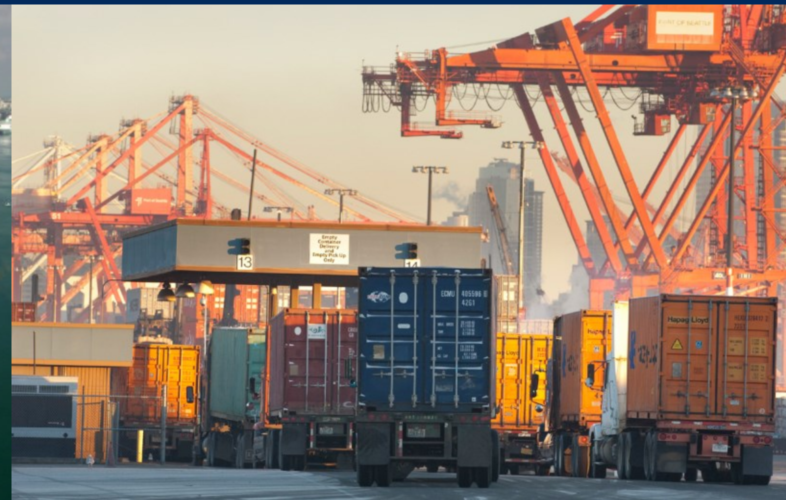

Panama Canal Expansion Study

Phase I Report:
Developments in Trade and National and Global Economies

November 2013

U.S. Department of Transportation

Maritime Administration

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Post-Panamax container ship at sea, Credit iStockphoto
Panamax vessel transiting the Panama Canal, Credit iStockphoto

PANAMA CANAL EXPANSION STUDY

PHASE I REPORT

Developments in Trade and National and Global Economies

U.S. DEPARTMENT OF TRANSPORTATION
MARITIME ADMINISTRATION

November 2013

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FOREWORD

The U.S. Department of Transportation (DOT) and Maritime Administration (MARAD) commissioned a study to examine the anticipated economic and infrastructure impacts of the Panama Canal expansion on U.S. ports and port-related freight transportation infrastructure. The study has been conducted in four defined phases that examine a full range of impacts on U.S. ports, waterways, and intermodal freight systems. This report is the first of two reports intended to be issued. This first report covers Phase I of the study; a second report will cover Phases II – IV of the study.

The purpose of this Phase I report is to identify and explain the pending developments in world ocean trade routes and national and global economies that are likely to affect global and U.S. freight corridors relevant to the Panama Canal expansion. The Phase I report also sets the stage for subsequent phases of the study, and identifies and describes the capabilities of U.S. ports to accommodate changes in the physical and market attributes needed to receive Post-Panamax vessels. This report also provides a preliminary assessment of potential shifts in commodity flows once the Panama Canal expansion is complete.

The second phase (Phase II) of the study will provide a detailed assessment of the physical attributes of U.S. ports and inland infrastructure and the markets they serve. It will evaluate current port and land-side infrastructure capacity and assess investment plans that ports have developed to address the expected impacts of the Canal expansion. This phase of the study will use information developed from stakeholder interviews with key ports and transportation system operators to assess the cost implications of using rail, highway, and marine systems that serve U.S. inland markets with shipments passing through the expanded Panama Canal. Phase II will also include the results of a shippers survey and an assessment of infrastructure conditions at key U.S. ports most likely to be affected by the Canal expansion.

The third phase (Phase III) will assess potential opportunities for applying investment funding towards future development of port capacity. It will also assess possibilities for leveraging surface transportation funds, port and logistics system investments, and other private investment opportunities. The potential effects of funding opportunities will be assessed with the intent of framing discussions relevant to policy decisions concerning the economic benefits of the Canal expansion on the U.S. economy.

The fourth and final phase (Phase IV) of the study will revisit the issues identified in Phase I, in light of feedback received from listening sessions and other stakeholder outreach efforts, and will review the infrastructure needs and funding issues assessed during Phases II and III. The final phase will: identify a range of investment considerations; present perspectives on potential recommendations to address these areas; and produce a set of specific and actionable policy recommendations for consideration by DOT and MARAD.

It is important to highlight DOT's and MARAD's efforts to collaborate with other relevant Federal partners as well as a cross-section of public and private industry transportation entities to ensure the overall study provides a broader national transportation planning perspective. Most notably, DOT and MARAD established a comprehensive and robust peer review process developed specifically to assess and evaluate the methods, procedures, and findings designed for each phase of the study. The peer review process incorporates three distinct groups of industry experts: 1) the DOT multi-modal administrations, comprised of DOT Office of the Secretary, MARAD, Federal Highway Administration (FHWA), Federal Railroad Administration (FRA), and the Federal Motor Carrier Safety Administration (FMCSA); 2) the U.S. Coast Guard (USCG) and the U.S. Army Corps of Engineers (USACE) Institute for Water Resources (IWR); and 3) an independent panel of reviewers who were identified with the assistance of the Transportation Research Board of the National Academies. The peer reviewers were carefully selected to ensure that the results of the study represent a wide range of diverse geographic and modal perspectives. Comments and recommendations received from the peer review process were considered in the development of this report.

Looking forward, DOT and MARAD will continue their robust public outreach and stakeholder engagement program for Phases II and III in 2012, and intend to wrap-up the final stages of the study in 2013. Results of the outreach program will be evaluated and appropriately factored into the study's final report. The peer review process will continue through the remainder of this study.

ACKNOWLEDGEMENTS

The U.S. Department of Transportation (DOT) and Maritime Administration (MARAD) would like to acknowledge and thank the many Federal government employees who worked to complete the first phase of this comprehensive study of the Panama Canal expansion, as well as the extensive research and analytical support contributed by Economic Development Research Group, Inc. (EDRG) and its team of technical experts. Among the Federal agencies and offices whose staff have provided extensive review, analysis, and input to this document are the following: the DOT Assistant Secretary for Transportation Policy, MARAD's Office Policy and Plans, Office of Intermodal System Development and the multiagency Committee on Marine Transportation System (CMTS); the Federal Highway Administration (FHWA); the Federal Railroad Administration (FRA); the Federal Motor Carrier Safety Administration (FMCSA); the U.S. Coast Guard (USCG); the U.S. Army Corps of Engineers-Institute for Water Resources (USACE); the Office of the U.S. Trade Representative, and Office of Management and Budget (OMB).

Additionally, we would like to extend our sincere appreciation to the various independent peer reviewers, who were identified with the assistance of the Transportation Research Board of the National Academies, for their extensive and comprehensive review of Phase I Report and study methodology. The analysis completed by these individuals significantly contributed to the successful completion of the Phase I work and presented valuable and insightful feedback for the overall study effort.

Finally, we would like to thank the hundreds of industry stakeholders and other entities who participated in our agency's Panama Canal Expansion Study Listening Sessions, as well as the other related outreach engagements conducted over the past year. We appreciate the opportunity to collect their valuable feedback regarding the Panama Canal expansion and its potential impacts on the Nation's overall transportation system.

We look forward to continued collaboration with our many Federal partners, peer reviewers and industry stakeholders.

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TABLE OF CONTENTS

LIST OF TABLES

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LIST OF FIGURES

EXECUTIVE SUMMARY

Expansion of the Panama Canal is scheduled for completion in 2015, just over 100 years after the Canal opened.[1] This report describes ways that shipping patterns and industry costs could change when the Panama Canal expansion is completed, assesses the potential shifts in trade flows tied to the Panama Canal expansion and identifies potential markets that could be affected.

As the first of two volumes intended to inform current and future investment decisions for U.S. ports and related transportation infrastructure, this report presents information in four key areas:

1. Panama Canal Expansion and its Potential Effects
2. Major Factors that Shape Impacts on U.S. Ports and Infrastructure
3. Impacts on U.S. Trade
4. Impacts of Panama Canal Expansion on U.S. Regions

PANAMA CANAL EXPANSION AND ITS POTENTIAL EFFECTS

The Panama Canal is an important link in global trade, accommodating an estimated five percent of the world's total cargo volume.[2] One of the largest construction projects in the world, the Panama Canal expansion could have significant impacts on U.S. ports and inland infrastructure. Expansion of the Panama Canal will allow for the passage of larger container vessels, potentially reducing the cost of trans-ocean shipping, particularly for those trade routes providing East-West services between the Far East and U.S. East and Gulf Coast ports. This is especially relevant to the container shipping services that have evolved during the past half-century, as trade between Asia and Western economies has come to dominate demand for Panama Canal capacity.[3] U.S. exports of both containerized and bulk cargoes to these same regions are also transported through the Panama Canal—especially agricultural commodities shipped to Asia from the United States via Gulf Coast ports. More cost-effective service, using larger vessels operating at deeper drafts, could improve the ability of some U.S. exports to compete in global markets for agricultural products and energy.

Panama Canal expansion will allow passage of much larger ships. The Panama Canal Authority (PCA) estimates that the combined effect of allowing between 12 and 14 larger vessels per day

[1] Plume, J. "Panama Canal Authority Confirms 6-Month Delay". *Breakbulk News*. July 2, 2012. Available at: http://www.breakbulk.com/breakbulk-news/industry-sector/ports-and-terminals/panama-canal-authority-confirms-6-month-delay/.

[2] Rodrigue, J.P. Factors Impacting North American Freight Distribution in View of the Panama Canal Expansion. *Van Horne Institute*, 2010. Available at: http://www.vanhorne.info/files/vanhorne/Panama%20Canal%20Expansion%20Study,%20Final%20Report.pdf.

[3] The primary trade routes between the U.S. East Coast and Asia, Europe and Asia, and Europe and the U.S./Canadian West Coast accounted for 42 percent to 46 percent of the total volume of trade between 2000 and 2011 (Panama Canal Authority. *Transit Statistics, Fiscal Year 2011*. Available at: http://www.pancanal.com/eng/op/transit-stats/index.html).

through the new locks and using the existing locks for smaller vessels will double Canal capacity. The increased size of the vessels—particularly container ships of up to 13,000 TEUs—will play a critical role in increasing Canal throughput capacity from 300 million PCUMS Tons to 600 million PCUMS Tons.[4]

MAJOR FACTORS THAT SHAPE IMPACTS ON U.S. PORTS AND INFRASTRUCTURE

The physical attributes of U.S. ports, their ability to move goods efficiently, and their dependence on other surface infrastructure to gain access to inland markets are among many factors that influence how the expansion of the Panama Canal will affect U.S. trade and the cost of shipping through the Canal. Factors that will shape the impact of the Panama Canal expansion on the United States include the following:

- **More concentrated U.S. port calls.** Use of larger ships will increase the volume of containers that must be moved at each port call for those larger vessels. This will likely lead to fewer and more concentrated ship calls at larger ports for any given service, especially for vessel deployments serving the Northeast Asia – U.S. East/ Gulf Coast trade. Fewer calls by larger ships would lead to higher peak loads and tend to favor ports that have greater capacity in container handling, storage and movement to inland destinations.
- **Readiness of U.S. ports and related infrastructure.** Readiness includes navigational channel depth and height (air draft) restrictions, terminal handling and storage capabilities, rail connectivity and capacity and inland transportation systems (specifically, intermodal rail and "last mile" port and terminal connections).
- **Use of foreign container transshipment ports.** The extent to which U.S. ports and others invest to improve vessel handling capacity and more concentrated cargo volumes, and move the cargo inland, could influence whether shipping companies decide to make greater use of Caribbean or Panamanian container transshipment ports.
- **Development of marine highways.** Port capacity constraints and more concentrated port calls could lead to greater use of marine highway services to move containers via water between larger and smaller U.S. ports. As with foreign transshipment, the handling and transport costs as well as the externalities (e.g., landside traffic congestion) of competing modes are a significant factor in determining the viability of a marine highway as a competitive option.

IMPACTS ON U.S. TRADE

The emphasis in this report is on containerized traffic, the segment of Panama Canal traffic most likely to see operational cost savings due to the expansion. However, other commodities, such as

[4] PCUMS is an acronym for Panama Canal Universal Measurement System, the basis upon which vessels are charged for use of the Canal. One PCUMS ton is approximately 100 cubic feet of cargo space. A twenty-foot long container (TEU) is equivalent to approximately 13 PCUMS tons.

grain exported from the U.S. Midwest, and new opportunities for exports, such as coal, oil and petroleum products, and liquefied natural gas (LNG), may also be able to capitalize on expanded Panama Canal capacity, especially if U.S. Gulf ports are able to handle larger vessels.

Based on research completed for this report, the potential effects of Panama Canal expansion on U.S. trade are as follows:

- Carriers serving direct all-water routes between U.S. East Coast and Gulf ports and foreign ports (specifically those in Asia and the West Coast of South America) could provide more cost-competitive services by deploying larger and more efficient oceangoing vessels through the expanded Canal.
- The transition from 5,000 TEU vessels to vessels of up to 13,000 TEUs on Northeast Asia - U.S. East/Gulf Coast routes via the Panama Canal may provide savings to shippers; however, a significant amount of transportation cost savings associated with the use of larger vessels is expected to be absorbed by providers of transportation services.
- As the average size of vessels serving West Coast ports also increases over time from an average of 6,000 TEUs per vessel today to 13,000 TEUs (or greater), the cost for transportation to West Coast ports from Asia would also be reduced, with a portion of those savings being passed on to shippers.

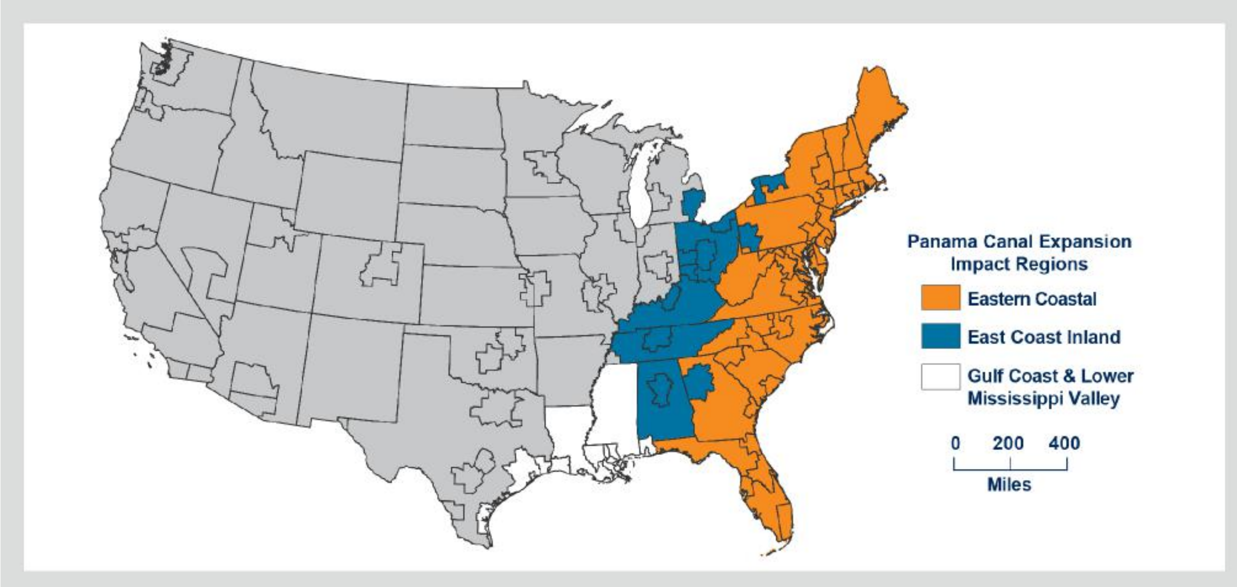
Each of these findings is tentative and will need to be more thoroughly investigated in subsequent research. The savings realized by ocean carriers depend on many factors, including vessel operation patterns, Panama Canal tolls, and port fees associated with servicing larger vessels. Projections of how shippers and carriers may respond to potential cost savings, the potential for pass-through of increased savings to beneficial cargo owners, and the response of ports and railroads will also be evaluated.

IMPACTS OF PANAMA CANAL EXPANSION ON U.S. REGIONS

Impacts are likely to be significantly different by geographic region and by the type of product transported. The study identifies areas of the United States where net cost reductions are unlikely to affect trade flows (the States and metropolitan areas highlighted in gray in Figure ES – 1). The study also identifies regions that already receive a large share of their Asian imports, particularly for lower value products, via the Panama Canal (the States and metropolitan areas highlighted in orange in Figure ES – 1). These areas will benefit the most from cost reductions associated with Canal expansion.

The study has developed preliminary information about U.S. inland regions where cost reductions for both East Coast and West Coast transpacific service could result in “contested markets”—regions where service through either U.S. East Coast or U.S. West Coast ports is possible, but where uncertainties about inland infrastructure capacity, costs, and market response make conclusions about the volume and commodity mix of trade flows more difficult to determine. This area includes the inland East Coast regions shown in blue in Figure ES – 1. The study assesses the types of commodities and industries most likely to take advantage of cost savings associated with service from either coast.

Figure ES – 1. **U.S. REGIONS AFFECTED BY PANAMA CANAL EXPANSION – CONTAINER TRADES**



Source: Parsons Brinckerhoff, Panama Canal Expansion Study, June 2012

Regions of the United States most likely to access Gulf ports are shown in white in Figure ES – 1. These regions may have both port capacity and inland connections to regional markets sufficient to provide cost advantages over U.S. West Coast ports. Moreover, agricultural and energy exports to Asia from these Gulf ports would be able to move through the Panama Canal on larger bulk vessels operating at deeper drafts than current Panamax vessels. Increased bulk product exports from these ports could in turn generate greater traffic on low-cost barge and rail services that bring products to the ports from the U.S. interior that extends northward along the Mississippi and Ohio Rivers.

IMPLICATIONS AND NEXT STEPS

The geographic extent of the impacts of Panama Canal expansion will depend on a number factors, including: the capacity of individual U.S. ports and their related infrastructure to handle shifting trade flows, the response of shipping companies to port and inland infrastructure capacity development, the adaptation of supply-chain management methods that take advantage of the scale economies offered by Canal expansion, and the allocation of cost savings among the various domestic and foreign players.

Information developed in this report is designed to identify the role that the Panama Canal plays in U.S. trade with the rest of the world. Development of information about both public and private sector capacity expansion plans, refinement of cost information (including possible pass-through cost savings), and financial considerations concerning the potential for funding these capacity improvements will be the subject of the next phase of this study. The ways that shippers will respond to cost savings are an important factor in determining the impacts of Panama Canal expansion on U.S. ports. Because the relative costs of transpacific services to U.S. West Coast ports will also be affected by the use of much larger and more fuel-efficient vessels, future phases of this study will solicit additional information about market responses to changes in shipping costs. These costs will include input from vessel operators, transportation service providers, and shippers. Costs will also include the potential effects of port and port-related infrastructure investments that have been made or are currently anticipated by public and private sector parties.

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CHAPTER 1: INTRODUCTION

1.1 IMPACTS OF PANAMA CANAL EXPANSION ON U.S. PORTS AND INLAND INFRASTRUCTURE

The Panama Canal is being expanded to include a third set of locks—larger than the existing ones—and widening and deepening Gatun Lake, access channels, and the channel that cuts between Panama's mountains. This is one of the largest construction projects in the world and is expected by many in the logistics industry to have significant impacts on global trade and on U.S. ports and inland infrastructure. The principal questions to be answered by this study are:

- How will this development affect U.S. ports and inland infrastructure?
- What public policies will capture the most public benefit from the expansion?

As described in the Foreword, this report addresses potential impacts of the expansion and examines issues that may influence investment policies devised in response to the changing demands on U.S. ports and inland infrastructure brought about by the Canal's increased capacity.

The Panama Canal expansion is primarily expected to impact shipping in two ways. First, larger locks and channels will allow the passage of ships over twice as large as those currently able to transit the Canal. Second, more vessels per day will be able to pass through the Canal due to the new locks. Accordingly, the total annual throughput capacity of the Canal (as measured in PCUMS Tons) will double. Together, these changes will (a) affect the size of vessels calling at some U.S. ports and the types of carrier services offered at those ports, and (b) require changes in some port and landside infrastructure to handle larger vessels and move cargoes to inland markets. These changes are also likely to affect shipping patterns and routing of cargo for major U.S. trade lanes. The nature of these changes and their reasons and implications are discussed in this report.

For container ships, the current maximum size that can transit the Canal will increase from ships able to carry roughly 5,000 twenty-foot equivalent unit (TEU) containers to those able to carry 13,000 TEUs. As described in Chapter 3, transits of larger ships will be similarly enabled in other shipping categories. The impact of larger ships will depend on vessel types, commodities carried and specific trade lanes. Both the expansion of capacity and the use of larger ships will affect (a) the complex and highly integrated marine and landside transportation network serving the United States and (b) logistics and shipping services that depend on this network. Key elements of this network include North American coastal and transshipment ports and the inland transportation system connected to coastal ports. However, the global transportation network serving the United States will also be affected by the constrained capacities of North American ports and inland infrastructure.

Based on overall changes in the U.S. transportation network, two sets of impacts are expected. First, the use of larger ships could lead to reduced total delivered costs by reducing ocean transportation costs per TEU and providing the volume of containers necessary to justify port and terminal operators' investments in high-capacity container management systems. These systems are more cost-effective on a per TEU basis, and also help to provide the volumes of containers needed to justify investments in high-efficiency rail service between U.S. East Coast ports and inland markets. Cost savings will be shared by the ocean shipping companies, ports and marine terminal operators, the PCA, rail lines, trucking companies, marine highway operators, intermodal carriers, beneficial cargo owners, and consumers. Given that costs include a large fuel component, reduced fuel consumption will have its own economic effects and environmental benefits.

The other set of impacts is likely to consist of shifts in the flow of goods: sourcing, distribution networks, routing via the Panama Canal and use of the North American inland transportation system may all be altered. These shifts could be seen in volume changes for some U.S. transportation system service providers, including North American and transshipment ports as well as rail, trucking and waterway operators. Changes in the transportation system and the use of larger ships may also affect the timing and concentration of the volumes that move through ports, storage facilities and inland transportation facilities.

THIS PHASE I REPORT HAS FOUR MAJOR CHAPTERS:

- **Chapter 2** provides background information on the Panama Canal, the expansion program and the likely impacts of expansion—particularly the use of larger ships—on aggregate capacity and on specific trade lanes and commodity flows. These impacts will affect the U.S. trade flows discussed in Chapter 4.
- **Chapter 3** examines the global and U.S. transportation networks and the role of the Canal in these networks. This chapter also assesses some of the transportation network factors that may influence impacts on U.S. ports and infrastructure.
- **Chapter 4** examines factors that are likely to affect both aggregate and specific U.S. trade flows. This chapter also assesses the net impacts of Canal expansion on particular U.S. regions.
- **Chapter 5** reviews the effects of Panama Canal expansion on key U.S. trade routes, assesses the likely range of cost savings that may accrue to various transportation operators, and identifies the factors that may lead to rerouting cargoes from the U.S. West Coast to the U.S. East and Gulf Coasts after the Panama Canal expansion is opened in 2015. This chapter also assesses the net impacts of Canal expansion on particular U.S. regions.

CHAPTER 2: PANAMA CANAL EXPANSION PROGRAM

This chapter provides an overview of the Panama Canal and the expansion project. The expansion of the Canal will provide more capacity and receive larger vessels. Both changes could alter trade flows and change the demands on transportation networks, services and operations.

2.1 PANAMA CANAL OVERVIEW

Since opening in 1914, the Panama Canal has been a critical element of the global transportation network. It now serves over 140 maritime trade routes to over 80 countries; an estimated five percent of global maritime cargo transits the Panama Canal every year.[5] Providing an all-water passage between the Atlantic and Pacific Oceans, the Canal facilitates trade between Northeast Asia, Europe, the Caribbean, and the Americas—some of the heaviest cargo flows in the world. For information on the History of the Panama Canal, see Technical Notes Section TN - 1.

From the perspective of the U.S. economy, the Panama Canal is not only an alternative to West Coast routing of Asian trade. The Canal is a critical connection with Central and South American economies. For many commodities traded between the United States and these countries (particularly between ports along the western coasts of South and Central America and the U.S. East and Gulf Coasts), the Canal is the most economical shipping option, as alternative water routes are too long and costly.

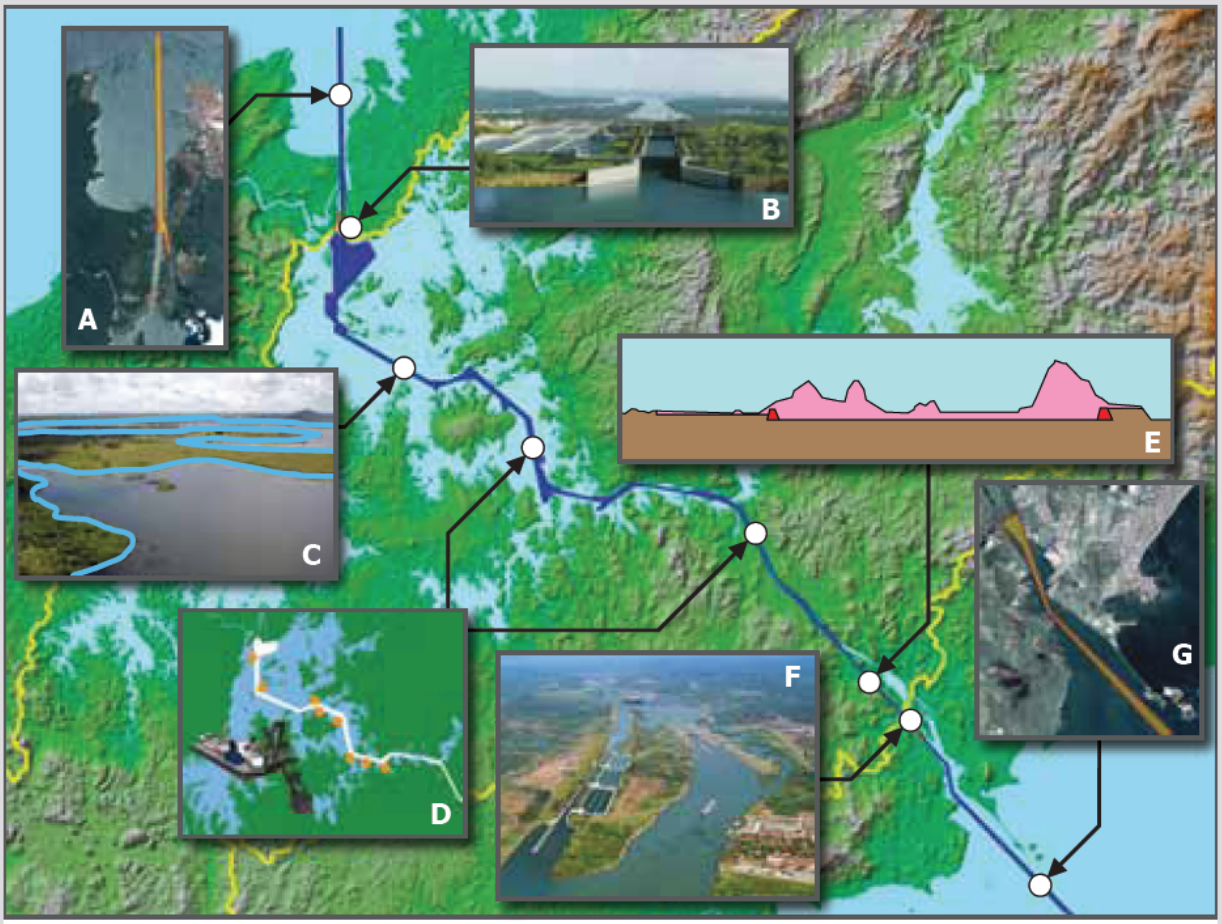
2.2 PANAMA CANAL EXPANSION PROGRAM

The objectives of the Panama Canal expansion program are to increase the capacity of the Canal to allow the transit of large vessels that are currently restricted by the dimensions of the existing Canal locks and to maximize the Canal's total possible volume of cargo and other traffic. The program will essentially create a third lane of traffic through the Canal that will allow the passage of increasingly prevalent Post-Panamax vessels. As depicted in Figure 1 below, the major components of the program include:

- Deepening and widening the Canal entrances;
- Construction of two new Post-Panamax complexes, one at the Atlantic (north) and another at the Pacific (south) ends of the Canal;
- Excavation of a new north access channel for the Pacific Post-Panamax locks;
- Elevation of Gatun Lake's maximum operation level; and
- Deepening and widening of the Gatun Lake and Culebra Cut navigational channels.

[5] Panama Canal Authority. *2009 Annual Report*. Available at: https://www.pancanal.com/eng/general/reporte-anual/2009/pdf/InformePDFingles.pdf.

Figure 1. **KEY ELEMENTS OF CANAL EXPANSION PROGRAM**



A) Atlantic entrance deepening and widening
B) Atlantic Post-Panamax locks
C) Increasing Gatun Lake's maximum operating level
D) Deepening and widening of Gatun Lake and Culebra Cut navigational channels
E) Post-Panamax locks Pacific access channel
F) Pacific Post-Panamax locks
G) Pacific entrance deepening and widening

Source: Panama Canal Authority, Canal Expansion Program – Components Report, p. 2, 2011. Available at: http://www.pancanal.com/eng/expansion/rpts/components/2011.pdf

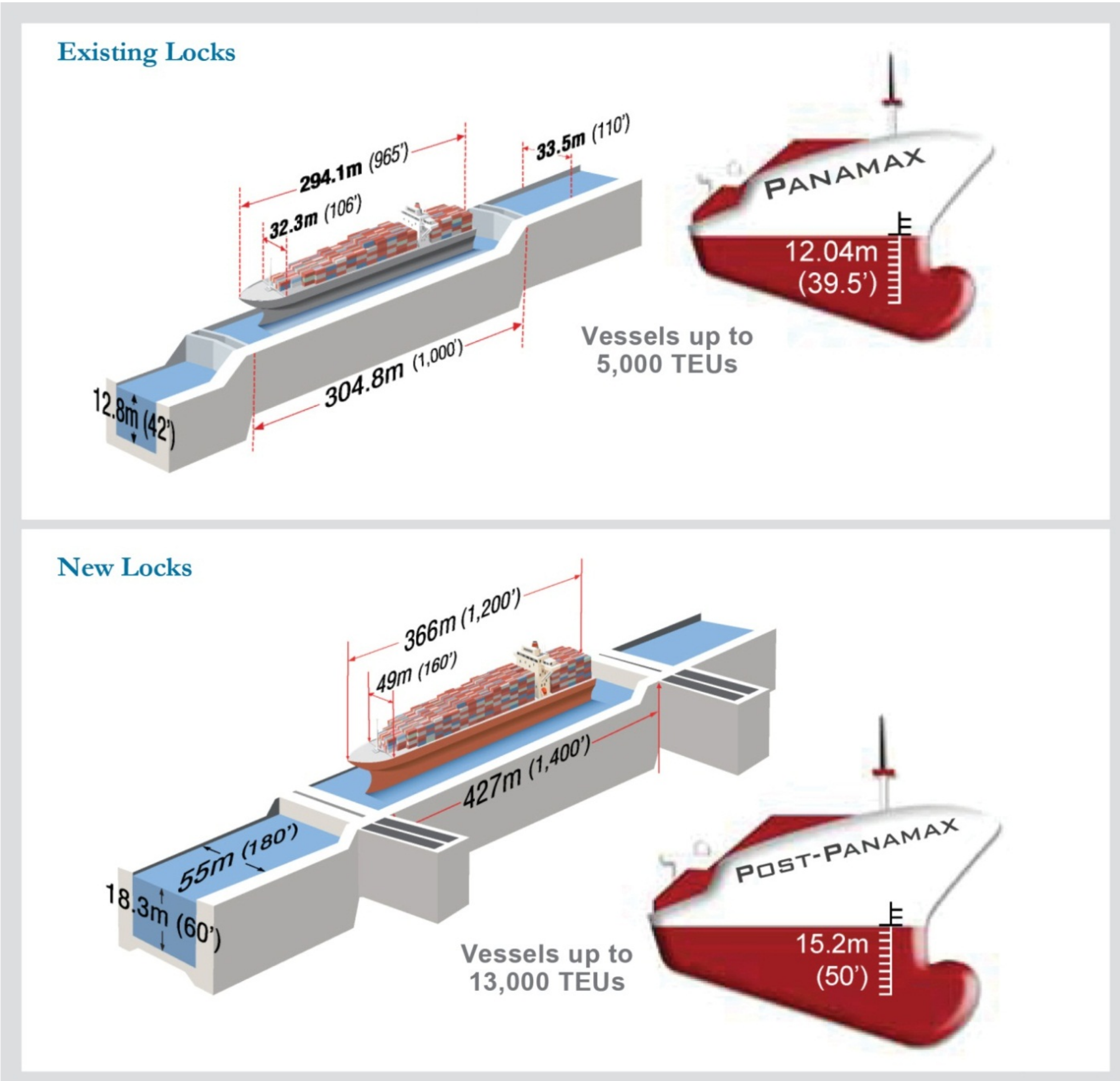
2.2.1 NEW LOCKS

Since the Panama Canal is not a sea-level passage, it depends on two traffic lanes and sets of locks to move vessels through different elevation levels over the entire transit. The existing locks are each 1,000 feet long, 110 feet wide and 42 feet deep, limiting transit to vessels with a nominal carrying capacity of up to approximately 5,000 TEUs or 85,000 deadweight tons (dwt) of capacity (carrying up to 62,000 metric tons of bulk cargo at a 40-foot draft). These locks are currently unable to accommodate vessels in the Post-Panamax size range, which can reach (or exceed) 1,200 feet in length, 160 feet wide, and 50 feet in draft.

The expansion program includes a third traffic lane and set of locks, one on the Atlantic end of the Canal, to the east of the existing Gatun Locks, and the other at the Pacific end, southwest of the existing Miraflores Locks. These new locks (see Figure 2) are 1,400 feet long, 180 feet wide, and 60 feet deep, and will accommodate vessels with a nominal carrying capacity of up to 13,000 TEUs or 180,000 dwt (carrying up to 140,000 metric tons of bulk cargo) at a 50-foot draft.

The new locks will have three consecutive chambers, which act as steps to move vessels from sea level to the level of Gatun Lake and back down again. Each chamber will have three lateral water reutilization basins, filled and emptied by gravity rather than by pumps.

Figure 2. **LOCK CONFIGURATIONS FOR EXISTING AND EXPANDED CANAL**



Source: Panama Canal Authority, Canal Expansion Program – Components Report, p. 6, April 2012. Available at: http://www.pancanal.com/eng/expansion/rpts/components/2012.pdf

2.2.2 NAVIGATION CHANNELS

The expansion will also include the excavation of new navigational channels to connect the new locks with the existing channels (see Figure 3). An access channel is being excavated to link the new Atlantic locks to the ocean entrance. On the Pacific side, two new channels are being constructed on either side of the locks. The northern access channel will connect the new lock with the Culebra Cut, while the southern access channel will lead into the Pacific Ocean.

The expansion program also includes deepening the Culebra Cut and Gatun Lake navigation channels by four feet. This will allow for cross-navigation (two-directional, simultaneous vessel transits) in the lake. Additionally, the Canal's sea entrances will be widened and deepened—allowing Post-Panamax vessels to navigate the Canal and permitting two-way passage of vessels.

Figure 3. **LOCATIONS OF THIRD SET OF LOCKS IN THE PANAMA CANAL**

Location of the New Atlantic Locks

Location of the New Pacific Locks

Source: Panama Canal Authority, May 2012

2.2.3 OPERATIONAL LEVEL OF GATUN LAKE

To support additional water use for the new locks without affecting the supply of water for human use from the Canal lakes, the maximum operational level of Gatun Lake will be raised by 1.5 feet—from 87.5 to 89 feet. This effort involves altering operational structures on the lake's banks: specifically, the south end of the Gatun locks, the northern segment of the Pedro Miguel locks, the Gatun spillway and some small-vessel piers.

2.2.4 EXPANSION STATUS

Since construction began in 2008, the $5.25 billion Panama Canal expansion program has generally met its budget and schedule milestones. The construction of the new set of locks, widening and deepening of new and existing channels, dredging and excavation efforts and water-supply improvements are all well underway. Quality control and labor issues were reported during 2012, which could cause time delays and cost overruns. In response, the contractor, Grupo Unidos por el Canal (GUPC), has accelerated the work to try to meet the project deadline.[6] Up-to-date information on the Panama Canal expansion status can be found at the PCA website: http://www.pancanal.com/. The scheduled opening date for commercial transits is currently 2015.[7]

2.3 EFFECTS OF PANAMA CANAL EXPANSION

Because the expansion of the Panama Canal will double capacity (in terms of total cargo volume) and allow the passage of much larger ships than those currently able to transit the Canal, these changes could alter international trade flows and change the demands on transportation networks, service and operations.

2.3.1 PANAMA CANAL CAPACITY

Measuring Panama Canal capacity is not a precise science; capacity can vary with weather conditions, operating conditions and the size distribution of transiting vessels. Capacity has been increased in the past by improving various physical components of the Canal, modifying labor practices, developing a reservation system, and changing navigational rules along Canal segments.

The PCA measures volume across its various market segments using the Panama Canal Universal Measurement System (PCUMS). A PCUMS ton is equivalent to approximately 100 cubic feet of cargo space (or twenty-foot long container [TEU] is equivalent to 13 PCUMS tons). Every commercial ship has a unique PCUMS value that reflects the ship's cargo-carrying capacity and this metric is used to calculate transit tolls. Based on this volumetric measure, the Canal's current annual capacity has been estimated to be over 300 million PCUMS tons.

Since 2001, the use of the Canal has increased by one-third based on this measure (see Figure 4). By 2007, the Canal was approaching its estimated maximum capacity, even after implementing service improvements and modernization projects such as incorporating new tie-up stations and gradually eliminating nighttime restrictions at the locks. During and after the 2007-2009 recession, the Panama Canal experienced a decrease in traffic tied to an overall decrease in global trade volumes, which lasted through 2010. In 2011, however, Panama Canal cargo volume increased to 322 million PCUMS tons—a level comparable to its highest pre-recession volumes.

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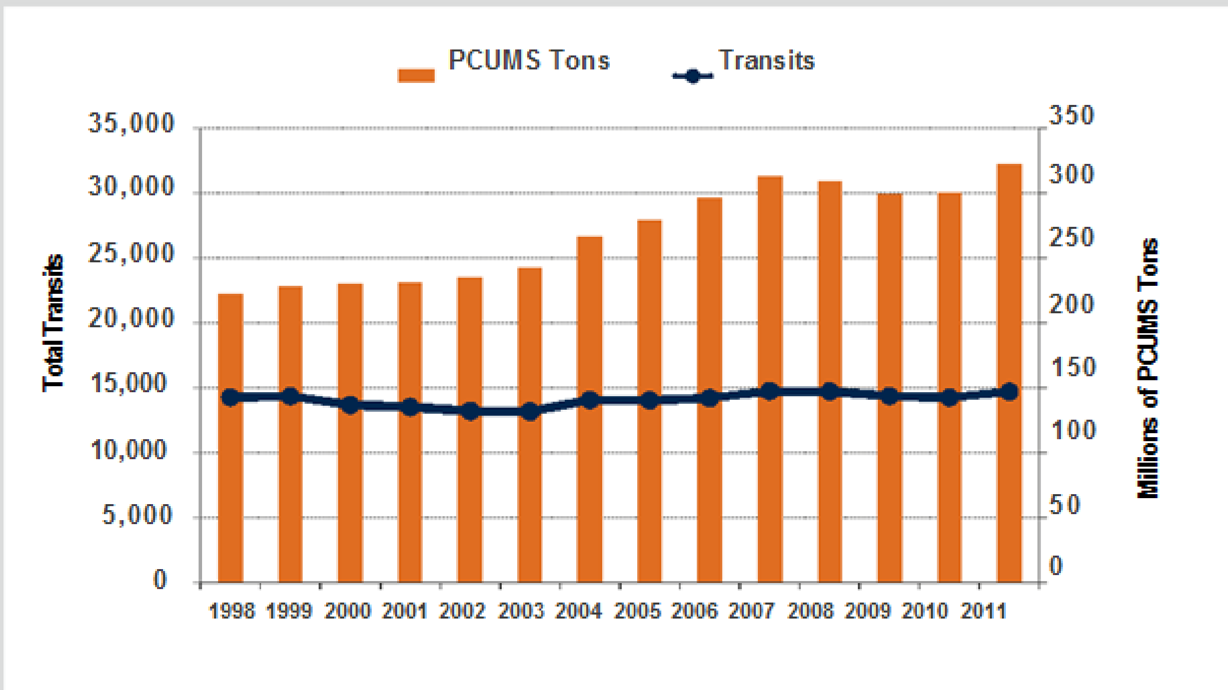
[6] The Bulletin Panama. *Construction of Panama Canal Locks Seven Months Behind*. April 2, 2012. Available at: http://thebulletinpanama.com/construction-of-panama-canal-locks-seven-months-behind.

[7] Plume, J. "Panama Canal Authority Confirms 6-Month Delay". *Breakbulk News*. July 2, 2012. Available at: http://www.breakbulk.com/breakbulk-news/industry-sector/ports-and-terminals/panama-canal-authority-confirms-6-month-delay/.

Figure 4. **CANAL UTILIZATION 1998 TO 2011**[8]



Source: Panama Canal Authority, May 2012

The expansion is expected to double the Canal's maximum cargo-carrying capacity in terms of PCUMS tons.

Panama Canal Reservation System

The Panama Canal reservation system was developed in the mid-1980s as a way of managing traffic through premium pricing for higher-value cargoes such as containerized goods. It allows customers with reservations to have a high level of certainty of transiting the Canal within an 18-hour window. The cost of a reservation is paid in advance, in addition to the transit toll, and is assessed on a graduated scale by vessel size. Based on historical toll revenue contributions and transits, a customer ranking system has been developed that is used to prioritize booking requests.

2.3.2 LARGER SHIPS

The two principal effects of larger ships transiting the expanded Panama Canal will be 1) a reduction in gross transportation costs and 2) changes in ship operations and transportation service designs.

[8] The information presented in this graph is based on the Panama Canal Authority fiscal calendar, which begins October 1 of each year.

Lower Transportation Costs

The savings realized by ocean carriers depends on many factors, including vessel operation patterns, Panama Canal tolls, and port and terminal fees associated with servicing larger vessels. Per unit of cargo costs for shipping generally decrease as the size of a vessel increases. This relationship is expected to be true for container ships used to move goods from Northeast Asia to the U.S. East and Gulf Coasts, as well as for other types of vessels transiting the Panama Canal. The current maximum size for container ships will nearly triple from a nominal carrying capacity of 5,000 TEUs to 13,000 TEUs (see Figure 2). The resulting scale economies are expected to reduce, as vessels sizes increase over time, the average operating costs for transporting containers from Northeast Asia to the U.S. East Coast. As will be discussed in Chapter 5, beneficial cargo owners will realize only a portion of these savings—the share not retained by transportation service providers.

Capital Investments and Operational Changes

The introduction of larger ships is bringing about a number of capital investment and operational changes by U.S. ports, vessel operators, and intermodal terminals. These include purchases of new equipment and facilities, operational changes at ports and intermodal facilities to handle larger cargo volumes (e.g., port and inland transportation peak system capacity issues), and potential alteration of transshipment patterns in ocean shipping.

2.3.3 IMPACTS ON PORT AND TERMINAL OPERATIONS

As larger ships are gradually introduced into service, they will make greater demands on container terminals. In order to achieve the cost savings possible with larger ships, time spent in port must be carefully limited; therefore, terminal facilities will need to be able to handle more containers per vessel per hour. Because the cost of delaying a ship and its cargoes increases with vessel size, carriers will desire more efficient container-handling as ship sizes grow in order to avoid excessively long port stays.

Two container ships discharging at port

Photo courtesy: A.P. Moller – Maersk Group

Fleets are changing and vessel sizes are increasing to take advantage of lower operating costs. Vessel deployments will change to reflect an ever-evolving fleet mix. Historically, as ship sizes increased, vessels in most trade lanes would call at fewer ports on a given coast or in a given region. This allows ship lines to minimize the costs and delays of coming into and out of multiple ports and to avoid excessive delays to the cargoes/containers that would be discharged last. As a consequence, the volume of containers to be handled per ship call is likely to rise at least in proportion to the increase in ship size. Containers moving on a particular route will, if anything, be more concentrated at a limited number of ports. Of course, different carriers will call at different ports as part of a vessel string.[9]

Impact on Call Size and Call Duration

Current Panamax ships of 4,500-5,000 TEU capacity deployed in the Far East – U.S. East Coast trade generally carry about 2,600-2,900 containers (also called "boxes" or "loads"), reflecting the mix of twenty-foot and forty-foot containers in that trade. These containers are discharged at three or four ports, but typically with as much as 40-45 percent of the cargo discharged at the first inbound port. Assuming the ship is loaded back with an equal number of full or empty containers, about 2,000 or more container moves may be required for the first inbound call.[10] Handling an average of 25 moves per hour per crane, four cranes would need to work continuously for 20 hours each to load and discharge those 2,000 or more containers.[11]

With an intermediate-sized Post-Panamax ship of 8,000-9,000 TEU capacity, the number of containers on board roughly doubles and, because fewer ports are called, the number to be discharged at each port could more than double. Larger facilities with more and faster handling equipment could reduce the time required in port. Instead of four cranes handling about 100 containers per berth-hour, it will be desirable to have an increased number of faster and stronger cranes, so that 150 or 200 containers can be handled per berth-hour. The flow of containers between the berth and yard will also need to increase, which may be achieved through yard reconfiguration, yard handling equipment upgrades and/or process changes. For servicing 13,000 TEU vessels, the requirements for container handling will increase even more substantially. Each port has specific characteristics with regard to available land for container handling and storage, access to rail and highways, labor agreements, port fees, and other factors that impact cargo operations. Port and terminal capacity is discussed further in Chapter 3 of this report and a more comprehensive compilation of port and terminal statistics, throughput, and capacity will be provided in the second report of this study.

Another important consequence of the increasing ship sizes to keep in mind is that, until volume levels rise substantially, ports will likely see fewer—not more—ship calls, with each ship call accounting for a larger fraction of a port's traffic. For ports that have very large or numerous cargo terminals that already handle multiple ship services each day, the increasingly sharp peak demand periods will have only a limited impact, but smaller ports and cargo terminals could see a larger share of cargo arriving with a single ship call. This increase in discharge volume per ship call may create special demands for labor, storage capacity, handling equipment and other resources.

[9] A vessel string refers to a group, or series, of cargo ships engaged simultaneously in transport along an established service route. Vessel strings are often modified by increasing or decreasing the number of vessels engaged along a route to provide suitable frequency of service calls at various ports along the route.

[10] Assumes 20-, 40-, or 45-foot ISO intermodal container.

[11] Based on analysis provided by Mercator International.

Meeting the Demands of Larger Vessels at Port Terminals

To deliver high performance to larger ships, changes are needed across all aspects of terminal operations. Many of these improvements are already being made at certain terminals as they expand capacity to be ready for larger ships in 2015.

More and Larger Ship-to-Shore Cranes. The expanded Panama Canal will accommodate Post-Panamax size ships with up to 19 container rows stowed side by side on deck, compared to 12 to 13 container rows wide for Panamax vessels.[12] Post-Panamax vessels also are capable of stacking containers higher than the smaller, Panamax vessels. Therefore, ships of this size require cranes that not only have a longer reach, but also have higher vertical clearances needed to adequately service the vessels. In addition to wider and higher container reach, terminals must also be prepared to work the longer length of Post-Panamax vessels. Whereas the Panamax size vessels might be worked with four or five cranes, the larger ships arriving via the expanded Panama Canal after 2015 will routinely need to be worked with six or more cranes.

Expanded Container Storage. The more than doubling of ship capacity implies that the volume of containers discharged from a single ship may also more than double. Because discharged containers are typically stored from two days to one week (or longer) at the terminal, terminals may need to be larger in terms of container storage capacity. Only a large terminal, with a container yard area of at least 100 acres, can effectively handle a few thousand containers from a single ship and hold a similar number ready for load back. To accommodate larger discharge volumes per vessel call, some terminals may need to modify their container stacking arrangements to achieve higher-density storage, which could have an impact on how quickly cargo is available for delivery and also affect handling costs.

Gate-Processing Capability. With more cargo arriving and departing on a single ship, the demand for truck pickup and delivery on a particular day will also increase. Terminals will need to increase the number of trucks they can efficiently handle each hour or each day by expanding physical gate facilities, speeding up processing through existing facilities (for example, with improved information technology and automation) and/or increasing their hours of operations. If not carefully managed, peaks in truck traffic may contribute to excessive congestion, emissions or other adverse impacts in areas around the port.

Trucks carrying containers at the Port of Los Angeles

Photo courtesy: Port of Los Angeles

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[12] Estimate based on ship design principles and the advertised width of the new locks. Note that container ships that exceed 13,000 TEU and which are too large for the Panama Canal expansion can have widths exceeding 23 container rows.

Operational Changes at Rail Intermodal Terminals

In some cases, rail intermodal terminals may face challenges like those faced by marine terminals. If East Coast ports are successful at increasing their shares of U.S. inland markets for Northeast Asian container imports, then volumes for intermodal rail terminals serving those ports will likely increase. Because Post-Panamax container ships are already arriving at some U.S. East Coast ports from Asia via the Suez Canal, an increase in Post-Panamax vessels arriving via the Panama Canal could place increased demand on the rail intermodal system in the eastern United States for routes between East Coast ports and inland destinations. However, if the effect on U.S. East Coast ports primarily involves the movement of goods to or from their local markets, intermodal volumes of Northeast Asian containers arriving at the West Coast and moving to inland locations may not be significantly affected. Although routing patterns might change, the total local truck volumes in local markets would likely remain unchanged, except for growth in trade volumes attributable to local demand.

Increased rail volumes per ship call would create sharper peaks in the demand profile increasing the potential delay for some intermodal cargo. Rail terminals may require more storage capacity to support larger volumes and higher demand peaks, and need more and higher-capacity container handling equipment to efficiently dispatch larger trains.

CHAPTER 3: GLOBAL AND U.S. TRANSPORTATION NETWORKS

This chapter begins with an overview of the global transportation network and how Panama Canal expansion will affect that network, particularly in the United States. This is followed by a more detailed review of U.S. transportation system components and financing issues.

3.1 GLOBAL TRANSPORTATION NETWORK

The modern global transportation network has become a highly integrated network, enabling a world marketplace where goods, services, and labor can be reallocated with remarkable speed and efficiency. A range of innovations during the past century, including the promotion of free trade and technological advances in the transportation industry have significantly contributed to globalization of the world's economy.

During the post-World War II era, the global reduction of tariffs and other barriers to trade allowed countries to specialize in industries in which they have a comparative advantage and to sell to more markets, giving rise to the international cargo flows that would ultimately shape the global transportation network.

Cellular container vessel sailing in open waters

Photo credit: iStock

The containerization of goods beginning in the late 1950s and the concept of bulk shipping have greatly lowered the costs of transportation, making high-volume trade between distant countries increasingly economically feasible. The modern global transportation system can be seen as a network of trade routes connecting disparate locations (or nodes). (See Technical Notes Section TN - 1). Currently, of the United States' top 10 trading partners, Asian countries dominate U.S. waterborne trading activity with three Northeast Asian nations accounting for a collective share of more than 30 percent by value of total U.S. waterborne trade in 2011 (see Table 1). In addition to Northeast Asian trading partners, the three Latin American countries shown in Table 1 comprise ten percent and the three European countries make up nine percent of the total U.S. waterborne imports

Table 1. **TOP U.S. TRADING PARTNERS IN WATERBORNE GOODS (2011 DATA)**

Country	Total Trade ($ billions)	% of Total Trade	Exports ($ billions)	% of Exports	Imports ($ billions)	% of Imports
China	$341.6	19.7%	$69.9	12.2%	$271.7	23.4%
Japan	$127.0	7.3%	$35.0	6.1%	$92.1	7.9%
Mexico	$76.0	4.4%	$27.2	4.8%	$48.8	4.2%
Germany	$75.8	4.4%	$19.5	3.4%	$56.3	4.9%
Republic Of Korea	$62.2	3.6%	$25.0	4.4%	$37.2	3.2%
Saudi Arabia	$58.2	3.4%	$11.0	1.9%	$47.2	4.1%
Brazil	$54.0	3.1%	$26.1	4.6%	$27.8	2.4%
Venezuela	$52.2	3.0%	$9.0	1.6%	$43.2	3.7%
United Kingdom	$39.7	2.3%	$16.2	2.8%	$23.6	2.0%
Russia	$38.3	2.2%	$5.8	1.0%	$32.6	2.8%
Total, Top 10 Countries	$925.1	53.5%	$244.6	42.9%	$680.5	58.7%
Total all countries	$1,729.9	100.0%	$570.7	100.0%	$1,159.2	100.0%

Source: WISERTrade, Foreign Trade Database, Reported in July 2012.

Note: Trade with Canada and most trade with Mexico is not reflected in the table as these trades are dominated by land-based transportation modes.

3.1.1 U.S. TRANSPORTATION NETWORK

The U.S. freight transportation network includes port facilities, the national highway system, freight railroads, coastal and inland waterways, cargo airports, and various intermodal transfer facilities.

Maritime ports and airports serve as major gateways (nodes on a network that serve as entrances to other networks) for goods (other than those that move by land from Mexico and Canada) to enter and exit the national transportation network; railroads, interstate highways, and inland waterways provide long-distance nationwide transport within the United States; and highways, roads, and some waterways provide short-distance transport.

Today, a typical U.S. cargo import will have traveled thousands of miles from its origin, switched transportation modes at least three times, and been temporarily stored at a warehouse, distribution center or both before arriving at a retail shop or an industrial facility. A typical export item will go through a similarly complex logistics chain.

3.2 OCEAN TRANSPORTATION

Modern maritime vessels are built to carry the largest practical amount of cargo per voyage to capitalize on economies of scale, often resulting in the unit cost of maritime cargo transportation being lower than that of other modes, such as rail and highways. There are six major types of commercial cargo ships:

- Cellular container ships

- Dry bulk ships (for commodities such as grains, ores, fertilizers, scrap metal and cement)
- Tanker ships (for liquid bulk cargoes such as crude oil, petroleum products and liquid chemicals)
- Roll-on/roll-off ships (for cars, trucks, cargo in trailers, other transportation equipment and certain types of machinery)
- Reefer break-bulk ships (for commodities requiring refrigeration, such as fruits and frozen meats)
- General cargo ships (for commodities requiring special crane equipment for loading and unloading such as: pulp and paper products, bagged grain products, steel products, and certain machinery)

3.2.1 CELLULAR CONTAINER SHIPS

Cellular container ships transport cargoes that have been unitized into standardized steel boxes—usually eight feet wide, 8.5 to 9.5 feet high and 20, 40, or 45 feet long—known as intermodal containers. A standard unit of measure is the twenty-foot equivalent unit, or TEU, which represents one such twenty-foot long container (a forty-foot long container is an FEU or two TEUs). Cellular container vessels are designed to transport containers above and below the upper deck with cellular guides permanently affixed in their holds.

