U.S. Port and Inland Waterways Modernization:
Preparing for Post-Panamax Vessels

Institute for Water Resources

U.S. Army Corps of Engineers

US Army Corps of Engineers®

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IWR INSTITUTE FOR WATER RESOURCES

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FOREWORD

The United States is a maritime nation. From its origin as 13 former colonies to its place as the preeminent world power today, our Nation's success has been dependent on our coastal ports and inland waterways to conduct trade. Recognizing the importance of transportation to trade, the Nation had made a strong intergenerational commitment to develop its transportation networks. From the building of roads and canals in the early days of our Nation, to later construction of the transcontinental railroad and to the creation and development, just within my lifetime, of the Interstate Highway System, the Nation has committed the time and resources to enable and facilitate the large scale movement of raw materials and finished goods from their origin to manufacturer or market, both within our borders and internationally.

These networks of highways, railways and inland waterways connect the interior of our country to our ports, which connect us to the rest of the world. These transportation networks have contributed to our success by providing a cost-efficient and environmentally sustainable means to transport large quantities of cargo over long distances and across oceans, keeping this Nation competitive in world trade.

Population and income drive demand for trade, and trade drives the demand for transportation services. The U.S. population is expected to increase 32 percent, or almost 100 million people, in the next 30 years. The greatest population growth will occur in the South and West. Per capita income is expected to increase 170 percent in the same time period. These increases will drive increased trade, with imports expected to grow more than fourfold and exports expected to grow more than sevenfold over 30 years. The recent U.S. Navy Commercial (http://www.youtube.com/watch?v=EEtZ5r0ClYI), which states that 70% of the world is covered by water, 80% of all people live near water, 90% of all trade travels by water, highlights the importance of waterborne commerce to the Nation and the world.

Our interconnected transportation networks, built in the last century or earlier, resulted in a competitive trade position for this Nation. In order to pass on to future generations the benefits of our competitive trade position, the Nation needs to ensure effective, reliable, national transportation networks and interconnections for the 21st Century. However, as Admiral John C. Harvey, Jr., Commander of the U.S. Fleet Forces Command, put it, "…many of our citizens have taken our maritime services for granted – we are no longer a 'sea conscious' Nation – even though we live in a global economy where 90% of all commerce is still transported by ship…" Despite this, I believe we have an opportunity as a Nation to strategically position public and private investments to become again a world maritime leader.

The Nation is taking steps to seize that opportunity. The Conference Report for the Consolidated Appropriations Act of 2012 (Public Law 112- 74) requested a report from the Institute for Water Resources on how Congress should address the critical need for additional port and inland waterway modernization to accommodate *post-Panamax* vessels. *Post-Panamax* vessels are a reality today. They make up 16% of the world's container fleet, but account for 45% of the fleet's capacity. The efficiencies

of scale they provide drive the deployment of more and more of these vessels. By 2030, they are expected to make up 27% of the world's container fleet, accounting for 62% of its capacity. This report provides an analysis of the broad challenges and opportunities presented by the increasing deployment of *post-Panamax* vessels and outlines options on how the Congress could address the port and inland waterway infrastructure needs to accommodate those vessels.

This Nation must address the need and the challenges of a modern transportation system and evaluate potential investment opportunities. This report advances that objective. It contributes to an ongoing public discussion, which is already underway, and will help inform current and future decisions on the maintenance and future development of our ports and waterways and their related infrastructure.

Major General (MG) Michael J. Walsh
United States Army Corps of Engineers
Deputy Commanding General for Civil Works and Emergency Operations

Preface

The U.S. Army Engineer Institute for Water Resources (IWR) welcomed the opportunity provided by the Consolidated Appropriations Act of 2012 (P.L. 112-74) to prepare this report, *U.S. Port and Inland Waterways Modernization: Preparing for Post-Panamax Vessels*. We approached this assignment in a manner befitting the trust and confidence in IWR's work that is reflected in the Committee's designation for this important study.

The resulting document was developed as a true team effort, with the collaborative participation of not only IWR's own in-house specialists and visiting scholars, but also from experts in USACE's various navigation mission specialties from across the organization including the National Planning Centers of Expertise in Deep Draft Navigation and Inland Navigation, located at USACE Mobile and Huntington Districts, respectively, and cost specialists from Walla Walla District and USACE Headquarters. The Institute's efforts were also supported via contracts with the private sector and through a robust public outreach process administered by its Conflict Resolution and Public Participation Center. The Center helped to facilitate openness and transparency as the study progressed, providing public listening sessions and opportunities for input and comment from the navigation community and other interested parties.

Nevertheless, providing advice on "how the Congress should address the critical need for additional port and inland waterway modernization to accommodate *post-Panamax* vessels," as requested in P.L.112-74, implies that the Committee has substantial expectations regarding the certainty and utility of such advice. Let me clarify those expectations at the front and acknowledge that if the history of maritime transportation is any indication – despite what we think we know – uncertainty will persist in the years immediately after the opening of the expanded Panama Canal as to how the Canal's new capacity will specifically drive the future direction of intermodal freight logistics in the U.S., particularly with regard to the timing of the resulting infrastructure needs that will ultimately manifest.

As Christopher Koch, President and CEO of the World Shipping Council, testified earlier this year before the House Transportation and Infrastructure Committee's Water Resources and Environment Subcommittee, "There is neither a single issue nor solution to how to prepare for future maritime transportation infrastructure needs… There is a plethora of studies, opinions and prognostications about what the effects of the new [Panama Canal] locks will be on trade flows, ship sizes, volumes, transshipment port development, and which U.S. ports will benefit by the new locks…It will probably take some years before it is clear exactly what changes to cargo flow, and its supporting transportation network, will result from the new locks."

What we do know is that the world economy is changing, with the pace and scope of these changes accelerating and expanding in unpredictable ways. Shifts in global alliances and political structures, the critical role of emerging technologies, the waxing and waning of the wealth of nations, and even changes to the climate and the natural environment that are impacting agricultural production and the availability of water, are all manifesting right before our very eyes.

But that is the challenge – often we don't pick up the signals that announce many of these changes, nor truly appreciate the significance of the shifts while they are happening or understand the long-term implications associated with these permutations. It is only later, in retrospect, that we recognize some of these changes as transformative "game-changers" to the status quo we mistakenly assumed would continue into the future ad infinitum.

In fact, although many now trace the existence of today's modern containerships to the vision of American truck magnate Malcom McLean, who deployed the first container vessel in the U.S., the converted T2 tanker *Ideal X*, who among us realized that when the *Ideal X* carried 58 containers from Port Newark, NJ to Houston, TX on its maiden voyage on April 26, 1956 that we were witnessing the beginning of a revolution in modern shipping that represented a mega-shift in world trade? In his book "*The Box*," author Marc Levinson points out that "absolutely no one anticipated that containerization would open the way to vast changes in where and how goods are manufactured, that it would provide a major impetus to transport deregulation, or that it would help integrate East Asia into a world economy that previously had centered on North America."

By undertaking the current expansion, Panama will double the Canal's capacity. The resulting economy of scale advantage for larger ships will likely change the logistics chains for both U.S. imports and exports. Despite the uncertainties in timing and port-specific implications that still need to play out, the certain injection of successive new generations of *post-Panamax* vessels into the world fleet could be a "game-changer" for the U.S. over the long term, as it has the potential to not only provide a cost-effective complement to the intermodal transport of imports via the U.S. land bridge, while also re-shaping the service from Asia to the Mediterranean and on to the U.S. East Coast, but may also affect the highly competitive transport price structure along the Midwest to Columbia-Snake route for grain and other bulk exports bound for trans-Pacific shipping. Inland waterways play a key role in the cost efficient transport of grains, oilseeds, fertilizers, petroleum products and coal. Gulf ports play key roles in the transport of these commodities, such as New Orleans being the dominant port for the export of grains from the U.S. Therefore the expanded canal could provide a significant competitive opportunity for U.S. Gulf and South Atlantic ports and for U.S. inland waterways – if we are prepared.

Through effective planning and strategic investment the U.S. can be positioned to take advantage of this opportunity. The railroad industry has been investing $6-8 billion a year over the last decade to modernize railways and equipment, and U.S. ports plan public and private-sourced landside investments of the same magnitude over each of the next five years. Annual spending on waterside infrastructure has been averaging about $1.5 billion.

While the U.S. has ports on the West Coast (Los Angeles, Long Beach, Oakland and Seattle/Tacoma) and East Coast (New York, Baltimore and Hampton Roads) expected to be ready with *post-Panamax* channels in 2014, there is currently a lack of *post-Panamax* capacity at U.S. Gulf and South Atlantic ports – the very regions geographically positioned to potentially be most impacted by the expected changes in the world fleet. The Corps currently has 17 studies investigating the opportunity to economically invest in deep draft ports. At the Port of Savannah, USACE has identified an economically viable expansion to accommodate *post-Panamax* vessels. This project is estimated to cost $652 million dollars. It is possible

that several of the remaining studies will also show economic viability and, if so, the challenge will be to fund these investments. In addition, justified investments in inland waterway locks and dams will be needed to allow the waterway transport capability to take advantage of an expanded canal for U.S. exports. This emphasizes the strategic need to address the revenue challenge within the Inland Waterway Trust Fund.

Given this opportunity presented by the deployment of *post-Panamax* vessels, it is critical that the U.S. develop and move forward with a strategic vision for a globally competitive navigation system that sets the context for ensuring adequate investment in maintaining current waterside infrastructure and also facilitates the strategic targeting of investments to ensure the U.S. is ready for *post-Panamax* vessels and "cascade" fleet deployments consistent with the growth in global trade that is anticipated over the next twenty years.

Constrained Federal funding both for harbor channels and inland waterways can be expected due to overall economic and fiscal conditions and concerns about the deficit. This underscores the need to consider new and innovative public and private funding sources and financing methods with long-term reliability that can finance the navigation system maintenance and expansion that will be necessary to ensure a globally competitive U.S. navigation system. The Institute stands ready to support USACE, the Administration and Congress in realizing this 21st Century vision.

Robert. A. Pietrowsky
Director, Institute for Water Resources

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Executive Summary

"The potential economic gains from trade for America are far from exhausted. Roughly three quarters of world purchasing power and almost 95% of world consumers are outside America's borders... Trade remains an engine of growth for America."

Office of the United States Trade Representative
http://www.ustr.gov/trade-topics/economy-trade

The health of the U.S. economy depends, in part, upon the vitality and expansion of international trade. International trade depends upon the Nation's navigation infrastructure, which serves as a conduit for transportation, trade, and tourism and connects us to the global community. Marine transportation is one of the most efficient, effective, safe and environmentally sound ways to transport people and goods. It is a keystone of the U.S. economy. Ninety-five percent of our international trade moves through the Nation's ports.[1]

Cargo carriers, seeking to service this global trade more efficiently and lower costs, are commissioning the building of ever larger ships, known as *post-Panamax* vessels. These vessels are currently calling at U.S. ports and are expected to call in increasing number. The completion of the Panama Canal in 2014 will influence the timing of their arrival at certain ports. However, *post-Panamax* vessels will dominate world trade and call at U.S. ports regardless of the Panama Canal expansion as they are expected to represent 62 percent of total container ship capacity by 2030.

How the Nation invests in the maintenance and modernization of its navigation infrastructure presents financial challenges to be met and economic opportunities to be seized. Sustaining a competitive U.S. navigation system that can enhance economic opportunities for future generations without significant harm to the environment will require a coordinated effort between government, industry and other stakeholders.

Identifying Capacity Maintenance and Expansion Issues Associated with *post-Panamax* Vessels

Congress directed the USACE Institute for Water Resources to submit to the Senate and House committees on appropriations a "report on how the Congress should address the critical need for additional port and inland waterways modernization to accommodate *post-Panamax* vessels." This report fulfills that request. This report identifies capacity maintenance and expansion issues associated with the deployment of *post-Panamax* vessels to trade routes

[1] Complete Statement of the Honorable Jo-Ellen Darcy, Assistant Secretary of the Army (Civil Works) before the Committee on Transportation and Infrastructure, Subcommittee on Water Resources and Environment, United States House of Representatives, on the Economic Importance of Seaports: Is the United States Prepared for 21st Century Trade Realities – October 26, 2011

serving U.S. ports. This identification has been accomplished through an evaluation of the future demand for capacity in terms of freight forecasts and vessel size expectations and an evaluation of the current capacity of the Nation's inland waterways and coastal ports.

Despite the recent worldwide recession, the expected general trend for international trade is one of continued growth as the world's population and standard of living grow. As international trade expands, the number of *post-Panamax* vessels is expected to increase. The Nation's ability to attract these vessels and allow efficient use of their capacity is the key to realizing the transportation cost savings these vessels represent. For example, the Corps investigation of the Port of Savannah indicates a $652 million dollar investment where the benefits far exceed the cost.

