessel classes were then allocated to the Panamax fleet. The number of vessel calls required by this class was based on historical averages of Savannah's share of vessel capacity for the Panamax vessel class.

To summarize, the Sub-Panamax calls reflect historical shares of total tonnage and Savannah's historical share of vessel capacity for this class. The Post-Panamax vessel calls were imputed based on a commodity forecast developed by the PDT and by modifying a methodology applied by MSI in determining the fleet of Post-Panamax vessels calling at Savannah. The Panamax vessel calls reflect the residual forecasted commodities allocated to Panamax vessels based on the historical utilization of Panamax vessel capacity used for Savannah cargo. The flowchart details the many steps used in deriving the transportation savings (Attachment 2).

Table 43 shows the forecasted Savannah calls by vessel class, project year and depth for all route services. This information illustrates how the composition shifts for subsequent project increments. The number and composition of vessel trips remains constant at project depths of 47 and above.

[22] Maximum share of capacity, not the total maximum capacity of the vessel

Table 43: Forecast Vessel Calls by Vessel Size Class, Channel Depth, and Year

42-Foot Depth	2017	2020	2025	2030
SPX	497	593	758	947
PX	1,196	778	1,122	1,196
PPX1	479	866	1,006	1,421
PPX2	120	271	382	527
Total	*2,292*	*2,509*	*3,267*	*4,092*
44-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,135	700	992	1,067
PPX1	312	478	471	672
PPX2	239	533	761	1,035
Total	*2,183*	*2,304*	*2,982*	*3,720*
45-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,109	671	952	1,007
PPX1	312	474	467	666
PPX2	239	527	753	1,027
Total	*2,157*	*2,265*	*2,930*	*3,647*
46-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,096	658	932	982
PPX1	312	471	465	662
PPX2	239	524	749	1,021
Total	*2,144*	*2,247*	*2,903*	*3,613*
47-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,092	649	924	975
PPX1	312	471	462	661
PPX2	239	524	749	1,018
Total	*2,140*	*2,238*	*2,892*	*3,601*
48-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,092	649	924	975
PPX1	312	471	462	661
PPX2	239	524	749	1,018
Total	*2,140*	*2,238*	*2,892*	*3,601*

3.5 Summary Information and Assumptions

1. Post-Panamax Generation 1 ships currently call at Savannah on the FE (Suez) ECUS, ECUS MED, and ECUS EU GULF PEN trade routes that do not transit the Panama Canal.

2. When the expanded Panama Canal opens (estimated to be 2015), PPX ships will call on the Savannah Harbor in both the without- and with-project conditions on the larger trade routes which are currently constrained by the canal - FE (Panama) ECUS, FE ECUS MED PEN, FE ECUS EU PEN and RTW.

3. If Savannah Harbor is deepened, there will be a shift toward PPX2 vessels (47.6 ft. design draft) on routes currently utilizing PPX1 vessels as well as on those routes which transit the Panama Canal.

4. Carrier lines tend to deploy larger vessels on trade routes with deeper channels and large volumes of trade and due to propensity of fewer constraints on operations.

5. Usable tide is based on the tide characteristics of the Savannah River. Pilots are assumed to use tide to their advantage.

6. The required vessel underkeel clearances for safety range from 2.7 feet to 3.0 feet, depending on the size of vessel. These figures were based on present operating practices and validated by pilots. There were also additional clearances for fresh water sinkage, which range from 0.7 to 1.3 feet, again depending on the size of the vessel. The total vessel underkeel clearance requirements range from 3.5 to 4.3 feet.

7. It is assumed that the Garden City Terminal will have a maximum capacity of 6.5 million TEUs, as described by the Garden City Terminal's Master Plan. This estimate was found to be reasonable given the long term commitments from importers at nearby distribution centers, the rapid growth in the U.S. Southeast, and the current throughput rate of nearly 3 million TEUs (and well below its actual capacity) as well as good STS crane and berth productivity. The 6.5 million TEU terminal capacity is forecasted to be reached by 2030; therefore, cargo volumes were held constant beyond this project year.

8. Initially, there was insufficient information available to precisely determine the average weight of those containers that did not originate in or were destined for Savannah. However, PIERS data was compiled for the East Coast according to the traded services and reconciled with data for Savannah for 2007. This analysis enabled reasonable estimation of the average weight per container on board the vessel as it served the East Coast and Savannah. Therefore, an average weight per container was applied for evaluation although it is recognized that some containers are lighter or heavier than the average. Upon discovering that for some trade routes, some vessels ended up exceeding their MPD more than 15% of the time, the PDT calibrated the model using average cargo weights that would not exceed the 85% assumption."

9. Economic speed for vessel cost data by class was about 85% to 90% of service speed capability. Transit speeds for all classes of vessel were adjusted to be uniform for maintenance of schedule and based on current surveys of trading and employment of vessels. Costs were adjusted based on a service speed of 17 knots for all Panamax and Post-Panamax.

10. Estimates of total cargo carried on each vessel class were imputed based on observed sailing drafts and the application of load factor evaluations. Subject evaluations were based on certain critical assumptions including allowances for vacant slots, a minimum number empties, weight, and weight per TEU.

11. The model allocates the forecasted cargo to the PPX classes and the Sub-Panamax class first, based on the PPX capacity forecast, with the residual forecasted cargo allocated to the Panamax class.

12. Over the long term, there are no assumed barriers in the form of limitations on shipyard capacity, availability to finance, etc. It is clear that fleet growth and trade growth are highly correlated. The new building must be ordered to meet net fleet growth and replace those vessels that are scrapped. Over the long term sufficient vessels will be ordered and delivered but the pattern of ordering will not be even. This process is determined by market conditions.

13. Base year of 2017; Federal Discount Rate of 4.125%

14. The capital improvement plan at Garden City terminal would be consistently applied to the without and with project condition.

4. TRANSPORTATION COST SAVINGS BENEFIT ANALYSIS

NED benefits were estimated by calculating the reduction in transportation cost for each project depth. Channel deepening reduces transportation cost by allowing a more efficient future fleet mix. The TCSM reflects the decisions of vessel fleet owners to allocate their largest vessels to routes that have adequate traffic and reliable project depth. Savannah Harbor is the second largest container port on the east coast and is expected to continue to outperform competing ports. As the Savannah Harbor channel is deepened, the reliability of the channel depth increases. The increased reliability is expected to encourage shippers to replace smaller less efficient vessels with the larger more efficient vessels on Savannah route services.

There are three primary impacts from channel deepening that cause changes in the future fleet at Savannah. The first is increases in a vessel's maximum practicable loading capacity[23]. Channel restrictions limit a vessels capacity by limiting its draft. Deepening the channel reduces this constraint and the vessel's maximum practicable capacity increases towards its design capacity. This increase in vessel capacity results in fewer vessel trips being required to transport the forecasted cargo. The second impact of increased channel depth is the increased reliability of water depth, which encourages the deployment of larger vessels to Savannah. The third impact is a consequence of the second. The increase in Post-Panamax vessels displaces the less economically efficient Panamax class vessels.

Forecasted commodities were allocated to the future fleet in the following manner. First, a share of future tonnage was allocated to the sub-Panamax vessel class. As this fleet was not constrained by the existing depth (the maximum design draft was less than 35 feet), additional project depth would not affect the future fleet for this class of vessels and market. The allocation of future traffic to this vessel class was based on its historical share at Savannah and with an expected drop in SPX capacity of approximately 33 percent between now and 2015. The allocation varies by route and overall accounts for about a small percentage of the forecasted traffic.

The second allocation was to the forecasted Post-Panamax container fleet. Traditional Corps' analysis for bulk commodities would require the analyst to "load" each vessel to a specific channel-constrained depth and compute the transportation costs. This was not done in the TCSM. Container vessels are not characterized by "there and back again" routes common to the bulk cargo trade. Container vessels are deployed on liner service routes which often serve 5 to 15 ports, with some routes serving as many as 20 ports. The sailing drafts into and out of each port can vary widely. The TCSM model does not explicitly account for vessel sailing drafts. Rather, based on historical data, the share of a vessel's capacity that is used to load and off load cargo at Savannah was calculated for the existing Panamax class fleet for each trade route. Table

[23] The practicable loading capacity is more fully explained in the "Load Factor Analysis" section.

44 shows the share of vessel capacity used for imports and exports by route service. The FE (Suez) ECUS and FE (Panama) ECUS services received and delivered the highest share of cargo and thus their share of the future capacity is higher.

Table 44: Savannah Share of Vessel Capacity Utilized by Route[24]

Route Service	Share
FE (Panama) ECUS	17.15%
FE (Suez) ECUS	20.87%
FE ECUS EU PEN	16.04%
FE ECUS MED PEN	15.82%
AU ECUS EU PEN	7.83%
ECUS AU PEN	6.05%
ECUS EU GULF PEN	6.24%
ECUS MED	7.17%
ECUS WCSA-ECSA	16.64%
RTW	9.02%

This percent of vessel capacity utilized by Savannah trade was applied to the maximum practicable vessel capacity of the forecasted Post-Panamax vessels. Table 45 shows the maximum practicable capacity for PPX1 vessels by route service and channel depth. Table 46 shows the same information for the PPX2 vessel class, which are designed to carry more tonnage.

Table 45: Maximum Practicable Capacity by Service Route - PPX1 - Metric Tons

World Region Route	Channel Depth (feet)					
	42	44	45	46	47	48
RTW	42,153	45,951	47,850	48,419	48,419	48,419
FE (Suez) ECUS	41,001	44,694	45,888	45,888	45,888	45,888
FE (Panama) ECUS	40,685	42,820	42,820	42,820	42,820	42,820
FE ECUS MED PEN	41,511	45,250	47,120	47,284	47,284	47,284
FE ECUS EU PEN	41,044	44,673	44,673	44,673	44,673	44,673
ECUS AU PEN	42,651	46,493	48,414	48,991	48,991	48,991
ECUS EU GULF PEN	42,160	45,958	47,857	48,427	48,427	48,427
ECUS MED	42,457	46,282	48,195	48,769	48,769	48,679
ECUS WCSA-ECSA	41,296	45,016	46,803	46,803	46,803	46,803
AU ECUS EU PEN	42,891	46,755	48,687	49,267	49,267	49,267

[24] Used for allocating Savannah's share of tonnage on Post-Panamax vessels

Table 46: Maximum Practicable Capacity by Service Route - PPX2 - Metric Tons

World Region Service	Channel Depth (feet)					
	42	44	45	46	47	48
RTW	55,665	60,645	63,135	65,624	67,865	67,865
FE (Suez) ECUS	54,143	58,986	61,408	63,830	64,313	64,313
FE (Panama) ECUS	53,726	58,532	60,014	60,014	60,014	60,014
FE ECUS MED PEN	54,816	59,720	62,172	64,624	66,271	66,271
FE ECUS EU PEN	54,199	59,048	61,473	62,611	62,611	62,611
ECUS AU PEN	56,322	61,360	63,879	66,399	68,666	68,666
ECUS EU GULF PEN	55,673	60,654	63,144	65,634	67,876	67,876
ECUS MED	56,066	61,082	63,590	66,098	68,355	68,355
ECUS WCSA-ECSA	54,533	59,411	61,851	64,290	65,596	65,596
AU ECUS EU PEN	56,639	61,706	64,240	66,773	69,053	69,503

Table 47 shows the estimated tonnage carried per call for the Post-Panamax fleet by project depth for imports on the FE (Panama) ECUS route service and the ECUS EU GULF PEN route service. For example, given a 44-foot channel, a PPX2 vessel on the FE (Panama) ECUS route service, would carry 10,039 metric tons of Savannah cargo. This is the product of 58,532 (from Table 46) times 17.15% (from Table 44).

Table 47: Average Tonnage Carried Per Call by Channel Depth - Imports

Vessel Class	Draft (feet)					
	42	44	45	46	47	48
Route: FE (Panama) ECUS						
PPX1	6,978	7,344	7,344	7,344	7,344	7,344
PPX2	9,214	10,039	10,293	10,293	10,293	10,293
Route: ECUS EU GULF PEN						
PPX1	2,629	2,866	2,984	3,020	3,020	3,020
PPX2	3,472	3,783	3,935	4,093	4,233	4,233
Route: FE (Suez) ECUS						
PPX1	8,557	9,328	9,577	9,577	9,577	9,577
PPX2	11,300	12,311	12,817	13,322	13,423	13,423

These average tonnages per trip were then multiplied by the forecasted number of trips for each Post-Panamax vessel fleet in order to calculate the share of the forecasted tonnages carried by this vessel class. The remaining, unallocated forecasted cargo was then assigned to the Panamax class fleet (Figure 32).

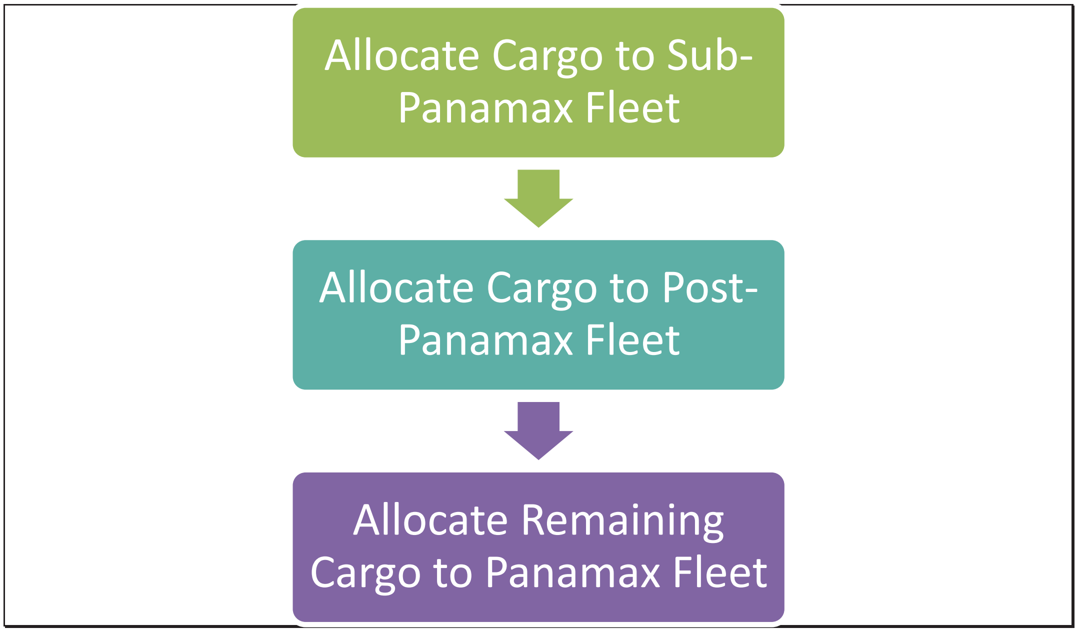


Figure 32: Order of Cargo Allocation (by fleet type)

Table 48 shows the corresponding number of trips required to move the allocated cargo, by vessel class, channel depth and forecast year.

Table 48: Vessel Trips by Year, Vessel Class, and Channel Depth

42-Foot Depth	2017	2020	2025	2030
SPX	497	593	758	947
PX	1,196	778	1,122	1,196
PPX1	479	866	1,006	1,421
PPX2	120	271	382	527
Total	*2,292*	*2,509*	*3,267*	*4,092*
44-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,135	700	992	1,067
PPX1	312	478	471	672
PPX2	239	533	761	1,035
Total	*2,183*	*2,304*	*2,982*	*3,720*
45-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,109	671	952	1,007
PPX1	312	474	467	666
PPX2	239	527	753	1,027
Total	*2,157*	*2,265*	*2,930*	*3,647*
46-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,096	658	932	982
PPX1	312	471	465	662
PPX2	239	524	749	1,021
Total	*2,144*	*2,247*	*2,903*	*3,613*
47-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,092	649	924	975
PPX1	312	471	462	661
PPX2	239	524	749	1,018
Total	*2,140*	*2,238*	*2,892*	*3,601*
48-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,092	649	924	975
PPX1	312	471	462	661
PPX2	239	524	749	1,018
Total	*2,140*	*2,238*	*2,892*	*3,601*

4.1. Estimated Share of World Fleet

The previous table provided the number of vessel calls forecast for the Savannah Harbor. The estimated number of vessels required to transport the forecast cargo is shown in the following tables. The values for number of vessels shown in Table 49 and 50 are approximate, or equivalent number of vessels, assuming an average string (service) of vessels is made up of 9 vessels calling weekly. These equivalent vessel numbers are a result of dividing the number of vessel calls in table 48 by 52 weeks and multiplying by 9 vessels per service. While some services have fewer than 9 vessels and some have more depending upon the frequency of service and the distance of the trade route, 9 vessels is a general average as is the weekly service calls.

The percent of world fleet values shown in the table is derived by simply dividing the equivalent number of vessels in given year by the number of vessels in the respective classes by the historic and projected world fleet presented earlier in this appendix.

The purpose of this analysis and presentation is to serve as a cross check on the reasonableness of the projected number of vessel calls by comparing them to the historic and future world fleet. As shown in table 49, in 2007 PMX vessels (3900 to 5200 TEUs) calling Savannah amounted to a historic high of about 37% of the world fleet. As PPX vessels began calling Savannah in 2006, the percent share of PMX vessels calling Savannah began to decline to about 27% in 2010. As shown in Table 50, In the without project, 42 foot channel conditions, PPX 1 vessels (5200 to 7600 TEUs) are projected to call in greater numbers and become the most common vessel class calling in both total number of equivalent vessels calling and as a percent of the world fleet of that class of vessels reaching about 29% in 2030. For the 47 foot channel with project condition PPX2 vessels (7600 to 12000 TEUs) become the most common vessels reaching about 24% of the world fleet of that class. For the combined number of PPX1 and PPX2 vessels calling in 2030, they would be about 20 percent of the combined number of vessels projected in the world fleet.

The conclusion of this "backcheck" confirms that the projected vessel calls do not result in an inordinate amount of world fleet projected to call Savannah in the without or with project conditions, and supports the reasonableness of the TCSM results regarding vessel calls.

Table 49: Historic Percent of World Fleet Calling Once Per Week on Savannah [25]

	2000		2005		2007		2010	
42 ft. depth	**Vessels**	**% World Fleet**	**Vessels**	**% World Fleet**	**Vessels**	**% World Fleet**	**Vessels**	**% World Fleet**
SPX	100	4%	102	4%	121	4%	90	3%
PX	20	10%	125	34%	178	37%	190	27%
PPX1	0	0%	0	0%	13	4%	37	8%
PPX2	0	0%	0	0%	0	0%	1	0%
Total	158	4%	227	6%	312	7%	318	7%

[25] It is assumed that there are 9 vessels calling weekly on each 'string.'

Table 50: Percent of World Fleet Utilized on Average Calling Savannah Once Per Week

	2017		2020		2025		2030	
	Vessels	% World Fleet	Vessels	% World Fleet	Vessels	% World Fleet	Vessels	% World Fleet
42 ft. depth								
SPX	86	2%	91	2%	117	2%	146	3%
PX	207	25%	120	14%	173	19%	184	19%
PPX1	83	15%	133	23%	155	24%	219	29%
PPX2	21	4%	42	8%	59	9%	81	11%
Total	397	7%	386	6%	503	6%	629	9%
44 ft. depth								
SPX	86	2%	103	3%	131	2%	164	4%
PX	196	24%	121	15%	172	19%	185	19%
PPX1	54	10%	83	14%	81	12%	116	16%
PPX2	41	9%	92	18%	132	21%	179	24%
Total	378	7%	399	7%	516	6%	644	9%
45 ft. depth								
SPX	86	2%	103	3%	131	2%	164	4%
PX	192	23%	116	14%	165	18%	174	18%
PPX1	54	10%	82	14%	81	12%	115	15%
PPX2	41	9%	91	18%	130	21%	178	24%
Total	373	7%	392	6%	507	6%	631	9%
46-foot depth								
SPX	86	2%	103	3%	131	2%	164	4%
PX	190	23%	114	14%	161	18%	170	17%
PPX1	54	10%	82	14%	80	12%	115	15%
PPX2	41	9%	91	18%	130	21%	177	24%
Total	371	7%	389	6%	503	6%	625	9%
47 ft. depth								
SPX	86	2%	103	3%	131	2%	164	4%
PX	189	23%	112	14%	160	18%	169	17%
PPX1	54	10%	82	14%	80	12%	114	15%
PPX2	41	9%	91	18%	130	21%	176	24%
Total	370	7%	387	6%	501	6%	623	9%

4.2. Calculation of Transportation Costs

The transportation costs are calculated for each route service by project year for each project depth. The lowest level calculation multiplies the number of calls by vessel class by route service (by year by project depth) times the voyage cost per 1,000 nautical miles by vessel class, times the Savannah portion of the total route service distance/1,000. This is done across all vessel classes and all project depths and all route services for forecast years, 2017, 2020, 2025 and 2030.

4.2.1. Voyage Cost by Vessel Class

The TCSM model disaggregates the four vessel classes used in this report (SPX, PX, PPX1, and PPX2) into even smaller, sub-categories. For example, there are 7 sub-categories within the Panamax vessel class. Table 51 presents each vessel class broken down with its associated voyage cost per 1000 nautical miles. The voyage costs are based on EGM 08-04: Deep Draft vessel operating cost adjusted for a 17 knot operating speed.

Table 51: Voyage Cost per 1000 Nautical Miles and Other Selected Statistics

	Vessel Class Number	Voyage Cost per 1000 Nautical Miles	TEU Rating Homogeneous (14THM)	TEU Rating Nominal	Aggregate MXSLLD Draft-Feet	Aggregate Length Overall (Feet)	Aggregate Length Between Perpendiculars (feet)	Aggregate Breadth (Feet)	Deadweight Tonnage (DWT; Metric)
Sub-Panamax	4	$26,172	838	907	26.2	466	435	73	11,726
	5	$30,728	1,066	1,090	28.9	499	466	79	14,924
	6	$35,733	1,317	1,388	30.3	535	502	85	18,438
	7	$38,874	1,474	1,447	31.3	571	534	87	20,643
	8	$41,070	1,585	1,529	32.5	576	540	84	22,184
	9	$44,059	1,734	1,618	33.5	585	549	90	24,283
	10	$44,814	1,772	1,778	34.6	596	559	92	24,812
	11	$45,608	1,812	1,894	35.6	603	566	92	25,370
	12	$53,826	2,224	2,268	36.2	657	621	98	31,139
	13	$57,740	2,420	2,470	37.6	676	636	99	33,887
Panamax	14	$69,558	3,013	3,084	38.5	777	729	105	42,183
	15	$71,165	3,094	3,188	39.4	766	723	104	43,311
	16	$73,558	3,214	3,389	40.3	794	753	106	44,991
	17	$80,794	3,576	3,841	41.2	846	801	106	50,070
	18	$90,369	4,057	4,125	42.5	907	859	106	56,792
	19	$87,652	3,920	3,993	43.4	887	839	104	54,885
	20	$101,999	4,640	4,729	44.4	959	921	106	64,956
PPX1	27	$104,391	5,291	6,186	46.0	954	905	132	74,069
PPX2	41	$138,722	7,415	8,670	47.6	1,106	1,060	143	103,817

4.2.2. Calculation of Distances for Each Route

Voyage distance is another factor considered when determining the transportation costs and was calculated for each benefiting service. Since there may be many individual services within each trade route, the itineraries for each of the 47 services calling on the Savannah Harbor were determined. The vessel call list included over 20 domestic and foreign ports for some of the pendulum services and as few as 5 ports on smaller service routes. After identifying the port rotation for each individual service, the distance between the respective ports on each list was determined. As an example, the itinerary for the four individual services which comprise the

ECUS EU GULF PEN world region service is shown in Table 52. The sum of the distances between all of the ports comprises what is known as “circuit miles.

Table 52: ECUS EU GULF PEN World Region Service - Individual Service Rotations

GAX		TA2		MSEUF		MSCEU	
Port Rotation	**Distance from Previous Port**	**Port Rotation**	**Distance from Previous Port**	**Port Rotation**	**Distance from Previous Port**	**Port Rotation**	**Distance from Previous Port**
Savannah		Savannah		Antwerp		Savannah	
Norfolk	480	Mobile	1,067	Hamburg	351	Charleston	72
Antwerp	3,463	Houston	434	Bremerhaven	90	Antwerp	3,754
Thamesport	134	Miami	935	Felixstowe	290	Felixstowe	116
Bremerhaven	325	Norfolk	759	Le Havre	174	Bremerhaven	290
Charleston	3,887	Rotterdam	3,491	Valencia	1,533	LeHavre	441
Miami	423	Felixstowe	125	Charleston	3,987	Charleston	3,587
Houston	935	Bremerhaven	290	Savannah	72	Savannah	72
Savannah	1,316	New York/NJ	3,419	Port Everglades	362	Port Everglades	362
Total Distance	**10,963**	Charleston	618	Freeport	76	Freeport	76
		Savannah	72	Vera Cruz	1,066	Veracruz	1,066
		Total Distance	**11,210**	Altamira	237	Altamira	237
				Houston	466	Houston	466
				New Orleans	399	New Orleans	399
				Freeport	816	Freeport	816
				Savannah	353	Savannah	353
				Chas	72	**Total Distance**	**12,107**
				Antwerp	3,754		
				Total Distance	**14,098**		

Once the voyage distances were determined, the TEU capacity of each service was determined. First, the number of vessels on each service was multiplied by the average TEU capacity of the vessels utilized on that service. Next, the TEU capacities of each individual service were summed to establish the TEU capacity of the world region service. The total TEU capacity of the world region service was then divided by individual service capacity to determine what percent of world region service’s TEU capacity could be attributed to each individual service. The percent share for each individual service was then multiplied by the total distance for that service to establish the weighted mileage for that service. This calculation process was repeated for each service on the world region service; the distances were then summed to establish the total distance to be used for the world region service. This process is illustrated in Table 53 below.

Table 53: ECUS EU GULF PEN World Region Service - Distance Calculation

Service	Number of Vessels	Avg TEU Capacity/ Vessel	Total TEU Capacity	Percent Share	Circuit Miles	Weighted Mileage
GAX	5	3,200	16,000	12%	10,963	1,304
TA2	5	4,100	20,500	15%	11,210	1,708
MSEUF	8	6,567	52,536	39%	14,098	5,505
MSCEU	7	6,500	45,500	34%	12,107	4,095
ECUS EU GULF PEN			**134,536**			**12,612**

The weighted mileage calculation was performed for each world region service, following the steps identified above. Table 54 shows the results of this evaluation.

Table 54: World Region Service - Total Trip Distance

World Region Service	Total Trip Distance
ECUS Africa	discontinued in 2006
FE (Panama) ECUS	22,653
FE (Suez) ECUS	24,196
FE ECUS EU PEN	31,356
FE ECUS MED PEN	34,321
AU ECUS EU PEN	28,526
ECUS AU PEN	21,614
ECUS EU GULF PEN	12,612
ECUS MED	10,568
ECUS WCSA-ECSA	11,701
RTW	25,753

4.2.3. Savannah Portion of the Total Route Service Distance and Share of Voyage Costs

The basic transportation cost model computes the costs per thousand miles for the forecasted vessel calls for the without and with project condition. The savings in costs between the without and with project condition make up the transportation cost savings benefits per thousand miles. The total trade route distance is then determined based on the weighted average origin-to-destination distances as discussed above. It should be noted that improvements at Savannah Harbor which result in fewer container vessel trips to the port does not necessarily translate into similar reductions in vessel trips for the entire trades routes that service Savannah harbor. Port rotations are constantly changing. Therefore, to estimate actual transportation cost savings attributable to changes at Savannah Harbor, the amount of total round trip vessel cost savings is multiplied ***by Savannah's cargo share of vessel utilization when calling at Savannah***. In essence, the voyage cost is "allocated" based on Savannah's share of all cargo on vessels calling at Savannah.

To determine how much "weight" or vessel cost "allocation" to attribute to Savannah Harbor improvements, the study team first examined Savannah's historical share of cargo for each trade route, specifically the 2005/2007 cargo plus weight of all laden and empty boxes The historical data for vessel calls at Savannah provided information as to number of TEUs and cargo weight, expressed in tons, of laden TEUs off loaded (Inbound/Import) and on loaded (Outbound/Export) at Savannah, but it unfortunately did not include total number of TEUs or weight (tons) of carried on the vessels when they sailed in and out of Savannah. In addition, the historical data did not include total TEUs or weight of cargo on the entire trade route. Therefore, to estimate Savannah's share of trade route cargo, the study team needed to use proxies derived from the LFA and the analysis of sailing draft relative to design draft.

Recall that the container vessels contained a mix of cargo originating from and going to multiple ports and that a certain share of each vessel's cargo was exclusive to Savannah.

The total tonnage is imputed by using the total carriage weight from the LFA for each vessel by sailing draft relative to design draft from the historical calls.

Equation 3: Percent of Savannah Cargo on All Vessels and Trips for Each Route

% of Savannah Cargo on All Vessels and Trips for Each Route =

(Total tons of Savannah cargo, carriage, etc. from all calls on route)/
(Total tons of cargo, carriage, etc. for all calls to Savannah on route

Table 55: Percent of Vessel Cargo Allocated to Savannah

Service Route	Calculated % Savannah Tonnage of All	Savannah Cargo (tons) - Numerator	Est. Total Cargo for all Vessels @ Savannah - Denominator
FE (Panama) ECUS	24.48%	10,327,722	42,182,468
FE (Suez) ECUS	32.45%	2,562,763	7,897,620
FE ECUS EU PEN	20.21%	2,141,636	10,595,409
FE ECUS MED PEN	20.38%	1,452,782	7,128,748
AU ECUS EU PEN	16.00%	699,835	4,373,929
ECUS AU PEN	15.99%	50,805	317,775
ECUS EU GULF PEN	9.40%	377,601	4,014,935
ECUS MED	15.31%	855,804	5,590,178
ECUS WCSA-ECSA	11.49%	213,813	1,860,444
RTW	11.86%	216,005	1,820,758
Total		**18,898,766**	**85,782,264**

The following table shows the weighted average estimated Savannah share of trade route cargo carried by Panamax ships on each trade route when the vessels call the Savannah port[26].