Container ships almost always operate on an advertised schedule between specified ports or on a specified route. These carrier specific scheduled port calls are often referred to as liner services. Since the Ocean Shipping Reform Act of 1998, most shipping rates are set in service contracts negotiated between the carriers and the beneficial cargo owner or freight forwarder (collectively known as “shippers”). Carriers have a published rate schedule based on commodity, but shippers are rarely charged the full tariff rate as they opt to negotiate a service contract if they have any significant volume.

In the mid-1960s, liner services for U.S. East Coast exports to and imports from Europe began to use containers and dedicated container-carrying ships, as pioneered by Sea-Land Service. Sea-Land also introduced the first transpacific container shipping service to and from California in 1967. The logistical, security, and economic advantages of the ocean container over the traditional break-bulk method of shipping manufactured goods on pallets were so great that, by the early 1970s, the liner shipping industries between the United States and Europe and the United States and Asia were dominated by dedicated (“fully cellular”) container ships. By the mid-1970s, containerization had also become the prevalent mode of shipping cargoes between the United States and Australia/New Zealand, the Mediterranean, the Arabian Gulf and Central America.

Since then, a wide variety of cargo types have been shipped to and from the United States, primarily in intermodal containers. For example, in the 1980s, certain imported agricultural imports—in particular coffee, tea and rubber—were largely converted from the break-bulk, palletized mode of shipping to containers, as were selected lumber products for export. Over the last decade, U.S. exporters of specialty grain products (such as lentils, peas and certain grades of grain) have begun to export their products in intermodal containers. The advantage of intermodal containers for these products is that they facilitate smaller shipments being delivered directly to customers. Other advantages of containerization include reduced handling costs, protection from unobserved tampering or contamination, and the ability to identify its provenance, if organic or not derived from genetically modified organisms (GMO).

Size of Container Vessels

Currently deployed container ships range in size/capacity from less than 1,000 TEUs to over 15,550 TEUs, as listed in Table 2. Vessels on the smaller end of that range, generally the Feedermax and Handymax vessels, tend to be used on short-haul—or "feeder"—operations, carrying coastal traffic to and from the transshipment ports that connect to the long-haul deep-sea routes served by larger vessels, or for direct short sea services.

The maximum capacity of ships that can currently transit the Panama Canal is about 5,000 TEUs and the size class ranging from 4,000 to 5,000 TEUs is designated as "Panamax." Over the past 20 years, the average size of container ships has increased significantly, with a growing number of "Post-Panamax" ships being built to realize economies of scale on routes that do not include the Panama Canal—in particular, the Far East–Europe and Far East–U.S. West Coast trades. The combination of the rise of Post-Panamax ships and the potential economic advantages of even larger container vessels ("Suezmax") coupled with U.S. land bridge rail operations have been major factors behind the Panama Canal expansion program.[13]

Table 2. **SIZE CATEGORIES OF SPECIALIZED CONTAINER VESSELS (2011 DATA)**

Vessel Category	Vessel TEU Capacity	World Cellular Fleet Size (Number of Vessels)	Percent of Fleet	Percent World TEU Capacity
Feedermax	<1,000	1,035	21%	4%
Handymax	1,000-1,999	1,294	26%	11%
Sub-Panamax	2,000-3,999	1,037	21%	18%
Panamax	4,000-5,000	641	13%	21%
Post-Panamax or New Panamax[A]	5,001 – 13,000	862	17%	39%
Suezmax (Ultra-Large Container Ships [ULCS])	13,001+ [B]	69	2%	6%

[A] Depending on ship design, some ships at the upper end of this category may be able to transit the Panama Canal, while others of the same nominal capacity may not.

[B] The TEU Capacity of a Suezmax vessel can reach up to 18,000 TEUs. Maersk Line is scheduled to take delivery of its first Triple E 18,000 TEU container ship in June 2013, the first of 20 such vessels that will be delivered over the period from 2013-2015.

Sources: Alphaliner, January 2012: Alphaliner Cellular Fleet Forecast, June 2012; U.S. Army Corps of Engineers, Manual for Deep Draft Navigation, April 2010; Mercator International, Containerisation International, June 2012

[13] Note that the terminology for these ships continues to evolve. Post-Panamax is sometimes referred to as "New Panamax" with larger vessels sizes being "Suezmax" (referring to the maximum size of vessels that can pass through the Suez Canal). Table 2 reflects the size category definitions used in this report.

Growth in Container Fleet Size

Over the last decade, container ships have been the largest and fastest-growing market segment for the Panama Canal. In Fiscal Year (FY) 2011, there were 3,253 container vessel transits of the Canal, representing 11.5 million TEUs in carrying capacity and 5.3 million TEUs actually transported. Transits doubled from 1998 and increased 7.3 percent from 2010 levels, while PCUMS tonnage and TEU capacity both increased 8.7 percent in 2011.[14] Appendix 1 includes transit statistics for major vessel type categories for 1998 to 2011.[15]

Based on current orders for new ships, the worldwide fleet of container ships is projected to grow in TEU capacity by 30 percent from the end of 2011 to the end of 2015, not counting any scrapping of older ships. The portion of the worldwide fleet (as measured in TEU capacity) that cannot transit the Canal's existing locks will therefore increase from 45 percent to 50 percent, with the largest size class generating nearly half of the cumulative TEU growth of the fleet. Figure 5 shows the current fleet by ship size as of the end of 2011 (blue bars), as well as the fleet by ship size projected for the end of 2015 (orange bars represent the net increase in ships in each size category).

With Maersk Line, a Danish carrier, now building twenty 18,000-TEU ("Triple-E"-class) ships, the growth in the number of new ships of 10,000 TEUs and greater is bound to continue beyond 2015, as Maersk's global competitors will order larger Post-Panamax and Suezmax ships to maintain unit-cost parity. It is noteworthy that ships with capacities significantly larger than 13,000 TEUs will not be able to transit the expanded Panama Canal.

About 93 percent of the 10,000+ TEU ships currently in operation are deployed in the Far East-Europe trade lanes because they have the requisite volume scale, voyage length, channel depths, and configuration of base ports and intermediate ports to support the use of such vessels. Nearly 55 percent of the existing 7,500-9,999 TEU ships in operation are also assigned to the Far East-Europe trade, while another 22 percent are serving the Far East-U.S. West Coast markets; the remaining 23 percent are deployed mainly in the Far East-Suez Canal-U.S. East Coast corridor and the Far East-West Coast of South America trade.[16]

In summary, the composition of the global container ship fleet is changing rapidly, with an emphasis on larger, more fuel-efficient vessels (see Figure 5). Expansion of the Panama Canal was undertaken based, in part, to respond to trends toward the use of larger vessels. In turn, the deployment of larger container vessels on trade routes that require transits of the Panama Canal will have an important influence on U.S. ports. While the new very large container vessels (10,000 to 18,000 TEU) will be largely engaged in Asia-Europe trade via the Suez Canal or the trans-Pacific routes (including in the near-term as Asia-Europe trade has weakened under current economic conditions), there is a likelihood that many of these larger vessels (up to 18,000 TEU)

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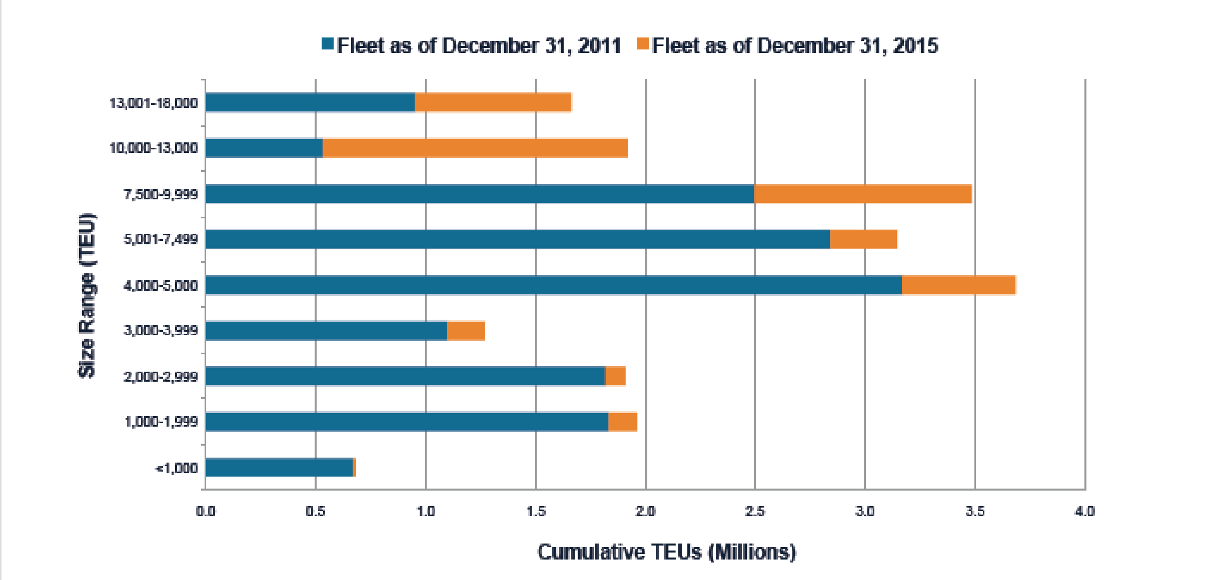
[14] The Panama Canal Authority's Fiscal Year begins in October.

[15] Panama Canal Authority, Transit Statistics, Fiscal Year 2011, Available at: http://www.pancanal.com/eng/op/transit-stats/index.html.

[16] Containerisation International On-Line Database, Mercator International analysis, June 2012.

will eventually engage in direct U.S. East Coast trade via the Suez Canal or (for vessels up to 13,000 TEU) the expanded Panama Canal.

Figure 5. SIZE AND USE OF CONTAINER SHIPS



Source: Alphaliner Cellular Fleet Forecast, June 2012

3.2.2 DRY BULK SHIPS

Dry Bulk vessel being loaded with coal

Photo credit: iStock

Dry bulk vessels have cavernous holds below a single deck. They carry a variety of commodities such as minerals, metals and ores, grain, coal, and fertilizers.

Bulk vessels most often operate on a charter basis, where ship owners and cargo shippers negotiate single voyages, or on longer-term agreements based on time or tonnage. Due to the relatively low-value nature of the cargo, dry bulk shippers put a premium on economy and flexibility. Delivery of such cargoes is not as time-sensitive as delivery of containers or vehicles and routing decisions (e.g., whether to transit the Panama Canal or travel around Cape Horn) mostly depend on the cost of the voyage.

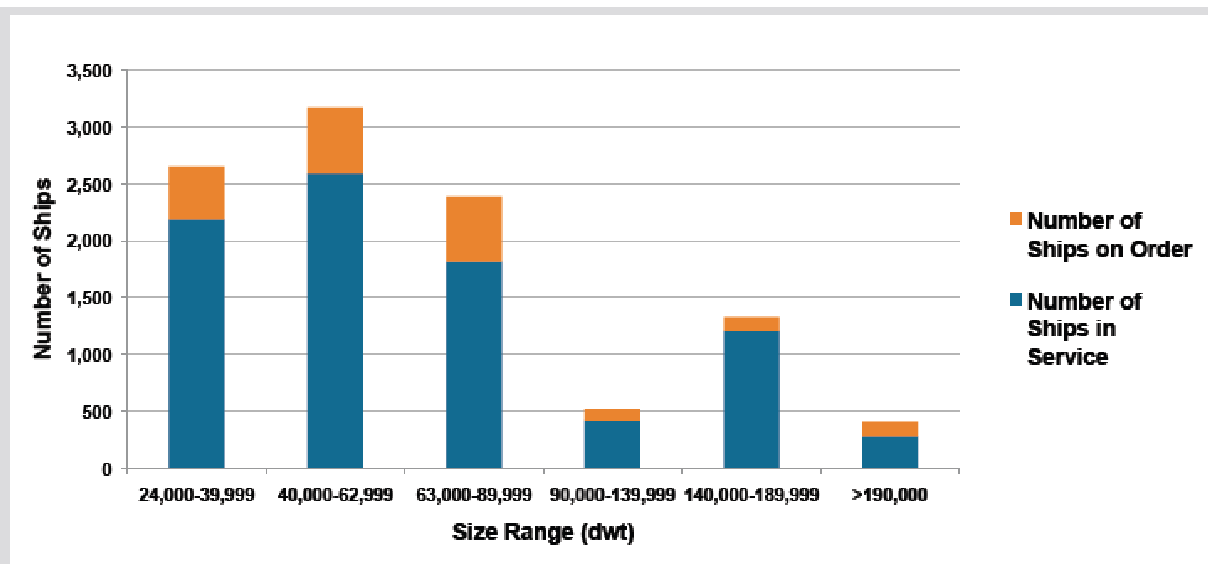
Table 3. DRY BULK VESSEL CATEGORIES

Vessel Category	Size Range (DWT)	Constrained by Existing Canal Dimensions	Constrained by Expanded Canal Dimensions
Handysize	24,000-39,999		
Handymax/Supramax	40,000-62,999		
Panamax[A]	63,000-89,999	✓<some vessels>	
Small Capes[A]	90,000-139,999	✓	✓<some vessels>
Capesize	140,000-189,000	✓	✓<some vessels>
Very Large Ore Carriers (VLOC)	190,000 and above	✓	✓

[A] Depending on ship design, some ships at the upper end of these categories may be able to transit the Panama Canal or expanded Canal, while others of the same capacity may not.

Source: Mercator International, 2012

Figure 6. DRY BULK SHIPS IN SERVICE AND ON ORDER



Source: Alphabulk Monthly Monitor, July 2012

The average size of dry bulk vessels, like that of container ships, has been increasing over the years. Over 1,900 vessels in the worldwide dry bulk carrier fleet are unable to transit the Canal's existing locks while fully laden. Another 350 such vessels are on order for delivery as of July 2012. These include all Very Large Ore Carriers (VLOC), Capesize vessels, and Small Cape ships under construction. In 2011, 3,285 dry bulk vessels transited the Canal, a slight decline from 1998 but an increase of 7.7 percent from 2010. Panamax vessels represented over two-thirds of dry bulk vessel transits in 2011.

Almost all of the VLOCs are used in the iron-ore trades from Brazil and Australia to China and other Asian steel-producing countries. Similarly, almost all of the Capesize vessels are chartered to support the largest coal trades, as well as selected iron-ore movements. While a number of Small Cape and Capesize vessels are too large to transit the Canal now, most Small Capes and some Capesize vessels will be able to transit the expanded Canal depending on their capacity utilization (loading). However, those vessels might not be able to sail at full capacity if the weight of the cargo causes their draft to exceed the depth of the Canal. Given the dimensions of the new lock system and depth of channel when transiting in fresh water between the new locks, it is likely that Capesize ships of up to 180,000 dwt may be able to use the expanded Canal (depending on dimensions and with loading restrictions in some cases); the larger vessels in this size category will still be too big. Potential U.S. cargoes for Small Cape and Capesize ships could include grain, fertilizers, and coal from Gulf Coast ports bound for Asia.

3.2.3 ROLL-ON/ROLL-OFF SHIPS

Automobiles and other vehicles were historically carried first on cargo liners and later aboard bulk vessels with fitted car decks. As vehicle trades grew in the 1970s, specialized vehicle-carrying vessels were developed to meet the demand for more efficient transportation. These vessels have from four to ten decks, high-speed engines, internal decks and ramps designed to minimize damage to the cargo during loading and unloading, and external ramps allowing automobiles, trucks and other wheeled equipment to be driven on and off.

There are three types of roll-on/roll-off (Ro-Ro) vessels: Pure Car Carriers (PCCs), Pure Car and Truck Carriers (PCTCs), and multi-purpose Ro-Ro carriers. PCCs and PCTCs are operated in trade lanes in which newly built automobiles and trucks are exported in sufficient volumes to support these dedicated ships. PCTCs have higher decks than PCCs and, in recent years, have become increasingly prevalent. Multi-purpose Ro-Ro carriers are used in trade lanes that regularly ship heavy transport equipment and wheeled farming and mining equipment.

Due to the high value of their cargo, vehicle carriers are operated with an emphasis on transit speed and schedule reliability.[17] In 2011, there were more than 633 vehicle carrier transits of the Panama Canal, an increase of 16 percent from 1998 and up 4.3 percent from 2010. Most vehicles carried through the Canal are Asian-manufactured cars bound for U.S. East Coast markets or European-manufactured cars destined for U.S. West Coast markets. While there is a trend towards the use of larger PCC/PCTC ships, the increase in average Ro-Ro vessel size has not been as pronounced as it has been for cellular container ships and all can currently be accommodated by the Panama Canal. Accordingly, Canal expansion will not affect the size of transiting Ro-Ro ships, at least for the foreseeable future.

Ro-Ro vessel moving into port with tugs

Photo credit: Dreamstime

[17] Several Ro-Ro carriers operate selected vessels (especially PCC and PCTC ships) in certain high-volume trade lanes on fixed schedules.

3.2.4 LIQUID BULK VESSELS

Transportation of bulk liquids such as crude oil, oil products, chemicals, petrochemicals, and LNG generally requires tankers or LNG carriers. Tankers are single-deck vessels designed to carry liquid cargo in sealed, baffled and vented-type holds or tanks. Tankers include the largest ships in the global fleet, with the largest size category—the Ultra-Large Crude Carriers (ULCCs)—being over 320,000 dwt (see Table 4). LNG carriers are specialized liquid bulk vessels that provide the necessary refrigeration and hold pressure for the transportation of liquefied gases. LNG carriers are almost always purpose-built for specific trade routes and are part of a vertically-consolidated production and transportation operation.

Tanker moving out of port with tugs

Photo credit: Dreamstime

Table 4. **LIQUID BULK VESSEL CATEGORIES**

Vessel Category	Size Range (DWT)	Constrained by Existing Canal Dimensions	Constrained by Expanded Canal Dimensions
Product Tanker	10,000-60,000		
Panamax	60,000-79,999	✓ <some vessels>	
Aframax	80,000-119,999	✓	
Suezmax	120,000-199,999	✓	✓ <some vessels>
VLCC	200,000-319,999	✓	✓
ULCC	320,000 and above	✓	✓

Source: Mercator International, Panama Canal Expansion Study, June 2012

Most of the Canal's current liquid bulk traffic consists of crude oil and gasoline trade between the United States and South America and petrochemical trade between the U.S. Gulf Coast and Asia. In 2011, there were 2,322 transits of the Canal by liquid bulk vessels, just above the number of transits in 1998 and an increase of four percent from 2010.

LNG carrier sailing into port

Photo credit: Dreamstime

Due to the availability of direct deepwater routings from petroleum exporting regions, such as in the Middle East, to petroleum importers in Asia, Europe, and the United States, most tankers and LNG carriers in global service do not transit the Panama Canal. Moreover, even for trade routes for which the Panama Canal would make economic sense, the existing locks are too small for most tankers and LNG vessels. However, many of these vessels (including most of the LNG vessels and more than half of the world's existing tanker fleet) have dimensions that could be accommodated by the expanded Canal. Important to an emerging U.S. LNG export market, the PCA has estimated that 86 percent of the world's current LNG fleet will be able to pass through the expanded Canal, compared to only six percent now. This ability may facilitate LNG trade on specific routes, particularly from the U.S. Gulf to Northeast Asia, where demand for natural gas is large and market prices for natural gas are significantly higher than in the United States. Expansion of the Canal could also stimulate trade in petroleum products and petrochemicals using Aframax-sized vessels and partially-loaded Suezmax-sized vessels, especially between the U.S. Gulf and the West Coast of South America and from sources in the U.S. Gulf Coast and Venezuela to markets in Northeast Asia.[18] More about the developing U.S. energy export trade will be provided in the second report of this study.

3.2.5 REEFER BREAK-BULK CARGO CARRIERS

Cargoes that require refrigeration—generally, perishable products such as fruit, vegetables, meat, and seafood—are frequently transported on refrigerated break-bulk cargo vessels, also known as "reefers," that have 80 percent or more of their carrying capacity insulated or temperature-controlled. Since many fruit cargoes, such as bananas, come from countries with underdeveloped port structures, reefers are generally equipped with onboard cranes. These vessels tend to be small compared to container ships and bulk vessels.

Reefer vessel moving out to sea

Photo credit from Wiki: Clipper via WikiMedia

Although the cargo is often of relatively low-value, its perishable nature makes voyages somewhat time-sensitive. While reefers still dominate the refrigerated cargo trade, increasing shares of frozen foods and other perishable items are transported in refrigerated containers aboard container vessels equipped with special electrical outlets.

The majority of reefers that transit the Panama Canal carry fruit from Chile and Ecuador to Europe and the U.S. East Coast. During 2011 there were 1,479 reefer Canal transits, down a third from 1998 levels and a decrease from 1,718 in 2010. Existing and projected reefer ships are of sizes that can be easily accommodated within the existing dimensions of the Canal. Thus, the expansion of the Canal is unlikely to result, in its own right, in any increase in size of reefers transiting the Canal.

[18] Oxford Analytica. "International: Asia Continues to Drive Energy Trade". *OxResearch Daily Brief Service*. July 6, 2009. Available at: http://www.relooney.info/0_New_5402.pdf.

3.2.6 GENERAL CARGO

General cargo ships, also called break-bulk ships, are vessels equipped with gear to handle cargoes that are lifted to and from the vessel and are loose or palletized, but not containerized. Cargoes include steel products, logs, paper rolls, bulk materials and un-wheeled machinery. These vessels tend to operate in loosely scheduled or "tramp" services. General cargo ships can operate under different forms of contract, but most commonly have time-charter arrangements for specific trade routes.

Cargo vessel being loaded at port

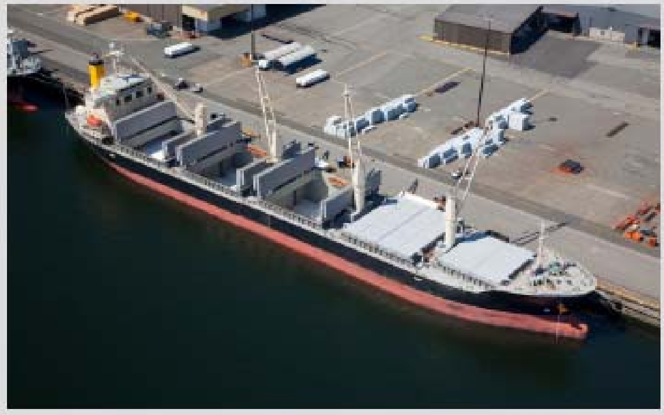


Photo credit: iStock

Older 'tweendecker' general cargo vessels are being replaced by multipurpose vessels that can carry containers in addition to general cargo. General cargo and multipurpose vessels can range in size up to 24,000 dwt, well within the dimensions of the existing Canal. Expansion of the Canal will not affect the size of vessels serving existing general cargo trades.

3.3 U.S. CONTAINER LINER SERVICES

The principal impacts of Panama Canal expansion are likely to occur in liner services of the container trades. This section provides more detail on how this critical segment of U.S. trade may be affected.

In 2011, approximately 17.1 million loaded TEUs were imported into the United States and about 11.7 million loaded TEUs were exported.[19] According to U.S. Census Bureau data, the value of containerized imports was $635.4 billion in 2011 and containerized export value was $249.0 billion. In addition, approximately 2.0 million loaded TEUs of cargoes moved in containers and trailers between the U.S. mainland and non-contiguous States and possessions of the United States (i.e., Hawaii, Alaska, Puerto Rico, Guam, and the U.S. Virgin Islands). Altogether, 30.5 million loaded TEUs containing U.S. imports, exports, or domestic cargoes were transported on regularly scheduled container liner services operated at more than 80 U.S. ports in 2011.[20]

[19] U.S. Army Corps of Engineers. "U.S. Waterborne Container Traffic by Port/Waterway in 2011". *Navigation Data Center: Waterborne Commerce Statistics Center.* Revised August 2013. Available at: http://www.navigationdatacenter.us/wcsc/by_portnames11.html.

[20] Ibid.

3.3.1 LINER SERVICES

Container liner services operate on a fixed schedule, usually weekly, with the number of vessels required for each service determined by voyage length and transit and port times. Major container carriers may also operate as part of larger 'alliances' where cumulative vessel container capacity is shared among the vessels of the alliance members, thereby providing opportunities to increase the frequency of calls along common service ports or terminals. Additional discussion regarding this concept is provided below in section 3.3.2. Since the principal trade route that may be affected by Panama Canal expansion is from Northeast Asia to the United States, this section describes how the liner carrier services operate on this trade lane including all service alternatives. Examples of services from a major carrier are shown in Figure 7 through Figure 9. Specific ports called upon in Asia and North America vary by service.

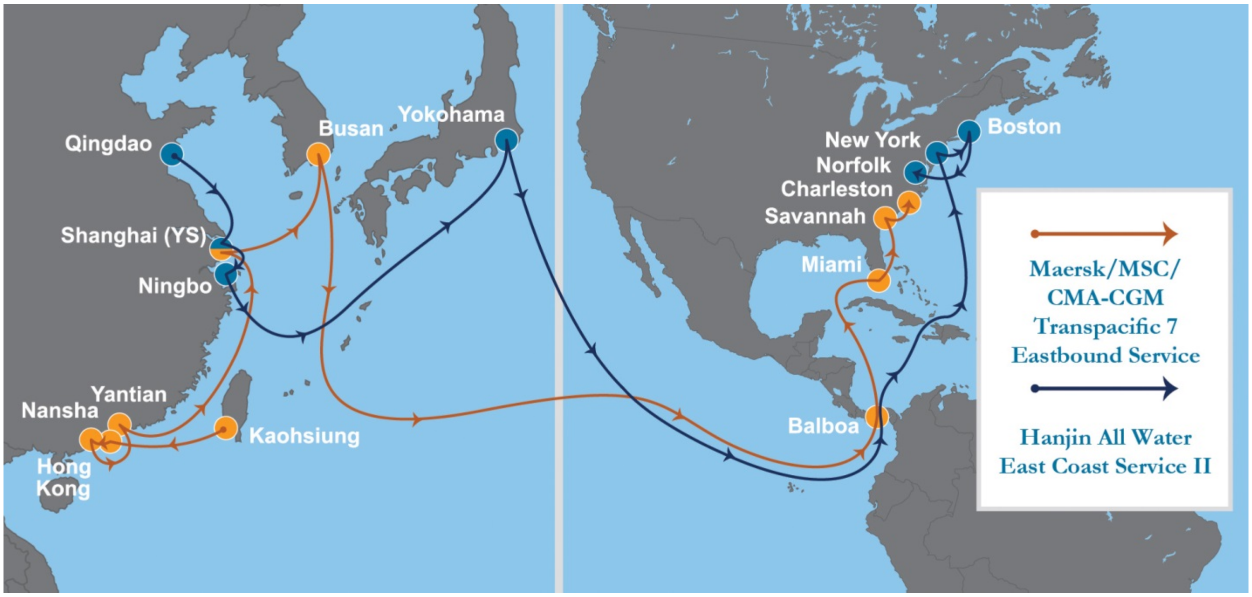
There are three principal patterns for reaching U.S. markets from Northeast Asia:

- Transpacific to the North American West Coast (see Figure 7)
- Transpacific to the U.S. East Coast through the Panama Canal (see Figure 8)
- Asia to the U.S. East Coast through the Suez Canal (see Figure 9)

Figure 7. **NORTHEAST ASIAN TRANSPACIFIC ROUTES TO NORTH AMERICAN WEST COAST**

Source: A.P Moeller Maersk Group, Service Schedule, June 2012; Hanjin, Service Schedule, June 2012

Figure 8. NORTHEAST ASIAN TRANSPACIFIC ROUTES TO THE U.S. EAST COAST THROUGH THE PANAMA CANAL



Source: A.P Moeller Maersk Group, Service Schedule, June 2012; Hanjin, Service Schedule, June 2012

Figure 9. NORTHEAST ASIAN TRANSPACIFIC ROUTES TO THE U.S. EAST COAST THROUGH THE SUEZ CANAL

Source: A.P Moeller Maersk Group, Service Schedule June 2012

3.3.2 STRUCTURE OF THE LINER SHIPPING INDUSTRY SERVING THE UNITED STATES

The more than 50 container carriers that operate international liner vessel services for U.S. trade lanes can be classified into three basic categories:

- "Global" carriers with service networks covering the major trade lanes linking North America with the Far East, Indian Subcontinent/Arabian Gulf, and Europe/Mediterranean regions predominantly have an East–West network configuration.

- "Multi-trade" carriers with service networks that cover company-specific combinations of major and/or minor trade lanes to and from North America (along with certain trade lanes that do not involve North America), but which do not cover all of the world's major east-west trade lanes.
- "Regional" carriers that operate primarily to or from North America and typically serve only a few U.S. trade lanes.

Global carriers, which control over 70 percent of the world's dedicated container ship capacity, effectively determine worldwide vessel/TEU capacity and service patterns in the world's major trade lanes.[21] Table 5 lists the 16 container lines that offer U.S. importers and exporters multiple weekly sailings to and from the Far East and the United States. These carriers also operate multiple vessel deployments between the Far East and Europe, as well as between Europe and the United States. Because their services traverse the Pacific, Indian, and Atlantic Oceans and link the world's three largest trading blocs (Northeast Asia, North America, and Europe), these companies are considered as having *global* service networks.

Since the late 1990s, ten of these 16 companies have operated three separate operational alliances that cover the Asia–North America, Asia–Europe, and Europe–North America trade lanes:

- The Grand Alliance (NYK, OOCL, and Hapag-Lloyd)
- The New World Alliance (APL, MOL, and Hyundai)
- The CKYH Alliance (COSCO, K Line, Yang Ming and Hanjin)

In recent years, several other lines have entered into vessel-sharing agreements for specific routes such as Maersk, CMA-CGM, Zim, and the Grand Alliance; and Evergreen and China Shipping. These alliances and operational agreements enable the carriers to serve a broader range of trade routes, and they also provide a larger base of cargo to ensure that the carriers utilize their vessels at a profitable level on a weekly basis. In addition, the carriers belong to discussion agreements, particularly the Transpacific Stabilization Agreement (TSA) and Westbound Transpacific Stabilization Agreement (WTSA), where they can have limited antitrust immunity for discussions regarding the allocation of worldwide container capacity.

[21] Containerisation International Online (www.ci-online.co.uk).

Table 5. GLOBAL CONTAINER LINES SERVING U.S. MARKETS

Carrier	Country of Headquarters Office
Maersk	Denmark
Med Shipping	Switzerland
CMA CGM	France
COSCO	China
Hapag-Lloyd	Germany
Evergreen	Taiwan
APL	Singapore
Hanjin	South Korea
China Shipping	China
OOCL	Hong Kong
MOL	Japan
NYK	Japan
K Line	Japan
Yang Ming	Taiwan
Hyundai	South Korea
Zim	Israel

Source: Containerisation International On-Line Database (as of June 15, 2012)

All 16 global carriers use the Panama Canal on a weekly basis, primarily to move containers between Northeast/Southeast Asia and the U.S. East Coast, a trade served by all of them. All 16 also serve the Far East–U.S. West Coast trade lane, and all but one of them serve the U.S.–Europe trade lane.

Each of these carriers' networks also includes sets (or "strings") of vessels linking one or more of the primary Southern Hemisphere regions (i.e., West Africa, South Africa, Australia/New Zealand, and the West and East Coasts of South America) with one or more of the primary Northern Hemisphere regions (i.e., East Asia, North Europe, Mediterranean Europe, and the West and East Coasts of North America).

End-to-End Shuttles

The predominant container ship service pattern for major trade lanes in U.S. liner trades is referred to as an end-to-end shuttle, in which a string of similarly-sized ships make regularly scheduled calls back and forth between two continents. In the U.S. trade lanes, this type of service has scheduled calls at ports within a region outside the U.S. (Asia or Europe), then crosses either the Pacific or Atlantic Oceans to the United States, calls at selected ports on that coast of the United States, returns back across the ocean, and then repeats this cycle. Table 6 shows the total number of weekly liner sailings for the key international U.S. trade lanes, the number of those services that are end-to-end shuttles, and whether they are global or non-global operators. Table 7 shows the total number of sailings per week and the number of those sailings that are end-to-end shuttles serving U.S. East and Gulf ports.

Table 6. FAR EAST VESSEL SERVICE SUMMARY TO ALL U.S. PORTS[A, B]

	{A}	{B}	{C}	{D}	{E}	{F}
	Total Number of Sailings Per Week	Number of End-to-End Shuttles	Number of End-to-End Shuttles of Global Shipping Lines	Number of End-to-End Shuttles of Non-Global Shipping Lines	Number of Non-Shuttle Strings of Global Carriers	Number of Non-Shuttle Strings of Non-Global Carriers
Far East – Pacific Northwest	13	9	9	0	4	0
Far East – California	29	24	22	2	4	1
Far East – U.S. East/Gulf via Panama	17	15	15	0	2	0
Far East – U.S. East/Gulf via Suez	6	5	5	0	1	0
Australia/NZ – U.S. West Coast	2	2	2	0	0	0
Australia/NZ – U.S. East Coast	1.5	1.5	1.5	0	0	0

Calculation Formula: {B} = {C} + {D}; {A} = {B} + {E} + {F}

[A] *Bi-weekly services are counted as 0.5 sailings per week.*

[B] *Services that call in Los Angeles/Long Beach and the Pacific Northwest are assigned to the region in which the first inbound port of call is located.*

Source: Alphaliner database (as of June 11th, 2012); Mercator International analysis, Panama Canal Expansion Study, June 2012

Table 7. U.S. EAST AND GULF COAST VESSEL SERVICE SUMMARY: ATLANTIC ROUTES[A, B]

Trade Lane	Total Number of Sailings per Week	Number of End-to-End Shuttles
North Europe – U.S. East/Gulf Coasts	14	11
Mediterranean – U.S. East/Gulf Coasts	11	6
Mideast/Subcontinent – U.S. East/Gulf	7	4
South America East Coast – U.S. East/Gulf Coasts	6	6
South America West Coast – U.S. East/Gulf Coasts	2	2
Central America/Caribbean – U.S. East/Gulf Coasts[C]	49	49
Africa – U.S. East/Gulf Coasts	1	1

[A] *Bi-weekly services are counted as 0.5 sailings per week.*

[B] *Does not include Far East services.*

[C] *This includes the numerous services with small ships between South Florida and various Caribbean Basin countries.*

Source: Alphaliner database (as of June 11th, 2012); Mercator International analysis, Panama Canal Expansion Study, June 2012

Emerging Developments in End-to-End Shuttles

Despite the current prevalence of end-to-end shuttles in most U.S. East and Gulf Coast trade lanes, two significant and interrelated factors will affect the structure of shipping lines' vessel services for multiple U.S.-focused international trade lanes: the expansion of the Panama Canal and global carriers' increased use of container ships with more than 8,000 TEUs capacity. The latter factor has been a trend in the Far East–Europe and Far East–U.S. West Coast lanes for at least the past five years and will continue to affect vessel network designs.

Given the pronounced transition to larger container ships that is already underway, it is expected that most of the global carriers now serving the Northeast Asia–U.S. East Coast route with 4,000-5,000–TEU ships will rapidly begin to replace them with 8,000-10,000–TEU ships (or larger) after 2015, assuming U.S. East Coast ports can accommodate them. This development will impact service patterns on other U.S. trades as well.

Pendulum Services

Global carriers operate some of their ships in so-called "pendulum" service patterns that start in a specific port range, cross an ocean or major body of water, make one or more port calls in a second port range, traverse another ocean or major body of water, call at a third port range, and then return to the first port range via the intermediate port range. An example of a pendulum deployment is the TP3/ TP9/Columbus service operated by Maersk Line and CMA-CGM with Post-Panamax ships. The ships assigned to this service call at Pacific Northwest ports, traverse the Pacific Ocean westbound, call at several Far East ports, then cross the Indian Ocean, Red Sea, Mediterranean Sea and Atlantic Ocean to call at several U.S. East Coast ports, after which they turn around and back-track to the Far East via the Suez Canal again, and ultimately traverse the Pacific Ocean back to the Pacific Northwest.

Pendulum service patterns can achieve higher levels of vessel capacity utilization than shuttle services, because the capacity on any leg of the voyage can be allocated to multiple trade lanes and because container slots can be "re-used" at least once in the same direction of the voyage. Pendulum services can eliminate the need for overlapping port calls in the intermediate port range that occurs with two end-to-end shuttle services that "meet" in the intermediate port range.

Pendulum routes can also be structured to begin in the Far East, transit the Panama Canal to the Caribbean and U.S. East Coast, and then cross the Atlantic to call at ports in North Europe before returning to Asia via the Panama Canal. This service pattern could become more attractive once the expanded Panama Canal allows for the deployment of efficient Post-Panamax ships. Thus, the expansion of the Panama Canal will allow global carriers to operate more pendulum services.

Round-the-World Services

Following the opening of the Panama Canal's new set of locks, some global carriers may choose to deploy Post-Panamax ships in "round-the-world" (RTW) services that run eastbound from the Far East through the Panama Canal, to the U.S. East Coast, to a few Mediterranean ports, through the Suez Canal, and then across the Indian Ocean (with or without scheduled stops in the Arabian Gulf or Indian Subcontinent) back to the Far East. Such services may also run westbound from the Far East to the Suez Canal (with or without stops at an Indian Ocean relay port) to one or two Mediterranean transshipment ports and then across the Atlantic to the U.S. East Coast, returning to Asia via the Panama Canal (and possibly with a brief stop in a California port). Carriers would consider operating such RTW services because, when properly designed, they can reduce the number of vessels that need to be operating in the carrier's network.

Regional Services Covered by the Jones Act

Regional ocean liner services between mainland U.S. States and the noncontiguous States (Hawaii and Alaska) and U.S. territories (e.g. Puerto Rico and U.S. Virgin Islands) are regulated by section 27 of the Merchant Marine Act of 1920 (the Jones Act). The Panama Canal expansion is unlikely to have a major impact on the service patterns of the carriers serving those trades, as all of the current Jones Act vessels currently fit through the Panama Canal and there is not sufficient trade to justify larger vessels. In some cases, a limited amount of transshipment may occur from U.S. ports served directly by larger international line ships, particularly if landside linkages to the ports are congested due to high volumes of truck, car, and rail operations. Otherwise, the factors that will continue to influence the Jones Act trade will include the number, condition, and capacity of existing ships; the economics of using U.S.-built and U.S.-crewed ships; the cargo volumes moving in the head-haul direction from mainland states to Alaska, Hawaii and Puerto Rico; and terminal capacity in Anchorage, Honolulu, San Juan, and other ports that accommodate Jones Act shipping.[22]

[22] There are attempts underway to develop a new container terminal on the south side of Puerto Rico at Ponce, but no major capacity expansion is being planned.

Effects of New Service Patterns on U.S. Ports Calls

New large-ship pendulum and RTW deployments, together with the use of 8,000+ TEU ships on conventional shuttle services between the Far East and U.S. East Coast via the Panama Canal, could result in fewer port calls at U.S. and other ports, with greater reliance on transshipment services to smaller ports. The larger vessels enabled by the expanded Canal will carry cargo bound for many different destinations but will be limited in the number of port calls they can make due to draft and port time considerations, making some transshipment inevitable. Through the careful selection of transshipment ports, the vessel operators offering these pendulum and RTW transshipment services would gain meaningful slot-cost and revenue advantages over other carriers such as multi-trade or regional carriers serving only the Gulf Coast–East Coast of South America trade and/or the Far East–Brazil/Argentina trade (via the Cape of Good Hope).[23] More discussion about U.S. port calls and transshipment ports is provided immediately below.

3.3.3 ROLE OF TRANSSHIPMENT IN LINER SERVICES SERVING THE UNITED STATES

One of the key elements in many container service networks is the use of transshipment; that is, a vessel dropping a container at a port (referred to as a hub or transshipment center), where it is picked up by another vessel to complete its journey. Partially due to network intersections between their East–West and North–South deployments, all 16 global carriers described above design their networks to regularly relay loaded and empty containers from one vessel string to another at such transshipment ports.

Hub ports are strategically located in a handful of regions where such exchanges are geographically and economically convenient. Some of the busiest ports in the world, such as Singapore, are major transshipment hubs.

There are also major ports in North Europe and Northeast Asia at which significant volumes of containers are relayed between “line-haul” ships (that link either of these regions with other continents) and “feeder” strings (that call at ports primarily within those same two regions).

For various reasons, none of the major U.S. ports function as a regional hub for these global carriers. Current pricing of terminal services to ocean carriers at U.S. East Coast ports and current pricing of North-South truck and intermodal rail services along the Eastern Seaboard to beneficial cargo owners make it difficult to establish such feeder services, although a few do exist over short distances using tug and barge operations.

As previously mentioned, congested landside routes paralleling navigable waterways, port capacity constraints, and more concentrated port calls by larger vessels could encourage development of domestic transshipment services that move containers by water between larger and smaller U.S. ports. MARAD is currently working with the industry to develop short sea shipping capabilities through its America’s Marine Highways (AMH) Program. This program and other MARAD efforts to develop U.S. short sea services aboard U.S.-flag vessels could lead

[23] Most container trade between the Far East and the East Coast of South America now moves on vessels of 4,200-5,500–TEU capacity that traverse the Indian Ocean.

to the use of some U.S. ports as hubs for domestic feeder services. Detailed information about the DOT's AMH Program can be found in the Report to Congress, April 2011.[24]

Caribbean Transshipment Hubs

Many global carriers use the ports on either end of the Panama Canal and/or in the Caribbean Sea to transfer containers between North–South services (to/from South America and/or Central America) and East–West services that transit the Panama Canal.

Caribbean transshipment hubs allow shipping lines to load a given ship in Asia with cargo destined for a range of destinations along the U.S. East Coast, the Caribbean, Central and South America, and the east coast of Mexico. Similarly, on the backhaul to Asia, a large transshipment hub in the Caribbean can be used to consolidate container cargo from multiple sources onto Asia-bound container ships, increasing westbound utilization levels. In essence, the added costs of transshipment are compensated for by the lower unit shipping costs realized by using larger vessels.

There are multiple Caribbean and Central American locations that have modern container terminals at which feeder services can move containers imported from Asia to destinations throughout the Americas. The locations and capacities of the larger hubs that are most likely to play a role in post-Canal-expansion of high-volume transshipment services are shown in Table 8.

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[24] U.S. Department of Transportation. "America's Marine Highway Report to Congress". *Maritime Administration*. April 2011. Available at: http://www.marad.dot.gov/documents/MARAD_AMH_Report_to_Congress.pdf.

Table 8. MAJOR CARIBBEAN TRANSSHIPMENT HUBS

Port	Country	2011 Throughput (Millions of TEUs)	Capacity (Millions of TEUs/year)	Draft
Freeport Container Port	Bahamas	1.12	1.80	52.5 ft / 16.0 m
Kingston	Jamaica	1.76	2.80	43.0 ft / 13.1 m
Caucedo	Dominican Republic	1.00[A]	1.25	41.0 ft / 12.5 m
Cartagena	Colombia	1.85	2.30	43.0 ft / 13.1 m
Manzanillo International Terminal (MIT)	Panama (Atlantic Coast)	1.90	3.00	45.9 ft / 14.0 m
Balboa/Cristobal	Panama	3.40[A]	6.50[B]	49.2 ft / 15.0 m

[A] *The most recent throughput data available are for 2010.*

[B] *Panama Ports Company's planned capacity at Balboa and Cristobal by 2015.*

Note: Manzanillo International Terminal, while located on the Atlantic side of the Canal with Cristobal, is independent from the Panama Ports Company. The ports of Balboa and Cristobal's Capacity and Planned Capacity are listed as one figure because the Panama Ports Company lists the two ports' capacity in a combined number.

Source: Port websites, Mercator International, Inc.; WorleyParsons; Containerisation International, May 2012

Several other smaller ports are used for selected—predominantly local—transshipment flows (see Table 9) but do not offer the capacity or geographic range of services of the larger hubs.

Table 9. SMALLER CARIBBEAN TRANSSHIPMENT FLOW PORTS

Port	Country	2011 Throughput (Millions of TEUs)	Capacity (Millions of TEUs/year)	Draft
Rio Haina	Dominican Republic	0.29[A]	0.30	32.8 ft / 10.0 m
San Juan	U.S.A. (Puerto Rico)	1.48	2.80	40.0 ft / 12.2 m
Port-of-Spain	Trinidad & Tobago	0.39[A]	0.60	34.8 ft / 10.6 m

[A] *The most recent throughput data available is 2010.*

Source: Port websites, Drewry's Annual Review of Global Terminal Operators, Mercator International, Inc.; Containerisation International, May 2012

These transshipment hubs, large and small, are shown on the map in Figure 10.[25] The larger transshipment hubs are expanding their capacity and deepening channel depths in order to keep pace with expected growth in transshipment when larger vessels are able to transit the expanded

[25] Port-of-Spain, Trinidad & Tobago, is shown in Figure 10 although it is outside the normal Far East–U.S. East Coast route; however, it is expanding its transshipment operations to accommodate Brazilian cargo exports to the Far East and Europe.

Panama Canal. (See Technical Notes Section TN - 3 for a discussion of potential Cuban port options.) Notwithstanding the potential economic advantages of Caribbean transshipment operations, shipping lines are not expected to use transshipment to serve most U.S. ports due to the large volumes of containers that move from Asia to the United States and the lack of alternate destinations reachable from Asia through the Panama Canal that would have higher container volumes. Moreover, some shipping lines will likely decide to operate Far East–Panama Canal–U.S. East Coast deployments with large Post-Panamax ships without making an intermediate stop at a Caribbean hub port to transfer containers to non-U.S. ports, at least on the eastbound leg of the voyage. Such a decision would likely be based, at least in part, on the need to avoid increasing transit times for Asian containers destined to U.S. ports (as those containers would be filling the majority of the capacity of the deployment) and to thereby maintain commercial competitiveness in that core market.

Figure 10. TRANSSHIPMENT HUBS IN CENTRAL AMERICA & THE CARIBBEAN

Source: Parsons Brinkerhoff, Panama Canal Expansion Study, June 2012

Ocean carriers undertaking eastbound transshipment operations at one or more Caribbean ports need ports with terminals that have high stevedoring productivity (to minimize the time the line-haul ships spend in port), multiple berths (to avoid berthing delays), and are close to the primary navigation corridors between the Panama Canal and the main U.S. East Coast ports (to minimize the time that the line-haul vessels spend deviating from those corridors to call at the transshipment port).

In addition, as trade volumes grow and larger ships are deployed for the Far East–U.S. East Coast trade, certain global carriers could initiate feeder services linking their Caribbean transshipment centers with smaller-volume ports in the South Atlantic range (such as Wilmington, NC and Jacksonville, FL) and in the Gulf Coast (such as Tampa, FL and Mobile, AL) in order to reduce their inland transport costs. Of course, some carriers may choose to serve these ports directly.

3.4 U.S. TRADE LANES AND THE SUEZ CANAL

This section addresses the current use of the Suez Canal by container shipping companies, specifically with respect to their services to and from the United States. Potential changes in their use of the Suez Canal after expansion of the Panama Canal are also considered.

Container vessel sailing on a Suez Canal trade route

Photo courtesy: A.P. Moller – Maersk Group

3.4.1 THE SUEZ CANAL AND U.S. TRADE

Although the Suez Canal has historically been the dominant route for container trade between North/Mediterranean Europe and the Far East, South Asia, the Arabian Gulf, and East Africa, it is currently of markedly less importance to U.S. liner trades than the Panama Canal for the two reasons described below.

No Impacts Expected on West Coast Trade

First, there are no foreign trade segments to or from the U.S. West Coast for which it is geographically logical to ship containers through the Suez Canal. For example, it is much shorter to transport goods between the Pacific Northwest and California and the Mediterranean through the Panama Canal and across the Atlantic Ocean than across the Pacific and Indian Oceans and through the Suez Canal.[26]

Relatively Low Volumes for U.S. Mideast-South Asia Container Trades

Second, several of the foreign trade routes for which it is geographically logical to ship containers through the Suez Canal have relatively small head-haul volumes, compared to those of the principal liner trades serving the United States.

Exports from the U.S. East and Gulf Coasts to the Middle East, Red Sea and East Africa regions are about 300,000 TEUs/year, whereas U.S. East/Gulf Coast imports from Northeast Asia are about 2.9 million TEUs/year (at least 90 percent of which are routed via the Panama Canal) and those from North Europe are nearly 1.2 million TEUs/year.

[26] For example, the sailing distance from Seattle to Haifa is about 10,350 miles via the Panama Canal and about 12,360 miles via the Pacific and Indian Oceans and the Suez Canal.

Two other trade-lane segments have significant U.S. traffic flows (especially U.S. imports) that move through the Suez Canal but these are still relatively small compared to flows from Europe and East Asia:

- Nearly 80 percent of U.S. container imports from the Indian Subcontinent, or about 480,000 TEUs/year, move to U.S. East/Gulf Coast ports through the Suez Canal and Mediterranean Sea.
- About 25 percent of U.S. imports from Southeast Asia, or about 400,000 TEUs per year, are routed through the Suez Canal to U.S. East Coast and Gulf Coast ports. Another 65 percent move through West Coast ports, while the remaining ten percent move through the Panama Canal.

Because the Indian and Southeast Asian segments have had solid growth rates during the past decade (excluding the 2007-2009 recession), ocean carriers collectively have increased the number of vessels serving these segments. Clearly, if this trend should continue as expected—particularly if manufacturing activity shifts to Southeast, South, and Southwest Asian centers—the role of the Suez Canal in U.S. trade will become more important.

U.S. Imports from the Indian Subcontinent Will Be Unaffected by Panama Canal Expansion

Consistent with the previous section on the effect of the Suez Canal, trade with the Indian Subcontinent is unlikely to be affected by the expansion of the Panama Canal. U.S. containerized exports to the Arabian Gulf region far exceed U.S. imports from that region and U.S. imports from the Indian Subcontinent exceed U.S. exports to that region. For these reasons, four of the eight shipping lines that currently serve the U.S.-Arabian Gulf market send three of their total of five deployments from the U.S. East Coast through the Mediterranean Sea and Suez Canal to the Port of Jebel Ali (Dubai) and then call at one or more ports in India using pendulum services, before returning back to the East Coast via the Suez Canal. This pattern should be unaffected by Panama Canal expansion.

Three carriers jointly deploy vessels between the U.S. East Coast and India/Pakistan. As the trade volume in this segment continues to increase, there are likely to be additional weekly services, but this is also unrelated to Panama Canal expansion.

U.S. Imports from Southeast Asia to the U.S. East Coast May Shift to the Panama Canal

Major Asian ports and potential diversion patterns to the Suez Canal are shown in Figure 11 (chiefly in the area of overlap between the two ovals shown on the map). Deployment patterns that use the Suez Canal to serve U.S. East Coast liner trades and that are likely to be affected by the Panama Canal expansion are those covering import traffic from Southeast Asia.

There are presently six weekly deployments, operated by 11 ocean carriers, serving this trade lane. Five of the six deployments are fundamentally shuttle services between Southeast Asia and the U.S. East Coast, transiting the Suez Canal in both directions, but only one of the five sails directly from the Strait of Singapore to New York without any intermediate port calls—the other four make one or more stops at transshipment ports in either the Indian Ocean and/or

Mediterranean Sea. In addition, four of the five shuttles actually begin their westbound voyage (and end their eastbound voyage) at ports north of Singapore (specifically in Thailand, Vietnam, South China and/or Shanghai).

Figure 11. **SUEZ CANAL ALTERNATIVES TO PANAMA CANAL**

Source: Parsons Brinckerhoff, Panama Canal Expansion Study, June 2012

The other service is the TP3/TP9/Columbus pendulum service of Maersk and CMA CGM described previously in this report. This service uses 6,000-8,000–TEU ships, allowing the two carriers that operate it to match the economies of scale of Post-Panamax vessels carrying loaded containers from Japan, China and Southeast Asia to the U.S. West Coast. However, once the Panama Canal is expanded, this pendulum pattern will probably be used less since routing from Far East ports north of Hong Kong to New York, Norfolk and especially Savannah are far shorter through the Panama Canal than through the Suez Canal.

Cargo vessels approach the Gatun Locks from Gatun Lake

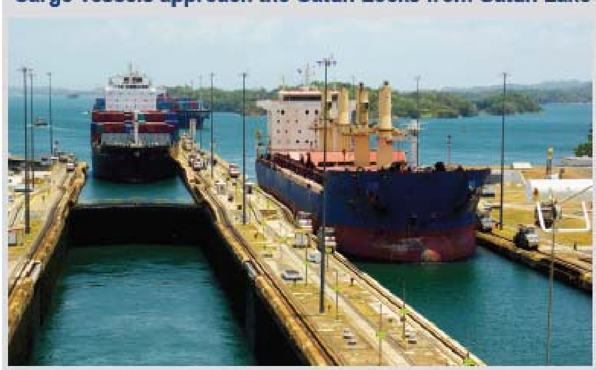

Photo courtesy: A.P. Moller – Maersk Group

Although the expansion of the Panama Canal will attract some services currently using the Suez Canal, this effect will be mitigated by some advantages to Suez Canal routings, particularly in the future. Very large westbound container ships from Asia have access to transshipment hubs in Sri Lanka, Djibouti, Oman, Egypt, Malta, and southern Spain on their way to the U.S. East Coast. The greater number of trade lanes that can be served by vessel deployments operating on the Suez Canal route will likely become more important as container ship sizes grow beyond the 13,000 TEU limit of the expanded Panama Canal (demanding ever greater cargo volumes) and as economic growth in South Asia leads to more manufacturing and trade along this westbound route.

All else being equal, for U.S. imports from Southeast Asia to the U.S. East Coast, the major impact of the Panama Canal expansion is likely to be a shift from Suez routing to the Panama Canal for a limited number of ports in Southeast Asia (including transshipped cargoes). An indirect impact may take the form of minor increases in the discretionary volumes (destined for inland regions) handled by various U.S. East Coast ports.

3.4.2 STABILITY OF THE PANAMA CANAL'S SHARE OF CONTAINER TRAFFIC FROM NORTHEAST ASIA

Although some container traffic from Hong Kong/Yantian and other Chinese ports to the U.S. East Coast (particularly to New York) will move through the Suez Canal after 2015, most of that traffic segment will continue to move via Panama, which offers shorter transits to the South Florida, South Atlantic and Mid-Atlantic markets. For carriers currently running Suez services from Hong Kong/Yantian to the U.S. East Coast with intermediate stops at hubs in the Strait of Malacca, the Indian Ocean, and the Mediterranean, switching to the Panama route can offer faster transits to the New York market as well.