Growth is expected in overall trade and deployment of *post-Panamax* vessels to U.S. ports is certain for multiple trade routes. The expansion of the Panama Canal, currently underway, will accelerate the timing of the deployment of these vessels to more U.S. ports. There is, however, uncertainty in the port specific details: at which ports they will call; when these vessels will arrive in large numbers; how deep these vessels will draft arriving and departing; and the supporting infrastructure needed (channel depth and width, number and sizes of cranes, size of available container storage area). Despite the lack of port specific certainty, the Nation can move forward identifying individual projects using established risk informed decision making methods.

The Panama Canal expansion is scheduled to be completed in 2014 and will double its existing capacity. The new locks will be able to pass vessels large enough to carry three times the volume of cargo carried by vessels today. The availability of larger, more efficient vessels passing though the new locks on the canal is expected to potentially have at least three major market effects. (1) Currently, there is significant freight shipped to the eastern half of the United States over the intermodal land bridge formed by the rail connections to West Coast ports. The potential for reduced cost of the water route through the canal may cause freight traffic to shift from West Coast to East Coast ports. (2) To take full advantage of the very largest vessels that will be able to fit through the expanded canal but may be too large to call at most U.S. ports, a transshipment service in the Caribbean or a large U.S. port may develop. The largest vessels would unload containers at the transshipment hub for reloading on smaller feeder vessels for delivery to ports with less channel capacity. (3) On the export side the ability to employ large bulk vessels is expected to significantly lower the delivery cost of U.S. agricultural exports to Asia and other foreign markets. This could have a significant impact on both the total quantity of U.S. agricultural exports and commodities moving down the Mississippi River for export at New Orleans.

There is uncertainty in the port specific details of when such vessels will arrive in large number, which ports they will call, how deep vessels calling will draft and, consequently, how deep navigation channels must be. Over time these uncertainties will reduce as experience replaces expectation. Even in the face of this uncertainty, individual ports are actively engaged in port expansions and studies to deepen and widen Federal access channels. We can predict that in the

absence of transshipment centers *post-Panamax* vessels will call in large numbers, they will call at most major ports and their sailing drafts will become known. Our challenge is to invest in capacity expansion in the right places at the right time consistent with industry needs.

Port capacity depends upon channel depths, channel widths, turning basin size, sufficient bridge heights, and port support structures such as dock and crane capacity to offload and onload goods. The deepest channel requirements are likely to be driven by "weight trade" services. Vessels can be filled to their weight capacity or their volume capacity. Vessels loaded to their weight capacity sail at their maximum design draft; they sit deeper in the water. For volume trade routes, channel width and turning basin size may be of greater importance than additional channel depth at some ports, as vessels loaded to their volume capacity often sail at significantly less than their design draft. The Asian export trade is considered a "cube trade" (i.e. volume trade). Careful consideration is needed when determining channel depth requirements at U.S. ports for this trade route.

> "I've talked a lot about the expansion of the Panama Canal in the last couple of years...but the one thing I've learned is that nobody really knows what's going to happen."
>
> –Ricky Kunz, Port of Houston Authority's vice president for origination, as quoted in the *New York Times*, February 18, 2012.

Post-Panamax Ready

For this report, a port is considered "*post-Panamax* ready" if it has a channel depth of about 50 feet with allowances for tide, as well as sufficient channel width, turning basin size, dock and crane capacity. U.S. West Coast ports at Seattle, Oakland, Los Angeles and Long Beach all have 50-foot channels. Northeastern U.S. ports at Baltimore and New York have or will soon have 50-foot channels. In the Southeast, Norfolk has 50-foot channels. South of Norfolk along the Southeast and Gulf Coasts there are no ports with 50-foot channel depths, although Charleston with a 45 foot channel depth and nearly 5 feet of tide can accommodate most *post-Panamax* vessels. This is also the region with the greatest forecast population and trade growth.

Cascade Effect

A system vision should extend beyond the major ports to include lower tier ports. New, large vessels are typically deployed on the longest and largest trade service – Asia to Northern Europe. The "smaller" vessels on that service re-deploy to the next most efficient service for that vessel size. Cascading typically increases average vessel size for each trade service. A navigation system vision should address this cascade effect and its impact on infrastructure for shallower ports. Analysis of individual ports will determine whether the port will need to accommodate *post-Panamax* vessels or the cascade effect.

Remaining Globally Competitive

To remain competitive in a changing global trade market, the U.S. would need to continue making the justified investments necessary to maintain and improve its navigation transportation infrastructure where it is appropriate and efficient to do so. Understanding the current funding challenges and making long-term plans for operations and maintenance (O&M) and justified investments are critical to developing an effective vision for a competitive navigation system.

USACE Civil Works appropriations to address waterside infrastructure have averaged about $1.5 to $2 billion per year for the last decade. These expenditures have been used to maintain, construct and improve the most highly justified inland and coastal navigation infrastructure projects, and reflect the nation's most efficient navigation investment strategy.

To accommodate expected increase in agricultural exports through the Gulf, the current inland waterways must be adequately maintained through maintenance dredging and justified major rehabilitation.

USACE currently has 17 active studies investigating possible port improvements, most associated with the desire to be *post-Panamax* ready. One such study at the Port of Savannah is nearing completion and indicates an economically justified project that will cost about $652 million. It is likely that other studies will also show economically justified projects, either to become "*post-Panamax* ready" or "cascade ready." The preliminary estimate to expand some ports along these two coasts was about $3-$5 billion. Specific investments in ports must be individually evaluated for their timing and economic and environmental merits.

Financing Options

Addressing "the critical need for additional port and inland waterway modernization to accommodate post-Panamax vessels" necessitates an examination of the current delivery mechanisms, the identification of issues and the offering of options for the future. Among the issues identified, securing funding sources to take advantage of modernization opportunities in a timely manner, given the constrained fiscal environment, was judged the most critical. A notional list of financing options is presented to initiate discussion of possible paths to meet this challenge—it is anticipated that a variety of options may be desirable, and in all cases individual project characteristics, including its economic merits, would need to be considered in selecting the optimal financing mechanisms. These options are illustrative only and do not necessarily represent any Administration, USACE or IWR position. Some options include:

- Coastal ports
    - Increase Federal appropriations in the USACE budget for harbor maintenance and improvements while maintaining current cost share responsibilities.

- Increase Harbor Maintenance Trust Fund (HMTF) user fees and allocate increased revenues to harbor improvements.
- Maintain or increase Federal appropriations and also increase local cost share requirements.
- Encourage individual port initiatives by phasing out the HMTF, expecting individual ports to collect their own fees and make their own investment and maintenance decisions.

- Inland waterways
  - To support waterway improvements, increase the fuel tax and provide increases in Federal appropriations to track with the increased revenues flowing into the IWTF; depending upon the revenues from the fuel tax, reduce the share of total costs that is paid from general appropriations.
  - Replace the fuel tax with a vessel user fee and/or combine the fuel tax with a vessel user fee and increase revenues and appropriations for improvements at least by the amount of the increased revenues[2].
  - Implement public-private partnerships with the responsibility for improving, operating and maintaining the inland waterway navigation infrastructure along specified segments of the system. Financing for these actions would be secured in private capital markets with revenues to repay the financed activities earned from a combination of vessel user fees (segment fees or lockage fees) and appropriations.

Regardless of the Federal government's role in funding future navigation improvements, maintenance and operations, USACE will continue to have an environmental regulatory oversight responsibility. Under most options USACE will continue its responsibility for performing environmental assessments and developing environmental protection and mitigation plans. However, if individual ports choose to proceed on their own with harbor deepening projects then USACE would need to provide permits for any proposed action.

Environmental Impacts

Since the 1970s, compliance with the National Environmental Policy Act (NEPA), Clean Water Act, Endangered Species Act (ESA) and other regulatory law has greatly reduced the adverse environmental impacts of many previous practices and positively transformed social attitudes toward the environment. Due to these changes in national commitments, future modernization actions that would have significant adverse impacts will be mitigated, often at great expense, and will play an important role in modernization decisions. In this section, the "environmental footprint" caused by the transportation system is first described to help identify the potential for future environmental impact and mitigation needs. Then indicators of potential impact

[2] The Administration transmitted a legislative proposal to the Congress to reform the laws governing the Inland Waterways Trust Fund as part of the Jobs Bill proposal in September 2011.

sources and vulnerabilities are compared to determine which regions may require the most impact mitigation as a consequence of modernization.[3]

The Environmental Footprint

The national footprint of adverse environmental impacts has accumulated over many decades and is not indicative of the present rate of adverse impact, which is much improved. Measured in geographical terms, the environmental footprint directly impacted by development of transportation system infrastructure is a small fraction of the conterminous United States. But the degree of adverse impact on natural systems and wild species of public interest has been particularly intense and the offsite impacts on air, water and habitat quality from systems operations have been far reaching. The sources of past environmental effects indicate the type of future modernization impacts that are likely to occur from expansion of harbor, port and intermodal infrastructure and from transportation systems operations. Modernization will need to be accompanied by justified mitigation to avoid further 1) degraded air and water quality that threatens human health and safety, especially of low income and minority groups; 2) loss of important natural and cultural heritage found in parks, refuges, wetlands and scarce species; or 3) loss of recreational, commercial and other economically important resources.

Potential infrastructural development along coasts and waterways is a concern because coastal ports and inland waterway infrastructure is closely associated with two of the scarcest types of ecosystems—free flowing rivers and estuarine wetlands. Lock and dam impoundments have contributed substantially to the imperilment of numerous freshwater species by reducing free-flowing river habitat. In general, dredging of nontoxic bottoms impacts coastal and riverine benthic organisms temporarily and bottoms typically recolonize quickly following disturbance. In the past, about 10 percent of bottom sediments were contaminated with toxic materials and resistant to colonization by some bottom species. Sediment toxicity directly affects bottom species and indirectly affects the fish and other species that feed on them and humans at the end of the food chain. Contaminated sediments are now disposed of in isolated containment areas. In 1992, USACE was authorized to beneficially use dredge material for environmental improvement. Today about 20 to 30 percent of port and waterway dredged material is used for habitat creation and other beneficial use. But dredging also has had some persistent effects, including some unavoidable take of imperiled species (e.g., sea turtle take is about 35 per year) and damage to shallow-water estuarine ecosystems. Deepening coastal navigation channels can also favor destructive saltwater intrusion into freshwater ecosystems and domestic water supplies.

With respect to operations, future emissions of potentially harmful materials into air and water, including green house gasses, also are a significant environmental concern. Because harbors concentrate transportation system operations in densely populated areas, they remain a significant source of air quality degradation and inequitable impact on low income and minority

[3] Please see the main report for *U.S. Port and Inland Waterways Modernization: Preparing for Post-Panamax Vessels,* Chapter 4: Environmental Impacts of Capacity Expansion, for references.

groups (which is inconsistent with Federal policies pertaining to environmental justice). Trucks contribute much more than any other mode to atmospheric emissions. In general, relying more on oceanic shipment by large vessel and inland shipment by train and waterway in place of truck transport is preferred because trucks are so much less fuel and emissions efficient. Ports have made improvements to reduce emissions and are planning more, consistent with social concerns. As freight transport operations increase, accidents may increase. Accidental collision of whales and other marine mammals with vessels approaching and leaving ports has been a significant mortality source, but may moderate with recent speed restrictions. Potential oil and other contaminants spills are associated with all modes.

Potential Regional Impact Differences

Past vulnerabilities and adverse impacts revealed in the transportation system footprint of ports and harbors informed selection of 11 indicators of potential impact, which was assessed regionally. These indicators reveal the potential for somewhat greater environmental impact in the Southeast Atlantic Region and, to less extent, in the Pacific Region. Freight transport is expected to grow most rapidly in those regions because of high regional population growth rate. In the Southeast, more harbor expansion is needed to accommodate the largest vessel sizes. In addition, in the Southeast Atlantic Region environmental impact mitigation may be more costly because of greater wetland and endangered species vulnerability. In the Pacific Region mitigation may be more costly due to greater vulnerability of economically important water resource use and low income and minority communities. The Northeast Atlantic Region was ranked lowest because it has the slowest population growth, the greatest amount of unused port capacity, and the least vulnerability to loss of wetlands, parks and other preserves, and threatened and endangered species. The Gulf Region was not ranked quite so low because of its high regional population growth rate, less unused port capacity and greater vulnerability to wetland and endangered species losses.

> "Factoring in environmental and public health costs needs to be part of the decision making process at every step in order to ensure future sustainability of our ports, our coastline, and our population."
>
> –Environmental Defense Fund

The effects of Panama Canal expansion have the potential to redistribute some freight transport growth from Pacific Coast ports to Southeastern ports, raising their impact level as increased impact at Pacific ports fall somewhat. The canal expansion may also favor more transport of grains and soybeans on the Upper Mississippi and Illinois Rivers, increasing the need for lock maintenance. Adverse impacts from possible lock rehabilitation are expected to be minor except for the potential need to mitigate unavoidable loss of riparian wetlands. Some positive effects on air emissions are expected because of less time needed in lock transit.

Adaptive management is a wise strategy to use for future modernization, given the uncertainties held in future modernization actions and mitigation costs, which depend on specific locations, types of actions taken and other unknowns.