Table 56: Savannah Share of Voyage Cost

Service Route	Weight	Route Service Distance	Savannah Proportion
FE (Panama) ECUS	24.48%	22,653	5,572
FE (Suez) ECUS	32.45%	24,196	7,852
FE ECUS EU	20.21%	31,356	6,337
FE ECUS MED PEN	20.38%	34,321	6,994
AU ECUS EU	16.00%	28,526	4,564
ECUS AU PEN	15.99%	21,614	3,456
ECUS EU GULF PEN	9.40%	12,612	1,185
ECUS MED	15.31%	10,568	1,618
ECUS WCSA-ECSA	11.49%	11,701	1,344
RTW	11.86%	25,753	3,054

4.3. Transportation Cost Savings Benefits by Project Depth

The total transportation cost savings benefits were estimated for a 50-year period of analysis for the years 2017 through 2066. Transportation cost savings were estimated using the TCSM for the years 2017, 2020, 2025 and 2030. Since Garden City terminal capacity of 6.5 million TEUs is expected to be reached by 2030, the transportation cost savings were held constant beyond 2030. The present value was estimated by interpolating between the aforementioned dates and discounting at the current FY 2011 Federal Discount rate of 4.125 percent. Estimates were determined for each alternative project depth. Table 57 shows the average annual equivalent transportation cost savings by project depth by trade service route. The FE (Panama) ECUS, the FE ECUS EU PEN, and the FE ECUS MED PEN are all services that transit the Panama Canal. Combined with the FE (Suez) ECUS service, which transits the Suez Canal, these 4 trade route services comprise more than ninety percent of the total transportation cost savings. For the FE (Panama) ECUS world region service, the savings do not increase beyond a 45-foot project as the vessels on this route are generally expected to “cube” out by that depth due to relatively light cargo. On the FE ECUS EU PEN savings do not increase beyond a 46-foot project depth. The FE (Suez) ECUS service, with its large make-up of heavier imports as well as a large forecasted contingent of Post-Panamax vessels, will continue to reap cost savings as the channel is deepened to 47 feet. For five services, transportation savings continue to accrue with a 47-project depth due to the fact that vessels are expected draft deeper and, at times, attain full design draft.

[26] Note the FE (Suez) ECUS and ECUS EU GULF account for both Post-Panamax and Panamax vessels in the weighted average.

Table 57: AAE Transportation Cost Savings by Project Depth

Service Route	42 feet	44 feet	45 feet	46 feet	47 feet	48 feet
FE (Panama) ECUS	$ -	$ 37,020,000	$ 46,520,000	$ 46,520,000	$ 46,520,000	$ 46,520,000
FE (Suez) ECUS	$ -	$ 31,670,000	$ 44,230,000	$ 53,560,000	$ 54,500,000	$ 54,500,000
FE ECUS EU PEN	$ -	$ 14,740,000	$ 19,900,000	$ 22,330,000	$ 22,330,000	$ 22,330,000
FE ECUS MED PEN	$ -	$ 10,720,000	$ 16,340,000	$ 20,210,000	$ 22,700,000	$ 22,700,000
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 600,000	$ 910,000	$ 1,150,000	$ 1,330,000	$ 1,330,000
ECUS MED	$ -	$ 550,000	$ 830,000	$ 1,050,000	$ 1,220,000	$ 1,220,000
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 2,910,000	$ 4,420,000	$ 5,560,000	$ 6,450,000	$ 6,450,000
Total AAE Benefits	$ -	$ 98,210,000	$ 133,150,000	$ 150,370,000	$ 155,040,000	$ 155,040,000
Present Value End of Period Basis		$ 2,065,320,000	$ 2,800,050,000	$ 3,162,200,000	$ 3,260,590,000	$ 3,260,590,000

Table 58 shows the incremental average annual equivalent transportation cost savings by project and route service. The savings increase at a decreasing rate for each incremental project depth. There were small additional savings at 47 feet but no incremental savings beyond that depth. This is due primarily to the size of vessels anticipated to make use of the Savannah Harbor on a regular basis.

Table 58: Incremental Transportation Cost Savings by Project Depth

Service Route	42 feet	44 feet	45 feet	46 feet	47 feet	48 feet
FE (Panama) ECUS	$ -	$ 37,020,000	$ 9,500,000	$ -	$ -	$ -
FE (Suez) ECUS	$ -	$ 31,670,000	$ 12,560,000	$ 9,330,000	$ 950,000	$ -
FE ECUS EU PEN	$ -	$ 14,740,000	$ 5,170,000	$ 2,430,000	$ -	$ -
FE ECUS MED PEN	$ -	$ 10,720,000	$ 5,620,000	$ 3,870,000	$ 2,490,000	$ -
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 600,000	$ 310,000	$ 230,000	$ 180,000	$ -
ECUS MED	$ -	$ 550,000	$ 290,000	$ 220,000	$ 170,000	$ -
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 2,910,000	$ 1,500,000	$ 1,150,000	$ 890,000	$ -
Total AAE Benefits	*$ -*	*$ 98,210,000*	*$ 34,940,000*	*$ 17,220,000*	*$ 4,680,000*	*$ -*
Present Value End of Period Basis		*$ 2,065,320,000*	*$ 734,730,000*	*$ 362,150,000*	*$ 98,390,000*	*$ -*

5. SENSITIVITY ANALYSES

The Principles & Guidelines and subsequent ER1105-2-100 recognize the inherent variability to water resources planning. Navigation projects and container studies in particular are fraught with uncertainty about future conditions. A sensitivity analysis is a useful technique that addresses uncertainty by systematically adjusting parameters in a model to determine the effects of such changes.

After completing the transportation cost model for the base condition, the study team performed sensitivity analysis by varying major input assumptions of the base condition (i.e., to explore analysis sensitivity and resultant changes in benefits and vessel calls). The types of sensitivity analyses were developed by the PDT to address specific areas of uncertainty and issues and questions raised during review of the draft report. Some sensitivities which had been presented in the draft report were dropped either because they were redundant and did not provide additional insights, or because they were determined to be no longer relevant. In addition, some sensitivities have been added to address specific questions raised and/or because of recognition of particular areas of uncertainty not considered in prior evaluations. The sensitivities have also been reorganized from the draft report and are grouped by the general categories of: sensitivities to the commodity forecasts, sensitivities to vessel availability and loadings, and other sensitivities. The following is a listing of the sensitivity analyses:

Sensitivities to Commodity Forecasts

1. Increase annual commodity growth by 1%
2. Increase annual commodity growth by 3%
3. Decrease annual commodity growth by 1%
4. Decrease annual commodity growth by 3%
5. No growth in commodity forecast

Sensitivities to Vessel Availability and Loadings

6. Historical Sub-Panamax share of Capacity Calling
7. Reduce future Sub-Panamax share of Capacity Calling
8. Increase amount of Savannah Cargo carried on Post-Panamax Vessels
9. Full deployment of Post-Panamax Vessels in Without (42 ft) Project Condition
10. Reduce Post-Panamax Vessel Calls by 25%
11. Deployment of Post-Panamax Vessels by Unit Costs
12. Increase Post-Panamax Vessel Loading beyond Maximum Practicable Capacity
13. Reduce PPX 1 Replacement of PPX2 Vessels, Use historical Sub-Panamax share of capacity calling, and Deploy PPX Vessels by unit costs

Other Sensitivities

14. Increase Cargo density
15. Increase Savannah Share of Trade Route Cargo by 25%
16. Decrease Savannah Share of Trade Route Cargo by 25%
17. Draft Report Values – for comparison purposes

5.1. Sensitivities to Commodity Forecast

5.1.1. Sensitivity 1: Increase Annual Commodity Growth by 1%

For this sensitivity analysis, the commodity growth forecast was adjusted upward by 1 percent per year. If, for example, on a particular route the rate of growth in the base line forecast was 3 percent between two particular years, 4 percent was used for that period in this analysis. With this adjustment, the resultant TEU forecast for 2030 is 7.8 million, compared to 6.5 million in the baseline, an increase of about 20 percent. Table 59 shows the results of the TCSM benefits with the higher growth rate. Average annual equivalent transportation cost savings are about 19 percent greater than the baseline. These benefits are attainable only if this increased growth rate occurs AND throughput capacity of the container terminal is sufficient to handle 7.8 million TEUS in 2030. Otherwise, with a 6.5 million TEU throughput capacity limitation the benefits are over stated. Table 60 shows vessels calls by year, alternative channel depth, and vessel class. They too are substantially higher than the baseline.

Table 59: Sensitivity 1 – Increase Annual Commodity Growth by 1% - AAE Transportation Cost Savings

Service Route	42 feet	44 feet	45 feet	46 feet	47 feet	48 feet
Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 43,890,000	$ 55,160,000	$ 55,160,000	$ 55,160,000	$ 55,160,000
FE (Suez) ECUS	$ -	$ 38,200,000	$ 53,080,000	$ 63,520,000	$ 65,150,000	$ 65,150,000
FE ECUS EU PEN	$ -	$ 17,460,000	$ 23,590,000	$ 26,460,000	$ 26,460,000	$ 26,460,000
FE ECUS MED PEN	$ -	$ 12,700,000	$ 19,360,000	$ 23,950,000	$ 26,900,000	$ 26,900,000
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 720,000	$ 1,080,000	$ 1,360,000	$ 1,570,000	$ 1,570,000
ECUS MED	$ -	$ 650,000	$ 990,000	$ 1,240,000	$ 1,440,000	$ 1,440,000
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 3,450,000	$ 5,230,000	$ 6,590,000	$ 7,650,000	$ 7,650,000
Total AAE Benefits	*$ -*	*$ 117,060,000*	*$ 158,490,000*	*$ 178,290,000*	*$ 184,340,000*	*$ 184,340,000*
Service Route	**42 feet**	**44 feet**	**45 feet**	**46 feet**	**47 feet**	**48 feet**
Incremental Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 43,890,000	$ 11,270,000	$ -	$ -	$ -
FE (Suez) ECUS	$ -	$ 38,200,000	$ 14,890,000	$ 10,440,000	$ 1,630,000	$ -
FE ECUS EU PEN	$ -	$ 17,460,000	$ 6,130,000	$ 2,880,000	$ -	$ -
FE ECUS MED PEN	$ -	$ 12,700,000	$ 6,660,000	$ 4,590,000	$ 2,950,000	$ -
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 720,000	$ 370,000	$ 280,000	$ 220,000	$ -
ECUS MED	$ -	$ 650,000	$ 340,000	$ 260,000	$ 200,000	$ -
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 3,450,000	$ 1,780,000	$ 1,360,000	$ 1,060,000	$ -
Total	*$ -*	*$ 117,060,000*	*$ 41,430,000*	*$ 19,800,000*	*$ 6,050,000*	*$ -*

Table 60: Sensitivity 1 - Increase Annual Commodity Growth by 1% - Forecast Vessel Calls

42-Foot Depth	2017	2020	2025	2030
SPX	531	652	873	1,144
PX	1,284	854	1,290	1,449
PPX1	509	952	1,159	1,714
PPX2	127	298	440	636
Total	*2,451*	*2,756*	*3,762*	*4,943*
44-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	531	652	873	1,144
PX	1,219	768	1,141	1,285
PPX1	331	525	542	811
PPX2	254	586	877	1,251
Total	*2,335*	*2,531*	*3,433*	*4,491*
45-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	531	652	873	1,144
PX	1,192	737	1,095	1,213
PPX1	331	520	538	805
PPX2	254	579	868	1,241
Total	*2,307*	*2,489*	*3,374*	*4,403*
46-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	531	652	873	1,144
PX	1,178	723	1,075	1,186
PPX1	331	518	534	798
PPX2	254	576	863	1,234
Total	*2,294*	*2,469*	*3,344*	*4,363*
47-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	531	652	873	1,144
PX	1,173	715	1,063	1,174
PPX1	331	516	532	798
PPX2	254	576	863	1,231
Total	*2,289*	*2,460*	*3,331*	*4,347*
48-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	531	652	873	1,144
PX	1,173	715	1,063	1,174
PPX1	331	516	532	798
PPX2	254	576	863	1,231
Total	*2,289*	*2,460*	*3,331*	*4,347*

5.1.2. Sensitivity 2: Increase Annual Commodity Growth by 3%

For Sensitivity Analysis 2, the commodity forecast was adjusted upward by 3 percent per year. If, for example on a particular route the rate of growth in the baseline forecast was 3 percent between two particular years, 6 percent was used for that same period with this analysis. With this adjustment, the resultant TEU forecast for 2030 is 11.4 million, substantially higher than the anticipated Garden City Terminal capacity of 6.5 million TEUs. Table 61 shows the results of the TCSM benefits with the higher growth rate. Average annual equivalent transportation cost savings are about 67 percent greater than the baseline. These benefits are attainable only if this increased growth rate occurs AND if throughput capacity of the Garden City container terminal is sufficient to handle 11.4 million TEUS in 2030. Otherwise, with a 6.5 million TEU throughput capacity limitation the benefits are over stated. Table 62 shows vessels calls by year, alternative channel depth, and vessel class. Forecast vessel calls are substantially higher than the baseline and likely greater than harbor capacity regardless of TEU throughput capabilities.

Table 61: Sensitivity 2 – Increase Annual Commodity Growth by 3% - AAE Transportation Cost Savings

Service Route	42 feet	44 feet	45 feet	46 feet	47 feet	48 feet
Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 61,620,000	$ 77,460,000	$ 77,460,000	$ 77,460,000	$ 77,460,000
FE (Suez) ECUS	$ -	$ 53,440,000	$ 74,340,000	$ 88,990,000	$ 91,240,000	$ 91,240,000
FE ECUS EU PEN	$ -	$ 24,480,000	$ 33,090,000	$ 37,140,000	$ 37,140,000	$ 37,140,000
FE ECUS MED PEN	$ -	$ 17,800,000	$ 27,140,000	$ 33,590,000	$ 37,740,000	$ 37,740,000
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 1,010,000	$ 1,520,000	$ 1,910,000	$ 2,210,000	$ 2,210,000
ECUS MED	$ -	$ 910,000	$ 1,390,000	$ 1,750,000	$ 2,030,000	$ 2,030,000
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 4,840,000	$ 7,340,000	$ 9,240,000	$ 10,730,000	$ 10,730,000
Total AAE Benefits	*$ -*	*$ 164,090,000*	*$ 222,280,000*	*$ 250,090,000*	*$ 258,560,000*	*$ 258,560,000*
Service Route	**42 feet**	**44 feet**	**45 feet**	**46 feet**	**47 feet**	**48 feet**
Incremental Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 61,620,000	$ 15,840,000	$ -	$ -	$ -
FE (Suez) ECUS	$ -	$ 53,440,000	$ 20,900,000	$ 14,650,000	$ 2,250,000	$ -
FE ECUS EU PEN	$ -	$ 24,480,000	$ 8,610,000	$ 4,040,000	$ -	$ -
FE ECUS MED PEN	$ -	$ 17,800,000	$ 9,340,000	$ 6,450,000	$ 4,150,000	$ -
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 1,010,000	$ 510,000	$ 390,000	$ 300,000	$ -
ECUS MED	$ -	$ 910,000	$ 480,000	$ 360,000	$ 280,000	$ -
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 4,840,000	$ 2,500,000	$ 1,910,000	$ 1,490,000	$ -
Total	*$ -*	*$ 164,090,000*	*$ 58,190,000*	*$ 27,800,000*	*$ 8,480,000*	*$ -*

Table 62: Sensitivity 2 - Increase Annual Commodity Growth by 3% - Forecast Vessel Calls

42-Foot Depth	2017	2020	2025	2030
SPX	605	786	1,154	1,662
PX	1,477	1,027	1,701	2,091
PPX1	572	1,146	1,533	2,491
PPX2	143	358	581	923
Total	*2,797*	*3,317*	*4,970*	*7,167*
44-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	605	786	1,154	1,662
PX	1,403	924	1,504	1,853
PPX1	372	632	717	1,179
PPX2	286	705	1,160	1,817
Total	*2,666*	*3,046*	*4,535*	*6,511*
45-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	605	786	1,154	1,662
PX	1,372	886	1,442	1,748
PPX1	372	627	712	1,169
PPX2	286	698	1,147	1,802
Total	*2,635*	*2,995*	*4,456*	*6,382*
46-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	605	786	1,154	1,662
PX	1,356	869	1,416	1,710
PPX1	372	623	706	1,160
PPX2	286	694	1,141	1,793
Total	*2,619*	*2,972*	*4,417*	*6,324*
47-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	605	786	1,154	1,662
PX	1,351	860	1,399	1,691
PPX1	372	621	704	1,160
PPX2	286	694	1,141	1,788
Total	*2,614*	*2,961*	*4,399*	*6,300*
48-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	605	786	1,154	1,662
PX	1,351	860	1,399	1,691
PPX1	372	621	704	1,160
PPX2	286	694	1,141	1,788
Total	*2,614*	*2,961*	*4,399*	*6,300*

5.1.3. Sensitivity 3: Decrease Annual Commodity Growth by 1%

For this sensitivity analysis, the commodity forecast was adjusted downward by 1 percent per year. For example, if on a particular route the rate of growth in the baseline forecast was 3 percent between two years, only 2 percent was used for that period in this analysis. With this adjustment, the resultant TEU forecast for 2030 is 5.3 million, compared to 6.5 million in the baseline, a reduction of about 18 percent. With this lower growth rate, the Garden City Terminal does not reach it's build out capacity of 6.5 million TEUs until 2037.

Table 63 shows the results of the TCSM benefits with the lower growth rate. Average annual equivalent transportation cost savings are about 5 percent less than the baseline. There is, however, a small understatement in the benefits presented. Since the TCSM is set to compute benefits for growth up to 2035, approximately 2 years in additional growth and benefits are not included. The results, likewise, show a small increase in incremental benefits between 46 and 47 feet. This is due to the computation of benefits between 2030 and 2035 compared to the base condition which held benefits constant after 2030. Overall, expected annual benefits remain high ranging from about $94 to $147 million for the alternative plans. Table 64 shows vessel calls for each alternative through 2030. As expected, vessel calls for each vessel class are lower than the baseline condition.

Table 63: Sensitivity 3 – Decrease Annual Commodity Growth by 1% - AAE Transportation Cost Savings

Service Route	42 feet	44 feet	45 feet	46 feet	47 feet	48 feet
Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 35,010,000	$ 43,960,000	$ 43,960,000	$ 43,960,000	$ 43,960,000
FE (Suez) ECUS	$ -	$ 30,700,000	$ 42,420,000	$ 50,900,000	$ 52,570,000	$ 52,570,000
FE ECUS EU PEN	$ -	$ 13,950,000	$ 18,820,000	$ 21,100,000	$ 21,100,000	$ 21,100,000
FE ECUS MED PEN	$ -	$ 10,140,000	$ 15,460,000	$ 19,110,000	$ 21,460,000	$ 21,460,000
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 540,000	$ 820,000	$ 1,030,000	$ 1,190,000	$ 1,190,000
ECUS MED	$ -	$ 490,000	$ 740,000	$ 930,000	$ 1,080,000	$ 1,080,000
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 2,760,000	$ 4,180,000	$ 5,260,000	$ 6,100,000	$ 6,100,000
Total AAE Benefits	*$ -*	$ 93,580,000	$ 126,390,000	$ 142,290,000	$ 147,470,000	$ 147,470,000
Service Route	**42 feet**	**44 feet**	**45 feet**	**46 feet**	**47 feet**	**48 feet**
Incremental Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 35,010,000	$ 8,950,000	$ -	$ -	$ -
FE (Suez) ECUS	$ -	$ 30,700,000	$ 11,720,000	$ 8,480,000	$ 1,680,000	$ -
FE ECUS EU PEN	$ -	$ 13,950,000	$ 4,870,000	$ 2,290,000	$ -	$ -
FE ECUS MED PEN	$ -	$ 10,140,000	$ 5,320,000	$ 3,650,000	$ 2,340,000	$ -
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 540,000	$ 280,000	$ 210,000	$ 160,000	$ -
ECUS MED	$ -	$ 490,000	$ 250,000	$ 190,000	$ 150,000	$ -
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 2,760,000	$ 1,420,000	$ 1,080,000	$ 840,000	$ -
Total	*$ -*	$ 93,580,000	$ 32,810,000	$ 15,900,000	$ 5,180,000	$ -

Table 64: Sensitivity 3 - Decrease Annual Commodity Growth by 1% - Forecast Vessel Calls

42-Foot Depth	2017	2020	2025	2030
SPX	465	540	657	782
PX	1,114	708	973	991
PPX1	451	788	872	1,174
PPX2	113	246	331	436
Total	*2,142*	*2,282*	*2,833*	*3,383*
44-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	465	540	657	782
PX	1,056	636	861	884
PPX1	294	434	408	555
PPX2	225	485	660	855
Total	*2,040*	*2,095*	*2,586*	*3,076*
45-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	465	540	657	782
PX	1,032	610	826	834
PPX1	294	431	405	550
PPX2	225	480	653	848
Total	*2,015*	*2,060*	*2,541*	*3,015*
46-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	465	540	657	782
PX	1,020	599	809	814
PPX1	294	428	403	547
PPX2	225	477	649	844
Total	*2,003*	*2,044*	*2,518*	*2,987*
47-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	465	540	657	782
PX	1,015	590	802	808
PPX1	294	428	401	546
PPX2	225	477	649	841
Total	*1,999*	*2,036*	*2,508*	*2,977*
48-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	465	540	657	782
PX	1,015	590	802	808
PPX1	294	428	401	546
PPX2	225	477	649	841
Total	*1,999*	*2,036*	*2,508*	*2,977*

5.1.4. Sensitivity 4: Decrease Annual Commodity Growth by 3%

For this sensitivity analysis, the commodity growth forecast was adjusted downward by a maximum of 3 percent per year. If, for example, on a particular route the rate of growth in the baseline forecast was 5 percent between two years only 2 percent was used for that period. However, if the rate of growth was 2 percent, a 0 percent rate of change was applied. In other words, no negative growth between any two years was assumed. With this adjustment, the resultant TEU forecast for 2030 is 3.6 million TEUs, compared to 6.5 million in the baseline, a reduction of about 45 percent. With this lower growth rate, the number of TEUs in 2035 is 3.9 million TEUs and the Garden City Terminal does not reach it's build out capacity of 6.5 million for a number of years. Table 65 shows the results of the TCSM analysis with the lower growth rate. Average annual equivalent transportation cost savings are about 36 percent less than the baseline. However, the benefits presented are substantially understated as the TCSM is set to compute benefits for growth up to 2035. Therefore, several years of additional growth and benefits are not included. The results show a decrease in incremental benefits between 46 and 47 feet of about 26 percent. Overall, estimated benefits range from about $63 to $99 million for the alternative plans. Table 66 shows vessel calls for each alternative through 2030. As expected, vessel calls for each vessel class are substantially lower than the baseline condition.

Table 65: Sensitivity 4 – Decrease Annual Commodity Growth by 3% - AAE Transportation Cost Savings

Service Route	42 feet	44 feet	45 feet	46 feet	47 feet	48 feet
Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 23,450,000	$ 29,430,000	$ 29,430,000	$ 29,430,000	$ 29,430,000
FE (Suez) ECUS	$ -	$ 20,690,000	$ 28,560,000	$ 34,260,000	$ 35,390,000	$ 35,390,000
FE ECUS EU PEN	$ -	$ 9,360,000	$ 12,610,000	$ 14,140,000	$ 14,140,000	$ 14,140,000
FE ECUS MED PEN	$ -	$ 6,810,000	$ 10,380,000	$ 12,820,000	$ 14,390,000	$ 14,390,000
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 360,000	$ 550,000	$ 690,000	$ 800,000	$ 800,000
ECUS MED	$ -	$ 330,000	$ 500,000	$ 630,000	$ 730,000	$ 730,000
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 1,850,000	$ 2,810,000	$ 3,530,000	$ 4,090,000	$ 4,090,000
Total AAE Benefits	*$ -*	*$ 62,860,000*	*$ 84,840,000*	*$ 95,500,000*	*$ 98,970,000*	*$ 98,970,000*
Service Route	**42 feet**	**44 feet**	**45 feet**	**46 feet**	**47 feet**	**48 feet**
Incremental Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 23,450,000	$ 5,980,000	$ -	$ -	$ -
FE (Suez) ECUS	$ -	$ 20,690,000	$ 7,870,000	$ 5,700,000	$ 1,130,000	$ -
FE ECUS EU PEN	$ -	$ 9,360,000	$ 3,250,000	$ 1,530,000	$ -	$ -
FE ECUS MED PEN	$ -	$ 6,810,000	$ 3,570,000	$ 2,440,000	$ 1,570,000	$ -
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 360,000	$ 190,000	$ 140,000	$ 110,000	$ -
ECUS MED	$ -	$ 330,000	$ 170,000	$ 130,000	$ 100,000	$ -
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 1,850,000	$ 960,000	$ 720,000	$ 560,000	$ -
Total	*$ -*	*$ 62,860,000*	*$ 21,990,000*	*$ 10,660,000*	*$ 3,470,000*	*$ -*

Table 66: Sensitivity 4 - Decrease Annual Commodity Growth by 3% -Forecast Vessel Calls

42-Foot Depth	2017	2020	2025	2030
SPX	406	445	491	531
PX	962	584	729	675
PPX1	400	650	653	797
PPX2	100	203	248	296
Total	*1,868*	*1,882*	*2,121*	*2,299*
44-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	406	445	491	531
PX	911	525	645	602
PPX1	260	358	306	377
PPX2	200	400	494	581
Total	*1,777*	*1,728*	*1,936*	*2,091*
45-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	406	445	491	531
PX	890	503	619	568
PPX1	260	356	303	374
PPX2	200	396	489	576
Total	*1,755*	*1,699*	*1,902*	*2,049*
46-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	406	445	491	531
PX	879	494	607	554
PPX1	260	354	301	372
PPX2	200	394	486	573
Total	*1,745*	*1,686*	*1,885*	*2,030*
47-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	406	445	491	531
PX	876	487	601	550
PPX1	260	354	300	371
PPX2	200	394	486	572
Total	*1,741*	*1,679*	*1,878*	*2,024*
48-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	406	445	491	531
PX	876	487	601	550
PPX1	260	354	300	371
PPX2	200	394	486	572
Total	*1,741*	*1,679*	*1,878*	*2,024*

5.1.5. Sensitivity 5: No Growth in Commodity Forecast

As an extreme case sensitivity analysis, the TCSM was run with no change in commodities imported or exported over the base year tonnage of 18,155,938 metric tons and 2,618,487 loaded and empty TEUs. Average annual equivalent transportation cost savings range from about $37 to $59 million (

Table 67), or about 62 percent lower than the baseline. Savings are solely attributable to changes in the fleet of vessels calling and the ability to carry more Savannah cargo with channel improvements. Incremental benefits between 46 and 47 feet at $2.2 million are about 53 percent lower than the baseline. As shown in Table 68, over time and with additional depth, Sub-Panamax vessels remain the same, Panamax vessel calls decrease, and Post-Panamax vessel calls increase.

Table 67: Sensitivity 5 – No Growth in Commodity Forecast - AAE Transportation Cost Savings

Service Route	42 feet	44 feet	45 feet	46 feet	47 feet	48 feet
Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 13,100,000	$ 16,270,000	$ 16,270,000	$ 16,270,000	$ 16,270,000
FE (Suez) ECUS	$ -	$ 12,580,000	$ 17,820,000	$ 21,470,000	$ 22,210,000	$ 22,210,000
FE ECUS EU PEN	$ -	$ 5,640,000	$ 7,470,000	$ 8,260,000	$ 8,260,000	$ 8,260,000
FE ECUS MED PEN	$ -	$ 4,210,000	$ 6,200,000	$ 7,440,000	$ 8,300,000	$ 8,300,000
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 360,000	$ 540,000	$ 680,000	$ 790,000	$ 790,000
ECUS MED	$ -	$ 320,000	$ 480,000	$ 600,000	$ 700,000	$ 700,000
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 1,230,000	$ 1,860,000	$ 2,340,000	$ 2,720,000	$ 2,720,000
Total AAE Benefits	*$ -*	*$ 37,430,000*	*$ 50,640,000*	*$ 57,060,000*	*$ 59,250,000*	*$ 59,250,000*
Service Route	**42 feet**	**44 feet**	**45 feet**	**46 feet**	**47 feet**	**48 feet**
Incremental Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 13,100,000	$ 3,170,000	$ -	$ -	$ -
FE (Suez) ECUS	$ -	$ 12,580,000	$ 5,240,000	$ 3,650,000	$ 750,000	$ -
FE ECUS EU PEN	$ -	$ 5,640,000	$ 1,830,000	$ 790,000	$ -	$ -
FE ECUS MED PEN	$ -	$ 4,210,000	$ 1,990,000	$ 1,240,000	$ 860,000	$ -
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 360,000	$ 180,000	$ 140,000	$ 110,000	$ -
ECUS MED	$ -	$ 320,000	$ 160,000	$ 120,000	$ 100,000	$ -
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 1,230,000	$ 630,000	$ 480,000	$ 370,000	$ -
Total	*$ -*	*$ 37,430,000*	*$ 13,200,000*	*$ 6,430,000*	*$ 2,190,000*	*$ -*

Table 68: Sensitivity 5 - No Growth in Commodity Forecast - Forecast Vessel Calls

42-Foot Depth	2017	2020	2025	2030
SPX	348	348	348	348
PX	774	383	376	286
PPX1	342	513	486	534
PPX2	85	161	184	198
Total	*1,548*	*1,404*	*1,395*	*1,365*
44-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	348	348	348	348
PX	730	337	331	272
PPX1	222	283	224	244
PPX2	171	316	362	377
Total	*1,471*	*1,283*	*1,265*	*1,242*
45-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	348	348	348	348
PX	712	317	311	263
PPX1	222	281	222	239
PPX2	171	313	359	371
Total	*1,452*	*1,259*	*1,240*	*1,220*
46-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	348	348	348	348
PX	702	310	303	258
PPX1	222	279	221	236
PPX2	171	311	357	367
Total	*1,443*	*1,248*	*1,228*	*1,209*
47-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	348	348	348	348
PX	699	306	297	254
PPX1	222	279	220	235
PPX2	171	311	357	366
Total	*1,439*	*1,243*	*1,222*	*1,203*
48-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	348	348	348	348
PX	699	306	297	254
PPX1	222	279	220	235
PPX2	171	311	357	366
Total	*1,439*	*1,243*	*1,222*	*1,203*

5.2. Sensitivities to Vessel Availability and Loadings

5.2.1. Sensitivity 6: Historical Sub-Panamax Share of Capacity Calling

For this sensitivity analysis, the TCSM was run using the historical average of Sub-Panamax capacity of total capacity calling from data years 2005 and 2007 (source: port and pilot records). This resulted in less total cargo available for Panamax and Post-Panamax vessels. The purpose of this sensitivity analysis is to test the reasonableness of the baseline condition assumption that the amount of total cargo carried on small vessels will decline over time, even if no improvements are made to the Savannah Harbor. The results are shown in Table 69, and reflect an increase in benefits of about 2 percent, but a 4 percent decrease in incremental benefits between 46 and 47 feet. It may appear that the small increase in benefits is counterintuitive. However, upon further examination the results make sense in the construct of the overall TCSM. Post-Panamax vessel calls are initially determined by relating the total commodity forecast to total capacity calling. Post-Panamax vessel calls are then determined by a percentage of total capacity. Next, they are allocated to the various routes in proportion to the amount of cargo not carried on Sub-Panamax vessels. It so happens that a higher proportion of historical cargo was carried on Sub-Panamax vessels on the non-benefiting and relatively small benefiting trade routes. Therefore, when Sub-Panamax vessel calls are increased on these routes, more Post-Panamax vessels are allocated to the larger benefiting routes such as the FE (Panama) ECUS and the FE (Suez) ECUS routes and their benefits increase. The overall result is a slight increase in total benefits. As shown in Table 70, Post-Panamax vessel calls are the same as in the without project condition, while Sub-Panamax vessel calls increase significantly and Panamax vessel calls decline from baseline estimates. A large portion of the changes in vessel calls occur on the non-benefiting trade routes.