The Panama Canal expansion will thus cause Far East–Suez–U.S. East Coast services to be designed primarily as shuttles focused on inbound traffic from Vietnam, Singapore/Indonesia/Malaysia, Thailand and the Indian Subcontinent with containers from the Indian Subcontinent relayed to the line-haul services at an Indian Ocean hub port, such as Colombo, Djibouti, or Salalah (see Technical Notes Section TN - 4).

3.5 U.S. LINER NETWORKS AND CLIMATE CHANGE

Icebreaker towing cargo ship through thick ice-field

Photo credit: iStock

This section addresses the extent to which climate change could impact vessel network designs and corollary liner service patterns relevant to the major U.S. import/export trade lanes. In particular, it is possible (for discussion purposes only) that, as a result of climate change, it may eventually be feasible to operate container ships between the Bering Strait and both the North Cape of Norway (via the East Siberian Sea) and Pentland Firth in northern Scotland (via the Beaufort Sea, Parry Channel, Davis Strait, and Kap Farval) all year without ice-breakers, with conventionally-designed hulls, and running at normal service speeds.

3.5.1 CLIMATE CHANGE AND U.S. VESSEL PATTERNS

A container ship taking a direct route from Shanghai (now the largest loading port in Asia) via the Pacific Ocean and Panama Canal to New York (the largest destination market on the U.S. East Coast) without any intermediate port calls travels approximately 10,700 nautical miles. But if that ship were to sail northeast to the Bering Sea, pass through the Bering Strait to Point

Barrow (Alaska), follow the northern coast of Alaska across the Beaufort Sea and through the Parry Channel (of Canada), then head south through the Davis Strait (between Newfoundland and Greenland) to Cape Race (near St. John's) and down the Atlantic Coast to New York, the trip would only be some 9,300 nautical miles.

If this "northern passage" were ice-free and safe to navigate by conventional container ships on a year-round basis (or at least for a major portion of the year), it would seem that shipping lines could operate a Far East–U.S. East Coast vessel string with one fewer ship by using the Arctic Ocean route, instead of the Pacific Ocean route. However, this would be the case only if the two strings had only one port call on the U.S. East Coast. In fact, deployments on this trade lane need to call at two or more major East Coast ports (for example, calling at either Savannah or Charleston and at either Norfolk or Baltimore) in addition to New York in order to achieve acceptable capacity-use levels. The extension of the Arctic string's port rotation south of New York to Norfolk and Savannah would eliminate its theoretical cost advantage over the Pacific string because, although the voyage length would be shorter, it would not be short enough to operate with one fewer ship. (There would be some cost savings, however, from reduced fuel consumption and avoiding Panama Canal tolls.)

One might argue that some ocean carriers might still be interested in operating a Far East–U.S. East Coast string on the Arctic Route simply to reduce transit time to New York by four[27] days (versus transit time on the best Pacific Route), but most lines can be expected to prefer the Panama Canal route, which offers much higher and more consistent capacity usage and voyage earnings by allowing for an intermediate stop at a Caribbean Basin hub port and at either a Southeast U.S. port or at Norfolk (the Arctic Route offers few, if any, cargo pickup and drop-off opportunities). The Caribbean stop is especially important because it enables the shipping line to access five markets (Central America, South America, the Caribbean Islands, the U.S. Gulf Coast, and the U.S. East Coast) on the same vessel string—versus only the Canadian and U.S. East Coast market using the Arctic Route. Moreover, East Coast importers using all-water vessel services (as opposed to intermodal land bridge services via West Coast ports) generally place less importance on transit time than on reliability and price. Even if the route were ice-free and safe to navigate year-round, it would have to be demonstrated as commercially viable.

Because the distance between Los Angeles/Long Beach (the largest U.S. West Coast port complex) and Rotterdam/Antwerp (the largest European port complex) is actually about 100 miles shorter via the Panama Canal than via the Pacific Ocean, Bering Sea, and "Russian" Arctic Ocean, an ocean carrier would derive minimal benefits (aside from Canal toll savings) from moving its Europe– California traffic to the Arctic Route. Moreover, the current volume of container traffic moving between the Pacific Northwest and North Europe via the Panama Canal is far too small to support an alternative (i.e. Arctic Route) weekly liner service.[28]

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[27] Four days of transit time savings is derived by assuming an average vessel running speed of 18 knots (i.e. slow steaming) for both routes for the 1,400-mile differential, plus allowing for the time saved by not having to transit through the Panama Canal.

[28] Currently, Pacific Northwest to Europe cargo is carried by three vessel services that also call at California and Mexico ports, as well as Caribbean ports, and thus is integrated in deployments serving multiple trade lanes.

There are no other significant U.S.-based trade lanes for which an Arctic Ocean routing would be relevant in terms of sailing distances. In any case, the availability of this route, at least over the next ten to twenty years, appears unlikely due to the uncertainties surrounding the rate at which ice will disappear and the investments that would be required in necessary escort vessels, staging ports, and channel preparation. Other issues, such as national claims to the waters, must also be resolved.

3.6 NORTH AMERICAN COASTAL PORTS AND TERMINALS

Previous sections have described global shipping with an emphasis on container services. This section focuses on the interface between global shipping and U.S. inland regions—that is, North American ports. It should be noted here, however, that although the ports of the Great Lakes are generally grouped with coastal ports for national commodity flow and activity analyses, the nature of existing waterborne trade flows into and out of the Great Lakes ports are not particularly suited to any increase in service frequency or efficiency arising from the expansion of the Panama Canal. This report does discuss potential impacts of the expanded Panama Canal as they relate to bulk commodities (coal, grain, ore, etc.) which are commonly transported on the inland waterways, but these impacts would be very minor, at best, for Great Lakes ports that connect to the Atlantic Ocean via the St. Lawrence Seaway.

U.S. marine ports handle most overseas goods traded between the United States and the major economies of the world. In 2011, according to U.S. Census Bureau data, 99 percent of U.S. overseas trade in tonnage was handled by U.S. ports and one percent was transported by air.[29] In addition, a small but growing share of U.S. overseas trade is handled by major Canadian and Mexican ports and transferred by rail or truck to U.S. inland destinations. Note that overseas trade as defined here excludes trade with Canada and Mexico, which is largely transported by rail and truck.

[29] Includes imports and exports from all countries other than Canada and Mexico. Source: U.S. Census Bureau Foreign Trade Division, May 2012, Available at: http://www.census.gov/foreign-trade/Press-Release/2011pr/12/ft920/ft920.pdf and team analysis.

Table 10. **TOP 20 U.S. PORTS IN 2010-2011: TOTAL FOREIGN CARGO OF ALL TYPES, INCLUDING BULK CARGO (Metric Tons - Millions)**

	Imports			Exports			Total	
	2010	2011		2010	2011		2010	2011
Total All Ports	**783.3**	**770.0**		**522.2**	**572.6**		**1,305.4**	**1,342.6**
Houston, TX	80.1	81.4		66.5	71.2		146.6	152.7
New Orleans, LA	26.1	30.2		61.4	65.4		87.5	95.5
New York/New Jersey	55.2	55.5		19.5	23.3		74.8	78.8
Los Angeles, CA	44.6	46.5		19.5	23.6		64.1	70.1
Gramercy, LA	22.5	22.1		35.4	39.2		57.9	61.3
Corpus Christi, TX	36.8	32.7		12.0	14.7		48.8	47.4
Morgan City, LA	45.1	44.9		0.0	0.0		45.1	44.9
Long Beach, CA	19.3	18.8		23.8	25.0		43.1	43.7
Port Arthur, TX	30.2	32.4		8.0	7.8		38.3	40.2
Norfolk, VA	8.3	8.6		23.8	28.3		32.0	36.9
Philadelphia, PA	36.5	34.1		1.8	2.7		38.3	36.8
Baltimore, MD	13.8	12.7		15.7	21.5		29.5	34.2
Texas City, TX	27.7	25.0		7.3	7.7		35.0	32.7
Savannah, GA	15.4	14.8		16.0	17.3		31.4	32.1
Lake Charles, LA	24.5	24.3		5.9	7.0		30.4	31.2
Mobile, AL	13.5	13.0		13.4	13.6		26.9	26.6
Pascagoula, MS	18.9	18.6		5.9	7.1		24.8	25.7
Beaumont, TX	19.7	13.9		7.3	10.3		27.0	24.2
Baton Rouge, LA	13.4	14.9		5.9	6.8		19.3	21.7
Seattle, WA	7.8	7.6		13.1	13.8		21.0	21.5

Source: U.S. Census Bureau, Foreign Trade Data, May 2012

Ranking by cargo weight favors ports that handle large quantities of liquid and/or dry bulk cargoes, which are significantly heavier, although lower in average value per ton, than container and other general cargoes. As shown in Table 11, ranking the top 20 facilities by cargo value produces a more even distribution between the coasts.

Table 11. **TOP 20 U.S. PORTS IN 2010-2011: TOTAL FOREIGN CARGO VALUE (In $ billions)**

	Imports		Exports		Total	
	2010	2011	2010	2011	2010	2011
Total All Ports	**$978.9**	**$1,159.1**	**$455.2**	**$570.3**	**$1,434.1**	**$1,729.4**
Los Angeles, CA	$202.6	$229.2	$33.7	$43.8	$236.3	$273.0
New York/New Jersey	$125.1	$145.2	$46.3	$56.2	$171.3	$201.5
Houston, TX	$60.2	$80.3	$70.7	$88.3	$130.9	$168.6
Long Beach, CA	$56.6	$59.8	$31.8	$34.9	$88.4	$94.7
Savannah, GA	$34.4	$40.8	$24.2	$30.9	$58.6	$71.7
Charleston, SC	$30.8	$36.7	$19.4	$22.2	$50.2	$58.9
New Orleans, LA	$17.5	$25.9	$24.6	$32.7	$42.1	$58.6
Norfolk, VA	$26.3	$30.0	$20.3	$23.9	$46.6	$53.9
Baltimore, MD	$27.0	$30.8	$14.3	$20.5	$41.3	$51.2
Oakland, CA	$24.4	$27.5	$15.5	$18.0	$39.9	$45.5
Seattle, WA	$32.7	$30.4	$10.0	$12.9	$42.8	$43.3
Philadelphia, PA	$24.8	$31.6	$2.3	$3.4	$27.1	$35.0
Tacoma, WA	$21.8	$26.9	$6.1	$7.6	$27.9	$34.4
Morgan City, LA	$24.9	$33.8	$0.2	$0.3	$25.1	$34.1
Corpus Christi, TX	$19.1	$20.8	$6.0	$9.9	$25.0	$30.7
Port Arthur, TX	$16.3	$23.4	$2.8	$3.3	$19.1	$26.7
Gramercy, LA	$10.8	$11.8	$10.7	$13.5	$21.5	$25.4
Miami, FL	$11.0	$13.0	$10.3	$11.9	$21.2	$24.9
Texas City, TX	$14.5	$17.9	$4.7	$5.5	$19.2	$23.4
Port Everglades, FL	$8.3	$10.0	$11.1	$13.3	$19.4	$23.3

Source: U.S. Census Bureau, Foreign Trade Data, May 2012

3.6.1 CONTAINER PORTS

As shown in Table 10, most of the 20 largest ports, by tonnage, are located on the U.S. Gulf Coast. These cargoes are primarily petroleum and petroleum-related products. However, the largest container ports are located on the U.S. West Coast and U.S. East Coast (see Table 12). The geographic distribution of U.S. container ports by TEUs is shown in Figure 12.

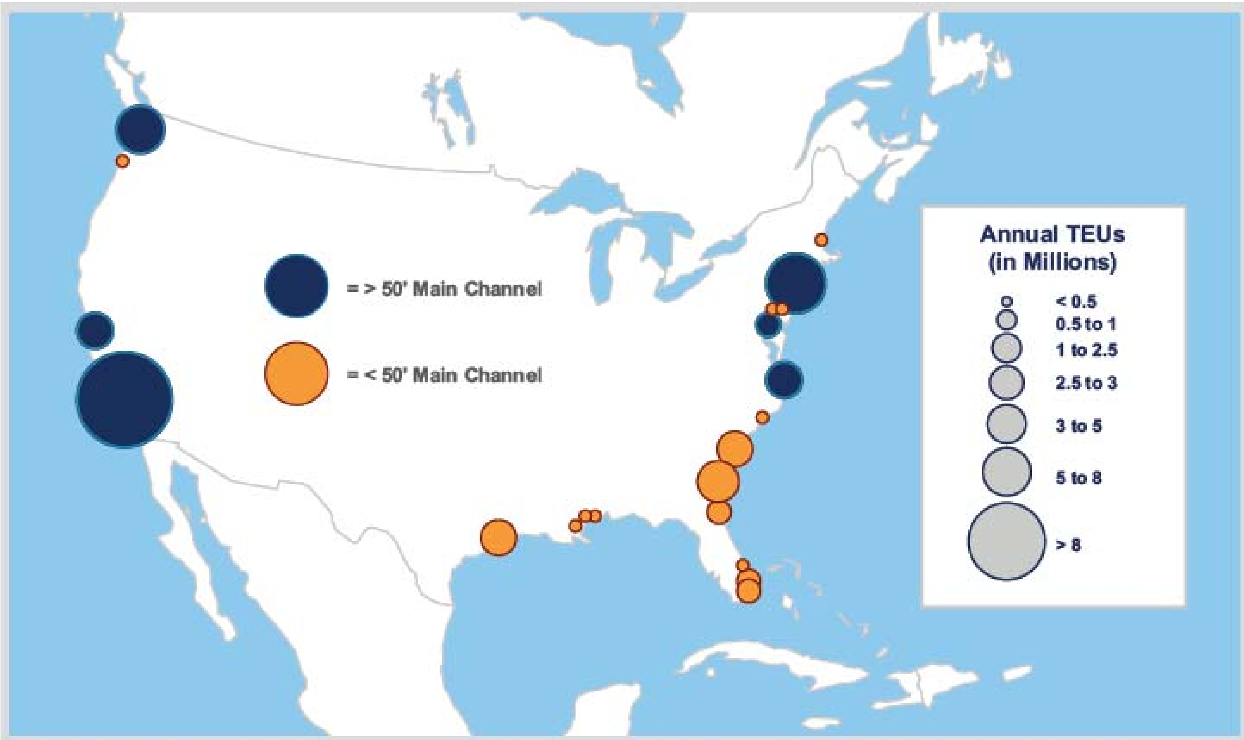
Table 12. TOP 20 U.S. PORTS IN 2010-2011: TOTAL CONTAINERIZED VALUE (in $ billions)

	Imports		Exports		Total	
	2010	2011	2010	2011	2010	2011
Total All Ports	**$561.3**	**$635.4**	**$211.3**	**$249.2**	**$772.6**	**$884.6**
Los Angeles, CA	$178.6	$200.7	$26.0	$33.6	$204.6	$234.3
Newark, NJ	$91.3	$106.0	$33.8	$112.5	$123.8	$143.7
Long Beach, CA	$48.8	$50.3	$24.2	$25.9	$73.1	$76.3
Savannah, GA	$29.4	$34.8	$17.9	$22.4	$47.3	$57.2
Houston, TX	$15.9	$20.5	$22.8	$26.2	$38.7	$46.7
Norfolk, VA	$25.2	$28.0	$14.0	$16.6	$39.2	$44.6
Charleston, SC	$28.0	$32.7	$10.8	$11.7	$38.8	$44.4
Oakland, CA	$23.5	$26.6	$12.4	$14.5	$35.9	$41.1
Seattle, WA	$31.8	$29.3	$6.6	$8.6	$38.4	$37.9
Tacoma, WA	$19.0	$23.0	$3.3	$3.8	$22.3	$26.8
Baltimore, MD	$15.8	$17.5	$4.0	$5.0	$19.8	$22.6
Miami, FL	$10.0	$11.9	$6.7	$7.9	$16.7	$19.8
Port Everglades, FL	$5.3	$6.1	$6.4	$7.8	$11.8	$13.9
New Orleans, LA	$4.0	$5.9	$4.2	$5.3	$8.1	$11.2
Jacksonville, FL	$2.4	$3.4	$3.1	$3.9	$5.5	$7.3
Philadelphia, PA	$4.1	$5.1	$1.1	$1.5	$5.2	$6.5
Wilmington, NC	$3.6	$4.1	$2.3	$2.4	$5.8	$6.5
Boston, MA	$2.7	$3.9	$0.9	$1.0	$3.6	$4.8
San Juan, PR	$3.4	$3.4	$1.3	$1.3	$4.7	$4.7
Chester, PA (Port)	$2.4	$2.9	$1.4	$1.7	$3.8	$4.6

Source: U.S. Census Bureau, Foreign Trade Data, May 2012

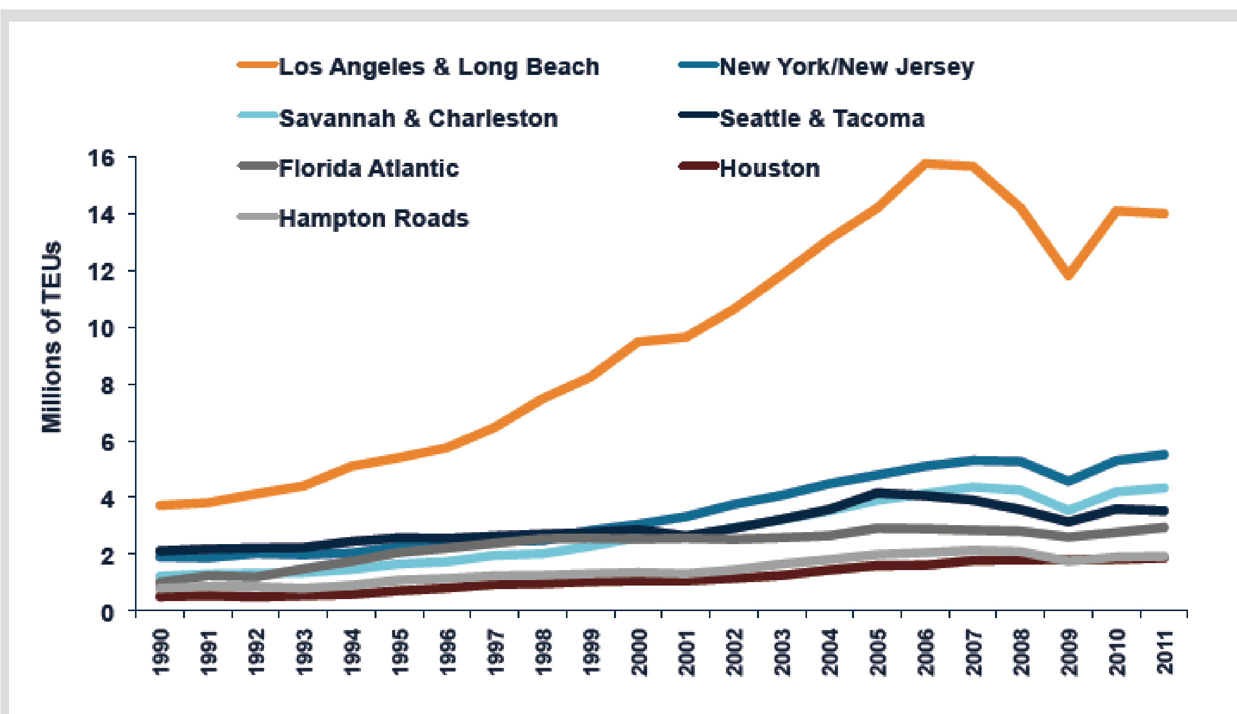
As shown in Figure 13, West Coast ports, especially the San Pedro Bay ports of Los Angeles and Long Beach, experienced significant growth in container volume over the past two decades, although there was a substantial decline in the recession years (late-2007 through mid-2009). Over the last decade, U.S. container trade volumes have become more concentrated in fewer leading ports. In 2011, the top ten container ports accounted for 62 percent of U.S. seaborne container trade value, up from 58 percent in 2000. Due to the past decade's significant rise in Asia–North America trade, Los Angeles and Long Beach have remained the principal gateway for U.S. container trade, although they handle four times more inbound trade than outbound trade.

Figure 12. **TOP 20 U.S. CONTAINER PORTS BY VOLUME (TEUS) AND DEPTH**



Source: Parsons Brinckerhoff, Panama Canal Expansion Study, June 2012

Figure 13. **GROWTH IN CONTAINER TRAFFIC (1990 to 2011, includes empties)**



Source: American Association of Port Authorities, 2012

3.6.2 NON-U.S. WEST COAST CONTAINER PORTS

Canadian and Mexican ports and their rail connections are important components of the North American transportation network. To the extent these ports and rail corridors serving the West Coast are competitive with U.S. West Coast ports and railroads and are able to provide less expensive, timelier, or more reliable transportation services, West Coast alternatives to the Panama Canal will be strengthened, lessening potential impacts of the Panama Canal expansion. This is particularly true because the greater utilization of the Panama Canal for Asia-U.S. East Coast shipping over the last decade has been driven, at least in part, by concerns about access to U.S. West Coast ports due to port and landside congestion, labor issues, and environmental impacts—for which the non-U.S. ports offer a partial alternative. Although U.S. West Coast ports have implemented important steps to address the above access concerns, recent developments at the ports of Prince Rupert (British Columbia) and Lazaro Cardenas (Mexico) could alter patterns of cargo flows into the United States through West Coast routes. A brief description on each port development follows.

Prince Rupert, British Columbia, Canada

The Port of Prince Rupert, on the West Coast of Canada, consists of three cargo terminals capable of handling deepwater vessels. Prince Rupert is the first purely intermodal port in North America (having only a very small local market) and is served only by Canadian National Railway's (CN) northern main line, which offers service to the U.S. Midwest and Gulf Coast, as well as to Eastern Canadian regions. Because Prince Rupert was designed for rapid connections to CN's rail network and is the closest North American West Coast port to Asia (by about 1,000 nautical miles relative to Los Angeles/Long Beach), its container traffic has grown rapidly (albeit from a small base) since its opening in 2007. In 2011, volume totaled over 410,000 TEUs. The Port of Prince Rupert can accommodate 500,000 TEUs per year with vessels having drafts of 55 feet and, under a proposed Phase II expansion plan, would be able to handle two million TEUs per year. Moreover, a second container terminal is being designed to enable the Port to handle up to five million TEUs by 2020.[30] Other cargo facilities at Prince Rupert include a coal export terminal that handles about two million tons per year and a grain terminal with a throughput capacity in excess of seven million tons a year. The United States currently does not have coal handling facilities at its ports along the West Coast.

Cargo port/intermodal rail station; Vancouver, BC, Canada

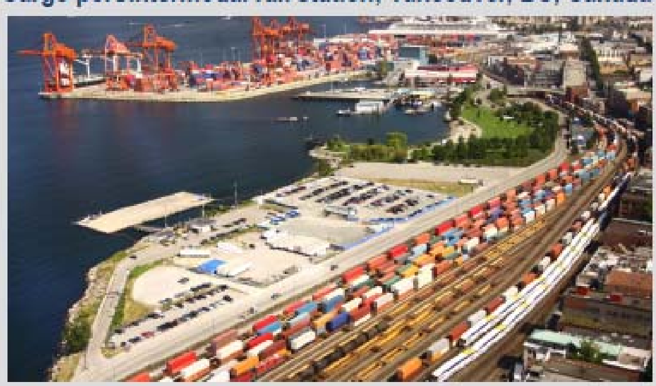


Photo courtesy: iStock

Vancouver, British Columbia, Canada

The Vancouver port complex, near the U.S.-Canadian border, is accessed through the Strait of Georgia and the Frasier River. It serves the Vancouver metropolitan area and portions of the U.S. Pacific Northwest, but primarily provides a gateway for Asian

[30] Prince Rupert Port Authority. *A Vision for the Future*. Available at: http://www.rupertport.com/trade/vision.

cargo to British Columbia's lower mainland, the Prairie Provinces, the U.S. Great Lakes region, and Eastern Canada. Canada has undertaken a $1 billion (Canadian) Asian-Pacific Gateways and Corridor initiative to improve rail service to the U.S. Midwest by providing grade separation and increasing intermodal capacity at several locations along the Canadian corridor between Vancouver and Winnipeg. Because Vancouver is primarily a container gateway for trade between Northeast Asia and Canada/U.S. Midwest markets, the Panama Canal expansion is not expected to alter the port's flow of traffic to and from the United States. The Port of Vancouver handled 2.5 million TEUs in 2011, and, because it has the ability to serve vessels drafting up to 51 feet, is seeking to service as many as seven million TEUs per year by 2020.

Lazaro Cardenas, Michoacan, Mexico

In 2005, Kansas City Southern (KCS) completed the purchase of a controlling interest in Transportacion Ferroviaria Mexicana (TFM), creating the 1,300-mile Lazaro Cardenas-Laredo rail transportation corridor connecting Mexico's Pacific seaports with Central Mexico and U.S. South Central markets. This corridor could become an alternative gateway to the U.S. West Coast ports for Asian goods destined for U.S. inland regions. As the largest Mexican seaport, the Port of Lazaro Cardenas has an annual throughput capacity of 25 million tons of cargo and two million TEUs. The port handled nearly one million TEUs in 2011 and can accommodate vessels with 52-foot drafts or more. APM Terminals, a division of Denmark's A.P. Moller-Maersk Group, is scheduled to complete the first phase of a second container terminal at the port in 2015. The four-berth terminal will have an estimated throughput capacity of two million TEUs annually.

Punta Colonet, Baja California del Norte, Mexico

The port development of Punta Colonet has been proposed since the early 2000s, but it was not until December 2009 that the Mexican government issued urban and port development plans for the proposed facility. Located about 150 miles south of the U.S. border, Punta Colonet is envisioned to have a capacity of one million TEUs and to serve as a lower-cost alternative to the Los Angeles/Long Beach ports for Asian container traffic to and from U.S. South Central and Midwest states. To accomplish this, developers would have to construct a 400+ mile rail link connecting with the Union Pacific main line at or near Yuma, Arizona. From there, developers have envisioned land bridge operations serving inland markets in the Midwest.

The economic feasibility of this proposed project is still under consideration. If developed, the effects of this project would be expected to strengthen non-U.S. West Coast alternatives (potentially diverting cargo from other West Coast ports). By adding more capacity to the West Coast and providing lower cost rail access to the United States, it could also lessen the attractiveness of all water access to the U.S. East Coast. Lower cost service to Central and Midwest States could also adversely affect the potential for Panama Canal service to these areas via the Gulf ports. There would be only limited effects on Panama Canal traffic to the U.S. East Coast.

3.6.3 PORT AND RELATED INFRASTRUCTURE CAPACITY CONSTRAINTS

The degree to which the Panama Canal expansion may affect cargo movement in the United States will depend heavily on the capacities, performance, and operating conditions of North American port facilities. Factors that could limit Panama Canal expansion impacts, including the navigability of U.S. East Coast and Gulf Coast ports, air draft restrictions, terminal capacity, and landside connectivity are addressed in the following section.

Navigability of U.S. East Coast and Gulf Coast Ports

After the opening of the Panama Canal expansion, liner companies will likely begin to deploy larger container vessels on long distance, high-volume trade routes in order to benefit from economies of scale. Ports that will receive the largest of these ships must have channels and water depths alongside berths that are 50 feet deep to accommodate the largest Post-Panamax vessels which, fully laden, require 47.6 feet of draft without tidal restrictions. All the major West Coast container ports (Los Angeles, Long Beach, Oakland, Seattle, Tacoma, Vancouver, and Prince Rupert) already have sufficient water depth to accommodate these vessels, and four major ports on the East Coast can handle such large ships already (Baltimore, MD and Norfolk, VA) or will be able to do so by the time the expanded Panama Canal opens (Miami, FL and New York/New Jersey). Other East Coast ports are making preparations for dredging to channel depths of 45 feet or more, depths that can accommodate many of the Post-Panamax ships.

Table 13 summarizes the current and planned future channel depths for the primary East Coast container ports.[31] The U.S. Army Corps of Engineers (USACE) is responsible for studies to investigate the economic impacts of port improvement projects, including channel deepening, in many of these ports. Several of these projects have been designated for expedited review and several others have progressed beyond the design stage.[32]

[31] U.S. Army Corps of Engineers. "U.S. Port and Inland Waterways Modernization: Preparing for Post-Panamax Vessels". *Institute for Water Resources*. June 12, 2012. Available at: http://www.iwr.usace.army.mil/Missions/Navigation/PortandInlandWaterwaysModernizationStrategy.aspx.

[32] White House, *Executive Order -- Improving Performance of Federal Permitting and Review of Infrastructure Projects*. July 19, 2012. Available at: http://www.whitehouse.gov/the-press-office/2012/07/19/we-can-t-wait-obama-administration-announces-5-major-port-projects-be-ex.

Table 13. CHANNEL DEPTHS AT PRIMARY EAST COAST CONTAINER PORTS

Port	MLW Channel Depth	Planned Channel Depth	Scheduled Completion Year
Boston	40 ft (12.2 m)	48-50 ft (14.6-15.2 m)	Currently under study[33]
New York	45-50 ft (13.7-15.2 m)	50 ft (15.2 m)	2014[34]
Delaware River	40 ft (12.2 m)	45 ft (13.7 m)	2017[35]
Baltimore	50 ft (15.2 m)	No immediate plans	No immediate plans[36]
Hampton Roads	50 ft (15.2 m)	55 ft (16.8 m)	Not available[37]
Wilmington, NC	42 ft (12.8 m)	>42 ft (>12.8 m)	Currently under study (Report Expected Jun. 2014)
Charleston	45 ft (13.7 m)	>47 ft (>14.3 m)	Currently under study (Report Expected Sept. 2015)
Savannah	42 ft (12.8 m)	≥47 ft (≥14.3 m)	2016[38]
Jacksonville	40 ft (12.2 m)	45-47 ft (13.7-14.3 m)	Currently under study[39]
Port Everglades	42-45 ft (12.8-13.7 m)	>48 ft (>14.6 m)	Currently under study[40]
Miami	42 ft (12.8 m)	50 ft (15.2 m)	2014[41]
Mobile	45 ft (13.7 m)	≥50 ft (≥15.2 m)	Currently under study[42]
New Orleans	45 ft (13.7 m)	50 ft (15.2 m)	Currently under study
Houston	45 ft (13.7 m)	No immediate plans	No immediate plans

Source: Port authority websites, NOAA, and U.S. Army Corps of Engineers

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[33] U.S. Army Corps of Engineers. *Boston Harbor Navigation*. Available at: http://www.nae.usace.army.mil/Missions/ProjectsTopics/BostonHarbor.aspx.

[34] U.S. Army Corps of Engineers. *New York and New Jersey Harbor*. Available at: http://www.nan.usace.army.mil/Missions/Navigation/NewYorkNewJerseyHarbor.aspx.

[35] U.S. Army Corps of Engineers. *Delaware River Main Channel Deepening*. April 2013. Available at: http://www.nap.usace.army.mil/Missions/Factsheets/FactSheetArticleView/tabid/4694/Article/6559/delaware-river-main-channel-deepening.aspx.

[36] U.S. Army Corps of Engineers. *Baltimore Harbor and Channels, MD & VA*. Available at: http://www.nab.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/10470/Article/9079/baltimore-harbor-and-channels-md-va.aspx.

[37] U.S. Army Corps of Engineers. *Norfolk District: Civil Works Mission*. Available at: http://www.nao.usace.army.mil/Missions/CivilWorks.aspx.

[38] Georgia Ports Authority. *Savannah Harbor Expansion Project*. Available at: http://www.gaports.com/shep/.

[39] Jacksonville Port Authority. *Harbor Deepening*. http://www.jaxport.com/cargo/maritime-resources/harbor-deepening.

[40] U.S. Army Corps of Engineers. *Port Everglades Feasibility Study: Facts and Information*. Available at: http://www.saj.usace.army.mil/Portals/44/docs/Navigation/Port%20Everglades%20Fact%20Sheet%20July%202013.pdf.

[41] Port Miami. *Deep Dredge*. Available at: http://www.miamidade.gov/portmiami/deep-dredge.asp.

[42] U.S. Army Corps of Engineers. *Draft Environmental Assessment: Mobile Harbor Turning Basin Expansion*. May 18, 2012. Available at: http://www.sam.usace.army.mil/Portals/46/docs/planning_environmental/docs/EA/Draft_EA_MHTB_Expansion%20_2.pdf.

As Table 13 indicates, the Port of New York and New Jersey also has 50-foot water depths in portions of its harbor. USACE is completing a series of dredging contracts that will provide 50-foot water depth to three of the port's major container terminals. The harbor deepening project for the Port of New York and New Jersey includes 17 dredging contracts, 11 of which have already been completed. The 50-foot access to the Newark Bay and Global Marine terminals was completed in December 2012 and deepening the channel to the New York Container Terminal is scheduled to be completed by December 2013.[43] Since Global Marine Terminal is situated ahead of the entrance to the Kill Van Kull, ships calling at the terminal do not transit under the Bayonne Bridge. With no air draft limitations (see below) and 50 feet of water depth at its berths, Global Marine Terminal will be able to handle the largest container vessels transiting the expanded Panama Canal, as well as Post-Panamax vessels arriving from the east via the Suez Canal.

The deepening of the Port of Miami's channel from 42 feet to 50 feet is scheduled to be completed by 2014, making it the fourth East Coast port able to accommodate the largest Post-Panamax ships that can traverse the expanded Panama Canal. After receiving the necessary environmental permits in mid-2012, the construction contract was awarded in May 2013, and the dredge project is scheduled to begin in summer 2013.[44]

Savannah is the second-largest gateway on the East Coast for Asian imports. The Georgia Port Authority's proposed deepening project (expected to cost $652 million) for the Savannah River has recently been designated for a fast-track permit review. With navigation channels of 47 feet, shipping lines deploying large Post-Panamax ships in their Far East–U.S. East Coast services could make calls at the Port of Savannah during periods when tides are favorable.[45]

Jacksonville's Jaxport-Blount Island seaport at Dames Point

Photo credit: iStock

Among the other East Coast ports, Charleston requires the least amount of dredging to deepen its channel to a 50-foot depth. Several other ports, such as Philadelphia, Wilmington (NC), Boston, and Jacksonville, each would need extensive dredging costing at least $250 million per port. Studies for the deepening of the

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[43] U.S. Army Corps of Engineers. *New York & New Jersey Harbor (50 ft Deepening) Navigation Project*, February 2012, Available at: http://www.nan.usace.army.mil/Portals/37/docs/harbor/Harborfact/nynj%2050.pdf.; U.S. Army Corps of Engineers. *New York & New Jersey Harbor (50 ft Deepening) Navigation Project*, July 2013, Available at: http://www.nan.usace.army.mil/Portals/37/docs/harbor/Harborfact/NYNJ%20HDP%20Fact%20Sheet%20JUl%202013.pdf; and Shea, T.J. "NY & NJ Harbor Deepening Project Status Update and Lessons Learned". *U.S. Army Corps of Engineers*. October 25, 2012. Available at: http://dredging12.pianc.us/docs/Thursday/Room%201/shea_10_17_12_pianc.pdf.

[44] Port Miami, Deep Dredge, Op.cit.; and Miami Herald. *Army Corps of Engineers awards contract to deepen Miami port*. May 16, 2013. Available at: http://www.miamiherald.com/2013/05/16/3401727/army-corps-of-engineers-awards.html.

[45] White House, July 19, 2012, Op. cit.

Jacksonville harbor from its existing authorized depth of 40 feet to a navigable channel of up to 50 feet, and accompanying reviews and approvals of a new intermodal container facility at the Port of Jacksonville, are under expedited review at this time.

Air Draft Restrictions

In the Port of New York and New Jersey, plans are advancing rapidly to raise the deck of the Bayonne Bridge, which spans the Kill Van Kull Channel. It is presently too low for larger Post-Panamax ships, limiting access to four of the port's five container terminals. In May 2013, the U.S. Coast Guard approved the Port Authority of New York and New Jersey's planned project to raise the deck of the Bayonne Bridge by 64 feet to address this issue.[46] The $1.3 billion construction project is scheduled to be complete by 2017, with navigational obstructions removed in time for the Panama Canal expansion opening by 2015.[47]. The Bayonne Bridge project was one of seven projects designated to receive expedited permitting under a new federal initiative.[48] Other ports with bridges spanning navigable channels that will be used by Post-Panamax vessels have the same problem including the Port of Long Beach, which is in the process of replacing the Gerald Desmond Bridge.

Terminal Capacity

Ports called upon by much larger container vessels will need the capacity, labor, cranes, and terminal equipment to quickly load and unload greater volumes of cargo from larger vessels and transfer it efficiently from or onto connecting transportation modes within 24 to 40 hours. Although the availability of labor to handle cargo is critical to the capacity of all ports and terminals, an analysis of specific labor contracts and implications for cargo handling capacity is beyond the scope of this study. Therefore, this study and future phases of this project have assumed continued availability of labor consistent with existing conditions and contract arrangements.

Port of Newark Container Terminal

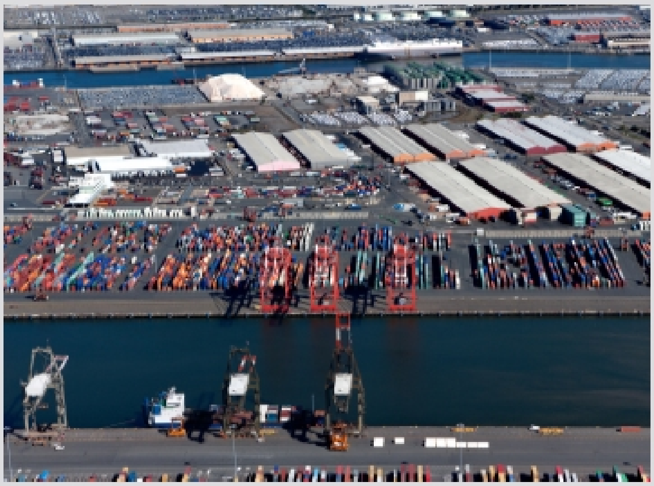


Photo credit: iStock

Several major East and Gulf Coast ports have the berth and yard capacity needed to efficiently process the high-volume exchanges of containers that will be generated by large Post-Panamax ships in Far East–U.S. East Coast services. Other larger container terminals will be able to handle the anticipated additional cargo volumes by investing in terminal

[46] Port of New York and New Jersey, *Bayonne Bridge Navigational Clearance Program: Progress.* Available at: http://www.panynj.gov/bayonnebridge/

[47] Port of New York and New Jersey, *Bayonne Bridge Navigational Clearance Program: Frequently Asked Questions.* Available at: http://www.panynj.gov/bayonnebridge/#faqsBayonneBridgeClearQu13

[48] Ibid.

equipment and systems to achieve higher density operations, implementing cargo storage limits to optimize terminal cargo throughput, and/or making improvements in technology to increase productivity;[49] provided draft and other requirements (e.g., inland connections) are also met.

Moreover, even at those ports that may not have the existing capability to handle increased volumes from Post-Panamax container ships, there remains a significant portion of undeveloped land along the East and Gulf Coast port areas, either at existing port terminals or at greenfield sites in or near existing ports, that can provide supplemental capacity once developed. On the U.S. East Coast, a few gateways, led by Hampton Roads, have the land to quickly expand terminal capacity in response to Panama Canal expansion. At Hampton Roads, both the Norfolk International Terminal and the APM-Portsmouth Terminal can be physically expanded, and the port has already secured an additional site, Craney Island, for a massive new container terminal. At the Port of New York and New Jersey, Global Terminal is scheduled to open an expanded facility in 2014 with a throughput capacity of 1.7 million TEUs. In New York Harbor, Port Newark Container Terminal can be enlarged and the New York Container Terminal on Staten Island could also add an adjacent berth.

In Baltimore, the primary container terminal, Seagirt, has a modest amount of land available for expansion. The other container terminal, Dundalk, could handle significantly more container traffic than is presently moving through it, but this would require both a major investment and the displacement of some non-container traffic. In Charleston, there is a possibility that the North Charleston terminal could be enlarged on its northern side, which would require displacement of non-container traffic. The Port also has a site (transferred from the U.S. Navy) on which a three-berth container terminal could be developed.

The primary container terminals of the Ports of Philadelphia, Wilmington (DE), Miami, Port Everglades and Savannah cannot easily expand their footprints, given the land uses on the bordering parcels; however, they may have ample space for growth on additional acreage elsewhere in the region (e.g. Philadelphia's Southport Marine Terminal, Savannah and Charleston's jointly-owned Jasper Ocean Terminal).

Although Jacksonville has enough open land adjacent to its recently completed terminal at Dames Point to develop another terminal and Wilmington (NC) could enlarge its container terminal by displacing break-bulk warehouses on the facility's northern side, both ports, as noted above, will require extensive and expensive dredging to be seriously considered as ports of call for the major lines' large Post-Panamax vessels.

At the Gulf Coast's dominant gateway, the Port of Houston, one container terminal, Barbours Cut, has minimal ability to be enlarged, while a newer one, Bayport, has room on its eastern border to add another berth and commensurate yard acreage. Although container terminals elsewhere in the Gulf have rather limited possibilities for expansion (with the exception of

[49] Note that U.S. ports have much lower TEU/gross terminal acre averages (2,307) than do Asian and European ports. (For information on improved performance from existing acreage see: The Tioga Group. "Container Port Capacity Study". U.S. Army Corps of Engineers. December 2010. Available at: http://savethecape.org/stcwp1/wp-content/uploads/PDFs/Port%20Capacity%20Report%20Draft120310.pdf).

Tampa), Gulf Coast states are planning for the development of new terminals in expectation of increasing container volumes. For example, the La Quinta Trade Gateway Terminal is being designed for the Port of Corpus Christi, with the capacity to handle about one million TEUs annually. In Port Manatee, FL, construction of a berth extension and the first 10 acres of a planned 52-acre container terminal is expected to be completed by 2013. The state of Louisiana has proposed the development of the Louisiana International Gulf Transfer Terminal, a 250-acre container port 90 miles downriver from the Port of New Orleans.

Without a significant increase in container terminal capacity, the number and geographic configuration of Far East all-water services that can be effectively operated to the East and Gulf Coasts could become constrained over the long term (beyond 2025). Subsequent phases of this study will provide a more in-depth analysis of current port and terminal capacity and any anticipated constraints as a result of the Panama Canal expansion.

Availability of Containers

The availability of containers, for both import and export trade, is also an important consideration. An extreme shortage of containers arose after 2007 due to the worldwide recession that began in December 2007 and ended in June 2009, which caused an abrupt drop in manufacturing of new containers and increased scrapping of older ones. However, the market for containers has since recovered. Remaining shortages in container supply largely reflecting growing demand[50], to which the world container manufacturing market will respond. It is not expected that incremental increases in voyage times caused by rerouting of some containers through the expanded Panama Canal would lead to shortages in available containers that could not be accommodated by the container industry. Localized shortages of containers within the United States may still occur, such as in farm areas of the U.S. Midwest where containers must be repositioned from urban locations to accommodate containerized grain exports, or due to other imbalances in containerized trade that may occur independently of the effects of the Panama Canal expansion. The future supply of containers is not, however, expected to pose any obstacle to changes in service patterns which may arise as a result of the expanded Panama Canal.

Landside Connectivity

Increases in aggregate volumes—along with volume spikes resulting from larger unloads and from larger but relatively fewer ship calls—will make greater demands on landside connections to inland rail and highways. Given that U.S. East or Gulf Coast ports that would become ports of call for Post-Panamax vessels are in or near urban centers (although the size of the urban center varies significantly from port to port), it is often difficult either to increase the volumes moving on current connections or the capacity of those connections.

[50] Pacific Tycoon. *Shipping Container Shortage is a Sign of Economic Growth*. January 16, 2013. Available at: http://pacific-tycoon.blogspot.com/2013/01/shipping-container-shortage-is-sign-of-economic-growth.html.

Although trucking, rather than rail or barge, is—and will likely continue to be—the predominant mode of inland container transport for every East and Gulf Coast port, rail links for a number of these ports must be improved in the near term, for several reasons:

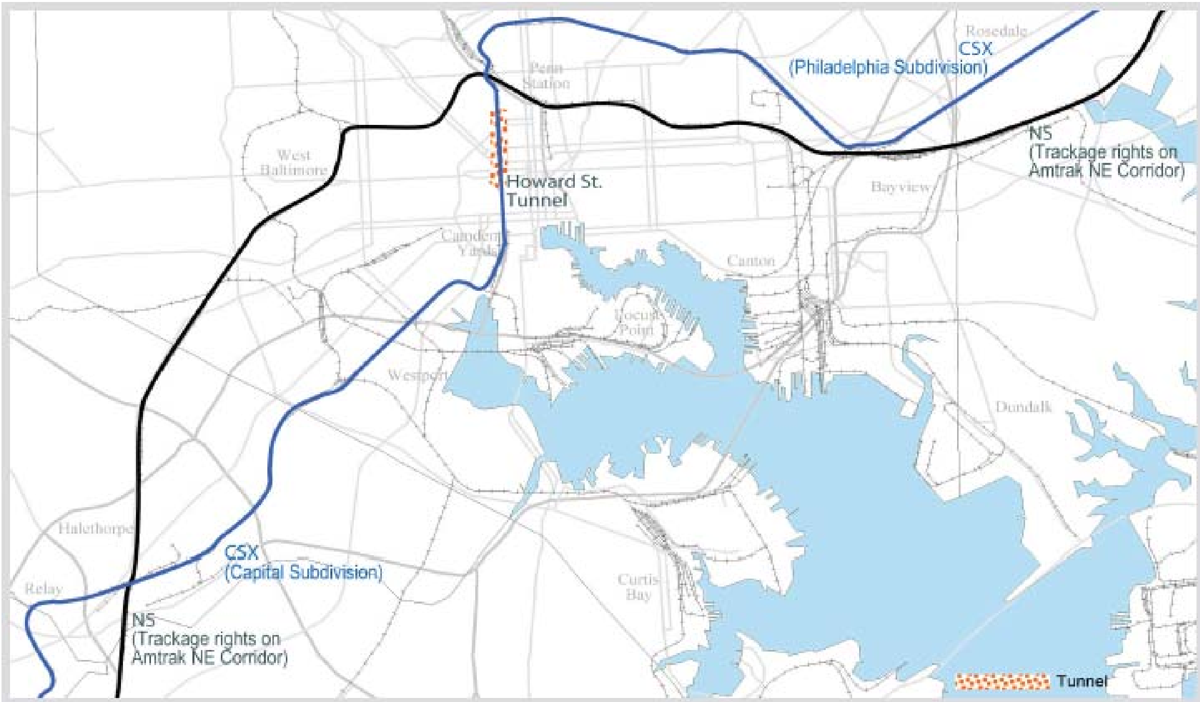
- Building and/or expanding highways serving many East Coast ports, especially those in major cities, is generally much more expensive, time-consuming and difficult than enhancing railroad lines and yards.
- To fill Post-Panamax vessels, liner operators will want to carry traffic for metropolitan markets that are 300-500 miles inland (such as Montreal, Toronto, Buffalo, Pittsburgh, and Cleveland) and will want to use lower-cost (relative to trucking) intermodal rail services via East Coast gateway ports, especially as the volumes will likely be enough to warrant dedicated blocks on trains.
- Increasing the percentage of the port's throughput that moves inland by rail, rather than by truck, helps the port authority, terminal operators, and ocean carriers achieve their environmental objectives and reduce noise, wear-and-tear, and congestion impacts on urban roadways.

Several U.S. East and Gulf Coast ports that are positioned to be called on by Post-Panamax ships on Far East all-water deployments are disadvantaged by the limitations which their locations and hinterland market sizes impose on the rail infrastructure supporting their container terminals.

For example, although Baltimore's two main terminals have on-dock rail transfer facilities, access by double-stack intermodal trains to and from those facilities is impeded by main-line infrastructure factors. CSX trains between the Seagirt/Dundalk marine terminals and the Ohio Valley and Southeast must transit the Howard Street Tunnel in Baltimore, which is too low for high-cube containers to be loaded on the top tier of a stack car. [51] To address this constraint, CSX will, as part of its National Gateway initiative, relocate its intermodal facility from the Seagirt to a nearby location in Baltimore south of the Howard Street Tunnel that will enable double-stack rail service to the Midwest. For Norfolk Southern (NS), which uses Amtrak's Northeast Corridor main line between Baltimore and Perryville to move intermodal trains to and from the Great Lakes region, that line's electric catenaries impose similar height restrictions.

[51] The CSX National Gateway project does not include removal or replacement of the Howard Street Tunnel.

Figure 14. PORT OF BALTIMORE RAIL ACCESS



Source: Maryland Department of Transportation; Revisions by Parsons Brinckerhoff, June 2012

Charleston is another major East Coast port with suboptimal rail connectivity; its largest container terminal (Wando-Welch) lacks direct rail service and the nearest intermodal terminal is more than 10 miles away. Its other two terminals have on-dock rail tracks but lack the space in which to construct a more efficient transfer facility.

There is a small rail facility within Jacksonville's Talleyrand Terminal and on-dock rail is also available at the Port of Palm Beach. The other two of Florida's four Atlantic Coast container ports presently lack an on-dock intermodal rail terminal. However, construction is underway at both Port Everglades and the Port of Miami to connect rail services to intermodal terminals. While New York's five marine container terminals now have or (in the cases of the Global Terminal and Port Newark Container Terminal [PNCT]) soon will have either on-dock or near-dock intermodal transfer facilities, none currently have the track and intermodal yard capacity to support the peak volume levels that would be generated by a large Post-Panamax ship on a Far East all-water service making a first-inbound call (at which 45–50 percent of its capacity could be discharged). Moreover, because of passenger and freight train densities in the North Jersey area, the Class I railroads serving these ports are actively pursuing further improvements to support it as a gateway for Post-Panamax deployments. The Port Authority of New York and New Jersey is improving rail access to the port through its ExpressRail program, and increasing the share of containers moved by train. Currently, rail moves only about 15 percent of containers; trucks carry almost all the remainder.[52]

3.7 MOVEMENT OF GOODS BETWEEN PORTS AND INLAND MARKETS

So far, we have described the global ocean transportation system and U.S. ports. This section provides an overview of the movement of goods between U.S. ports and inland areas by rail, truck, and waterways and how these movements may be affected by Panama Canal expansion. Rail and trucking are the principal modes used for the inland moves of containerized U.S. imports from Northeast Asia, the trade that will be most affected by Canal expansion. Waterways are used primarily to transport bulk commodities for which Canal expansion may increase export opportunities. Waterways may also provide a cost-effective alternative for handling increased container trade, by moving traffic off congested highways and onto Marine Highway corridors.

3.7.1 WEST COAST GATEWAYS AND CORRIDORS

U.S. West Coast ports handle most containerized U.S. imports from Northeast Asia—69 percent of 2010 and 2011 tonnage, according to U.S. Census Bureau data. The principal West Coast port gateway regions for moving goods into the United States, by order of size, are as follows (Canadian and Mexican ports have relatively small shares):

- Southern California (Los Angeles, Long Beach and San Diego)
- Pacific Northwest (Seattle, Tacoma and Portland)
- Northern California (Oakland)
- British Columbia (Prince Rupert and Vancouver)
- Mexico (Lazaro Cardenas)

With the exception of Prince Rupert and Lazaro Cardenas, each of these West Coast gateway regions serves a large local market and also acts as a gateway into U.S. inland regions. From gateway ports[53], goods move into inland regions in one of three ways:

- By North American rail intermodal services provided by the West Coast Class I railroads. Transfer to rail connections may occur at on-dock or off-dock locations, the latter requiring local truck drayage. (The intermodal systems of Class I railroads are described in Appendix 2.)

[52] The Port's $600 million ExpressRail program provides dedicated rail facilities and additional support track and rail yards for each of the port's major container terminals. These facilities include ExpressRail Elizabeth, ExpressRail Newark, and ExpressRail Staten Island. The support yards include the Corbin Street Intermodal Support Yard and the Arlington Yard on Staten Island.

[53] "America's freight transportation gateways-seaports, airports, and land border crossings . . . are the entry and exit points for merchandise trade between the United States and countries around the world." (U.S. Department of Transportation. "America's Freight Transportation Gateways". *Research and Innovative Technology Administration: Bureau of Transportation Statistics*. November 2009. Available at: http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/americas_freight_transportation_gateways/index.html).

- By truck to inland destinations.
- By truck to transload centers where the contents are unpacked from 40-foot international containers and repacked into 53-foot domestic containers for more efficient transport to inland locations. The largest transloading area is the "Inland Empire," about 60 miles from the large port complex of Los Angeles and Long Beach.

Trucks typically provide last mile delivery of intermodal containers from inland railheads—most freight trips will involve at least some truck participation.

3.7.2 WEST COAST INLAND CORRIDORS

To a limited extent, West Coast gateways specialize in reaching U.S. inland regions based on geography and costs, although most serve substantial local markets as well. Prince Rupert specializes in intermodal moves to Chicago and Memphis via the Canadian National railroad (see Figure 40 in Appendix 2). While Canadian and U.S. West Coast ports all serve Chicago and the Midwest, Pacific Northwest ports have a comparative advantage in reaching more northerly inland markets (such as Minneapolis). Southern California ports have a similar comparative advantage in moving goods to Texas or the Southeast. Lazaro Cardenas' target market in the United States is Texas and the Gulf Coast (see Figure 44 in Appendix 2). Figure 15 provides an overview of transit times from Northeast Asia to U.S. major inland destinations that may be reached through West Coast ports versus U.S. East Coast ports, showing ocean transit times and intermodal transit times.[54] In some cases, faster, premium train services are available, with transit time from Los Angeles to Chicago of 51 hours.