Non-Financial Considerations

There are many non-financial factors to be considered when modernizing the Nation's navigation infrastructure:

- A modernization strategy should be part of a national transportation strategy that considers multi-modal connectivity and capacity of the intermodal freight transportation corridors. This would necessitate consistency with other Federal programs such as DOT Tiger Grants.
- Navigation infrastructure modernization will have environmental impacts that will most likely require impact avoidance or replacement of lost environmental quality. Total avoidance of impact may be indicated where the effects are of such national significance that development of transportation infrastructure at the proposed site should not be supported at the Federal level.
- Opportunities to contribute to the Administration's initiative to increase exports, energy independence and enhance national security should be considered.
- Local sponsor commitment in terms of cost sharing and community support should be taken into consideration.
- Consideration should be given to ports that facilitate traffic to multiple regions of the country as opposed to serving only a local catchment area.
- When infrastructure projects are planned, designed and implemented, they should explicitly include the concept of adaptive management (i.e., the identification of sequential decisions and implementation based on new knowledge and thresholds) within a risk management framework.

Who Benefits?

Who benefits from deep water port and inland waterways maintenance and enhancement? The use of larger ships will provide economies of scale to the ocean carriers. These cost savings might be shared with the shippers, the producers and, ultimately, with consumers.

However, it should be noted that the portion of traffic transiting the Panama Canal will also benefit the Panama Canal Authority (ACP). In fact it may be possible for the ACP, through its toll structure, to extract a majority of the benefits on routes that use the canal, limiting the cost savings associated with the use of larger vessels through the canal that will be available to

carriers, shippers, producers or consumers. A careful understanding of this is required when choosing which ports to deepen and how to finance the project.

Ports could benefit from increased freight moving through them. As noted, reduced costs for an all-water route from Asia to the East Coast could cause a shift of some market share from the West Coast ports to the East Coast. However, given the expected overall increase in trade, it is not a zero sum game and it is possible that even if West Coast ports were to lose some market share, they will still see an increase in cargo moving through their ports. Moreover, West Coast ports and their rail partners are investing heavily to increase the capacity and efficiency of the intermodal land bridge to ensure it remains competitive and retains market share.

Transshipment might offer some cost savings to cargo headed for ports that are not *post-Panamax* ready. However, transshipment hubs add time and extra handling, costs that may exceed the benefits of using a larger vessel.

The opportunities for reduced costs available to U.S. agricultural exporters through the use of larger bulk carriers are also available to their competitors in international markets.

What seems certain is that some mix of these impacts will be realized gradually over time as market participants gain better certainty of the options they face.

Additional Thoughts

A modernization strategy should be part of an overall national intermodal freight transportation strategy. While the three dominant freight carrier modes – water, rail and truck – compete for market share, there is a growing recognition of the need for multi-modal linkages and for infrastructure investments to be coordinated across the modes to ensure that they complement each other and ensure the best overall use of the available funds for the Nation. This can be supported by prioritizing navigation investment according to their multi-modal connectivity. On March 1, 2012 USACE signed a Memorandum of Understanding with the Department of Transportation on collaboration with a purpose to identify and capitalize on opportunities to improve the Nation's transportation infrastructure investments where shared equities exist.[4]

A national intermodal freight transportation strategy could also consider local sponsor commitment in terms of cost sharing and community support. Opportunities to contribute to the Administration's initiative to increase exports, energy independence and enhance national security must be considered.

[4] See appendix C for a copy of this MOU.

Report Observations and Findings

The main observations and findings of the report are as follows:

- World trade and U.S. trade is expected to continue to grow.
- *Post-Panamax* size vessels currently call at U.S. ports and will dominate the world fleet in the future.
- These vessels will call in increasing numbers at U.S. ports that can accommodate them.
- Along the Southeast and Gulf coast there may be opportunities for economically justified port expansion projects to accommodate *post-Panamax* vessels.
    - This is indicated by an evaluation of population growth trends, trade forecasts and an examination of the current port capacities.
    - Investment opportunities at specific ports will need to be individually studied.
- The potential transportation cost saving of using *post-Panamax* size vessels to ship agricultural products to Asia, through the Panama Canal may lead to an increase in grain traffic on the Mississippi River for export at Gulf ports.
    - An analysis indicated the current Mississippi River capacity is adequate to meet potential demand if the waterways serving the agricultural export market are maintained.
    - A need for lock capacity expansion is not indicated.
- Despite the uncertainty in market responses to the deployment of *post-Panamax* vessels and the expansion of the Panama Canal, individual investment opportunities for port expansion can be identified using established decision making under uncertainty techniques. Adaptive management techniques can also be used to address uncertainty issues. Preliminary estimates indicate the total investment opportunities may be in the $3-$5 billion range.
- Environmental mitigation costs associated with port expansion can be significant and will play an important role in investment decisions.
- The primary challenge with the current process to deliver navigation improvements is to ensure adequate and timely funding to take advantage of potential opportunities.
    - A notional list of financing options is presented to initiate discussion of possible paths to meet this challenge—it is anticipated that a variety of options may be desirable, and in all cases individual project characteristics, including its economic merits, would need to be considered in selecting the optimal financing mechanisms.

Introduction

The United States, its navigation industry and the customers it serves face a potential opportunity. The continued expansion of international trade combined with the building of ever larger ships is reducing ocean transportation costs. However, the extent to where these larger vessels will call at U.S. ports will depend on many factors, including the strategic decisions made by the industry and the Nation, as well as decisions made by the Panama Canal Authority and other parties.

The Committees on Appropriations of the Congress have asked the U.S. Army Engineer Institute for Water Resources (IWR) to submit a report on "how the Congress should address the critical need for additional port and inland waterways modernization to accommodate *post-Panamax* vessels." This report identifies the needs and presents options for meeting the infrastructure needs for U.S. ports and inland waterways.

Post-Panamax vessels will call at U.S. ports in increasing number, either across the Atlantic or through the Panama Canal. How will this affect trade to the U.S., especially along the East and Gulf Coasts? To understand this, we first need to understand that some U.S. ports are already able to accommodate these vessels and others will soon be able to do so. We then need to consider the condition and capacity of some of our other major ports, in order to understand why they do not and will not soon be able to accommodate these vessels. Finally, we will need to consider the condition and capacity of the multi-modal infrastructure that supports cargo movements to and from all of these ports.

There is uncertainty concerning the way in which markets will respond to the deployment of *post-Panamax* vessels. However, with a general picture of the current condition and capacity of our major ports and the multi-modal infrastructure that serves them we can begin to understand the extent to which these vessels may provide an opportunity for further investment, so that options can be developed to move forward.

Given the time available to complete this report, IWR relied on currently available data and could not assess impacts through techniques such as the analysis of specific economic and environmental impacts or the economic modeling of alternative future scenarios.

Congressional Direction

Conference language from Public Law 112-74, the Consolidated Appropriations Act of 2012 (H.R. 2055): Within the funds provided, the Institute for Water Resources is directed to submit to the Senate and House Committees on Appropriations within 180 days of enactment of this Act, a report on how the Congress should address the critical need for additional port and inland waterway modernization to accommodate post-Panamax vessels. This study will not impede nor

delay port or inland waterway projects already authorized by Congress. Factors for consideration should include costs associated with deepening and widening deep-draft harbors; the ability of the waterways and ports to enhance the nation's export initiatives benefiting the agricultural and manufacturing sectors; the current and projected population trends that distinguish regional ports and ports that are immediately adjacent to population centers; the availability of inland intermodal access; and the environmental impacts resulting from the modernization of inland waterways and deep-draft ports.

About the Study Author

The U.S. Army Engineer Institute for Water Resources is a field operating activity under the staff supervision of the Deputy Commanding General for Civil and Emergency Operations and the Director of Civil Works, Headquarters, U.S. Army Corps of Engineers. The Institute is the USACE knowledge center for integrated water resources management (IWRM) and is specifically recognized as a national expertise center for planning methods, risk analysis, hydrologic engineering, conflict resolution and public participation, international water resources, global climate change science, and the collection, management and dissemination of Civil Works and navigation information, including the Nation's waterborne commerce data.

IWR was established by the USACE Chief of Engineers in 1969 with the approval of the House and Senate Appropriations Committees and the Subcommittees on Public Works in order "to enhance the capability of the Corps of Engineers to develop and manage the Nation's water resources, within the scope of the Corps' responsibilities, by developing essential improvements in planning to be responsive to the changing concerns of our society."

The Institute's mission is to facilitate the adaptation of the Civil Works program to future needs by providing USACE with the capability for developing forward-looking analysis and state-of-the-art methodologies. IWR fulfills this mission by supporting the Civil Works Directorate and USACE Major Subordinate Commands (MSCs) and District offices by providing: (a) analysis of emerging water resources trends and issues; (b) state-of-the-art planning, hydrologic engineering and risk assessment methods, models, training and custom applications; and (c) national data management of results-oriented program and project information across Civil Works business lines.

The Institute is a member of the Federal Laboratory Consortium for Technology Transfer (FLC), a nationwide network of over 250 Federal institutions chartered by the Federal Technology Transfer Act of 1986. IWR also has a cooperative relationship with the National Institutes for Water Resources (NIWR), which represents 54 state and U.S. territorial university-based water centers through the U.S. Department of the Interior and U.S. Geological Survey (USGS). The FLC and NIWR provide USACE with the framework for developing technology transfer strategies and opportunities by promoting and facilitating technical cooperation in cooperation with USACE Districts and expertise centers and among Federal laboratories, industry, academia, and state and local governments.

What Is Navigation Infrastructure?

For this report, the term navigation infrastructure refers to the basic facilities required for safe and efficient vessel movement and handling. This infrastructure includes:

For coastal ports

- channels (including harbor entrance channels, port channels, ocean-route canals and connecting channels)
- turning basins
- navigation jetties
- dredge material placement facilities
- berthing facilities (docks, dredged berths and anchorage areas)
- aids to navigation (channel buoys, global GPS, AIS and updated charts)

For inland waterways

- channels
- locks and dams
- channel training structures
- dredged material placement facilities
- tow marshalling areas
- berthing facilities (docks, dredged berths and anchorage areas)
- aids to navigation (channel buoys, global GPS, AIS and updated charts)

These lists are not exhaustive but are generally representative of the facilities included in navigation infrastructure. Other infrastructure, such as cranes, storage yard space and intermodal transfer connections are critical to the efficient movement of cargo, but are not considered navigation infrastructure.

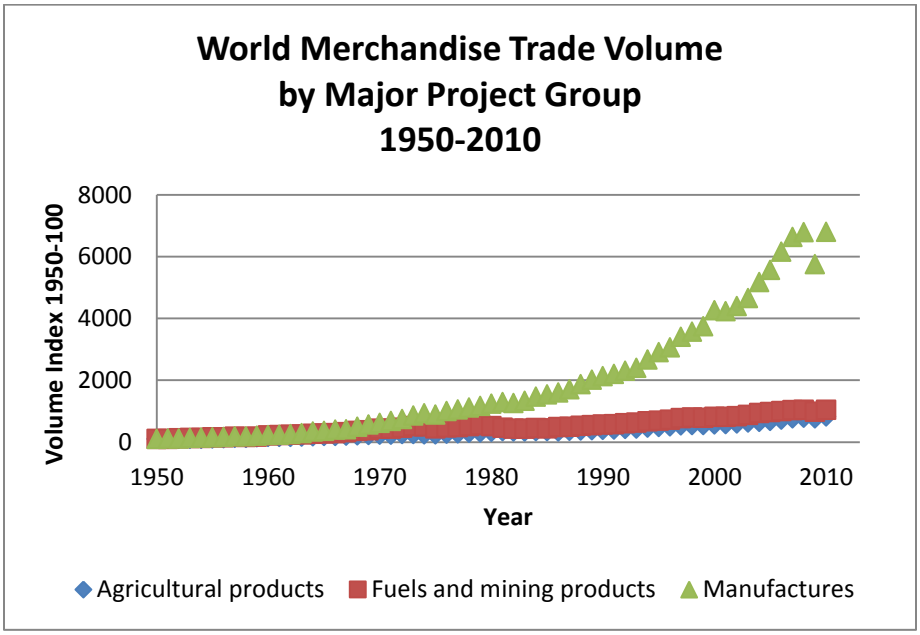
Acknowledgement

IWR thanks the U.S. Department of Transportation, Maritime Administration (MARAD) for their selfless cooperation and sharing of their work.

Chapter 1: Discussion of Demand for Future Capacity

The demand for future capacity within the U.S. freight transportation system is dependent on the volume of future trade. Transportation service is often referred to as a derived demand because it is the demand for goods and services that creates the demand for trade and, thus, for transportation services. For example, the level of world trade determines the demand for international transportation services.

The history of world trade has generally been one of expansion. The volume of world trade has increased about 100 fold (Figure 1) since 1950 according to the World Trade Organization.[5] Trade in agricultural products increased at an average annual rate of 3.6 percent between 1950 and 2011, fuels and mining products at 4.0 percent and manufactures at 7.3 percent. As populations and incomes increase globally, the opportunity and desire for trade expands. In this broad sense, the future is expected to look like the past.