Table 69: Sensitivity 6 – Historical SPX Share of Capacity Calling - AAE Transportation Cost Savings

Service Route	42 feet	44 feet	45 feet	46 feet	47 feet	48 feet
Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 37,990,000	$ 47,740,000	$ 47,740,000	$ 47,740,000	$ 47,740,000
FE (Suez) ECUS	$ -	$ 32,660,000	$ 45,610,000	$ 55,220,000	$ 56,200,000	$ 56,200,000
FE ECUS EU PEN	$ -	$ 15,260,000	$ 20,600,000	$ 23,110,000	$ 23,110,000	$ 23,110,000
FE ECUS MED PEN	$ -	$ 11,090,000	$ 16,910,000	$ 20,920,000	$ 23,500,000	$ 23,500,000
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 540,000	$ 810,000	$ 1,020,000	$ 1,180,000	$ 1,180,000
ECUS MED	$ -	$ 330,000	$ 510,000	$ 640,000	$ 740,000	$ 740,000
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 2,130,000	$ 3,230,000	$ 4,070,000	$ 4,720,000	$ 4,720,000
Total AAE Benefits	*$ -*	$ 100,000,000	$135,410,000	$152,730,000	$157,200,000	$157,200,000
Service Route	**42 feet**	**44 feet**	**45 feet**	**46 feet**	**47 feet**	**48 feet**
Incremental Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 37,990,000	$ 9,750,000	$ -	$ -	$ -
FE (Suez) ECUS	$ -	$ 32,660,000	$ 12,950,000	$ 9,620,000	$ 980,000	$ -
FE ECUS EU PEN	$ -	$ 15,260,000	$ 5,350,000	$ 2,510,000	$ -	$ -
FE ECUS MED PEN	$ -	$ 11,090,000	$ 5,820,000	$ 4,010,000	$ 2,580,000	$ -
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 540,000	$ 270,000	$ 210,000	$ 160,000	$ -
ECUS MED	$ -	$ 330,000	$ 170,000	$ 130,000	$ 100,000	$ -
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 2,130,000	$ 1,100,000	$ 840,000	$ 650,000	$ -
Total	***$ -***	**$ 100,000,000**	**$ 35,410,000**	**$ 17,310,000**	**$ 4,470,000**	**$ -**

Table 70: Sensitivity 6 - Historical SPX Share of Capacity Calling - Forecast Vessel Calls

42-Foot Depth	2017	2020	2025	2030
SPX	741	886	1,131	1,413
PX	1,004	545	827	833
PPX1	477	866	1,006	1,421
PPX2	119	271	382	527
Total	2,342	2,568	3,346	4,194
44-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	741	886	1,131	1,413
PX	943	468	698	705
PPX1	310	477	471	671
PPX2	239	533	761	1,034
Total	2,234	2,364	3,061	3,824
45-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	741	886	1,131	1,413
PX	918	441	660	648
PPX1	310	473	467	665
PPX2	239	527	753	1,026
Total	2,208	2,327	3,010	3,752
46-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	741	886	1,131	1,413
PX	905	430	641	625
PPX1	310	471	464	662
PPX2	239	524	749	1,020
Total	2,196	2,310	2,985	3,720
47-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	741	886	1,131	1,413
PX	901	422	634	620
PPX1	310	471	462	660
PPX2	239	524	749	1,017
Total	2,192	2,302	2,975	3,710
48-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	741	886	1,131	1,413
PX	901	422	634	620
PPX1	310	471	462	660
PPX2	239	524	749	1,017
Total	2,192	2,302	2,975	3,710

5.2.2. Sensitivity 7: Reduce Future Sub-Panamax Share of Capacity Calling

For Sensitivity Analysis 7, the percent of capacity calling on Sub-Panamax vessels (i.e., the amount of Savannah cargo) was reduced by 65% from the 2005-07 historical records, as compared to the 33% reduction in the baseline condition. The reason being is that it was observed in some of the MSI fleet forecast information, the Sub-Panamax percentage of the world fleet, and the anticipated share of capacity calling at Savannah is expected to continue to decline beyond the 2017 base year, to about 65 percent by 2030. Table 71 shows the results of this further reduction in the capacity calling and amount of Savannah cargo carried on Sub-Panamax vessels, which increases the amount of cargo to be forecast to be carried on Panamax and Sub-Panamax vessels. The results show a decrease in annual benefits of about 2 percent but an increase in incremental benefits between 46 and 47 feet of about 4 percent. As in Sensitivity 6, these results are explained by the fact that the largest trade routes, historically, have less cargo carried on Sub-Panamax vessels than the smaller trade routes, and are therefore affected by this change in assumption by losing Post-Panamax vessels calls to the lower benefiting routes. Table 72 shows vessel calls by vessel class and alternative project depths. Note that Post-Panamax vessel calls are the same as the baseline condition while Sub-Panamax vessel calls are reduced considerably.

The overall results of sensitivities 6 and 7 show that the benefits derived from the TCSM are not very sensitive to assumptions regarding amount of capacity and cargo carried on Sub-Panamax vessels, but the overall number of vessel calls are sensitive.

Table 71: Sensitivity 7 – Reduce Future SPX Share of Capacity Calling - AAE Transportation Cost Savings

Service Route	42 feet	44 feet	45 feet	46 feet	47 feet	48 feet
Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 36,140,000	$ 45,410,000	$ 45,410,000	$ 45,410,000	$ 45,410,000
FE (Suez) ECUS	$ -	$ 30,780,000	$ 42,980,000	$ 52,040,000	$ 52,960,000	$ 52,960,000
FE ECUS EU PEN	$ -	$ 14,260,000	$ 19,260,000	$ 21,610,000	$ 21,610,000	$ 21,610,000
FE ECUS MED PEN	$ -	$ 10,370,000	$ 15,810,000	$ 19,560,000	$ 21,970,000	$ 21,970,000
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 660,000	$ 1,000,000	$ 1,260,000	$ 1,460,000	$ 1,460,000
ECUS MED	$ -	$ 740,000	$ 1,130,000	$ 1,420,000	$ 1,650,000	$ 1,650,000
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 3,620,000	$ 5,490,000	$ 6,920,000	$ 8,030,000	$ 8,030,000
Total AAE Benefits	***$ -***	**$ 96,580,000**	**$131,090,000**	**$ 148,230,000**	**$ 153,090,000**	**$153,090,000**
Service Route	**42 feet**	**44 feet**	**45 feet**	**46 feet**	**47 feet**	**48 feet**
Incremental Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 36,140,000	$ 9,270,000	$ -	$ -	$ -
FE (Suez) ECUS	$ -	$ 30,780,000	$ 12,200,000	$ 9,060,000	$ 920,000	$ -
FE ECUS EU PEN	$ -	$ 14,260,000	$ 5,000,000	$ 2,350,000	$ -	$ -
FE ECUS MED PEN	$ -	$ 10,370,000	$ 5,440,000	$ 3,750,000	$ 2,410,000	$ -
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 660,000	$ 340,000	$ 260,000	$ 200,000	$ -
ECUS MED	$ -	$ 740,000	$ 390,000	$ 290,000	$ 230,000	$ -
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 3,620,000	$ 1,870,000	$ 1,420,000	$ 1,110,000	$ -
Total	***$ -***	**$ 96,580,000**	**$ 34,510,000**	**$ 17,140,000**	**$ 4,870,000**	**$ -**

Table 72: Sensitivity 7 - Reduce Future SPX Share of Capacity Calling - Forecast Vessel Calls

42-Foot Depth	2017	2020	2025	2030
SPX	260	310	396	495
PX	1,383	1,003	1,407	1,549
PPX1	481	866	1,006	1,421
PPX2	120	271	382	527
Total	*2,244*	*2,451*	*3,190*	*3,992*
44-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	260	310	396	495
PX	1,322	924	1,277	1,417
PPX1	313	478	471	672
PPX2	240	534	761	1,036
Total	*2,134*	*2,245*	*2,905*	*3,620*
45-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	260	310	396	495
PX	1,295	894	1,236	1,356
PPX1	313	474	467	667
PPX2	240	528	753	1,028
Total	*2,108*	*2,206*	*2,852*	*3,545*
46-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	260	310	396	495
PX	1,282	880	1,214	1,329
PPX1	313	472	465	663
PPX2	240	525	749	1,022
Total	*2,094*	*2,187*	*2,824*	*3,509*
47-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	260	310	396	495
PX	1,277	870	1,205	1,319
PPX1	313	472	462	661
PPX2	240	525	749	1,020
Total	*2,089*	*2,177*	*2,812*	*3,495*
48-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	260	310	396	495
PX	1,277	870	1,205	1,319
PPX1	313	472	462	661
PPX2	240	525	749	1,020
Total	*2,089*	*2,177*	*2,812*	*3,495*

5.2.3. Sensitivity 8: Increase Amount of Savannah Cargo Carried on Post-Panamax Vessels

In this sensitivity analysis, the amount of Savannah cargo carried on Post-Panamax vessels was increased by 5 percent relative to their Maximum Practicable Capacity. This is generally reflective of the notion that in future years, as trade increases, the number of calls at ECUS ports may change, particularly in the manner of reducing the number of ECUS ports of calls for the largest vessels in operations on the trade routes. According to many in the shipping industry, continued consolidation of shipping companies is possible while they may have incentives to reduce the number of ports on an entire rotation. The results of this sensitivity analysis for benefits and vessel calls are shown in Table 73 and Table 74 . This sensitivity results in an increases in annual benefits of about 5 and 1 percent respectively for channel depths of 44 and 45 feet while no change in benefits for depths of 46 feet and greater. However, the number of Panamax vessels decline from the base line as more cargo is carried on Post-Panamax vessels.

Table 73: Sensitivity 8 – Increase Amount of Savannah Cargo Carried on PPX Vessels - AAE Transportation Cost Savings

Service Route	42 feet	44 feet	45 feet	46 feet	47 feet	48 feet
Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 41,040,000	$ 48,410,000	$ 48,410,000	$ 48,410,000	$ 48,410,000
FE (Suez) ECUS	$ -	$ 29,530,000	$ 41,480,000	$ 50,050,000	$ 51,290,000	$ 51,290,000
FE ECUS EU PEN	$ -	$ 16,140,000	$ 21,910,000	$ 24,620,000	$ 24,620,000	$ 24,620,000
FE ECUS MED PEN	$ -	$ 12,090,000	$ 16,860,000	$ 20,100,000	$ 21,860,000	$ 21,860,000
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 660,000	$ 1,000,000	$ 1,260,000	$ 1,460,000	$ 1,460,000
ECUS MED	$ -	$ 580,000	$ 890,000	$ 1,120,000	$ 1,310,000	$ 1,310,000
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 2,930,000	$ 4,440,000	$ 5,590,000	$ 6,490,000	$ 6,490,000
Total AAE Benefits	*$ -*	*$ 102,980,000*	*$ 135,000,000*	*$ 151,160,000*	*$ 155,440,000*	*$ 155,440,000*
Service Route	**42 feet**	**44 feet**	**45 feet**	**46 feet**	**47 feet**	**48 feet**
Incremental Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 41,040,000	$ 7,370,000	$ -	$ -	$ -
FE (Suez) ECUS	$ -	$ 29,530,000	$ 11,950,000	$ 8,570,000	$ 1,240,000	$ -
FE ECUS EU PEN	$ -	$ 16,140,000	$ 5,770,000	$ 2,710,000	$ -	$ -
FE ECUS MED PEN	$ -	$ 12,090,000	$ 4,770,000	$ 3,240,000	$ 1,760,000	$ -
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 660,000	$ 340,000	$ 260,000	$ 200,000	$ -
ECUS MED	$ -	$ 580,000	$ 310,000	$ 230,000	$ 180,000	$ -
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 2,930,000	$ 1,510,000	$ 1,150,000	$ 900,000	$ -
Total	*$ -*	*$ 102,980,000*	*$ 32,020,000*	*$ 16,160,000*	*$ 4,280,000*	*$ -*

Table 74: Sensitivity 8 – Increase Amount of Savannah Cargo Carried on PPX Vessels - Forecast Vessel Calls

42-Foot Depth	2017	2020	2025	2030
SPX	497	593	758	947
PX	1,104	618	891	916
PPX1	479	855	1,006	1,402
PPX2	120	267	382	520
Total	*2,200*	*2,333*	*3,036*	*3,786*
44-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,037	532	782	769
PPX1	312	471	465	662
PPX2	239	526	751	1,023
Total	*2,084*	*2,122*	*2,755*	*3,401*
45-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,008	502	735	748
PPX1	312	466	460	648
PPX2	239	520	745	1,002
Total	*2,056*	*2,081*	*2,697*	*3,346*
46-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	994	492	719	730
PPX1	312	462	457	643
PPX2	239	516	739	995
Total	*2,042*	*2,064*	*2,673*	*3,314*
47-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	989	489	708	724
PPX1	312	462	456	642
PPX2	239	514	738	990
Total	*2,037*	*2,058*	*2,660*	*3,303*
48-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	989	489	708	724
PPX1	312	462	456	642
PPX2	239	514	738	990
Total	*2,037*	*2,058*	*2,660*	*3,303*

5.2.4. Sensitivity 9: Full Deployment of Post-Panamax Vessels in Without (42 ft) Project Condition

The baseline condition assumed that 50 percent of the "unconstrained" PPX2 vessels would call in the without project (42-foot) condition. This sensitivity analysis assumes that essentially the same number of PPX 2 vessels would call Savannah Harbor in a 42-foot channel as would call in a 47- or 48- foot channel, but obviously carry less cargo due to the channel constraints. The results are shown in Table 75 and Table 76. Average annual benefits are about 5 to 8 percent higher than the baseline. This is due to the fact that with full deployment of PPX2 vessels in the without condition, due to their loading constraints in a 42-foot channel, round trip vessel costs are actually higher than they would be under the baseline condition. Note additionally that incremental benefits are the same as the baseline for depths greater than 44 feet, and vessel calls are the same as the baseline for all depths except 42 feet.

Table 75: Sensitivity 9 – Full Deployment of PPX Vessels in Without Project Condition - AAE Transportation Cost Savings

Service Route	42 feet	44 feet	45 feet	46 feet	47 feet	48 feet
Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 40,040,000	$ 49,540,000	$ 49,540,000	$ 49,540,000	$ 49,540,000
FE (Suez) ECUS	$ -	$ 34,870,000	$ 47,420,000	$ 56,750,000	$ 57,700,000	$ 57,700,000
FE ECUS EU PEN	$ -	$ 15,580,000	$ 20,740,000	$ 23,170,000	$ 23,170,000	$ 23,170,000
FE ECUS MED PEN	$ -	$ 11,240,000	$ 16,860,000	$ 20,740,000	$ 23,220,000	$ 23,220,000
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 620,000	$ 920,000	$ 1,160,000	$ 1,340,000	$ 1,340,000
ECUS MED	$ -	$ 570,000	$ 860,000	$ 1,070,000	$ 1,240,000	$ 1,240,000
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 3,010,000	$ 4,510,000	$ 5,660,000	$ 6,550,000	$ 6,550,000
Total AAE Benefits	*$ -*	*$ 105,920,000*	*$ 140,860,000*	*$ 158,080,000*	*$ 162,760,000*	*$ 162,760,000*
Service Route	**42 feet**	**44 feet**	**45 feet**	**46 feet**	**47 feet**	**48 feet**
Incremental Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 40,040,000	$ 9,500,000	$ -	$ -	$ -
FE (Suez) ECUS	$ -	$ 34,870,000	$ 12,560,000	$ 9,330,000	$ 950,000	$ -
FE ECUS EU PEN	$ -	$ 15,580,000	$ 5,170,000	$ 2,430,000	$ -	$ -
FE ECUS MED PEN	$ -	$ 11,240,000	$ 5,620,000	$ 3,870,000	$ 2,490,000	$ -
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 620,000	$ 310,000	$ 230,000	$ 180,000	$ -
ECUS MED	$ -	$ 570,000	$ 290,000	$ 220,000	$ 170,000	$ -
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 3,010,000	$ 1,500,000	$ 1,150,000	$ 890,000	$ -
Total	*$ -*	*$ 105,920,000*	*$ 34,940,000*	*$ 17,220,000*	*$ 4,680,000*	*$ -*

Table 76: Sensitivity 9 - Full Deployment of PPX Vessels in Without Project Condition - Forecast Vessel Calls

42-Foot Depth	2017	2020	2025	2030
SPX	497	593	758	947
PX	1,210	809	1,165	1,257
PPX1	312	487	472	682
PPX2	239	542	763	1,055
Total	*2,258*	*2,431*	*3,158*	*3,941*
44-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,135	700	992	1,067
PPX1	312	478	471	672
PPX2	239	533	761	1,035
Total	*2,183*	*2,304*	*2,982*	*3,720*
45-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,109	671	952	1,007
PPX1	312	474	467	666
PPX2	239	527	753	1,027
Total	*2,157*	*2,265*	*2,930*	*3,647*
46-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,096	658	932	982
PPX1	312	471	465	662
PPX2	239	524	749	1,021
Total	*2,144*	*2,247*	*2,903*	*3,613*
47-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,092	649	924	975
PPX1	312	471	462	661
PPX2	239	524	749	1,018
Total	*2,140*	*2,238*	*2,892*	*3,601*
48-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,092	649	924	975
PPX1	312	471	462	661
PPX2	239	524	749	1,018
Total	*2,140*	*2,238*	*2,892*	*3,601*

5.2.5. Sensitivity 10: Reduce Post-Panamax Vessel Calls by 25%

This sensitivity tests how much the benefits and number of vessel calls would be impacted by a reduction in the availability and number of Post-Panamax Vessel calls. The world fleet forecast and the amount of that fleet available to call at Savannah could be highly undercertain. This sensitivity assumes that only 75% of the base line forecast of Post-Panamax vessel calls at Savannah are actually realized. The results are shown in Table 77 and Table 78 . Average annual benefits would be about 13 to 17 percent lower than the baseline. The total number of vessel calls at Savannah would increase over the baseline as more Panamax vessels would call to make up for the lost capacity from fewer Post-Panamax vessels.

Table 77: Sensitivity 10 – Reduce PPX Vessel Calls by 25% - AAE Transportation Cost Savings

Service Route	42 feet	44 feet	45 feet	46 feet	47 feet	48 feet
Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 27,770,000	$ 34,890,000	$ 34,890,000	$ 34,890,000	$ 34,890,000
FE (Suez) ECUS	$ -	$ 31,400,000	$ 46,270,000	$ 57,420,000	$ 59,640,000	$ 59,640,000
FE ECUS EU PEN	$ -	$ 11,050,000	$ 14,930,000	$ 16,740,000	$ 16,740,000	$ 16,740,000
FE ECUS MED PEN	$ -	$ 8,040,000	$ 12,250,000	$ 15,160,000	$ 17,020,000	$ 17,020,000
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 450,000	$ 680,000	$ 860,000	$ 1,000,000	$ 1,000,000
ECUS MED	$ -	$ 410,000	$ 620,000	$ 790,000	$ 910,000	$ 910,000
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 2,180,000	$ 3,310,000	$ 4,170,000	$ 4,840,000	$ 4,840,000
Total AAE Benefits	*$ -*	$ 81,300,000	$ 112,960,000	$ 130,020,000	$ 135,050,000	$ 135,050,000
Service Route	**42 feet**	**44 feet**	**45 feet**	**46 feet**	**47 feet**	**48 feet**
Incremental Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 27,770,000	$ 7,120,000	$ -	$ -	$ -
FE (Suez) ECUS	$ -	$ 31,400,000	$ 14,870,000	$ 11,140,000	$ 2,220,000	$ -
FE ECUS EU PEN	$ -	$ 11,050,000	$ 3,870,000	$ 1,820,000	$ -	$ -
FE ECUS MED PEN	$ -	$ 8,040,000	$ 4,220,000	$ 2,900,000	$ 1,870,000	$ -
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 450,000	$ 230,000	$ 180,000	$ 140,000	$ -
ECUS MED	$ -	$ 410,000	$ 210,000	$ 160,000	$ 130,000	$ -
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 2,180,000	$ 1,130,000	$ 860,000	$ 670,000	$ -
Total	*$ -*	$ 81,300,000	$ 31,660,000	$ 17,060,000	$ 5,020,000	$ -

Table 78: Sensitivity 10 - Reduce PPX Vessel Calls by 25% - Forecast Vessel Calls

42-Foot Depth	2017	2020	2025	2030
SPX	497	593	758	947
PX	1,424	1,218	1,664	1,941
PPX1	359	650	755	1,073
PPX2	90	203	286	398
Total	*2,370*	*2,664*	*3,462*	*4,359*
44-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,378	1,133	1,562	1,797
PPX1	234	365	354	516
PPX2	179	407	572	795
Total	*2,288*	*2,498*	*3,246*	*4,055*
45-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,358	1,095	1,513	1,729
PPX1	234	365	354	516
PPX2	179	407	572	795
Total	*2,269*	*2,460*	*3,197*	*3,987*
46-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,349	1,076	1,487	1,693
PPX1	234	365	354	516
PPX2	179	407	572	795
Total	*2,259*	*2,442*	*3,171*	*3,951*
47-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,345	1,069	1,477	1,680
PPX1	234	365	354	516
PPX2	179	407	572	795
Total	*2,255*	*2,435*	*3,161*	*3,938*
48-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,345	1,069	1,477	1,680
PPX1	234	365	354	516
PPX2	179	407	572	795
Total	*2,255*	*2,435*	*3,161*	*3,938*

5.2.6. Sensitivity 11: Deployment of Post-Panamax Vessels by Unit Costs

This sensitivity analysis employs the same basic assumptions as were presented in the draft report published in December 2010. The primary assumption being that PPX 2 vessels would deploy in accordance a strict unit cost comparison by trade route, as shown in Table 38. The results for benefits are shown in Table 79 and vessel calls are shown in Table 80. Average annual benefits would be about 3 to 4 percent lower than the baseline, and there would be no change in incremental benefits between 46 and 47 feet. Vessel calls change due to the differing assumptions regarding PPX2 deployment by channel depth. This sensitivity is most similar to what is presented later for Sensitivity 17 which are actually the values presented in the draft report.

Table 79: Sensitivity 11 – Deployment of PPX Vessels by Unit Costs - AAE Transportation Cost Savings

Service Route	42 feet	44 feet	45 feet	46 feet	47 feet	48 feet
Transportation Cost Savings						
FE (Panama) ECUS	$ -	$34,000,000	$ 43,500,000	$ 43,500,000	$ 43,500,000	$ 43,500,000
FE (Suez) ECUS	$ -	$33,000,000	$ 43,230,000	$ 52,560,000	$ 53,510,000	$ 53,510,000
FE ECUS EU PEN	$ -	$13,890,000	$ 19,060,000	$ 21,480,000	$ 21,480,000	$ 21,480,000
FE ECUS MED PEN	$ -	$10,190,000	$ 15,810,000	$ 19,680,000	$ 22,170,000	$ 22,170,000
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 640,000	$ 960,000	$ 1,130,000	$ 1,310,000	$ 1,310,000
ECUS MED	$ -	$ 600,000	$ 890,000	$ 1,030,000	$ 1,200,000	$ 1,200,000
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 3,140,000	$ 4,710,000	$ 5,470,000	$ 6,360,000	$ 6,360,000
Total AAE Benefits	*$ -*	*$95,470,000*	*$128,170,000*	*$144,850,000*	*$149,530,000*	*$149,530,000*
Service Route	**42 feet**	**44 feet**	**45 feet**	**46 feet**	**47 feet**	**48 feet**
Incremental Transportation Cost Savings						
FE (Panama) ECUS	$ -	$34,000,000	$ 9,500,000	$ -	$ -	$ -
FE (Suez) ECUS	$ -	$33,000,000	$ 10,230,000	$ 9,330,000	$ 950,000	$ -
FE ECUS EU PEN	$ -	$13,890,000	$ 5,170,000	$ 2,430,000	$ -	$ -
FE ECUS MED PEN	$ -	$10,190,000	$ 5,620,000	$ 3,870,000	$ 2,490,000	$ -
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 640,000	$ 320,000	$ 170,000	$ 180,000	$ -
ECUS MED	$ -	$ 600,000	$ 300,000	$ 130,000	$ 170,000	$ -
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 3,140,000	$ 1,570,000	$ 750,000	$ 890,000	$ -
Total	*$ -*	*$95,470,000*	*$ 32,700,000*	*$ 16,680,000*	*$ 4,680,000*	*$ -*

Table 80: Sensitivity 11 - Deployment of PPX Vessels by Unit Costs - Forecast Vessel Calls

42-Foot Depth	2017	2020	2025	2030
SPX	497	593	758	947
PX	1,183	759	1,078	1,154
PPX1	647	1,238	1,540	2,148
PPX2	0	0	0	0
Total	*2,326*	*2,590*	*3,376*	*4,248*
44-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,122	694	982	1,048
PPX1	457	745	854	1,171
PPX2	136	334	476	666
Total	*2,211*	*2,366*	*3,070*	*3,832*
45-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,105	663	941	993
PPX1	356	561	586	826
PPX2	208	465	668	912
Total	*2,166*	*2,282*	*2,953*	*3,678*
46-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,096	658	932	982
PPX1	312	471	465	662
PPX2	239	524	749	1,021
Total	*2,144*	*2,247*	*2,903*	*3,613*
47-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,092	649	924	975
PPX1	312	471	462	661
PPX2	239	524	749	1,018
Total	*2,140*	*2,238*	*2,892*	*3,601*
48-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,092	649	924	975
PPX1	312	471	462	661
PPX2	239	524	749	1,018
Total	*2,140*	*2,238*	*2,892*	*3,601*

5.2.7. Sensitivity 12: Increase Post-Panamax Vessel Loading Beyond Maximum Practicable Loading

For sensitivity analysis 12, it was assumed that vessel loadings would respond to having a larger tidal window due to deeper channel depths by having average loadings greater than the estimated Maximum Practicable Capacity by loading on average more cargo. It reflects a further change in overall sailing draft distributions with deeper channels. To run this sensitivity, the PDT assumed that for a 1 foot channel depth beyond which PPX vessels can attain their MPC on each trade route, they would load 2/3rds more cargo (tonnes), on average, than they would load at one foot less than it's MPC. And for 2 feet of additional channel they would load on average 1/3rd more cargo. For example, on the FE (Panama) ECUS route, it is estimated that on average, PPX 1 vessels would carry 6,978 tonnes of Savannah cargo in a 42 foot channel and 7,344 tonnes in a channel of 44 to 48 feet (Table 42). In this sensitivity, it is assumed that the PPX1 vessels, on average would carry 7,600 tonnes in a 45 ft channel and 7,690 tonnes in a 46-foot channel. The results on benefits are shown in Table 81 . Average annual benefits are the same at 44 feet, but begin to increase substantially at 45 feet, when the effects of the increased loading assumption begin to take effect. Note that the results show an increase in benefits from 47 to 48 feet such that the 48 foot alternative in this analysis has over $4 million in incremental benefits. This sensitivity analysis also reflects, at least in a general sense, the effects on project benefits and channel depth optimization that would likely occur if vessels with drafts greater than 48 ft called on Savannah on a regular basis. Also note the reduction in vessel calls for depths greater than 44 feet from the baseline, and the reduction in number of calls between 47 and 48 feet.

Table 81: Sensitivity 12 - Increase PPX Vessel Loading Beyond MPC - AAE Transportation Cost Savings

Service Route	42 feet	44 feet	45 feet	46 feet	47 feet	48 feet
Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 37,020,000	$ 53,030,000	$ 61,780,000	$ 63,970,000	$ 63,970,000
FE (Suez) ECUS	$ -	$ 31,670,000	$ 44,230,000	$ 54,770,000	$ 58,020,000	$ 59,140,000
FE ECUS EU PEN	$ -	$ 14,740,000	$ 23,730,000	$ 27,490,000	$ 29,140,000	$ 29,700,000
FE ECUS MED PEN	$ -	$ 10,720,000	$ 16,340,000	$ 20,210,000	$ 22,810,000	$ 24,560,000
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 600,000	$ 910,000	$ 1,150,000	$ 1,350,000	$ 1,480,000
ECUS MED	$ -	$ 550,000	$ 830,000	$ 1,050,000	$ 1,240,000	$ 1,360,000
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 2,910,000	$ 4,420,000	$ 5,560,000	$ 6,560,000	$ 7,210,000
Total AAE Benefits	*$ -*	*$ 98,210,000*	*$ 143,480,000*	*$ 172,010,000*	*$ 183,080,000*	*$ 187,420,000*
Service Route	**42 feet**	**44 feet**	**45 feet**	**46 feet**	**47 feet**	**48 feet**
Incremental Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 37,020,000	$ 16,010,000	$ 8,750,000	$ 2,190,000	$ -
FE (Suez) ECUS	$ -	$ 31,670,000	$ 12,560,000	$ 10,550,000	$ 3,240,000	$ 1,130,000
FE ECUS EU PEN	$ -	$ 14,740,000	$ 8,990,000	$ 3,760,000	$ 1,650,000	$ 560,000
FE ECUS MED PEN	$ -	$ 10,720,000	$ 5,620,000	$ 3,870,000	$ 2,600,000	$ 1,750,000
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 600,000	$ 310,000	$ 230,000	$ 200,000	$ 130,000
ECUS MED	$ -	$ 550,000	$ 290,000	$ 220,000	$ 190,000	$ 120,000
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 2,910,000	$ 1,500,000	$ 1,150,000	$ 1,000,000	$ 650,000
Total	*$ -*	*$ 98,210,000*	*$ 45,280,000*	*$ 28,530,000*	*$ 11,070,000*	*$ 4,340,000*

Table 82: Sensitivity 12 - Increase PPX Vessel Loading Beyond MPC - Forecast Vessel Calls

42-Foot Depth	2017	2020	2025	2030
SPX	497	593	758	947
PX	1,196	778	1,122	1,196
PPX1	479	866	1,006	1,421
PPX2	120	271	382	527
Total	*2,292*	*2,509*	*3,267*	*4,092*
44-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,135	700	992	1,067
PPX1	312	478	471	672
PPX2	239	533	761	1,035
Total	*2,183*	*2,304*	*2,982*	*3,720*
45-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,100	655	936	984
PPX1	312	474	467	666
PPX2	239	527	753	1,027
Total	*2,148*	*2,249*	*2,914*	*3,624*
46-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,078	628	900	940
PPX1	312	470	462	661
PPX2	239	524	749	1,018
Total	*2,126*	*2,215*	*2,869*	*3,566*
47-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,070	615	884	911
PPX1	312	470	462	661
PPX2	239	523	747	1,018
Total	*2,118*	*2,202*	*2,851*	*3,537*
48-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,067	611	877	901
PPX1	312	468	461	659
PPX2	239	523	747	1,018
Total	*2,114*	*2,196*	*2,842*	*3,525*

5.2.8. Sensitivity 13: Reduce PPX1 Replacement of PPX2 Vessels, Use Historical SPX Share of Capacity Calling, and Deployment of PPX by Unit Costs

This sensitivity analysis employs some basic assumptions that were originally used when the TCSM was developed for the Savannah study. First it assumes the deployment by unit cost depths as presented in Sensitivity 11 and presented in the draft report. Secondly, it assumes the historic Sub-Panamax share of capacity calling as presented in Sensitivity 6. And finally, it assumes that when PPX2 vessels do not call on a particular route due to channel constraints, they will be replaced on a vessels for vessel basis rather than a capacity for capacity basis as included in the baseline condition. These were all assumptions used prior to refinements that have evolved throughout the SHEP study as more information became available. The results are shown in Table 83 and Table 84. Annual benefits and vessel calls increase substantially over the baseline ranging from 28 to 35 percent greater. The number of vessel calls also increase primarily due to the high number of Sub-Panama vessels, and the increase in PPX1 calls.