Rail Efficiencies

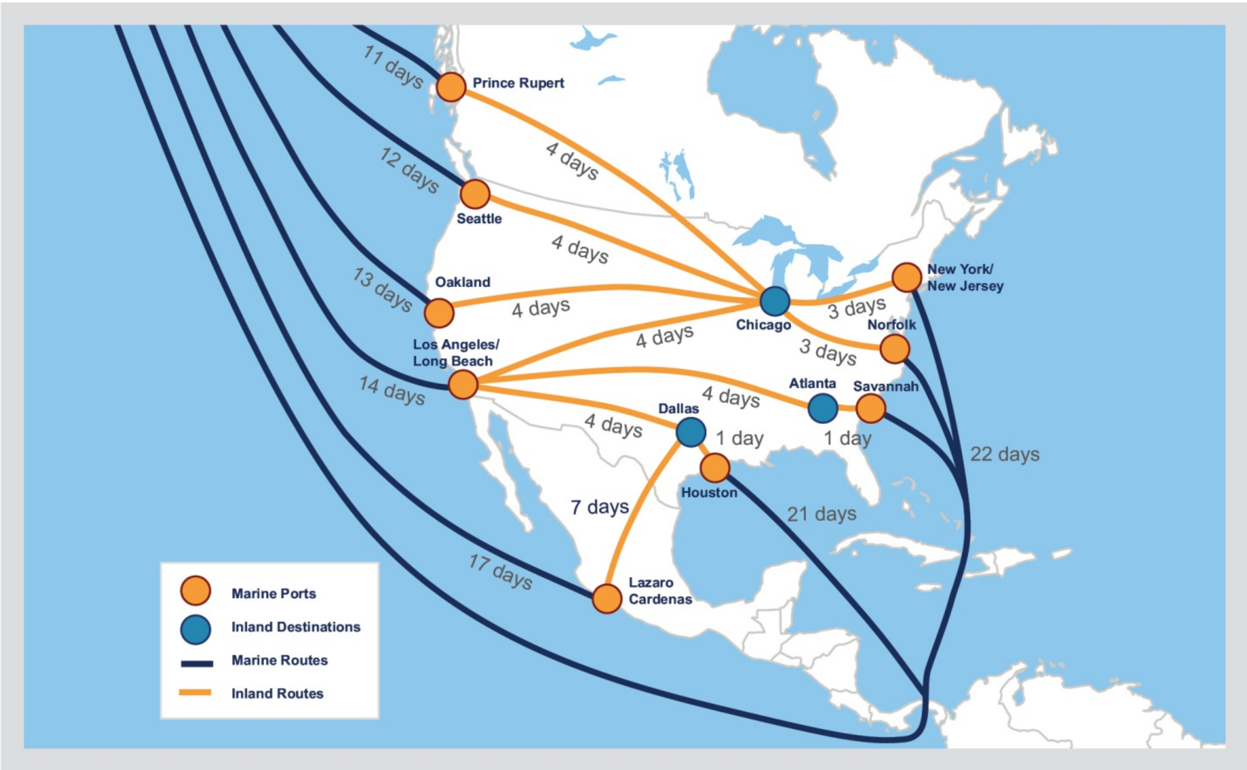
Goods moving by rail in the West Coast inland corridors described above are generally transported on double-stack trains, which move containers more efficiently than older single-stack cars and trains. Efficient container transport also depends on long "unit trains" that provide economies of scale. Until 1990, there were fewer than 100 double-stack trains a week moving in North America, with virtually all the moves being East-West to and from California. More recently, more than 3,000 double-stack trains have moved weekly in all directions from both maritime gateways and domestic intermodal rail facilities.

Western railroads are also improving train efficiency. Typical double-stack container unit train lengths in the recent past have been from 6,000 feet (200 container capacity) to 7,500 feet (250 container capacity) in length, but on high volume routes (such as Los Angeles to Chicago) trains of 10,000 (325 container capacity) to 12,000 feet (400 container capacity) have been introduced over the last several years, with experiments involving a length of 18,000 feet (600 container

[54] Inland times in Figure 15 represent approximate transit times (rounded to days) to the major inland market destinations of Chicago, Atlanta and Dallas from West Coast ports compared to transit times from East Coast ports. These times represent intermodal times from rail carriers' schedules (except for Houston to Dallas which represents approximate transit time by truck). These times do not represent total intermodal transit times or schedules from West Coast ports to East Coast markets (the times are not additive).

capacity).[55] The larger unit trains, which are possible given the very large container volumes from some West Coast ports, offer lower per unit costs for moving containers inland and could enable West Coast ports to compete more effectively for cargo that might otherwise be drawn to East and Gulf Coast ports via the Panama Canal.

Figure 15. ROUTES FROM NORTHEAST ASIA TO MAJOR INLAND DESTINATIONS (CHICAGO, ATLANTA, DALLAS/FT. WORTH)



Source: Parsons Brinckerhoff, Panama Canal Expansion Study, June 2012

3.7.3 EAST AND GULF COAST GATEWAYS AND CORRIDORS

East and Gulf Coast gateway ports handle a much smaller share of containerized imports from Northeast Asia than U.S. West Coast ports—31 percent of 2011 tonnage, according to U.S. Census Bureau data. This cargo is handled by a more diffuse network of ports and inland transportation services. Eleven East Coast gateway ports (Halifax, Boston, New York/New Jersey, Baltimore, Hampton Roads, Wilmington [NC], Charleston, Savannah, Jacksonville, Port Everglades and Miami) and four Gulf Coast gateway ports (Tampa, Mobile, New Orleans, and Houston) handle Asian container traffic. Because this cargo is moved shorter distances to closer local markets, and because (until recently) double-stack rail service has been unavailable, more

[55] Mongelluzzo, B. "Union Pacific Tests Ultra Long Train". *Journal of Commerce*. January 13, 2010. Available at: http://www.joc.com/rail-intermodal/union-pacific-tests-ultra-long-train.

of it is moved by truck than by rail. In 2010, 75 percent of container cargo tonnage imported from Northeast Asia through East and Gulf ports was moved by truck to inland destinations.[56]

Compared to West Coast ports, East Coast ports have a much lower load density for supporting regular and efficient container unit-train operations. Most rail cargo from East Coast ports must be moved to inland locations before it can be reconfigured into denser and more balanced trains. For example, the Port of Tacoma has the density to operate a full unit train a week just for Memphis delivery, while rail cars from Charleston, Savannah and Jacksonville (although starting far closer to Memphis) would have to move to Atlanta to be reconfigured into a Memphis-bound train. It remains to be seen whether Panama Canal expansion can bring enough new container traffic to East Coast ports to lower the unit costs of their train operations.

Recent Developments in Rail Networks

Railroads serving East and Gulf Coast ports (CSX, Norfolk Southern Railway [NS], Florida East Coast Railway [FEC], Kansas City Southern Railways [KCS], Canadian National Railway [CN] and Canadian Pacific Railway [CP]) have been developing new high-speed double-stack corridors in anticipation of the growing intermodal market for East and Gulf Coast ports. These corridors include the Heartland Corridor (NS), the National Gateway (CSX) and the Crescent Corridor (NS), among others. See Appendix 2 for a description and the locations of these corridors. Details on the funding initiatives that enabled the development of several of these corridors are provided in section 3.11.3 of this report, "Innovative Developments in Financing, Operation, and Ownership." KCS and CN have increased their capacities for high-volume, north-south, double-stack service; KCS has initiated a double-stack routing from Lazaro Cardenas.

3.8 NORTH AMERICAN TRUCKING AND PORT DRAYAGE

Trucking is an essential component of the North American inland transportation system, carrying over 70 percent of total U.S. cargo tons imported through West Coast ports and over 60 percent of such imports through East and Gulf Coast ports in 2010.[57] These shares vary by type of cargo and final destination.

Trucking is the primary mode of transportation serving most markets close to ports. There are few alternatives, no matter the cost or how congested local highways and bridges may be. For some intermediate distances, long-haul trucking may be cost-competitive with rail, especially where intermodal rail nodes are far from the origin or destination, requiring local trucking at a marginally higher cost. However, for moving goods to more distant inland locations, movement by rail becomes a preferred alternative. For West Coast gateway ports, the large majority of containers moved to distant inland markets are transported by rail (including transloaded and drayed containers to off-dock rail yards).

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[56] FHWA FAF3 data and study team analysis.

[57] FHWA FAF3, U.S. waterborne imports, including inland moves by rail, truck, water and multiple (intermodal) modes.

Shippers making routing decisions face a wide variety of concerns (many unrelated to Panama Canal expansion) that may affect the ultimate cost of transportation, including port and terminal access (the "last mile"), road congestion (especially in major urban areas such as Los Angeles and New York) and the environmental impacts of trucking and port drayage. Government regulations at the local, regional, state and federal levels may also affect costs and therefore impact routing decisions. These issues are outlined in Appendix 3. To the extent that they affect port and inland capacity or incremental transportation costs that may, in turn, affect routing decisions related to Panama Canal expansion, they will be considered more fully in the next phase of this study.

3.9 WATERWAYS

The United States has approximately 12,000 miles of inland and intracoastal waterways that are used for commercial transportation of goods and are maintained by USACE. These inland waterways serve 38 states and carry up to 10 percent (depending on distance of the move) of the volume of freight moved between U.S. States and cities.[58]

In terms of imports and exports, the inland waterways primarily service three U.S. coastal port areas. These include the port complex from Baton Rouge to the Gulf in South Louisiana, the port of Mobile, AL, and the port of Portland, OR. Impacts of the Panama Canal expansion are important for the ports in Louisiana and Mobile Bay for two reasons. First, they handle large volumes of bulk commodities, such as grain, that are exported by the United States. Some of these commodities are transported through the Panama Canal. The potential economic impacts resulting from Panama Canal expansion could result in shifts among ports that handle bulk exports and an overall increase bulk export volumes. Second, expanded utilization of America's Marine Highway system could provide a cost-effective alternative to both trucks and intermodal rail for container transport in some cases.[59]

Coal barge sailing down the Ohio River in Cincinnati, OH

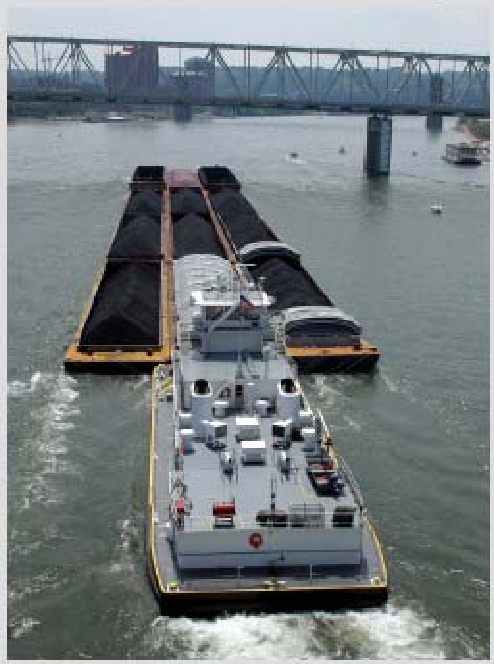

Photo credit: iStock

[58] Federal Highway Administration. "Freight Facts and Figures 2012". *Office of Operations: Freight Management and Operations*. January 2013. Available at: http://www.ops.fhwa.dot.gov/freight/freight_analysis/nat_freight_stats/docs/12factsfigures/figure2_1.htm.

[59] Water movements of domestic dry and liquid bulk commodities are treated separately from Marine Highway services, which the Maritime Administration has defined as the movement by water of passengers and freight in containers and trailers.

U.S. Inland Waterways

Not limited by highway weight restrictions or rail clearance limitations, the inland waterways can be more cost-efficient than other modes for moving cargo (especially heavy or hazardous materials), depending on the route. For example, a typical tow of 15 barges on the Upper Mississippi River can move about 22,500 tons as a single cargo unit, equivalent to 225 railcars or 870 tractor-trailer units.[60] This additional carrying capacity translates into greater fuel efficiency on a ton-miles per gallon basis. An inland barge tow carries approximately 575 tons every mile per gallon of fuel used while comparative railroad and truck fuel efficiency is approximately 412 and 155 ton-miles per gallon, respectively.[61] According to USACE, the inland waterways handled about 566 million tons of domestic cargo in 2010. Although not components of inland waterways, other U.S. domestic waterborne transportation, including coastwise, Great Lakes, internal, intraport, and intra-territory movements, accounted for an additional 327 million tons of domestic cargo—a total of 893 million tons of domestic cargo moved by water in 2010. The cargoes are mostly bulk commodities and raw materials such as coal (24 percent of the tonnage), petroleum (35 percent), crude materials (including aggregates and iron ore) (18 percent), grain and farm products (nine percent), chemicals (eight percent), various manufactured goods (five percent), and other materials.[62]

While the inland waterways account for a relatively small portion of the nation's overall freight tonnage, they remain a primary means of transport in certain regions of the country, particularly for the long distance movement of bulk goods that are coming from or going to an area near an inland waterway. They are particularly important to the transportation of U.S. agricultural commodities for export. The Mississippi River system is the primary conduit for cargoes from the nation's Midwest grain belt to Gulf ports. According to a recent USACE report, approximately 60 percent of grain (more than 2.8 billion bushels) inspected for export moved from inland grain elevators to the Port of New Orleans and the Port of South Louisiana via the Mississippi River in 2010.[63]

Reductions in transportation costs due to Canal expansion could affect the movement of goods through the inland waterways in two ways. First, a reduction in ocean transportation costs out of Gulf ports due to the use of larger, more efficient bulk ships will tend to reduce aggregate costs of exporting bulk commodities, such as grain, by the Mississippi River route rather than by rail through Pacific Northwest ports. Bulk volumes would therefore tend to increase on the

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[60] U.S. Army Corps of Engineers. "Value to the Nation: Inland Waterway Navigation". *Institute for Water Resources*, May 2000. Available at: http://www.muskogeeport.com/images/uploads/Inland_Waterway_Navigation_Value_to_the_Nation.pdf.

[61] The Texas Transportation Institute, "A Modal Comparison of Domestic Freight Transportation Effects on the General Public". U.*S. Department of Transportation, Maritime Administration* and *National Waterways Foundation*. March 2009. Available at: http://www.americanwaterways.com/press_room/news_releases/NWFSTudy.pdf.

[62] U.S Army Corps of Engineers. *Waterborne Commerce of the United States: Calendar Year 2011 – Part 5: National Summaries*. Available at: http://www.navigationdatacenter.us/wcsc/pdf/wcusnatl11.pdf.

[63] U.S. Army Corps of Engineers. *U.S. Port and Inland Waterways Modernization: Preparing for Post-Panamax Vessels*. June 12, 2012. Available at: http://www.iwr.usace.army.mil/Missions/Navigation/PortandInlandWaterwaysModernizationStrategy.aspx.

Mississippi River and decrease on rail routes to West Coast ports. Second, lower transportation costs attributable to expansion of the Panama Canal could increase export volumes as the transportation element of U.S.-produced commodity costs helps to make U.S. exports more competitive in world markets. One recent study indicates that an all-water route between Northeast Asia and U.S. Gulf ports served by larger bulk vessels could result in a cost reduction of up to $0.35 per bushel for exported soybeans, representing a 13 percent reduction in transportation costs.[64]

Overall traffic levels on the Mississippi River have been experiencing a long-term decline. Although the new Panama locks will accommodate bulk carriers with significantly more carrying capacity than current vessels serving this trade, the impact of these larger bulk carriers is not anticipated to require the expansion of the locks on the Mississippi River or the Illinois Waterway to accommodate the barge traffic needed to supply these vessels, at least in the near-term.[65] However, as noted in USACE report, were the inland waterways to become more congested due to increases in barge traffic, inland transportation costs may increase. An increase in barge transportation costs on the inland system could partially offset some of the ocean transportation costs reductions attributable to the use of larger bulk ships.

America's Marine Highways

Through the 2007 Energy Independence and Security Act, Congress directed the U.S. Department of Transportation (DOT) to implement the America's Marine Highway (AMH) Program. This program has the potential, by shifting freight and passenger services to underutilized waterways, to reduce congestion on highways and roads, reduce greenhouse gas emissions, contribute to improvements in safety, and provide additional sealift military resources to support national defense. Through this program, the Secretary of Transportation has designated 18 marine highway corridors throughout the United States, each of which is named after the congested interstate highway corridor it parallels (see Figure 16 for a map of the corridors).

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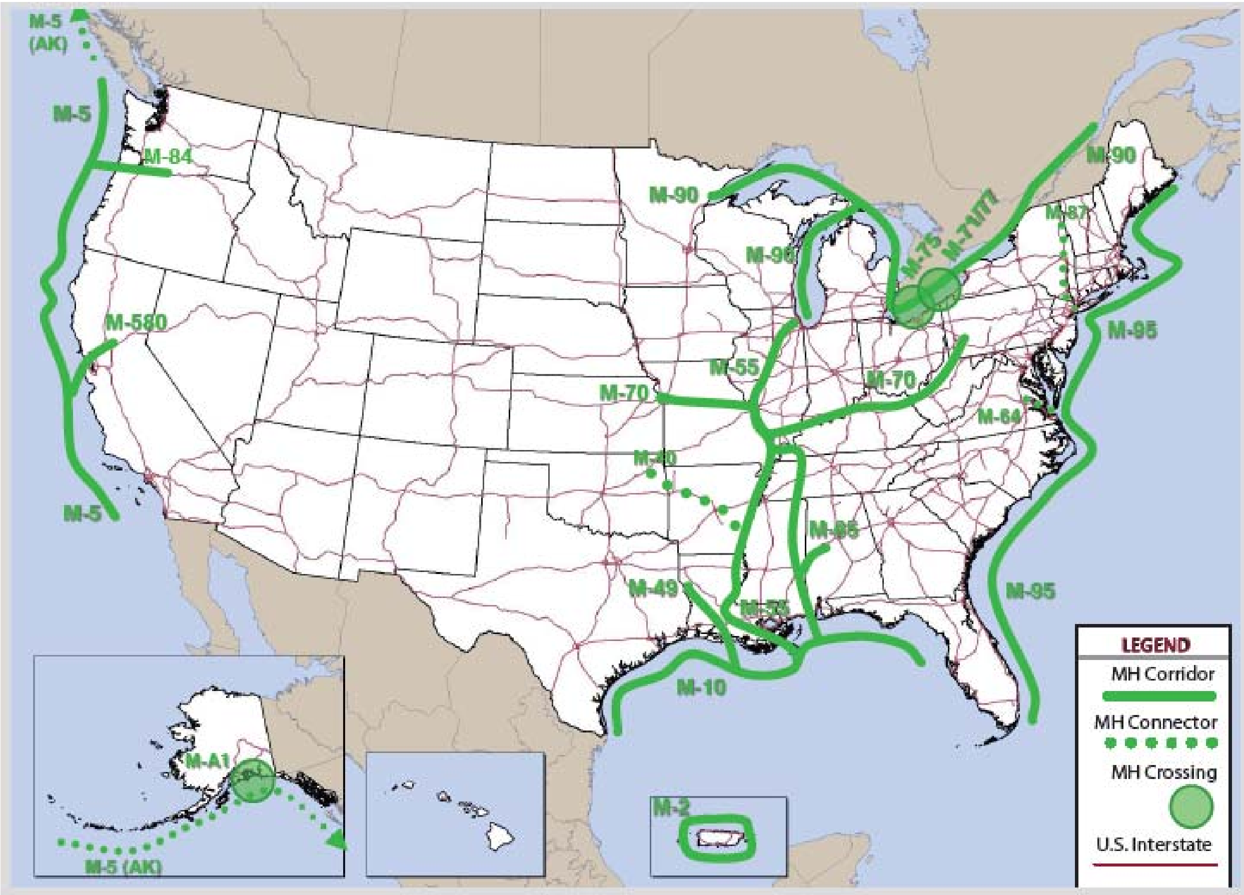
[64] Informa Economics. "Panama Canal Expansion: Impact on U.S. Agriculture", *United Soybean Board, U.S. Soybean Export Council and Soy Transportation Coalition*. September 2011. Available at: http://www.unitedsoybean.org/wp-content/uploads/Panama-Canal-Expansion-Impact-on-US-Agriculture.pdf.

[65] U.S. Army Corps of Engineers, June 12, 2012, op.cit., pp. 56-58.

Figure 16. MARINE HIGHWAY CORRIDORS



Source: U.S. Maritime Administration, February 2011

The Marine Highway Program was fully implemented in April 2010 through publication of a Final Rule in the Federal Register.[66] The 18 marine corridors consist of 11 major waterways, four connectors, and three crossings. These corridors include routes where the ample water capacity for freight transport, when added as an intermodal option, presents an opportunity to carry commercial traffic that would otherwise move on congested landside corridors, reduce highway-related air emissions, and address other logistics challenges.[67]

One of the likely impacts of Panama Canal expansion is more concentrated large vessel calling patterns at larger East and Gulf Coast hub ports. This suggests the possibility that international goods could then be transferred to U.S. flag coastal feeder vessels destined for smaller ports along the Mississippi River, Tennessee-Tombigbee River, Gulf Coast and Atlantic seaboard. However, the viability of this form of potential coastwise service is uncertain due to the

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[66] Government Printing Office. "America's Marine Highway Program". *Federal Register*. Volume 75, Number 68, pp. 18095-18107. April 9, 2010. Available at: www.gpo.gov/fdsys/pkg/FR-2010-04-09/html/2010-7899.htm.

[67] U.S. Department of Transportation. "America's Marine Highway Program." *Maritime Administration. Program Description Page*. Available at: http://www.marad.dot.gov/ships_shipping_landing_page/mhi_home/mhi_home.htm.

economics of operating coastal feeder services and the inability of these services to capture, in the form of revenues, the benefits of reducing landside congestion and air emissions.

Tug assisting large container ship maneuver in port

Photo courtesy: Seafarers International Union

Furthermore, while the waterways may be more cost efficient in some instances, the potential acceptance of marine highway services by container cargo beneficial owners is diminished by lack of existing services available along coastal routes. Federal or State government funding assistance such as grants or loan guarantees for capital investments, or operating subsidies, could support marine highway development, including construction of purpose-built vessels. In this case, the development of marine highway services based on transshipment of international trade flows could also provide domestic freight savings by supporting the development of waterborne freight cargo services where they may not be viable on a stand-alone domestic freight basis.[68]

3.10 TRANSPORTATION NETWORK ECONOMICS AND COST

Preceding sections have reviewed components of the global and U.S. transportation network, including the Panama Canal. This section looks at these components as part of a global network of linked transportation services.

Transportation services are mainly offered by independent providers who typically have operating agreements with the other transportation providers in the network. To move containerized goods from a manufacturing location in China to a U.S. inland location, for example, ocean carriers provide liner services from ports in China to North American ports, whereupon these ports and their terminal operators provide container handling and storage services that provide connections to rail or trucking services operated by railroads or trucking companies, or through intermodal marketing companies. There are, of course, many variations to this pattern. Ocean carriers may also own port terminal operators or full-service logistics providers. End-to-end transportation costs and rates for services may be provided to shippers by third parties (e.g., freight forwarders, non-vessel operating common carriers and brokers) or by the carriers themselves. These arrangements are the results of negotiated agreements between providers, with each network component generally setting its rates based on its own costs and market position. Whether packaged together as a single rate or added up individually, rates and costs ultimately depend on the total costs of all the service providers in the network. For more detail on factors that affect network design, see Technical Notes Section TN - 6.

[68] For more information on the potential contributions of America's Marine Highway Program, refer to the DOT Maritime Administration's Report to Congress (U.S. Department of Transportation. "America's Marine Highway Report to Congress". *Maritime Administration*. April 2011. Available at: http://www.marad.dot.gov/documents/MARAD_AMH_Report_to_Congress.pdf).

3.10.1 INTERACTION OF TIME, RELIABILITY, AND TRANSPORTATION COSTS

Three factors are generally considered to be the prime determinants of how goods are moved: reliability, transit time, and transportation costs. Of these three, reliability is the most subjective. Reliability can be influenced by variation in transit time, frequency of transportation service, flexibility of distribution networks, or many other factors. Ultimately, however, it reflects the shipper's confidence that cargo will consistently arrive at its specified destination on schedule, in good condition, and at predictable rates. Transit time is important in determining how goods move because "time is money." Higher-value products tend to be shipped on faster routes and services, with the most valuable goods shipped by air, if possible. Later sections of this report will discuss differences in how higher value goods are shipped by faster routes, despite significant transportation cost differences.

Of course, transportation costs also affect how goods are moved. All-water routing from Northeast Asia to the U.S. East Coast through the Panama Canal is particularly attractive for transporting lower-value products, for which longer transit times are less important than the net transportation costs. Even in the case of low and moderate value products, however, reliability is still important, particularly when the all-water leg serves as part of an "inventory in transit" management system. The role of each of these factors is significant in determining which cargo flows will be affected by Panama Canal expansion. One way to convert the value of time into costs is to compute an inventory carrying cost. For instance, if one container is used to transport a product with a high value of ten dollars per kilogram and a container can carry 18 tons of that product, the value of the cargo is $180,000. At a cost of capital of ten percent, the annual inventory carrying costs for that cargo is $18,000, or about $50 per day.

Thus, from an inventory-carrying-cost point of view, a shipper may be indifferent to a transportation cost savings of $100 if it takes two more days to ship the product. But the result for a lower-value product is much different. At two dollars per kilogram, the inventory carrying cost is ten dollars per day and the $100 cost savings translates into an acceptable ten-day difference in transit time—more than enough time to allow for transporting the product from Northeast Asia to the U.S. East Coast by the longer and slower Panama Canal route. Of course, to the extent a cargo is perishable or otherwise time sensitive, additional costs may be incurred from longer transit times even with lower valued goods. While the time sensitivity of perishable goods such as produce is obvious, other examples of time sensitive products could include seasonal consumer goods where getting these products to markets on time is critical, or goods that are shipped "just in time" to reduce storage or stock-out costs. In this case the dollar value of time is not the inventory carrying cost, rather the potentially large loss in product value when it is not on store shelves in time.

3.10.2 TRANSPORTATION COSTS VERSUS RATES

Since the economic impacts of Panama Canal expansion result largely from lower transportation costs, later phases of this study will examine the costs of providing transportation services since 1) they are a fundamental component of rates charged to shipping customers and 2) they can be built up from individual cost components such as labor, fuel usage and capital expenses. In general, costs provide a long-range floor on which the actual rates charged to customers are based. Unless transportation services are subsidized, transportation providers that lose money on a long-term basis cannot stay in business.

Rates can also fluctuate widely based on short-term economic and demand conditions, while costs can be somewhat more stable. Of course, given the large role that fuel plays in transportation costs, petroleum prices can also cause significant changes in transportation costs and thus in rates.

A very important consideration in defining costs is how to treat load imbalances. For example, in a shuttle service between two locations, cargo may only be carried in one direction. The cost of carrying that cargo cannot be understood as simply the costs of a one-way trip; the full costs of the round trip are incurred to carry the cargo one way. Other examples are more complex. For many transportation services, loads are partially imbalanced, with the "head-haul" cargo defining the overall demand for the transportation service and the "back-haul" cargo helping pay part of the overall cost, often at lower rates determined by competitive conditions. Back-haul costs often include the repositioning, handling, and return of empty containers and such costs add to the overall cost of the transportation service. In this case, costs for carrying the head-haul cargo are less than the full round-trip costs but more than the one-way cost. As a result, a subjective but explicit allocation of costs is generally made in order to estimate costs.

For liner services, a cost estimate for moving a container can be even more complex, since liner services are generally scheduled on a fixed-rotation basis, calling on many ports. The method chosen to allocate costs is particularly important in examining one of the most important trade flows that may be impacted by Panama Canal expansion—U.S. imports from Northeast Asia. Estimated costs for carrying imports should reasonably include most of the round-trip cost of providing the service. Additional details on cost data and sources are provided in Technical Notes Section TN - 6.

3.10.3 COST CHANGES DUE TO USE OF LARGER SHIPS

Panama Canal expansion will allow larger ships to transit the Canal, and this will tend to result in lower costs per TEU for the Panama Canal route. The maximum size for container ships transiting the Canal will increase almost by a factor of three, from 5,000 TEUs to 13,000 TEUs, according the Panama Canal Authority (see Figure 2 in Chapter 2).[69] Operating cost changes resulting from the deployment of larger ships will be assessed in detail in the second report of this study. Each of the components of the cost of vessel operations offer opportunities for cost reductions as larger vessels are introduced into markets that depend on transiting the Panama Canal. Only a portion of the total cost savings that accrue to vessel owners and operators are likely to be passed on to Beneficial Cargo Owners. These cost savings depend on a number of additional factors that are described in Chapter 5.

[69] An absolute maximum number of TEU-positions that can be carried on the new Panamax ship has not yet been precisely defined, as it depends on ship owners' exact ship designs. However, it is estimated that the new maximum will be at least 12,600 TEU and could potentially be 13,500 TEU (based on discussions with carrier executives and ship designers).

Four components of vessel operating costs will be considered in future cost savings evaluations:

- Vessel Charter/Operating Costs
- Fuel Costs (main and auxiliary engines)
- Port Call Costs
- Panama Canal Transit Tolls

Vessel charter and operating costs (non-fuel related) decrease on a unit basis as the size of the vessel increases and are part of the economies of scale associated with the lower labor and capital costs (per TEU). The improved technologies for vessel operations designed into larger, newer vessels also lead to cost reductions. Operating cost savings are estimated to exceed 30 percent per TEU for the largest container vessels likely to transit the expanded Panama Canal when compared to the maximum size 5,000 TEU vessel currently able to use the Canal.

Fuel use costs can account for over half of total vessel operating costs, depending on the price of fuel. (See Technical Notes Section TN – 7 for a discussion of recent fuel prices and their effects on vessel operating costs). Fuel use is also highly dependent on vessel operating speed, with fuel consumption disproportionately higher as operating speeds increase. Thus, shipping companies' development of "slow steaming" strategies can significantly decrease fuel costs and, in turn, total per-TEU costs. Quantifying this effect requires that costs are calculated on the basis of speed of service, which is derived from actual liner service schedules.

Another factor affecting fuel cost is the type of fuel used. A variety of regulations require switching to cleaner fuels in Emission Control Areas (clean fuel zones) in U.S. Coastal regions.[70] When in port, vessels are usually required to switch off auxiliary engine power to mitigate emissions and comply with local air quality requirements or to use on-shore power sources (cold ironing) as a source of power. Switching to cleaner fuels to power auxiliary engines also impacts operating costs related to fuel use. Newer Post-Panamax vessels, designed to minimize fuel consumption and adapted to newer "slow steaming" specifications, can result in main engine fuel savings ranging between 25 percent and 30 percent per TEU compared to current Panamax vessels. Likewise, newer, fuel efficient and emission-controlled auxiliary engines can provide savings of between 20 percent and 25 percent of those used on current vessels.[71]

[70] The North American ECA includes waters adjacent to the Pacific coast, the Atlantic/Gulf coast and the eight main Hawaiian Islands and extends up to 200 nautical miles from coasts of the United States, Canada, and the French territories. (U.S. Environmental Protection Agency. "Designation of North American Emission Control Area to Reduce Emissions from Ships". *Office of Transportation and Air Quality*. March 2010. Available at: http://www.epa.gov/otaq/regs/nonroad/marine/ci/420f10015.pdf). The U.S. Caribbean ECA includes waters adjacent to coasts of the Commonwealth of Puerto Rico and the U.S. Virgin Islands, up to roughly 50 nautical miles (nm) from the territorial sea baselines of the included islands. The ECAs are bounded and do not extend into marine areas subject to the sovereignty, sovereign rights, or jurisdiction of any state other than the United States. (U.S. Environmental Protection Agency. "Designation of Emission Control Area to Reduce Emissions from Ships in the U.S. Caribbean". *Office of Transportation and Air Quality*, July 2011. Available at: http://www.epa.gov/otaq/regs/nonroad/marine/ci/420f11024.pdf).

[71] These percent changes are estimated based on models derived for this project. See Technical Notes Section TN-7.

Port call costs are a major factor in vessel operations, especially for the larger vessels. The efficiencies of economies of scale at ports, which includes larger, higher capacity cranes and the operational efficiencies associated with servicing larger vessels, can result in cost savings compared to the costs incurred by current Panamax vessels.

The transit tolls for liner vessels wishing to use the expanded locks have not yet been established by the Panama Canal Authority. Although it is likely that the reservation system, established to provide priority transit under the current system, will be preserved in some manner and applied to the new locks, this, too, has not be determined. However, to the extent that the authority is able successfully to structure its charges in a way that maximizes its revenue, there could be significantly less cost savings associated with the use of a larger ship; and thus, fewer benefits would remain to allocate among the producers, consumers, ship owners, shippers, ports, labor, and others involved in the cargo movement. The subsequent report in this study will address transit tolls and reservation fees as they affect costs, if such information becomes available.

A number of factors will influence the rate at which newer, larger, and more efficient vessels will be deployed in the trade lanes most likely to use the expanded Panama Canal facilities. For the largest container ships capable of transiting the expanded Panama Canal (13,000 TEUs), these scale economies (lower per TEU costs arising from the use of larger vessels) are expected to reduce the costs of transporting containers from Northeast Asia to the U.S. East Coast over time. Total savings will depend on how quickly the larger vessels capable of transiting the expanded Panama Canal are deployed. If there are sufficient cargoes to fully utilize these larger vessels, an overall fleet mix comprised of larger vessels (10,000 to 13,000 TEUs) will produce greater savings than a transiting fleet comprising primarily 8,000 to 10,000 TEU vessels. This mix may also be influenced, to some degree, by the ability of U.S. East Coast ports to accept these larger vessels.

Cost savings resulting from the use of 13,000-TEU vessels on an expanded Panama Canal service must be considered in relation to cost reductions that will occur elsewhere due to the use of larger ships. If the current average size of vessels serving West Coast ports is also increased, from an average of 6,000 TEUs to 13,000 TEUs[72], the cost for transportation through West Coast ports would also be reduced. However, the overall savings associated with the shift to larger vessels will be greater for all water East Coast service. Vessel size for shipping to the East Coast via the Panama Canal is currently restricted to vessels of 5,000 TEU or less, while no restriction applies to the West Coast (where the average vessel is now 6,000 TEU). Accordingly, vessel size increases up to 13,000 TEU (the largest vessel size expected for West Coast ports) will be proportionately greater for East Coast service through the Panama Canal. Also, the vessel savings component of an all water service to the U.S. East Coast (or areas near to the East Coast) is a larger share of total per TEU delivered cost than is the water component to the East Coast via a West Coast port (which has a significant intermodal component that is not subject to vessel size economies).

[72] For example, the 12,500 TEU MSC *Fabiola* has already begun calling on U.S. West Coast ports. (World Maritime News. *Port of Long Beach Welcomes Largest Container Ship Ever to Call to North America*. March 19, 2012. Available at: http://worldmaritimenews.com/archives/49912).

3.11 FINANCING THE U.S. TRANSPORTATION SYSTEM TO CAPTURE BENEFITS FROM CANAL EXPANSION

Previous sections have described the global transportation system, how expansion of the Panama Canal will change shipping economics and costs, and, in a general sense, how cost reductions may benefit the United States. These previous sections have also highlighted factors that may limit potential benefits to the United States, particularly capacities of U.S. ports and inland infrastructure. This section describes the current structure of funding and financing for ports and related infrastructure to meet needs resulting from Panama Canal expansion and explains how these investment decisions are influenced by the approaches that public and private sectors take to investment evaluation. Public and private funding decisions will impact when and how infrastructure improvements necessary to accommodate larger vessels take place. These investments include everything from harbor dredging to investments in on-dock rail and new cranes. Many of these investments are now paid for through some combination of private investment, public cost sharing, user fees, and port charges. Public funds used for port infrastructure investments are typically limited or otherwise restricted based upon several factors including: requirements for matching funds; statutory or regulatory restrictions on the use of the funds; equitable geographic distribution of funds; requirements pertaining to project inclusion in established priority lists, transportation plans, or capital programs; fiscal year or time limited funds; etc.

3.11.1 OVERVIEW OF CURRENT FUNDING PATTERNS

Freight transportation improvements focused on waterborne cargo are funded through diverse financing options including user fees and taxes, government funding and/or private investment.[73]

User Fees

Almost all ports in the U.S. rely on some form of user fees to fund improvements and expansion. Fees assessed on cargo range from port security and harbor fees assessed by the U.S. government to transit and demurrage charges for empty container and railcar storage charged by public and private providers. At almost every stop along the supply chain from producer to consumer, there is a possibility to charge a fee for services provided that can be leveraged to support infrastructure. Landside fees, including those for intermodal transportation services, can often equal or exceed port charges and ocean-transit fees. As volumes of cargo at major ports increase and impact nearby roads, bridges and tunnels, owners of this infrastructure (in many cases local governments) may seek additional revenues from commercial users to deal with any shortcomings—since much of the benefits for such investments do not accrue to the local government (or its citizens), but rather to freight transportation providers and shippers and those who produce or consume the goods.

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[73] The 2009 TRB Special Report #297 (Transportation Research Board. Special Report 297: Funding Options for Freight Transportation Projects. 2009. Available at: http://onlinepubs.trb.org/onlinepubs/sr/sr297.pdf) and 2012 U.S. Army Corps of Engineers study(U.S. Army Corps of Engineers. *U.S. Port and Inland Waterways Modernization: Preparing for Post-Panamax Vessels*. June 12, 2012. Available at: http://www.iwr.usace.army.mil/Missions/Navigation/PortandInlandWaterwaysModernizationStrategy.aspx) present further details regarding financing options for freight transportation projects.

Public Financing

Public funds—meaning funds from non-port sources such as general revenues or grants—tend to be used for either greenfield (new) development or major expansions that cannot be supported by existing revenue sources. Reliance on user fees means that ports must compete for business on the basis of efficiency and service against a relatively level playing field, since all ports are "paying" their own capital costs. In contrast, a port may compete much more effectively if public capital is available to fund assets that would not require increases in direct user fees. Most major U.S. ports are publicly owned by a State, city, or regional authority which typically issues special-obligation tax-exempt revenue-backed debt for port purposes.[74] The Port of Houston is a notable exception; its owner, Harris County, issues debt backed by county general-fund taxes. The Port Authority of New York and New Jersey is another exception in that it has a portfolio of assets including ports, airports, tunnels, bridges and real estate, and issues consolidated debt against the combined revenues of these assets.

Similarly, highway access investments using Federal or State funds often do not require repayment through fees or tolls.

Private Investment

The private sector has typically provided freight-related investment for non-highway infrastructure, particularly railroads and port terminals. Private investment in these facilities is often fully funded by revenues or some type of private financing based on anticipated future revenue, and therefore does not require support from the public sector. These privately funded and guaranteed investments fund expansions of storage yards, cranes, warehouses, cargo handling equipment, inventory systems, etc. However, the effectiveness of these investments, in terms of the comparative attractiveness of ports capable of serving the same markets, depends on the condition of the associated water and landside infrastructure such as channels, wharves, and roads, which may be largely financed with public (Federal, State, or local) or quasi-public port authority funds.

Public-Private Partnerships

Public-private partnerships (known as "P3s") are becoming more and more common in all aspects of the freight transport system. Over the last five years, a number of public marine terminals— including Seagirt in the Port of Baltimore and the Outer Harbor Terminal in Oakland—have been concessioned to private operators who have taken on the long-term

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[74] Privately owned and operated ports in the United States tend to be smaller industrial ports, primarily on the Great Lakes and the Gulf of Mexico. Large state-owned-and-operated ports include the Port of Virginia, Georgia Ports Authority, and South Carolina State Ports Authority. Larger U.S. ports tend to be landlord ports, owned by a local, regional, or State governmental entity and operated under contract by a private company. These include ports in Alabama, California, Delaware, Michigan, New Jersey, and New York. (Federal Highway Administration. "FHWA Operations Support—Port Peak Pricing Program Evaluation". *Office of Operations: Freight Management and Operations*. January 2009. Available at: http://ops.fhwa.dot.gov/publications/fhwahop09014/).

obligations to expand, operate and maintain them.[75] In Jacksonville, Mitsui/Trapac and Hanjin agreed to build, finance, and operate new terminals in partnership with Jaxport. The Mitsui/Trapac terminal opened in 2009[76], although Hanjin decided in March 2013 not to build its terminal.[77] Other ports are considering P3 structures for port expansion, highway access, on-dock rail, and other needed improvements whose investment profiles do not fit the traditional port finance models. Most of these are being done as concessions, whereby the concessionaire takes on full revenue risk/reward and bears all responsibility for the asset's operation. Further discussion of these projects can be found in Section 3.11.3.

3.11.2 FINANCING INFRASTRUCTURE IMPROVEMENTS

Enhancements to U.S. ports and terminals, inland waterways, channel and harbor deepening, and upgrading landside connectivity to accommodate Post-Panamax ships require considerable investment, whether the asset is publicly or privately controlled.

Ports and Terminals

Ports typically finance their own development, growth, and local share of channel maintenance, primarily by collecting revenues as a landlord from terminal operators, on-dock railroads and freight forwarders, as well as other marginal revenues from auxiliary services. Most ports construct and maintain wharves, jetties, and berths, and dredge to maintain channel depth. Some own and rent cranes and other equipment for the use of terminal operators and a few provide other auxiliary services to generate additional revenues. Terminals, the operating interfaces between ports and ships, are primarily privately owned by stevedoring firms and shipping lines. The terminal operators schedule ship calls, provide the labor and equipment to load and unload ships, and offer storage for cargo awaiting further transit. There are numerous operating models throughout the United States, with larger ports having multiple terminals that compete with each other, as well as with other ports. Terminal operators' revenues come from cargo-handling and are either leveraged directly

Container terminal in Long Beach, CA

Photo courtesy: the Port of Long Beach

[75] The difference between concessioning and long-term leasing is usually based on allocations of risk and of control over financing and terms. Unlike concessions, long-term leases typically have no upfront payment to the port authority for the "value" of the business and generally have higher periodic rents. Such leases often grant less autonomy to the tenant than would be given to a concessionaire. Large ports often have a mix of terminals with some publicly owned, some leased, and some developed as full concessions.

[76] Bauerlein, D. "TraPac terminal officially opens at Dames Point". *The Florida Times-Union: Jacksonville, Business*. January 13, 2009. Available at: http://jacksonville.com/business/2009-01-13/story/trapac_terminal_officially_opens_at_dames_point.

[77] Bauerlein, D. "Hanjin decides against Jacksonville cargo terminal". *The Florida Times-Union: Jacksonville, Business*, March 21, 2013. Available at: http://jacksonville.com/news/metro/2013-03-21/story/hanjin-decides-against-jacksonville-cargo-terminal.

to support project-specific debt and rent to the port or taken into corporate revenues, with corporate capital from both debt and equity being used for facility development.

U.S. port and terminal operators are making major investments in port facilities and related land-side infrastructure, including local expenditures for dredging and security measures. According to the American Association of Port Authorities, 63 U.S. ports and their private sector partners are projected to spend about $46 billion in new construction and modernization of marine terminals in the next five years. Public port authorities will invest $18.3 billion, while private sector investments will total $27.6 billion from FY 2012 to FY 2016.[78]

Waterways

The public sector is heavily involved in the development, operation, and maintenance of U.S. coastal and inland waterways, with a significant role played by the Federal government. Through USACE, the government administers both a maintenance-dredging and a harbor-deepening program. The maintenance program for coastal and Great Lakes ports, funded by a 0.125 percent ad valorem Harbor Maintenance Tax (HMT) assessed on most imported and domestic cargo, pays 100 percent of the costs of maintaining channel depth for navigation channels up to 45 feet in depth, and 50 percent for channels more than 45 feet in depth.[79] The income from that tax goes into the Harbor Maintenance Trust Fund (HMTF) and must then be appropriated by Congress to specific projects. The HMTF is a point of controversy within the maritime community, as more is collected annually than has been spent. The HMTF began FY 2012 with a balance of more than $6.1 billion.[80]

The U.S. Army Corps of Engineers also constructs coastal navigation projects—with the Federal share of the costs financed with U.S. Treasury general revenue funds. The program prescribes a specific funding percentage for ports seeking to construct a deeper harbor and provides Federal money ranging from 40 percent to 80 percent for eligible projects based on channel depth.

On the inland waterways, taxpayers pay more than 90 percent of the total costs. The General Fund of the Treasury finances 100 percent of the costs of inland waterways studies and all operation and maintenance costs. Inland waterway operators pay a 20-cent-per-gallon excise tax on diesel fuel used by commercial vessels on most of the inland waterways. The proceeds from this tax are deposited into the Inland Waterways Trust Fund (IWTF) and used to finance the users' 50 percent share of capital investments (construction, replacement, rehabilitation, or expansion of an inland waterways project). However, the level of spending from the IWTF for

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[78] American Association of Port Authorities. *U.S. Port Infrastructure Spending Survey, 2012 – 2016*. June 4, 2012. Available at: http://aapa.files.cms-plus.com/2012%20AAPA%20Port%20Infrastructure%20Spending%20Survey%20Summary.pdf.

[79] Frittelli, J. "Harbor Maintenance Trust Fund Expenditures". *Congressional Research Service*. January 10, 2011. Available at: http://www.fas.org/sgp/crs/misc/R41042.pdf.

[80] U.S. House of Representatives: Committee on Ways and Means. "Boustany and Tiberi Announce Hearing on Harbor Maintenance Funding and Maritime Tax Issues". *Hearing Advisory*. February 1, 2012. Available at: http://waysandmeans.house.gov/News/DocumentSingle.aspx?DocumentID=276548.

such work has declined since 2006 as the balance of the fund has been drawn down, caused by flat or declining tax revenue streams and escalating costs of existing projects.[81]

The Inland Waterways Users Board (IWUB) has recommended a level of annual expenditures for capital investments (paid 50 percent from the General Fund and 50 percent from the IWTF) of approximately $380 million a year. By comparison, the annual level of expenditures for such investments since 1994 has been approximately $234 million on average, and in FY 2011 was approximately $170 million, $210 million less than the IWUB has recommended.[82]

Rails, Roads and Bridges

Rail connections to U.S. ports have historically been the responsibility of the privately owned Class I and short-line railroads. In the early part of the twentieth century, most ports were developed hand-in-hand with rail and real estate interests, and the railroads have a long history of serving coastal ports by using their own balance sheets to raise money for needed infrastructure construction and improvement. Governmental partners have stepped in from time to time to help develop and fund infrastructure, including corridor and local improvements that are designed to make the ports more efficient and competitive. Notwithstanding public-private projects, the Class I railroads have little difficulty raising capital in the current market and typically on a non-project-specific basis.

Container being loaded onto a double stack train

Photo courtesy: Port of Seattle image by Don Wilson

Highway and bridge links to the ports are typically financed, like any other highway transportation improvement, through a combination of Federal, State, and local grants and, in some cases, tolls. Federal programs provide the majority of public funding for surface freight-related transportation projects. The Highway Trust Fund (HTF) is the principal funding source of highway and transit programs through collections from highway user excise taxes, such as the Federal fuel taxes and other truck-related taxes. The Federal fuel taxes (currently 18.4 cents per gallon of gasoline and 24.4 cents per gallon of diesel) raised almost $75 million per day in revenue in 2009, with additional revenue from other taxes.[83] The Congressional Budget Office's recent baseline projections for the HTF indicate that if the tax and spending policies in effect in 2012 continued through 2022,

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[81] Taxpayers for Common Sense. *Inland Waterways Trust Fund Fact Sheet*. January 2012. Available at: http://www.taxpayer.net/user_uploads/file/Transportation/Trust%20Funds/IWTF%20-%20TCS%20-%20FINAL%202012-01-18.pdf

[82] Stern, C.V. "Inland Waterways: Recent Proposals and Issues for Congress". *Congressional Research Service*. May 3, 2013. Available at: www.fas.org/sgp/crs/misc/R41430.pdf.

[83] Federal Highway Administration. "Our Nation's Highways: 2011". Chapter 6. *Office of Highway Policy Information*. May 2010. Available at: http://www.fhwa.dot.gov/policyinformation/pubs/hf/pl11028/chapter6.cfm.

the receipts credited to the fund would total about $442 billion, $147 billion less than the fund's projected outlays of about $589 billion.[84]

HTF monies can be used to fund access roads to ports, provided such projects are part of the Federal-Aid Highway System and included in regional Long Range Transportation Plans, Transportation Improvement Programs (TIPs), and Statewide Transportation Improvement Plans (STIPs). Such roads are classified as National Highway System "freight connectors." However, States and metropolitan planning organizations (MPOs) often consider freight as a lower priority when compared with the needs of passenger travel. The generally low profile of freight operations in the community, the fact that freight operations are conducted by the private sector, and the perception that the benefits of such corridors accrue to users outside of the region, creates challenges for focusing local public sector interest and resources on freight projects.[85] Improved coordination, in part spurred by the grant application process for the Transportation Investment Generating Economic Recovery (TIGER) Discretionary Grant program, will likely lead to greater investment in port access roads.

The Congestion Mitigation and Air Quality (CMAQ) program is funded through annual sums authorized from the HTF. It is jointly administered by FHWA and the Federal Transit Administration to fund projects that reduce criteria air pollutants from transportation-related sources and which are based in designated air quality nonattainment or maintenance areas. Accordingly, CMAQ funds can be used by States, regional authorities and MPOs for freight transportation and port projects that meet these eligibility requirements. However, the availability of CMAQ funds for freight-related development is highly constrained by the above eligibility requirements.

The HTF is the also the primary mechanism for funding Federal highway programs authorized by the Moving Ahead for Progress in the 21st Century Act (MAP-21).[86] MAP-21 reauthorizes the Federal-aid highway program for two fiscal years beginning in FY2013. It reduces Federal programs from over 90 to less than 30 and consolidates several freight programs into a single program designed to focus on the movement of goods. MAP-21 includes five core non-finance programs:

- National Highway Performance Program
- Transportation Mobility Program
- National Freight Network Program
- Congestion Mitigation and Air Quality Improvement Program, and
- Highway Safety Improvement Program

[84] Congressional Budget Office. *How Would Proposed Fuel Economy Standards Affect the Highway Trust Fund?* May 2012. Available at: http://www.cbo.gov/publication/43198.

[85] Federal Highway Administration. "Executive Summary; NHS Intermodal Freight Connectors: A Report to Congress". *Office of Operations: Freight Management and Operations*. October 2009. Available at: http://ops.fhwa.dot.gov/freight/freight_analysis/nhs_intermod_fr_con/exec_sum.htm.

[86] MAP-21 funds surface transportation programs at over $105 billion for FY 2013 and 2014, and is the first long-term highway authorization enacted since 2005.

The latter two are continuations of existing programs. MAP-21 also modified the Transportation Infrastructure Finance and Innovation Program (TIFIA), designed to provide direct loans, loan guarantees, and lines of credit to surface transportation projects.

Within these new programs, MAP-21 includes a number of initiatives designed to address improvements in the national freight transportation system, many of which will be assessed in later phases of this study. These include:

- National Freight Policy (Section 1115): Establishes a policy to improve the condition and performance of the national freight network to ensure it provides the foundation for the United States to compete in the global economy and achieve goals related to economic competitiveness, congestion, productivity, safety, security, resilience of freight transportation state of good repair, use of advanced technology, economic efficiency and environmental impacts.
- National Freight Strategic Plan (Section 1115): Directs DOT to develop a national freight strategic plan that will assess the condition and performance of the national freight network; identify highway bottlenecks that cause significant freight congestion; forecast freight volumes; identify major trade gateways and national freight corridors; assess barriers to improved freight transportation performance; identify routes providing access to energy areas; identify best practices for improving the performance of the national freight network and mitigating the impacts of freight movement on communities; and provide a process for addressing multistate projects and strategies to improve freight intermodal connectivity.
- State Freight Advisory Committees and State Freight Plans (Section 1117/118): Requires DOT to encourage each State to establish a freight advisory committee and develop a freight plan for its immediate and long-range planning and investment with respect to freight.
- National Freight Network (Section 1115): Requires DOT to establish a network to assist States in strategically directing resources toward improved movement of freight on highways. The primary freight network will identify a maximum of 27,000 centerline miles of existing roadways that are most critical to the movement of freight.
- National Goals and Performance Management Measures (Section 1203): Requires DOT to establish performance measures, within 18 months, for states to use to assess freight movement on the interstate system. DOT must also prepare a biennial report describing the condition and performance of the national freight network. MAP-21 further requires each State and MPO to set performance targets in relation to the DOT-established measures and integrate the targets within its planning processes. States and MPOs must also report periodically on their progress in relation to the targets.

The American Recovery and Reinvestment Act (ARRA) of 2009, which authorized the first TIGER program, provided funding to surface transportation projects of all types, including $27.5 billion in formula grants to highway projects. ARRA funding obligation deadlines were designed to support “shovel-ready” projects, leading to an emphasis by States and public agencies on repaving and other rehabilitation projects rather than new infrastructure projects such as those that might provide additional highway access to ports. ARRA also provided USACE with $4.6

billion for shovel-ready Corps Civil Works projects, with part being used both for channel deepening projects nationwide, including San Diego, Galveston and Houston, and Baltimore, and to facilitate recovery for ports severely damaged by hurricanes in 2005 through 2008.[87]

Other Federal assistance programs supporting freight transportation improvements include: the Transportation Infrastructure Finance and Innovation Act (TIFIA) programs (noted under MAP-21 above), Federal-Aid Surface Transportation Program (which now includes expanded port project eligibility similar to that in TIFIA), and the Railroad Rehabilitation and Improvement Financing (RRIF).

The TIGER I, II and III programs awarded $1.5 billion, $600 million, and $511 million respectively, in three rounds of discretionary grants for freight and port infrastructure, with eight percent of the award amount in the first round, 17 percent of the second, and 12 percent of the third going directly to ports or port-related projects and additional amounts going to intermodal projects sponsored by the Class I railroads. The FY 2012 TIGER IV awards were announced in June 2012.[88] Of the $485 million distributed, $79 million was given to ports or port-related projects (16 percent of the total funding).

3.11.3 INNOVATIVE DEVELOPMENTS IN FINANCING, OPERATION AND OWNERSHIP

In the face of diminishing economic investment from the government, public and private entities are working together to support port and inland surface transportation projects that will help accommodate potential freight-related growth from the Panama Canal expansion. The following projects illustrate the use of funding from a variety of sources—both public and private—to finance large transportation infrastructure projects.

The 20-mile Alameda Corridor was built in 2002 under a public-private partnership between the ports of Los Angeles and Long Beach, Union Pacific Railroad, and BNSF Railway, with significant participation from local authorities. DOT provided a $400 million loan; this was the first Federal loan to be subordinated to project bonds and set a precedent for the future TIFIA program. The Alameda Corridor Transportation Authority (ACTA) raised half of the $2.4 billion to build the project by selling bonds in advance against the revenue stream from a fee on all containers carried out of the basin on rail whether or not the corridor was used. ACTA's debts are also partially backed by the ports themselves. The project has significantly improved rail links to the ports, while reducing highway congestion and air pollution.

Private investment in CSX's National Gateway project has served as a means to improve the flow of goods between the eastern and western rail networks. CSX has committed to fund $575 million of the $842 million program.[89] DOT awarded a $98 million TIGER grant in 2010 to the

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[87] U.S. Army Corps of Engineers. *Deep Water Ports and Harbors: Value to the Nation*. January 2010. Available at: http://www.iwr.usace.army.mil/Portals/70/docs/VTN/VTNDeepPortsHarbors_loresprd.pdf.