Source: World Trade Organization; International Trade Statistics. 2011

Figure 1: World Merchandise Trade Volume

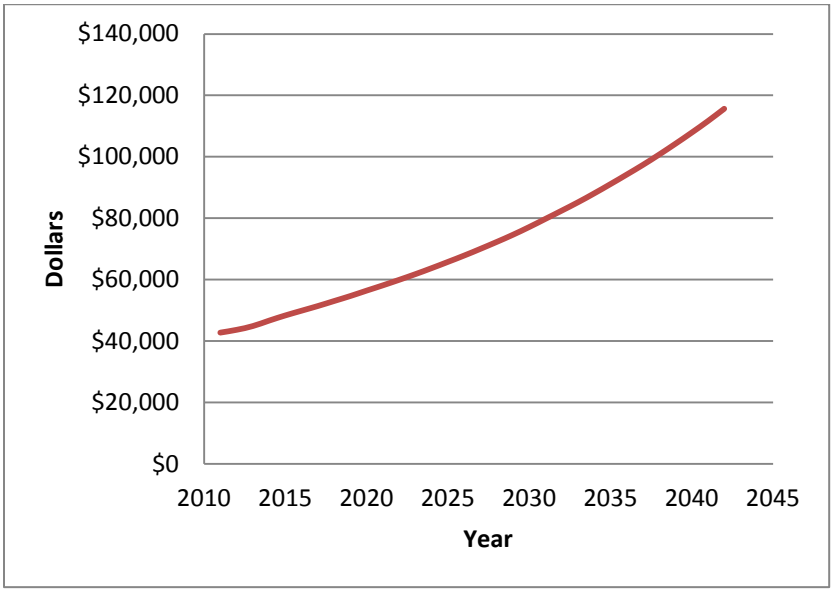
U.S. Population and Income

While global population and income expand world trade, population and income within the U.S. also influence trade volumes and patterns. The overall forecasts of U.S. income and population indicate support for increased demand for transportation services.

[5] World Trade Organization. 2011. International trade statistics.

Projections for Increases in U.S. Income Are Dramatic

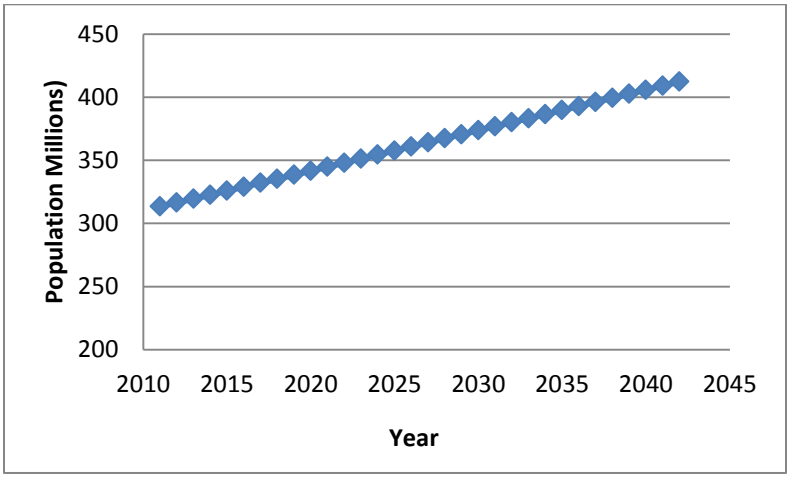
Figure 2 illustrates the expected growth in U.S. per capita income. From a base of $42,800 in 2011, per capita income is expected to increase 170 percent to $115,600 by 2042.



Source: Based on data from IHS Global Insight 2012

Figure 2: U.S. Per Capita Income Forecast 2011-2042

The U.S. population is expected to increase 32 percent from 313.4 million people in 2011 to 412.2 million in 2042, as shown in Figure 3.[6]

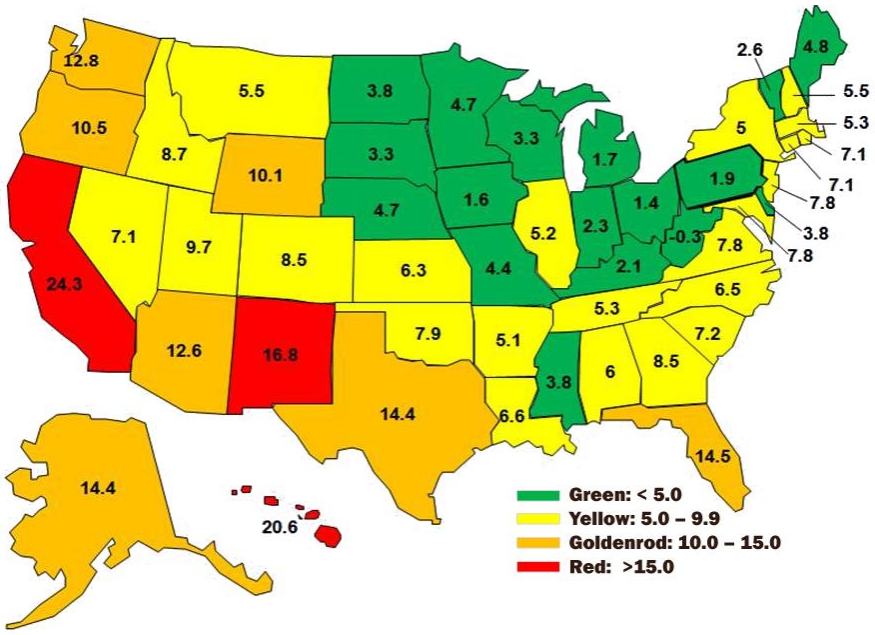


Source: Based on data from IHS Global Insight 2012

Figure 3: U.S. Population Forecast 2011-2042

[6] The U.S. Economy, The 30-Year Focus. 2012. IHS Global Insight, First Quarter 2012.

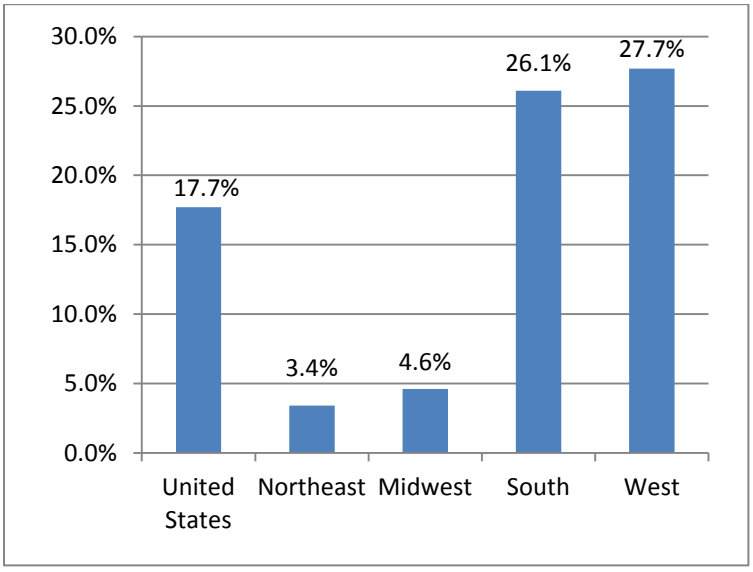
However, this growth in the U.S. is not expected to be evenly distributed geographically. It is predicted that the prevailing trend of population shifts to warmer, urban areas will continue over the next several decades. The growth in demand for transportation infrastructure and services will be greatest in those areas of the U.S. with the highest population growth.



Source: U.S. Census Bureau; Projections of the Total Population of States, 1995 to 2025

Figure 4: U.S. Population Growth by State 2015-2025

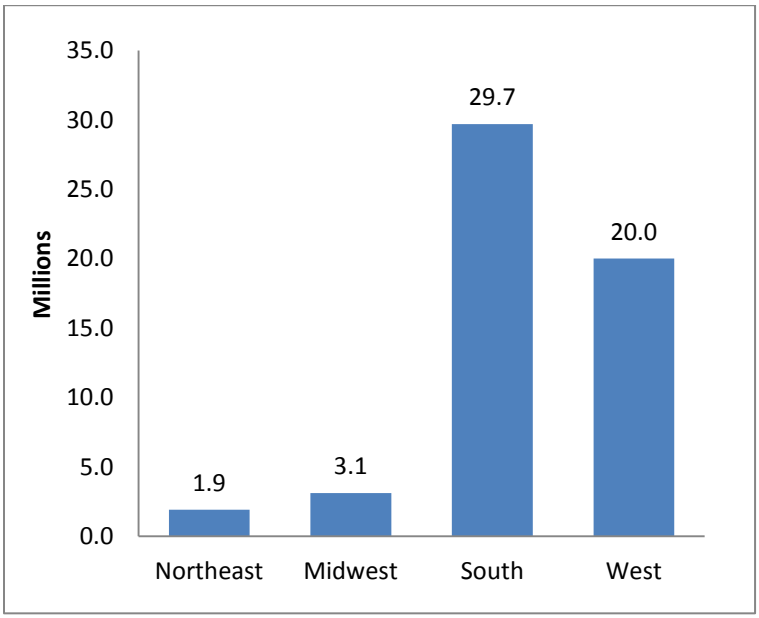
Figure 4 shows the percent population growth by state forecast by the U.S. Census Bureau between 2015 and 2025. Figure 5 shows percent growth projections by U.S. region and Figure 6 shows the forecast numerical change in population by region.



Source: U.S. Census Bureau, Population Division; 2005 Interim State Population Projections

Figure 5: Percent Change in Population by Region of U.S. 2010-2030

Each of these forecasts indicates greatest population growth in the West and South. Since change in demand for transportation services follows change in population, it follows that the largest growth in demand for future transportation services will be in the West and South.



Source: U.S. Census Bureau, Population Division; 2005 Interim State Population Projections

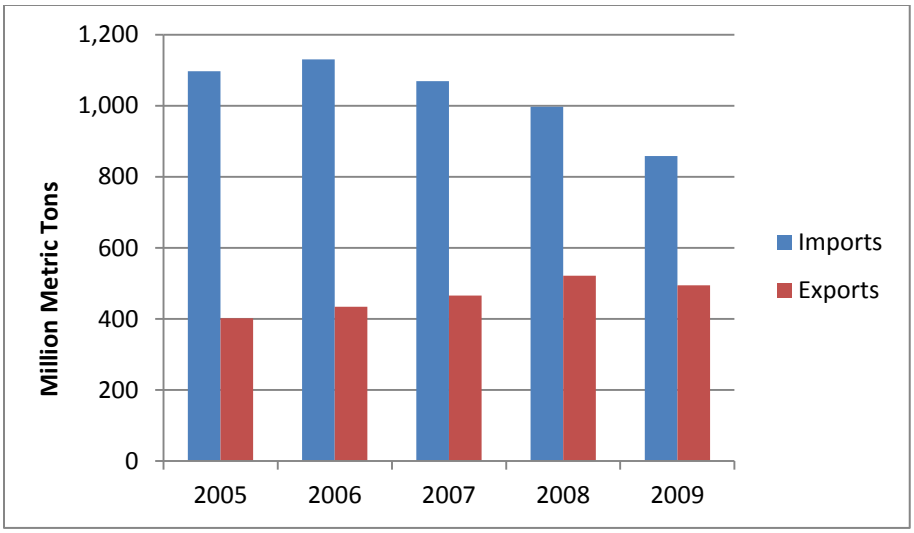
Figure 6: Change in Population by U.S. Region 2010-2030

U.S. Historical Commodities and Composition

U.S. Historical Trade

A look at historical U.S. trade adds perspective to the forecasts. In 2010 U.S. foreign water trade totaled 2.34 billion short tons[7]. Figure 7 shows the total U.S. imports and exports for a 5-year range. Petroleum products make up over half of all U.S. imports with respect to tonnage. Imports declined between 2006 and 2009 due to the U.S. economic recession. Exports increased between 2005 and 2008. Exports decreased slightly in 2009 reflecting the global economic downturn.