Table 83: Sensitivity 13 – Reduce PPX1 Replacement of PPX2 Vessels, Use Historical SPX Share of Capacity Calling, and Deployment of PPX by Unit Costs - AAE Transportation Cost Savings

Service Route	42 feet	44 feet	45 feet	46 feet	47 feet	48 feet
Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 57,200,000	$66,940,000	$ 66,940,000	$66,940,000	$ 66,940,000
FE (Suez) ECUS	$ -	$ 39,240,000	$59,870,000	$ 68,950,000	$70,770,000	$ 70,770,000
FE ECUS EU PEN	$ -	$ 19,950,000	$25,300,000	$ 27,810,000	$27,810,000	$ 27,810,000
FE ECUS MED PEN	$ -	$ 13,630,000	$19,450,000	$ 23,460,000	$26,030,000	$ 26,030,000
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 460,000	$ 700,000	$ 990,000	$ 1,150,000	$ 1,150,000
ECUS MED	$ -	$ 290,000	$ 440,000	$ 690,000	$ 800,000	$ 800,000
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 1,860,000	$ 2,780,000	$ 4,210,000	$ 4,860,000	$ 4,860,000
Total AAE Benefits	*$ -*	*$132,630,000*	*$175,480,000*	*$193,050,000*	*$198,370,000*	*$198,370,000*
Service Route	**42 feet**	**44 feet**	**45 feet**	**46 feet**	**47 feet**	**48 feet**
Incremental Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 57,200,000	$ 9,750,000	$ -	$ -	$ -
FE (Suez) ECUS	$ -	$ 39,240,000	$ 20,630,000	$ 9,080,000	$ 1,830,000	$ -
FE ECUS EU PEN	$ -	$ 19,950,000	$ 5,350,000	$ 2,510,000	$ -	$ -
FE ECUS MED PEN	$ -	$ 13,630,000	$ 5,820,000	$ 4,010,000	$ 2,580,000	$ -
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 460,000	$ 230,000	$ 300,000	$ 160,000	$ -
ECUS MED	$ -	$ 290,000	$ 150,000	$ 250,000	$ 100,000	$ -
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 1,860,000	$ 930,000	$ 1,420,000	$ 650,000	$ -
Total	*$ -*	*$132,630,000*	*$ 42,850,000*	*$ 17,570,000*	*$ 5,320,000*	*$ -*

Table 84: Sensitivity 13 - Reduce PPX1 Replacement of PPX2 Vessels, Use Historical SPX Share of Capacity Calling, and Deployment of PPX by Unit Costs - Forecast Vessel Calls

42-Foot Depth	2017	2020	2025	2030
SPX	741	886	1,131	1,413
PX	1,127	826	1,223	1,362
PPX1	549	1,029	1,235	1,748
PPX2	-	-	-	-
Total	*2,417*	*2,741*	*3,588*	*4,523*
44-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	741	886	1,131	1,413
PX	994	535	833	815
PPX1	409	685	745	1,063
PPX2	140	344	490	685
Total	*2,284*	*2,450*	*3,198*	*3,976*
45-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	741	886	1,131	1,413
PX	929	481	712	720
PPX1	334	517	528	746
PPX2	215	475	682	931
Total	*2,220*	*2,359*	*3,052*	*3,810*
46-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	741	886	1,131	1,413
PX	905	447	665	655
PPX1	310	467	459	656
PPX2	239	519	742	1,011
Total	*2,196*	*2,319*	*2,997*	*3,736*
47-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	741	886	1,131	1,413
PX	901	442	659	643
PPX1	310	465	459	654
PPX2	239	519	740	1,011
Total	*2,192*	*2,312*	*2,989*	*3,722*
48-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	741	886	1,131	1,413
PX	901	442	659	643
PPX1	310	465	459	654
PPX2	239	519	740	1,011
Total	*2,192*	*2,312*	*2,989*	*3,722*

5.3. Other Sensitivities

5.3.1. Sensitivity 14: Increase Cargo Density

Sensitivity 14 tests what would occur if, as has been suggested by some, that cargo may become more dense in the future as shippers look for ways to cut costs by reducing packing materials and putting more product/commodity weight in containers. Additionally, this sensitivity test assumes that average cargo weight per TEU on each trade route would be such that the MPC of PPX vessels would be equal to the design draft of the vessels. For cargo densification, the PDT added ½ ton per TEU to the average cargo weight for Savannah imports on each trade route, as it is the import cargo that would be most subject to densification. In addition, the PDT replaced the load factor analysis for each trade route by a load factor analysis for a trade route that had the heaviest cargo and fewest minimal empty TEUs and vacant slots. The results are shown in Table 85 and Table 86. Average annual benefits increase from 2 to 37 percent with the greater increases being with greater depths as the effects of the Load Factor Analysis come more and more in to effect. The reason for the increase is the overall heavier loading of PPX vessels particularly at deeper drafts. However, the number of vessel calls also increase. This is primarily due to the need for more Panamax vessels as the number of PPX vessel decrease, and can accommodate fewer Savannah TEUs because of the additional average cargo weight they would carry. There are fewer PPX vessel calls because they are developed based on the TEU forecast. With increased import cargo weight per TEU, the Savannah TEU forecast is actually slightly lower and the 6.5 million TEU capacity is not reached until 2031.

Table 85: Sensitivity 14 – Increase Cargo Density - AAE Transportation Cost Savings

Service Route	42 feet	44 feet	45 feet	46 feet	47 feet	48 feet
Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 35,750,000	$ 54,190,000	$ 68,240,000	$ 79,190,000	$ 79,190,000
FE (Suez) ECUS	$ -	$ 37,960,000	$ 56,020,000	$ 67,240,000	$ 75,880,000	$ 75,880,000
FE ECUS EU PEN	$ -	$ 12,670,000	$ 19,190,000	$ 24,150,000	$ 28,010,000	$ 28,010,000
FE ECUS MED PEN	$ -	$ 9,530,000	$ 14,430,000	$ 18,160,000	$ 21,070,000	$ 21,070,000
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 570,000	$ 870,000	$ 1,090,000	$ 1,260,000	$ 1,260,000
ECUS MED	$ -	$ 520,000	$ 800,000	$ 1,000,000	$ 1,160,000	$ 1,160,000
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 2,740,000	$ 4,150,000	$ 5,220,000	$ 6,050,000	$ 6,050,000
Total AAE Benefits	*$ -*	*$ 99,750,000*	*$ 149,630,000*	*$ 185,090,000*	*$ 212,620,000*	*$ 212,620,000*
Service Route	**42 feet**	**44 feet**	**45 feet**	**46 feet**	**47 feet**	**48 feet**
Incremental Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 35,750,000	$ 18,430,000	$ 14,050,000	$ 10,950,000	$ -
FE (Suez) ECUS	$ -	$ 37,960,000	$ 18,060,000	$ 11,220,000	$ 8,630,000	$ -
FE ECUS EU PEN	$ -	$ 12,670,000	$ 6,510,000	$ 4,960,000	$ 3,860,000	$ -
FE ECUS MED PEN	$ -	$ 9,530,000	$ 4,900,000	$ 3,730,000	$ 2,910,000	$ -
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 570,000	$ 290,000	$ 220,000	$ 170,000	$ -
ECUS MED	$ -	$ 520,000	$ 270,000	$ 210,000	$ 160,000	$ -
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 2,740,000	$ 1,410,000	$ 1,070,000	$ 830,000	$ -
Total	*$ -*	*$ 99,750,000*	*$ 49,880,000*	*$ 35,460,000*	*$ 27,520,000*	*$ -*

Table 86: Sensitivity 14 - Increase Cargo Density - Forecast Vessel Calls

42-Foot Depth	2017	2020	2025	2030
SPX	497	593	758	947
PX	1,323	1,040	1,451	1,648
PPX1	464	838	971	1,377
PPX2	116	262	368	511
Total	*2,400*	*2,733*	*3,547*	*4,483*
44-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,265	934	1,326	1,472
PPX1	302	471	456	662
PPX2	232	524	736	1,021
Total	*2,296*	*2,523*	*3,275*	*4,102*
45-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,230	870	1,245	1,375
PPX1	302	470	456	659
PPX2	232	524	736	1,016
Total	*2,261*	*2,457*	*3,195*	*3,997*
46-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,208	836	1,182	1,314
PPX1	302	467	456	654
PPX2	232	520	736	1,008
Total	*2,239*	*2,417*	*3,132*	*3,923*
47-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,192	812	1,133	1,265
PPX1	302	465	456	650
PPX2	232	517	736	1,002
Total	*2,223*	*2,387*	*3,082*	*3,864*
48-Foot Depth	**2017**	**2020**	**2025**	**2030**
SPX	497	593	758	947
PX	1,192	812	1,133	1,265
PPX1	302	465	456	650
PPX2	232	517	736	1,002
Total	*2,223*	*2,387*	*3,082*	*3,864*

5.3.2. Sensitivity 15: Increase Savannah Share of Trade Route Cargo by 25%

The base line estimate of benefits used 2005 and 2007 vessel calls, Savannah cargo and empty containers, and sailing draft information combined with the Load Factor Analysis to estimate the amount of vessel capacity utilized when vessels called at Savannah Harbor. This information was then used to "allocate" the total round trip vessel costs to estimate benefits attributable to improving Savannah Harbor. It is recognized that this assumption is highly uncertain, because the amount of Savannah cargo carried varies considerably from trip to trip and year to year. Additionally, vessel itineraries change over time. While a number of variables in the analysis were updated from the 2005/07 base years used in the draft report by incorporating information from 2008 and 2010, sailing drafts were not analyzed for these years, therefore newer estimates of total cargo carried has not been revised. The amount of Savannah cargo carried as a percent of total cargo carried could vary considerable. For this sensitivity analysis, it was assumed that the amount of Savannah cargo carried relative to total cargo is 25% greater than observed and calculated from the 2005 and 2007 estimates. The results for average annual benefits are shown in Table 87. As expected, the annual benefits are 25 percent greater than the base line. This is because this is a straight linear relationship in the model. Thus a 10 percent or even a 50 percent change in amount of Savannah cargo carried relative to total cargo would result in 10 and 50 percent changes in benefits respectively.

Table 87: Sensitivity 15 – Increase Savannah Share of Trade Route Cargo by 25% - AAE Transportation Cost Savings

Service Route	42 feet	44 feet	45 feet	46 feet	47 feet	48 feet
Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 46,280,000	$ 58,150,000	$ 58,150,000	$ 58,150,000	$ 58,150,000
FE (Suez) ECUS	$ -	$ 39,590,000	$ 55,280,000	$ 66,940,000	$ 68,130,000	$ 68,130,000
FE ECUS EU PEN	$ -	$ 18,420,000	$ 24,880,000	$ 27,910,000	$ 27,910,000	$ 27,910,000
FE ECUS MED PEN	$ -	$ 13,390,000	$ 20,420,000	$ 25,260,000	$ 28,370,000	$ 28,370,000
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 750,000	$ 1,140,000	$ 1,430,000	$ 1,660,000	$ 1,660,000
ECUS MED	$ -	$ 680,000	$ 1,040,000	$ 1,310,000	$ 1,520,000	$ 1,520,000
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 3,640,000	$ 5,520,000	$ 6,950,000	$ 8,070,000	$ 8,070,000
Total AAE Benefits	*$ -*	*$122,760,000*	*$166,430,000*	*$187,960,000*	*$193,810,000*	*$193,810,000*
Service Route	**42 feet**	**44 feet**	**45 feet**	**46 feet**	**47 feet**	**48 feet**
Incremental Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 46,280,000	$ 11,870,000	$ -	$ -	$ -
FE (Suez) ECUS	$ -	$ 39,590,000	$ 15,700,000	$ 11,660,000	$ 1,180,000	$ -
FE ECUS EU PEN	$ -	$ 18,420,000	$ 6,460,000	$ 3,030,000	$ -	$ -
FE ECUS MED PEN	$ -	$ 13,390,000	$ 7,030,000	$ 4,840,000	$ 3,110,000	$ -
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 750,000	$ 380,000	$ 290,000	$ 230,000	$ -
ECUS MED	$ -	$ 680,000	$ 360,000	$ 270,000	$ 210,000	$ -
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 3,640,000	$ 1,880,000	$ 1,430,000	$ 1,120,000	$ -
Total	*$ -*	*$122,760,000*	*$ 43,670,000*	*$ 21,530,000*	*$ 5,850,000*	$ -

5.3.3. Sensitivity 16: Decrease Savannah Share of Trade Route Cargo by 25%

For this sensitivity, the estimated amount of Savannah cargo relative to total cargo was decreased by 25%. The purpose of this analysis is the same as described in Sensitivity 15; it is a highly uncertain parameter in the analysis of benefits. Table 88 shows the results on average annual benefits and as expected the results in both annual benefits and incremental benefits are a decrease of 25 percent from the base line. For this sensitivity and sensitivity 15, vessel calls are not shown because they are the same as in the base line condition. Only the amount of Savannah cargo to total cargo carried for purposes of allocated round trip distance cost changes.

Table 88: Sensitivity 16 – Decrease Savannah Share of Trade Route Cargo by 25% - AAE Transportation Cost Savings

Service Route	42 feet	44 feet	45 feet	46 feet	47 feet	48 feet
Transportation Cost Savings						
FE (Panama) ECUS	$ -	$27,770,000	$34,890,000	$ 34,890,000	$ 34,890,000	$ 34,890,000
FE (Suez) ECUS	$ -	$23,750,000	$33,170,000	$ 40,170,000	$ 40,880,000	$ 40,880,000
FE ECUS EU PEN	$ -	$11,050,000	$14,930,000	$ 16,740,000	$ 16,740,000	$ 16,740,000
FE ECUS MED PEN	$ -	$ 8,040,000	$12,250,000	$ 15,160,000	$ 17,020,000	$ 17,020,000
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 450,000	$ 680,000	$ 860,000	$ 1,000,000	$ 1,000,000
ECUS MED	$ -	$ 410,000	$ 620,000	$ 790,000	$ 910,000	$ 910,000
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 2,180,000	$ 3,310,000	$ 4,170,000	$ 4,840,000	$ 4,840,000
Total AAE Benefits	*$ -*	*$73,660,000*	*$99,860,000*	*$112,770,000*	*$116,280,000*	*$116,280,000*
Service Route	**42 feet**	**44 feet**	**45 feet**	**46 feet**	**47 feet**	**48 feet**
Incremental Transportation Cost Savings						
FE (Panama) ECUS	$ -	$27,770,000	$ 7,120,000	$ -	$ -	$ -
FE (Suez) ECUS	$ -	$23,750,000	$ 9,420,000	$ 7,000,000	$ 710,000	$ -
FE ECUS EU PEN	$ -	$11,050,000	$ 3,870,000	$ 1,820,000	$ -	$ -
FE ECUS MED PEN	$ -	$ 8,040,000	$ 4,220,000	$ 2,900,000	$ 1,870,000	$ -
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 450,000	$ 230,000	$ 180,000	$ 140,000	$ -
ECUS MED	$ -	$ 410,000	$ 210,000	$ 160,000	$ 130,000	$ -
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 2,180,000	$ 1,130,000	$ 860,000	$ 670,000	$ -
Total	*$ -*	*$73,660,000*	*$26,200,000*	*$ 12,920,000*	*$ 3,510,000*	*$ -*

5.3.4. Sensitivity 17: December 2010 Draft Report Values

Sensitivity 17 is presented primarily for comparison purposes. It is simply a display of the TCSM baseline results that were presented in the draft report on SHEP. The draft report values are shown in Table 89 and Table 90. The average annual benefits are 5 to 10 percent lower than the current baseline in this final report. While the overall commodity forecast in tonnes is lower in the final report than what was presented in the draft report, the forecast number of TEUs is higher due primarily to increased numbers of empty containers and changes in cargo weights that resulting from incorporating 2008 – 2010 actual shipments at Savannah. Also, the new Post-Panamax vessel call forecast resulted in an increase in the number of PPX 2 vessels in the early years of the analysis period. Additionally, a 2017 base year is used in the final report baseline compared to a 2015 year base year in the draft report, resulting in higher early year benefits. The discount rate of 4.125 percent for FY 2011 likewise results in an upward adjustment of benefits. And finally, changes in assumptions regarding deployment of PPX 2 vessels in the without project condition, as is occurring presently, results in an increase in benefits. Sensitivity 11 shown and discussed above, used the same deployment by depth assumption as was used in the draft report analysis, and resulted in values closer to the draft report numbers shown in the following table.

Table 89: Sensitivity 17 – December 2010 Draft Report Values - AAE Transportation Cost Savings

Service Route	42 feet	44 feet	45 feet	46 feet	47 feet	48 feet
Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 47,030,000	$ 59,830,000	$ 59,830,000	$ 59,830,000	$ 59,830,000
FE (Suez) ECUS	$ -	$ 18,810,000	$ 23,260,000	$ 29,010,000	$ 30,150,000	$ 30,150,000
FE ECUS EU PEN	$ -	$ 14,490,000	$ 19,700,000	$ 22,150,000	$ 22,150,000	$ 22,150,000
FE ECUS MED PEN	$ -	$ 10,610,000	$ 16,440,000	$ 20,360,000	$ 22,860,000	$ 22,860,000
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 190,000	$ 280,000	$ 330,000	$ 390,000	$ 390,000
ECUS MED	$ -	$ 1,280,000	$ 1,920,000	$ 2,210,000	$ 2,560,000	$ 2,560,000
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 600,000	$ 910,000	$ 1,050,000	$ 1,220,000	$ 1,220,000
Total AAE Benefits	*$ -*	*$ 93,010,000*	*$ 122,350,000*	*$ 134,930,000*	*$ 139,150,000*	*$ 139,150,000*
Service Route	**42 feet**	**44 feet**	**45 feet**	**46 feet**	**47 feet**	**48 feet**
Incremental Transportation Cost Savings						
FE (Panama) ECUS	$ -	$ 47,030,000	$ 12,810,000	$ -	$ -	$ -
FE (Suez) ECUS	$ -	$ 18,810,000	$ 4,450,000	$ 5,740,000	$ 1,150,000	$ -
FE ECUS EU PEN	$ -	$ 14,490,000	$ 5,210,000	$ 2,450,000	$ -	$ -
FE ECUS MED PEN	$ -	$ 10,610,000	$ 5,830,000	$ 3,920,000	$ 2,510,000	$ -
AU ECUS EU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS AU PEN	$ -	$ -	$ -	$ -	$ -	$ -
ECUS EU GULF PEN	$ -	$ 190,000	$ 100,000	$ 50,000	$ 50,000	$ -
ECUS MED	$ -	$ 1,280,000	$ 640,000	$ 280,000	$ 350,000	$ -
ECUS WCSA-ECSA	$ -	$ -	$ -	$ -	$ -	$ -
RTW	$ -	$ 600,000	$ 300,000	$ 140,000	$ 170,000	$ -
Total	*$ -*	*$ 93,010,000*	*$ 29,340,000*	*$ 12,580,000*	*$ 4,220,000*	*$ -*

Table 90: Sensitivity 17 - December 2010 Draft Report Values - Forecast Vessel Calls

42-Foot Depth	2015	2020	2025	2030	2032
SPX	324	390	485	584	633
PX	1,540	788	759	1,112	1,290
PPX1	308	1,188	1,704	2,058	2,226
PPX2	-	-	-	-	-
Total	*2,172*	*2,367*	*2,948*	*3,754*	*4,148*
44-Foot Depth	**2015**	**2020**	**2025**	**2030**	**2032**
SPX	324	390	485	584	633
PX	1,512	700	641	970	1,137
PPX1	260	647	755	906	977
PPX2	34	386	677	823	892
Total	*2,131*	*2,124*	*2,559*	*3,284*	*3,639*
45-Foot Depth	**2015**	**2020**	**2025**	**2030**	**2032**
SPX	324	390	485	584	633
PX	1,507	669	596	912	1,074
PPX1	252	564	614	737	795
PPX2	40	446	777	943	1,022
Total	*2,123*	*2,069*	*2,472*	*3,177*	*3,524*
46-Foot Depth	**2015**	**2020**	**2025**	**2030**	**2032**
SPX	324	390	485	584	633
PX	1,505	658	579	891	1,051
PPX1	248	524	548	662	716
PPX2	43	475	824	997	1,078
Total	*2,121*	*2,047*	*2,436*	*3,134*	*3,478*
47-Foot Depth	**2015**	**2020**	**2025**	**2030**	**2032**
SPX	324	390	485	584	633
PX	1,505	653	570	880	1,040
PPX1	248	524	548	662	716
PPX2	43	475	824	997	1,078
Total	*2,120*	*2,042*	*2,426*	*3,124*	*3,467*
48-Foot Depth	**2015**	**2020**	**2025**	**2030**	**2032**
SPX	324	390	485	584	633
PX	1,505	653	570	880	1,040
PPX1	248	524	548	662	716
PPX2	43	475	824	997	1,078
Total	*2,120*	*2,042*	*2,426*	*3,124*	*3,467*

5.4. Sensitivity Summary

Table 91 and Table 92 show an overall summary of the baseline benefits from the TCSM and the sensitivity tests run on various assumptions employed in the model. Table 91 shows annual costs, annual benefits, and net annual benefits (benefits minus costs) by alternative channel depth for all sensitivities. The table also shows the percent change in annual benefits from baseline estimates. This table is used to provide information and insight as to the overall justification of the alternatives. Table 92 provides incremental annual costs, incremental annual benefits, as well as incremental cost minus incremental net benefits. This table provides information as to the maximization of net incremental benefits to provide insight into the identification of the NED plan (e.g., that plan which provides maximum net benefits).

These analyses are presented using the circuit distance benefits computed for the project from the TCSM for container ships and do not reflect the effects of tidal delays and additional benefits which may be derived from reductions in tidal delays and non-container cargo which are discussed and presented in the next section of this appendix. However, circuit distance benefits far outweigh the benefits measured for tidal delay and other cargo savings, which are additive to the benefit shown herein. The magnitude of the benefits is such that they do not have a major impact on overall economic justification and plan optimization.

The baseline and sensitivities have been run testing various assumptions employed in the analysis. While this is not a fully exhaustive list of all future conditions or combinations of assumptions which could potentially be realized, it is sufficient for the analyst, interested parties, and decision makers to make informed judgments and inferences regarding overall plan justification and optimization.

As shown in Table 91 all plans have benefits which exceed costs for all channel depths, including Sensitivity 5 (no growth in tonnage and TEUs imported and exported at Savannah). With a no tonnage commodity growth, the 47 foot alternative has a benefit to cost ration of 1.8 to 1.0. Table 91 also shows that maximum net benefits are attained at a channel depth of 47 feet for all but one of the scenarios. Sensitivity 12 shows maximum net benefits at 48 feet. Sensitivity 12 also demonstrates that there are two factors which could lead to maximization of net benefits for most all sensitivities at 48 feet: 1) a reaction by carriers to take advantage of the larger tide window afforded by the 48-foot alternative by carrying more overall cargo when calling at Savannah and/or 2) larger PPX2 vessels than the 47.6 feet design draft vessel used in this analysis. Another conjecture can be made regarding what factors and circumstances could result in plan optimization at channel depths lower than 47 feet. Such circumstances could include fewer PPX2 vessels deployed on the heavier cargo trade routes (RTW, ECUS MED, ECUS EU GULF, FE SUEZ ECUS, and FE ECUS MED) which could lead to optimization at 46-foot channel depth. Additionally, in conducting these sensitivity analyses, one can conjecture that port rotation matters. When Savannah is a first or early port of call on the East Coast United States, there seems to be a tendency for vessels to carry generally lighter cargo overall as they would be carrying mostly imports which are lighter than exports and vessel would tend to sail at shallower drafts. Conversely, when Savannah is the last or near the end of the ECUS portion of their itinerary, they would tend to carry proportionally more of the heavier export cargo and thus tend to sail deeper and make greater use of available channel depths.

Table 91: Sensitivity Summary Table – Net Benefits

Sensitivity Analysis - Summary							
AAE Transportation Cost Savings ($1,000) and Sensitivity Ratio under the Baseline Condition							
		Project Depth (design dimensions)					**Maximum Absolute Deviation**
		44	45	46	47	48	
	Annual Costs	$29,370,000	$31,640,000	$33,750,000	$35,800,000	$37,820,000	
Commodity Projections	Baseline	*$98,210,000*	*$133,150,000*	*$150,370,000*	*$155,040,000*	*$155,040,000*	
	Net benefits	*$68,840,000*	*$101,510,000*	*$116,620,000*	*$119,240,000*	*$117,220,000*	
	1-Increase Annual Commod. Grwth by 1%	*$117,060,000*	*$158,490,000*	*$178,290,000*	*$184,340,000*	*$184,340,000*	
	Deviation from the baseline in %	*19.19%*	*19.03%*	*18.57%*	*18.90%*	*18.90%*	*19.00%*
	Net benefits	*$87,690,000*	*$126,850,000*	*$144,540,000*	*$148,540,000*	*$146,520,000*	
	2-Incr Annual Commod. Grwth by 3%	*$164,090,000*	*$222,280,000*	*$250,090,000*	*$258,560,000*	*$258,560,000*	
	Deviation from the baseline in %	*67.08%*	*66.94%*	*66.32%*	*66.77%*	*66.77%*	*67.00%*
	Net benefits	*$134,720,000*	*$190,640,000*	*$216,340,000*	*$222,760,000*	*$220,740,000*	
	3-Decrease Annual Commod Grwth by 1%	*$93,580,000*	*$126,390,000*	*$142,290,000*	*$147,470,000*	*$147,470,000*	
	Deviation from the baseline in %	*-4.71%*	*-5.08%*	*-5.37%*	*-4.88%*	*-4.88%*	*5.00%*
	Net benefits	*$64,210,000*	*$94,750,000*	*$108,540,000*	*$111,670,000*	*$109,650,000*	
	4-Decrease Annual Commod Grwth by 3%	*$62,860,000*	*$84,840,000*	*$95,500,000*	*$98,970,000*	*$98,970,000*	
	Deviation from the baseline in %	*-35.99%*	*-36.28%*	*-36.49%*	*-36.16%*	*-36.16%*	*36.00%*
	Net benefits	*$33,490,000*	*$53,200,000*	*$61,750,000*	*$63,170,000*	*$61,150,000*	
	5 - No Growth in Commodity Forecast	*$37,430,000*	*$50,640,000*	*$57,060,000*	*$59,250,000*	*$59,250,000*	
	Deviation from the baseline in %	*-61.89%*	*-61.97%*	*-62.05%*	*-61.78%*	*-61.78%*	*62.00%*
	Net benefits	*$8,060,000*	*$19,000,000*	*$23,310,000*	*$23,450,000*	*$21,430,000*	
Vessel Availability and Loading	6-Historical SPX Share of Capacity Calling	*$100,000,000*	*$135,410,000*	*$152,730,000*	*$157,200,000*	*$157,200,000*	
	Deviation from the baseline in %	*1.82%*	*1.70%*	*1.57%*	*1.39%*	*1.39%*	*2.00%*
	Net benefits	*$70,630,000*	*$103,770,000*	*$118,980,000*	*$121,400,000*	*$119,380,000*	
	7-Red Future SPX Share of Capacity Call.	*$96,580,000*	*$131,090,000*	*$148,230,000*	*$153,090,000*	*$153,090,000*	
	Deviation from the baseline in %	*-1.66%*	*-1.55%*	*-1.42%*	*-1.26%*	*-1.26%*	*2.00%*
	Net benefits	*$67,210,000*	*$99,450,000*	*$114,480,000*	*$117,290,000*	*$115,270,000*	
	8–Incr. Amnt of Sav Cargo Carr on PPX	*$102,980,000*	*$135,000,000*	*$151,160,000*	*$155,440,000*	*$155,440,000*	
	Deviation from the baseline in %	*4.86%*	*1.39%*	*0.53%*	*0.26%*	*0.26%*	*5.00%*
	Net benefits	*$73,610,000*	*$103,360,000*	*$117,410,000*	*$119,640,000*	*$117,620,000*	
	9 - Full Deployment of PPX in W/O	*$105,920,000*	*$140,860,000*	*$158,080,000*	*$162,760,000*	*$162,760,000*	
	Deviation from the baseline in %	*7.85%*	*5.79%*	*5.13%*	*4.98%*	*4.98%*	*8.00%*
	Net benefits	*$76,550,000*	*$109,220,000*	*$124,330,000*	*$126,960,000*	*$124,940,000*	
	10 - Reduce PPX Vessel Calls by 25%	*$81,300,000*	*$112,960,000*	*$130,020,000*	*$135,050,000*	*$135,050,000*	
	Deviation from the baseline in %	*-17.22%*	*-15.16%*	*-13.53%*	*-12.89%*	*-12.89%*	*17.00%*
	Net benefits	*$51,930,000*	*$81,320,000*	*$96,270,000*	*$99,250,000*	*$97,230,000*	
	11 - Deploy PPX Vessels by Unit Costs	*$95,470,000*	*$128,170,000*	*$144,850,000*	*$149,530,000*	*$149,530,000*	
	Deviation from the baseline in %	*-2.79%*	*-3.74%*	*-3.67%*	*-3.55%*	*-3.55%*	*4.00%*
	Net benefits	*$66,100,000*	*$96,530,000*	*$111,100,000*	*$113,730,000*	*$111,710,000*	
	12 - Incr PPX Load Beyond MPC	*$98,210,000*	*$143,480,000*	*$172,010,000*	*$183,080,000*	*$187,420,000*	
	Deviation from the baseline in %	*0.00%*	*7.76%*	*14.39%*	*18.09%*	*20.88%*	*21.00%*
	Net benefits	*$68,840,000*	*$111,840,000*	*$138,260,000*	*$147,280,000*	*$149,600,000*	
	13 - Red PPX1 Repl of PPX2, Hist SPX Share Cap Call and Deploy PPX by Unit $	*$132,630,000*	*$175,480,000*	*$193,050,000*	*$198,370,000*	*$198,370,000*	
	Deviation from the baseline in %	*35.05%*	*31.79%*	*28.38%*	*27.95%*	*27.95%*	*35.00%*
	Net benefits	*$103,260,000*	*$143,840,000*	*$159,300,000*	*$162,570,000*	*$160,550,000*	
Other	14 - Increase Cargo Density	*$99,750,000*	*$149,630,000*	*$185,090,000*	*$212,620,000*	*$212,620,000*	
	Deviation from the baseline in %	*1.57%*	*12.38%*	*23.09%*	*37.14%*	*37.14%*	*37.00%*
	Net benefits	*$70,380,000*	*$117,990,000*	*$151,340,000*	*$176,820,000*	*$174,800,000*	
	15 - Increase Savannah Share of Trade Route Cargo by 25%	*$122,760,000*	*$166,430,000*	*$187,960,000*	*$193,810,000*	*$193,810,000*	
	Deviation from the baseline in %	*25.00%*	*24.99%*	*25.00%*	*25.01%*	*25.01%*	*25.00%*
	Net benefits	*$93,390,000*	*$134,790,000*	*$154,210,000*	*$158,010,000*	*$155,990,000*	
	16 - Decrease Savannah Share of Trade Route Cargo by 25%	*$73,660,000*	*$99,860,000*	*$112,770,000*	*$116,280,000*	*$116,280,000*	
	Deviation from the baseline in %	*-25.00%*	*-25.00%*	*-25.00%*	*-25.00%*	*-25.00%*	*25.00%*
	Net benefits	*$44,290,000*	*$68,220,000*	*$79,020,000*	*$80,480,000*	*$78,460,000*	
	17 - Draft Report Values	*$93,010,000*	*$122,350,000*	*$134,930,000*	*$139,150,000*	*$139,150,000*	
	Deviation from the baseline in %	*-5.29%*	*-8.11%*	*-10.27%*	*-10.25%*	*-10.25%*	*10.00%*
	Net benefits	*$63,640,000*	*$90,710,000*	*$101,180,000*	*$103,350,000*	*$101,330,000*	