[88] U.S. Department of Transportation. *FY 2012 TIGER Awards*. October 2012. Available at: http://www.dot.gov/tiger/2012-tiger-awards.

[89] Further descriptions of the National Gateway project, the Crescent Corridor, and the Heartland corridor are provided in Appendix 2, along with maps showing the projects (see Appendix 2, Figure 47 through Figure 50).

States of Ohio, Pennsylvania, West Virginia, and Maryland to support the project. The States of Ohio and Pennsylvania have committed $30.5 million and $35 million, respectively. The remaining costs associated with this public-private partnership will be covered by a combination of Federal, State, and possibly additional CSX funds. CSX asserts that the Federal and State aid will support more than 10 billion dollars in public benefits in the route's first 30 years of operation with $35 in public benefits generated for every one dollar of public money invested.[90]

At a cost of $321 million, the Heartland Corridor Project was funded by Norfolk Southern Railway (NS) and Federal and state agencies through a public-private partnership. According to NS, each partner contributed funds proportional to the benefits they receive. NS funded $140.1 million of the project, while the Federal government provided $111 million in SAFETEA-LU and ARRA funds. The Commonwealth of Virginia financed $9.0 million through the Virginia Rail Enhancement Fund and the State of Ohio contributed $0.8 million to the tunnel expansion projects. [91]

On the Gulf Coast, a public-private partnership between the Mississippi State Port Authority and the KCS Railway Company is providing upgrades to the KCS Line to accommodate double-stacked containers, which cannot be efficiently and effectively moved over the existing rail line. The $50 million project upgrades 76.5 miles of rail to accommodate 49 mph double-stack intermodal service; current service runs at 10 mph single-stacked. The project is a component of the much larger post-Katrina Gulfport restoration project funded by the U.S. Department of Housing and Urban Development (HUD). DOT provided a $20 million TIGER grant in support of the project.

In a landmark 2009 transaction, the Port of Miami and the State of Florida entered into an agreement with a group of international contractors and investors to finance and build an underwater tunnel into the port in order to improve truck connections to the mainland interstate highway system and make the port more competitive with other East Coast deepwater ports. The Port of Miami tunnel, now under construction at a cost of one billion dollars, is being paid for with a combination of private equity and State and county funding raised through the port authority's own tax-exempt bond issues. The private operators will be repaid through annual payments from the State, called availability payments. DOT also awarded $22.8 million to Miami-Dade County to assist in funding intermodal container rail service to the Port of Miami. The project, which has a total cost of $46.9 million, involves upgrades to rail, signals, and switching between the Florida East Coast

Aerial view of the Port of Miami

Photo credit: iStock

[90] National Gateway Website http://www.nationalgateway.org/.

[91] Federal Highway Administration. *Project Profiles: Heartland Corridor*. Available at: http://www.fhwa.dot.gov/ipd/project_profiles/wv_heartland.htm.

Railroad (FEC) Hialeah rail yard (adjacent to the Miami International Airport) and the port. In addition, Tiger II dollars are being used to create an intermodal container rail transfer facility complete with a crane at the port, and to pay for electrical, mechanical, and structural repairs on the rail bridge to the port.

In 2009, the Oakland Board of Port Commissioners approved a first of its kind U.S. marine terminal concession agreement—a 50-year concession for a private company to operate, invest in capital improvements, and develop Port of Oakland's Outer Harbor berths 20-24. The precedent-setting agreement with Ports America Group, a company owned by Highstar Capital, called for a $60 million upfront fee to the Port of Oakland and annual rent of at least $19.5 million.[92] A similar deal was approved by the state of Maryland in 2009 with Ports America to operate Port of Baltimore's Seagirt Marine Terminal for 50 years. The concession agreement also required Ports America to build a 50-foot deep berth capable of handling the new Post-Panamax vessels, which was finished in 2012 as part of the $105 million expansion of the Seagirt facility. Ports America completed the installation of four super Post-Panamax cranes at the facility in early 2013.[93] Ports America made an upfront payment of $100 million and an annual rent payment of $3.2 million, adjusted for inflation, plus a $15 fee for each cargo container moved at the terminal above a 500,000 threshold. According to the Port Authority, the agreement is expected to provide more than $1.3 billion in revenue to the State, create 5,700 jobs, and deliver more than $15 million annually in new tax revenues.[94]

The Virginia Port Authority (VPA) entered into another type of public-private partnership in 2010, a 20-year agreement with APM Terminals to lease a private terminal and operate it as part of the Port Authority's Virginia International Terminals operating subsidiary, giving the Authority full control of all container facilities in Virginia. More recently, APM Terminals approached VPA to take over the operation of the state's cargo terminals for the next 48 years. In the proposal, APM would have transferred ownership of the private terminal to VPA and paid between three to four billion dollars to operate the port authority's facilities. In addition to monthly payments to VPA based on port revenues, APM would also have made $1.1 billion in capital investments.[95] In March 2013, however, the Virginia Port Authority Board of Directors voted unanimously to reject offers to privatize the port, instead favoring a reorganization of the agency and its operations.[96]

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[92] Port of Oakland. *A Market First as Port of Oakland Breaks New Ground in U.S. Port Terminal Concession Agreements*. Press Release. March 2009. Available at: http://www.portofoakland.com/newsroom/pressReleases/2009/pr_161.aspx.

[93] Office of Governor Martin O'Malley, Maryland. *Governor O'Malley Leads Groundbreaking for 50-foot Berth at Port of Baltimore.* March 2010. Available at: http://www.governor.maryland.gov/pressreleases/100308.asp.

[94] Maryland DOT. "Governor O'Malley Announces 50 Year Contract with Ports America to Operate Port of Baltimore's Seagirt Marine Terminal". *Maryland Port Administration, Press Release*. November 2009. Available at: http://www.mpa.maryland.gov/content/news-publications-2009.php.

[95] Leach, P.T. "APM Terminals Bids to Take Over Virginia Terminals," *Journal of Commerce*, May 23, 2012. Available at: http://www.joc.com/port-news/apm-terminals-bids-take-over-virginia-terminals_20120523.html.

[96] Whack, E. "Virginia Port Authority rejects offers to privatize, moves to reorganize". *The Washington Post*, March 26, 2013. Available at: http://articles.washingtonpost.com/2013-03-26/local/38029433_1_ocean-carriers-and-port-cargo-volume-virginia-maritime-association.

Collectively, the financial arrangements for these projects served as effective instruments to improve transportation infrastructure that will support increased traffic flows that could develop as a result of the Panama Canal expansion. A consideration in the second report of this study is assessing the optimal level of both private and government investment allocated to future projects such as these that will maximize the net benefits from the Canal expansion.

3.11.4 UNDERSTANDING HOW INVESTMENT DECISIONS DRIVE FUNDING

Benefit-Cost Analysis

Benefit-cost analysis (BCA) is a tool used by some governmental funding authorities to evaluate the economic merits of potential infrastructure projects. Typically, BCA involves the definition of a "no build" base case scenario, against which various "build" alternatives are compared in terms of their incremental construction costs and transportation benefits relative to the base case. The evaluation is usually conducted in increments using an analysis period of 20 or more years, with annual costs and benefits for each year of the analysis converted into present year dollars using a social discount rate. In theory, the build alternative with benefits exceeding costs (if any) by the greatest amount would be the preferred action.

The Federal government requires BCA for some of the projects financed with Federal funds that are provided in annual appropriations acts and are subject to its discretionary allocation. However, most surface transportation projects involving highways and transit in the United States are funded from either State and local funds or from multi-year (mandatory) authorization acts and are allocated by formula (and thereby not subject to Federal discretion). Whereas some States and local governments voluntarily apply BCA to some formula-funded transportation projects, most do not. BCA is required for DOT TIGER grants, which are provided in annual appropriations acts and are subject to Federal discretionary funding decisions, as well as channel and harbor construction projects funded by USACE.

USACE has led the Federal government in the development of BCA procedures and standards, beginning in the 1930s. As the first step of any application to USACE for a Civil Works Project, Congress must authorize and fund USACE to investigate a potential project. This investigation begins with a reconnaissance study to evaluate the nature of the water resources problem to be corrected and assess the project's overall relationship to the Federal interest. The reconnaissance study is generally completed within 12 months. If USACE finds that the project warrants further study (this occurs in about one-third of the studies), USACE will proceed to a full feasibility study. In the feasibility study, USACE formulates alternative plans, investigates engineering feasibility, conducts detailed BCA of a project's local, regional, and national impacts, and assesses environmental impacts of the project. An important outcome of the feasibility study, which averages two to three years to complete, is a determination of whether or not the project warrants further Federal investment (i.e., whether it has sufficient national economic development benefits).

Based on the outcome of the feasibility study, the Chief of Engineers signs a final recommendation on the project, which is sent to the Assistant Secretary of the Army for Civil Works and Office of Management and Budget (OMB). Following review by the Assistant Secretary and OMB, the President may seek authorization for the project from Congress, although Congress may act on its own to authorize funding based on an informational copy it receives of the Chief of Engineers recommendation. USACE can perform preconstruction engineering and design activities (which averages approximately two years to complete) while construction authorization is being pursued. Once Congress authorizes the project, the President's budget seeks Federal funds for the Federal share of the construction project in the annual Energy and Water Development Appropriations Act. The Congressional Research Service reports that only 16 of every 100 reconnaissance studies lead to constructed projects. [97]

With regard to applications of BCA outside of the USACE framework, such as among different applicants to a DOT discretionary grant program, BCA is an effective tool for assessing a range of options for a particular investment. Moreover, BCA can—if the methodology, performance measures, economic values and other assumptions used in the BCA are standardized—yield valuable information for use in prioritizing investments. However, because BCA approaches can vary significantly among practitioners, it is difficult to compare BCAs done for different projects by different sponsors. DOT, for instance, in its evaluation of BCAs submitted for TIGER discretionary grant applications, seeks only to be reasonably confident that the benefits of a particular project exceed its costs.

Evaluation of Economic Impact

State and local authorities often view ports as powerful drivers of regional economic growth, creating jobs not only at the port but in areas of the city or State beyond the port boundaries. Because of the historical role of ports as creators of net employment and because of their role in influencing the costs of both inbound and outbound trade, the public port authorities and State agencies responsible for port investment decisions frequently highlight how an investment can enhance the local or regional economy.

Thus, BCA is often supplemented or replaced at local government levels by an economic impact analysis that investigates how port transportation benefits spread through the local or regional economy in the form of jobs and economic growth. Economic impact studies focus on local and regional jobs created, payroll taxes collected, changes in business revenues and land values, wages paid for construction of the project, and new businesses supported. In some cases, however, the increases in jobs and revenues reported in an economic impact study are relocated from other ports and communities, as when a carrier transfers its operations from another port to the local port because of the project in question. Thus, an increase in jobs and revenues shown by a local economic impact analysis of a port project does not necessarily translate into a comparable increase in jobs and revenues at a national level.

Return on Investment

In contrast to government financing, a prospective private investor will focus on the depth of the market, the ability to compete against those that hold market share, the required rate of investment return, duration of payback and the associated business risks. The key is the ability to

[97] Carter, N.T. and C.V. Stern. "Army Corps of Engineers Water Resource Projects: Authorization and Appropriations". Congressional Research Service, March 22, 2013. Available at: http://planning.usace.army.mil/toolbox/library/Misc/R41961_Corps_fiscal_challenges-11Aug.pdf .

offer a suitably attractive price advantage and still be profitable enough to enable a viable business enterprise. In determining whether a project will achieve an acceptable return on the invested (ROI) capital, a pro forma cash flow analysis is performed to estimate the revenues, operating and capital costs, and cash flows of the project. The determination of financial feasibility will be based on a number of metrics (which differ from those used in public sector BCA), including earnings before interest, taxes, depreciation and amortization (EBITDA), the net present value of the net free cash flows, ROI, and the internal rate of return (IRR). A financial feasibility analysis will also involve a sensitivity analysis of the project to changes in key financial drivers such as volume, rates, and capital investment costs.

It is also important to evaluate the market feasibility of the proposed project by comparing the ability of the facility operator to compete for the target markets and customers at the rate levels that are required to fully cover the investor's costs and earn an acceptable return on its investment. One of the more difficult challenges for analysts involved in port development is to try to predict what other ports will be doing during the same period that will affect local economic growth and return on investment.

As funding for most port improvements comes from port revenues, local taxes, or private funds, a wider vision of national impacts is often not considered. Growth by one port may take business or business growth from other ports. Decision-making based on the rate of investment return or economic impact that address only local or regional impacts of port investments will likely lead to an overall pattern of national port development that is at best inefficient and possibly redundant from a national standpoint. By comparison, the Federal government generally strives to promote a national impacts perspective using BCA, evaluating costs and benefits at a national level (e.g., reductions in transportation costs to shippers from within and outside the region).

In its study, *Funding Options for U.S. Freight Transportation Projects*, the Transportation Research Board (TRB) noted that the current rate of public investment in capacity is inadequate to respond to the expected future intensification of cargo traffic.[98] The source of future investments in the U.S. transportation network is hard to predict. It could come in the form of more public-private financing initiatives, or there could be more emphasis on purely private capital investment. The current approach focuses on individual port improvement projects. U.S. ports compete for business both with each other and with other ports outside of the United States. Regardless of the sources of future financing, a fundamental policy question to be addressed in the next report of this study is whether or not existing funding practices can be reshaped to consider a national port system rather than solely financing a collection of individual port improvement projects.

[98] Transportation Research Board. *Special Report 297: Funding Options for Freight Transportation Projects*. 2009. Available at: http://onlinepubs.trb.org/onlinepubs/sr/sr297.pdf.

CHAPTER 4: U.S. TRADE AND FACTORS AFFECTING GROWTH

The Panama Canal expansion is anticipated to affect U.S. trade volumes and patterns. In 2010, total U.S. international trade in goods and services amounted to $4.2 trillion with exports amounting to $1.8 trillion and imports of $2.4 trillion. By 2012, the total reached almost $5.0 trillion. Over the ten-year period from 2000 to 2010, U.S. trade grew at an annual rate of 5.2 percent, with exports (at 5.5 percent) growing slightly faster than imports (4.9 percent).[99] Changes in the patterns of U.S. trade—including growth rates, commodity mix, and the ports of entry through which traded goods enter and leave the United States—will have an important influence on how public and private investments in transportation infrastructure are made in the future. Understanding the evolution of these trade patterns and how they have grown and changed over time is important for framing any discussion of future trade.

Trade in all goods is commonly measured in value (dollars), weight (tons), and volume (TEUs). As has been noted in previous chapters, goods are traded in a variety of ways—as containerized, bulk (dry and liquid), roll-on-roll-off, and project cargoes. For containerized cargoes, the most common unit of measure is the twenty-foot equivalent unit (TEU). Each measure is important to one or more of the key service providers along the supply chain—from ports to port operators, and from shippers to beneficial cargo owners. The Panama Canal expansion may affect significant portions of U.S. trade flows, but the effects will vary by commodity, by international trading partners, and by U.S. coast, port, and inland region.

To provide a context for interpreting the magnitude of impacts U.S. trade flows, this chapter presents baseline forecasts of U.S. trade flows and reviews factors that may influence trade growth. It should be noted, however, that any extrapolation or forecast of economic activity or trade is subject to a degree of uncertainty that increases over time. This analysis focuses specifically on waterborne trade and commodities that are most likely to be shipped through the Panama Canal. Special attention is given to containerized cargoes since the increasing size of container ships was a major motivation for expanding the Canal. Transportation cost savings are expected as these larger vessels are deployed on routes through the expanded Panama Canal.

4.1 U.S. TRADE FORECASTS

U.S. trade forecasts to 2040 have been released by the Federal Highway Administration (FHWA) as part of the Freight Analysis Framework (FAF3), which was most recently updated in December 2011.[100] FAF3 forecasts of U.S. imports and U.S. exports by commodity were prepared for FHWA by IHS Global Insight, utilizing their World Trade Model (WTM). These

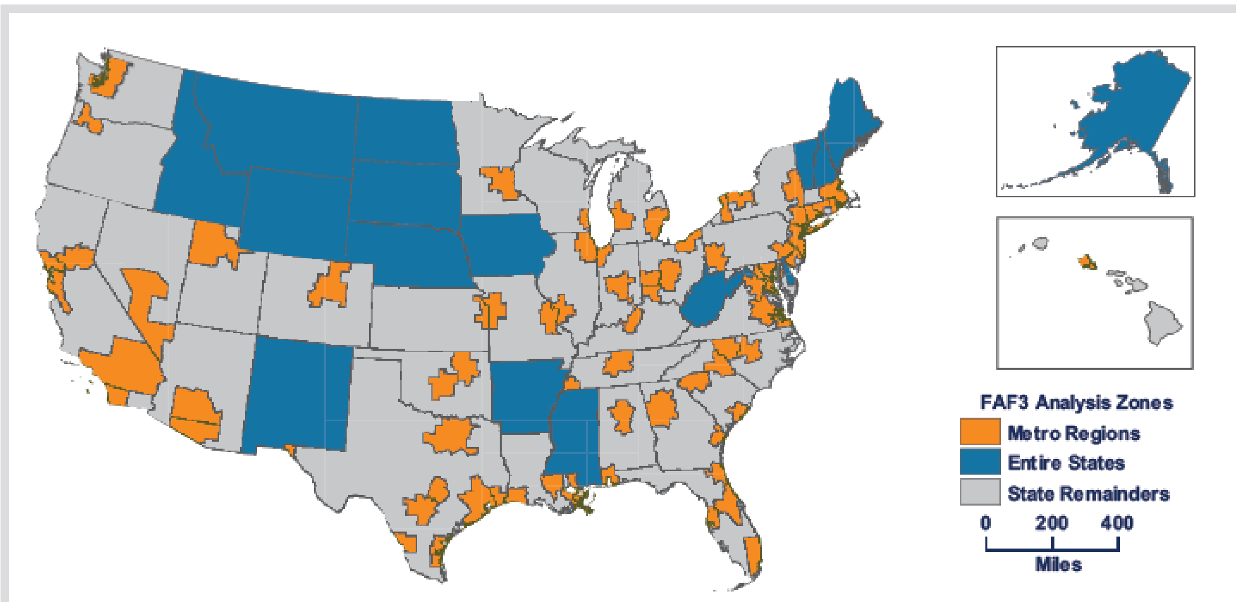
[99] U.S. Census Bureau. *The 2012 Statistical Abstract*. Available at: http://www.census.gov/compendia/statab/.

[100] Data used in this report—and detailed trade and domestic flows by commodity and mode—are available on FHWA's website at http://ops.fhwa.dot.gov/freight/freight_analysis/faf/index.htm.

forecasts provide flows by U.S. gateway, foreign geographic regional market, and Standard Classification Transported of Goods (SCTG) commodity. FAF3 also provides internal U.S. freight flows by commodity group for foreign imports and exports to and from states and major metropolitan areas.

Later sections of this report will assess regional impacts of Panama Canal expansion. The geographic definitions used in this assessment of commodity flows within the United States are shown in Figure 17. The eight world regions for which international trade data are available include: Canada, Mexico, the rest of the Americas, Northeast Asia, Southeast Asia and Oceania, South Central and Western Asia, Europe, and Africa.

Figure 17. **FREIGHT ANALYSIS FRAMEWORK 3 (FAF3) ANALYSIS ZONES**



Source: Parsons Brinckerhoff, Panama Canal Expansion Study, June 2012 (based on Freight Analysis Framework 3)

Historic trade data includes the most recent year for which comprehensive domestic and international trade data are available (2007) and an estimate for 2010 based on updated U.S. trade statistics. The forecasts, based on global macroeconomic projections prepared by IHS Global Insight in 2010, took into account the global downturn of 2007-2009. Table 14 and Table 15 summarize the information provided in these forecasts for U.S. international trade—showing total U.S. trade for all modes and regions—and by volume, value, and foreign origin and destination of waterborne trade. Table 14 and Table 15 also show projected compound average annual growth rates (CAGRs) over the 30-year forecast period for the volume and value of international trade between the United States and each region for exports and imports. It is important to note that these forecasts do not incorporate shifts in routing or modes such as those that might occur as a result of Panama Canal expansion and should therefore be considered trend or baseline projections.

4.1.1 TOTAL U.S. TRADE VOLUME AND VALUE

As shown in Table 14, the total volume of U.S. imports from all world regions and by all modes (water, air and land) is projected to more than double over 30 years—from 1.2 billion tons in 2010 to 2.6 billion tons in 2040—at an average annual growth rate of 2.7 percent. Of the eight trading regions of origin summarized in the forecasts, Northeast Asia has the greatest import volume growth—4.4 percent annually—followed by Southeast Asia at 3.6 percent annually.

Based on the global macroeconomic projections prepared by IHS Global Insight in 2010, exports are forecasted to grow significantly more quickly than imports, although from a much lower base (total imports in 2010 were 1.2 billion tons, while total exports amounted to 0.8 billion tons).

Table 14. **U.S. TRADE VOLUMES – 2010 & 2040 (Millions of Tons)**

	Imports			Exports		
World Region	**2010**	**2040**	**CAGR**	**2010**	**2040**	**CAGR**
Canada	344.3	786.7	2.8%	136.1	378.1	3.5%
Mexico	124.0	266.0	2.6%	95.3	230.5	3.0%
Rest of Americas	205.1	430.6	2.5%	118.3	242.6	2.4%
Europe	110.0	209.7	2.2%	104.8	239.5	2.8%
Africa	137.6	273.9	2.3%	30.8	63.4	2.4%
SW & Central Asia	122.9	216.2	1.9%	51.5	115.8	2.7%
Northeast Asia	90.6	333.1	4.4%	192.7	473.8	3.0%
SE Asia & Oceania	21.6	62.9	3.6%	32.9	80.6	3.0%
World Total	1,156.0	2,579.1	2.7%	762.3	1,824.2	3.0%
Asia Share of World	**20.3%**	**23.7%**		**36.3%**	**36.7%**	

**CAGR = Compound Average Annual Growth Rate*

Source: Federal Highway Administration, Freight Analysis Framework 3, December 2011

Forecasts for the growth rate of trade value (see Table 15) show higher overall growth rates than is the case for volume. Northeast Asia (particularly due to China) is the United States' major regional trade partner for imports and exports, with the highest dollar value of U.S. trade and the highest growth rate for both U.S export and imports.

Table 15. TOTAL U.S. TRADE VALUE – 2010 & 2040 (in $ billions)

	Imports			Exports		
World Region	**2010**	**2040**	**CAGR**	**2010**	**2040**	**CAGR**
Canada	$261.9	$684.3	3.3%	$230.6	$628.0	3.4%
Mexico	$219.4	$553.2	3.1%	$149.8	$441.0	3.7%
Rest of Americas	$175.2	$515.4	3.7%	$196.0	$630.0	4.0%
Europe	$271.6	$958.2	4.3%	$228.5	$909.6	4.7%
Africa	$86.0	$154.5	2.0%	$22.7	$69.1	3.8%
SW & Central Asia	$122.3	$251.0	2.4%	$82.8	$254.4	3.8%
Northeast Asia	$613.5	$2,327.4	4.5%	$251.9	$1,052.3	4.9%
SE Asia & Oceania	$65.7	$224.0	4.2%	$54.7	$210.7	4.6%
World Total	$1,815.6	$5,667.9	3.9%	$1,217.1	$4,195.1	4.2%
Asia Share of World	44.1%	49.4%		32.0%	36.2%	

Source: Federal Highway Administration, Freight Analysis Framework 3, December 2011

These forecasted trade patterns underscore the importance of Asian trade to the future of the U.S. economy and the need to accommodate a forecast of more than threefold increase in the value of imports from and almost a fourfold increase in exports to the whole of Asia (NE, SW, and SE) from 2010 to 2040. Of course, as shown in Table 14, the value of trade with other regions will also grow significantly.

Waterborne Trade between the United States and Major Trading Partners

For this study, the most relevant trade flows are those involving international water transports, especially in containers. Table 16 displays the number of full waterborne import and export TEUs by international trading partner region. Table 17 shows the share (in terms of tonnage of containerized and bulk freight) of the waterborne trade moving between the United States and the eight international trading regions. Since the TEU metric only applies to waterborne transport, the numbers in this table reflect a portion of the total trade shown in Table 14 and Table 15.

View of the Port of Singapore container terminal

Photo credit: iStock

Northeast Asia is the predominant exporter to the United States in terms of container trade, accounting for 10.2 million imported TEUs in 2010, or 61 percent of the U.S. waterborne total. Northeast Asia is also the primary destination for U.S. container exports, at 4.9 million TEUs in 2010, or 42 percent of the U.S. total. Container trade is projected to triple from 2010 to 2040.

Table 16. TOTAL U.S. WATERBORNE CONTAINER TRADE – 2010 & 2040 (in Millions of Loaded TEUs)

	Imports				Exports		
World Region	**2010**	**2040**	**CAGR**		**2010**	**2040**	**CAGR**
Mexico & Rest of Americas	1.7	3.8	2.8%		2.5	7.1	3.6%
Europe	2.1	4.7	2.9%		1.8	6.5	4.6%
Africa	0.1	0.4	3.9%		0.3	0.9	3.7%
SW & Central Asia	0.8	2.7	4.3%		1.0	2.6	3.4%
Northeast Asia	10.2	37.1	4.5%		4.9	16.2	4.2%
SE Asia & Oceania	1.7	3.9	2.8%		1.3	3.7	3.8%
World Total	**16.6**	**52.6**	**4.1%**		**11.7**	**37.0**	**4.0%**
Asia Share of World	77.0%	83.0%			60.0%	61.0%	

Source: PIERS Container Report Calendar 2011, U.S. Census Bureau Foreign Trade Statistics and Federal Highway Administration, Freight Analysis Framework 3, December 2011. Note that PIERS report does not include Canada container trade data

It is apparent that the vast majority of overseas U.S. trade volume, as measured by tons, is carried by water on oceangoing vessels. This excludes trade with Mexico and Canada where large shares of trade are transported overland by rail or truck, or via the Great Lakes by water. As noted previously in this report, the principal U.S. international trade that will be affected by Panama Canal expansion is that with Northeast Asia where 96 percent of import tons and 98 percent of export tons are transported by water.

Table 17. WATERBORNE TRADE AS A SHARE OF TOTAL U.S. TRADE – 2010 & 2040

	Waterborne Share of U.S. Trade (In Tons)						Waterborne Share of U.S. Trade (In Value)				
	Imports			Exports			Imports			Exports	
World Region	**2010**	**2040**		**2010**	**2040**		**2010**	**2040**		**2010**	**2040**
Canada	17.6%	19.4%		21.6%	22.1%		7.3%	4.5%		2.2%	2.1%
Mexico	63.9%	56.0%		36.8%	25.5%		17.9%	9.5%		9.8%	6.6%
Rest of Americas	99.4%	99.0%		99.1%	98.5%		70.9%	59.1%		55.7%	48.4%
Europe	97.4%	95.9%		93.8%	92.9%		45.8%	38.7%		32.8%	31.4%
Africa	99.9%	99.8%		99.8%	99.4%		98.5%	97.1%		87.7%	84.6%
SW & Central Asia	99.8%	99.7%		99.2%	98.7%		85.8%	83.3%		57.2%	52.0%
Northeast Asia	96.4%	96.1%		98.5%	98.4%		60.6%	54.1%		44.6%	35.0%
SE Asia & Oceania	97.8%	97.2%		98.5%	98.6%		79.7%	69.5%		67.0%	57.4%

Source: Federal Highway Administration, Freight Analysis Framework 3, December 2011

4.2 COMMODITY FORECASTS

Product value is one of the critical determinants of both the mode and the route by which goods are transported. Very high-value products such as pharmaceuticals tend to be transported by air. Relatively high-value, time sensitive products such as apparel tend to be transported by water through West Coast ports to inland regions rather than using the longer Panama Canal route. In both cases, the choice reflects the need to move valuable or time-sensitive goods more quickly to reduce inventory carrying costs and other cost-related factors.

4.2.1 CONTAINERIZED CARGO

DOT data cover 42 commodity groups defined by the Standard Classification of Transported Goods (SCTG) (see Appendix 4). As described in Chapter 3, containerized cargoes are likely to be impacted by Panama Canal expansion, especially U.S. imports from Northeast Asia. Of the 42 SCTG commodity groups, about half are highly containerized products moving in significant volumes. (The remaining commodity groups represent products that are largely moved in bulk or containerized goods with relatively small import volumes.) Table 18 and Figure 18 show U.S. containerized waterborne import volumes from all foreign regions and the portion imported from Northeast Asia in terms of TEUs. Table 19 and Figure 19 display similar information for exports. The 19 largest product groups that are highly containerized have been aggregated under the term *container/vehicle*. The motorized vehicle product group has been included in this aggregated classification because it includes both vehicles (which are primarily carried in specialized vehicle carriers) and vehicle parts (which are primarily containerized).

Overall, containerized imports from Northeast Asia are projected to quadruple in terms of TEUs from 2010 to 2040, representing a change in share from 62 to 65 percent of all U.S. waterborne imports. On the other hand, containerized exports to Northeast Asia are substantially smaller (in terms of TEUs), but are forecast to increase by a factor of roughly 2.5, representing a change in share from 40 to 41 percent of all U.S. exports. These trends are illustrated in Figure 18 and Figure 19.

Table 18. **TOTAL WATERBORNE AND NORTHEAST ASIA CONTAINER IMPORTS (in Millions of TEUs)**

Commodity (SCTG)	World			Northeast Asia	
Container/vehicle	**2010**	**2040**		**2010**	**2040**
Other agricultural products	0.8	3.3		0.1	0.3
Meat/seafood	0.3	0.7		0.1	0.3
Milled grain products	0.2	0.7		0.0	0.1
Other foodstuffs	0.8	2.4		0.2	0.7
Basic chemicals	0.7	2.2		0.3	0.8
Chemical products	0.3	1.2		0.1	0.6
Plastics/rubber	1.4	5.4		1.0	3.8
Wood products	0.6	1.1		0.3	0.6
Newsprint/paper	0.1	0.4		0.0	0.1
Paper articles	0.1	0.2		0.1	0.1
Printed products	0.1	0.4		0.1	0.3
Textiles/leather	1.4	4.7		1.0	3.4
Articles-base metal	1.0	5.2		0.8	4.2
Machinery	1.1	5.0		0.9	3.9
Electronics	0.9	4.7		0.8	4.1
Motorized vehicles	0.7	1.5		0.6	1.3
Precision instruments	0.1	0.3		0.0	0.2
Furniture	1.2	7.5		1.0	6.3
Miscellaneous manufacturing products	0.8	3.8		0.7	3.6
Container/vehicle Subtotal	**12.6**	**50.7**		**8.3**	**34.8**
Bulk/other TEU	**4.0**	**11.5**		**2.0**	**5.6**
Total	**16.6**	**62.1**		**10.2**	**40.4**
Northeast Asia % of World				**62.0%**	**65.0%**

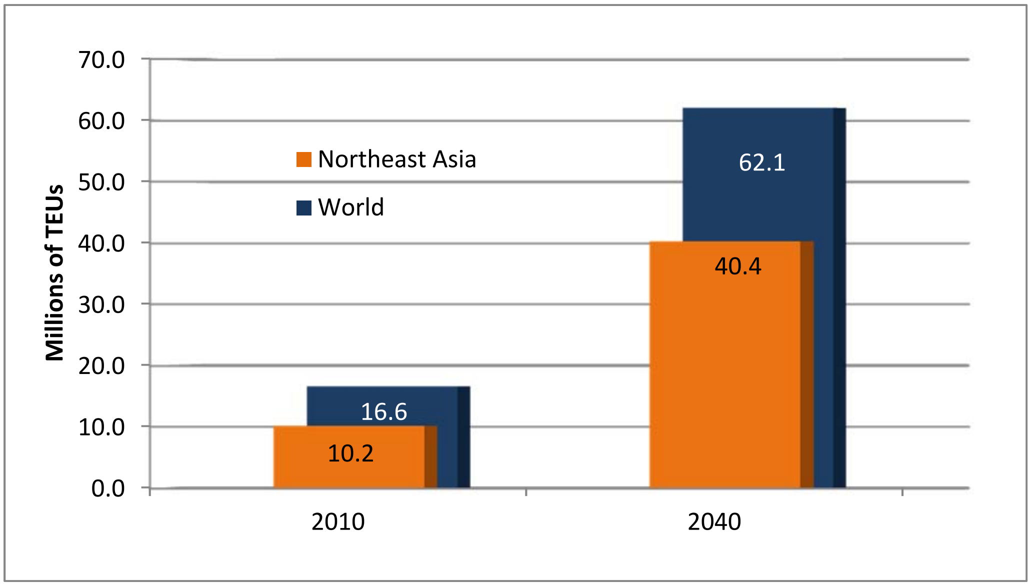
Source: PIERS Container Report Calendar 2011, U.S. Census Bureau Foreign Trade Statistics and Federal Highway Administration, Freight Analysis Framework 3, December 2011. Note that PIERS report does not include overland container trade data for Canada and Mexico.

Table 19. U.S. TOTAL WATERBORNE CONTAINERIZED EXPORTS TO NORTHEAST ASIA AS A SHARE OF THE U.S. TOTAL (in Millions of TEUs)

Commodity (SCTG)	World			Northeast Asia	
Container/vehicle	2010	2040		2010	2040
Other agricultural products	0.8	1.6		0.3	0.6
Meat/seafood	0.6	1.3		0.3	0.6
Milled grain products	0.3	0.8		0.1	0.2
Other foodstuffs	0.7	2.3		0.2	0.5
Basic chemicals	0.8	2.4		0.2	0.7
Chemical products	0.6	2.0		0.1	0.4
Plastics/rubber	1.6	4.7		0.5	1.4
Wood products	0.2	0.3		0.1	0.1
Newsprint/paper	0.9	1.6		0.3	0.5
Paper articles	0.1	0.3		0.0	0.1
Printed products	0.0	0.1		0.0	0.0
Textiles/leather	0.2	0.5		0.0	0.1
Articles-base metal	0.1	0.3		0.0	0.1
Machinery	0.3	1.1		0.1	0.2
Electronics	0.1	0.5		0.0	0.1
Motorized vehicles	0.2	0.5		0.0	0.1
Precision instruments	0.0	0.1		0.0	0.0
Furniture	0.0	0.1		0.0	0.0
Miscellaneous manufacturing products	0.1	0.2		0.0	0.0
Container/vehicle Subtotal	**7.5**	**20.7**		**2.2**	**5.7**
Bulk/other TEU	**4.2**	**10.6**		**2.7**	**6.8**
Total	**11.7**	**31.4**		**4.9**	**12.5**
Northeast Asia % of World				**41.0%**	**40.0%**

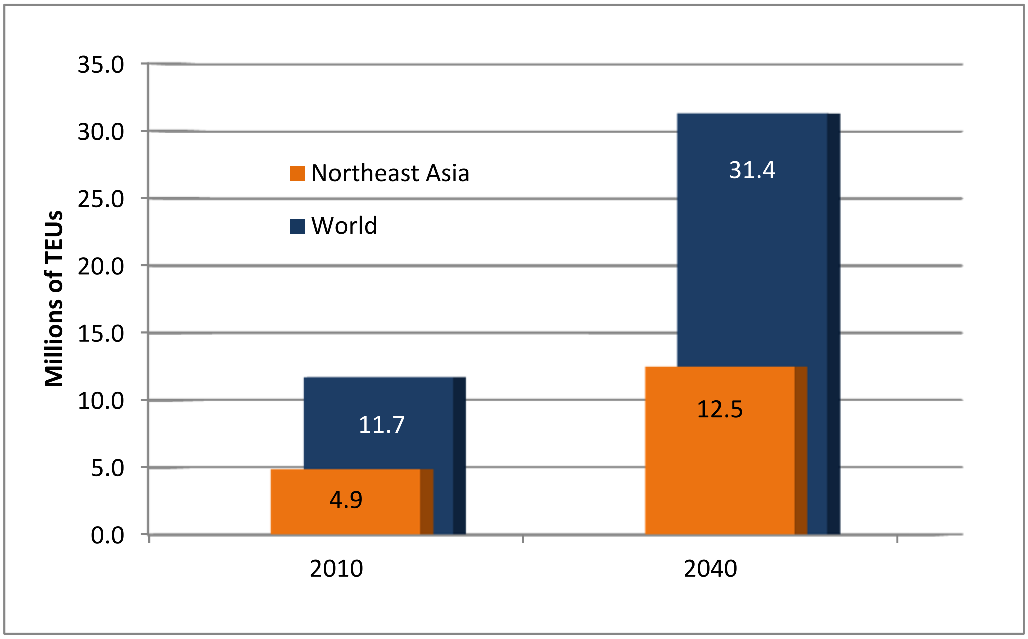
Source: PIERS Container Report Calendar 2011, U.S. Census Bureau Foreign Trade Statistics and Federal Highway Administration, Freight Analysis Framework, December 2011.Note that PIERS report does not include overland container trade data for Canada and Mexico.

Figure 18. TRENDS IN U.S. IMPORTS FROM NORTHEAST ASIA RELATIVE TO TOTAL U.S. WATERBORNE IMPORTS (in Millions of TEUs)



Source: PIERS Container Report Calendar 2011, U.S. Census Bureau Foreign Trade Statistics and Federal Highway Administration, Freight Analysis Framework, December 2011. Note that PIERS report does not include overland container trade data for Canada and Mexico.

Figure 19. TRENDS IN U.S. EXPORTS TO NORTHEAST ASIA RELATIVE TO TOTAL U.S. WATERBORNE EXPORTS (in Millions of TEUs)



Source: PIERS Container Report Calendar 2011, U.S. Census Bureau Foreign Trade Statistics and Federal Highway Administration, Freight Analysis Framework, December 2011. Note that PIERS report does not include overland container trade data for Canada and Mexico.

4.3 FACTORS AFFECTING VOLUME GROWTH

The trade and commodity flow forecast from FHWA outlined in the previous section should be viewed not as a prediction, but rather as a reasonable baseline projection or forecast. Like any other forecast, it is based on imperfect and incomplete knowledge, and outcomes will vary depending on a wide range of global and U.S. economic and other developments. In addition, the FHWA forecasts are based on a continuation of many current factors such as modal, coastal, and port shares, which can change over time.

This section summarizes some of the economic drivers that are most likely to affect marine shipping volumes described in the previous sections. Most of these volume drivers are independent of Panama Canal expansion impacts. Instead, they affect the trade flow volumes that may then be impacted by Canal expansion.

4.3.1 GLOBAL ECONOMIC AND TRADE DEVELOPMENT

Economic and Consumer Demand Growth

The U.S. trade forecasts are based on a number of trends and assumptions concerning the growth and development of the U.S. economy. These forecasts are also based on the ability of U.S. trading partners to both produce goods for U.S. consumption and consume goods and services exported by the United States. These trends and assumptions include the effects of aggregate consumer demand as driven by population and income growth, the willingness and ability of foreign consumers and industries to purchase U.S. exports, and the relative costs of producing the kinds of goods that U.S. consumers and industries are willing and able to import. These trends were considered in the development of long-range trade forecasts shown in Table 18 and Table 19.

Panama Canal expansion will primarily influence the costs of ocean transportation between the U.S. East and Gulf Coasts and Northeast Asia and to a lesser extent a number of smaller trade lanes involving ocean shipping between Latin America's West Coast ports and the U.S. Gulf and East Coasts, and between the U.S. West Coast and ports along the East Coast of Latin America. Although the volume of trade is small, relative to current U.S. trading patterns such as Northeast Asia trade, the expansion of the Panama Canal will provide shippers with the opportunity to lower shipping costs on these trade lanes and respond to growth in demand associated with the increasing populations and rising relative incomes of Latin American countries.

Growth and Shift in Manufacturing

In the post-World War II era, firms from developed nations have increasingly sourced inputs and located manufacturing operations in countries such as China, Taiwan, Hong Kong and South Korea, and more recently in countries like India, Thailand, and the Philippines where factors such as labor costs, availability of other inputs, exchange rates, and foreign direct investment opportunities have made it cheaper to manufacture their goods. But as these conditions change over time, so will the centers of manufacturing upon which U.S. importers rely. Energy and transportation costs also factor heavily in decisions regarding the location of manufacturing facilities, leading some firms to reconsider sourcing of products in locations nearer to the point of consumption (especially for heavier products), or in areas with some combination of relatively low labor and low transport costs.

Long-term forecasts, provided in Table 18 and Table 19, do not take into account possible shifts in future manufacturing away from locations in Northeast Asia. Possible shifts in the location of manufacturing to other countries in Southeast and Southwest Asia will be examined in the second report of this study. To the extent that the location of manufacturing shifts from present centers in Northeast Asia to other locations, existing trade patterns and the volume of trade on these routes will also change.

4.3.2 LONG-TERM U.S. ECONOMIC GROWTH AND DEMAND

Impacts of Panama Canal Expansion on Import Volumes

Total import volumes both in aggregate and for individual products are not expected to be affected significantly by Panama Canal expansion due to the factors described below in Section 5.1 and 5.2. Rather, these volumes provide the baseline of cargo flows that may be affected by changes in the relative costs of transporting commodities through the expanded Panama Canal or by other routes. Both port and landside transportation costs will influence the choice of each transportation mode. For such factors, the expansion's effect on different product groups is expected to vary widely.

Large container vessel sailing in open water

Photo courtesy: A.P. Moller – Maersk Group

Population

The influence of the Panama Canal and its expansion on U.S. cargo movement (particularly imports) depends, in part, on U.S. demographics. A review of U.S. demographics shows that there has been a gradual shift in the concentration of population from the Northeast and Midwest to the Atlantic/Gulf and Western regions over the past decade. Newly released 2010 U.S. Census data and the most recent State-level interim projections show that the populations of the Southern and Western regions of the United States (especially Texas) have been growing more quickly than the populations of other regions of the United States and will continue to do so.[101] This will contribute to demand for consumer goods imported from Northeast and Southeast Asia, especially if the current cost advantages of producing these goods in Asia can be maintained.

[101] National-level population projections through 2060 can be found at: U.S. Census Bureau. *2012 National Population Projections.* Available at: http://www.census.gov/population/projections/data/national/2012.html. Interim State-level population projections produced in 2005 and based on 2000 Census results can be found in Table 6 at: U.S. Census Bureau. *2005 Interim State Population Projections.* Available at: http://www.census.gov/population/projections/data/state/projectionsagesex.html.

According to U.S. Census Bureau data, Texas, Georgia, Arizona and Nevada had some of the nation's highest population growth rates from 2000 to 2009. This demographic shift is expected to continue over the long term. The population in the Atlantic/Gulf region is projected to increase by 12.3 percent from 2010 to 2020 and by as much again in the decade thereafter, while the population in the West is projected to grow by 13.0 percent, on average, per decade from 2010 through 2030. In contrast, the Northeast and Midwestern states are expected to see only modest population increases, particularly after 2020. Table 20 below presents historic and projected U.S. population changes by region.

Table 20. HISTORIC AND PROJECTED REGIONAL POPULATION GROWTH IN THE UNITED STATES

Region	% Change in Population 2000-2010	% Change in Population 2010-2020	% Change in Population 2020-2030
Northeast	4.1%	2.4%	0.9%
Midwest	4.7%	3.1%	1.5%
South (Atlantic / Gulf)	13.3%	12.3%	12.3%
West	14.2%	13.1%	12.9%
United States	9.8%	8.7%	8.3%

Source: 2005 Interim State Population Projections, Available at: http://www.census.gov/population/projections/data/state/projectionsagesex.html

All else being equal, shippers generally favor ports closest to cargo's destination, hoping to minimize the more expensive inland transportation leg of the shipment. As will be discussed further in Chapter 5, this preference is less important for high-value goods where transit times are more important. For Asian imports, then, Panama Canal expansion will increase the potential for direct all-water access to South Atlantic and Gulf Coast ports—gateways to approximately 37 percent (and rising) of the nation's population, based on state population projections. But since similarly strong population growth is expected in the West, a region for which the Canal is not competitive, it is reasonable to conclude that any changes in the Canal's market share of U.S. imports resulting from population shifts alone will be limited. As noted in this report, the more relevant factors influencing market access are related to the types of commodities being shipped and the factors that influence the final cost savings for beneficial cargo owners.

Shifts in Business Demographics

In the United States, with the emergence of the service sector and the rapid increase in net imports over the past 30 years, the spatial pattern of manufacturing (as measured by GDP) has shifted dramatically over time, as shown in Table 21. U.S. manufacturing has become much less concentrated in the eastern Midwest and Atlantic regions and more concentrated in the Southern and Western regions since 1980. Accordingly, the East North Central and Middle Atlantic regions show the largest declines in the share of national manufacturing GDP between 1980 and 2010 (see Figure 20 for a map of the U.S. Census regions). The most dramatic increases were in the Pacific region, with more modest gains in the Mountain and West South Central regions. As will be shown in Chapter 5, each of these latter regions (with certain exceptions for specific commodities) has much stronger trade linkages to Asian imports through the West Coast ports than through the Gulf or Eastern ports.

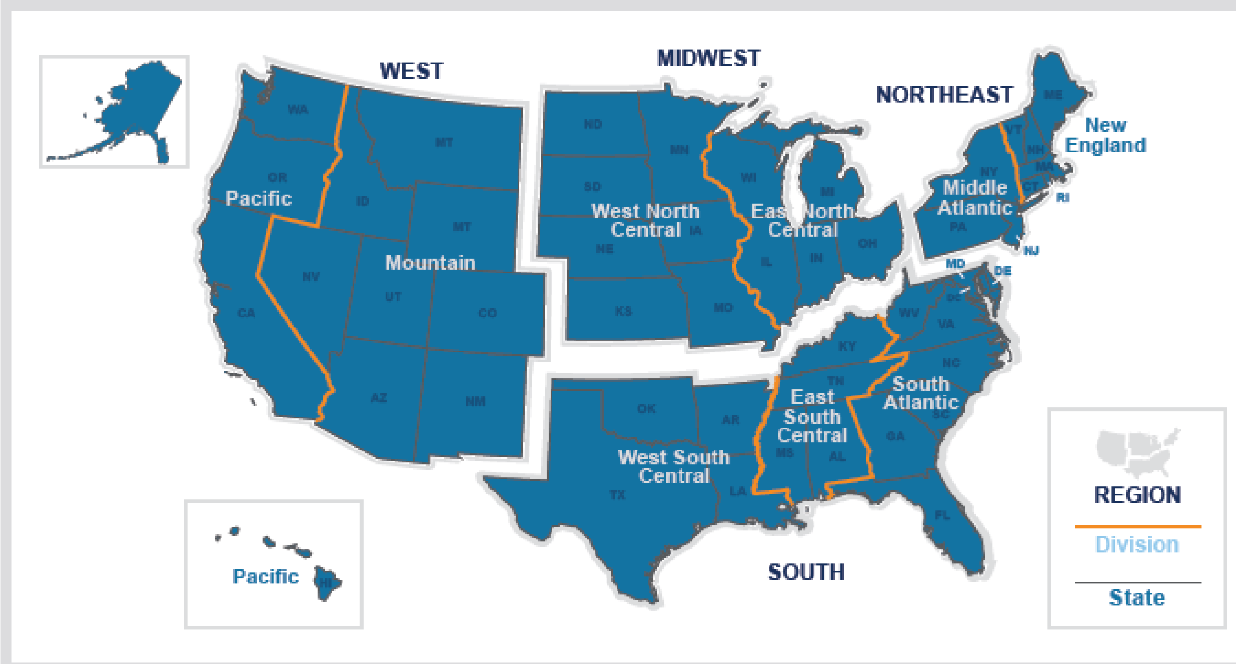
Table 21. CONCENTRATION OF GDP FROM MANUFACTURING BY U.S. CENSUS REGION (in billions of 2010 Dollars)

Census Bureau Division	2011 GDP (Billions of Dollars)	1980	1990	2000	2010	2020	2030
East North Central	$ 340.19	27.02%	25.14%	24.25%	18.98%	18.71%	17.91%
East South Central	$ 104.83	6.83%	7.42%	6.48%	6.04%	5.80%	5.58%
Middle Atlantic	$ 171.93	18.59%	15.77%	13.02%	9.86%	9.51%	9.56%
Mountain	$ 82.52	1.88%	2.19%	3.38%	4.57%	4.91%	5.25%
New England	$ 88.80	4.73%	4.74%	4.66%	4.97%	4.99%	4.91%
Pacific	$ 327.40	8.32%	10.04%	13.28%	18.07%	18.35%	18.39%
South Atlantic	$ 261.01	13.96%	16.40%	16.08%	14.73%	14.37%	14.19%
West North Central	$ 131.20	7.45%	7.66%	7.69%	7.40%	7.27%	7.20%
West South Central	$ 269.12	11.22%	10.63%	11.17%	15.38%	16.08%	17.01%

Source: Moody's economy.com, June 2012

Table 21 also provides forecasts of future concentration of manufacturing GDP by region through 2030. Changes for the next 20 years are not predicted to be as great (in percentage terms) as in the past, suggesting the emergence of a more stable geographic distribution of manufacturing than has been evident for the past 30 years. Only the West South Central region gains more than one percentage point in the national share of manufacturing GDP during this period relative to 2010.

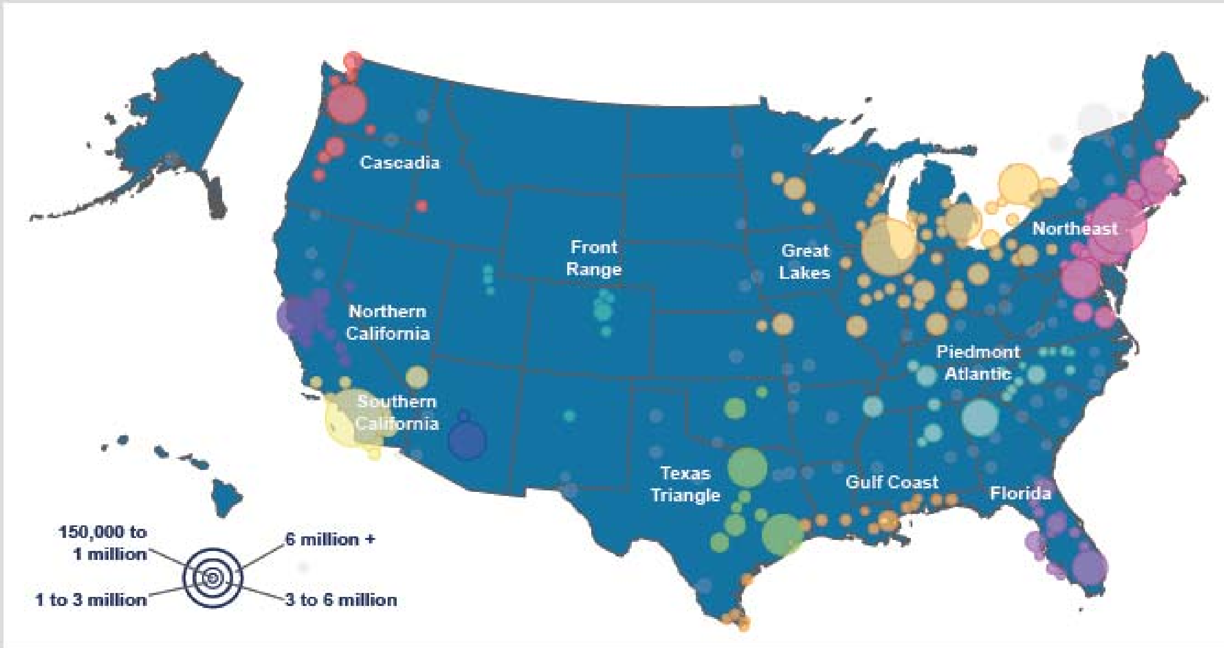
Figure 20. **CENSUS REGIONS AND DIVISION OF THE UNITED STATES**



Source: U.S. Census Bureau, Geography Division, June 2012, Available at: *http://www.census.gov/geo/www/us_regdiv.pdf*

Shifts in manufacturing GDP are not the only predictors of total trade volumes. The demand for consumer goods generated by metropolitan markets and "mega-regions" along the East Coast and the Midwest is driven largely by the incomes and business requirements of the service sector. These market factors create significant demand for imported consumer goods. The populations of mega-region are shown schematically in Figure 21.

Figure 21. **EMERGING MEGA-REGIONS IN THE UNITED STATES**



Source: Regional Plan Association, America 2050, 2011

4.3.3 SOURCING OF GOODS: IMPORT PROPENSITY

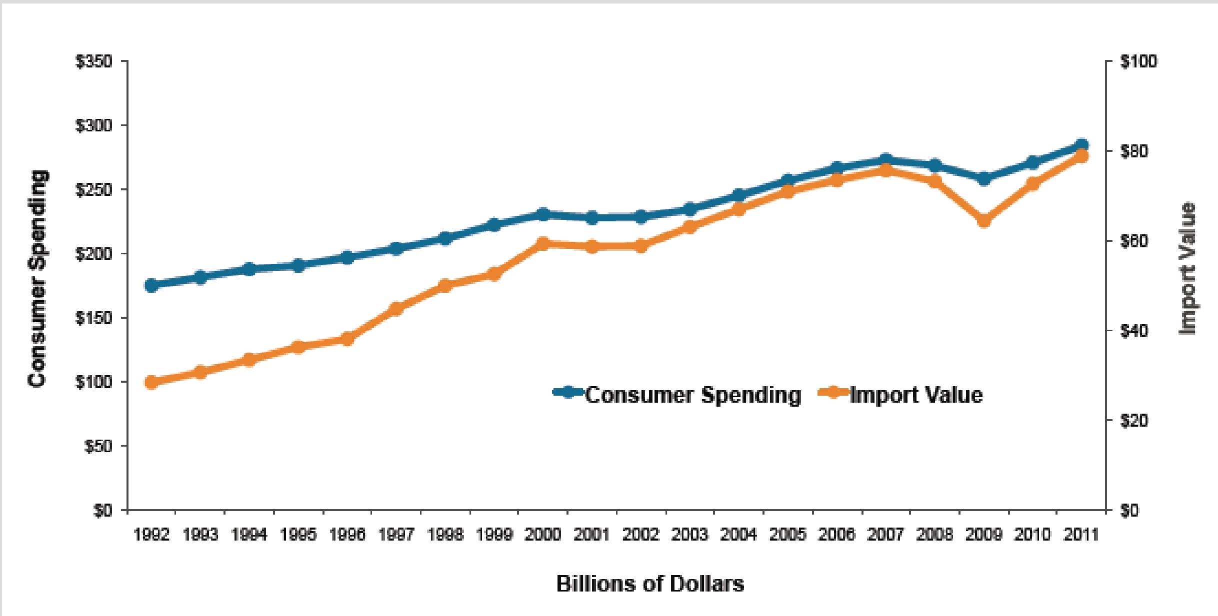
The previous sections have used FAF3 data to describe how freight volumes are influenced by fundamental demand drivers. Regional and state-level allocations of FAF3 projections to 2040 are based on current shares and would likely need to be modified if the sourcing of goods shifted. The source of goods also determines the share and volume of goods that are imported, the extent to which goods are imported through East or West Coast ports, and whether such goods would be likely to move through the Panama Canal. Sourcing factors include 1) the share of goods imported and 2) the country of origin for imported goods.