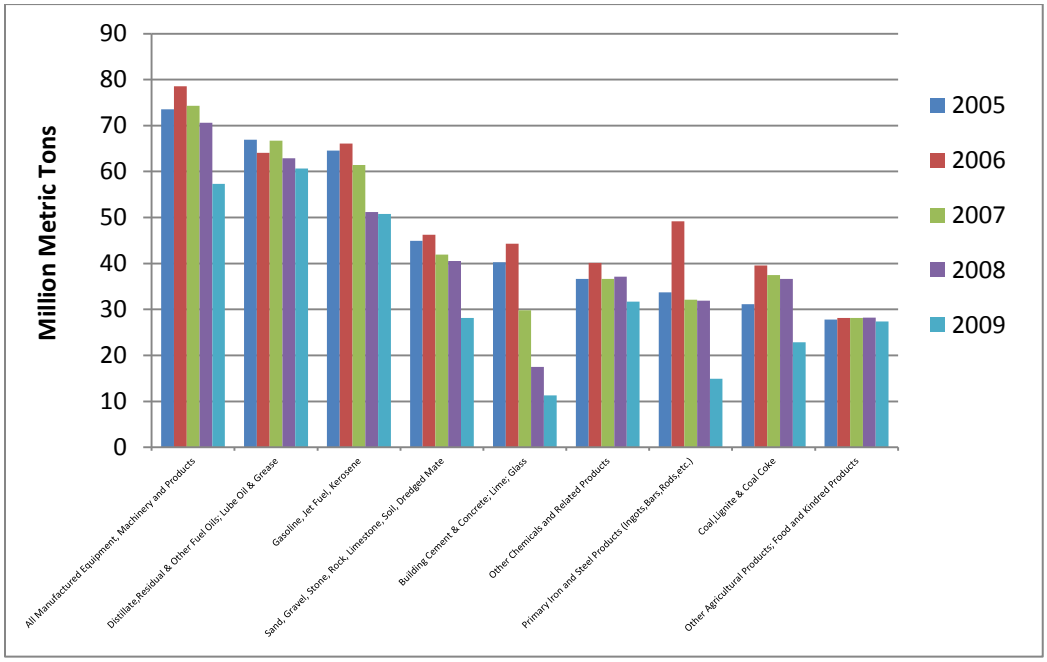
[77] Waterborne Commerce Statistics Center, Transportation Facts and Information, 2011.



Source: USACE Institute for Water Resources, Waterborne Commerce Statistics Center

Figure 7: Total U.S. Imports and Exports, Historical

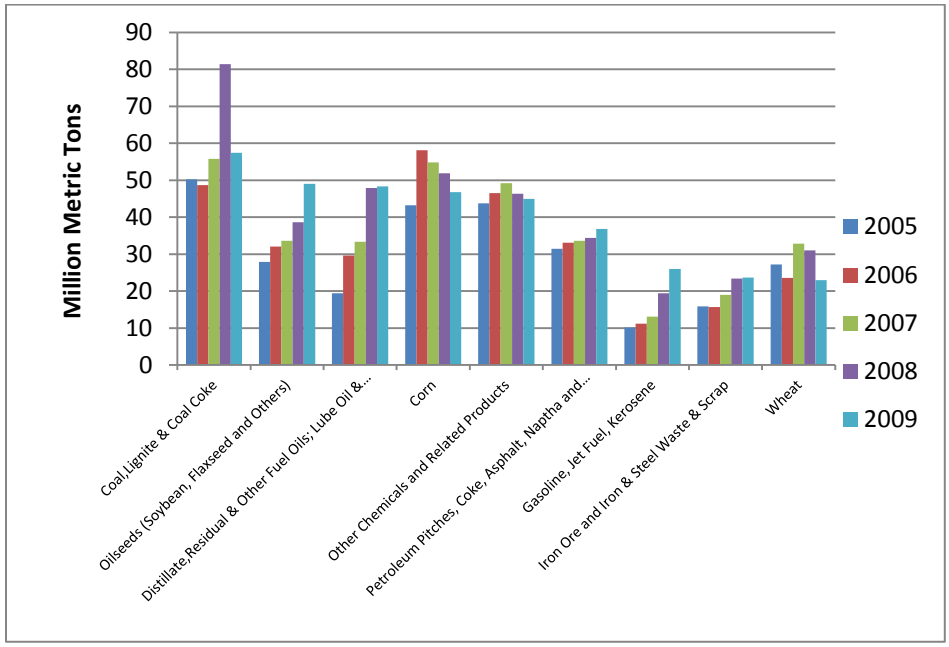
It is clear that while exports grew over the five-year period, imports appear to have been impacted by a series of events in the U.S. and abroad. Significantly impacted were commodities such as building cement, iron and steel, which have decreased more than 50 percent from their peak of the housing boom in 2006. Figure 8 shows U.S. imports by commodity type for the years 2005-2009.



Source: USACE Institute for Water Resources, Waterborne Commerce Statistics Center

Figure 8: U.S. Imports by Commodity Type 2005-2009

Figure 9 illustrates selected U.S. exports for the years 2005-2009 by commodity type. These exports represented the largest exports by volume based on 2009 tonnages. As shown, exports were dominated by coal products in 2009. While imports were clearly impacted by recessionary pressures, exports were affected less so. As a whole exports increased 23 percent from 2005 through 2009.

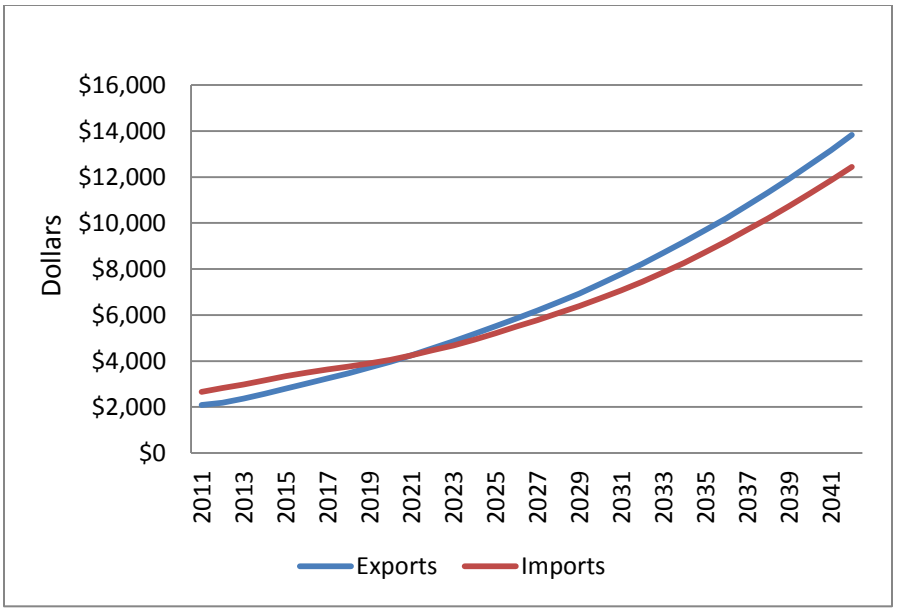


Source: USACE Institute for Water Resources, Waterborne Commerce Statistics Center

Figure 9: Selected U.S. Exports by Commodity Type 2005-2009

Trade Forecast

IHS Global Insight (IHS-GI) has forecast U.S. imports and exports through 2042. Imports are expected to grow from $2,666 billion in 2011 to $12,444 billion in 2042. Exports are projected to increase from $2,088 billion to $14,831 billion over the same time period. Exports are forecast to exceed imports beginning in 2022 (Figure 10).

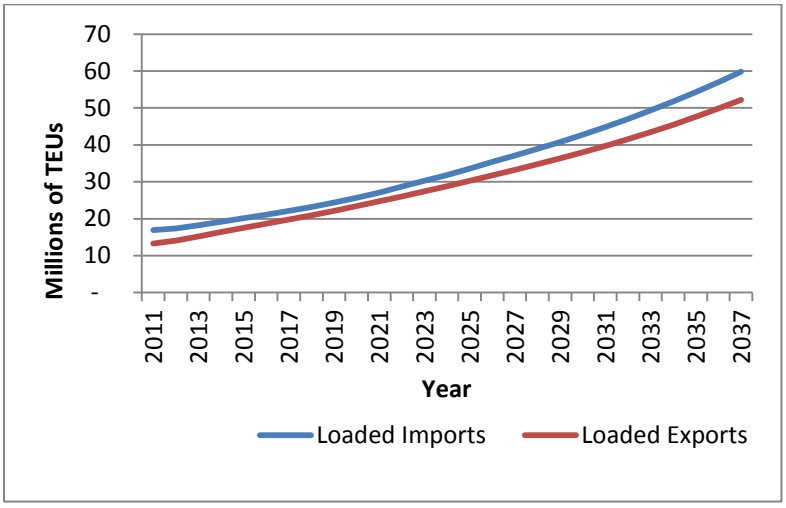


Source: IHS Global Insight, The U.S. Economy, The 30-Year Focus, First Quarter 2012

Figure 10: Forecast of U.S. Trade 2011-2042

Forecast and Containerized Cargo

IHS-GI forecasts for bulk and containerized trade is presented in Figure 11. Figure 12 indicates TEU imports increasing from about 17 million to 60 million from 2011 to 2037.[8] Exports are shown to increase from 13 million to 52 million containers over the same time period.



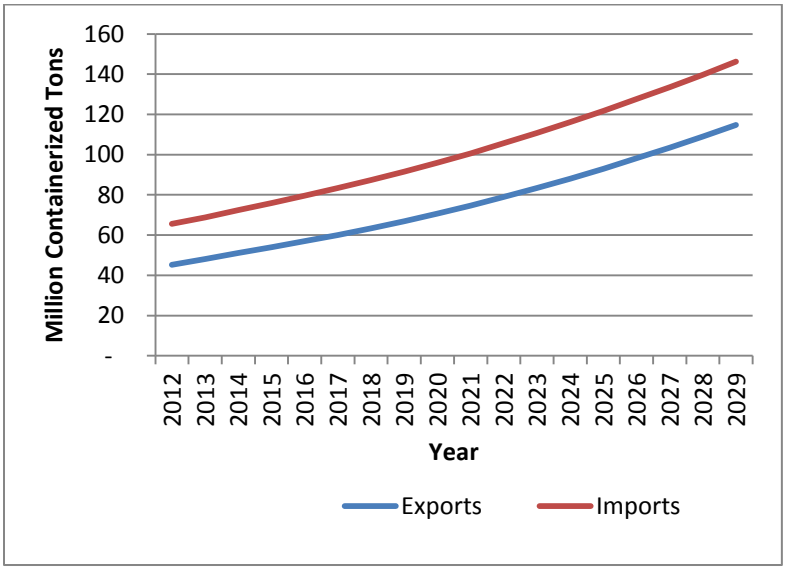
Source: IHS Global Insight

Figure 11: U.S. Forecast Import and Export TEUs 2011-2037

[8] TEU or **twenty-foot equivalent unit** is an inexact unit of cargo capacity often used to describe the capacity of container ships and container terminals. Actual containers vary in length from 20 to 53 feet.

Regional Breakdowns

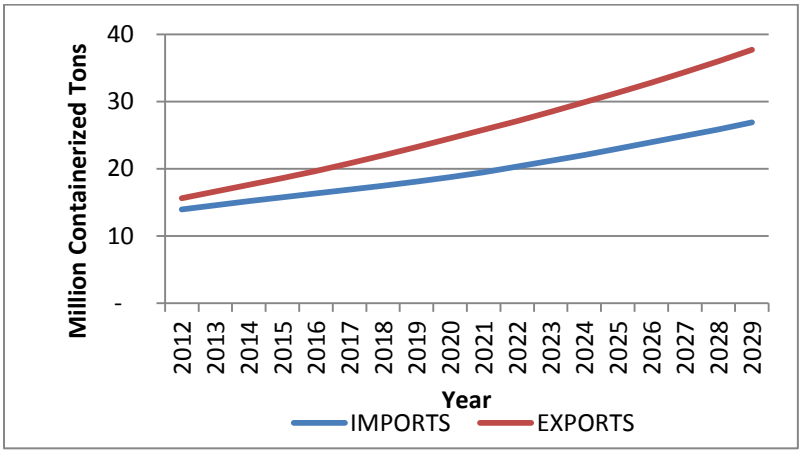
Several regional forecasts were available to this study. Two from IHS-GI represented the East and Gulf Coast forecast of containerized tons. One from the Tioga Group focused on San Pedro Bay. One from MSI forecast total East Coast TEU traffic. Figure 12 shows containerized tons on the East and Gulf Coasts through 2029. On the East Coast, import and export tonnage is expected to grow from 65.66 million tons to 146.3 million tons, an increase of 123 percent by 2029.



Source: IHS Global Insight

Figure 12: East Coast Containerized Imports and Exports 2012-2029

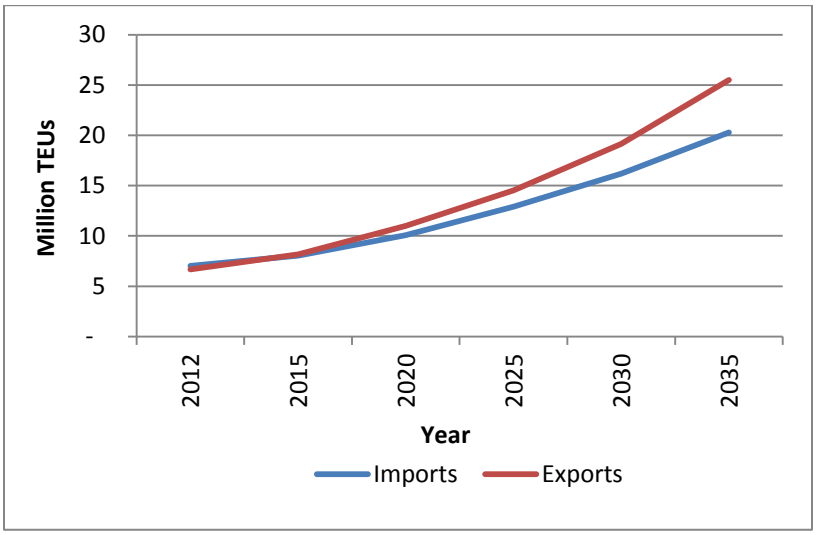
Figure 13 illustrates that Gulf Coast containerized tonnage is expected to grow from 29.6 million tons to 64.6 million tons, an increase of 118 percent by 2029.