Table 92: Sensitivity Summary – Net Incremental Benefits

Sensitivity Analyses - Summary						
Net Incremental Benefits						
		Project Depth (design dimensions)				
		44	45	46	47	48
	Incremental Annual Costs	$29,370,000	$2,270,000	$2,110,000	$2,050,000	$2,020,000
Commodity Projections	Baseline	$98,210,000	$34,940,000	$17,220,000	$4,670,000	$0
	Net Incremental benefits	$68,840,000	$32,670,000	$15,110,000	$2,620,000	-$2,020,000
	1 - Increase Annual Commodity Growth by 1%	$117,060,000	$41,430,000	$19,800,000	$6,050,000	$0
	Net Incremental benefits	$87,690,000	$39,160,000	$17,690,000	$4,000,000	-$2,020,000
	2 - Increase Annual Commodity Growth by 3%	$164,090,000	$58,190,000	$27,810,000	$8,470,000	$0
	Net Incremental benefits	$134,720,000	$56,090,000	$25,700,000	$6,420,000	-$2,020,000
	3 - Decrease Annual Commodity Growth by 1%	$93,580,000	$32,810,000	$15,900,000	$5,180,000	$0
	Net Incremental benefits	$64,210,000	$30,710,000	$13,790,000	$3,130,000	-$2,020,000
	4 - Decrease Annual Commodity Growth by 3%	$62,860,000	$21,980,000	$10,660,000	$3,470,000	$0
	Net Incremental benefits	$33,490,000	$19,710,000	$8,550,000	$1,420,000	-$2,020,000
	5 - No Growth in Commodity Forecast	$37,430,000	$13,210,000	$6,420,000	$2,190,000	$0
	Net Incremental benefits	$8,060,000	$10,940,000	$4,310,000	$140,000	-$2,020,000
Vessel Availability and Loading	6 - Historical SPX Share of Capacity Calling	$100,000,000	$35,410,000	$17,320,000	$4,470,000	$0
	Net Incremental benefits	$70,630,000	$33,140,000	$15,210,000	$2,420,000	-$2,020,000
	7-Red Future SPX Share of Capacity Call.	$96,580,000	$34,510,000	$17,140,000	$4,860,000	$0
	Net Incremental benefits	$67,210,000	$32,240,000	$15,030,000	$2,810,000	-$2,020,000
	8–Incr. Amnt of Sav Cargo Carr on PPX	$102,980,000	$32,020,000	$16,160,000	$4,280,000	$0
	Net Incremental benefits	$73,610,000	$29,750,000	$14,050,000	$2,230,000	-$2,020,000
	9 - Full Deployment of PPX in W/O	$105,920,000	$34,940,000	$17,220,000	$4,680,000	$0
	Net Incremental benefits	$76,550,000	$32,670,000	$15,110,000	$2,630,000	-$2,020,000
	10 - Reduce PPX Vessel Calls by 25%	$81,300,000	$31,660,000	$17,060,000	$5,030,000	$0
	Net Incremental benefits	$51,930,000	$29,390,000	$14,950,000	$2,980,000	-$2,020,000
	11 - Deploy PPX Vessels by Unit Costs	$95,470,000	$32,700,000	$16,680,000	$4,680,000	$0
	Net Incremental benefits	$66,100,000	$30,430,000	$14,570,000	$2,630,000	-$2,020,000
	12 - Incr PPX Load Beyond MPC	$98,210,000	$45,270,000	$28,530,000	$11,070,000	$4,340,000
	Net Incremental benefits	$68,840,000	$43,000,000	$26,420,000	$9,020,000	$2,320,000
	13 - Red PPX1 Repl of PPX2, Hist SPX Share Cap Call and Deploy PPX by Unit $	$132,630,000	$42,850,000	$17,570,000	$5,320,000	$0
	Net Incremental benefits	$103,260,000	$40,580,000	$15,460,000	$3,270,000	-$2,020,000
Other	14 - Increase Cargo Density	$99,750,000	$49,880,000	$35,460,000	$27,530,000	$0
	Net Incremental benefits	$70,380,000	$47,610,000	$33,350,000	$25,480,000	-$2,020,000
	15 - Increase Savannah Share of Trade Route Cargo by 25%	$122,760,000	$43,670,000	$21,530,000	$5,850,000	$0
	Net Incremental benefits	$93,390,000	$41,400,000	$19,420,000	$3,800,000	-$2,020,000
	16 - Decrease Savannah Share of Trade Route Cargo by 25%	$73,660,000	$26,200,000	$12,910,000	$3,510,000	$0
	Net Incremental benefits	$44,290,000	$23,930,000	$10,800,000	$1,460,000	-$2,020,000
	17 - Draft Report Values	$93,010,000	$29,340,000	$12,580,000	$4,220,000	$0
	Net Incremental benefits	$63,640,000	$27,070,000	$10,470,000	$2,170,000	-$2,020,000

6. MEETING AREA AND TIDE DELAY ANALYSES

The purpose of this analysis is to describe the benefits associated with the reduction in transit time required to navigate Savannah Harbor as a result of channel modifications which will reduce congestion within the harbor. The study involves an evaluation of the navigation constraints associated with the harbor. Transportation cost savings were estimated in terms of the reduction in harbor transit times and consequent vessel delays. Transit costs were estimated by analyzing the condition that is most likely to occur in the absence of channel deepening or a meeting area located within Savannah Harbor and comparing those results to the transit times/costs that were derived when including the channel deepening and different meeting area alternatives. The economic benefits were determined using the HarborSym model developed by the IWR.

6.1. HarborSym Model

The IWR developed HarborSym as a planning level, general purpose model to analyze the economic impacts of various waterway modifications within a harbor. HarborSym is a Monte Carlo simulation model of vessel movements at a port for use in economic analyses. While many harbor simulation models focus on landside operations, such as detailed terminal management, HarborSym instead concentrates on specific vessel movements and transit rules on the waterway.

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

6.1.1. Inputs

The data required to run HarborSym are separated into six categories:

- Simulation Parameters. Parameters include start date, the duration of the iteration, the number of iterations, the level of detail of the result output, and the wait time before rechecking rule violations when a vessel experiences a delay. These inputs were included in the model runs for the Savannah Harbor Expansion Project. The base year for the model was 2017, due to the 2016 estimated finish date of construction. A model run was performed for each year of the project life in four increments until 2030, at which time the forecast number of TEUs was held constant until the end of the period of analysis. Each model run consisted of 50 iterations. The number of iterations was determined to be sufficient when comparing the average time of the fleet in the system. The following graph illustrates that initially 100 iterations were used; however, variability in system time stabilized with fewer iterations and 50 iterations was determined sufficient for this analysis.

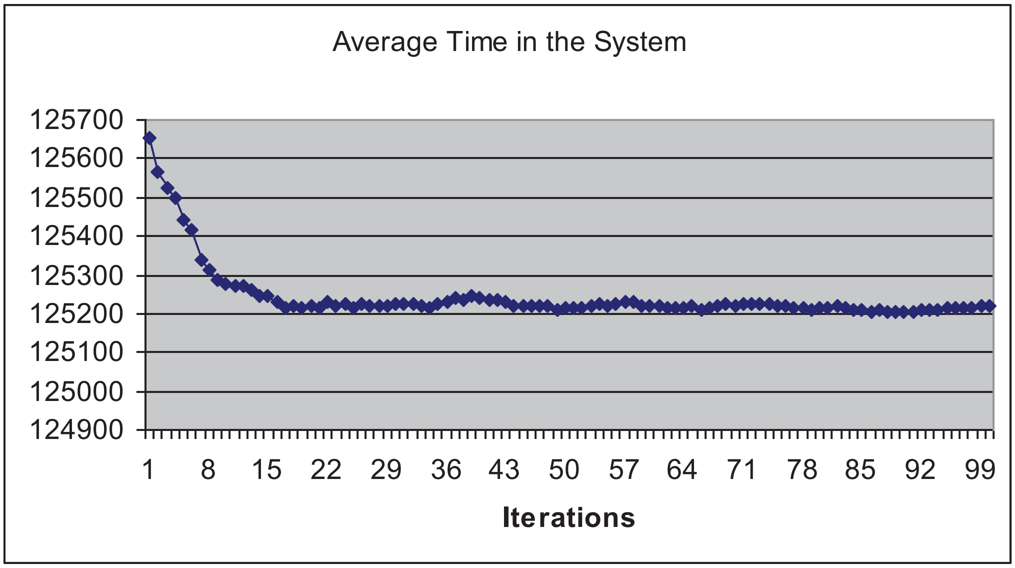


Figure 33: HarborSym Iterations - Hours

- Specific physical and descriptive characteristics of the Savannah Harbor. These data inputs include the specific network of Savannah Harbor such as the node location and type, reach length, width, and depth, in addition to tide and current stations. This also includes information about the docks in the harbor such as length and the maximum number of vessel the dock can accommodate at any given time. Figure 34 displays the Node network used for Savannah Harbor.

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

- Vessel speeds. With the assistance of the Savannah Bar Pilots and the Georgia Ports Authority, the speeds at which vessels operate in the harbor, by vessel class both loaded and light loaded, were determined for each channel segment.

- Transit rules for each reach. Vessel transit rules for each reach reflect restrictions on passing, overtaking, and meeting in particular segments of Savannah Harbor, and are used to evaluate delays in the system. Underkeel clearance requirements are also used along with tide to determine if a vessel can enter the system.

- Vessels calls: the vessel call lists are made up of vessel calls forecast for a given year. Each call is given a movement number based on its date and time of entry into the harbor. The vessel call list is imported into HarborSym using an excel spreadsheet.

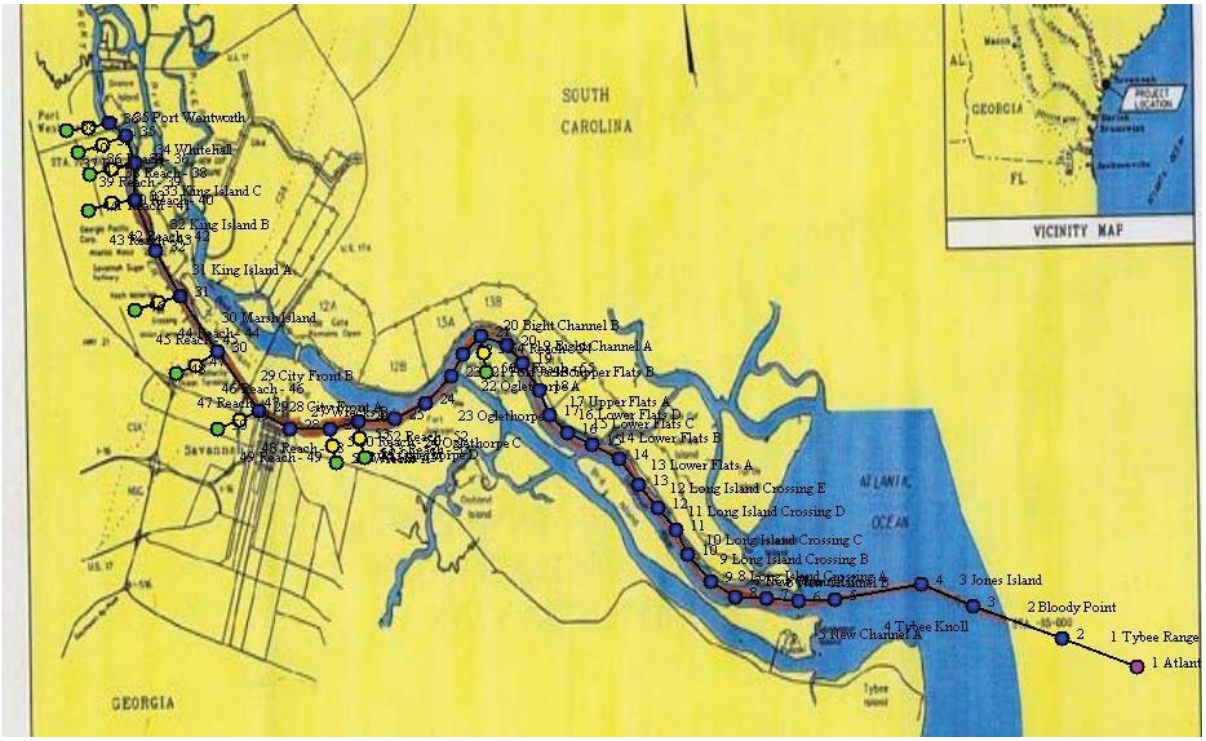


Figure 34: Savannah Harbor Node Network

6.1.2. Outputs

A number of parameters are collected and stored in HarborSym after the model runs are completed. Among these parameters are the number of vessels entering/exiting the harbor, the average time a vessel class spends in the system (hours), the average transit cost of a vessel for each class, the total transit cost of the annual fleet, vessel time and location (e.g., entry, dock, turning basin, etc.) spent waiting in the, vessel times in anchorage areas, vessel times docking and undocking, vessel times loading and unloading, commodity quantities transferred, and total commodity statistics at the port. These outputs are then used to quantify delay reduction benefits.

6.2. Savannah Harbor Expansion Project – Meeting Area Analysis

6.2.1. Meeting Area Alternatives

The need for meeting areas was expressed by the Savannah Harbor Bar Pilots subsequent to preliminary channel design. Meeting areas provide locations for two Post-Panamax vessels to be able to meet in transit to avoid delays that would otherwise be incurred if a vessel had to either wait at the entrance channel or at dock until another Post-Panamax vessel had exited the channel.

The Pilots indicated that they currently "can meet all vessel classes using the harbor now including two Post-Panamax vessels, but that is rare and it would take a significant amount of coordination". Also, the pilots felt uncertain as to how the Post-Panamax vessels would handle with the increase in channel depth given the narrower bottom configuration of the proposed channel and the increase in vessel draft due to being more fully loaded. Because of these changes in condition, the pilots felt that meeting areas within the harbor were needed to ensure greater flexibility in vessel movement.

During the beginning stages of the SHEP navigation study, the pilots initially suggested the Long Island Range (Station 16+500 to 19+500) as a long straight reach that would be appropriate. During the simulation runs the pilots typically met in the Fort Jackson range using a widened potion of the design channel as a meeting area. As a result, Pilots requested, and the navigation study recommended that the Oglethorpe Range (Station 55+000 to 58+000) be considered as a meeting area being centrally located on a long straight reach.

In a subsequent meeting with the pilots, a need was expressed for a meeting area across from the CITGO dock as pilots experienced delays when vessels are anchored at the CITGO dock. Initial design was a meeting area that ran through Marsh Island Turning Basin (Station 89+134 to 92.000). This area was eventually removed from consideration as attempts to provide more adequate length for a meeting area produced considerable upland taking of real estate.

After the ship simulations were completed the optimum lengths of the meeting areas were determined. For use in HarborSym, the Long Island meeting area was modeled with a length of 8,000 feet and the Oglethorpe meeting area a length of 4,000 feet. Additional details are provided in the following sections.

For the future without-project condition at Savannah Harbor, the current channel configuration was modeled for each potential project depth ranging from 44 to 48 feet in one foot increments. For the meeting area analysis, the current channel alignment is considered to be the existing condition for each channel depth being modeled for the deepening study. Given current channel dimensions (500 foot width), two Post-Panamax vessels are not allowed to meet (pass or overtake) while transiting the harbor. As a result, a Post-Panamax vessel exiting the harbor would cause a transit delay for an arriving Post-Panamax vessel. This would also occur for the reverse scenario. All other vessel classes in the system are allowed to pass/overtake while transiting the harbor with the exception of a loaded Liquid Natural Gas (LNG) vessel. When an LNG vessel enters the system, all other vessels are restrained until it has reached its dock. The purpose of this HarborSym analysis is to determine if the inclusion of a meeting area(s) would decrease time delays associated with Post-Panamax vessels transiting the harbor. For this reason, the HarborSym model was run at each potential depth. The transit times/costs generated were then compared to meeting area alternatives, which consist of two separate meeting area alternatives and a combination of the two.

6.2.1.1. Existing Condition

Savannah Harbor is a major deep water port comprised of 11.4 miles of ocean channel and 21.3 miles of inner harbor channel. The ocean channel is 44 feet deep MLLW and 600 feet wide. The inner harbor channel is 42 feet deep MLLW and 500 feet wide. For each project depth alternative, the current channel alignment was considered the existing condition for that scenario.

6.2.1.2. Long Island Alternative

The Long Island meeting area alternative evaluates an 8,000 foot meeting area located from approximately Station 14 to 22 (Corps of Engineers Annual Survey data 1996). This alternative has 1,000 foot transitions and provides for an additional width of 100 feet, making this channel segment 600 feet wide. This alternative is located closest to the entrance of the Savannah River System. This alternative would expand the width of the channel in this area and allow two Post-Panamax vessels to pass once inside the harbor channel, thus decreasing the voyage time/cost for this vessel class.

6.2.1.3. Oglethorpe Alternative

The Oglethorpe Alternative evaluates a 4,000 foot meeting area located from approximately Station 55 to 59 (Corps of Engineers Annual Survey data). This alternative has 1,000-foot transitions and provides for an additional width of 100 feet. The location is approximately one mile upstream from the Elba Island LNG terminal. This channel modification would expand the width of the channel to 600 feet and would allow for two Post-Panamax vessels to pass once inside the harbor channel, thus decreasing the voyage time/cost for this vessel class.

6.2.1.4. Long Island – Oglethorpe Alternative

The Long Island – Oglethorpe Alternative is the inclusion of both the previously mentioned meeting areas within the Savannah River System. Post-Panamax vessels would be allowed to pass in both locations.

6.2.2. Vessel Call List

For all ports there is a specific fleet that transits the harbor. Once a vessel fleet was determined for Savannah Harbor, specifics about the fleet were included in the model. Each vessel call list contains the following information: arrival date, arrival time, vessel name, entry point, exit point, arrival draft, import/export, dock name, dock order, commodity, units, origin/destination, vessel type, Lloyds Registry, net registered tons, gross registered tons, dead weight tons, capacity, length overall, beam, draft, flag, and tons per inch immersion factor. The call list for the base year and each additional year were compiled in four increments from 2017 to 2030, the point at which the Garden City terminal is anticipated to reach its capacity. The arrival dates and times were developed in excel using the random function. From 2030 till the end of the period of analysis, the fleet remains constant.

6.2.2.1. Container Vessel Fleet

The container fleet used in the with and without project conditions were those used for the deepening study. The fleet and the forecast sailing draft distributions are required data inputs when tide and under keel clearance are factors in traffic movement. The fleet forecasts assume that TEU throughput is increased at the harbor (to 6.5 million TEUs) and that Garden City Terminal capacity will be reached in 2030. For the remainder of the period of analysis, 2030 to 2066, the annual TEUs moved through the Savannah Harbor were held constant. The container fleet averages 16 hours at the dock and the transit time round trip is approximately 6 hours. The following tables provide the estimated annual number of container vessel calls at each project depth. The number of calls estimated for project depths of 45 through 48 feet are similar, but are shown since they differ slightly. A more detailed description of the forecast container fleet can be found in Section 3.4 of this Economics Appendix.

Table 93: Containerized Vessel Fleet – 44-Foot Depth (2017-2030)

Year	Sub-Panamax	Panamax	PPX1	PPX2
2017	497	1,135	312	239
2020	593	700	478	533
2025	758	992	471	761
2030	947	1,067	672	1,035

Table 94: Containerized Vessel Fleet – 45-Foot Depth (2017-2030)

Year	Sub-Panamax	Panamax	PPX1	PPX2
2017	497	1,109	312	239
2020	593	671	474	527
2025	758	952	467	753
2030	947	1,007	666	1,027

Table 95: Containerized Vessel Fleet – 46-Foot Depth (2017-2030)

Year	Sub-Panamax	Panamax	PPX1	PPX2
2017	497	1,096	312	239
2020	593	658	471	524
2025	758	932	465	749
2030	947	982	662	1,021

Table 96: Containerized Vessel Fleet – 47-Foot Depth (2017-2030)

Year	Sub-Panamax	Panamax	PPX1	PPX2
2017	497	1,092	312	239
2020	593	649	471	524
2025	758	924	462	749
2030	947	975	661	1,018

Table 97: Containerized Vessel Fleet – 48-Foot Depth (2017-2030)

Year	Sub-Panamax	Panamax	PPX1	PPX2
2017	497	1,092	312	239
2020	593	649	471	524
2025	758	924	462	749
2030	947	975	661	1,018

6.2.2.2. Liquid Natural Gas (LNG) Vessel Fleet

Southern LNG, Inc. operates the Elba Island terminal, which is one of only four LNG terminals currently operating in the continental US. Southern has plans to expand its Elba Island LNG terminal located in Savannah, Georgia in order to increase storage and send-out capacity. Southern LNG plans to complete the expansion in two phases. The total project is estimated to cost approximately $350 million. Phase I of the project will add one 200,000 cubic meter storage tank which will hold 1,250,000 barrels. This phase of expansion was placed in service in July 2010 and will add approximately 4.2 billion cubic feet (Bcf) of LNG storage capacity to the terminal. Maximum send out capacity will be 0.405 Bcf/d. Phase I of the project also includes modifying the north and south docks to accommodate new, larger vessels and to facilitate the simultaneous unloading of two ships.

Phase II of the project will add one 200,000 cubic meter (1,250,000 barrels) storage tank. This tank will add approximately 4.2 Bcf of storage capacity to the terminal in 2012 and increase send out by 0.495 Bcf/d. The liquefied natural gas for the expansion will be transported by ship from gas rich regions outside of the United States. Southern LNG's facilities at Elba Island will vaporize the LNG and inject the natural gas into Southern's existing pipeline.[27]

Due to the channel transit restrictions placed on LNG vessels when entering the harbor, an estimate of the number of annual number of LNG vessel calls is essential. Any LNG vessel entering Savannah Harbor has a safety zone restriction both upstream and downstream. The restriction means that when a LNG vessel is transiting the harbor, for safety purposes, no other vessel is allowed within that distance. For Savannah harbor, the distance is from the Atlantic entrance of the harbor to the Elba Island terminal. While an LNG vessel is transiting the system, all other traffic is restricted until the LNG vessel begins to dock. The total number of LNG vessels evaluated in the HarborSym analysis is shown in Table 98 below.

During the base year, the terminal is anticipated to operate at 60 percent capacity increasing to 80 percent capacity by 2030. The fleet was held constant from 2030 till the end of the period of analysis. Note, at 100 percent capacity, the possible number of calls could reach approximately 200. These vessels take approximately 4 hours round trip to transit the harbor channel and spend on average 24 to 30 hours at the dock, depending on the size of the vessel. Table 98 below displays the annual number of calls forecast each year and the size of each vessel class.

Table 98: LNG Vessel Fleet (bcm) (2017-2030)

Year	Total Vessels	BU SAMRA 266,000 17.4%	AL HUWAILA 217,000 12.7%	MERSK ARWA 165,500 23.9%	LUSAIL 145,000 23.5%	BRITISH TRADER 135,000 22.5%
2017	126	22	16	30	30	28
2020	136	24	17	32	32	30
2025	151	26	19	36	35	34
2030	167	29	21	40	39	37

6.2.2.3. General Cargo Vessel Fleet

The General Cargo vessel class will not benefit from channel modification at Savannah Harbor (i.e., deepening nor the addition of meeting areas); however, determining the annual number of general cargo vessels calling Savannah Harbor was critical for properly assessing harbor congestion. Any vessel not identified as a container or LNG vessel was included in this vessel class.

[27] http://www.elpaso.com/elba3/elba3expansion/project_desc.shtm

Using Waterborne Commerce data provided for the years 2001 through 2008, a growth rate was estimated for forecasting the number of General Cargo vessels. The average annual growth for this period was 3.6 percent. Using Georgia Ports Authority data for 2006, an annual vessel fleet was determined for the base year of the project, 2017, and for four increments until 2030. The forecast was then held constant through the end of the period of analysis. The fleet for each future year was then distributed to the general cargo docks in the same percentages as the 2008 vessel fleet. Table 99 provides the total General Cargo fleet for HarborSym modeling purposes.

Table 99: General Cargo Fleet – Annual Vessel Calls (2017-2030)

Year	Vessels
2017	1,867
2020	2,068
2025	2,468
2030	2,946

6.2.3. Sailing Draft Distribution

Vessel sailing draft distributions are critical for determining the benefits of both the meeting area and tide delay analyses due to channel depth and underkeel requirements. The distribution for the container fleet and the LNG fleet were determined because the transit times and costs for these vessel classes are altered by the inclusion of one or more meeting areas and channel deepening. General Cargo vessel transits are not altered by meeting areas and channel deepening has an insignificant impact due to the low number of vessels that transit the system with a draft greater than 38 feet. Therefore, a detailed sailing draft distribution was not developed for this class vessel, and a range was input at 19 to 35 feet based on empirical data from Waterborne Commerce.

6.2.3.1. Container Vessel Fleet

6.2.3.1.1. Background. For the container vessel fleet, an analysis of observed sailing drafts at various deepwater ports was performed. The data represents that obtained from the pilots at Savannah as well as two of the world's largest container fleet operators. The historical data covers various years and will be identified in the following text.

6.2.3.1.2. Purpose and Scope. The purpose of this analysis was to provide the SHEP empirical evidence to support key assumptions about future sailing drafts to be used in the Meeting Area and Tide Delay evaluations. The analysis identifies observed sailing drafts at port terminals around the world. It also examines the sailing drafts by vessel class and terminal depth. Finally it incorporates specific observations at Savannah Harbor and estimates future sailing drafts by vessel class for alternative project depths. It should be noted that all Sub-Panamax vessels were set to a sailing draft of 34 feet. While there would be a range of sailing drafts for this vessel class, it was determined that the maximum draft for a Sub-Panamax vessel would be 34 feet. Therefore, since the draft of these vessels would not alter the benefits, all vessels were set at that sailing draft.

6.2.3.1.3. The Data Set. As mentioned, the USACE was provided container vessel operations data from two large companies as well as the harbor pilots at Savannah Harbor. This data was provided by the Georgia Ports Authority and/or its contractor and is considered sensitive. The USACE has agreed that the data will only be used to further the efforts of the SHEP. Specific permission must be obtained from the GPA prior to any additional proposed use.

The dataset from each of the identified sources was divided among vessel classes: Panamax, PPX1, and PPX2. Vessel classes were defined as follows: Panamax – 2,900-5,200 TEUs, PPX1 – 5,200-7,600 TEUs, and PPX2 – greater than 7,600 TEUs. Each vessel class was then analyzed separately. Documentation of the evaluation process follows.

6.2.3.1.3.1. Panamax Vessel Class. It was assumed that under future without project conditions, Panamax vessels would continue to operate at Savannah as they have historically. Therefore, historical data was summarized and is shown in the following table. Note, Panamax vessels calling on Savannah are assumed to be using tide when those vessels are sailing at drafts greater than 38 feet.

According to harbor pilot data, there were a total of 2,365 Panamax vessel transits at Garden City Terminal in 2006. Of this total, 88% percent (2,093 transits) were sailing drafts of less than or equal to 38 feet. Accordingly, 12 percent of all vessel transits were at sailing drafts greater than 38 feet and were therefore utilizing tide to safely navigate the harbor channel. By 2007, approximately 16 percent of Panamax vessel transits were at sailing drafts requiring tide.

Table 100: Historical and Future Without Project Condition Sailing Draft Distribution – Panamax Vessel Class

	Sailing Draft (feet)								
	<=38	39	40	41	42	43	44	45	Total
Pilots 2006	2,093	97	80	58	36	1	0	0	**2,365**
Pilots 2007	2,287	152	110	78	82	4	0	0	**2,713**
Total	**4,380**	**249**	**190**	**136**	**118**	**5**	**0**	**0**	**5,078**
Percent of Total Transits	86%	5%	4%	3%	2%	0%	0%	0%	**100%**
Cumulative Percentage	**86.3%**	**91.2%**	**94.9%**	**97.6%**	**99.9%**	**100.0%**	**100.0%**	**100.0%**	**100%**

Source: Harbor Pilots Data

Savannah Harbor data from the aforementioned carriers was analyzed for use in estimating future with project condition behavior. This dataset covered calendar year 2008 and the first eight months of 2009. The following table illustrates the results of this analysis. An explanation of how this data was applied to estimate future vessel sailing drafts will be presented in the paragraphs that follow.