Import Propensity

The first sourcing factor is whether goods are imported or produced domestically. If the share of goods imported (known as "import propensity") increases, then import volumes will increase, all other demand factors being equal. For many product groups, the import propensity has indeed risen over past decades. Figure 22 shows that imports of apparel grew relative to consumer spending through the 1990s and early 2000s.[102]

[102] There is no direct measure of import shares of consumer spending categories.

Figure 22. **U.S. CONSUMER SPENDING ON APPAREL VERSUS IMPORTS (in $ billions)**



Source: U.S. Census Bureau, Foreign Trade Division, May 2012

For many product groups, including footwear and electronics, a large share of goods consumed in the United States is now imported. Growth in import propensity has been driven by many factors including reduced trade barriers, improved transportation and supply chains, growth of low cost manufacturing in Asia and elsewhere, and rising demand for low-cost manufactured and consumer goods in the United States. Figure 22 shows that import volumes of apparel, for example, have tracked very closely with consumption since 2000 (except for 2009, when there were significant reductions in inventory levels). This stable relationship suggests that imports of apparel are not likely to increase relative to consumption of apparel and, therefore, that import volumes will increase only if consumers buy more.

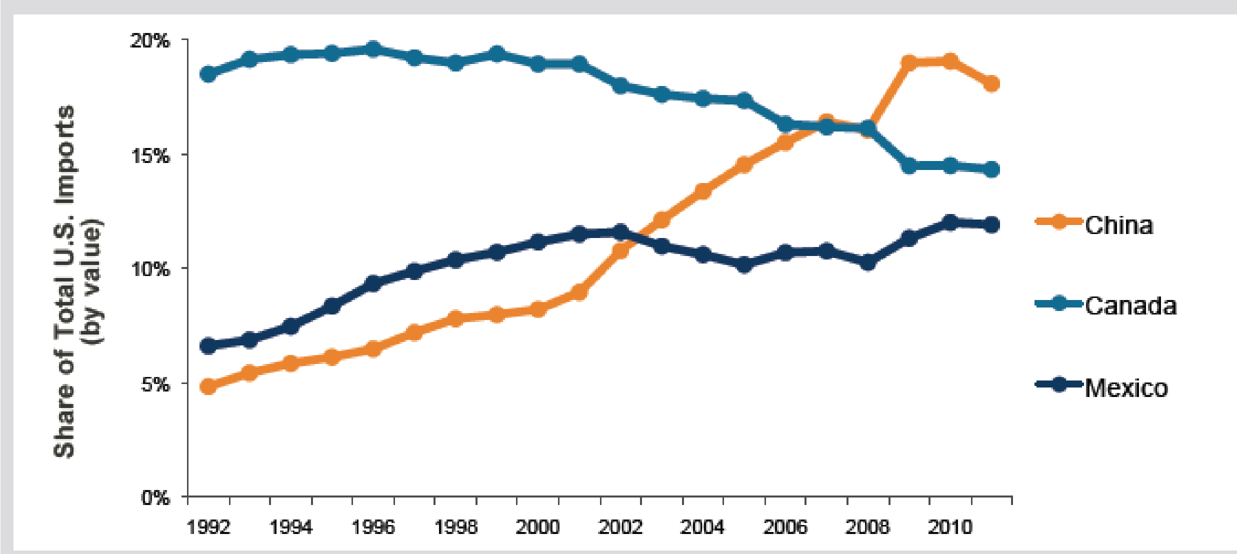
4.3.4 SOURCING OF GOODS: COUNTRIES OF ORIGIN

The long-term growth of U.S. maritime trade and the impacts of Panama Canal expansion on the transportation network will both be determined in part by the countries from which the U.S. imports. This affects trade in two ways, outlined in the subsequent pages.

Shifts from North American to Overseas Trade

The significant growth of U.S. container port volumes over the past decade resulted in part from a shift in U.S. import sourcing from Canada and Mexico to Asia. With Canada and Mexico sharing nearly 7,500 miles of land border with the United States, most of their exports to the United States are moved via road and rail rather than by sea. Changes in their shares of U.S. imports have therefore affected U.S. seaports' share of total cargo volume. Imports from China have grown much more quickly than imports from Canada and Mexico and most imports from China reach the United States by sea (some are transported by air). As shown in Figure 23, by 2007 China had become the largest exporter to the United States in terms of value.

Figure 23. COUNTRY SHARES OF TOTAL U.S. IMPORT VALUE, 1992-2011



Source: U.S. Census Bureau, Foreign Trade Division, May 2012

Shifts in Overseas Sourcing

The volumes of trade flowing through the Panama Canal will in part depend on U.S. import sourcing trends. If China continues to grow in dominance as a source of imports to the United States, the Panama Canal will likely continue to grow in importance as a conduit for imports to the U.S. East and Gulf Coasts.

However, this expected volume increase could be dampened if other countries erode China's share of U.S. imports. As noted previously, to the extent that India, Vietnam or other Southwest/Southeast Asian countries increase their shares of U.S. imports at the expense of China, the Panama Canal could lose a portion of its market share of Asia–U.S. cargo to the Suez Canal as a result of relatively shorter sailing distance via the Suez Canal and lower costs. The impact of the Panama Canal expansion attributable to use of larger ships would also be lessened if China were to lose share to countries in regions such as Central America or South America (e.g., Brazil), that are nearer to the United States (making the use of large vessels less likely), or that are less likely to use the Panama Canal to reach U.S. markets.

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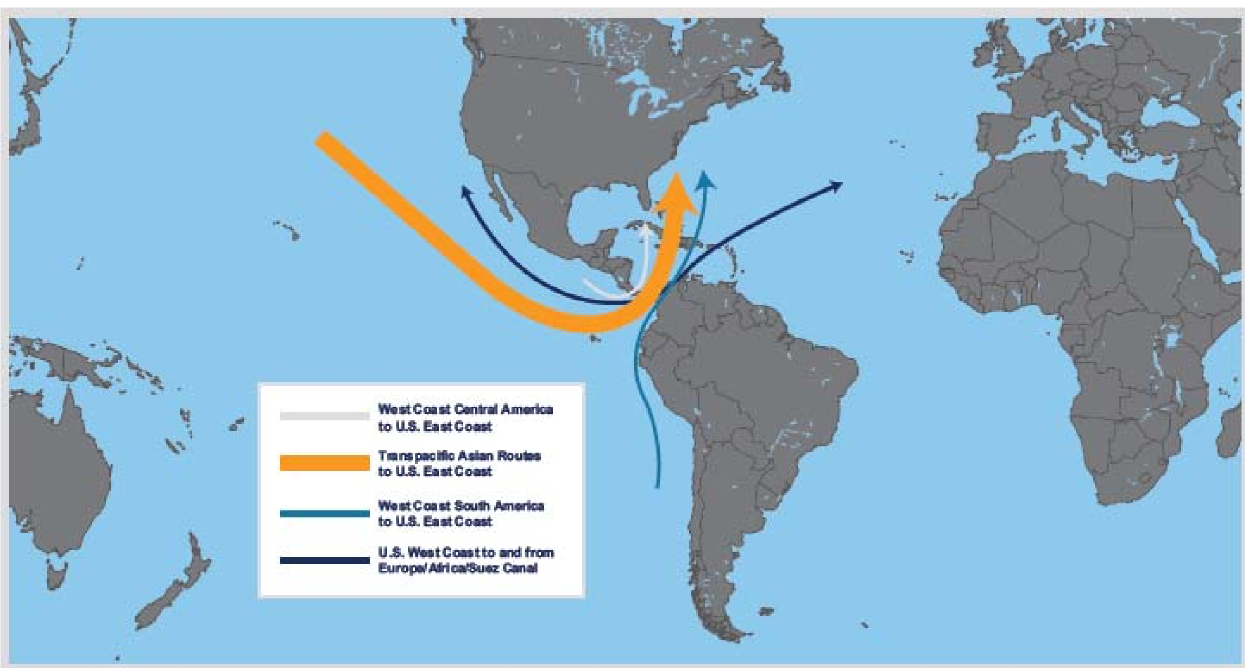
CHAPTER 5: EFFECTS OF PANAMA CANAL EXPANSION

This section begins by discussing the trade flows that are most likely to be affected by the Panama Canal expansion due to the use of larger ships. The affected trade flows are those for which there is more potential for transportation cost reductions. Later phases of this study, covered in the second report, will assess these cost reductions in detail. Subsequent sections of this chapter include an overview of these possible effects for each of the U.S. regions.

5.1 U.S. TRADE LIKELY TO BE AFFECTED BY PANAMA CANAL EXPANSION

Panama Canal expansion impacts will not be uniform across all trade lanes and commodity types. While increased capacity may generally benefit all users of the Panama Canal, noticeable reductions in shipping costs will occur only where it is economically feasible to deploy significantly larger vessels; that is, in long-distance and high-volume trades. Figure 24 shows the major North American trade routes (by volume) that transit the Panama Canal.

Figure 24. **PANAMA CANAL PRINCIPAL TRADE ROUTES**



Source: Parsons Brinckerhoff, Panama Canal Expansion Study, June 2012

The United States is the largest market served by the Panama Canal. In 2012, about two-thirds of the cargo tonnage transiting the Canal either originated from or was destined for the United States. Table 22 shows the major Panama Canal cargo trade lanes in Fiscal Year 2012, in terms of total tonnage.

***Table 22*. PRINCIPAL PANAMA CANAL TRADE ROUTES BY CARGO TONNAGE – FY 2012**

Panama Canal Principal Trade Routes	Volume (million long tons)	Percent of Total 2012 Tonnage
Northeast Asia-East Coast U.S.	84.3	38.7%
East Coast U.S.-West Coast South America	27.6	12.7%
Europe-West Coast South America	14.4	6.6%
South America Intercoastal	11.1	5.1%
East Coast U.S.-West Coast Central America	12.2	5.6%
Europe-West Coast U.S./Canada	9.8	4.5%
U.S. Intercoastal	5.7	2.6%
East Coast South America-West Coast U.S./Canada	3.7	1.7%
East Coast U.S. Canada-Oceania	2.0	0.9%
All Other Routes	47.6	21.7%
Total	**218.1**	**100.0%**

Source: Panama Canal Authority, Statistics and Models Administration Unit (MEEM), October 2012.

5.1.1 RELATIVE PATTERNS OF NORTHEAST ASIA-U.S. TRADE

The U.S. trade lane most likely to be impacted by Panama Canal expansion is Northeast Asia-East Coast U.S. trade because it is the largest trade lane (as shown in Table 22) and because it is where larger ships are most likely to be deployed. East Coast U.S.-West Coast of South America trade, the second-largest trade lane in terms of tonnage, could also be affected. There is likely to be minimal impact on trade lanes with smaller volumes, such as U.S. East Coast trade with the West Coast of Central America, which are handled by feeder services using smaller vessels and transshipment through Panamanian ports.

Within the Northeast Asia-U.S. trade, the impacts of Canal expansion will vary significantly by cargo type. Containerized cargoes, bulk cargoes, and vehicles comprise the majority of cargo types shipped in these lanes, and are discussed in the following sections.

Containerized Cargoes

Northeast Asia–U.S. trade, particularly the import of Chinese manufactured consumer goods, is dominated by containerized cargoes. Since the United States does not export as much containerized cargo volume to Northeast Asia as it imports, container vessels are more fully loaded in their eastbound trip to the United States and carry many empty containers on their return voyages. Thus, container vessel deployment decisions along the Northeast Asia-U.S. trade lane are largely based on U.S. demand for imports.[103]

[103] The Port of Savannah, which handles a significant amount of U.S. exports, is an exception.

Bulk Cargoes

Dry bulk cargo transiting the Panama Canal along the Northeast Asia-East Coast U.S. trade route is largely westbound, dominated by U.S. exports of grains to Asia. Japan, South Korea, and Taiwan import a significant amount of U.S. corn, wheat, and sorghum while China primarily imports U.S. soybeans to produce food and animal feed. Use of larger vessels, such as Small Cape and some Capesize ships, could result in reduced per-unit transportation costs, potentially reducing prices and thus increasing potential additional U.S. exports of grain as well as of other bulk commodities such as coal.

Potential effects on U.S. exports could be limited in the short term, due to port capacity limitations in Northeast Asia such as insufficient channel depth for grain-handling destination ports in Japan, South Korea and Taiwan. In the longer term, however, these limitations may be addressed in response to Northeast Asian demand for bulk commodities.[104] In contrast, China's deepwater bulk facilities are capable of handling larger ships that could be used to import U.S. grain.

Vehicles

The Panama Canal expansion will likely have little impact on vehicle shipments from Northeast Asia to the United States. While there could be cost advantages in shifting to larger vessels, there are port limitations in several of the U.S. East Coast gateway ports for vehicle imports flows (such as Brunswick, GA and Jacksonville, FL) which make immediate routing changes after 2015 unlikely. While auto terminals may not require specialized unloading equipment, storage space is a major requirement, as multi-level vehicle garages are not usually available.[105] Over the past few years container terminals have increasingly crowded out auto-handling facilities, especially those at deepwater ports. For example, vehicle imports which were previously handled in Los Angeles/Long Beach have been moved to San Diego and Port Hueneme.

Ro-Ro vessel docked at port

Photo courtesy: Farrell Lines

These shifts in ports handling vehicle imports were made possible in part by the relatively shallow drafts of the existing vehicle-carrier fleet. It is expected that vehicle-carrier vessel

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[104] South Korea has been working on a number of improvement projects at such secondary ports as Mokpo, Pyongtaek, and Gwangyang, while Japan is periodically doing the same, but at ports such as Hitachinaka and Yokkaichi, which are less prominent in current U.S. trade since they are not container ports.

[105] There are several land-constrained European ports, such as Barcelona and Bremerhaven, where multi-level garages have been built on-dock to increase auto terminal capacity.

designs and size will remain relatively steady over the long term and that vehicle-shipping economics will therefore be minimally affected by the Canal expansion.

In summary, the cargoes and U.S. trade lanes most likely to be affected by Panama Canal expansion are containerized imports from Northeast Asia due to increased efficiency arising from larger container vessels transiting the Panama Canal and possibly U.S. exports of bulk goods to Northeast Asia due to increased Panama Canal capacity to accommodate more vessels and larger bulk vessels. These impacts are examined in more detail below and will be further addressed in the second report of this study.

5.2 POTENTIAL COST-REDUCTION IMPACTS OF PANAMA CANAL EXPANSION

Given that the Panama Canal expansion will enable use of larger ships, potential impacts of Panama Canal expansion on U.S. containerized imports from Northeast Asia could be:

- Reductions in transportation costs for goods currently being shipped to U.S. East and Gulf Coast ports via the Panama Canal.
- Transportation cost reductions that lead to shifts to U.S. East and Gulf Coast ports of goods currently imported through the West Coast.

These impacts are discussed below, but a more detailed analysis of potential cost savings is provided in the second report of this study.

5.2.1 CURRENT FREIGHT SHIPPED TO U.S. EAST AND GULF COASTS

As discussed in Chapter 3, gross cost savings for shipping containers from Northeast Asia to the U.S. East Coast via the expanded Canal will depend on growth in the size of vessels deployed on "all-water" services from the current maximum capacity of 5,000 TEUs to a new maximum of 13,000 TEUs, and on the price of main engine bunker fuel. Cost savings could grow over time depending on the capabilities of U.S. East and Gulf Coast ports to handle larger ships, the evolution of liner service designs, how quickly larger ships are deployed and other factors described in other sections of this report (see Chapter 3, Section 3.10).

Potential transportation cost reductions for container cargo handled by U.S. Gulf Coast ports could be significantly smaller than savings for East Coast cargo for two reasons. First, given the generally shallower depths of Gulf ports, and the smaller increase in the size of ships likely to call at Gulf ports, the cost savings per TEU would be lower than the per TEU savings possible for East Coast ports. Second, total container volumes in the Gulf are smaller than East Coast volumes which could affect deployment decisions by vessel operators.

5.2.2 DISTRIBUTION OF COST SAVINGS

Initial assessments indicate that it is highly unlikely that all of the gross cost savings arising from any reduction in shipping costs via the expanded Panama Canal will be passed on to beneficial cargo owners and consumers in the United States. The various parties involved in transporting cargo through the Panama Canal will likely each retain portions of gross cost savings. Major possible beneficiaries of shipping cost reductions include:

- Companies producing products for export (exporter)
- Ocean carriers providing the lower-cost service
- Other transportation carriers in the intermodal chain, especially railroads that may have substantial pricing power
- Other providers of transportation services and support operations in the network including U.S. ports and Caribbean transshipment ports
- The Panama Canal Authority, through increases in tolls and fees
- Beneficial cargo owners (importers) who ultimately make shipping and product pricing decisions
- U.S. consumers

To the extent that transportation service providers or exporters retain a percentage of gross savings in the form of higher prices, cost savings to beneficial cargo owners will be reduced. Beneficial cargo owners can be either U.S. or foreign companies. However, since most major manufacturers in the United States are multinational companies, and since most manufactured items likely to be shipped via the Panama Canal and consumed in the United States have a mix of foreign-sourced and U.S.-sourced content, isolating the effects of transportation cost savings on containerized imports accruing to U.S.-based versus foreign-based beneficial cargo owners would require significant insight into individual manufacturing processes, sourcing, and even intercompany transfer payments. Similarly, the decisions by beneficial cargo owners to pass their savings along to consumers in the form of lower sales prices will depend on the competitive conditions in commercial markets, which will vary by product.

Two of the major factors to be considered in estimating the degree to which overall cost savings are captured by beneficial cargo owners and, potentially, consumers are: 1) Panama Canal tolls and reservation system fees; and 2) the potential use of Caribbean transshipment ports.

The Panama Canal Authority consults with its direct customers in setting its toll rates and reservation system fees, especially in light of changing market conditions. However, it ultimately acts independently to set tolls and fees relative to the service it provides, and it might be expected to attempt to maximize its revenues over time. Potential increases in tolls by the Panama Canal Authority, or changes in the way that it structures these tolls, are an unknown at this point in assessing net cost reductions to the United States. Uncertainties concerning tolls will be addressed in the next report of this study.

Several U.S. ports are investing to improve their ability to support direct service calls using larger container ships. Nevertheless, some ocean carriers could elect to use Caribbean transshipment ports as an alternative to providing direct service to U.S. ports. To the extent that Caribbean transshipment hubs are used to serve U.S. markets, vessels calling in U.S. ports may be smaller than if direct services are provided by larger vessels. This would tend to switch a portion of the retained shares of cost reductions from U.S. ports to Caribbean transshipment ports. The use of transshipment ports could also reduce the overall cost savings to beneficial cargo owners since transshipment involves costs of unloading and reloading containers. The additional cost of transshipment could:

- Eliminate the pass-through savings available to cargo owners (and consumers)
- Eliminate incentives to switch cargo between coasts
- Reduce the savings available to the Panama Canal Authority and other transportation service providers
- Reduce maximum gross cost savings

On the other hand, the use of transshipment hubs—in the Caribbean or in the United States—could also reduce the need for costly investment in some U.S. ports.

5.2.3 POTENTIAL FREIGHT-SWITCHING FROM U.S. WEST COAST TO U.S. EAST COAST PORTS

Lower shipping costs available through the Panama Canal and U.S. East Coast ports may lead some cargo owners to re-route cargo now being moved through West Coast ports. However, the costs of transportation through West Coast ports would also be expected to drop due to the use of larger ships and improvements in rail services. These cost reductions would be independent of Panama Canal expansion and, depending on market conditions, available to cargo owners in any case—again depending in part on how much of the cost reduction savings is retained by transportation providers. It is important to note that there has previously been a significant shift in routing from Asia to the U.S. East Coast via the Panama Canal. The intermodal connection between U.S. West Coast ports to the East Coast accounted for 82 percent of East Coast TEUs in 2000. This 'land bridge' share of East Coast TEUs decreased to 55 percent in 2007[106] and has remained relatively stable since. More information about this trend is provided below.

Volumes of cargo which may be shifted between coasts due to lower transportation costs will depend on a variety of factors including the share of gross cost savings passed on to cargo owners. In addition to lowered ocean transportation costs, reductions in inland costs from West, Gulf and East Coast ports, due in part to planned improvements in rail capacity, have the potential to affect the split of containers shipped from Northeast Asia between coasts. More about the comparative costs of inland freight transportation are provided below in Section 5.4 *Regional Impacts from Canal Expansion*.

[106] Rodrigue, J.P. Factors Impacting North American Freight Distribution in View of the Panama Canal Expansion. *Van Horne Institute*, 2010, p. 18. Available at: http://www.vanhorne.info/files/vanhorne/Panama%20Canal%20Expansion%20Study,%20Final%20Report.pdf.

5.2.4 SECONDARY SAVINGS

Secondary cost reductions could occur that are indirectly related to Panama Canal expansion. Specifically, if the capacities of U.S. ports and inland infrastructure are developed primarily to handle the much larger ships able to transit the Panama Canal (enabling the cost reductions described in the previous section), ocean carriers will, over time, also deploy larger ships to handle U.S. container and bulk trades with other world regions (such as Europe) that do not involve Panama Canal transits. As this takes place, it will lead to transportation cost savings for those trade lanes in addition to the cost savings directly attributable to Panama Canal expansion. Some East Coast ports have already made improvements to accommodate Post-Panamax vessels and are now receiving large vessels on westbound routes through the Suez Canal – thus the cost of port improvements can be recovered from markets other than those using Panama Canal services.

5.3 FACTORS AFFECTING POTENTIAL SHIFTS IN CARGO FLOWS

Shifts in the movement of goods could occur in several ways. First, goods moving from a particular origin to a particular destination may simply be rerouted over the available transportation network to take advantage of changes in cost, time, or reliability. Such re-routing may be geographical—for example, through the Panama Canal rather than through West Coast ports and the North American intermodal system. Rerouting may also be modal—for example, switching between trucking, rail, and barge.

Second, the transportation network itself may change over time in response to market needs, changes in technology, and changes in other parts of the network. The original construction of the Panama Canal was such a case, as will be the Canal's expansion and any enhancement of port and inland infrastructure capacity. Changes in companies' distribution strategies and systems may also significantly affect the overall transportation network.

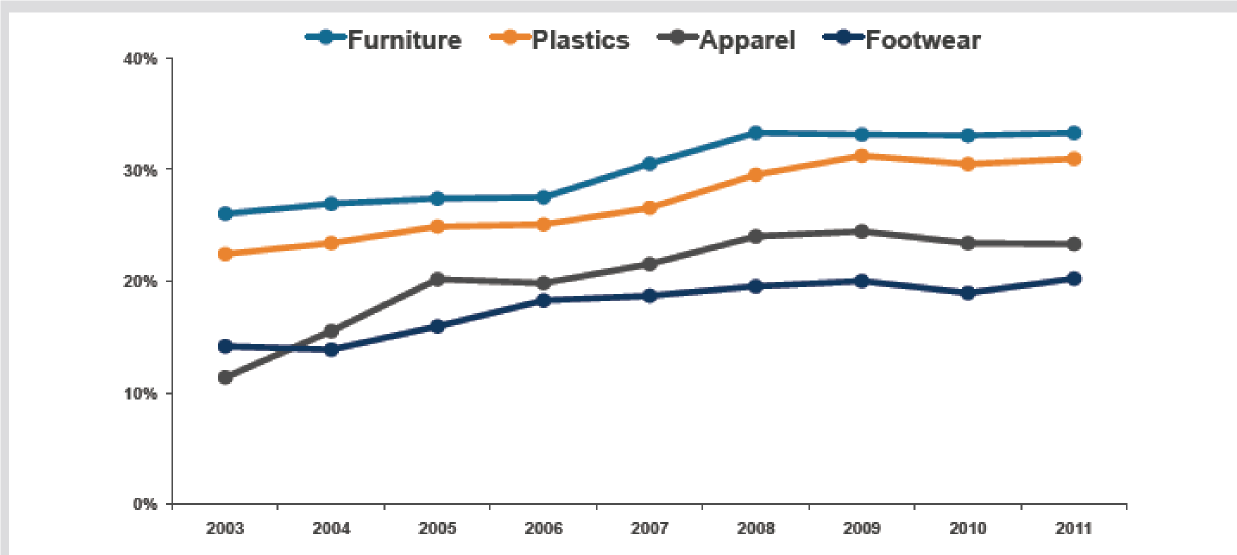
Third, the sourcing of goods and the location of production facilities can be changed in order to take advantage of lowered costs of transportation, materials, traffic and port congestion, or other factors.

Of the three factors outlined above that may affect the shifting of cargo, transportation rerouting may occur relatively quickly (within a matter of weeks) and may subsequently be reversed as conditions change. In contrast, more fundamental changes in transportation networks or supply chains may take longer to occur, but are also likely to be more stable.

5.3.1 HISTORIC INCREASES IN EAST COAST AND GULF SHARES OF U.S. IMPORTS FROM NORTHEAST ASIA

For the large Northeast Asia–U.S. waterborne trade, cargo has been shifting from the West Coast to the U.S. Gulf and East Coasts for the past decade as a result of port, highway, and rail disruptions and congestion, and due to the redesign of supply chains. Figure 25 displays East and Gulf Coast shares of the value of U.S. imports from Northeast Asia for selected major product groups.

Figure 25. **EAST COAST AND GULF PORT SHARES OF NORTHEAST ASIA – U.S. CONTAINERIZED VESSEL VALUE**



Source: U. S. Census Bureau, Foreign Trade Division, June 2012, Available at: *http://www.census.gov/foreign-trade*

5.3.2 POTENTIAL SHIFTS

Principal factors that may influence potential shifts in freight movement include:

- Geographic distribution of volumes
- Product type and value

These factors define the size of potential markets and the volumes that may shift, and are discussed in more detail in following sections.

Geographic Distribution of Volumes

The destination of imported products is a basic determinant of potential volume shifts in goods transportation. For example, if the destination of goods is concentrated on the U.S. Atlantic and Gulf Coasts and these markets are currently served largely by the Panama Canal, then potential shifts in transportation due to the Panama Canal expansion may be minimal. However, if destinations are concentrated in regions inland from the coasts, there may be more competition for alternative transportation routes and modes, and potential shifts may be greater.

FHWA FAF3 data provide information on flows between world regions but do not include any indication of international routing. For example, for the large and important trade flows from Northeast Asia to United States destinations, cargo flows by three principal routes:[107]

1. Across the Pacific Ocean to North American West Coast ports
2. Across the Pacific Ocean and through the Panama Canal to East Coast and Gulf ports (all-water routes)
3. Westbound from Asia through the Suez Canal and across the Atlantic Ocean to East Coast and Gulf ports

Product Type and Value

The second critical factor affecting potential cargo shifts is type of product. For different product groups, different characteristics determine where and how the goods are transported.

Very high-value products such as pharmaceuticals and high-end consumer products tend to be transported by air. Relatively high-value products such as apparel or auto parts tend to be transported by water using the quickest route possible. Relatively low-value products such as some industrial materials are also transported by water but via the least expensive route possible even though such routing may be much slower. Thus, apparel from Northeast Asia is more likely to be moved to inland regions of the United States through West Coast ports than by the longer Panama Canal route. In both cases, the choice reflects the need to move more valuable or time sensitive goods more quickly to reduce inventory carrying costs and other cost-related factors.

As discussed in Chapter 4, FHWA FAF3 data include detail for 42 commodity groups defined by the Standard Classification of Transported Goods (SCTG). Of the 42 commodity groups, several represent commodities largely moved in bulk and others have relatively small volumes moved from Northeast Asia to the United States.

Panama Canal expansion impacts will affect many commodities that are moved in containers. About half of the 42 SCTG product groups are highly containerized and are moved in significant volumes. The 19 product groups with the highest containerization rates have been selected for further examination. This subset includes the motorized vehicle product group, which includes vehicles (which are primarily carried in specialized vehicle carriers) and vehicle parts (which are primarily containerized). This 19-product subset is therefore referred to in this report as *container/vehicle*.

Product Value

Container/vehicle cargoes are further segmented into high-value products and lower-value products as displayed in Table 23. Low-value products include 13 product categories with an average value of $3.35 per kilogram. At $6.97 per kilogram, miscellaneous manufactured goods, which include a wide variety of consumer goods, is the highest value product category included

[107] FHWA FAF3 defines Eastern Asia as China, Hong Kong, Taiwan, Japan and South Korea. The term Northeast Asia is used in this document.

in the low-value group. For the low-value set of products, the overall West Coast share for moving goods to all U.S. regions was 66 percent in 2010—ranging from a low of 27 percent to a high of 77 percent. This product category includes products comprising 55 percent of total U.S. import tons from Northeast Asia, but represents just 29 percent of the total value of imports from Northeast Asia.

Table 23. U.S. WATERBORNE IMPORTS FROM NORTHEAST ASIA IN 2010

	U.S. Value (millions 2010 $)	U.S. Tons (Thousands)	$/kg	% Arriving Through U.S. West Coast Ports
Container/Vehicle	**$345,150**	**54,790**	**6.30**	**70.9%**
Low Value	**$100,762**	**30,103**	**3.35**	**66.2%**
03 Other agricultural products	$1,144	460	2.49	69.1%
05 Meat/seafood	$2,404	613	3.92	54.6%
06 Milled grain products	$357	189	1.88	74.2%
07 Other foodstuffs	$2,365	1,521	1.55	58.3%
23 Chemical products	$3,719	812	4.58	70.2%
24 Plastics/rubber	$18,259	6,012	3.04	72.3%
26 Wood products	$3,450	2,151	1.60	55.5%
27 Newsprint/paper	$652	325	2.01	26.9%
28 Paper articles	$847	367	2.31	74.9%
29 Printed products	$2,179	623	3.50	76.7%
33 Articles-base metal	$16,998	6,674	2.55	61.8%
39 Furniture	$17,154	5,875	2.92	67.6%
40 Miscellaneous manufacturing products	$31,235	4,481	6.97	71.7%
High Value	**$244,388**	**24,687**	**9.90**	**76.5%**
21 Pharmaceuticals	$503	27	18.70	76.2%
30 Textiles/leather	$57,362	6,486	8.84	77.2%
34 Machinery	$48,326	5,631	8.58	74.3%
35 Electronics	$63,237	5,294	11.95	84.8%
36 Motorized vehicles	$68,232	6,974	9.78	71.0%
38 Precision instruments	$6,728	275	24.43	84.7%
Bulk/Other	**$26,410**	**32,524**	**0.81**	**49.9%**

Source: Federal Highway Administration, Freight Analysis Framework 3, May 2012, Available at: http://ops.fhwa.dot.gov/freight/freight_analysis/faf/index.htm, and Study Team Analysis, May 2012

For the high-value product group the average product value is $9.90 per kilogram. Electronics, machinery, textiles, and motorized vehicles are the four largest product groups within this category in terms of both tons and value. The West Coast share for high value products was 76.5 percent in 2010, ten percent above the share for low-value products.

This product value data clearly shows that high-value products tend to be moved through U.S. West Coast ports to inland regions and that lower-value products are more likely than high-value goods to be transported by the slower but less expensive “all-water” routes through U.S. East Coast or Gulf ports.

5.3.3 GEOGRAPHIC DISTRIBUTION FOR HIGH VALUE VERSUS LOW VALUE PRODUCTS

As shown in the table above, the share of Northeast Asia product volume transported through West Coast ports is greater for higher value products than for lower value products. This section describes in more detail the geographic distribution for a higher value product group (electronics) and a lower value product group (rubber and plastics).

As described in an earlier section, it should be noted that for goods transported from Northeast Asia though Gulf and East Coast ports, an unknown portion of volumes are transported via the Suez Canal rather than the Panama Canal.[108]

West Coast-Oriented Product: Electronics

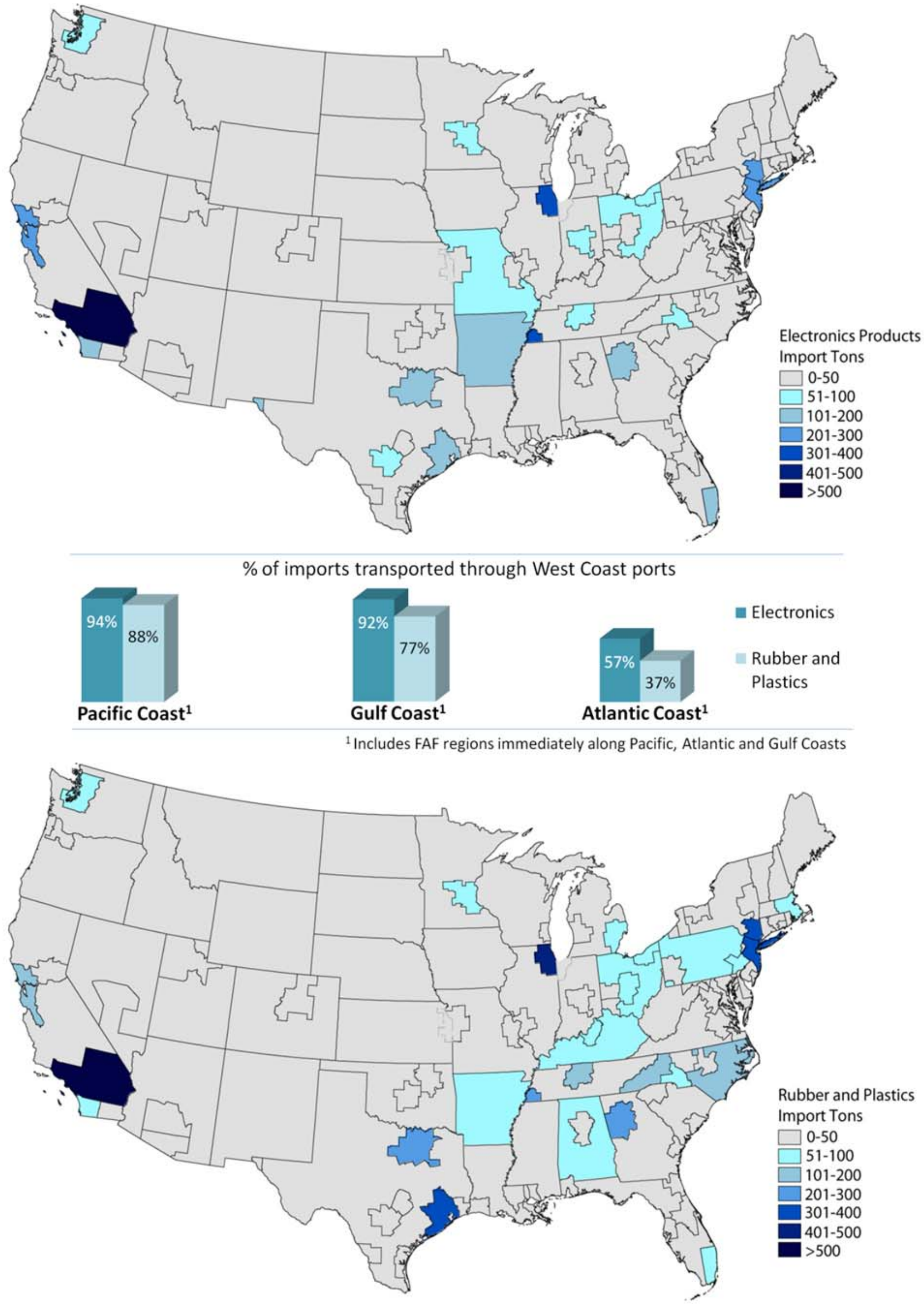
Figure 26 shows shipments to U.S. regions by import tons for Electronics and Rubber and Plastics Products, indicated by shading. The share of these shipments transported to the Pacific, Gulf and Atlantic Coast markets that are served via West Coast ports are indicated by bar charts.

The electronics product group accounted for 5.3 million tons and $63.2 billion of U.S. waterborne imports in 2010, with a high average value of nearly $12/kg. As shown in Figure 26, shipment destinations for this product group are concentrated in major distribution center locations, including Los Angeles, Memphis, Chicago, and New York.

The dominance of West Coast ports in serving these destinations is very pronounced, with a large majority of imports into Atlantic seaboard regions and almost all imports for other regions moving through West Coast ports.

[108] Based on container shipping capacities this is a small portion but it cannot be easily measured with any precision.

Figure 26. **U.S. WATERBORNE IMPORT TONS OF ELECTRONICS PRODUCTS AND RUBBER AND PLASTICS FROM NORTHEAST ASIA IN 2010**[109]



Source: Federal Highway Administration, Freight Analysis Framework 3, May 2012, Available at: [http://ops.fhwa.dot.gov/freight/freight_analysis/faf/index.htm,](http://ops.fhwa.dot.gov/freight/freight_analysis/faf/index.htm) and Study Team Analysis, May 2012

[109] This figure includes containerized and non-containerized cargoes.

East Coast Oriented Products: Rubber and Plastics Products

Large container vessel sailing from port

Photo courtesy: Hapag-Lloyd

Waterborne imports of rubber and plastics products from Northeast Asia totaled 6 million tons and $18.3 billion in 2010, with an average value of just over $3/kg. Major destination regions for imported rubber and plastics products include Los Angeles, New York, Chicago, Atlanta, and Houston. For regions from western New York through Ohio, Kentucky, Tennessee, Mississippi, Alabama, and Georgia, most of the volume was transported through West Coast ports in 2010, also shown in Figure 26. However, for regions along the U.S. Atlantic seaboard, an average of 63 percent of 2010 import tons moved through Atlantic and Gulf Coast ports.

5.4 REGIONAL IMPACTS FROM CANAL EXPANSION

This section focuses on containerized imports from Northeast Asia, which, as described above, is the principal U.S. contested trade flow that is expected to be affected by Panama Canal expansion, and addresses two fundamental questions:

- What regions will benefit from cost reductions resulting from Panama Canal expansion?
- How might the flow of goods be shifted due to Panama Canal expansion if cost reductions occur to promote such shifts?

Gross cost reduction savings and potential cargo shifts are assessed for four U.S. regions:

- Eastern Coastal region
- East Coast Inland region
- Gulf Coast and Lower Mississippi region
- Regions where the Panama Canal is currently non-competitive with West Coast routing

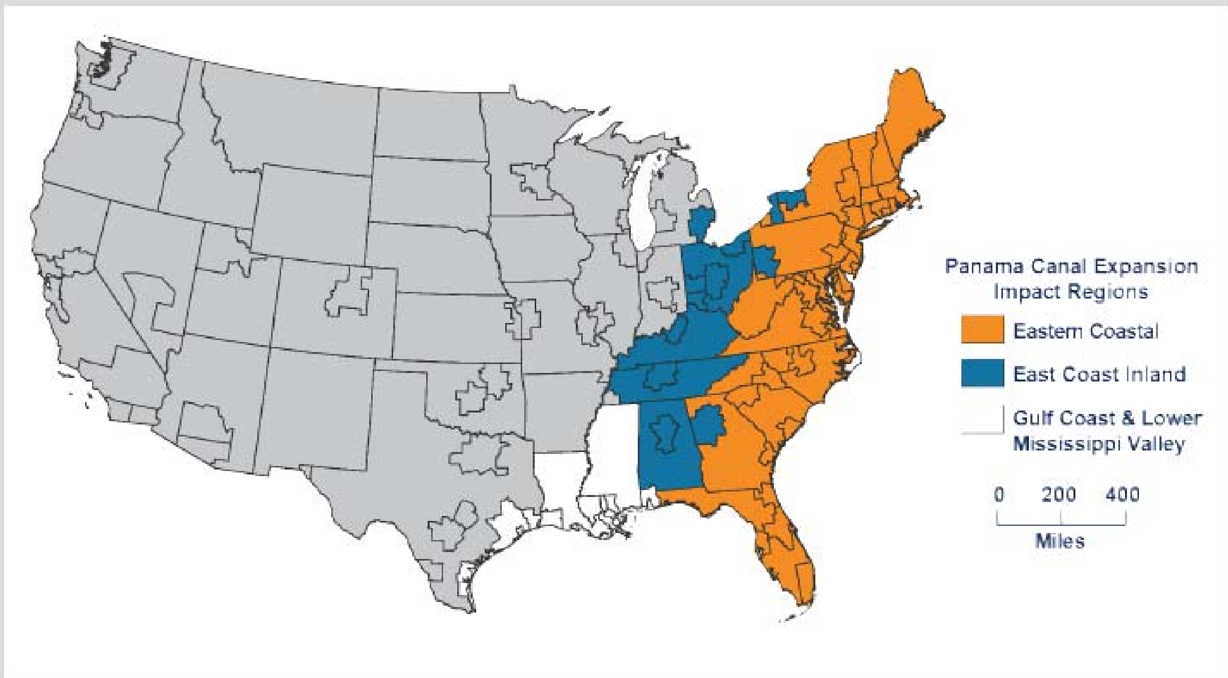
Eastern Coastal Region

The principal region where the Panama Canal routing is already well established is in the U.S. Eastern Coastal region (shown in orange in Figure 27) which includes U.S. East Coast States from Maine to Florida, except the inland metropolitan areas of Rochester, Buffalo, Pittsburgh and Atlanta.

East Coast Inland Region

The East Coast Inland region (shown in blue in Figure 27) stretches from western New York and Detroit south to Ohio, Kentucky, Tennessee and Alabama. This region, which currently receives a mix of West Coast and East Coast traffic, could be affected by the Canal expansion, with greater reliance on East Coast ports.

Figure 27. **PANAMA CANAL EXPANSION IMPACT REGIONS**



Source: Parsons Brinckerhoff, Panama Canal Expansion Study, June 2012

Gulf Coast and Lower Mississippi Valley Region

Metropolitan areas along the U.S. Gulf Coast and states in the Lower Mississippi Valley (shown in white in Figure 27), like those in the East Coast inland region, may be affected by lower container transportation costs resulting from Panama Canal expansion.

Non-Impact Region

Western, Mountain and West Central states shown in Figure 27 are not expected to be affected by Panama Canal expansion. The sections to follow describe in greater detail the volumes of imports from Northeast Asia and potential cost reduction impacts.

5.4.1 EASTERN COASTAL REGION COST REDUCTIONS AND CARGO SHIFTS

Eastern Coastal Region Commodity Flows

As shown in Table 24, the U.S. Eastern Coastal region was the destination for 13.9 million tons of total containerized and vehicle imports from Northeast Asia in 2010 or 25 percent of the U.S. total. Of this regional volume, East and Gulf Coast ports handled 61 percent, but this share varied by product category—51 percent for high-value products and 68 percent for low-value products.

Table 24. **U.S. EASTERN COASTAL WATERBORNE IMPORTS FROM NORTHEAST ASIA – 2010**

	U.S. Value (millions 2010 $)	U.S. Tons (Thousands)	$/kg	% Arriving Through U.S. East and Gulf Coast Ports
Container/Vehicle	**80,751.10**	**13,887.3**	**5.81**	**61.3%**
Low Value	**27,796.30**	**8,493.7**	**3.27**	**67.8%**
03 Other agricultural products	260.40	125.8	2.07	75.1%
05 Meat/seafood	811.90	222.2	3.65	86.3%
06 Milled grain prods	87.70	43.5	2.01	77.4%
07 Other foodstuffs	794.40	588.1	1.35	76.4%
23 Chemical products	1,468.70	273.0	5.38	45.4%
24 Plastics/rubber	4,522.80	1,506.1	3.00	62.6%
26 Wood products	1,086.60	609.1	1.78	80.1%
27 Newsprint/paper	185.20	95.3	1.94	81.8%
28 Paper articles	336.70	130.2	2.59	48.7%
29 Printed products	784.50	236.7	3.31	44.5%
33 Articles-base metal	4,084.40	1,795.9	2.27	69.4%
39 Furniture	5,508.90	1,833.7	3.00	71.2%
40 Miscellaneous manufacturing products	7,864.10	1,034.0	7.61	61.5%
High Value	**52,954.80**	**5,393.6**	**9.82**	**51.0%**
21 Pharmaceuticals	162.10	9.5	17.14	52.7%
30 Textiles/leather	22,494.80	2,380.7	9.45	45.2%
34 Machinery	10,993.90	1,325.9	8.29	62.5%
35 Electronics	12,849.20	1,040.5	12.35	42.6%
36 Motorized vehicles	5,473.10	578.3	9.46	64.2%
38 Precision instruments	981.70	58.7	16.72	46.0%
Bulk/Other	**5,982.50**	**6,591.7**	**0.91**	**80.0%**

Source: Federal Highway Administration, Freight Analysis Framework, May 2012, Available at: http://ops.fhwa.dot.gov/freight/freight_analysis/faf/index.htm, and Study Team Analysis, May 2012

Possible cost reductions and cargo shifts for the U.S. Eastern Coastal region include:

- Based on 2010 shares of U.S. container/vehicle imports from Northeast Asia, annual U.S. Eastern Coastal region cost reductions could amount to a majority of potential cost savings to be realized by the United States from the Panama Canal expansion. Note that the cost savings passed on to consumers and beneficial cargo owners would likely be distributed beyond the region depending on product distribution.
- Large shifts in high-value product shipments from the West Coast ports to U.S. East Coast are unlikely since:

  - High-value products destined for the East Coast region currently make up only a small share (20 percent) of total U.S. high-value product volumes and are likely to continue to be imported through West Coast ports due to faster delivery times to East Coast markets by intermodal rail than by all-water.
  - Because shorter transit times are important for high-value goods, marginal decreases in transportation costs are unlikely to offset the longer transit times and related inventory carrying costs.
- Significant increases in shipments of lower-value goods through U.S. East Coast ports to the East Coast Region are likely to be limited because East Coast port shares are already a high 68 percent.

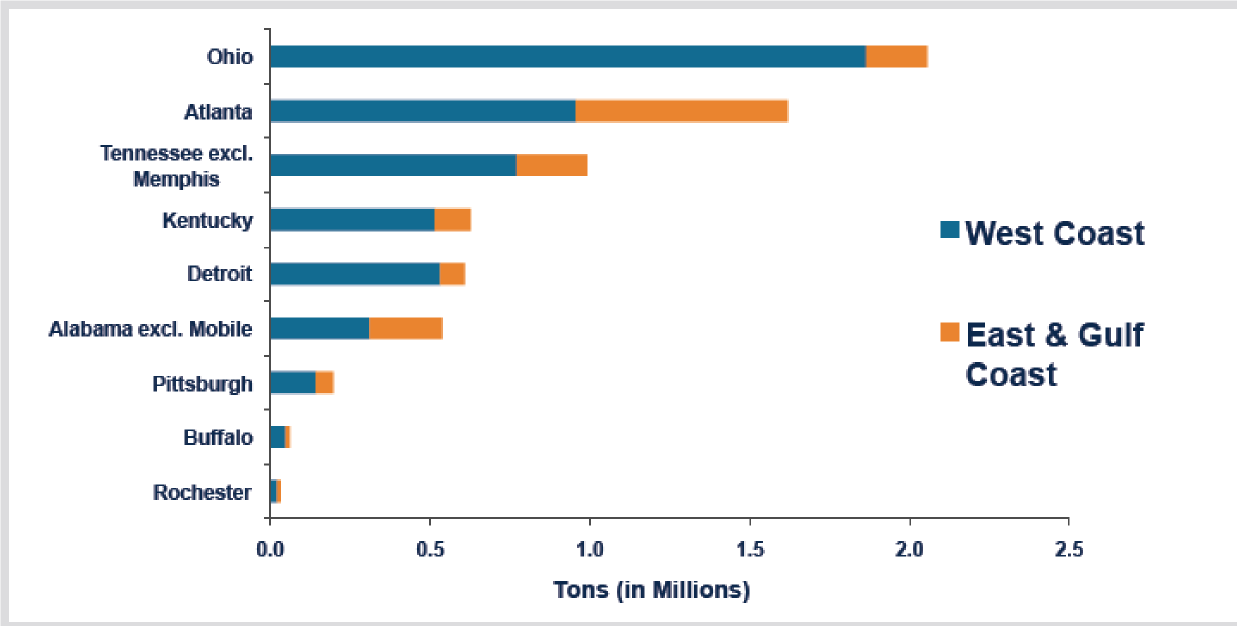
5.4.2 EAST COAST INLAND REGION

West Coast ports are the dominant gateway for moving products inland as far to the east as upstate New York, Pittsburgh, Ohio, and Atlanta. This is largely due to faster transit times and competitive transportation costs provided by intermodal rail service from West Coast ports to these major U.S. markets.

The East Coast Inland region is the primary one in which the lower costs made possible by the expanded Panama Canal may result in some shifting towards Panama Canal all-water services, especially where the development of ports and of inland infrastructure (such as Eastern Class I double-stacked container railroad improvements) further reduces relative transit times and costs. Principal examples include the recently completed Heartland Corridor and the ongoing CSX National Gateway project including its new intermodal hub in northwest Ohio.

The East Coast Inland region was the destination for about 11 percent of U.S. imports of containerized and vehicle tons from Northeast Asia in 2010. Of this regional volume, about 23 percent was transported through East and Gulf ports in 2010, compared to the much higher 61 percent for the Eastern Coastal region. Within this total, the largest single metropolitan market area is Atlanta, at three percent of U.S. imports.

Figure 28. **CONTAINER/VEHICLE IMPORTS FROM NORTHEAST ASIA IN 2010 (in Millions of Tons)**



Source: Federal Highway Administration, Freight Analysis Framework 3, May 2012, Available at: http://ops.fhwa.dot.gov/freight/freight_analysis/faf/index.htm, and Study Team Analysis, May 2012

The following sections describe individual metropolitan and State regions within the East Coast Inland region and the factors that may determine whether or not container ship routing is shifted from West Coast to East Coast ports for these regions. The regions are reviewed by State, moving from south to north, although in some cases only a large metropolitan area within a State is included in the East Coast Inland region.

Atlanta

The Atlanta metropolitan area is a very large market; its container/vehicle imports from Northeast Asia make up three percent of the U.S. total from that area. The movement of imports to Atlanta shows the reach of intermodal rail from the West Coast, with 59 percent of container/vehicle imports moving through West Coast ports and 41 percent through East Coast and Gulf ports, principally Savannah. Atlanta is a key intermodal transportation hub with 88-hour intermodal service from southern California ports as well as 21-hour intermodal service from Savannah and 28-hour service from Charleston. It is also within relatively close trucking distance (250 miles) of Savannah.

Given that Atlanta is one of the principal market areas defining the current dividing line between West and East Coast routes (see Figure 27), it may be a region where shifts toward Panama Canal/East Coast routes are most likely. As with the U.S. Eastern Coastal region, most of the high-value tonnage imported into Atlanta moves through West Coast ports (71 percent of textiles and 60 percent of electronics in 2010). Reduced transportation costs via the Panama Canal may cause only a slight shift in this share. However, the shift could be much greater for lower-valued products, especially because of the frequent intermodal shuttle service from Atlantic Coast ports.

The ports most likely to experience increased volumes are South Atlantic ports from Charleston and Savannah south to Florida.

Alabama

Alabama (excluding Mobile, which is included in the Gulf Coast region discussed below) is the destination for one percent of total U.S. imports of Northeast Asia container/vehicle goods (based on volume in 2010)—0.4 percent going to Birmingham and 0.6 percent to the rest of the state. The State has a relatively high concentration of vehicle and auto parts imports, especially outside of Birmingham, with most of these imports moving through the Port of Mobile. Imports into Birmingham are imbalanced between West Coast (72 percent) and East Coast and Gulf Coast ports (28 percent).

Alabama is served by rail connections to Birmingham through the KCS/NS Meridian Speedway and through Memphis on CSX.

With transportation service options from California ports, East Coast ports and the Port of Mobile, AL is a market area where shifts are likely due to lower costs resulting from Panama Canal expansion.

Tennessee

Together the Nashville area and the remainder of Tennessee (excluding Memphis) were the destination for 1.8 percent of total U.S. imports of Northeast Asia container/vehicle volumes in 2010. Imports to Nashville are concentrated in plastics and rubber products, and in vehicles and parts, for which West Coast ports handled a large 97 percent of 2010's total import tons.

For the remainder of the State, imports are concentrated in machinery, for which imports through West Coast ports were 55 percent in 2010.

As in other market areas, higher-value products will probably continue to be moved through West Coast ports while lower-value products could shift towards East Coast ports.

Kentucky

Kentucky imports of container/vehicle goods from Northeast Asia comprised 1.2 percent of U.S. total volume from that area in 2010, with concentrations in vehicles and parts (principally in Louisville) and machinery (mainly in the remainder of the State). Nearly all vehicle and parts imports were transported via West Coast ports while 35 percent of machinery volume entered through East Coast ports in 2010.

The ability to transport high-value products such as auto parts to Louisville effectively via intermodal transportation may mean that little shift is likely to occur in West Coast routing patterns. However, for lower-valued products imported into Kentucky, where transportation through East Coast ports is already prevalent, further shifts to East Coast routing are more likely.

Ohio

Imports of Northeast Asia container/vehicle products into Ohio made up 3.8 percent of the U.S. total volume from that area in 2010, with Columbus and Cleveland as the largest metropolitan area markets in Ohio (at 1.2 percent and 1.1 percent shares, respectively), followed by Cincinnati (0.6 percent), Dayton (0.1 percent) and the remainder of the state (0.7 percent).

Ohio imports are mildly concentrated in products connected to the automotive and industrial sectors. Ohio's imports of rubber and plastics products from Northeast Asia were 5.3 percent of the U.S. 2010 total; the share for machinery was 5.2 percent.

Ohio has been principally served through West Coast ports, which had a collective 91 percent share of total container/vehicle tons in 2010. Of this volume, about two thirds moved through California ports and one third through Washington ports.

Eastern Class I railroads have been developing significant enhancements to their rail networks for reaching Ohio. The CSX intermodal hub in northwest Ohio allows rail traffic to bypass Chicago intermodal connections and could make routing through West Coast ports more attractive. This hub, along with the National Gateway initiative, will also expedite cargo moved to Ohio through the Port of New York and New Jersey and other East Coast ports. Likewise, the NS Heartland Corridor has been designed to make movement of goods through Norfolk to Columbus and Cincinnati quicker and less expensive. The implications of these developments will be assessed in the next report of this study.

Detroit

The Detroit area imported 1.1 percent of total U.S. container/vehicle volume from Northeast Asia in 2010. Principal product concentrations are connected to the auto industry and include vehicles and auto parts (3.1 percent of the U.S. total) and machinery (2.1 percent of the U.S. total). A large share of imports to the Detroit market—87 percent—moved through West Coast ports in 2010. A much smaller volume of imports moves through the East Coast, primarily through the Port of New York and New Jersey.