Source: IHS Global Insight

Figure 13: Gulf Coast Containerized Imports and Exports 2012-2029

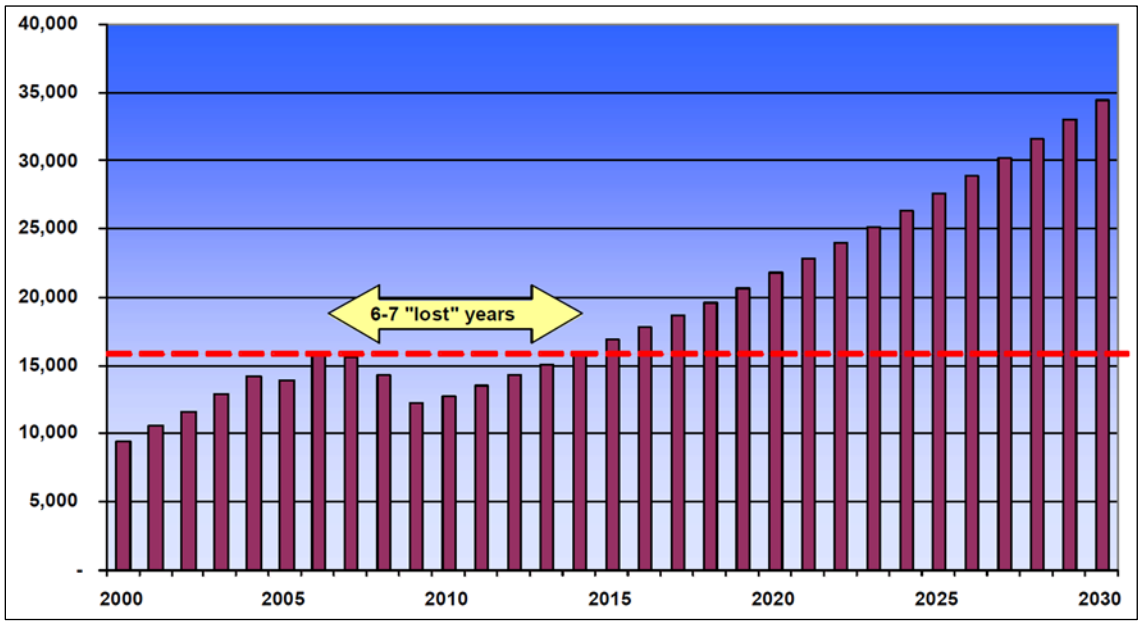
The MSI TEU forecast from 2010 to 2035 is shown in Figure 14. Movements of TEUs through East Coast ports are expected to triple from the current 15 million TEUs to about 45 million TEUs in 2035.



Source: MSI

Figure 14: East Coast Forecast TEUs 2012-2035

A forecast for San Pedro Bay TEU traffic, which is representative of West Coast trends, was obtained from the Tioga Group (Figure 15). This forecast was completed prior to the economic downturn of 2008 and then subsequently updated. The adjusted forecast shows traffic rebounding to historical levels by 2013 and projects growth to 36.7 million TEUs by 2030.



Source: Tioga Group; San Pedro Bay Container Forecast Update

Figure 15: San Pedro Bay TEU Forecast 2010-2030

Maritime Transportation Technology

Transportation Infrastructure and Global Trade

Global trade is encouraged by trade policies that act to remove barriers and protections for domestic producers. Seaborne trade linking continental land masses (e.g., Asia and North America) benefits from continuing advances in oceangoing vessel efficiencies and supporting infrastructure.

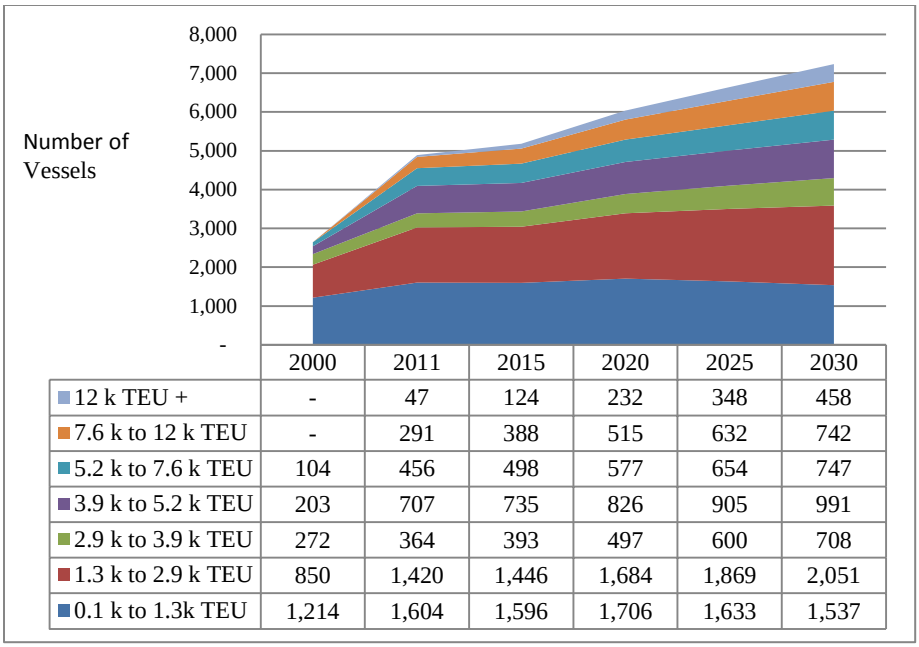
In the U.S., this infrastructure includes port facilities, port channels, ocean-route canals and connecting channels, highway and rail connections to ports, and overland and waterway feeder systems and line routes. Any inefficiencies in this transportation system act as a damper on U.S. exporters' abilities to realize the full potential of the export market and the vessels engaged in that trade.

World Vessel Fleet

The composition of today's world vessel fleet and what portion of that fleet calls at U.S. East, West and Gulf Coast ports is a basis for understanding how the fleet is changing and the ramifications that changes in fleet composition could have on U.S. ports. Vessels can be characterized by type and size. Shippers and carriers are using larger ships in global trade to gain transportation efficiencies and cost savings, which have enormous importance in this very competitive market. The larger containerships, tankers and bulk commodity vessels are currently in excess of 1,000 feet long, more than 125 feet wide and can draw in excess of 50 feet of water. The world vessel fleet is not static. Every year new ships are built and added to the fleet.

Containerships

Containerships are cargo ships that carry their load in containers measured in Twenty-Foot Equivalent Unit (TEU) "boxes." Since the inception of containerized cargo in the 1950s, the container shipping industry has continued to evolve toward greater efficiency. Greater efficiency means moving more loaded boxes per voyage, which in turn creates incentives to build even larger vessels. However, there are constraints to increased vessel sizes. Perhaps the most obvious constraint is the size of the Panama Canal, which is currently undergoing an expansion. *Post-Panamax* vessels exceed 5,200 TEU.



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

Source: MSI

Figure 16: Historical and Forecast Fully Cellular Container by TEU Band 2000-2030

According to the *Journal of Commerce*, half of containerships on order exceed 10,000 TEU capacities. Vessels of 10,000 TEUs and over accounted for 48 percent of the order book as of October 2011. It is evident that large ships are displacing smaller ships in all trade routes due to cost efficiencies of larger ships, which leads to a growth in average container vessel size over time. In 2000, the average container vessel size was 2,900 TEUs. In 2012, the average vessel size has grown to 6,100 TEUs. Figure 16 depicts this increase in size and number of larger vessels that make up the world fleet.

While the number of *post-Panamax* vessels projected for 2030 is only 30 percent of total vessels, Table 1 demonstrates they will represent 62 percent of the total TEU capacity of the container vessel fleet at that time.

Table 1: Unconstrained Forecast of TEU Capacity as a Percent of Total by TEU Band 2012-2030

Vessel Size	2012	2015	2020	2025	2030
0.1 k TEU to 1.3k TEU	8%	6%	6%	5%	4%
1.3 k to 2.9 k TEU	18%	15%	14%	13%	12%
c 2.9 k to 3.9 k TEU	7%	6%	6%	7%	7%
d 3.9 k to 5.2 k TEU	21%	19%	17%	15%	14%
e 5.2 k to 7.6 k TEU	19%	18%	17%	16%	15%
f 7.6 k to 12 k TEU	17%	20%	20%	21%	21%
g 12 k TEU +	9%	15%	20%	24%	26%
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Note: post-Panamax vessel bands shaded in gray
Source: MSI

Bulk Carriers

A bulk carrier is specially designed to transport unpackaged bulk cargo such as grains, coal, ore and cement. The current trend is to "light load" bulk vessels at New Orleans for vessels that serve export markets via the Panama Canal. These vessels do not currently fill to their full capacity due to draft restrictions at the Panama Canal. For vessels with a 45 foot design draft, which currently light load to 39.5 feet, transportation cost savings have been estimated to be $0.04 per bushel of grain for foreign flag vessels.[9] It is expected that these vessels would be able to fully load after the Panama Canal expansion. "Small" *Capesize* vessels (80,000+ Dead Weight Tons (DWT)) will be able to fit through the expanded canal. They will be capable of redeployment to serve the U.S. export market.

Like containerships, bulk carriers on order are also trending to larger sizes. Ship designers are working on new *Panamax* vessel designs to maximize the capacity and efficiency of the expanded canal. Table 2 shows the world bulk vessel fleet and the order book in 2010. Capacity growth is greatest in the *post-Panamax*, *Capesize* and *Very Large Ore Carryer* (VLOC) vessel classes. The *post-Panamax* fleet is expected to increase by 153 percent, the *Capesize* vessel class by 83 percent and the VLOC by 109.8 percent.

[9] USACE Institute for Water Resources

Table 2: Bulk Vessel Fleet and Order Book – 2010

Type of Vessel	Size (dwt)	Current Fleet		On Order		% Change of Fleet Capacity
		No. of Vessels	Capacity (mdwt)	No. of Vessels	Capacity (mdwt)	
Handysize	10,000-40,000	2,636	72.0	793	25.9	35.4%
Handymax	40,000-60,000	1,801	89.2	884	50.4	55.9%
Panamax	60,000-80,000	1,408	101.1	273	20.3	20.2%
Post-Panamax	80,000-110,000	311	27.7	461	40.5	153.0%
Capesize	110,000-200,000	793	131.0	625	107.0	83.0%
VLOC	200,000+	172	41.4	151	43.8	109.8%
Total		7,121	462.4	3,187.0	287.9	62.7%

Note: million deadweight tons (mdwt)

Source: U.S. Department of Agriculture and U.S. Department of Transportation; Study of Rural Transportation Issues. April 2010

The Panama Canal expansion offers an example of the effect that larger vessels and lower ocean rates can have on shipper opportunities. Informa Economics, Inc. estimates that the larger, more efficient *Cape* class ships reduce the cost of the movement of grains to northeast Asia by an all-water Panama Canal route by $0.31 to $0.35 per bushel of grain.[10] Delay times through the Canal will also be reduced – an additional benefit for bulk commodities that could not justify paying fees for reserving slots in the current canal. In fact, any infrastructure improvement that allows ports to take advantage of the larger global fleet enhances the competitive position of that port relative to other ports, and vessel efficiencies can be expected to have the same impact on other dry bulk commodity rates. This is significant to coal producers, the other dry bulk commodity exported in volume by the U.S.