Table 101: Carrier Reported Sailing Drafts at Savannah Harbor (2008-2009) – Panamax Vessel Class

	Sailing Draft (feet)								
	<=38	39	40	41	42	43	44	45	Total
Combined Carrier Transits	432	40	35	40	43	2	0	0	**592**
Percent of Total Transits	73%	7%	6%	7%	7%	0%	0%	0%	**100%**
Cumulative Percentage	**73.0%**	**79.7%**	**85.6%**	**92.4%**	**99.7%**	**100.0%**	**100.0%**	**100.0%**	**100%**

Source: Container Fleet Operators

Next, to estimate future with project conditions Panamax vessel class sailing draft distributions, it was assumed that the sailing drafts of Panamax vessels at world and United States ports with channel depths of 45 feet would be the best indicator of the 45-foot future with project conditions at Savannah Harbor. Therefore, data for ports with a terminal depth of 45 feet were extracted from the overall dataset obtained from the aforementioned sources.

The extracted records were for 21 world and U.S. ports and totaled 2,522 calls. The dataset covered all of 2008 and eight months of 2009. Table 102 provides a summary of the data obtained.

Table 102: Carrier Reported Sailing Drafts at World Harbors with 45-Foot Terminal Depth – Panamax Vessel Class

	Sailing Draft (feet)												
	<=38	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**Total**
Carrier 1	1,413	121	133	108	72	31	13	5	0	0	0	0	**1,896**
Carrier 2	273	101	85	60	55	31	14	5	1	0	1	0	**626**
Total Calls	1,686	222	218	168	127	62	27	10	1	0	1	0	**2,522**
Percent of Total Calls	67%	9%	9%	7%	5%	2%	1%	0%	0%	0%	0%	0%	**100%**
Cumulative Percentage	**66.9%**	**75.7%**	**84.3%**	**91.0%**	**96.0%**	**98.5%**	**99.5%**	**99.9%**	**100.0%**	**100%**	**100%**	**100%**	**100%**

Source: Container Fleet Operators

Next, to estimate future with project condition sailing drafts at Savannah Harbor for the 45-foot channel depth alternative, the estimated cumulative percentage at 45-foot harbors (Table 102) was divided by the carrier estimated cumulative percentage at Savannah under existing conditions (Table 101). The dividend was then multiplied by the existing condition cumulative percentage for all calls (Table 100) to estimate the with project 45-foot cumulative percentage for Savannah Harbor. The following equation illustrates this process as performed for determination of the cumulative percentage for the 38-foot sailing draft (45-foot channel alternative):

$$(66.9\% / 73.0\%) * 86.3\% = 79.0\%$$

This calculation process was then repeated for each sailing draft for the 45-foot channel alternative. The results of this effort are shown in Table 103.

Next, interpolation between the pilot's data for existing conditions and the estimated 45-foot sailing draft was performed to estimate the 44-foot with project condition sailing draft (Table 103). The Panamax class sailing draft distribution for the 45-foot alternative was then held constant and used for the 46, 47 and 48-foot alternatives as the design draft of the Panamax vessel is 44.9 feet (Figure 35).

Table 103: Panamax Vessel Class Sailing Draft Distributions

Project Alternative (feet)	Sailing Draft (feet)												
	<=38	39	40	41	42	43	44	45	46	47	48	49	50
42	86.3%	91.2%	94.9%	97.6%	99.9%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
44	82.6%	88.8%	94.2%	96.8%	98.1%	99.2%	99.8%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
45	79.0%	86.5%	93.4%	96.1%	96.2%	98.5%	99.5%	99.9%	100.0%	100.0%	100.0%	100.0%	100.0%
46	79.0%	86.5%	93.4%	96.1%	96.2%	98.5%	99.5%	99.9%	100.0%	100.0%	100.0%	100.0%	100.0%
47	79.0%	86.5%	93.4%	96.1%	96.2%	98.5%	99.5%	99.9%	100.0%	100.0%	100.0%	100.0%	100.0%
48	79.0%	86.5%	93.4%	96.1%	96.2%	98.5%	99.5%	99.9%	100.0%	100.0%	100.0%	100.0%	100.0%

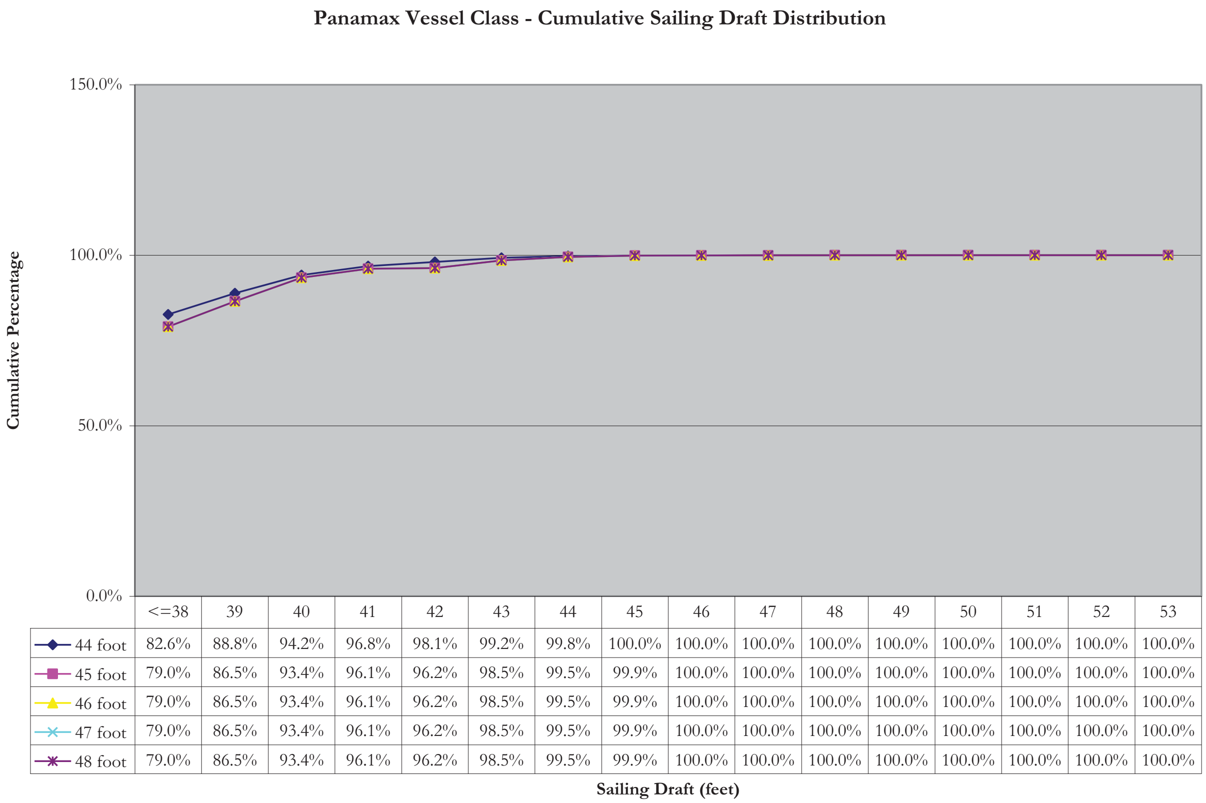


Figure 35: Panamax Vessel Class – Cumulative Sailing Draft Distribution

6.2.3.1.3.2. Post-Panamax Generation 1 Vessel Class. It was assumed that under future without project conditions, PPX1 vessels will continue to operate at Savannah as they have historically. Therefore, historical data was summarized and is shown in the following table. Note, Post-Panamax vessels calling on Savannah are assumed to be using tide when their sailing draft is greater than 37 feet.

According to harbor pilot data, there were a total of 333 Post-Panamax vessel transits at Garden City Terminal during calendar years 2006 and 2007. These calls were on two services, one of which provided 2008 data for use in the analysis that follows. Of the total number of Post-Panamax calls in 2006 and 2007, 64 percent (212 calls) were at sailing drafts less than or equal to 37 feet. Accordingly, 36 percent of all vessel calls were at sailing drafts greater than 37 feet and were therefore utilizing tide to safely navigate the harbor channel.

Table 104: Historical and Future Without Project Condition Sailing Draft Distribution – Generation 1 Post-Panamax Vessel Class

	Sailing Draft (feet)								
	<=37	38	39	40	41	42	43	44	Total
Pilots 2006	88	11	11	9	16	15	0	0	**150**
Pilots 2007	124	15	2	3	10	29	0	0	**183**
Total	212	26	13	12	26	44	**0**	**0**	**333**
Percent of Total Calls	64%	8%	4%	4%	8%	13%	**0%**	**0%**	**100%**
Cumulative Percentage	**64%**	**71%**	**75%**	**79%**	**87%**	**100%**	**100%**	**100%**	**100%**

Source: Harbor Pilot Data

Data from the carrier that provided 2008 and 2009 vessel call data at Savannah was analyzed for use in estimating future with project behavior for those services forecast to utilize PPX1 vessels. The following table illustrates the results of this analysis. An explanation of how this data was applied to estimate future vessel sailing drafts will be presented in the paragraphs that follow.

Table 105: Carrier Reported Sailing Draft Distribution (2008-2009) – Post-Panamax Generation 1 Vessel Class Calls at Savannah

	Sailing Draft (feet)								
	<=37	38	39	40	41	42	43	44	Total
Carrier Calls	35	11	2	2	2	8	0	0	**60**
Percent of Total Calls	58%	18%	3%	3%	3%	13%	0%	0%	**100%**
Cumulative Percentage	**58%**	**77%**	**80%**	**83%**	**87%**	**100%**	**100%**	**100%**	**100%**

Source: Container Fleet Operator

Next, to estimate future with project condition sailing draft distributions for the PPX1 vessel class, it was assumed that the sailing drafts of PPX1 vessels at world and United States ports with channel depths of 45 feet would be the best indicator of the 45-foot future with project conditions at Savannah Harbor. Therefore, data for ports with a terminal depth of 45 feet were extracted from the overall dataset obtained from the aforementioned sources.

The extracted records were for 11 world and U.S. ports and totaled 490 calls. The dataset covered all of 2008 and eight months of 2009. Table 106 provides a summary of the data obtained.

Table 106: Carrier Reported Sailing Drafts at World Harbors with 45-Foot Terminal Depth – PPX1 Vessel Class

	Sailing Draft (feet)													
	<=37	38	39	40	41	42	43	44	45	46	47	48	49	Total
Carrier 1	91	20	24	34	45	51	20	13	15	10	10	1	0	**334**
Carrier 2	17	14	14	13	23	25	21	14	10	5	0	0	0	**156**
Total Calls	108	34	38	47	68	76	41	27	25	15	10	1	0	**490**
Percent of Total Calls	22%	7%	8%	10%	14%	16%	8%	6%	5%	3%	2%	0%	0%	**100%**
Cumulative Percentage	**22%**	**29%**	**37%**	**46%**	**60%**	**76%**	**84%**	**90%**	**95%**	**98%**	**100%**	**100%**	**100%**	**100%**

Source: Container Fleet Operators

The same methodology utilized to determine the with project condition sailing draft distributions for the Panamax vessel class was then utilized to estimate PPX1 distributions. Table 107 illustrates the results of this effort. Note, to estimate the distribution for the 46-foot alternative, the rate of change between alternate depths (44 and 45 feet) was applied to the 45 foot sailing draft distribution. Following is an example of the calculation process for determining the cumulative percentage for vessels drafting 38 feet under the 46-foot with project condition.

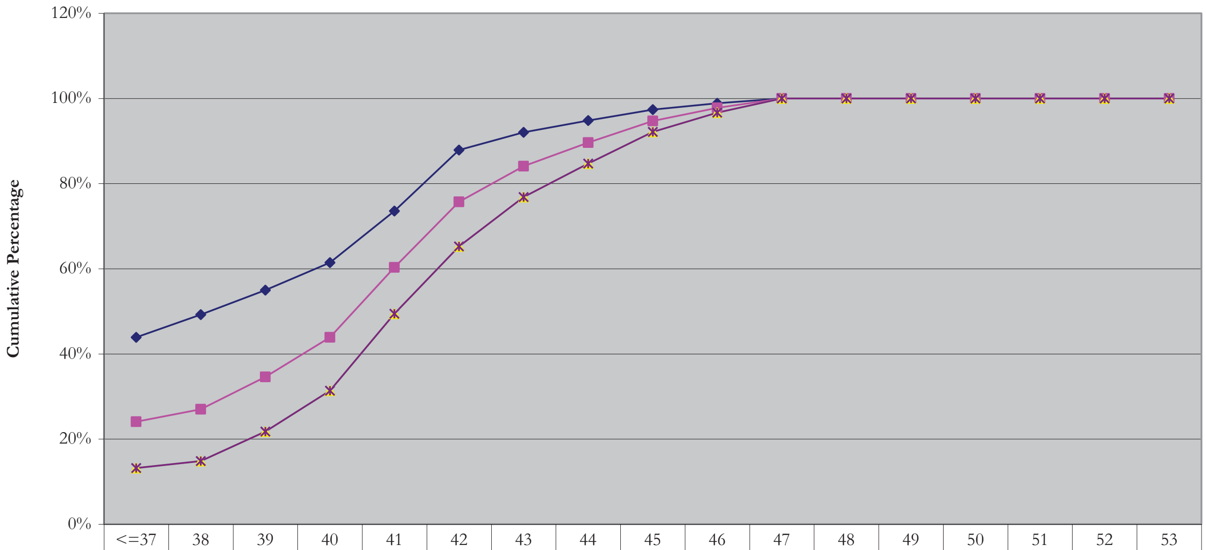
$$(27\% / 49\%) * 27\% = 15\%$$

This calculation was performed for each vessel sailing draft for the 46-foot with project condition. The sailing draft distribution for the 46-foot alternative was then held constant for the 47 and 48-foot alternatives as the design draft of the PPX1 vessel is 46 feet (Figure 36).

Table 107: Post-Panamax Generation 1 Vessel Class – Sailing Draft Distributions

Project Alternative (feet)	Sailing Draft (feet)												
	<=37	38	39	40	41	42	43	44	45	46	47	48	49
42	58%	77%	80%	83%	87%	100%	100%	100%	100%	100%	100%	100%	100%
44	44%	49%	55%	61%	74%	88%	92%	95%	97%	99%	100%	100%	100%
45	24%	27%	35%	44%	60%	76%	84%	90%	95%	98%	100%	100%	100%
46	13%	15%	22%	31%	49%	65%	77%	85%	92%	97%	100%	100%	100%
47	13%	15%	22%	31%	49%	65%	77%	85%	92%	97%	100%	100%	100%
48	13%	15%	22%	31%	49%	65%	77%	85%	92%	97%	100%	100%	100%

Post Panamax Generation 1 Vessel Class - Cumulative Sailing Draft Distribution



	<=37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
44'	44%	49%	55%	61%	74%	88%	92%	95%	97%	99%	100%	100%	100%	100%	100%	100%	100%
45'	24%	27%	35%	44%	60%	76%	84%	90%	95%	98%	100%	100%	100%	100%	100%	100%	100%
46'	13%	15%	22%	31%	49%	65%	77%	85%	92%	97%	100%	100%	100%	100%	100%	100%	100%
47'	13%	15%	22%	31%	49%	65%	77%	85%	92%	97%	100%	100%	100%	100%	100%	100%	100%
48'	13%	15%	22%	31%	49%	65%	77%	85%	92%	97%	100%	100%	100%	100%	100%	100%	100%

Sailing Draft

Figure 36: Post-Panamax Generation 1 Vessel Class–Cumulative Sailing Draft Distribution

6.2.3.1.3.3. Post-Panamax Generation 2 Vessel Class. Due to channel depth limitations, PPX2 vessels have not called on the Savannah Harbor. Under future without project conditions, it is assumed that these vessels will not be utilized on services that call on Savannah.

Since PPX2 vessels have not called on Savannah, there is no historical information from the harbor upon which to estimate future sailing drafts. Accordingly, to estimate the sailing draft distribution for the 44-foot channel alternative, the 44-foot alternative distribution for PPX1 vessels was multiplied by a factor of .97, which represents the difference in maximum practical loading of the PPX1 and PPX2 vessels on those routes which deploy PPX2 vessels under 44-foot with project conditions (i.e., FE ECUS PEN, FE ECUS MED PEN, and FE ECUS EU PEN). The following equation illustrates this process for a PPX2 vessel sailing at 37 feet:

$$44\% * .97 = 43\%$$

Next, the same calculation process was used to estimate the sailing draft distribution for the 45-foot channel depth alternative. This time, the factor used was .968, which represents the difference in the loading of PPX1 and PPX2 vessels being deployed under 45-foot with project conditions (i.e., FE SUEZ ECUS PEN). Again, the following equation illustrates this process for a PPX2 vessel sailing at 37 feet:

$$24\% * .968 = 23\%$$

The same process was then used to estimate the sailing draft distribution for the 46-foot channel. For this channel depth alternative a factor of .968 was used, representing deployment on the RTW, ECUS EU GULF PEN and ECUS MED services (PPX2 vessel sailing at 37-feet (46-foot project), 13% * .968 = 13%).

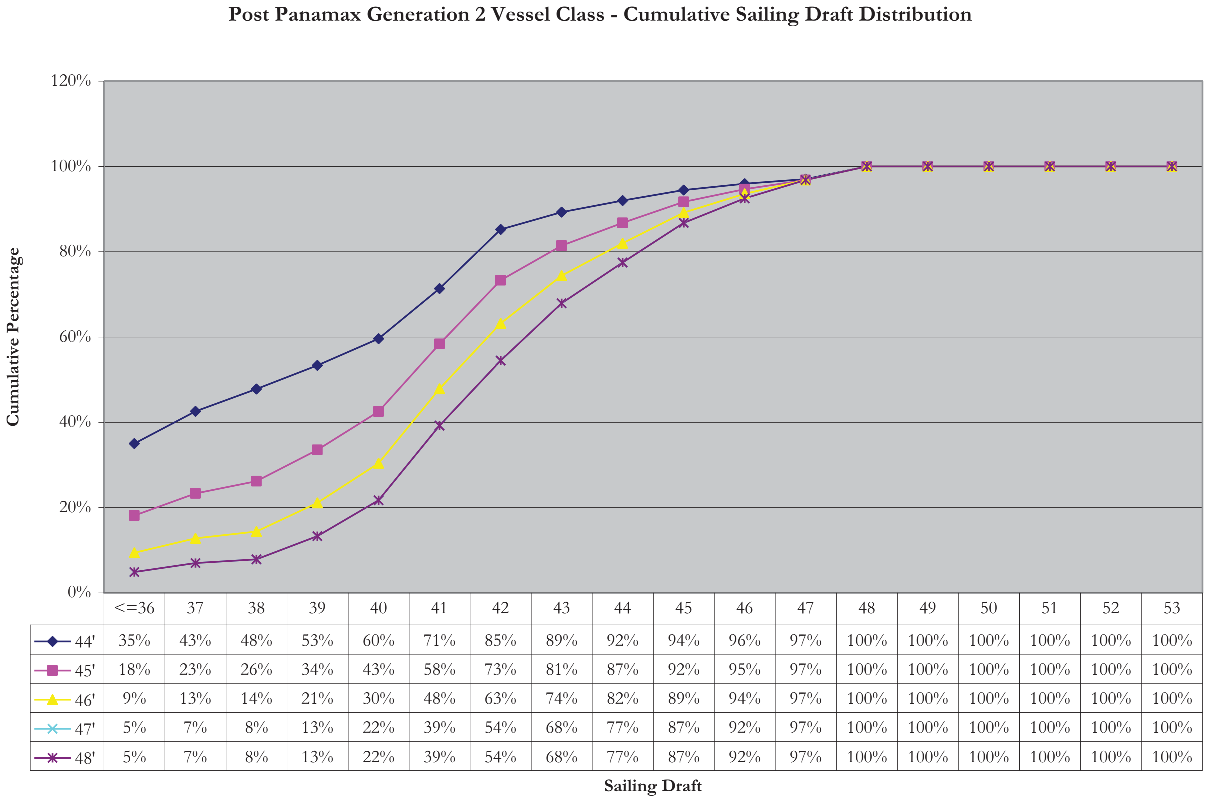
Since, the design draft of the PPX1 vessel is 46 feet, the sailing draft distribution for the 46-foot alternative with project condition was held constant for the 47 and 48-foot alternatives. Therefore, it was not possible to utilize the methodology described for estimating the 47-foot with project condition PPX2 sailing draft distribution as the sailing draft distribution would be the same as that for the PPX2 46-foot alternative. Accordingly, to estimate the PPX2 47-foot with project condition sailing draft distribution, extrapolation was performed. The following equation illustrates this process for a PPX2 vessel sailing at 37 feet (47-foot alternative):

$$(13\% / 23\%) * 13\% = 7\%$$

Since the PPX2 vessel has a design draft of 47.6 feet, the 47-foot sailing draft distribution was then held constant and utilized for the 48-foot with project conditions (Figure 37). The results of these calculations are shown in Table 108.

Table 108: Post-Panamax Generation 2 Vessel Class – Sailing Draft Distributions

Project Alternative (feet)	Sailing Draft (feet)												
	<=37	38	39	40	41	42	43	44	45	46	47	48	49
42	*PPX2 vessels will not call on the Savannah Harbor under without project conditions*												
44	43%	48%	53%	60%	71%	85%	89%	92%	94%	96%	97%	100%	100%
45	23%	26%	34%	43%	58%	73%	81%	87%	92%	95%	97%	100%	100%
46	13%	14%	21%	30%	48%	63%	74%	82%	89%	94%	97%	100%	100%
47	7%	8%	13%	22%	39%	54%	68%	77%	87%	92%	97%	100%	100%
48	7%	8%	13%	22%	39%	54%	68%	77%	87%	92%	97%	100%	100%



	<=36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
44'	35%	43%	48%	53%	60%	71%	85%	89%	92%	94%	96%	97%	100%	100%	100%	100%	100%	100%
45'	18%	23%	26%	34%	43%	58%	73%	81%	87%	92%	95%	97%	100%	100%	100%	100%	100%	100%
46'	9%	13%	14%	21%	30%	48%	63%	74%	82%	89%	94%	97%	100%	100%	100%	100%	100%	100%
47'	5%	7%	8%	13%	22%	39%	54%	68%	77%	87%	92%	97%	100%	100%	100%	100%	100%	100%
48'	5%	7%	8%	13%	22%	39%	54%	68%	77%	87%	92%	97%	100%	100%	100%	100%	100%	100%

Figure 37: Post-Panamax Generation 2 Vessel Class–Cumulative Sailing Draft Distribution

6.2.3.1.4. Underkeel Clearance Requirement. The Underkeel clearance requirements were provided by IWR with the assistance of the Savannah Harbor Bar Pilots. The clearance required depends on the vessel class. The following table provides the underkeel clearance that was input into HarborSym. The sailing draft, underkeel requirement, and tide data determine when the model will allow a vessel to enter into the system.

Table 109: Underkeel Clearance Requirement

Vessel Class	Clearance Requirement (Feet)
Sub-Panamax	3.75
Panamax	4.00
Post-Panamax Generation 1	4.20
Post-Panamax Generation 2	4.30

6.2.3.2. Liquid Natural Gas (LNG) Vessel Fleet

After discussion with the bar pilots and examining empirical data, it was determined that the sailing draft of most LNG vessel range between 38 and 40 feet. However, for reasons that include both safety and maneuverability, the pilots do not transit a LNG vessel until the tide window is available for the vessel to arrive at the dock at high slack tide. Therefore, for modeling purposes, all LNG class vessels were input with a 40 foot sailing draft allowing for one underkeel clearance to be input into the model. This was done for simplicity since regardless of sailing draft, LNG vessels entering Savannah Harbor will wait for high slack tide. The sailing draft, underkeel clearance, tide gauge, vessel speed, and distance to the dock ensure that the model accurately simulates the current operations within the Harbor.

6.2.4. Vessel Operating Costs

According to ER1105-2-100 vessel operating costs for navigation studies are provided by HQUSACE on an annual basis. Vessel operating costs were evaluated only for the vessel classes that are anticipated to be impacted by the inclusion of meeting areas into the system or an increase in channel depth. Those classes are the Panamax and Post-Panamax vessels for the container fleet and LNG vessels. While the LNG vessels do not use the meeting areas, due to the safety zone requirement they are impacted by the number of container vessels in the system at a given time.

6.2.4.1. Container Vessel Fleet

For the purposes of the meeting area analysis, hourly operating costs for Foreign Container Class vessels were obtained from IWR. The hourly costs presented in the table below are the latest estimates.

Table 110: Hourly Vessel Operating Costs Foreign Container Vessel Classes

Deadweight Tonnage (DWT: Metric Tonnes)			40,300	42,800	46,400	55,600	65,000	70,500	80,700	103,000
TEU			2,800	3,000	3,500	4,000	4,800	6,000	6,500	8,000
	At Sea									
	Propulsion/Prime Movers & Auxiliary Power Generation									
		Service Speed	$1,684	$1,692	$1,891	$2,170	$2,452	$3,392	$3,684	$3,954
		Economic Speed	$1,445	$1,456	$1,617	$1,842	$2,078	$2,815	$3,062	$3,310
		Half-Power	$1,190	$1,206	$1,323	$1,488	$1,673	$2,177	$2,369	$2,598
		Base Idle	$878	$899	$964	$1,059	$1,183	$1,416	$1,547	$1,749
	In Port									
	Propulsion/Prime Movers & Auxiliary Power Generation									
		Within Harbor/Channel	$1,175	$1,191	$1,305	$1,467	$1,649	$2,139	$2,329	$2,556
		Maneuvering	$1,023	$1,041	$1,130	$1,258	$1,411	$1,772	$1,932	$2,147
		Base Idle	$840	$859	$923	$1,014	$1,135	$1,363	$1,494	$1,690
		Dockside/Static Condition	$643	$664	$696	$743	$827	$886	$979	$1,158

The hourly operating costs were then developed for the container fleet forecast to call on Savannah Harbor. Since not all of the classes forecast appear in the table above, the values were interpolated by dead weight tonnage to obtain hourly costs for the Savannah fleet. While HarborSym has one input for “At Sea” and one for “At Dock,” it was determined that “At Sea” costs provided by IWR would inflate benefits since within the harbor system a vessel would not be operating at the same speed/cost as in open water. Therefore, both inputs were derived from “In Port” costs. For “At Sea,” the value for “Within Harbor/Channel” was used. For “At Dock,” an average of the “Base Idle” and the “Dockside/Static Condition” hourly cost was input. Table 111 displays the hourly operating cost used in the HarborSym model for the meeting area analysis for the container fleet.

Table 111: Container Fleet DWT

Vessel Class	Deadweight Tonnage	Within Harbor/ Channel	Base Idle
Panamax	65,000	$ 1,649	$ 981
PPX1	74,100	$ 2,206	$ 1,164
PPX2	86,100	$ 2,384	$ 1,282

6.2.4.2. Liquid Natural Gas (LNG) Vessel Fleet

Currently, the Corps of Engineers does not have published values to use for vessel operating costs for LNG class vessels. Therefore, data provided by the New England District, which was developed with the assistance of IWR, was used in order to determine vessel operating costs. These costs provided were for four different LNG vessel classes. The following table provides this data.

Table 112: LNG Vessel Operating Costs

		Hourly Total Cost At Sea	Hourly Total Cost At Port
125,000	cubic meters	$2,024	$1,492
1,081,000	barrels		
113,194	short tons		
102,689	metric tonnes		
145,000	cubic meters	$2,147	$1,575
1,254,000	barrels		
131,309	short tons		
119,123	metric tonnes		
177,000	cubic meters	$2,349	$1,715
1,531,000	barrels		
160,314	short tons		
145,436	metric tonnes		
200,000	cubic meters	$2,502	$1,824
1,730,000	barrels		
181,152	short tons		
164,340	metric tonnes		

7.

The data provided by the New England District was then interpolated to provide hourly operating costs for the forecast LNG vessel fleet. The operating costs for vessel classes not within the range of the data provided were obtained using a trendline. The table below shows the values developed.

Table 113: LNG Vessel Operating Cost

Bcm	At Sea	At Dock
135,000	$ 2,085	$ 1,533
145,000	$ 2,146	$ 1,575
165,000	$ 2,272	$ 1,661
217,000	$ 2,617	$ 1,908
266,000	$ 2,967	$ 2,168

The values shown above were input into HarborSym model to determine the impact of the inclusion of meeting areas on LNG class vessels.

6.2.5. Meeting Area Analysis – HarborSym Results

The HarborSym model was used for the economic analysis to compare the without project condition (channel deepened but no meeting area) to the with project alternatives (Long Island, Oglethorpe, Long Island/Oglethorpe combination) over a 50 year period of analysis. The model simulates the without project condition based upon the parameters that are currently maintained in the harbor. The existing rules and their parameters were entered into HarborSym to allow for an accurate representation of the current situation of the harbor. The future parameters of the harbor system were used to represent channel conditions both under the with and without project condition meeting area scenarios. The with project conditions illustrate the channel system if one of the three meeting area alternatives is implemented. Benefits associated with the meeting area for Savannah Harbor were evaluated based upon expanding the channel width of separate reaches, which would allow for alleviation of transit rules affecting the Post-Panamax vessels calling on the harbor. Benefits are based upon a decrease in transit times/costs for each meeting area alternative. The alleviation of transit rules under each proposed depths with project condition was compared to the meeting area without project condition (no channel modification at each proposed depth).

6.2.5.1. Meeting Area - HarborSym Results – Vessel Transit Costs

The HarborSym model was run for each of the three meeting area alternatives and the existing condition for each proposed project depth for the following years: 2017, 2020, 2025, and 2030. Each model run consisted of 50 iterations of a full year, beginning January 1st, 12:00 AM of each year. The average transit cost for the existing condition of each Panamax, Post-Panamax (Generation 1 and 2), and LNG vessel was determined and compared to the average transit cost in the system for each meeting area alternative. Since all other inputs remain the same (Speed in Reach, Docking/Undocking Times, Loading Rates, etc…) benefits are calculated using the reduction in the average transit cost for each of the affected vessel classes and the annual number of calls for each class. The following tables present the average cost for each affected vessel class for the 47 foot project depth. The 47 foot project results are given because due to the deepening benefits, this project depth is the current NED plan. The benefits for the 44, 45, 46, and 48 foot depths were calculated using the same methodology.