Pittsburgh

The Pittsburgh metropolitan area accounted for 0.4 percent of the total volume of U.S. imports of container/vehicle goods from Northeast Asia in 2010. Over 70 percent of this volume was transported through West Coast ports, despite the fact that Pittsburgh is only 360 highway miles from New York and 48-hour intermodal service is available from the Port of New York and New Jersey. Given the 2,500-mile distance from West Coast ports and the proximity of Pittsburgh to the Port of New York and New Jersey, lowered ocean transportation costs resulting from expansion of the Panama Canal could result in some rerouting of goods through this port.

Buffalo and Rochester

These two metropolitan areas together accounted for 0.2 percent of U.S. imports of container/vehicle volume from Northeast Asia in 2010, of which a majority moved through West

Coast ports. Intermodal service to Buffalo is available from the Port of New York and New Jersey.

5.4.3 GULF COAST AND LOWER MISSISSIPPI REGION

The Gulf Coast and Lower Mississippi Region accounted for five percent of the total U.S. container/vehicle tons imported from Northeast Asia in 2010. Within this region, the Houston metropolitan area is the largest destination.

Houston and Texas Gulf Port Regions

Houston is one of the largest destination markets in the United States for imports of goods from Northeast Asia, accounting for 4.1 percent of U.S. container/vehicle total import tons from that area in 2010. Other Texas Gulf port regions, specifically the Beaumont and Corpus Christi metropolitan areas, are also broken out in FHWA FAF3 data and shown as separate regions in Figure 27, but together account for a small fraction (about one percent) of the volume of total regional imports, and a much smaller fraction of national container/vehicle imports.

Houston's regional share of imports is boosted by large concentrations in industrial products, 10 percent to 15 percent of the U.S. total for product groups including chemicals, chemical products and articles of base metals. About 60 percent of the volumes for these product groups are imported through the Port of Houston, contributing to that port's status as the largest container port in the Gulf.

A relatively small three percent share of Houston's import volumes from Northeast Asia moves through U.S. East Coast ports, while 65 percent of container/vehicle tons are imported through West Coast ports. As is true for other regions of the country, West Coast port shares of high-value goods destined for Houston are very high; for example, over 90 percent for electronics and textiles.

Given Houston's large concentrated market, reduced costs resulting from the use of larger ships could lead to additional cargo from Northeast Asia being moved through the Port of Houston to the Houston metropolitan region, especially relatively low-value products.

Lower Mississippi and Central Gulf

Imports from Northeast Asia into Louisiana, Mississippi, and Mobile, AL accounted for a total of 0.9 percent of U.S. container/vehicle import tons from that area in 2010; over 80 percent of those imports moved through West Coast ports. Relatively small shares of container/vehicle imports into this region currently moved through Gulf Coast ports (10 percent) and East Coast ports (eight percent) in 2010.

Intermodal transportation services from the West Coast into this region are extensive. The major intermodal rail hub in Memphis serves the greater Memphis metropolitan area in Mississippi.

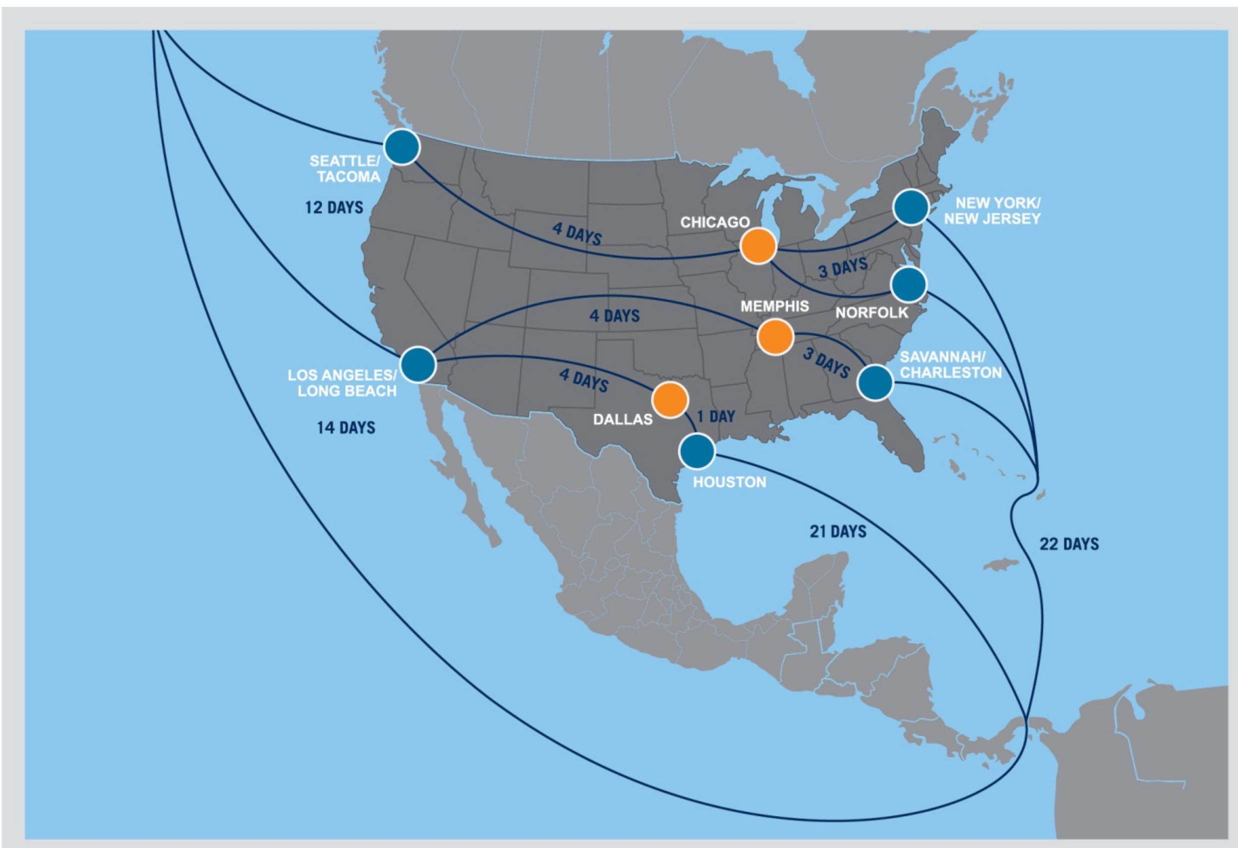
Intermodal service connects in Jackson, MS, via the KCS, CSX and CN railroads. New Orleans is served by all the four U.S. Class I railroads in addition to Canadian National.

Given the large current shares of goods moving to the region from West Coast ports, the proximity of the region to Gulf Coast ports, and the redevelopment of the Port of Gulfport and improvement of its rail connections after the damage of Hurricane Katrina, shifts in volumes of Northeast Asian imports through the ports of New Orleans, Gulfport, and Mobile are possible, but will be limited by the relatively small size of these destination markets.

5.4.4 REGIONS NOT COMPETITIVE FOR PANAMA CANAL ROUTING

For moving goods to major markets such as Chicago, Dallas, Memphis and metropolitan areas west and north of these major freight hubs, faster ocean transit times from the West Coast (United States and Canada) and relatively low intermodal rail and trucking costs make transportation through the Panama Canal non-competitive, even with the expansion of the Canal.

Figure 29. **COMPARATIVE SHIPMENT TIMES FROM NORTHEAST ASIA TO CHICAGO, MEMPHIS & DALLAS**



Source: Parsons Brinckerhoff, Panama Canal Expansion Study, June 2012

Figure 29 shows transit times to central U.S. market destinations from Northeast Asia that are not competitive for all water services through U.S. East Coast ports.[110] These transit times show the extent of the difference in reaching these locations from the East Coast and underlie the identification of the non-competitive regions shown in Figure 27. The following sections describe some of the factors that influence current service patterns for reaching important U.S. regional markets, including Dallas, Memphis and Chicago.

Dallas-Fort Worth and Other Inland Metropolitan Areas

Dallas-Fort Worth is the other very large destination market in Texas along with Houston, with 2010 imports of container/vehicle tons making up 3.1 percent of the U.S. total from Northeast Asia.

West Coast (specifically California) ports have a dominant 89 percent share of the Dallas-Fort Worth import market from Northeast Asia, based on 2010 tonnage. Dallas-Fort Worth is served by 109-hour intermodal service from Southern California (about 1,600 miles) and is home to the large intermodal hub and logistics park in Alliance, TX.

The two current primary alternatives for reaching Dallas-Fort Worth from Northeast Asia are routing through California ports and then movement by either truck or intermodal service (by rail and truck). The principal differences between these modal choices are time and cost. Long-haul movement by truck from Southern California ports to Dallas takes about 27 hours, while movement by rail takes a scheduled 109 hours but is less costly.

For this study, the question is whether expansion of the Panama Canal could provide a competitive third alternative—that is, shipment via the Panama Canal to the Port of Houston and then by rail or truck to Dallas.

Given the much longer transit time by ocean, as shown in Figure 29, the Panama Canal routing would need to be cost-competitive with the less expensive rail alternative to be economically viable. Depending on the assumptions made about size of vessels utilized, service through Houston could actually be both longer and the more expensive alternative to the rail option now in use. It therefore seems unlikely that shipment patterns to Dallas-Fort Worth will be affected by Panama Canal expansion.

The other inland metropolitan areas in Texas for which FHWA FAF3 data are broken out include Austin, Laredo, and San Antonio. Together these destinations accounted for 0.9 percent of total U.S. imports of container/vehicle tons from Northeast Asia in 2010. The highest concentration of these product imports is in electronics, with the metropolitan areas importing 3.1 percent of the U.S. total from Northeast Asia in 2010. About 94 percent of these areas' import volumes move through Southern California ports.

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[110] Inland times in Figure 29 represent approximate transit times (rounded to days) to the major inland market destinations of Chicago, Memphis, and Dallas from West Coast ports compared to transit times from East Coast ports. These times represent the intermodal times from rail carriers' schedules (except for Houston to Dallas which represents approximate transit time by truck). These times do not represent total intermodal transit times or schedules from West Coast ports to East Coast markets (the times are not additive).

Union Pacific provides intermodal services to San Antonio and Laredo. Alternative service to these inland areas would most likely require trucking from Houston, which lies about 160 miles from Austin and 200 miles from San Antonio. The resulting trucking cost could be less than the intermodal cost from Los Angeles, but, as with Dallas-Fort Worth, any land-leg advantage is likely to be outweighed by the greater time and cost of the all-water Panama Canal route to Houston. Thus, imports into these Texas inland areas are also unlikely to be affected by Panama Canal expansion.

Memphis

Memphis is a very large destination market for container/vehicle goods imports from Northeast Asia, with the Tennessee portion of the metropolitan area comprising 2.7 percent of the U.S. total, comparable to Atlanta's three percent share in 2010. Memphis is a principal gateway and connecting point of the Western and Eastern Class I railroads—a crossroads of international goods movement—as well as a principal terminal point for CN intermodal service from Canadian West Coast ports. It was the destination for 6.9 percent of the U.S. imports of electronics goods from Northeast Asia in 2010.

West Coast ports handled 94 percent of container/vehicle tons of Northeast Asian imports moving to the Memphis region in 2010. The 2,000-mile intermodal rail service from Southern California ports, which handle almost all of the West Coast cargo to Memphis, is scheduled at 80 hours. In comparison, intermodal service from Savannah to Memphis is scheduled for about 70 hours and costs less. Because the time and cost differentials for the land leg are fairly small, while ocean transit is a week shorter and less expensive (using vessels of comparable size) through the West Coast than through the Panama Canal to Savannah, the Memphis area is considered to be generally non-competitive for services through the expanded Panama Canal. The exception could be for low-value products that could be shipped through Gulf ports and then moved to Memphis on rail or barge.

Chicago

The Chicago metropolitan area (Illinois portion) is one of the largest destination areas in the United States for imports of container/vehicle goods from Northeast Asia, accounting for 7.8 percent of U.S. total tons in 2010. Of this volume, approximately 90 percent moved to the region through West Coast ports, with about 65 percent of this through California ports and 35 percent through Pacific Northwest (Washington and Oregon) ports. It should be noted that, based on increasing container volumes moving through the Port of Prince Rupert, B.C., an increasing share of goods moving into the Chicago region may enter through that Canadian gateway.

For inland transportation by rail, the comparison between West Coast and East Coast routes is a 2,300-mile move from a West Coast port on rail and a 1,000-mile rail move from New York, Norfolk, or other East Coast ports. For the West Coast move, this would involve a single Class I railroad— either BNSF, UP or CN—at a higher cost per container than from the East Coast, depending on port and railroad. However, due to longer sailing times and distances, the ocean cost component of a Northeast Asian container delivered to an East Coast port via the Panama Canal is significantly higher than for one delivered to a West Coast port. In general, total transportation cost differentials are unlikely to be overcome, even with the savings due to the use of larger ships via the expanded Panama Canal discussed earlier, and the transportation time advantage will favor transportation via West Coast ports. It is, therefore, unlikely that significant volumes of Northeast Asian goods to Chicago arriving from West Coast ports will be rerouted through the Panama Canal and East Coast ports after the Canal's expansion.

5.5 IMPACT OF PANAMA CANAL EXPANSION ON U.S. TRADE WITH SOUTH AMERICA

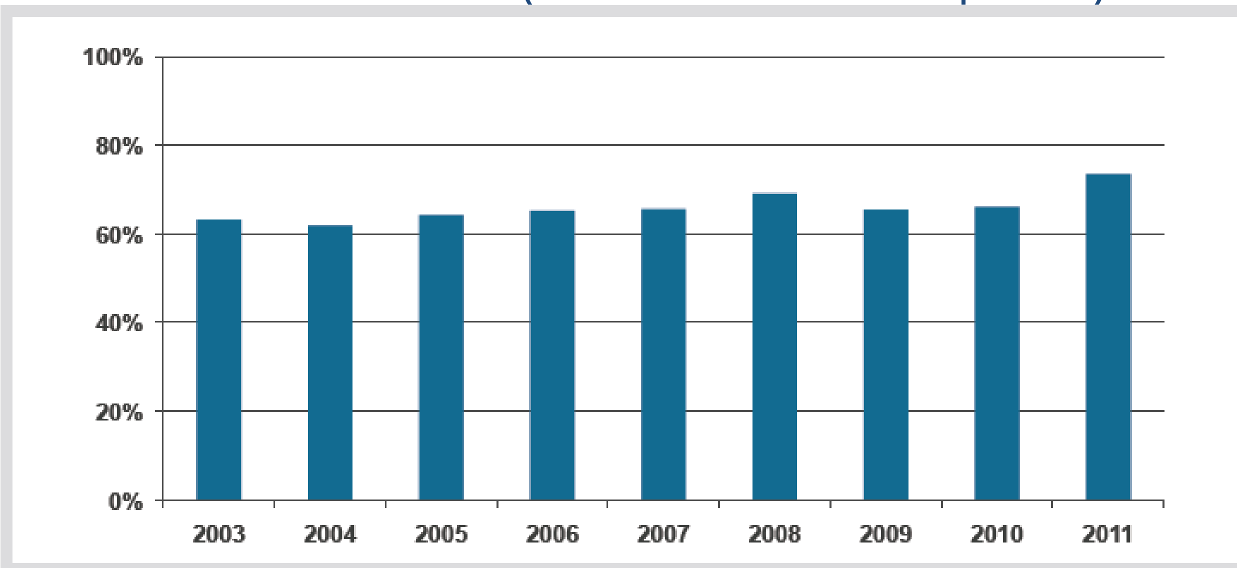
As discussed in Chapter 4, U.S. imports from the West Coast of South America (including Chile, Bolivia, Peru and Ecuador) are the second-largest U.S. trade lane through the Panama Canal. About 44 percent of the containerized tons exported from these countries to the United States in 2011 were comprised of vegetables, fruits and nuts, and food preparations from fruits and vegetables. Other significant product groups include fish, wine, and wood products.

In contrast to imports from Northeast Asia, a large share of U.S. imports from the West Coast of South America are currently shipped through the Panama Canal and this share has been relatively stable for many years. As shown in Figure 30, over two thirds of containerized import tons from the West Coast of South America into the United States are transported through U.S. Gulf and East Coast ports.

To a large extent, this trade lane is a captive market for the Panama Canal. The large U.S. East Coast market is directly north of the West Coast of South America and the shortest distance and cost for reaching these markets is through the Panama Canal to Gulf and East Coast ports.

An examination of U.S. exports to the West Coast of South America shows a stable pattern similar to the import activity trend presented in Figure 30. The dominant flow of trade is the import activity, however. Because the vessel sizes are largely dictated by the dominant flow of imports to the U.S. East and Gulf Coasts, it is unlikely that the U.S. export trade back to West Coast of South America will alter the size or numbers of vessels in this trade. The stable South American import market does not appear to be constrained by limitations on the size of vessels transiting the current Panama Canal configuration. Over the near term, at least, the expanded capacity offered by the wider and deeper Panama Canal lane is not expected to result in increased trade volumes between the United States and the West Coast of South America, although there is some potential for larger bulk movements of petroleum and LNG. Furthermore, most of the ports along the West Coast of South America have channel and berth limitations which cannot accommodate the increased draft offered by the Panama Canal expansion.

Figure 30. U.S. IMPORTS FROM THE WEST COAST OF SOUTH AMERICA THROUGH GULF AND EAST COAST PORTS (Share of U.S. Containerized Import Tons)



Source: U. S. Census Bureau, Foreign Trade Division, May 2012, Available at: http://www.census.gov/foreign-trade

While the trend toward larger vessels is likely to extend to South American liner services to Europe and Asia, it is unlikely that very large ships will be deployed on the U.S. West Coast-South America trades. The current pattern of using north-south feeder services for this purpose and linking these services to East-West services from Asia via transshipment ports in Panama, works well for liner companies.

As a result of the fundamental trade flows between North and South America, including the Canal's already dominant position in these trades, and the presence of effective liner services for serving these markets, it is expected that Panama Canal expansion will have little or no impact on the flows of container volumes between South America and the United States.

5.6 POTENTIAL IMPACTS ON U.S. EXPORTS

The Panama Canal expansion will create some potential for increasing U.S. export volumes as a result of lower transportation costs. The commodities and ports most likely to be affected will be examined more closely in the second report of this study. However, initial indications are that the magnitude and timing of these impacts are less certain than the magnitude and timing of the expansion's impacts on U.S. container imports. Decreases in transportation costs for U.S. exports that are passed on to foreign importers in lower product prices could lead to greater purchasing of these products from U.S. exporters. U.S. export increases could potentially occur in four market areas:

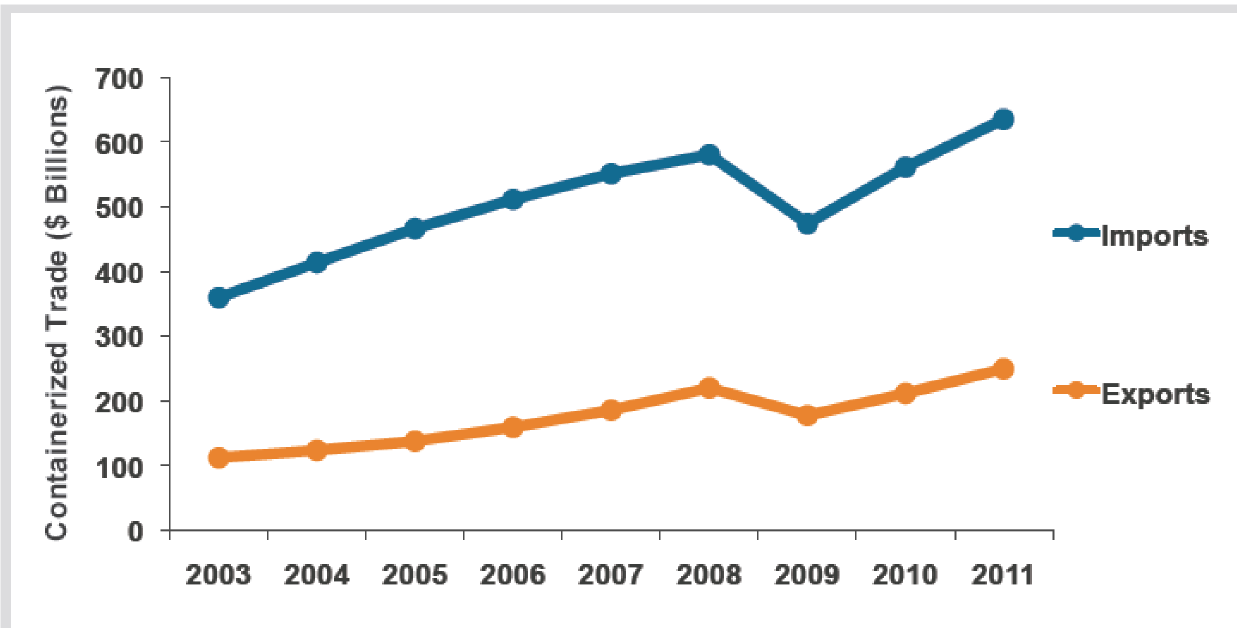
- Containerized goods
- Grain
- Coal
- Oil and natural gas products (including LNG)

The following sections briefly describe each of these export market areas which will be more fully developed in the second report.

5.6.1 CONTAINERIZED EXPORTS

The U.S. containerized trade is very imbalanced, with export volumes being much smaller in terms of weight and value than imports (see Figure 31). Where empty containers are readily available, carriers often offer low rates to exporters in order to capture paying export cargo rather than transporting empty containers. Use of larger ships will further reduce container transportation costs. Relatively low freight rates for exporting containerized goods could therefore be expected to continue in the future, depending on specific geographic markets and products. While lower freight rates may not be available in all markets or for all commodities, there may be opportunities for continued lower freight rates for exports due to overall reductions in ocean transportation costs and increased ship capacity.

Figure 31. **TOTAL U.S. WATERBORNE CONTAINERIZED TRADE (in $ billions)**



Source: U. S. Census Bureau, Foreign Trade Division, May 2012, Available at: http://www.census.gov/foreign-trade

5.6.2 GRAIN EXPORTS

As described in the section on ocean shipping, larger bulk ships, including a portion of the Capesize vessel fleet, could be used to move grain exports from U.S. Gulf ports to Asian markets via the expanded Panama Canal. The resulting decrease in transportation costs could have two effects. First, exports through the Gulf could be relatively less expensive when compared to the alternative route from the U.S. Midwest through Pacific Northwest ports, further concentrating exports through the Gulf ports. Second, bringing down transportation costs could reduce the delivered price of U.S. grain in foreign markets if these cost reductions are passed on to grain importers and thereby increase U.S. exports.

5.6.3 COAL EXPORTS

The Panama Canal expansion could also potentially affect U.S. coal exports. The U.S. Energy Information Administration has noted that:

> *"In the short term, low bulk rates and the expansion of the Panama Canal may improve U.S. competitiveness in coal export markets. In addition, sustained high international demand and prices and supply constraints in other coal-exporting countries support expectations of larger U.S. export volumes."*[111]

Trade routes likely to be affected are those to Northeast Asia. While West Coast ports are closer to coal production in the Western region in the United States, there is limited existing capacity for coal export in U.S. West Coast ports, and significant environmental local opposition to new facilities. Therefore, cost savings from the Panama Canal expansion coupled with existing capacity may make exports through U.S. East Coast and Gulf Ports a more attractive alternative. Several U. S. East Coast ports have historically served as a major coal exporting port for Europe, and expansion of the Panama Canal may enable coal producers in the Eastern coal fields to access Northeast Asian markets from existing facilities, as channel depths can accommodate bulk carriers with deep drafts supported by the expansion project. The U.S. Gulf Coast ports will not have the capability in 2015 to accommodate bulk ships loaded with coal or grain to 50-foot drafts and thus exporters will not initially be able to take full advantage of the expanded Canal, which will be able handle 50-foot drafts (as opposed to the 40-foot drafts the Canal can currently handle). Currently these ports have channels of 45 feet deep or less.

5.6.4 OIL AND NATURAL GAS PRODUCTS

Exports of oil and natural gas products offer both near-term export opportunities and long-term growth potential. Crude oil and refined petroleum products such as diesel fuel and gasoline have become the second-largest commodity group by weight shipped through the Panama Canal, overtaking grains and exceeded only by containers. U.S. Gulf and East Coast refiners currently make use of the existing Canal to provide customers in Asia and markets on the west coast of Central and South America with a variety of oil residuals and refined products. In 2012, U.S. refineries sent over five million tons of residuals and refined products to Asia via the Canal (mostly petroleum coke, which moves on bulk ships), almost eight million tons to South America (mostly diesel) and 3.5 million tons to Central America (mostly gasoline).[112]

U.S. petroleum export volumes, including petrochemicals, could increase significantly with the expansion of the Panama Canal due to both greater U.S. production of these products and lower transportation costs enabled by the use of larger tankers through the Canal. Currently, only 16 percent of the world's existing tanker fleet and less than seven percent of tankers on order are of a size that can use the Canal. The new locks of the expanded Canal will be able to accommodate vessels sizes that are characteristic of 56 percent of the existing tanker fleet and 44 percent of

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[111] U.S. Energy Information Administration, *International Energy Outlook, 2011*. July 2011.

[112] Kemp, J. "Panama Canal expansion to benefit oil refiners," *Arab News*, February 16, 2013. Available at: http://www.arabnews.com/economy/panama-canal-expansion-benefit-oil-refiners.

tankers on order.[113] More information about the outlook for the petroleum export market will be provided in the second report of this study.

As will be discussed in the second report of this study, the United States could become a significant exporter of LNG in the next decade due to shale gas production. The infrastructure needed to liquefy and export LNG is only now being planned and permitted, and there are lingering questions about how U.S. energy policy will affect our ability to export LNG in volumes large and consistent enough to maintain a role a as a long-term supplier of natural gas. Similarly, there is much uncertainty about future access of Asian countries to competing supplies and suppliers of LNG. These questions aside, it appears that if LNG exports do become part of the export stream shipped from U.S. ports, the concentration of planned infrastructure in and near the Gulf ports is the most likely to be used and the Panama Canal expansion will facilitate these exports.

Two LNG export terminals, at Sabine Pass and Freeport, TX, are under construction, with one other facility at Lake Charles recently approved by the Federal Energy Regulatory Commission. Northeast Asia is one potential market among several, including Europe, where U.S.-produced LNG could be competitive with LNG from other suppliers.[114]

Only a few LNG tankers are small enough to transit the Panama Canal through the current lock dimensions. However, many LNG tankers in the current fleet will be able to transit the larger locks, which could make some origin-destination trades more viable. This could facilitate LNG exports of U.S.-produced LNG from U.S. Gulf ports to Northeast Asia, depending on the development of LNG production and export facilities in the Gulf region and the conditions of world markets. Safety concerns regarding LNG carriers transiting the Panama Canal will also be a consideration.

5.7 SUMMARY OF THE EFFECTS OF PANAMA CANAL EXPANSION

The principal points of this chapter are:

- With regard to container shipments, the impacts of Panama Canal expansion are likely to be concentrated in U.S. imports from Northeast Asia.
- Impacts on container cargo flows will be affected by geographic markets, and product types and value. Geographic impacts will likely be concentrated in regions along the Atlantic Coast and regions relatively close to the coast.

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[113] Veazey, M.V. "US Gas Exports and the Panama Canal Expansion: Serendipity on Display?" *Rigzone*. May 16, 2013. Available at: http://www.rigzone.com/news/oil_gas/a/126102/US_Gas_Exports_and_the_Panama_Canal_Expansion_Serendipity_on_Display.

[114] Ebinger, C., K. Massy and G. Avasarala. "Liquid Markets: Assessing the Case for U.S. Exports of Liquefied Natural Gas". *Brookings Institution: Energy Security Initiative*. May 2012. pp 11-22. Available at: http://www.brookings.edu/~/media/research/files/reports/2012/5/02%20lng%20exports%20ebinger/0502_lng_exports_ebinger.pdf

- Impacts on containerized goods will include transportation cost reductions, but some savings may be retained by transportation providers including ocean carriers and the Panama Canal Authority and not passed on to beneficial cargo owners and consumers.
- Coastal shifts in cargo flows from the West Coast to the Gulf and East Coasts, to the extent they take place, are more likely to occur for lower-value products where transportation costs are relatively more important than transit times. Potential shifts will be affected by level of net cost savings.
- Impacts of the Panama Canal expansion may also be seen in increased volumes and rerouting of grain, coal, petroleum, and natural gas exports, particularly to Northeast Asia.

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CHAPTER 6: CONCLUSIONS

Expansion of the Panama Canal will change the cost of trans-ocean shipping—particularly for those trade routes providing East-West services between ports in the Far East and the East and Gulf Coast ports in the United States. This report has presented an array of issues that will influence ways in which the Panama Canal expansion could alter established global trade patterns and affect the future of global marine shipping as well as U.S. trade. This is especially relevant to the container shipping services that have evolved during the past half-century as trade between Asia and Western economies has increased. However, some bulk product producers (primarily agricultural and energy products exported from the U.S. Midwest) may also benefit from bulk carriers operating larger vessels from U.S. Gulf Coast ports.

The report also describes why shipping industry costs are expected to change when the Panama Canal expansion is opened for commercial transit in 2015, assesses the potential shifts in trade flows within the United States that are likely as vessel operations tied to Panama Canal expansion change, and identifies potential cargo types that could be affected. Finally, the report examines the coastal and inland markets most likely to be affected by changes in ocean shipping costs and identifies the some of the major landside infrastructure issues that may influence which U.S. ports are best able to serve these markets.

Additional research is nearing completion for the next report of this study to refine these initial assessments. The research will provide more in-depth information about how transportation service providers are planning to respond to new opportunities to deploy vessels, as well as how shippers and beneficial cargo owners are likely to respond to a range of options they may face in the future as their costs change and potential new markets become available to them.

Based on the background presented in this report, and on the findings and information developed in the next phases of this project, a series of options will be prepared to present to policy-makers as they develop broader national investment and transportation infrastructure prioritization policies to respond to the Panama Canal expansion and to the concurrent needs for port and landside transportation capacity enhancement.

Findings and preliminary assessments of these issues are summarized below in four major areas investigated for this report:

- Panama Canal Expansion and its Potential Effects
- Major Factors that Shape Impacts on U.S. Ports and Infrastructure
- Impacts on U.S. Trade
- Impacts of Panama Canal Expansion on U.S. Regions

Finally, some general implications of these findings are reviewed.

6.1 PANAMA CANAL EXPANSION AND ITS POTENTIAL EFFECTS

The Panama Canal is an important link in global trade, accommodating an estimated five percent of the world's total cargo volume.[115] Panama Canal expansion will double Canal capacity and allow passage of much larger ships than those currently able to transit the Canal.

- **Increased Size of Vessels Transiting the Canal.** The maximum-size container ship that can transit through the Canal will increase from those with a 5,000 TEU capacity (current "Panamax" size) to those with capacity for 13,000 TEUs or slightly more. For dry bulk shippers, the ability to send Capesize ships up to 180,000 dwt through the expanded Canal would enable transportation cost saving and may lead to alternative routing for U.S. exports of some bulk commodities such as grain, petroleum, and coal to Asia.
- **Increased cargo capacity.** Although only 12 to 14 additional vessels per day can be accommodated in the new lock system, the increased size of the vessels will result in doubling Panama Canal throughput from 300 million PCUMS tons to 600 million PCUMS tons.[116]

Significant shares of U.S. trade with Asia, Australia/New Zealand, and the West Coast of Central and South America move through the Panama Canal. With respect to the U.S. East Coast – Asia trade alone, the total volume moving through the Panama Canal from 2000 to 2011 has increased from 31.6 percent to 39.0 percent of all cargo transiting the Canal.[117] And trade between the U.S. East Coast and the West Coasts of South and Central America has increased from 11.3 percent in 2000 to 12.3 percent in 2011, making the U.S. East Coast ports the dominant source of Canal traffic (from 42.9 percent in 2000 to 51.6 percent in 2011).

6.2 MAJOR FACTORS THAT SHAPE IMPACTS ON U.S. PORTS AND INFRASTRUCTURE

The physical attributes of U.S. ports, their ability to move goods efficiently and their dependence on other surface infrastructure to gain access to inland markets all influence how the expansion of the Panama Canal will affect U.S. trade and the cost of shipping through the Canal. Impacts on U.S. ports and port-related infrastructure will depend on the following factors:

- **Relative concentration of U.S. port calls.** Use of larger ships will increase the volume of containers that must be moved at each port call to make the port call profitable for the carrier. This will likely lead to fewer and more concentrated ship calls at larger ports,

[115] Various sources cite a range of four to five percent of global trade. We reference a recent publication by Dr. Jean-Paul Rodrigue, PhD (Rodrigue, J.P. "Factors Impacting North American Freight Distribution in View of the Panama Canal Expansion". *Van Horne Institute*, 2010. Available at: http://www.vanhorne.info/files/vanhorne/Panama%20Canal%20Expansion%20Study,%20Final%20Report.pdf).

[116] PCUMS is an acronym for Panama Canal Universal Measurement System, the basis upon which vessels are charged for use of the Canal. It is approximately 100 cubic feet of cargo space. A twenty-foot long container (TEU) is equivalent to approximately 13 PCUMS tons.

[117] Based on PCUMS as reported by the Panama Canal Authority in its most recent statistics on trade lane activity, Available at: http://www.pancanal.com/eng/op/transit-stats/index.html.

especially for vessel deployments serving the Northeast Asia – U.S. East/Gulf Coast trade. Fewer calls by larger ships will lead to higher peak load demand at large ports, although because fewer ships will arrive, the ports will not necessarily receive greater annual volumes of containers. Ports with greater capacity in container handling, storage, and movement to inland destinations will be in a better position to serve these vessels than will ports with capacity deficiencies in one or more of these areas.

- **Readiness of U.S. ports and related infrastructure.** Issues range from channel depth and height (air draft) restrictions to terminal handling and storage capabilities to rail and highway connectivity and capacity as well as inland transportation systems (specifically intermodal rail and "last mile" port and terminal connections).

Container ship being unloaded at port

Photo credit: Wikimedia Commons

- **Use of foreign transshipment ports.** For a variety of reasons related to global vessel deployment strategies and costs, shipping companies could make greater use of Caribbean or Panamanian container transshipment ports as a partial solution to accommodating larger vessels and their cargoes. This practice could affect the size of vessels calling on U.S. ports.
- **Development of marine highways.** Port capacity constraints and more concentrated port calls could also encourage careful examination of marine highway services to move containers between larger and smaller U.S. ports.
- **Port and landside costs.** The cost competitiveness of different ports of entry is just one facet of the cost of greater use of all-water access to East and Gulf Coast ports, as landside fees can easily equal or exceed port charges and ocean transit fees.
- **Cost distribution and savings.** As discussed in Section 5.2, the distribution of cost savings accruing from increased vessel efficiency and reduced ocean transportation costs is difficult to project. Several of the factors which impact any cost savings remain to be determined (Panama Canal toll rate, etc.). However, if some cost savings arising from increased transport efficiency are passed on to beneficial cargo owners, then it is reasonable to expect they, and others in the supply chain, may utilize some portion of those savings to fund improvements in landside logistics which may generate additional savings over time.

6.3 IMPACTS ON U.S. TRADE

The emphasis in this report is on containerized traffic from Northeast Asia, the segment of Panama Canal traffic most likely to see operational cost savings due to the expansion. However, other commodities such as grain exported from the U.S. Midwest, and new opportunities for energy exports such as coal, petroleum, and natural gas, may also be able to capitalize on expanded Canal capacity. Shippers factor logistics costs, reliability, and market size into their network and distribution system decisions. Their likely cost responses and sensitivities to system performance will also be assessed in the second report of this study.

Based on preliminary research completed for this report, the potential effects of Panama Canal expansion on U.S. trade are as follows:

- Direct all-water routes between U.S. East Coast and Gulf ports and foreign ports—specifically those in Asia and, eventually, the West Coast of South America—have potential to provide more cost-competitive services.
- The transition from 5,000 TEU vessels to 13,000 TEU vessels on Northeast Asia-U.S. East/Gulf Coast routes will result in significant gross cost savings but a significant portion of these savings are expected to be absorbed by transportation service providers rather than be passed on the beneficial cargo owners.
- As the average size of vessels serving West Coast ports also increases over time from an average of 6,000 TEUs today to 13,000 TEUs (or greater), the cost for transportation to West Coast ports from Asia would also be reduced; reducing the relative value of savings associated with larger vessel service through the expanded Panama Canal.

Each of these findings will be more thoroughly investigated in subsequent research. The response of shippers and carriers to potential cost savings, the potential for pass-through of increased savings to beneficial cargo owners and the potential investments by ports and railroads currently serving Eastern and Midwest U.S. markets from the West Coast will also be assessed. These effects will be different for imports (primarily containerized commodities) and exports (primarily bulk, agricultural and energy production).

6.4 IMPACTS OF PANAMA CANAL EXPANSION ON U.S. REGIONS

Stern view of fully laden container ship

Photo credit: iStock

The geographic extent of the impacts of Panama Canal expansion will depend largely on how U.S. ports and inland transportation providers invest in improvements to their infrastructure, the response of shipping companies to this port and inland infrastructure development, and the adaptation of supply-chain management methods that take advantage of the scale economies offered by Canal expansion.

The examination of current trade patterns in Chapter 4 assessed both the coastal range through which various commodities enter the United States and their destination by State and region. This analysis identified several State, metropolitan, and multi-State regions that have the potential to realize cost savings from new services tied to the expansion of the Panama Canal. It also identified areas of the United States where net cost reductions provided by Panama Canal expansion are unlikely to affect trade flows. The study has developed preliminary information about U.S. inland regions where cost reductions for both East Coast and West Coast transpacific service may result in "contested markets"—regions where service through either U.S. East Coast or U.S. West Coast ports is likely, but where uncertainties about inland infrastructure capacity and costs make potential changes in the volume and commodity mix of trade flows difficult to estimate. For these areas, costs for intermodal service, capacity constraints, and operational decisions concerning the types of commodities and industries most likely to take advantage of marginal cost savings associated with service from either coast will be important to assess as part of the information being developed for the second report in this study.

We also know that ports, railroads, and logistics service providers will be investing in new capacity and infrastructure. Several intermodal rail investments were discussed in Chapter 3. Because most of these investments involve private funding sources, details about these plans, the level of investment, and the resulting capacity improvements and cost reductions likely to be passed on to shippers are difficult to determine. In addition, many short-term investments are being carefully re-thought in light of recent changes in the global economy. Long-term capacity plans, associated investments levels, and timing are also being reconsidered by the private sector. Their investment decisions are affected by public sector investment decisions in supporting infrastructure (e.g., roads, bridges, etc.), and by the potential of using public funds to leverage private sector investment in determining the timing and level of infrastructure capacity.

Impacts are likely to be significantly different by geographic region and by type of product transported. Potential regional impacts include:

- **Cargo Switching from West Coast.** Cost reductions will be derived from volumes of cargo switched from U.S. West Coast routing to all-water service to the U.S. East and Gulf Coasts. Shifts in shipments from West Coast to East Coast ports may occur due to per-TEU cost reductions but these shifts will be limited, relatively, by the already high current Panama Canal shares.
- **East Coast Region.** As this region already receives a large share of its imported goods (particularly for lower value products) via the Panama Canal, it will benefit the most from cost reductions associated with Canal expansion.
- **Inland East Coast Region.** Both the use of the Panama Canal for shipments inland through East Coast ports and the absolute cost reduction benefits related to current cargo flows will likely be small relative to intermodal service from West Coast ports. Nevertheless, shifts toward greater inland volume through East Coast ports could occur especially for lower-value products.
- **Gulf and Lower Mississippi Valley Region.** The share of international trade moving to this region via the Panama Canal is relatively low. Some redirection of cargoes from West Coast routing could occur, but preliminary analysis indicates that the overall cost savings would be relatively small whereas transportation times would be longer. The greatest potential impact from Panama Canal expansion is associated with costs savings for exported bulk cargoes.

For the remainder of the United States, routing through the Panama Canal is generally not competitive with routing through West Coast ports, in terms of both cost and transit time.

6.5 IMPLICATIONS AND NEXT STEPS

Information developed in this Phase I report is designed to identify the role that the Panama Canal plays in U.S. trade with the rest of the world. The operational aspects of Canal expansion and descriptions of trade patterns, the current capacity of the inland transportation network, and the post-expansion markets potentially served by the U.S. East and Gulf Coasts set the stage for subsequent assessment of the costs and capacity expansion plans of ports, railroads, and other logistics service providers. Development of information about both public sector and private sector capacity expansion plans, refinement of cost information (including pass-through cost savings) and financial considerations concerning the potential for funding these capacity improvements will be the subject of the next report in this study.

Expanded Panama Canal capacity will allow ocean carriers providing East-West services, particularly between ports in the Far East and U.S. East Coast and Gulf ports, to reduce service costs by deploying vessels with greater economies of scale. The greatest challenge facing U.S. ports and the operators of related infrastructure will be to evaluate the markets they are best positioned to serve and to assess their current and future competitive cost structures—both from the perspective of potential volume and savings attributable to the ocean trade leg and from the perspective of return on investments in landside infrastructure.

Ships docked at port with gantry cranes and stored containers

Photo credit: iStock

Shippers factor logistics costs, reliability, and larger market conditions into their network and distribution systems decisions. Their likely responses to changing costs for ocean transportation services and their sensitivities to system performance need to be better understood to properly gauge public policy and investment decisions. The next phase of this study will solicit additional information from shipping industry personnel and other experts about potential market responses to changes in shipping costs attributable to the Panama Canal expansion. Information will include operational assessments from vessel operators, transportation service providers, and shippers.

The second report of this study will also provide a more detailed assessment of the physical attributes of U.S. ports, their dependence on inland infrastructure, and the markets they serve. It will evaluate current port and land-side infrastructure capacity, and describe investment plans that ports have developed to address the expected impacts of Canal expansion using information developed from interviews and outreach to key ports and transportation system operators. The potential impacts of these investments on the cost of using rail, highway, and marine systems to serve U.S. inland markets will be assessed in association with the potential cost savings identified in this report associated with an expanded Panama Canal and the potential response of shippers to changing costs—especially in those inland markets identified in this report as likely to be most affected by changes in shipping costs.

Ports, railroads and logistics service providers will be investing in new capacity and infrastructure. Many of them are re-evaluating their plans in light of recent changes in the global economy, as well as anticipated effects due to the Panama Canal expansion and the introduction of larger vessels at U.S. West Coast, Canadian and Mexican ports. These investments and the changes in their levels and timing will also be considered in the next report of this study. Information developed about proposed public and private investments will be used to project the need for public investment in port-related infrastructure to address some of the effects of Panama Canal expansion identified in this report. These projections will be developed to inform policy decisions concerning the economic benefits of Panama Canal expansion on the U.S. economy.

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TECHNICAL NOTES

TN - 1: HISTORY OF THE PANAMA CANAL AND GLOBAL TRADE

The French engineer Ferdinand de Lesseps, developer of the Suez Canal, took on the challenge of building an equivalent passage through Central America in what is now Panama. The effort was begun in 1870 as another "big ditch"; that is, a sea-level canal without locks, like the Suez. This proved impossible, however, due to a combination of reasons—none of which were adequately planned for. These included adjusting their plans to address the mountainous terrain in the center of the project, diseases, living conditions, labor supply, and the paucity of funding which finally convinced the French team to abandon the effort.

Much of the work done by the French proved to be of little use when the United States took control of the project in 1904. Of the 2,149 buildings built by the French, some 1,500 had to be refurbished or demolished. Some 33 miles of water-holding areas were of no use. The 30 million cubic yards of dredging (about one-third the amount dredged for the Suez Canal) was a good start, but the Americans came with a different vision of how to engineer and build the new waterway. The United States set about developing a plan, which included the eradication of nearly every mosquito in Panama in order to eliminate yellow fever and malaria; even then, over 8,000 people died of these diseases. In the end, the United States spent $352 million on the Canal's construction (compared to the French investment of $287 million), as well as $40 million paid to the original French development company and $10 million paid to Panama.

The Canal's engineering centered on:

- Creating, by means of a dam, a new lake that would capture the vast amounts of water needed to operate the two sets of locks. The resulting Gatun Lake is the source of the fresh water used in the Canal's operation.
- Building a small power plant designed to power one of the first all-electric operating systems for a complex navigation system.
- Excavating a passage through the mountain range running through Panama. Some 61 million pounds of dynamite were used to break apart large rock formations, blast through the Culebra Cut, and make the passage as straight as possible. This was more explosive power than had been expended in all U.S. wars up to that time.

Upon completion, the Panama Canal connected the Atlantic Ocean at the northern entrance at Colón with the Pacific Ocean at the southern entrance at Balboa, near Panama City (see Figure 32). The Canal is approximately 48 miles long and has sets of locks at each end, which raise ships to 85 feet above sea level to cross the continental divide. The Canal includes a narrow channel through mountains at the Culebra Cut and a passage across Gatun Lake. On August 15, 1914, the *Ancon* was the first ship to transit the Panama Canal on a commercial basis.[118]

[118] McCullough, D. *The Path Between the Seas: The Creation of the Panama Canal 1870-1914.* New York: Simon & Schuster, 1978.

Figure 32. MAP OF PANAMA CANAL REGION

Source: Google maps, June 2012

In its early days, the Canal primarily spared ships moving between the Pacific and Atlantic Oceans the long and treacherous route via Cape Horn and the Drake Passage. Vessels sailing from the East Coast of the United States to Japan via the Canal saved about 3,000 miles versus the shortest alternative all-water route, with 5,000 miles saved for a voyage from Ecuador to Europe.

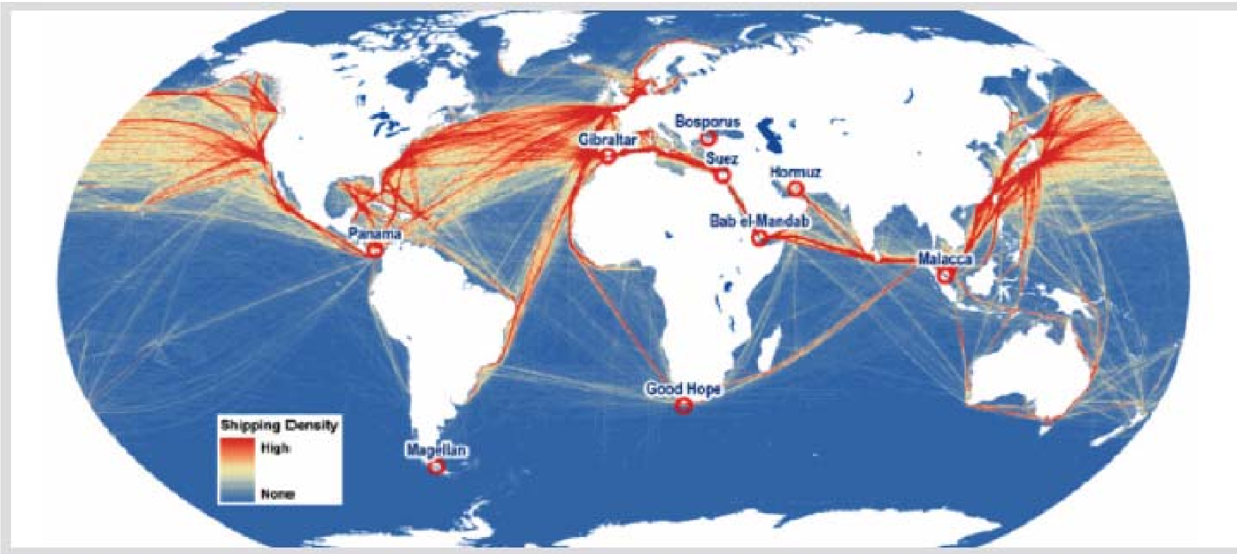
Over the years, as global trade patterns changed—for example, as Asia became the world's largest exporter of consumer goods to the West—the role of the Panama Canal in the global transportation network evolved. Today, one of the Canal's most important functions is to provide an all-water passage for goods from Northeast Asia to the U.S. Atlantic and Gulf Coasts, providing an alternative to moving goods through West Coast ports and the U.S. intermodal system to U.S. population and distribution centers closer to the Eastern seaboard (see Figure 33).

Under U.S. management and control during the 20th Century, the Panama Canal was an open waterway for all vessels of all types and sizes, and traffic grew steadily during most periods. Even after the U.S. trade embargo against Cuba, the Panama Canal still allowed the passage of—and the collection of tolls from—Cuban ships and ships carrying cargo to and from Cuba. By the year 2000, when the Canal's management was placed under Panamanian control and transferred to the Panama Canal Authority (PCA), annual revenues from the Canal operations had reached nearly $580 million in tolls, not to mention revenues from other maritime services. Under Panamanian management, the PCA generated $1.73 billion in tolls revenue on 14,684 vessel transits in FY 2011.[119]

[119] Panama Canal Authority. *Annual Report, Fiscal Year 2011*. Available at: http://www.pancanal.com/eng/general/reporte-anual/2011/pdf/Annual%20Report%202011.pdf.

Years of planning to expand the Canal to accommodate more and larger ships concluded with a national referendum in 2006, which passed by a large margin. Once the referendum passed, the Government of Panama had the legal authority to turn expansion planning into reality.

Figure 33. **CARGO DENSITIES OF GLOBAL SHIPPING ROUTES**



Source: Shipping density data adapted from National Center for Ecological Analysis and Synthesis, A Global Map of Human Impacts to Marine Ecosystems

TN - 2: HISTORIC AND PROJECTED CONTAINERIZATION

Since the inception of shipping containerization in the 1950s and its rapid adoption in the following decades, an increasing share of commodities has moved in containers rather than by bulk or break-bulk methods. Naturally, this has increased the container trade through the Panama Canal. The Canal expansion raises two questions concerning growth of containerized cargoes. First, how much more can containerization rates grow, particularly on the large trade lanes which will be most affected by Canal expansion? Second, for which commodities and trade lanes will containerization rates grow most? These questions are addressed in this technical note, specifically as they relate to U.S. trade via the Panama Canal.

Issues Related to Canal Expansion

Post-Panamax vessels need large volumes of cargoes to realize the cost efficiencies inherent in their increased capacity. Containerization rates and volumes for most commodities in the Northeast Asia-U.S. trade, however, are not likely to increase significantly as a result of Panama Canal expansion. There may be increasing containerization of U.S. exports to Asia, however, which could increase export container volumes and reduce the container flow imbalance on this trade lane.

Containerization levels could rise for U.S. imports of refrigerated commodities from Latin America, modestly increasing aggregate container volumes but accelerating a long-term trend of declining reefer vessel volumes (discussed below).

Potential Increases in Containerization on Key Trade Lanes

Imports from Northeast Asia are the largest U.S. overseas trade lane and also the trade lane most likely to be affected by Panama Canal expansion. As shown in Table 25, containerization rates for many commodities involved in this trade are already near 100 percent, allowing little opportunity for the Canal expansion to have an effect on containerization of these particular commodities.

Table 25. **CONTAINERIZATION RATES OF MAJOR PRODUCTS IN NORTHEAST ASIA – U.S. TRADE IN 2011**

	Northeast Asia-U.S. Vessel Value (Thousands)		
	Total	**Containerized**	**Containerization Rate**
Total All Commodities	**$423,329**	**$354,284**	**83.7%**
84 Machinery	$78,168	$71,142	91.0%
85 Electric Machinery, etc.; Sound Equipment; TV Equipment; Parts	$63,208	$59,276	93.8%
87 Vehicles (except Railway & Tramway) & Parts, etc.	$61,298	$22,133	36.1%
95 Toys, Games & Sport Equipment; Parts & Accessories	$22,128	$21,827	98.6%
94 Furniture; Bedding, etc.; Lamps, Nesoi[A], etc.; Prefabricated Beds	$20,641	$20,400	98.8%
64 Footwear	$15,142	$16,016	99.1%
73 Iron or Steel Articles	$14,574	$11,166	76.6%
39 Plastics & Plastic Articles	$14,389	$13,835	96.1%
61 Apparel & Accessories (Knit or Crochet)	$14,036	$13,602	96.9%
62 Apparel & Accessories (not Knit or Crochet)	$12,530	$12,011	95.9%

[A] *Not elsewhere specified or indicated.*

Source: U.S. Census Bureau, Foreign Trade Division, May 2012

There are four cargo product groups being regularly imported from Asia to Central and Eastern U.S. regions where increasing containerization could be considered. These include steel products, large machinery, heavy transport equipment, and passenger vehicles. Since these products are difficult to efficiently containerize, however, cost savings of a few hundred dollars per container in the eastbound direction are not likely to lead to increased containerization of these break-bulk or Ro-Ro commodities.

However, in the westbound direction, savings could potentially stimulate increased containerization of selected break-bulk and dry bulk commodities produced in the Southeast region and exported to Asia, such as pulp and phosphates.

U.S. Imports from Latin America

The emergence of end-to-end shuttle, pendulum, and RTW deployments, all using 8,000+ TEU ships for the Far East-U.S. East Coast trade via Panama, and increased Caribbean transshipment activity to north-south feeders, will likely bring unit cost savings of hundreds of dollars for various U.S.-Latin American trades.

Any potential savings, together with increased capacity of new large ships specifically designed with slots for refrigerated containers, will create further competitive pressure on the specialist, reefer break-bulk carriers, especially in the Chilean fruit trade.[120] Thus, provided that the global container ship lines can meet the logistical challenges of marshaling sufficient volumes of empty reefer containers and can pre-position those boxes to Chile and other Latin American markets, Canal expansion could result in further conversion of U.S. break-bulk fruit imports into transport by containers.

TN - 3: CUBA AS A POSSIBLE TRANSSHIPMENT PORT

Cuba does not currently operate a Caribbean transshipment port. Several port-operating firms have explored various options for operating a large transshipment port in Cuba. One possible location for a transshipment hub, which could also serve the cargo needs of the island itself, is on the Southeast coast near Guantanamo where the water offshore is around 300 feet deep. However, without the ability to serve U.S. markets, major international port development in Cuba would be difficult, if not impossible.

TN - 4: INDIAN OCEAN FEEDER NETWORKS

Using feeder ship networks, Indian Ocean hub ports enable shipping lines to use their Southeast Asia-U.S. East Coast deployments for multiple trade lanes by assigning a portion of each vessel sailing's TEU slots to intermediate markets (such as South China exports to Pakistan or Thailand exports—which are typically relayed to the line-haul vessel at Singapore or a Malaysian port—to East Africa). The intermediate market containers are discharged at the Indian Ocean hub port and transferred to one or more feeder vessels, and the line-haul vessel slots made empty by those discharges are then re-filled with boxes that those feeder vessels have transported from countries bordering the western Indian Ocean or the Arabian Gulf to the hub port, to be loaded onto the line-haul vessel for movement to the U.S. East Coast. This concept is illustrated schematically in Figure 34 for a particular Suez Corridor service design.