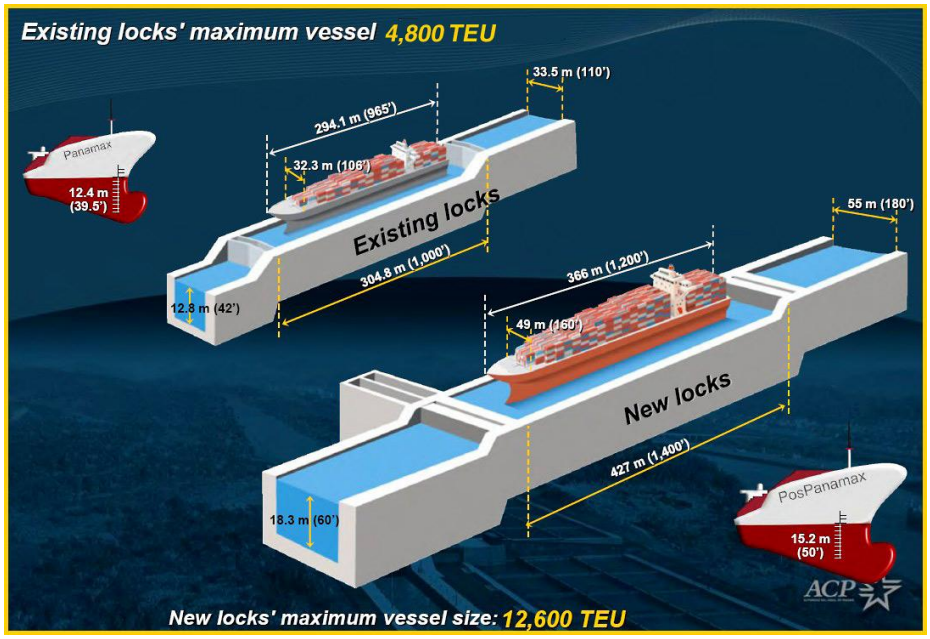
Panama Canal Expansion

The Panama Canal is set to double its cargo throughput capacity when it completes expansion plans in 2014. The new locks will move vessels large enough to carry three times the volume of what can move through the canal today, although the existing locks will remain *Panamax* limited. More efficient and larger vessels passing though the canal are expected to impact markets, although these impacts will depend on the structure and level of the Panama Canal fees and a variety of other factors. If there is a significant reduction in the cost of the water route as a result of going through the canal, some freight traffic may shift from calling at West Coast ports to calling at East Coast ports. Figure 17 shows the change in lock size of the Panama Canal expansion. Figure 18 shows a selected Asia to U.S. East Coast service route.

If ships transiting the Panama Canal are too large to call at East Coast or Gulf Coast ports, a transshipment service in the Caribbean or at a large East or Gulf Coast port may develop. A transshipment service allows the largest vessels to unload containers at the transshipment hub for reloading on smaller feeder vessels for delivery to ports with less channel capacity. These ideas are more fully explored in chapter 3.

[10] Panama Canal Expansion: Impact on U.S. Agriculture, Informa Economics, September 2011.
Note: This estimate of transportation cost savings assumes a Cape class vessel.

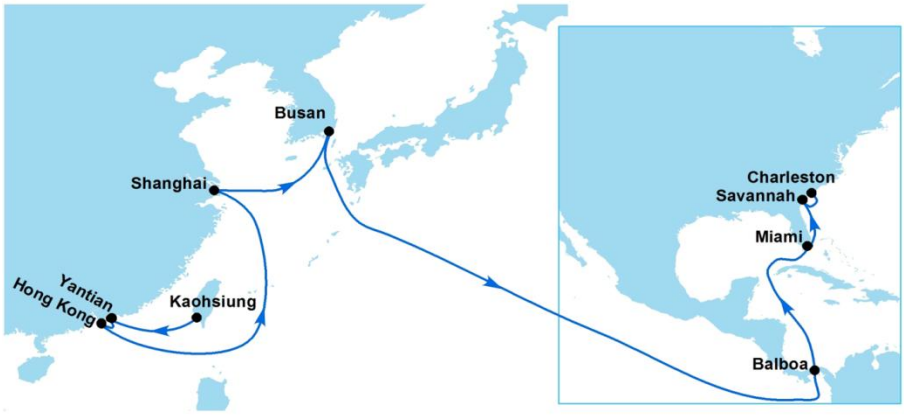
Vessels Transiting the Panama Canal 40% Longer, 64% Wider and 50 Ft Draft



Source: Panama Canal Authority, February 2011

Figure 17: Panama Canal Dimensions

Larger Vessels from the Pacific Rim Can Travel Directly to the Atlantic Coast



Source: A.P Moeller Maersk Group, 2011 Service Schedule

Figure 18: Routes from Pacific Rim to Atlantic Coast

The ability to employ larger bulk vessels could potentially lower the delivery cost of U.S. agricultural exports to Asia. This is not likely to have a significant impact on the mix or quantity of total U.S. agricultural or other commodities exported, but could have a significant impact on the mix or quantity of U.S. agricultural or other commodities moving down the Mississippi River for export at New Orleans.

However, there is uncertainty concerning the extent to which the Panama Canal expansion and the growth in average vessel size will impact trade and trade routes, but the industry is preparing for expected changes. West Coast ports and their rail partners are investing heavily now to increase the capacity and efficiency of the intermodal land bridge to ensure it remains competitive and keeps market share. While the possibility of building transshipment hubs at some ports is being explored, their use may add time and cost that may exceed the benefits of using larger vessels. The Panama Canal Authority may set its fee structure to capture the majority of transportation cost savings, which would limit the cost savings experienced by the shipper or carrier, the producer or the consumer. What seems certain is that some mix of these impacts will be realized gradually over time as market participants gain better certainty of the options they face.

Panama Canal Expansion Impacts on Vessel Fleets

There are mixed opinions regarding what kind of changes the Panama Canal expansion will bring to the fleet mix calling at U.S. ports and the routes that they follow. Shipper responses to change are affected by delivery time, reliability, capacity limits on alternative routes and volume. These variables can be linked to port facilities. Port facilities differ regionally regarding channel depths, crane capabilities and landside intermodal operations. Gulf and East Coast ports mainly distribute containers by truck, whereas West Coast distribution occurs mainly by rail. Many of the West Coast ports already provide adequate water depths to accommodate large vessels.

Experts in the shipping industry expect that once the Panama Canal expansion is complete in 2014, deployment from Asia to the East Coast will begin to closely resemble the fleet mix calling at the West Coast. IHS-GI has forecast the container fleet expected to call at East Coast ports. Table 3 shows the number of ships expected to be deployed on East Coast services through 2035. According to the forecast, in 2012, *post-Panamax* vessels are limited to trans-Atlantic trade. In 2015, with the expansion of the Panama Canal, the transition to *post-Panamax* vessels will include Asian origins. *Post-Panamax* vessels will dominate the East Coast fleet by 2020. This forecast assumes the East Coast ports have the capacity to accommodate the *post-Panamax* fleet. The actual number of vessels deployed to the East Coast and how efficiently these vessels are utilized will depend on the ports' future capacities, including channel depth and width, turning basin size, dock length and crane size.

Table 3: Forecast East Coast Container Fleet 2012-2035

	2012	2015	2020	2025	2030	2035
0.1 - 1.3 k TEU	24	11				
1.3 - 2.9 k TEU	34	12	6	4	3	3
2.9 - 3.9 k TEU	28	12	10	4	4	2
3.9 - 5.2 k TEU	140	95	78	58	42	29
5.2 - 7.6 k TEU	86	114	153	156	159	168
7.6 - 12.0 k TEU	26	61	96	155	227	322
12.0 k TEU +		3	13	42	82	136

Note: *post-Panamax* vessel bands shaded in gray
Source: MSI

Summary

Despite the recent worldwide recession, world trade is expected to increase along with population and income growth, as it has for the last 100-years. The world vessel fleet is projected to increase both in number and vessel size. The larger vessels have already begun to call at U.S. ports and will increase in number and size over time. This trend will be accentuated by the expansion of the Panama Canal.

Chapter 2: Current Capacity

Multi-Modal Transportation System

The U.S. multi-modal freight transportation system is comprised of deep-water ports, inland waterways, railways and highways. They all play a role in the movement of goods domestically and internationally.

Inland waterways, such as the Mississippi, Columbia-Snake and Ohio River systems, have the highest impact on grains, oilseeds and coal exports. Alternatively, northeast Asia is the largest export trading partner for West Coast ports.

Ocean transportation overland rail rates determine the geographic break point between making the haul by rail from the Midwest to the West Coast versus a barge haul to New Orleans along the Mississippi River System to make the lengthy ocean voyage to Northeast Asia. Oceangoing containership rates are generally stable due to negotiated rates. Bulk carrier rates are more susceptible to swings in demand, like the sudden rise caused by the growing Chinese demand for ores, coal and grain.

In recent years, *post-Panamax* vessels have started to call at U.S. ports. It is believed that the Panama Canal expansion will increase the opportunities for trade as it will enable carriers to deploy larger, *post-Panamax* vessels to its Asia-East Coast and Asia-Gulf services ports. Previously large vessel class trade with Asian markets occurred mainly at West Coast ports.

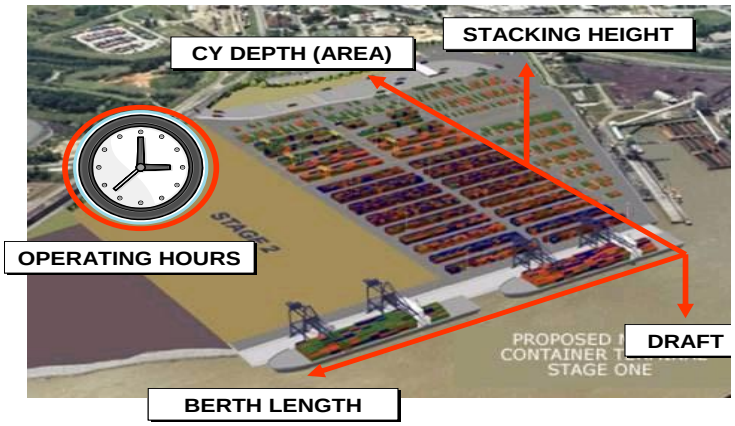
"Multi-modal" vs. "Intermodal"

Multi-modal refers to a multi-faceted transportation system, such as the one in the U.S. that encompasses deep-water ports, inland waterways, railways and highways in which freight carriers typically ship using at least two different methods of transportation but are financially liable for the cargo from start to finish.

Intermodal, on the other hand, refers to the ability to move containerized cargoes relatively seamlessly using a multi-modal transportation system; for example, moving goods in the same container from a ship to a truck or rail car.

U.S. Port Capacities

The capacity of a port broadly describes a port's ability to accommodate large volumes of cargo as well a wide variety of vessel sizes. A port's ability to handle influxes of cargo that accompany "just in time" delivery practices is critical. If, for example, a port were to approach its capacities and be unable to accommodate additional vessels or cargo, shippers may choose a different service route for their cargo.



Source: Tioga Group

Figure 19: Elements of Port Capacity

> "Just in time" delivery practices are planned to reduce the amount of time a ship is idle, thereby reducing transportation costs.

Many factors contribute to a port's ultimate capacity. Channel depth is important as it can indicate the maximum allowable sailing draft for a particular vessel (or the maximum vessel size) that could call at the port. Intermodal access, terminal space, stacking height rules, operating hours and productivity all play critical roles in moving cargo effectively and efficiently. There is little benefit to providing deeper channels if terminals do not have capacity to accommodate larger vessels. Likewise, if channels become a bottleneck, there is little benefit to expanding terminals unless channels will be improved. Therefore, a comprehensive look at both landside and waterside capacity is required.

Port Utilization

Since the advent of containerized cargo in 1956, U.S. ports have been seeking ways to accommodate larger vessels as well as provide space for an anticipated increase in containers. Physical limitations such as channel depth, storage yard space, berthing facilities, and landside productivity (i.e., container turnover rates) determine how much throughput a port can potentially handle in a given year. IWR is studying the near-term throughput capacities for a number of marine container terminals located in the U.S., several Canadian ports, a Mexican port and a potential "transshipment" port.[11]

That study will address the following questions:

- What are the near-term and long-term capacities of the major container ports in the U.S.?
- What factors constrain the capacities of these ports?
- How well is capacity currently utilized?
- How well are the major ports prepared to handle larger vessels?
- How do the smaller container ports or terminals fit into the picture?

[11] U.S. Army Corps of Engineers, Institute for Water Resources. *IWR Container Ports Capacity Report 2012 (draft).*

The preliminary conclusions of that draft study are that ports on the East and Gulf Coasts have sufficient used and unused physical capacity in the near term, particularly in the South Atlantic. The West Coast ports are closer to capacity than the East and Gulf Coast ports. Many industry observers interpreted the 2004 peak season congestion as a sign that the ports of Los Angeles and Long Beach were reaching capacity. However, that 2004 peak season congestion was followed by little or no congestion in subsequent years, in spite of increased cargo volumes; container yard capacity appears to be the most constrained.

Table 4 describes capacity metrics for major U.S. ports.[12] Values close to 100 percent would indicate a port is operating at or near capacity; low percentages often indicate capacity for growth.

- ***Container Yard/Gross Ratio*** reflects the proportion of the entire terminal that is dedicated to containers. Many U.S. ports have relatively low densities when compared with Asian and European counterparts. Asian and European terminals, however, typically devote almost all their terminal space to container yard (CY) functions and rarely have on-dock rail, chassis storage, warehousing, or other functions in the terminal acreage. As a result, Asian and European ports show much higher throughput per acre than in the U.S.

- ***Container Yard Utilization*** measures the productivity of the space dedicated to containers. It is often a function of the operating hours, crane speed and density of cargo. The figures range from a low of 14 percent in Mobile to 83 percent in the Port of Virginia.