Table 114: 47-Foot Channel Depth - 2017

2017	Existing Condition	Long Island	Oglethorpe	Long Island/Oglethorpe
135 LNG	$ 61,638	$ 61,682	$ 61,704	$ 61,777
145 LNG	$ 63,803	$ 63,918	$ 63,863	$ 63,928
165 LNG	$ 77,501	$ 77,552	$ 77,475	$ 77,522
217 LNG	$ 87,707	$ 87,618	$ 87,637	$ 87,631
266 LNG	$ 100,783	$ 100,892	$ 100,861	$ 100,970
Panamax	$ 23,829	$ 23,829	$ 23,829	$ 23,829
PPX1	$ 30,995	$ 30,907	$ 30,906	$ 30,842
PPX 2	$ 34,458	$ 34,372	$ 34,369	$ 34,306
2017	**Total Calls**	**Long Island**	**Oglethorpe**	**Long Island/Oglethorpe**
135 LNG	27	$ (1,187)	$ (1,787)	$ (3,754)
145 LNG	28	$ (3,232)	$ (1,686)	$ (3,507)
165 LNG	29	$ (1,482)	$ 742	$ (614)
217 LNG	15	$ 1,323	$ 1,044	$ 1,131
266 LNG	21	$ (2,278)	$ (1,643)	$ (3,924)
Panamax	1186	$ 166	$ 56	$ 368
PPX1	247	$ 21,737	$ 22,004	$ 37,744
PPX 2	201	$ 17,291	$ 18,018	$ 30,682
		$ 32,338	$ 36,748	$ 58,126

Table 115: 47-Foot Channel Depth – 2020

2020	Existing Condition	Long Island	Oglethorpe	Long Island/Oglethorpe
135 LNG	$ 62,957	$ 63,071	$ 63,211	$ 63,190
145 LNG	$ 66,239	$ 66,326	$ 66,502	$ 66,578
165 LNG	$ 77,440	$ 77,547	$ 77,652	$ 77,702
217 LNG	$ 89,709	$ 89,786	$ 89,970	$ 90,204
266 LNG	$ 102,375	$ 102,546	$ 102,692	$ 102,817
Panamax	$ 23,826	$ 23,824	$ 23,823	$ 23,821
PPX1	$ 31,474	$ 31,294	$ 31,293	$ 31,159
PPX 2	$ 35,131	$ 34,932	$ 34,924	$ 34,776
2020	**Total Calls**	**Long Island**	**Oglethorpe**	**Long Island/Oglethorpe**
135 LNG	30	$ (3,422)	$ (7,627)	$ (7,006)
145 LNG	32	$ (2,788)	$ (8,407)	$ (10,857)
165 LNG	32	$ (3,443)	$ (6,813)	$ (8,409)
217 LNG	17	$ (1,313)	$ (4,440)	$ (8,428)
266 LNG	24	$ (4,116)	$ (7,606)	$ (10,615)
Panamax	649	$ 1,397	$ 2,026	$ 2,922
PPX1	471	$ 84,921	$ 85,083	$ 148,270
PPX 2	524	$ 103,934	$ 108,334	$ 185,963
		$ 175,170	$ 160,550	$ 291,839

Table 116: 47-Foot Channel Depth – 2025

2025	Existing Condition	Long Island	Oglethorpe	Long Island/Oglethorpe
135 LNG	$ 67,653	$ 67,638	$ 67,995	$ 67,865
145 LNG	$ 69,561	$ 69,708	$ 69,727	$ 69,850
165 LNG	$ 82,744	$ 83,168	$ 83,155	$ 83,524
217 LNG	$ 97,484	$ 97,929	$ 98,264	$ 98,451
266 LNG	$ 108,815	$ 108,984	$ 109,184	$ 109,359
Panamax	$ 24,026	$ 24,017	$ 24,017	$ 24,008
PPX1	$ 32,158	$ 31,915	$ 31,935	$ 31,713
PPX 2	$ 35,757	$ 35,521	$ 35,502	$ 35,307
2025	**Total Calls**	**Long Island**	**Oglethorpe**	**Long Island/Oglethorpe**
135 LNG	34	$ 508	$ (11,627)	$ (7,216)
145 LNG	35	$ (5,126)	$ (5,800)	$ (10,098)
165 LNG	36	$ (15,265)	$ (14,801)	$ (28,082)
217 LNG	19	$ (8,457)	$ (14,822)	$ (18,371)
266 LNG	26	$ (4,411)	$ (9,601)	$ (14,165)
Panamax	924	$ 8,139	$ 9,052	$ 16,651
PPX1	462	$ 112,135	$ 102,995	$ 205,543
PPX 2	749	$ 177,010	$ 191,336	$ 337,201
		$ 264,532	$ 246,730	$ 481,464

Table 117: 47-Foot Channel Depth - 2030

2030	Existing Condition	Long Island	Oglethorpe	Long Island/Oglethorpe
135 LNG	$ 70,511	$ 70,291	$ 71,465	$ 70,770
145 LNG	$ 71,805	$ 72,042	$ 72,045	$ 71,908
165 LNG	$ 75,877	$ 76,165	$ 76,258	$ 76,437
217 LNG	$ 97,995	$ 98,571	$ 98,382	$ 98,903
266 LNG	$ 110,426	$ 110,137	$ 110,911	$ 110,593
Panamax	$ 24,831	$ 24,793	$ 24,796	$ 24,768
PPX1	$ 34,258	$ 33,896	$ 33,883	$ 33,690
PPX 2	$ 37,991	$ 37,626	$ 37,663	$ 37,373
2030	**Total Calls**	**Long Island**	**Oglethorpe**	**Long Island/Oglethorpe**
135 LNG	37	$ 8,132	$ (35,301)	$ (9,556)
145 LNG	39	$ (9,245)	$ (9,342)	$ (4,002)
165 LNG	40	$ (11,521)	$ (15,212)	$ (22,393)
217 LNG	21	$ (12,097)	$ (8,110)	$ (19,069)
266 LNG	29	$ 8,389	$ (14,073)	$ (4,856)
Panamax	975	$ 37,055	$ 34,396	$ 61,664
PPX1	661	$ 239,010	$ 247,565	$ 375,249
PPX 2	1018	$ 371,593	$ 333,581	$ 628,742
		$ 631,316	$ 533,504	$ 1,005,779

6.2.5.2. *Meeting Area - Annual Benefits*

Using the output data for transit costs provided by HarborSym (Displayed in Table 114 through Table 117), annual benefits was determined for each meeting area alternative at each project depth. The values provided for the model run years were then interpolated to attain benefits for the years between, remaining constant after 2030 when TEU capacity is forecasted to be reached. The benefits stated are in FY11 dollars and are provided in Table 118. As stated previously, the calculation for the 44, 45, 46, and 48 foot depths use the same methodology. All spreadsheet calculations were provided to the Deep Draft Center of Expertise for review. The approved for use white paper is provided as an attachment to this Economics Appendix (Attachment 3).[28]

Table 118: Annual Benefits - 47-Foot Channel Depth

Annual Benefits			
Year	**Long Island**	**Oglethorpe**	**Long Island/Oglethorpe**
2017	$89,471	$86,269	$151,611
2018	$118,037	$111,029	$198,354
2019	$146,603	$135,790	$245,097
2020	$175,170	$160,550	$291,839
2021	$193,042	$177,786	$329,764
2022	$210,915	$195,022	$367,689
2023	$228,787	$212,258	$405,614
2024	$246,660	$229,494	$443,539
2025	$264,532	$246,730	$481,464
2026	$337,889	$304,085	$586,327
2027	$411,246	$361,440	$691,190
2028	$484,602	$418,795	$796,053
2029	$557,959	$476,149	$900,916
2030	$631,316	$533,504	$1,005,779

6.2.5.3. *Average Annual Benefits – Meeting Area*

Average annual benefits were developed using the annual benefits from the proposed meeting area alternatives, the Federal Discount Rate for FY11 of 4.125%, and a 50 year period of analysis. Table 119 displays the average annual benefits, rounded to the nearest thousand, for each meeting area alternative at each project depth.

[28] The approved for use white paper will be developed during the review process. A copy of the document will be included in the final report.

Table 119: Average Annual Benefits

Average Annual Benefits			
Project Depth	**Long Island**	**Oglethorpe**	**Long Island/Oglethorpe**
44-Foot Depth	$400,000	$385,000	$717,000
45-Foot Depth	$401,000	$387,000	$722,000
46-Foot Depth	$407,000	$393,000	$731,000
47-Foot Depth	$450,000	$387,000	$730,000
48-Foot Depth	$424,000	$373,000	$723,000

6.2.5.4. Meeting Area - Average Annual Costs

The cost to construct each meeting area was determined for each potential project depth. The following table displays the estimated cost to construct each meeting area, along with the total cost to construct both. These costs are provided at the October 10 price level.

Table 120: Construction Cost - Meeting Areas

Project Depth	Long Island	Oglethorpe	Long Island/Oglethorpe
44-Foot Depth	$2,957,000	$4,146,000	$7,103,000$
45-Foot Depth	$3,127,000	$4,262,000	$7,389,000$
46-Foot Depth	$3,238,000	$4,318,000	$7,556,000$
47-Foot Depth	$3,465,000	$4,505,000	$7,970,000$
48-Foot Depth	$3,690,000	$4,687,000	$8,377,000$

Average annual costs were developed using the construction cost provided in the previous table for the proposed meeting area alternatives, the Federal Discount Rate for FY11 of 4.125%, and a 50 year period of analysis. Operations and Maintenance was considered negligible. This is due to the harbor being in equilibrium, meaning that there will be no increase in the amount of dredged material within the harbor due to the deepening. The following table displays the average annual costs, rounded to the nearest ten thousand, for each meeting area alternative at each project depth.

Table 121: Average Annual Cost - Meeting Areas

Project Depth	Long Island	Oglethorpe	Long Island/Oglethorpe
44-Foot Depth	$135,000	$189,000	$324,000
45-Foot Depth	$143,000	$195,000	$337,000
46-Foot Depth	$148,000	$197,000	$345,000
47-Foot Depth	$158,000	$206,000	$364,000
48-Foot Depth	$169,000	$214,000	$383,000

7.1.1.1. Benefit Cost Ratio – Meeting Areas

The average annual benefits and costs for the meeting areas were evaluated in order to determine that the meeting areas were incrementally justified and that the NED deepening plan includes the meeting area alternative that maximizes net benefits. As displayed in Table 122 the meeting area alternative that maximizes net benefits at each proposed project depth is the combination of both meeting areas.

Table 122: Benefit Cost Ratio - Meeting Areas

Long Island				
	AAB	AAC	Net Benefits	BC Ratio
44-foot Project Depth	$400,000	$135,000	$ 265,000	2.96
45-foot Project Depth	$401,000	$143,000	$ 258,000	2.80
46-foot Project Depth	$407,000	$148,000	$ 259,000	2.75
47-foot Project Depth	$450,000	$158,000	$ 292,000	2.85
48-foot Project Depth	$424,000	$169,000	$ 255,000	2.51
Oglethorpe				
	AAB	AAC	Net Benefits	BC Ratio
44-foot Project Depth	$385,000	$189,000	$ 196,000	2.04
45-foot Project Depth	$387,000	$195,000	$ 192,000	1.98
46-foot Project Depth	$393,000	$197,000	$ 196,000	1.99
47-foot Project Depth	$387,000	$206,000	$ 181,000	1.88
48-foot Project Depth	$373,000	$214,000	$ 159,000	1.74
Long Island/Oglethorpe				
	AAB	AAC	Net Benefits	BC Ratio
44-foot Project Depth	$717,000	$324,000	$ 393,000	2.21
45-foot Project Depth	$722,000	$337,000	$ 385,000	2.14
46-foot Project Depth	$731,000	$345,000	$ 386,000	2.12
47-foot Project Depth	$730,000	$364,000	$ 366,000	2.01
48-foot Project Depth	$723,000	$383,000	$ 340,000	1.89

6.3. Savannah Harbor Expansion Project – Tide Delay Analysis

Tide benefits were estimated as the reduction in the average tide delay cost of a vessel class and calculated by comparing the existing condition of 42 feet with the alternative project depths (44, 45, 46, 47, and 48 feet). Currently, due to underkeel requirements and vessel sailing drafts, there is a portion of the annual fleet that cannot transit the Savannah Harbor River System without the assistance of a tide that essentially increases the channel depth. With additional channel depth, the transit restrictions are decreased allowing the vessel to call on the harbor with fewer delays. The tide delay benefit analysis was performed by evaluating the anticipated vessel fleet at each proposed project depth and the projected sailing draft distribution at that depth. Benefits were derived by calculating the difference in the average vessel transit costs for each impacted vessel class for the anticipated 44 foot channel depth vessel fleet calling on the harbor with the channel depths set to 42 feet for the initial runs, and then a second set of runs with the channel depth set to 44 feet to find the reduction in the average transit costs. For each additional foot of depth, the

model runs were set up in the same manner. A 43 foot project was not evaluated since 43 foot was not an alternative evaluated for deepening benefits.
Table 123 displays this methodology.

Table 123: Tide Delay Methodology

Anticipated Vessel Fleet	Channel Depth – Model Run	
	Initial Run	Second Run
44-Foot Fleet	42-Foot	44-Foot
45-Foot Fleet	44-Foot	45-Foot
46-Foot Fleet	45-Foot	46-Foot
47-Foot Fleet	46-Foot	47-Foot
48-Foot Fleet	47-Foot	48-Foot

6.3.1. HarborSym Analysis – Tide Delay

The HarborSym model was used to calculate the tide delay benefits, or the reduction in tide delay times, for each channel deepening alternative. Meeting Areas were not included in the model runs to ensure that the benefits generated were due to additional depth only. The existing vessel operating rules and associated parameters were entered into HarborSym to allow for an accurate representation of existing harbor conditions. The anticipated future vessel operating rules and associated parameters of the harbor system were entered to represent channel conditions both under the with and without project condition channel deepening scenarios. The with project conditions illustrate the harbor system if the channel depth entered into the model was the same channel depth as the forecasted fleet mix at that depth (i.e. 44 foot vessel fleet call list, 44 foot channel depth). The without project condition assumes that the anticipated fleet mix has one foot less channel depth (two feet to compare 42 and 44) than is associated with the forecasted vessel fleet as described in the previous section (i.e. 44 foot vessel call list, 42 foot channel depth). Benefits calculated as the reduction in tide related delays were based upon the assumption that with each channel deepening alternative, opportunities for vessels to safely transit the channel would increase as vessels would not be as dependent on tide for movement.

6.3.2. Vessel Transit Costs – Tide Delay

The HarborSym model was run for each of the five channel depth alternatives and the 42 foot project depth for the following years: 2017, 2020, 2025, and 2030. Each model run consisted of 50 iterations of a full year, beginning January 1st, 12:00 AM of that year. The average transit cost for the initial scenario run of each Panamax, Post-Panamax (Generation 1 and 2), and LNG vessel was determined and compared to the average transit cost in the system when an additional one foot of depth was added. Since all other inputs remain the same (Speed in Reach, Docking/Undocking Times, Loading Rates, etc…) benefits are calculated using the reduction in the average transit cost for each of the affected vessel. The vessel operating costs methodology is the same as that used in the meeting area analysis. The following tables present the average cost for each affected vessel class for each channel depth alternative. The 46 and 47-foot project alternative results are displayed. The 44, 45, and 48 foot alternatives use the same methodology and have been reviewed by the Deep Draft Center of Expertise for accuracy.

Table 124: 46-Foot Fleet, 45 to 46-Foot Depth - 2017

46-Foot Vessel Fleet		
2017	45-Foot Depth	46-Foot Depth
135 LNG	$ 62,226	$ 62,173
145 LNG	$ 63,839	$ 63,745
165 LNG	$ 77,803	$ 78,110
217 LNG	$ 88,136	$ 87,972
266 LNG	$ 101,075	$ 101,047
Panamax	$ 23,953	$ 23,899
PPX1	$ 32,356	$ 31,672
PPX2	$ 35,291	$ 34,792
2017	Total Calls	Benefits
135 LNG	27	$ 1,447
145 LNG	28	$ 2,647
165 LNG	29	$ (8,914)
217 LNG	15	$ 2,468
266 LNG	21	$ 577
Panamax	1190	$ 64,379
PPX1	247	$ 168,965
PPX2	201	$ 100,346
		$ 331,915

Table 125: 46-Foot Fleet, 45 to 46-Foot Depth - 2020

46-Foot Vessel Fleet		
2020	45-Foot Depth	46-Foot Depth
135 LNG	$ 62,978	$ 63,252
145 LNG	$ 66,016	$ 66,488
165 LNG	$ 77,464	$ 77,395
217 LNG	$ 89,984	$ 90,478
266 LNG	$ 102,752	$ 102,554
Panamax	$ 23,939	$ 23,890
PPX1	$ 32,838	$ 32,143
PPX2	$ 36,003	$ 35,441
2020	Total Calls	Benefits
135 LNG	30	$ (8,224)
145 LNG	32	$ (15,100)
165 LNG	32	$ 2,205
217 LNG	17	$ (8,390)
266 LNG	24	$ 4,754
Panamax	658	$ 31,921
PPX1	471	$ 327,621
PPX2	524	$ 294,421
		$ 629,208

Table 126: 46-Foot Fleet, 45 to 46-Foot Depth - 2025

46-Foot Vessel Fleet		
2025	**45-Foot Depth**	**46-Foot Depth**
135 LNG	$ 67,510	$ 67,840
145 LNG	$ 69,094	$ 69,268
165 LNG	$ 82,789	$ 83,264
217 LNG	$ 96,382	$ 96,115
266 LNG	$ 107,843	$ 108,038
Panamax	$ 24,134	$ 24,097
PPX1	$ 33,451	$ 32,750
PPX2	$ 36,661	$ 35,993
2025	**Total Calls**	**Benefits**
135 LNG	34	$ (11,228)
145 LNG	35	$ (6,112)
165 LNG	36	$ (17,091)
217 LNG	19	$ 5,072
266 LNG	26	$ (5,070)
Panamax	932	$ 34,750
PPX1	465	$ 326,055
PPX2	749	$ 500,678
		$ 827,053

Table 127: 46-Foot Fleet, 45 to 46-Foot Depth – 2030

46-Foot Vessel Fleet		
2030	**45-Foot Depth**	**46-Foot Depth**
135 LNG	$ 71,107	$ 71,606
145 LNG	$ 71,346	$ 72,016
165 LNG	$ 75,298	$ 75,589
217 LNG	$ 98,106	$ 98,378
266 LNG	$ 110,661	$ 110,836
Panamax	$ 24,827	$ 24,801
PPX1	$ 35,411	$ 34,866
PPX2	$ 38,678	$ 38,152
2030	**Total Calls**	**Benefits**
135 LNG	37	$ (18,466)
145 LNG	39	$ (26,137)
165 LNG	40	$ (11,654)
217 LNG	21	$ (5,697)
266 LNG	29	$ (5,068)
Panamax	982	$ 25,956
PPX1	662	$ 360,952
PPX2	1021	$ 537,282
		$ 857,168

Table 128: 47-Foot Fleet, 46 to 47-Foot Depth – 2017

47-Foot Vessel Fleet		
2017	**46-Foot Depth**	**47-Foot Depth**
135 LNG	$ 61,836	$ 62,127
145 LNG	$ 63,904	$ 64,326
165 LNG	$ 77,662	$ 77,877
217 LNG	$ 88,215	$ 88,384
266 LNG	$ 101,018	$ 101,614
Panamax	$ 23,920	$ 23,895
PPX1	$ 31,648	$ 31,127
PPX2	$ 35,170	$ 34,611
2017	**Total Calls**	**Benefits**
135 LNG	27	$ (7,864)
145 LNG	28	$ (11,821)
165 LNG	29	$ (6,236)
217 LNG	15	$ (2,543)
266 LNG	21	$ (12,511)
Panamax	1186	$ 29,936
PPX1	247	$ 128,678
PPX2	201	$ 112,277
		$ 229,917

Table 129: 47-Foot Fleet, 46 to 47-Foot Depth – 2020

47-Foot Vessel Fleet		
2020	**46-Foot Depth**	**47-Foot Depth**
135 LNG	$ 63,169	$ 63,590
145 LNG	$ 66,200	$ 66,751
165 LNG	$ 77,482	$ 77,872
217 LNG	$ 89,358	$ 90,291
266 LNG	$ 102,515	$ 103,084
Panamax	$ 23,916	$ 23,881
PPX1	$ 32,089	$ 31,609
PPX2	$ 35,742	$ 35,283
2020	**Total Calls**	**Benefits**
135 LNG	30	$ (12,655)
145 LNG	32	$ (17,656)
165 LNG	32	$ (12,492)
217 LNG	17	$ (15,853)
266 LNG	24	$ (13,653)
Panamax	649	$ 22,777
PPX1	471	$ 226,189
PPX2	524	$ 240,655
		$ 417,311

Table 130: 47-Foot Fleet, 46 to 47-Foot Depth – 2025

47-Foot Vessel Fleet		
2025	46-Foot Depth	47-Foot Depth
135 LNG	$ 67,683	$ 68,324
145 LNG	$ 69,593	$ 70,442
165 LNG	$ 82,966	$ 83,738
217 LNG	$ 97,147	$ 98,507
266 LNG	$ 108,611	$ 109,961
Panamax	$ 24,121	$ 24,084
PPX1	$ 32,753	$ 32,302
PPX2	$ 36,417	$ 35,904
2025	Total Calls	Benefits
135 LNG	34	$ (21,795)
145 LNG	35	$ (29,709)
165 LNG	36	$ (27,783)
217 LNG	19	$ (25,842)
266 LNG	26	$ (35,088)
Panamax	924	$ 34,036
PPX1	462	$ 208,718
PPX2	749	$ 384,087
		$ 486,623

Table 131: 47-Foot Fleet, 46 to 47-Foot Depth – 2030

47-Foot Vessel Fleet		
2030	46-Foot Depth	47-Foot Depth
135 LNG	$ 70,840	$ 71,582
145 LNG	$ 72,068	$ 72,738
165 LNG	$ 75,887	$ 76,687
217 LNG	$ 97,579	$ 98,399
266 LNG	$ 110,812	$ 111,305
Panamax	$ 24,930	$ 24,822
PPX1	$ 34,761	$ 34,438
PPX2	$ 38,624	$ 38,182
2030	Total Calls	Benefits
135 LNG	37	$ (27,482)
145 LNG	39	$ (26,153)
165 LNG	40	$ (32,018)
217 LNG	21	$ (17,210)
266 LNG	29	$ (14,287)
Panamax	975	$ 105,841
PPX1	661	$ 213,069
PPX2	1018	$ 450,439
		$ 652,199

6.3.2. Tide Delay - Annual Benefits

Using the output data for transit costs provided by HarborSym, displayed in through Table 131 annual tide delay benefits were determined for each channel depth alternative. The values provided for the model run years were then interpolated to attain benefits for the years between. Tide delay benefits were held constant in 2030 when Garden City capacity is forecast to be reached. The benefits stated are in FY11 dollars and are displayed in Table 132. Calculations were provided to the Deep Draft Center of Expertise for review. The approved for use white paper is provided as an attachment to this Economics Appendix.[29]

Table 132: Tide Delay Benefits

Year	42 to 44 Feet	44 to 45 Feet	45 to 46 Feet	46 to 47 Feet	47 to 48 Feet
2017	$ 1,036,564	$ 554,120	$ 450,832	$ 304,875	$ 186,724
2018	$ 1,080,214	$ 586,951	$ 510,291	$ 342,354	$ 233,941
2019	$ 1,123,863	$ 619,781	$ 569,750	$ 379,832	$ 281,158
2020	$ 1,167,512	$ 652,611	$ 629,208	$ 417,311	$ 328,375
2021	$ 1,221,220	$ 711,386	$ 668,777	$ 431,174	$ 358,815
2022	$ 1,274,929	$ 770,161	$ 708,346	$ 445,036	$ 389,256
2023	$ 1,328,637	$ 828,936	$ 747,915	$ 458,898	$ 419,696
2024	$ 1,382,346	$ 887,711	$ 787,484	$ 472,761	$ 450,137
2025	$ 1,436,054	$ 946,486	$ 827,053	$ 486,623	$ 480,577
2026	$ 1,452,883	$ 978,093	$ 833,076	$ 519,738	$ 499,960
2027	$ 1,469,713	$ 1,009,699	$ 839,099	$ 552,853	$ 519,343
2028	$ 1,486,542	$ 1,041,306	$ 845,122	$ 585,969	$ 538,725
2029	$ 1,503,371	$ 1,072,912	$ 851,145	$ 619,084	$ 558,108
2030	$ 1,520,200	$ 1,104,519	$ 857,168	$ 652,199	$ 577,490

6.3.3. Tide Delay - Average Annual Benefits

Average annual benefits were developed using the annual benefits from the proposed project depth alternatives using the Federal Discount Rate for FY11 of 4.125% and a 50 period of analysis. Table 133 displays the rounded average annual benefits for each project alternative.

Table 133: Average Annual Benefits - Tide Delay

Project Depth	Cumulative Benefits
42 to 44 Feet	$1,408,000
44 to 45 Feet	$2,366,000
45 to 46 Feet	$3,146,000
46 to 47 Feet	$3,702,000
47 to 48 Feet	$4,190,000

[29] The approved for use white paper will be developed during the review process. A copy of the document will be included in the final report.

6.4. Cumulative Benefits – Meeting Area and Tide Delay Benefits

The following table displays the benefits of both the meeting area and tide delay benefits. The numbers have been rounded.

Table 134: Cumulative Benefits

Project Depth (feet)	Tide Benefits	Long Island	Total Benefits
42 to 44	$1,408,000	$ 400,000	$ 1,808,000
44 to 45	$2,366,000	$ 401,000	$ 2,767,000
45 to 46	$3,146,000	$ 407,000	$ 3,553,000
46 to 47	$3,702,000	$ 450,000	$ 4,152,000
47 to 48	$4,190,000	$ 424,000	$ 4,614,000
Project Depth	**Tide Benefits**	**Oglethorpe**	**Total Benefits**
42 to 44	$1,408,000	$ 385,000	$ 1,793,000
44 to 45	$2,366,000	$ 387,000	$ 2,753,000
45 to 46	$3,146,000	$ 393,000	$ 3,539,000
46 to 47	$3,702,000	$ 387,000	$ 4,089,000
47 to 48	$4,190,000	$ 373,000	$ 4,563,000
Project Depth	**Tide Benefits**	**Long Island/Oglethorpe**	**Total Benefits**
42 to 44	$1,408,000	$ 717,000	$ 2,125,000
44 to 45	$2,366,000	$ 722,000	$ 3,088,000
45 to 46	$3,146,000	$ 731,000	$ 3,877,000
46 to 47	$3,702,000	$ 730,000	$ 4,432,000
47 to 48	$4,190,000	$ 723,000	$ 4,913,000

6.5. Project NED Benefits Summary

The benefits attributable to channel expansion at Savannah Harbor include reduced total transportation costs for each incremental project depth, reduced tide delay costs, and reduced delay costs resulting from the construction of meeting areas. The following table summarizes average annual project benefits estimated for the SHEP. Benefits were calculated for the 50-year period of analysis (2017-2066) at the Fiscal Year 2011 Federal interest rate of 4.125 percent.

Table 13535: NED Benefits Summary FY-2011 (4.125%)

Benefit Category	Alternative (Project Depth - feet)				
	44	**45**	**46**	**47**	**48**
Transportation Cost Savings	$98,210,000	$133,150,000	$150,370,000	$155,040,000	$155,040,000
Meeting Area (Long Island/Oglethorpe)	$720,000	$720,000	$730,000	$730,000	$720,000
Tide Delay Reduction	$1,410,000	$2,370,000	$3,150,000	$3,700,000	$4,190,000
Total AAE Benefits	**$100,340,000**	**$136,240,000**	**$154,250,000**	**$159,470,000**	**$159,950,000**
Incremental Benefits ***FY11 Values***		**$35,900,000**	**$18,010,000**	**$5,220,000**	**$480,000**

6.5.1 Updated FY2012 Benefits for Recommended Plan

The recommended plan is the NED plan, the 47-foot alternative (See Section 11 of the GRR Main Report). The evaluation of alternative plans and plan selection addressed up to this point, have used FY 11 costs and benefits. Benefits were evaluated using vessel operating costs (VOCs) prepared by IWR and issued by HQ in Economics Guidance Memorandum (EGM) 11-04. In July 2011, new VOCs were prepared by IWR and issued by HQ in EGM 11-05. Benefits and costs for the recommended plan have been updated in December 2011 to reflect FY 2012 price levels using the federal 4% interest rate for Corps of Engineer Projects (EGM, 12-01). Vessel operating costs (VOC) for PMX and PPX vessels were also updated to incorporate the latest published rates (EGM 11-05). Vessel operating costs at-sea are used in the Load Factor Analysis which is an input to the Transportation Cost Savings Model (TCSM). They are expressed in the model in the form of cost per 1000 miles. VOCs within-harbor, expressed as hourly costs, are input for the HarborSym Model. The TCSM calculates the round trip water transportation benefits and HarborSym calculates the tide delay and meeting areas benefits. Approximately one percent of the increase in vessel operating cost is attributable to the decrease in the Federal discount rate 4.125% in FY2011 and 4.0 % in FY2012. The remaining increase in vessel operation cost represents a substantial increase in the operating cost at-sea, of which a large proportion is the increase in fuel (bunkerage) from $535 to $756. The following table 135a displays the costs per 1000 miles using FY2011 and FY2012 VOCs and the percent increase in vessel operating cost for typical vessels which were generally proportional across all relevant vessel classes (PMX and PPX 1 and 2). The new costs per 1000 miles for PMX and PPX 1 and 2 vessels were incorporated in to the TCSM and the model was rerun.

Table 135a: Change in at-sea Vessel Operating cost FY2012 (4.00%)

Change in Vessel Operating Cost Per 1000 Miles Updated to FY2012 Price Levels						
Typical Vessel	AVG DWT	AVG TEU	FY2011 Vessel Operating Cost	FY2012 Updated Vessel Operating Cost	Change in Vessel Operating Cost	Percentage Increase in Vessel Operating Costs
PMX	64,956	4,729	$101,999	$132,118	$30,119	30%
PPX1	74,070	6,186	$104,391	$145,949	$41,558	40%
PPX2	103,817	8,670	$138,722	$195,031	$56,309	41%

Tide delay and meeting area benefits derive from within-harbor vessel operating costs. Table 135b displays the hourly in harbor vessel operating costs for FY2011 and FY2012. The percentage change in cost was applied to the HarborSym delay output to update benefits. Note that for the PPX 2 vessel, the DWT changes from the FY2011 values to FY2012 values, and the relative increase in hourly costs increases more than for the other representative vessels. This is because prior HarborSym runs used a slightly smaller PPX 2 vessel that was used in the TCSM. This update to FY 2012 values, brings these vessels in to line for consistency and accuracies of the results.