As indicated, another advantage for a Suez all-water deployment is that it can also carry intermediate "wayport" cargoes to and from the countries bordering the Mediterranean Sea, if the carrier operating the service opts to make regular port calls at one or more hub ports in that body of water.

By way of comparison, vessel services that link Northeast Asia and the U.S. East Coast via the Panama Canal also can be utilized by ship lines to carry intermediate "wayport" cargoes and to use a portion of the service's capacity inbound from Asia for multiple trade lanes. In particular,

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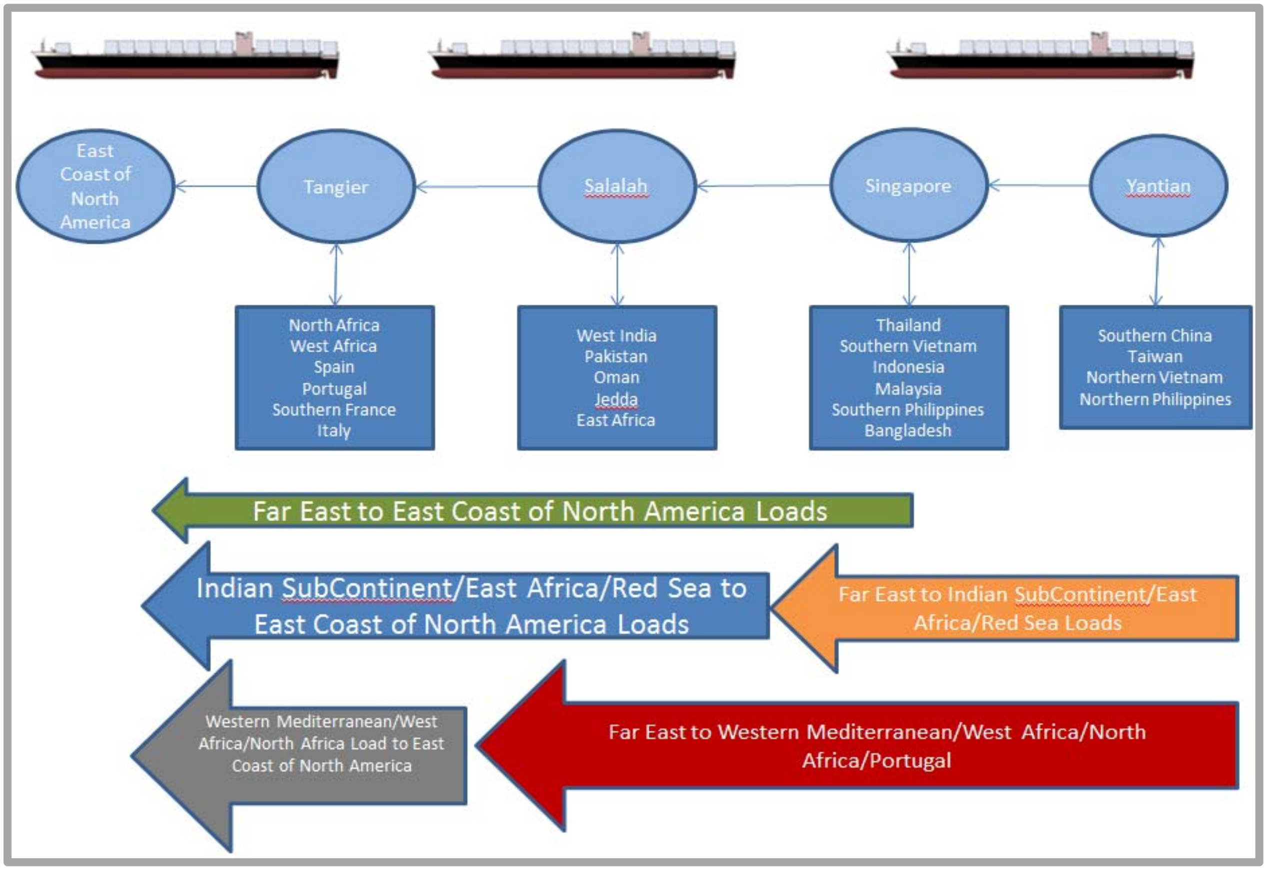
[120] Although a significant portion of Chilean fruit exports to the United States still moves in the break-bulk mode, most of Chile's fruit exports are containerized. Bulk reefer ships are disappearing from this trade route, and show up in Chile only during peak harvest period, and this is only to take the "excess" that cannot go into containers at the critical time.

carriers can decide to make regular port calls for such services at Mexican Pacific Coast ports (specifically, Manzanillo or Lazaro Cardenas), discharging Asia-Mexico containers and loading back Mexican exports to the Eastern United States; or, they can include weekly stops in their all-water services at a port adjacent or proximate to the Panama Canal, where Asian exports to Central American, South American, and Caribbean countries can be discharged and exports from those Latin American countries can be loaded back. Yet another alternative for these all-water deployments via the Panama Canal is to stop at a Caribbean hub port (such as Kingston (Jamaica), Caucedo (Dominican Republic), or Freeport (Bahamas)). These latter hubs have better locations than the Panamanian terminals for selected transshipment flows (such as Asia exports to Puerto Rico or U.S. Gulf Coast exports to Venezuela), but are inferior for other flows (such as Asia exports to Peru/Chile or Costa Rica exports to the Northeast United States).

Figure 34. EXAMPLE OF HOW INDIAN OCEAN/MEDITERRANEAN HUB PORTS ENABLE FAR EAST – USEC DEPLOYMENTS TO SERVE MULTIPLE TRADE LANES



Source: Mercator International

TN - 5: FACTORS AFFECTING CONTAINER VESSEL NETWORK DESIGNS

Panama Canal expansion and global carriers' increased use of very large container ships will continue to affect vessel network designs primarily because:

- At comparable capacity utilization levels, an 8,000-TEU ship has a markedly lower unit operating cost per TEU-day (or TEU-mile) than a 4,000-TEU ship. Similarly, a 13,000-TEU ship has a lower unit cost than an 8,000-TEU ship.
- The unit cost advantage accruing from increased vessel size is magnified as the price of bunker fuel rises and, as a result, ocean carriers have been ordering and using very large container ships in recent years partially as a means of mitigating the impact of an upward trend in oil prices. Newer vessels, such as the larger container ships, have more fuel efficient engines than do older vessels, and can better accommodate slow steaming.
- The liner shipping industry is intensely cost-competitive, and the easiest cost reduction strategy for a carrier to execute is to use the largest possible ships for each trade that it serves.[121]
- Recent trends in slow steaming and the order book for the liner fleet suggest that vessel operators foresee long-term fuel cost savings from a continuation of current slow steaming practices.

TN - 6: NETWORK COST DATA

The three primary transportation costs that constitute network costs are ocean shipping, rail transportation, and trucking. For ocean shipping of containers, average vessel operating cost data were provided by MDS Transmodal. Cost components include:

- Vessel capital costs
- Manning (labor)
- Fuel use
- Stores and lubes
- Maintenance
- Port costs, insurance, etc.

These costs are estimated for vessel size classes defined by capacity, from 3,500 TEUs to 14,000 TEUs. In general, costs for carrying a container decrease as vessel size increases. This economy of scale is the principal reason that Panama Canal expansion may affect shipping patterns. Because larger ships transiting the Canal will mean lower unit costs for transporting a container via the Panama Canal, volumes may be shifted to Panama Canal routes to take advantage of the lower relative cost.

[121] Other methods of cost cutting (such as "slow steaming") can be used to augment these cost reductions.

Rail costs are also developed on a detailed built-up basis and are derived from software and an associated database from USRail.desktop. This database incorporates aggregated cost data from the Surface Transportation Board Carload Waybill Sample and rail mileage information from ALK's PCMilerRail.

Trucking costs (which are addressed in more detail in Appendix 3) are also an important component of total transportation costs, but less important than ocean and rail costs in the analysis of relative costs of West Coast versus all-water East Coast routings. First, almost every cargo move involves some trucking: transporting cargo from foreign origins to foreign ports, local draying between U.S. ports and rail or truck terminals, or delivery to a final destination. But some of these trucking costs are either similar or the same for alternative route choices. For example, if a container is transported via rail to an intermodal terminal in Atlanta, a local truck move to a final destination near Atlanta is the same whether that container arrived in Atlanta via rail from a West Coast port or an East Coast port. Thus, in many cases, trucking costs would not be a factor making one of these routes preferable to another.

The second reason that trucking costs are less important for comparing total costs is that trucking is generally much more costly than rail transport for long-haul moves. Therefore, the choice of moving freight by long-haul trucking rather than by rail may indicate a preference for faster transit times, increased flexibility and control, or some factor other than a preference for lower transportation costs (which may be the primary effect of the Panama Canal expansion).

TN - 7: FUEL PRICING

Fuel consumption costs are generally the highest portion of vessel operating costs. Given the variability of fuel prices, which fluctuate widely based on short-term economic and demand conditions, an average fuel price was derived from an analysis of a one to two year history of main engine fuel prices (also referred to as HFO, or heavy fuel oil) and of auxiliary engine fuel (also referred to as MDO or marine diesel oil).

As shown in Figure 35 and Figure 36, prices for HFO during the years from 2010 to 2012 ranged from just over $400 per metric ton to about $730 per metric ton. Prices for HFO in June 2012 were in the $590- $620 per metric ton range (there is actually no one "world price" for this commodity, as the price varies depending on where in the world it is being purchased). Figure 37 shows comparable price volatility for MDO, with prices in June 2012 ranging from $920-$940 per metric ton.

Figure 35. TWO-YEAR HISTORY OF FLUCTUATIONS IN MAIN ENGINE FUEL (HFO) PRICE

Source: June 13, 2012, Available at: http://www.bloomberg.com/quote/BUNKI380:IND/chart

Figure 36. ONE-YEAR HISTORY OF FLUCTUATIONS IN MAIN ENGINE FUEL (HFO) PRICE

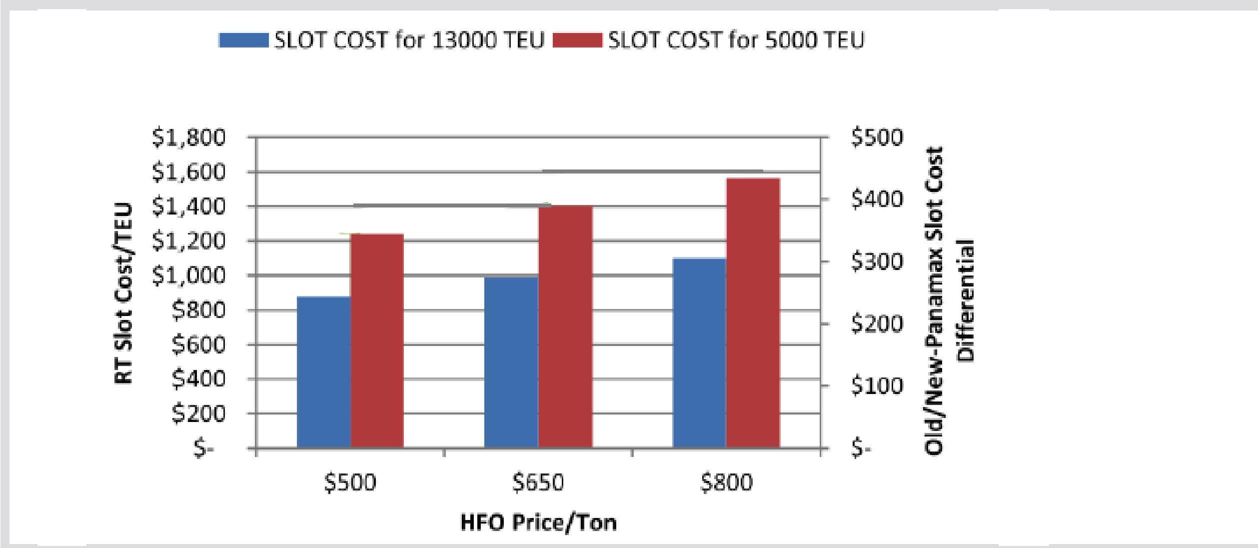
Source: Bunkerworld, June 13, 2012

Figure 37. ONE-YEAR HISTORY OF FLUCTUATIONS IN AUXILIARY ENGINE FUEL (MDO) PRICE

Source: Bunkerworld, June 13, 2012

The vessel deployment costing model for two classes of ships (5,000 TEU and 13,000 TEU) was run for the average June 2012 price of HFO and MDO, as well as two additional sets of bunker fuel price assumptions: a low price scenario of $500 per metric ton for HFO and $875 per metric ton for MDO and a high price scenario of $800 per metric ton for HFO and $1,175 per metric ton for MDO. The impact of changes in fuel prices on the slot cost differential between the two classes of ships is show on Figure 38. As is apparent, the absolute roundtrip slot cost advantage for the larger ship relative to the smaller ship becomes larger as the price of fuel increases.

Figure 38. **IMPACT OF BUNKER FUEL PRICE SWINGS ON SLOT COST DIFFERENTIAL BETWEEN OLD AND NEW PANAMAX VESSELS IN FAR EAST – U.S. EAST COAST DEPLOYMENT**



Source: Mercator International, Panama Canal Expansion Study, June 2012

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APPENDIX 1: TRANSIT STATISTICS

Table 26 provides a summary of all vessel transits through the Panama Canal from 1998 to 2011. More in depth statistics are available (including direction and laden vs. ballast) from the Panama Canal Authority website.[122]

Table 26. PANAMA CANAL VESSEL TRANSITS BY TYPE

	1998	1999	2000	2001	2002	2003	2004
Full Container Ships	1,640	1,628	1,704	1,780	2,012	2,370	2,536
Vehicle Carriers	545	609	723	738	773	816	794
Dry Bulk	3,563	3,433	3,117	2,922	2,684	2,351	2,542
Dry Bulk Carriers	3,502	3,379	3,024	2,769	2,630	2,318	2,510
Vehicle/Dry Bulk	61	54	38	34	8	6	3
Woodships	0	0	55	119	46	27	29
Liquid Bulk	2,151	2,121	2,133	2,053	1,802	1,581	1,872
Liquid Gas Carriers	191	206	200	215	191	249	252
Tankers	1,960	1,915	1,933	1,838	1,611	1,332	1,620
Refrigerated	2,073	2,036	2,004	2,076	2,135	2,207	2,316
Other	4,271	4,510	3,972	3,923	3,777	3,829	3,975
Total	**14,243**	**14,337**	**13,653**	**13,492**	**13,183**	**13,154**	**14,035**
	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Full Container Ships	2,879	3,290	3,622	3,544	3,364	3,031	3,253
Vehicle Carriers	754	766	835	817	469	607	633
Dry Bulk	2,636	2,756	2,406	2,420	2,687	3,050	3,285
Dry Bulk Carriers	2,612	2,734	2,376	2,395	2,663	3,034	3,271
Vehicle/Dry Bulk	0	4	3	3	0	1	1
Woodships	24	18	27	22	24	15	13
Liquid Bulk	1,749	1,684	1,969	2,066	2,317	2,233	2,320
Liquid Gas Carriers	135	123	149	150	161	178	186
Tankers	1,614	1,561	1,820	1,916	2,156	2,055	2,134
Refrigerated	2,305	2,096	2,188	2,166	1,972	1,718	1,479
Other	3,688	3,601	3,701	3,689	3,533	3,591	3,714
Total	**14,011**	**14,193**	**14,721**	**14,702**	**14,342**	**14,230**	**14,684**

Source: Panama Canal Authority Transit Statistics, June 2012

[122] Panama Canal Authority, *Transit Statistics*, Fiscal Year 2011. Available at: http://www.pancanal.com/eng/op/transit-stats/index.html.

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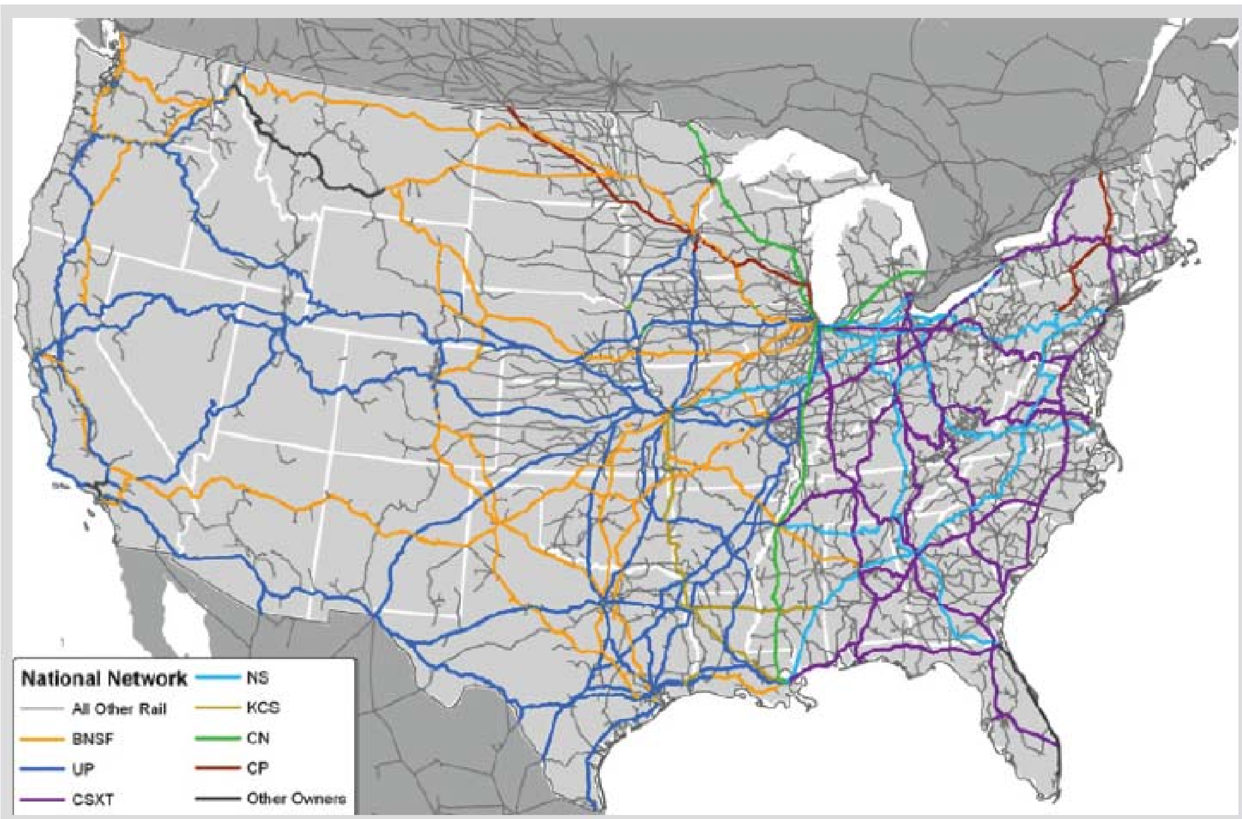
APPENDIX 2: NORTH AMERICAN INTERMODAL RAIL NETWORK

The maps presented in this appendix emphasize those portions of the rail systems for U.S. Class I Railroads assigned to intermodal (container) transportation. Complete network maps are available through the Association of American Railroads.[123]

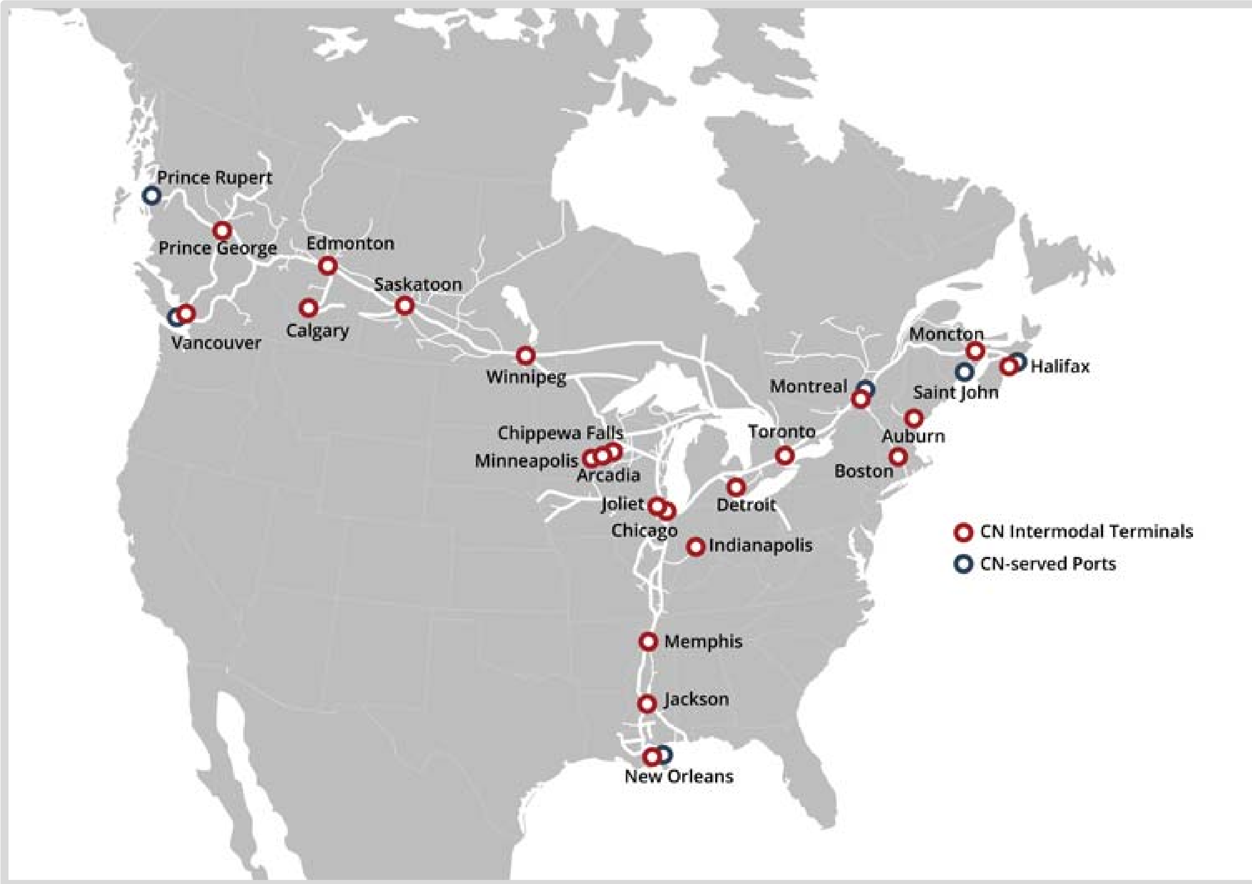
Figure 39. **U.S. NATIONAL RAILWAY SYSTEM MAP**



Source: Association of American Railroads, May 2012

[123] Association of American Railroads website, Available at: http://www.aar.org/.

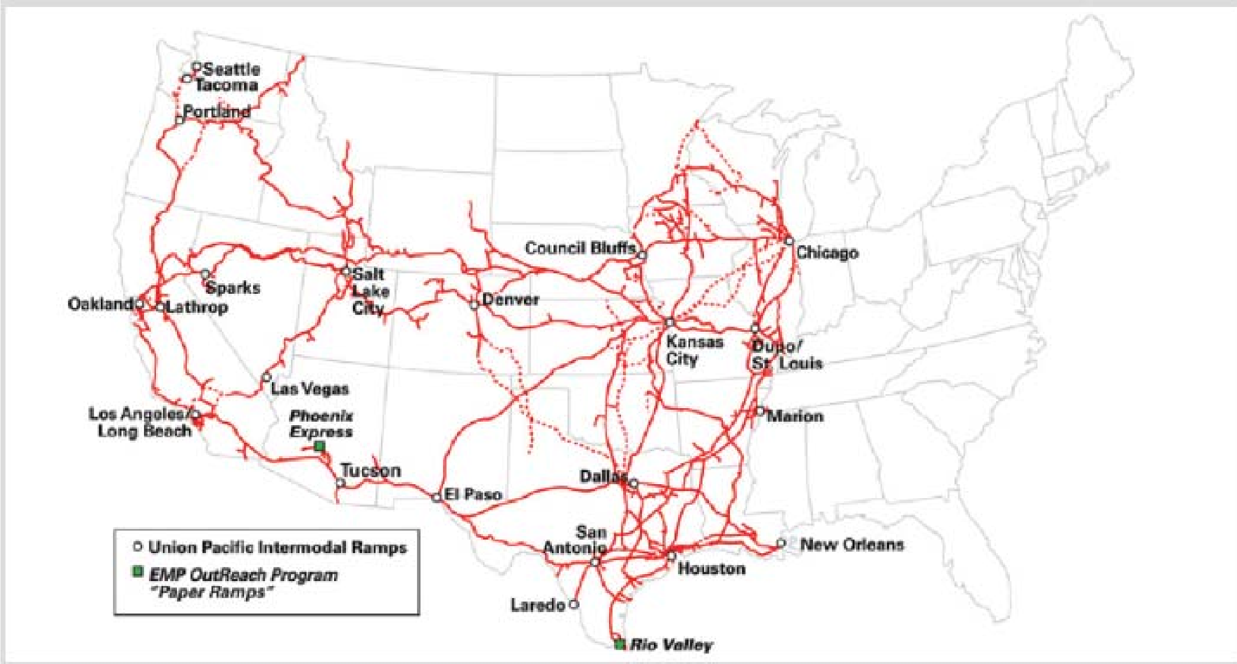
Figure 40. CANADIAN NATIONAL INTERNATIONAL INTERMODAL MAP



Source: Canadian National Railway[124]

[124] Canadian National. *CN Intermodal Terminals Map.* Available at: http://www.cn.ca/en/repository/popups/maps/cn-intermodal-terminals-map.

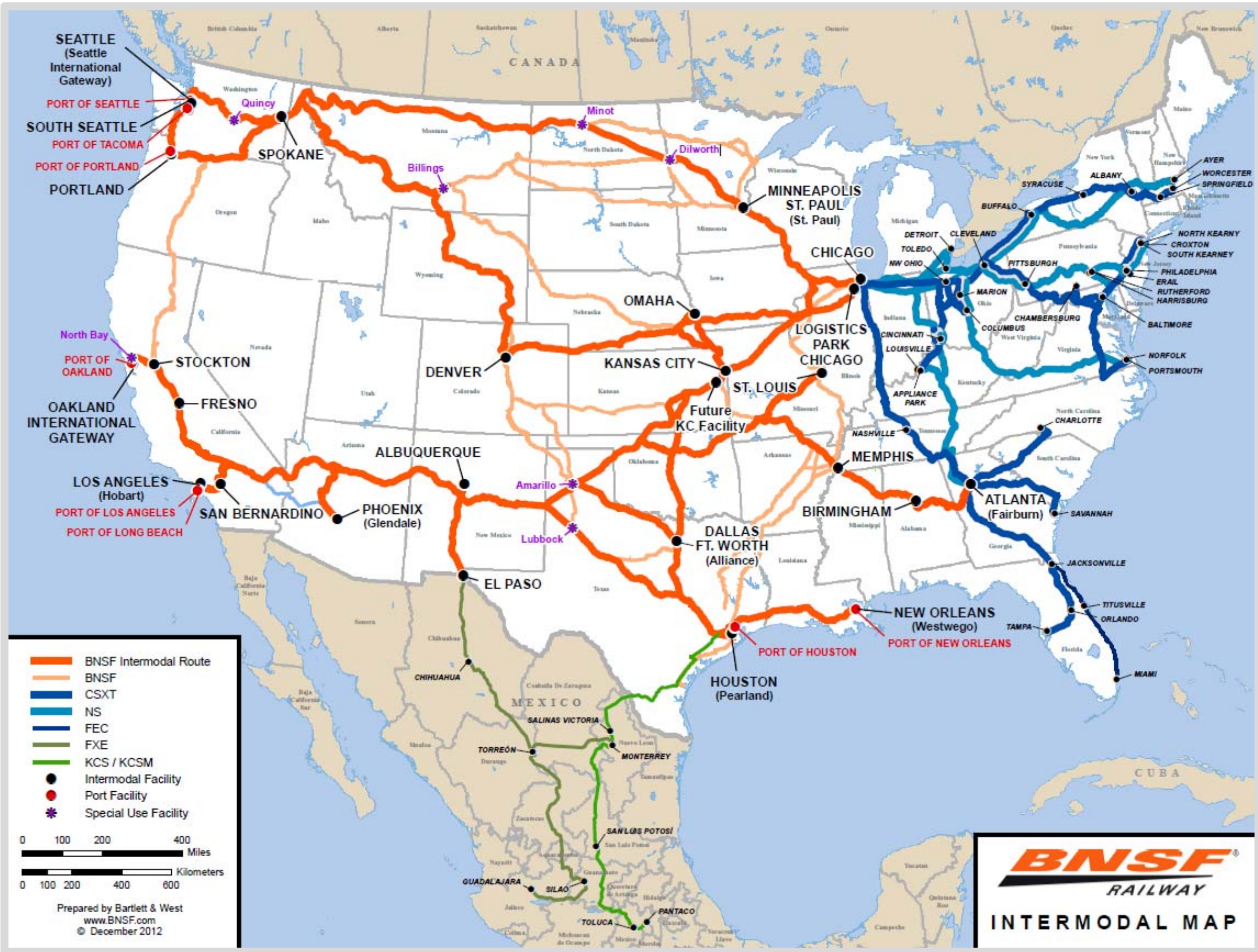
Figure 41. UNION PACIFIC INTERMODAL SYSTEM MAP



Source: Union Pacific Rail Road[125]

[125] Union Pacific Rail Road. *Intermodal System Map*. Available at: http://www.uprr.com/customers/intermodal/intmap/index.shtml.

Figure 42. **BNSF INTERMODAL NETWORK MAP**



Source: Burlington Northern Santa Fe Railway[126]

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[126] Burlington Northern Santa Fe (BNSF) Railway. *Intermodal Map*. Available at: http://www.bnsf.com/customers/pdf/maps/small-intermodal-map.pdf.

Figure 43. CANADIAN PACIFIC INTERMODAL MAP

Source: Canadian Pacific Railway[127]

[127] Canadian Pacific (CP) Railway. *Intermodal System Map*. Available at: http://www.cpr.ca/en/ship-with-cp/how-you-can-ship/intermodal/Pages/default.aspx.

Figure 44. KCS INTERMODAL NETWORK MAP

Source: Kansas City Southern Railway[128]

[128] Kansas City Southern Railway, *Cross Border Shipping Intermodal System Map*. Available at: http://www.kcsouthern.com/en-us/Services/Pages/CrossBorderShipping.aspx.

Figure 45. NS INTERMODAL SYSTEM MAP

Source: Norfolk Southern Railway[129]

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[129] Norfolk Southern Railway, *Intermodal System Map*, Available at: http://www.nscorp.com/nscintermodal/Intermodal/System_Info/Terminals/index.html.

Figure 46. CSXI INTERMODAL SYSTEM MAP

Source: CSX Intermodal[130]

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[130] CSX. *Intermodal Network*. October 2010. Available at: http://www.csxi.com/share/csxicustomer/main/docs/Core_2008_08-REF24487.PDF.

MAJOR INTERMODAL RAIL CORRIDOR INVESTMENTS

Three major intermodal rail corridor development projects in the Eastern United States are either complete or are in the process of being completed. These rail corridors are focused on upgrading trackage and clearances for double stack rail cars to provide service to inland markets from major U.S. East Coast ports. These three projects, described below, include the following:

- Crescent Corridor (NS)
- National Gateway Corridor (CSX Railroad)
- Heartland Corridor (NS)

THE CRESCENT CORRIDOR

The Crescent Corridor is a $2.5 billion intermodal freight initiative centered on the continued development of NS's rail intermodal route from the Gulf Coast to the Mid-Atlantic region. The program improves rail infrastructure to create a high capacity 2,500 mile intermodal route through 13 states. Initial projects include building three intermodal terminals in Tennessee, Alabama, and Pennsylvania and expanding two others; constructing 300 miles of double track and ten passing sidings; straightening curves; and adding signals. The Corridor would run from New Jersey to Memphis, and beyond to New Orleans. Completion of the Corridor is estimated to be in 2020.[131]

Additional NS corridor developments include the Meridian Speedway, a joint venture with Kansas City Southern that improves service along a 320-mile rail line between Meridian, MS, and Shreveport, LA; route improvements along the Patriot Corridor into New England, and the Mid-America Corridor, a joint venture with CN to create a Midwest – Southeast route through a track-sharing arrangement.

[131] Journal of Commerce. *Norfolk Southern's Crescent Corridor is awarded $105 million TIGER grant from U.S. Department of Transportation*. Available at: http://www.joc.com/norfolk-southern%E2%80%99s-crescent-corridor-awarded-105-million-tiger-grant-us-department-transportation.

Figure 47. **CRESCENT CORRIDOR**

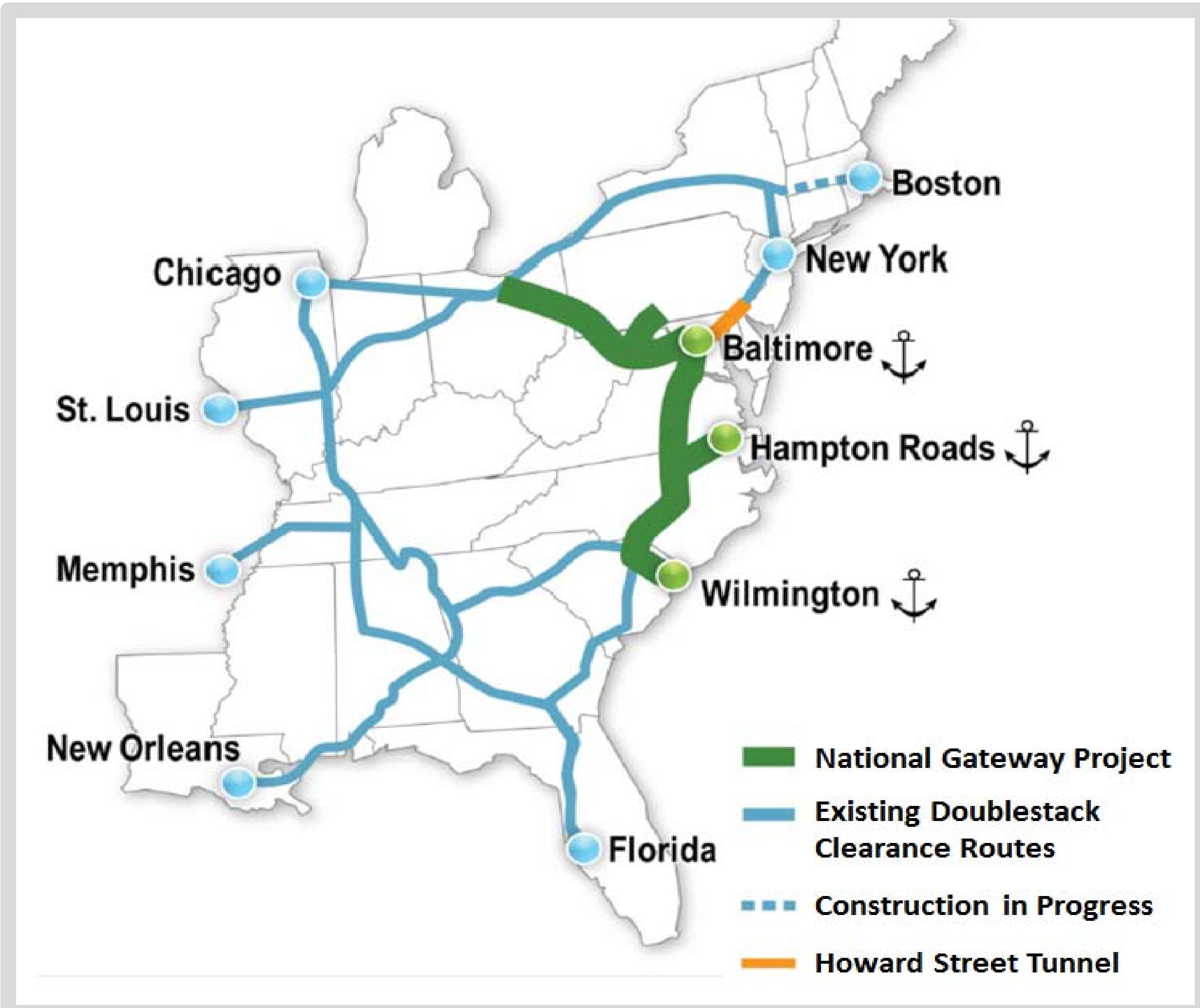
Source: Butler, D. Presentation to the J. P. Morgan Transportation Conference. March 10, 2010. Available at www.nscorp.com/nscorphtml/pdf/dhb031010.pdf

NATIONAL GATEWAY PROJECT

The National Gateway project is a package of rail infrastructure and intermodal terminal projects designed to improve the cargo flow along three major freight rail corridors owned and operated by CSX. The infrastructure project includes increasing 40 height clearances in four States to accommodate double-stack container cars through the Midwest and along the Atlantic coast. The project parallels the I-95 corridor, connecting North Carolina with Baltimore, MD, and travels east along the I-70/I-76 Corridor between Washington, DC and Northwest Ohio via Pittsburgh, PA. As part of Phase I of the project, new intermodal terminals in Chambersburg, PA and

Northwest Ohio have been completed and are operational. The project is scheduled for completion in 2015.[132] CSX is also championing regional projects to clear routes for double-stack access across its rail network, such as the New England I-90 Corridor and the Liberty Corridor expanding access to the Port of New York and New Jersey.

Figure 48. **NATIONAL GATEWAY CORRIDOR PROJECT**

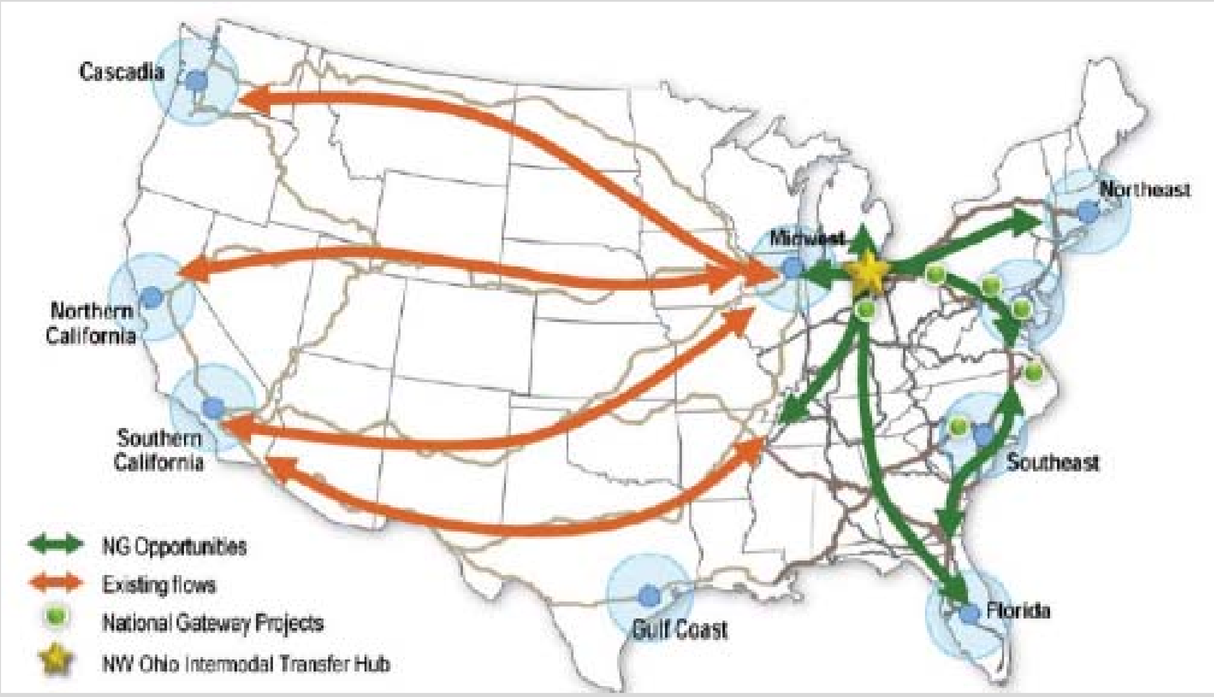


Source: "The National Gateway: Preparing for Tomorrow", 2010[133]

[132] Butler, D. *Presentation to the J. P. Morgan Transportation Conference*. March 10, 2010. Available at: www.nscorp.com/nscorphtml/pdf/dhb031010.pdf.

[133] Brinker, K. *The National Gateway Preparing for Tomorrow*. Presented at the 2010 TRB Environment and Energy Research Conference in Raleigh, NC. June 2010. Available at: http://www.cte.ncsu.edu/EEConference/sessions/documents/38-1_Brinker.pdf.

Figure 49. **NATIONAL GATEWAY CORRIDOR OPPORTUNITIES**



Source: State of Ohio, TIGER Application, 2009[134]

HEARTLAND CORRIDOR

The Heartland Corridor Project, a 530-mile railway line that became operational in September 2010, carries double-stack container freight trains between Hampton Roads and Chicago. The $200 million project improved the NS rail line connecting Virginia and Midwest states by clearing the double-stack rail overhead restrictions through the corridor. The three-year project was a public-private partnership initiative between NS, FHWA, and the States of Ohio, West Virginia, and the Commonwealth of Virginia. It raised the height of 28 tunnels and removed overhead obstacles on the main lines. The project also added provisions for rail-truck container transfer terminals along the route, such as the Intermodal Terminal in Columbus, OH. The project ultimately reduced each container move by approximately 250 route miles and decreased transit times by a day.[135]

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[134] State of Ohio. Grant Application for Transportation Investment Generating Economic Recovery for the National Gateway Project, September 2009. Available at: http://www.dot.state.oh.us/Divisions/Communications/TIGER%20Grant%20applications/Final_CSX_NG_Tiger_Application.pdf.

[135] The Future Needs Us. *Heartland Corridor Project Updates*. Available at: http://www.thefutureneedsus.com/project-updates/heartland-corridor/.

Figure 50. HEARTLAND CORRIDOR

Source: Norfolk Southern[136]

[136] The Future Needs Us. *Media: Heartland Corridor*. Available at: http://www.thefutureneedsus.com/latest-news/media/category/heartland-corridor/#.

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APPENDIX 3: TRUCKING AND DRAYAGE ISSUES

As part of the initial assessment of the total inland freight transportation system, the following list provides an overview of the major trucking related issues that shippers and logistics service providers are attempting to address in their current operations. More detailed information on the expected future costs of providing these services and an assessment of the response of service providers to potential changes in the baseline cost structure outlined below are part of the next report of this study.

- **Cost of Fuel:** Diesel prices rose from $2.70 per gallon in December 2009 to $3.51 per gallon in February 2011, "reaching a 53 week record."[137] National average prices were volatile but high throughout 2011 and the first half of 2012, crossing the $4.00 per gallon mark more than once before coming down to $3.68 at the end of June 2012.[138] Each time fuel escalates, surcharge pricing rises with it.

- **Transloading:** The advantages of transloading are that three 40-foot international containers can be transloaded into two 53-foot high cubed domestic containers or trailers and transported at two-thirds (or less) of the cost of moving the international containers. This efficiency, coupled with the realization that the ocean carriers (and other lessors of the containers) can control the return of the empty box at a substantial savings, has caused transloading to capture 45 percent of the import traffic in the Los Angeles basin.[139] The negative aspect is that it puts more trucks on local roads when compared to an on-dock rail shipment.

- **Environment:** There has been significant national debate on and regulatory attention directed to the effects that trucking has on the both the natural and human environment. Air quality, congestion on the highways and local roads, safety, and the effect of heavy trucks on maintenance of the roads and highways are some of the principal factors that will have a direct impact on the cost of moving goods by truck. The Ports of Los Angeles and Long Beach, although slightly different in their approaches to these issues, have introduced a model which may set a pattern for regional, if not national, policy. Both Ports have regulated access to their terminals by issuing licenses to truck operators. The common element is a requirement for a green and clean engine. While air quality concerns are more acute in the Los Angeles basin and have compelled its ports to action, other U.S. ports (e.g., Seattle, Tacoma, New York/New Jersey, Houston and Virginia) are

[137] Journal of Commerce. *Year 2010 Diesel Prices*. January 2011. Available at: www.joc.com/economy/year-2010-us-diesel-prices.

[138] U.S. Energy Information Administration. *Gasoline and Diesel Fuel Update.* June 2012. Available at: http://www.eia.gov/petroleum/gasdiesel.

[139] Tirschwell, P. "Transloading, Part II". *Journal of Commerce*, Jan 31, 2011. Available at: http://www.joc.com/transloading-part-ii_20110131.html.

closely observing, if not adopting, the licensing approach to assuring service from cleaner vehicles.

- **Last Mile:** For a variety of reasons, the 1956 Interstate Highway Program has not been fully completed. While the majority of the interregional connections were completed, it is the intraregional, and more specifically the intra-urban connections that have not been completed. In virtually every marine gateway, "last mile projects" are either planned (awaiting funding) or being created to complete the ability for unimpeded access to and egress from the port and terminals complexes. In addition to being costly (more frequently than not requiring construction in dense, metropolitan areas) and environmentally sensitive (existing land uses, sensitive environmental justice, and equity issues), the economic reality of near-term investments in these facilities is being challenged by the financing constraints facing public agencies and regional/local governmental bodies throughout the United States.

- **Hours of Service:** Current legislation dictates a maximum 11 hour driving time within a 14 consecutive hour driving window.[140] The drayage industry equates this to a 400 mile effective radius for a truck driver. One of the most critical elements of the financial capability of a motor freight firm is the ability to make several "turns" with their assets in a day. Again, balance and density play large roles, but delays at the terminal, delays due to near-port congestion, and the length of the haul all directly determine how many turns a truck can obtain in a day. For a local port drayage firm, with newer fuel efficient and environmentally friendly engines, a minimum of four turns a day is the typical benchmark needed to cover operating costs at current rates. As of the time-frame for this report, a new proposed rulemaking (effective July 2013) has retained the current 11 hour limit for hours of service, but reduced total work hours in a week from 82 to 70 and imposed certain restart and rest break provisions that constrain work periods further. Some in the industry believe these constraints will reduce turns on their equipment to some degree, which could affect decisions to dray containers versus to ship them using on-dock rail. The rulemaking process is designed to consider all issues regarding tradeoffs of safety, efficiency, cost and other impacts caused by changes to hours of service.

A trucker makes a call parked at a truck stop

Photo courtesy: iStock

- **Security and Safety:** The Federal Motor Carrier Safety Administration's (FMCSA) Compliance, Safety, Accountability (CSA) program (a quantitative assessment of motor

[140] J.J. Keller and Associates. *New Hours-of-Service FAQs*. Available at: http://www.jjkeller.com/webapp/wcs/stores/servlet/content____bi-hoursofservice-newrule-FAQs.

carriers and drivers by the federal government) was rolled out in 2011—with the objective of notifying individual companies and enforcing safety standards. The related Safety Measurement System (SMS) program is designed to help identify and monitor safety problems as part of the CSA safety improvement process. This program assesses violations and is being used to issue compliance notifications to trucking firms, and especially local drayage companies, resulting in much greater scrutiny for both security and safety for the drivers and their equipment. Transportation Worker Identification Cards (TWIC) are required of all drivers entering a maritime intermodal facility.[141] The background checks and documentation required for TWIC take several weeks to perform. Any safety or moving violation will also remove a driver or vehicle from the fleet.

- **Tolls and Surcharges:** As part of the "last mile" issue and in an attempt to mitigate the environmental and operational maintenance issues of trucking on regional highways and roads, more jurisdictions are contemplating tolling as a method of paying for the needed improvements to the inland transportation system. Several states and local governments are exploring the facility of Truck-Only-Toll (TOT) options and time-of-day pricing to manage demand. Increased costs due to tolling, to the extent that TOTs are not offset by improved reliability and congestion reduction, would increase net costs to the businesses using commercial trucking. On the other hand, appropriate tolling would internalize the costs of trucking to truck service providers, leading to a more rational allocation of public resources to the building and maintenance of transportation infrastructure.

- **Labor:** The trucking industry has long claimed that, with all of the new and proposed regulations, tightened security requirements, and the changing economics of providing freight services, they have not been able to create and maintain a good stable of qualified and competent drivers. Major long-haul trucking firms continue to experience more than 100 percent driver turn-over rates in a year, although locally-based fleets do better. The cost of maintaining a highly motivated and capable driver pool is again pushing the limits of the cost of motor freight transportation to the shipper. Typically, a market response to this situation would be to offer greater compensation to attract and keep qualified drivers.

[141] TWIC is a common identification credential for all personnel requiring unescorted access to secure areas of Maritime Transportation Security Act-regulated facilities and vessels, and all mariners holding Coast Guard-issued credentials.

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APPENDIX 4: STANDARD CLASSIFICATION OF TRANSPORTED GOODS

SCTG ID	Short Description	Long Description
01	Live animals/fish	Live animals and live fish
02	Cereal grains	Cereal grains
03	Other agricultural products	Other agricultural products
04	Animal feed	Animal feed and products of animal origin not elsewhere classified
05	Meat/seafood	Meat, fish, seafood, and their preparations
06	Milled grain products	Milled grain products and preparations, bakery products
07	Other foodstuffs	Other prepared foodstuffs and fats and oils
08	Alcoholic beverages	Alcoholic beverages
09	Tobacco products	Tobacco products
10	Building stone	Monumental or building stone
11	Natural sands	Natural sands
12	Gravel	Gravel and crushed stone
13	Nonmetallic minerals	Nonmetallic minerals not elsewhere classified
14	Metallic ores	Metallic ores and concentrates
15	Coal	Coal
16	Crude petroleum	Crude Petroleum
17	Gasoline	Gasoline and aviation turbine fuel
18	Fuel oils	Fuel oils
19	Coal-n.e.c.	Coal and petroleum products not elsewhere classified
20	Basic chemicals	Basic chemicals
21	Pharmaceuticals	Pharmaceutical products
22	Fertilizers	Fertilizers
23	Chemical products	Chemical products and preparations not elsewhere classified
24	Plastics/rubber	Plastics and rubber
25	Logs	Logs and other wood in the rough
26	Wood products	Wood products

SCTG ID	Short Description	Long Description
27	Newsprint/paper	Pulp, newsprint, paper, and paperboard
28	Paper articles	Paper or paperboard articles
29	Printed products	Printed products
30	Textiles/leather	Textiles, leather, and articles of textiles or leather
31	Nonmetallic mineral products	Nonmetallic mineral products
32	Base metals	Base metal in primary or semi-finished forms and in finished basic shapes
33	Articles-base metal	Articles of base metal
34	Machinery	Machinery
35	Electronics	Electronic and other electrical equipment and components and office equipment
36	Motorized vehicles	Motorized and other vehicles (including parts)
37	Transportation equipment	Transportation equipment not elsewhere classified
38	Precision instruments	Precision instruments and apparatus
39	Furniture	Furniture, mattresses and mattress supports, lamps, lighting fittings, and illuminated signs
40	Miscellaneous manufactured products	Miscellaneous manufactured products
41	Waste/scrap	Waste and scrap
43	Mixed freight	Mixed freight
99	Unknown	Commodity unknown

ACRONYMS

ACTA	Alameda Corridor Transportation Authority
AMH	America's Marine Highway
ARRA	The American Recovery and Reinvestment Act
BCA	Benefit-Cost Analysis
BNSF	Burlington Northern Santa Fe Railway
CAGR	Compound average annual growth rate
CMAQ	Congestion Mitigation and Air Quality
CN	Canadian National Railway
Corps	United States Army Corps of Engineers
CP	Canadian Pacific Railway
CSA	Compliance, Safety, Accountability program
DWT	Deadweight tons
DOT	U.S. Department of Transportation
EBITDA	Earnings before interest, taxes, depreciation, and amortization
FAF3	Freight Analysis Framework 3
FEC	Florida East Coast Railway
FEU	Forty-foot Equivalent Unit
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
ft	Feet
FY2011	Fiscal Year 2011
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GMO	Genetically modified organism
GUPC	Grupo Unidos por el Canal (the contractor doing construction work on the Canal expansion)
HFO	Heavy fuel oil
HMT	Harbor Maintenance Tax
HMTF	Harbor Maintenance Trust Fund
HTF	Highway Trust Fund
HUD	U.S. Department of Housing and Urban Development
IRR	Internal rate of return
IWTF	Inland Waterways Trust Fund
IWUB	Inland Waterways Users Board
KCS	Kansas City Southern Railway
kg	Kilogram

LNG	Liquefied natural gas
m	Meters
MAP-21	Moving Ahead for Progress in the 21st Century
MARAD	U.S. Maritime Administration
MDO	Marine diesel oil
MPO	Metropolitan Planning Organization
NE	Northeast
NOAA	National Oceanic and Atmospheric Administration
NS	Norfolk Southern Railway
NZ	New Zealand
P3	Public-Private Partnership
PAB	Private Activity Bond
PCA	Panama Canal Authority
PCC	Pure Car Carriers
PCTC	Pure Car and Truck Carriers
PCUMS	Panama Canal Universal Measurement System (approximately 100 cubic feet of cargo space—a twenty-foot long container (TEU) is equivalent to approximately 13 PCUMS tons)
PED	preconstruction engineering and design
PNCT	Port of Newark Container Terminal
Ro-Ro	Roll-on/roll-off vessel
ROI	Return on the invested capital
RRIF	Railroad Rehabilitation and Improvement Financing
RTW	Round-the-world
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SCTG	Standard Classification of Transported Goods
SE	Southeast
SMS	Safety Measurement System program
SW	Southwest
TEU	Twenty-foot Equivalent Unit
TFM	Transportacion Ferroviaria Mexicana
TIFIA	Transportation Infrastructure Finance and Innovation Act
TIGER	Transportation Investment Generating Economic Recovery
TIP	Transportation Improvement Programs
TOT	Truck-Only-Toll
TRB	Transportation Research Board
TSA	Transpacific Stabilization Agreement
TWIC	Transportation Worker Identification Cards
ULCC	Ultra-Large Crude Carriers
UP	Union Pacific Railway
U.S.	United States

USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
VLOC	Very Large Ore Carrier
VPA	Virginia Port Authority
WTO	World Trade Organization
WTSA	Westbound Transpacific Stabilization Agreement

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