Table 135b: Change in Within-Harbor Vessel Operating cost FY2012 (4.00%)

FY 2012 In Harbor Vessel Operating Cost				
Vessel	DWT	AVG TEU	FY11 VOC Per Hour	FY12 Updated VOC Per Hour
Panamax	65,000	4,720	$1,649	$2,296
PPX1	74,100	6,185	$2,206	$2,774
PPX2	86,100/103,817	7,200/8,670	$2,384	$3,516

The transportation cost savings benefits increased from $155, 040,000 to $206,900,000, the tide delay reduction benefits increased from $3,700,000 to $5,300,000 and the meeting area benefits increased from $730,000 to $1,020,000. Total average annual recommended plan benefits increased from $159,470,000 to $213,220,000, as displayed in Table 135c.

Table 135c: NED Benefits Summary FY-2012 (4.0%)

FY 2012 (4.0%) Average Annual Benefits	Recommended Plan
	47
Transportation Cost Savings	$206,900,000
Meeting Area (Long Island/Oglethorpe)	$1,020,000
Tide Delay Reduction	$5,300,000
Total AAE Benefits	**$213,220,000**

7.0 MULTIPORT ANALYSIS

Multiport analysis is a systematic assessment of the effects of the with-project condition on other ports. It also includes the effects of authorized projects at other ports on the with-project and without project conditions. The detailed multiport analysis conducted for the Savannah Harbor Expansion Project is contained in Attachment 4 to this Economics Appendix.

7.1. Multiport Analysis – GEC Evaluation (Final Report dated July 2006)

First, Savannah Harbor's economic study area was determined. For container traffic, principally imports, this study area was defined as a hinterland east of the Mississippi River with the following cities serving as a perimeter: Atlanta, New Orleans, Memphis, St. Louis, Chicago, and Detroit. Eleven other cities were ultimately used for the mapping of the competitive hinterland for the least total delivered transportation cost analysis: Mobile, Jackson, Birmingham, Charlotte, Nashville, Knoxville, Louisville, Cincinnati, Columbus, Indianapolis, and Cleveland.

Next, the historical volumes of container imports through Savannah Harbor and the alternative ports of Norfolk, Wilmington, Charleston, and Jacksonville were compiled. The container volumes were used as previously projected for the ports for the period 2004-2050, including major world trading areas for imports and exports. These projections were not constrained by any port capacity limitations. Then, the container vessel fleet composition for the ports was described relative to the services and major world areas.

The current cost of commodity (container) movements was compiled for Savannah Harbor, consisting of the vessel voyage cost (at sea), vessel and cargo related port costs, and hinterland transportation costs. A vector of sea costs was developed for the voyage legs that precede and follow Savannah Harbor in conjunction with calls at other U.S. East Coast ports, notably Norfolk and New York. Port cost, including vessel time in port was compiled based on vessel and cargo services, including pilotage, tug cost, dockage, wharfage, stevedoring, and container handling. Land transportation costs for truck and rail movements between the ports and hinterland cities were also compiled. Total delivered transportation cost (voyage, port, and hinterland) for imported containers through the 17 major hinterland cities (New Orleans, Mobile, Memphis, St. Louis, Jackson, Birmingham, Atlanta, Charlotte, Nashville, Knoxville, Louisville, Cincinnati, Columbus, Indianapolis, Chicago, Detroit, and Cleveland) were compiled.

Next, the current total delivered transportation cost of container movements was determined for competing harbors (Norfolk, Wilmington, Charleston, and Jacksonville) for benefiting services. Utilizing the aforementioned information, a spreadsheet was utilized to compute the least total cost port and the incremental costs for other ports. A range of hinterlands based on incremental least total delivered transportation costs of $50 per TEU was developed for sensitivity purposes.

In summary, the future cost of container movements under with-project conditions was determined for Savannah Harbor for benefiting services and alternative ports. The analysis determined that with project conditions would not result in a diversion of containers from other ports on the basis of least total transportation cost (voyage, port and hinterland).

The use of Savannah Harbor under without and with-project conditions with respect to imported containers was determined. For the benefiting services, Savannah Harbor has the least total delivered transportation cost under without-project conditions for the major nodes of Memphis, St. Louis, Jackson, Birmingham, Atlanta, and Knoxville. The least total cost nodes do not change under the with project conditions at Savannah Harbor. Alternatively, Charleston Harbor has the least total delivered transportation cost for the major nodes of Knoxville, Louisville, Cincinnati, and Indianapolis. Norfolk has the least total delivered transportation cost for the major nodes of Columbus, Chicago, Detroit, and Cleveland.

As mentioned, the multiport analysis determined that traffic would not be diverted and therefore no NED impacts were identified under the with-project conditions and a least total delivered transportation cost analysis. Further, there were no authorized projects at other competing ports (Norfolk, Wilmington, Charleston, and Jacksonville) that might affect possible diversion of cargo away from Savannah Harbor.

7.2. Update

The SHEP DEIS and GRR were prepared as directed by the authorization for the project which was provided in the Water Resources Development Act of 1999 (Public Law 106-53, Section 102 (b)(9). The SHEP was approved to include 1) an analysis of the impacts of project depth alternatives ranging from 42 through 48 feet and 2) a selected plan for navigation and an associated mitigation plan as required under Section 906 (a) of the Water Resources Development Act of 1986 (33 U.S.C. 2283 (a)). This authorization was in response to previous studies which determined that deepening of the navigation channel in Savannah Harbor was the only solution to the current inefficiencies of operation in the Federal Navigation channel caused by the existing depth (-42 feet mlw). Inefficiencies of operation are characterized by larger vessels having to light-load and/or wait on high tide. This situation is expected to worsen as larger ships replace the older, smaller vessels. The Purpose and Need section of the FEIS contains a more detailed discussion of these issues.

The findings of the GEC multiport study suggest that there would be no substantial changes in the origins and destinations of imports and exports to key U.S. markets served by Savannah. Given this study's findings, a basic assumption for the SHEP Economic Appendix would be no substantial changes in hinterland service area and therefore no change in overall cargo without and with channel improvements at Savannah harbor. This basic assumption is further supported by the fact that PPX 1 vessels are calling Savannah in increasing numbers and are anticipated to call in greater numbers once the Panama Canal is enlarged.

In the draft report, it was assumed that PPX 2 vessels would call only if the channel were deepened to at least 44 ft; however, recent developments and carrier announcements indicate that even in the without project condition, PPX 2 vessels have and will continue to call at Savannah. The savings per TEU for the ocean voyage costs range from about $10 to $60 depending on the trade route distance, percentage of Savannah cargo and other factors. This is derived by dividing the "benefiting tonnes" on each trade route, by the ocean voyage transportation costs for the respective routes. At these levels of savings, and with landside trucking costs within the local area of Savannah estimated to range from $100 to $150 each round trip, and movements outside of the local area are estimated to average $1.50 to $2.00 per round trip mile, there is not a sufficient differential to attract large amounts of cargo diverted from or to other ports. It is further believed that there are numerous other factors involved in port developments that would have a greater affect on cargo diversions such as new container yard developments, location of distribution centers, and landside transportation improvements.

The best estimates available without detailed research peg thirty percent of imports are delivered within 30 miles of Garden City and about thirty percent are destined along the I-16 Corridor to and including Atlanta. Export origins for pulp paper and poultry within 200 miles account for 45 percent, Clay within 200 miles about 20 percent and grain stuffing which is within 30 miles of the port accounts for about 5 percent.

Also, at these levels of savings, there is not a sufficient differential to support the additional handling cost involved in any "Super Port" concept.

Table 136: Savings per TEU - Imports (2025)

World Region Service	Savings/TEU - Imports - 2025				
	44	45	46	47	48
Fe (Panama) ECUS	$ 20	$ 25	$ 25	$ 25	$ 25
FE ECUS EU PEN	$ 33	$ 43	$ 48	$ 48	$ 48
FE (Suez) ECUS PEN	$ 36	$ 48	$ 57	$ 59	$ 59
RTW	$ 23	$ 34	$ 41	$ 47	$ 47
FE ECUS MED PEN	$ 31	$ 45	$ 54	$ 60	$ 60
ECUS MED	$ 23	$ 34	$ 42	$ 47	$ 47
ECUS EU GULF PEN	$ 16	$ 24	$ 29	$ 33	$ 33

8. SOCIOECONOMIC AND REGIONAL ANALYSES

Four accounts are established in the Principals and Guidelines to facilitate the evaluation and display of effects of alternative plans. The national economic development (NED) account displays changes in the economic value of the national output of goods and services. The environmental quality (EQ) account displays non-monetary effects on ecological, cultural and aesthetic resources including the positive and adverse effects of ecosystem restoration plans. The regional economic development (RED) account displays changes in the distribution of regional economic activity (e.g. income and employment). The other social effects (OSE) account displays plan effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts (e.g. community impacts, health and safety, displacement and energy conservation). Display of the national economic development and environmental quality accounts is required. Display of the regional economic development and other social effects accounts is discretionary.

8.1. Socioeconomic Overview

8.1.1. Demographics

The Garden City Terminal is located in Chatham County, Georgia. The county is comprised of 438.11 square miles and 529.8 persons per square mile. Neighboring counties are Effingham, Bulloch Bryan, Evans, Liberty, Long, Tattnall, and McIntosh. These counties can be found surrounding Chatham County the eastern most county on the Georgia Map below.

Figure 38: Georgia County Map

Jasper County, across the Savannah River from the Savannah Harbor, is located in the state of South Carolina. It and its surrounding counties of Hampton, Allendale, Colleton, Charleston and Beaufort can be found at the bottom of the South Carolina Map below.

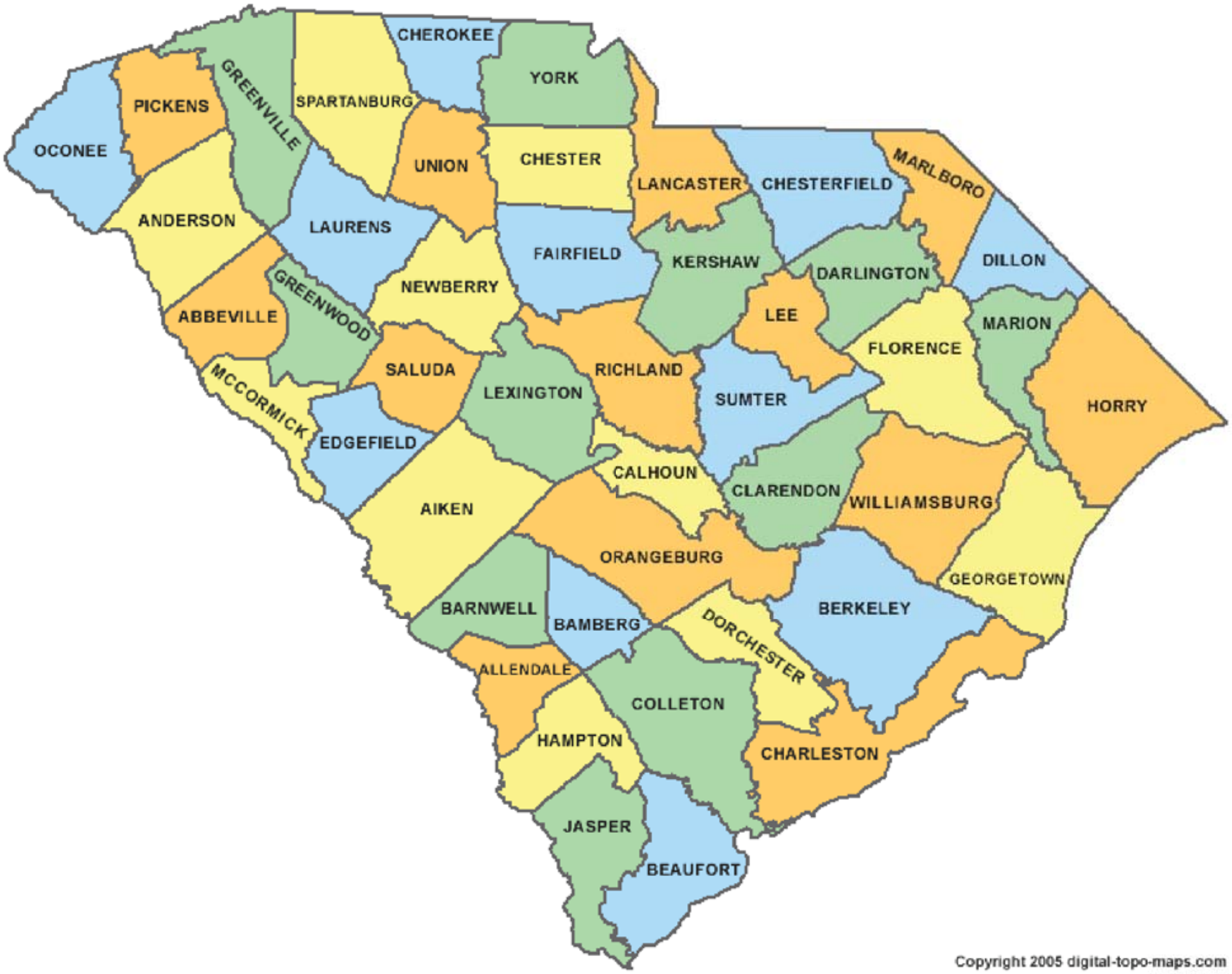


Figure 39: South Carolina County Map

The 2009 Chatham County, Georgia population estimate was 256,992 persons. The population in year 2000 was 232,247, showing a 10.7% increase from 2000 to 2009. The percent of females in the population in 2009 was 52.2%. The racial make-up consisted of 55.5% white, 40.4% black, 0.4% American Indian and Alaska Native persons, 2.2% Asian, 0.1% Native Hawaiian and Other Pacific Islander. The next table presents common statistics for these Georgia counties. These same statistics for Jasper County, South Carolina and surrounding counties are presented as well.

Table 137: Population and Demographics–Selected Georgia and South Carolina Counties

County	2009 Population	2000 Population	% Change	% Females	% White	% Black
Georgia Counties						
Chatham	256,992	232,247	10.7%	52.2%	55.5%	40.4%
Effingham	53,541	37,538	42.6%	50.1%	82.8%	14.9%
Bulloch	69,213	55,983	23.6%	51.1%	68.0%	29.6%
Bryan	32,559	23,417	39.0%	50.5%	80.7%	15.5%
Liberty	62,186	61,610	0.9%	50.5%	52.4%	41.0%
Evans	11,695	10,495	11.4%	51.8%	67.9%	30.4%
Long	12,234	10,304	18.7%	51.6%	71.7%	24.4%
Tattnall	24,493	22,305	9.8%	41.6%	68.4%	30.2%
McIntosh	11,378	10,847	4.9%	52.0%	65.5%	32.5%
South Carolina Counties						
Jasper	23,221	20,671	12.3%	46.2%	51.6%	46.6%
Beaufort	155,215	120,948	28.3%	50.5%	77.1%	20.1%
Hampton	21,014	21,382	-1.7%	49.3%	44.0%	54.9%
Allendale	10,195	11,211	-9.1%	46.7%	27.5%	71.4%
Colleton	39,246	38,264	2.6%	52.5%	57.8%	40.2%
Charleston	355,276	310,099	14.6%	51.7%	66.3%	30.5%

8.1.2. Employment

The pre-recession level of private nonfarm employment growth was very robust in most of the counties surrounding Chatham. All but a few counties had double digit growth except Evans which had a 7.9% increase. Decreases were evident in both Tattnall and McIntosh counties which experienced 12.2% and 18.8% declines in private nonfarm employment. Of note was in Tattnall County where 41.9% of the firms were women-owned, followed by Liberty, Chatham and Evans with 36.3%, 29.5% and 25.2%, respectively.

South Carolina counties, Jasper Beaufort and Charleston posted double digit growth of 12.3%, 28.2% and 14.6% respectively. Colleton County grew 2.6% while declines of -1.7% and -9.1% occurred in Hampton and Allendale Counties. The next table presents these statistics for selected Georgia and South Carolina counties.

Table 138: Employment Statistics - Selected Georgia and South Carolina Counties

County	2000 Private Nonfarm	2008 Private Nonfarm employment	2000 - 2008 Private Nonfarm employment % Change	Total Number of Firms 2002	% Women-owned Firms	% Black-owned Firms	% Asian-owned Firms	% Hispanic-owned Firms
Georgia Counties								
Chatham	7,256	122,759	14.6%	17,789	29.5%	12.4%	2.7%	0.9%
Effingham	725	7,398	38.2%	2635	22.4%	F	F	F
Bulloch	1,472	18,190	10.4%	3,982	17.9%	F	F	F
Bryan	614	5,775	83.2%	1,938	23.0%	F	F	F
Liberty	841	11,213	18.2%	2,473	36.3%	29.8%	4.3%	4.7%
Evans	241	3,897	7.9%	789	25.2%	22.1%	F	F
Long	73	399	81.4%	271	F	F	F	F
Tattnall	314	2,659	-12.2%	1,252	41.9%	F	F	F
McIntosh	230	1,646	-18.8%	929	F	F	F	F
South Carolina Counties								
Jasper	583	7,300	110.9%	1,436	27.1%	19.1%	F	F
Beaufort	5,025	55,682	18.0%	13,839	26.5%	7.6%	F	F
Hampton	407	4,311	-9.1%	1,275	19.7%	22.3%	F	F
Allendale	135	1,524	-34.5%	446	F	31.6%	F	F
Colleton	853	9,175	5.3%	3,074	19.4%	10.1%	F	F
Charleston	12,156	181,831	7.1%	30,232	28.1%	7.7%	1.8%	1.0%

F – Not Disclosed

8.1.3. Households

There were 117,991 housing units in Chatham County, Georgia, in 2009; in 2000 there were 89,865 households with 2.49 persons per household. The year 2000 homeownership rate for the county was 60.4% and the median value of owner-occupied housing was $95,000.

In Jasper County of South Carolina there were 9860 housing units in 2009; in 2000 there were 7042 households with 2.75 persons per household. The homeownership rate in Jasper County was 77.7% in 2000 and the median value of owner-occupied housing was $77,600.

Table 139: Housing and Households–Selected Georgia and South Carolina Counties

County	Housing Units 2000	Housing Units 2009	Persons per household 2000	Home ownership rate 2000	Median Value Owner occupied housing 2000
Georgia Counties					
Chatham	89,865	117,991	2.49	60.4%	$95,000
Effingham	13,151	19,559	2.84	82.6%	$106,600
Bulloch	20,743	28,734	2.53	58.1%	$94,300
Bryan	8,089	12,496	2.88	77.9%	$115,600
Liberty	19,383	25,119	2.93	50.7%	$79,800
Evans	3,778	4,708	2.62	71.5%	$69,000
Long	3,574	4,693	2.88	66.2%	$71,100
Tattnall	7,057	8,976	2.60	70.7%	$67,300
McIntosh	4,202	6,965	2.54	83.6%	$81,700
South Carolina Counties					
Jasper	7,042	9,860	2.75	77.7%	$77,600
Beaufort	45,532	84,530	2.51	73.2%	$213,900
Hampton	7,444	8,828	2.64	78.1%	$94,900
Allendale	3,915	4,643	2.56	72.7%	$46,900
Colleton	14,470	19,377	2.62	80.3%	$73,200
Charleston	123,326	175,059	2.42	61.0%	$94,900

8.1.4. Income

The Chatham County, Georgia, median house hold income in 2008 was $45,132 and the percent of persons below the poverty level was 17%, as compared to the State of Georgia's at 14.7%. Only two of the ten neighboring counties have a lower incidence of persons living below the poverty level, (i.e., compared to the State of Georgia).

In Jasper County, South Carolina the median household income in 2008 was $38,778 and the percent of persons below the poverty level was 19.8% compared to the State of Georgia's 14.7%. Four of the six, South Carolina counties surrounding Jasper County had greater percentages of persons below the poverty level compared to the State's 15.7% lead by Allendale County with 41.8 percent of persons below the poverty level. See the following table for these comparisons.

Table 140: Income and Poverty–Selected Georgia and South Carolina Counties

County	Median Household Income 2008	Percent of Persons Below Poverty Level	Georgia Persons Below Poverty Level	South Carolina Persons Below Poverty Level	USA Persons Below Poverty Level
Georgia Counties					
Chatham	$45,132	17.0%	14.7%	15.7%	13.2%
Effingham	$59,956	10.1%	14.7%	15.7%	13.2%
Bulloch	$38,631	23.1%	14.7%	15.7%	13.2%
Bryan	$62,038	10.2%	14.7%	15.7%	13.2%
Liberty	$39,997	15.4%	14.7%	15.7%	13.2%
Evans	$33,269	24.8%	14.7%	15.7%	13.2%
Long	$38,168	23.2%	14.7%	15.7%	13.2%
Tattnall	$36,647	24.5%	14.7%	15.7%	13.2%
McIntosh	$36,397	18.8%	14.7%	15.7%	13.2%
South Carolina					
Jasper	$38,778	19.8%	14.7%	15.7%	13.2%
Beaufort	$55,897	10.1%	14.7%	15.7%	13.2%
Hampton	$36,003	23.4%	14.7%	15.7%	13.2%
Allendale	$25,329	41.8%	14.7%	15.7%	13.2%
Colleton	$34,136	21.1%	14.7%	15.7%	13.2%
Charleston	$50,213	15.4%	14.7%	15.7%	13.2%

8.2. Regional Economic Development Analysis

The regional economic development (RED) account measures changes in the distribution of regional economic activity that would result from each alternative plan. Evaluations of regional effects are measured using nationally consistent projection of income, employment, output and population.

8.2.1. Regional Analysis

The USACE Online Regional Economic System (RECONS) is a system designed to provide estimates of regional, state, and national contributions of federal spending associated with Civil Works and American Recovery and Reinvestment Act ARRA Projects. It also provides a means for estimating the forward linked benefits (stemming from effects) associated with non-federal expenditures sustained, enabled, or generated by USACE Recreation, Navigation, and Formally Utilized Sites Remedial Action Program (FUSRAP). Contributions are measured in terms of economic output, jobs, earnings, and/or value added. The system was used to perform the following regional analysis for the SHEP.

8.2.2. Summary

This document section summarizes the analysis and provides estimates of the economic impacts of 2009 for The Savannah Harbor expansion Project. The U.S Army Corps of Engineers (USACE) Institute for Water Resources, the Louis Berger Group and Michigan USACE University developed the regional economic impact modeling tool called RECONS 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 and annual Civil Work program spending. 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 will be used as a means to document the performance of direct investment spending of the USACE as directed by the American Recovery and Reinvestment Act (ARRA). The Tool also allows the USACE to evaluate project and program expenditures associated with the annual expenditure by the USACE. The Tool has been developed in both a desktop and on-line version.

8.2.3. Results of the Economic Impact Analysis

This RED impact analysis was evaluated at three geographical levels: Local, Bi-State and National. The local represents the Savannah impact area which encompasses the area included in about a 40-mile radius around the project area. The Bi-State level will include the States of Georgia and South Carolina. The National level will include the 48 contiguous United States.

The following table displays the overall spending profile that makes up the dispersion of the total project construction cost among the major industry sectors. The spending profile also identifies the geographical capture rate, also called Local Purchase Coefficient (LPC) in RECONS, of the cost components. The geographic capture rate is the portion of USACE spending on industries (sales) captured by industries located within the impact area. In many cases, IMPLAN’s trade flows Regional Purchase Coefficients (RPCs) are utilized as a proxy to estimate where the money flows for each of the receiving industry sectors of the cost components within each of the impact areas.

Table 141: Spending and LPCs

Category	Spending (%)	Spending ($)	Local LPC (%)	State LPC (%)	National LPC (%)
Fuel	15%	$89,415,150	16%	18%	81%
Consumable Operating Expenses – Textiles, Lubricants, and Metal Valves and Parts	10%	$59,610,100	24%	34%	74%
Consumable Operating Expenses – Restaurants	1.4%	$8,345,414	100%	100%	100%
Repairs and Equipment	40%	$238,440,400	71%	83%	100%
Labor	25%	$149,025,250	5%	5%	100%
Consumable Operating Expenses – Other Food and Beverages	8.6%	$51,264,686	28%	51%	92%
Total	100%	$596,101,100			

Table 142 displays the geographical capture amounts for each of the three geographical impact analyses. Which is that portion of USACE spending that is captured in each impact area. It initially measures $226,692,771 at the local impact level and increases to $276,732,471 at the Bi-State level, Georgia and South Carolina, and expands to a $559,101,991 capture at the national level. The labor income represents all forms of employment earnings. In IMPLAN's regional economic model, it is the sum of employee compensation and proprietor income. The Gross Regional Product (GRP) which is also known as value added, is equal to gross industry output (i.e., sales or gross revenues) less its intermediate inputs (i.e., the consumption of goods and services purchased from other U.S. industries or imported). The number of jobs equates to the labor income. An interesting note is that in the local geography one job averages an annual wage of $41,320, the Bi-State equivalent is $42,309 and the National equivalent is $39,924 (labor income/job). The total impact, direct and secondary, yields a local average wage of $39,607, Bi-State $42,547 and $44,230 nationally.

Table 142: Overall Summary Economic Impacts

		Local	Bi-State	Nation
Capture Amount		$226,692,771	$276,732,471	$559,101,991
Direct Impact				
	Job	1,826.14	2,153.67	6,541.07
	Labor Income	$75,457,631	$91,120,637	$257,553,334
	GRP	$140,419,298	$168,743,184	$355,314,310
Total Impact				
	Job	2,428.10	3,725.99	11,554.98
	Labor Income	$96,169,986	$158,531,133	$511,073,882
	GRP	$185,208,212	$287,270,325	$794,610,195

The next three tables present the economic impacts by Industry Sector both for each geographical region. Note that the largest impact area is 417, Commercial and industrial machinery and equipment repair and maintenance, as one would expect in a heavily dredging operation. Impacts at the National level show a tremendous expansion most certainly due to the many multiple turnover of money that ripples throughout the national economy.

Table 143: Economic Impact at Local Region

Implan No.	Industry Sector	Sales	Jobs	Labor Income	GRP
	Direct Effects				
115	Petroleum refineries	$10,775,725	1.18	$452,487	$735,136
198	Valve and fittings other than plumbing manufacturing	$893,363	2.66	$169,702	$347,606
319	Wholesale trade businesses	$13,614,457	81.87	$5,039,680	$8,713,585
323	Retail Stores - Building material and garden supply	$7,232,415	83.91	$2,881,825	$4,694,880
324	Retail Stores - Food and beverage	$6,336,969	102.01	$2,631,314	$4,043,885
332	Transport by air	$13,964	0.05	$3,438	$4,373
333	Transport by rail	$149,273	0.39	$36,522	$86,757
334	Transport by water	$7,518	0.01	$974	$2,276
335	Transport by truck	$1,290,071	10.15	$469,031	$627,214
337	Transport by pipeline	$128,656	0.18	$34,717	$50,392
413	Food services and drinking places	$8,345,414	158.93	$2,699,302	$4,020,898
417	Commercial and industrial machinery and equipment repair and maintenance	$168,156,070	1,196.49	$53,230,241	$109,178,103
5001	Labor	$7,451,263	180.6	$7,451,263	$7,451,263
69	All other food manufacturing	$2,297,613	7.71	$357,135	$462,930
	Total Direct Effects	$83,859,128	601.96	$20,712,355	$44,788,914
	Total Effects	**$310,551,899**	**2,428.10**	**$96,169,986**	**$185,208,212**

Table 144: Economic Impact at Bi-State Level

Implan No.	Industry Sector	Sales	Jobs	Labor Income	GRP
	Direct Effects				
115	Petroleum refineries	$10,775,725	1.18	$452,487	$735,136
198	Valve and fittings other than plumbing manufacturing	$3,288,976	10.04	$624,771	$786,671
319	Wholesale trade businesses	$19,751,072	118.77	$7,358,811	$10,878,600
323	Retail Stores - Building material and garden supply	$8,275,889	96.02	$3,305,552	$5,093,838
324	Retail Stores - Food and beverage	$7,074,479	113.88	$2,941,935	$4,318,386
332	Transport by air	$52,049	0.2	$13,457	$14,244
333	Transport by rail	$293,240	0.77	$72,693	$122,979
334	Transport by water	$13,069	0.02	$1,782	$3,068
335	Transport by truck	$2,263,394	17.81	$827,773	$930,932
337	Transport by pipeline	$128,656	0.18	$34,717	$50,392
413	Food services and drinking places	$8,345,414	158.93	$2,699,302	$4,020,898
417	Commercial and industrial machinery and equipment repair and maintenance	$198,553,679	1,420.17	$63,513,002	$117,442,167
5001	Labor	$7,451,263	180.6	$7,451,263	$7,451,263
69	All other food manufacturing	$10,465,565	35.1	$1,823,094	$1,884,933
	Total Direct Effects	$207,787,622	1,572.32	$67,410,496	$118,527,141
	Total Effects	**$484,520,093**	**3,725.99**	**$158,531,133**	**$287,270,325**

Table 145: Economic Impact at National Level

Implan No.	Industry Sector	Sales	Jobs	Labor Income	GRP
	Direct Effects				
115	Petroleum refineries	$66,404,337	7.67	$2,788,404	$4,530,204
198	Valve and fittings other than plumbing manufacturing	$26,563,758	81.72	$5,345,938	$10,809,959
319	Wholesale trade businesses	$20,371,599	122.5	$7,605,520	$13,123,520
323	Retail Stores - Building material and garden supply	$8,351,742	96.9	$3,336,354	$5,431,543
324	Retail Stores - Food and beverage	$7,620,359	122.67	$3,176,042	$4,877,186
332	Transport by air	$58,040	0.23	$16,539	$21,451
333	Transport by rail	$335,375	0.88	$83,326	$195,901
334	Transport by water	$34,248	0.07	$5,287	$10,779
335	Transport by truck	$2,391,256	18.81	$880,100	$1,175,652
337	Transport by pipeline	$418,741	0.71	$123,426	$178,608
413	Food services and drinking places	$8,345,414	158.93	$2,699,302	$4,020,898
417	Commercial and industrial machinery and equipment repair and maintenance	$238,440,400	1,713.68	$77,005,694	$154,871,331
5001	Labor	$149,025,250	4,023.21	$149,025,250	$149,025,250
69	All other food manufacturing	$30,741,472	103.1	$5,462,150	$7,042,029
	Total Direct Effects	$859,122,773	5,103.91	$67,410,496	$439,295,885
	Total Effects	**$1,418,224,764**	**11,554.98**	**$158,531,133**	**$287,270,325**

Total Savannah Harbor Expansion Project Economic Impact for the Bi-State geographical area of Georgia and South Carolina as displayed in Table 144 is composed of $484,520,093 in sales, 3,726 jobs, $158,531,133 in labor income and a contribution of $287,270,325 to GRP.