- ***Crane Utilization*** in terms of annual TEU is relatively low, averaging 34 percent for the U.S. as a whole. This relatively low utilization might imply an excess of crane capacity. The primary purpose of crane capacity is to turn vessels quickly. Whether there is one vessel per week or five, each vessel will need two or more cranes. The terminals surveyed averaged two cranes per berth. Crane utilization is co-determined with berth and vessel utilization. A vessel is far more costly to own and operate than the cranes that serve it, so crane utilization is effectively sacrificed to vessel utilization.

- ***Berth Utilization*** is based on the number and lengths of berths as well as vessel calls. As most container vessels in service are less than 1,000 feet long and 1,000-foot berths are common, berth length *per se* has seldom been a limiting factor. That will eventually change as *post-Panamax* and *Super-post-Panamax* vessels become more common on the East and Gulf Coasts. As of 2010, the figures show significant potential for increased utilization. In practical terms, berths that are handling two vessels per week could probably handle four. This conclusion, however, depends on vessel size and the total cargo discharged and loaded. The average vessel capacities are low compared to the maximum vessel sizes that ports say that they can accommodate with the available

[12] IBID

draft. Ports typically receive few if any calls from the maximum size vessels, so most calls are made by a mix of smaller container ships.

- **Throughput** could be increased by using larger vessels for the same number of calls, making more calls with the same vessels, discharging and loading more of the vessel capacity at each call, or any combination of these changes. In each case, more container cranes and/or crane time would be required to handle the increased cargo while keeping the vessel on schedule. The crane capacity estimates are based on availability for two shifts per day, 250 days per year (4,000 annual hours). The cranes are, in fact, generally available 24 hours per day if the terminal operator needs the additional shifts to turn the vessel on schedule and is willing to pay for overtime.

The capacity and utilization measures presented in table 4 provide insights into the performance of U.S. container ports and the challenges they face in accommodating the nation's growing trade.

The container yard (CY) is the operating heart of the marine container terminal, the area where containers are held, sorted, and transferred between vessel arrivals and departures. On average, about 50 percent of the gross terminal space at U.S. terminals is devoted to CY operations. The average is lower at ports with extensive on-dock rail terminals, consolidation facilities, and other operations within the terminal boundaries.

Container yard utilization reflects the ability of the terminal to accommodate growth with existing handling methods. Industry rules of thumb suggest that about 80 percent utilization is a practical upper limit beyond which periodic congestion becomes likely. Ports and terminals approaching this limit, such as NYNJ at 75 percent, New Orleans at 82 percent, or LALB at 75 percent, can accommodate growth by expanding or shifting to more land-intensive operating systems.

Utilization of shore side container cranes is typically low, averaging 34 percent across U.S. ports. Cranes are usually used for one daily shift, with additional shifts used to accommodate tight vessel schedules. Crane utilization is secondary to the utilization and rescheduling of the far more costly container ships, so ports and terminals will usually have enough cranes to handle peak demand. Crane utilization may be particularly low at ports such as Mobiles and Virginia which have recently added new terminals and cranes to accommodate future growth.

The average size of vessels actually calling at the ports is usually much smaller than the maximum that could be accommodated. The ratio is highest for ports such as Philadelphia (Delaware River), Savannah, Jacksonville, Houston, and Portland with shallow drafts. The table likewise shows that a vessel does not typically discharge and load its full capacity at each port. The highest average is at LA/LB, where an average vessel discharges and loads 56% of its capacity (equivalent to discharging 28% and loading 28%). Most ports share vessel calls with multiple U.S. and foreign ports, with the average discharge/load ratio correspondingly lower.

Table 4 provides three measures of berth utilization. The first focuses on the number of vessel calls. On average, U.S. ports receive about 29 percent of the maximum number of vessel calls that could be accommodated. The average is higher at smaller ports, and at ports handling multiple trade routes and steamship lines. Where the average approaches 80 percent, such as at Savannah or New Orleans, there may be a need to extend berths. Berth utilization with average vessels measures the extent to which port volume can grow using the current vessel mix and discharge/load ratio. In several cases U.S. ports are approaching this limit, and will need to start handling larger vessels to accommodate increased traffic. Berth utilization with the maximum vessel sizes is generally much lower, except at Savannah where the shallow draft has constrained the use of larger vessels.

The table provides the same measures for the two Canadian port complexes in British Columbia. These ports have substantial reserve capacity and the ability to handle very large vessels in competition with U.S. ports.

Table 4: 2010 Capacity & Utilization Measures

Container Yard	CY/Gross Ratio	CY Utilization	Crane Utilization	Berth Utilization - Vessel Call Basis	Avg. vs. Max. Vessel Capacity	Avg. Vessel Utl Discharge/Load	Berth Utilization - Avg. Vessel Basis	Berth Utilization - Max. Vessel Basis	Nominal Maximum Channel/Berth Draft (Feet)	Estimated Maximum Vessel TEU
North Atlantic Ports										
Boston	49%	31%	21%	35%	73%	38%	35%	25%	45'	5,183
NY/NJ	59%	75%	36%	43%	53%	55%	43%	23%	50'	7,470
Delaware River	29%	68%	29%	30%	65%	52%	40%	26%	40'	3,420
Baltimore	50%	23%	18%	18%	44%	71%	14%	6%	50'	7,470
VPA	42%	83%	30%	60%	54%	32%	77%	41%	49'	6,967
S. Atlantic Ports										
Charleston	43%	25%	35%	79%	61%	30%	89%	55%	47'	6,031
Savannah	41%	36%	45%	71%	101%	39%	89%	89%	42'	4,067
Jacksonville	33%	24%	17%	13%	69%	104%	13%	9%	37'	3,420
Port Everglades	85%	42%	49%	43%	56%	60%	57%	32%	39'	4,067
Miami	72%	53%	31%	40%	77%	66%	27%	20%	42'	4,067
Gulf Ports										
Mobile	58%	14%	12%	9%	114%	55%	9%	10%	42'	3,420
New Orleans	62%	45%	31%	57%	65%	31%	57%	31%	45'	5,183
Houston	63%	57%	37%	51%	92%	67%	46%	42%	40'	3,420
West Coast Ports										
LA/LB	55%	75%	43%	25%	37%	112%	25%	18%	50'	13,000
Oakland	57%	53%	29%	40%	65%	28%	40%	26%	50'	7,470
Portland	59%	26%	8%	15%	97%	47%	15%	14%	43'	4,419
Seattle	49%	64%	21%	40%	68%	36%	40%	27%	50'	7,470
Tacoma	56%	37%	15%	23%	53%	52%	23%	12%	51'	7,997
U.S. Mainland Ports	51%	51%	34%	39%	n/a	61%	30%	n/a	n/a	n/a
Canadian W. Coast Ports										
Prince Rupert	46%	76%	40%	50%	43%	36%	61%	26%	61'	15,048
Vancouver	56%	63%	52%	40%	40%	64%	46%	19%	51'	13,000

Source: USACE Institute for Water Resources

While some ports on the U.S. West Coast (LA/LB in particular) are closer to their capacity in percentage terms, the system as a whole could handle roughly double 2008 volumes before hitting CY or berth capacity constraints. However, that result would only be attained if the increased trade were distributed according to the available capacity – an unlikely outcome. A far more likely outcome is that some ports and terminals would see a disproportionate share of the cargo growth and hit capacity constraints in the long term while other ports and terminals remained underutilized.

Table 5 displays the reserve container capacity by region, which is a key indicator of the ability to handle increased traffic and cargo.

Table 5: Reserve Container Port Capacity by Coast

Metric	N. Atlantic Ports	S. Atlantic Ports	Gulf Ports	West Coast Ports
2010 TEU	8,239,000	6,687,000	2,409,000	18,960,000
Reserve CY Capacity-TEU	10,612,402	13,869,035	2,669,003	10,484,996
Reserve Crane Capacity – TEU	20,895,164	12,501,742	4,423,466	37,237,002
Reserve Berth Capacity – Vessel Calls	9,964	4,013	1,105	13,923
Reserve Berth Capacity – Avg. Vessel Basis	11,832,298	1,922,907	2,799,609	53,031,819

Source: USACE Institute for Water Resources

Secondary Ports

The map below (Figure 20) shows primary and secondary ports in the U.S. Primary ports often feature more dedicated container or bulk terminals. Secondary ports supplement the capacity of the major ports and handle trades and cargoes that do not fit in well with the large, dedicated container terminals. Secondary ports handle a mix of containerized, bulk and break-bulk shipments, so their container capacities are difficult to determine with precision. This mix of capabilities does, however, provide flexibility, particularly for project cargoes and other limited-duration needs. While these ports handle relatively small volumes of containers, several have specific importance to the imported fruit trade (e.g., bananas) and other niche markets. Some are part of larger complexes that include major military shipping points.

Source: USACE Institute for Water Resources

Figure 20: Primary and Secondary East and Gulf Coast Ports

Channel Depth Comparisons

An important capacity consideration is the vessel size a port can accommodate. Along with other factors, channel width and depth establish the maximum size vessel that can call at a port. West Coast ports such as Seattle, Oakland, Los Angeles and Long Beach all have 50-foot or greater channels. Northeastern ports such as Baltimore and New York[13] have or will soon have 50-foot channels. In the Southeast, Norfolk has 50 feet. Below Norfolk along the Southeast and Gulf Coasts there are no ports with 50-foot channel depths. However, Miami is scheduled to have a depth of 50 feet by 2014 and Charleston can already accommodate, at high tide, ships that require a depth of 50 feet. Figure 21 shows channel depths at selected ports around the country.

[13]The Bayonne Bridge presents and air draft restriction for the largest vessels calling at some of the container terminals in New Jersey and Staten Island. The Port Authority of NY/NJ is planning to raise the Bayonne Bridge and expects to complete that work in 2016.

Source: USACE Institute for Water Resources

Figure 21: Main Channel Depths at Selected Ports

Additional Capacity Factors

Other factors affecting port capacity include productivity, storage area, stacking height rules, operating hours and the capacity of surrounding highways, railroads, intermodal connectors to move containers to and from ports, and trained personnel to operate expanded terminals. Ports such as LA/LB have made tremendous strides in increasing productivity through measures such as facility upgrades and scheduling.

U.S. Port Capital Investment Plans

The Nation's ports are making significant investment of their own. The American Association of Port Authorities recently conducted a survey of their members regarding capital improvement plans. Table 6 shows planned investments over the next 12 years total over $21 billion.

Table 6: Preliminary results of AAPA U.S. port authority infrastructure spending survey - 2012-2016

Port's Projected Capital Expenditures 2012-2016	Projected Private Sector Capital Expenditures at ports 2012-2016	Port's Local Share of Security Expenditures Since 9-11	Port's % of Annual Budget for Security
$16,218,000,000	$21,418,000,000	$1,429,000,000	10.3% (average)

Source: American Association of Port Authorities

Summary of Primary and Secondary Port Capacity

There is little benefit to providing deeper channels if terminals do not have capacity to accommodate larger vessels. Overall, the North Atlantic, South Atlantic, Gulf and West Coast ports have substantial inherent capacity. They have adequate capacity in their birth, cranes and container yards to accommodate near-term growth. That growth can be achieved through more intensive use of existing terminals, cranes and berths. The existence of aggregate reserve capacity does not preclude slot shortages at ports and terminals that receive more than their share of growth.

Competition from Other North American Ports

IWR also examined the capacities for a number of ports outside the U.S. that can be viewed as competition to U.S. ports. When congestion reached a peak in Long Beach in 2004, for example, some cargo had been diverted to Lorenzo Cardenas and Manzanillo in Mexico.[14] U.S. West Coast ports have become understandably concerned about the diversion of traffic to Prince Rupert in British Columbia, which began operations in 2007.[15] It boasts an ice-free, 115-foot deep harbor and is about 1,000 nautical miles closer to Asian ports (two-days shipment time) than Southern California ports. The Canadian National Railway Company's rates from Prince Rupert to Chicago are approximately $300 per container lower than Burlington Northern Santa Fe Railway and Union Pacific intermodal rates to Chicago from Los Angeles. Canadian National Railway Company has also been investing heavily to widen tunnels, reinforce bridges and build sidings along the route from Prince Rupert to Chicago. (The steepest grade between Canada's Pacific Northwest and its Chicago end points is 1 percent in the Rockies). Prince Rupert is planning to quadruple its capacity to approximately 2 million TEUs with its Phase 2 Expansion project.[16]

Competition from South American Ports

China continues to propose investments in ports (a deepwater bulk port in Brazil) and overland infrastructure (a rail connector proposed for linking Colombian coal fields on the Atlantic side of the country to a Pacific port) in South America. These investments would improve the competitive position of Brazil as an ore and soybean exporter and Colombia as a coal exporter.

Transshipment Centers

The Port of Freeport, Bahamas has been viewed as a potential transshipment port, or hub, for cargo, similar to Singapore and other transshipment centers. The terminal is approximately 100 miles east of Miami, was opened in 1997 and is used primarily as a transshipment point serving the U.S. East Coast and global trade routes. It is able to handle large containerships given its

[14] Delays at U.S. Ports May Push Nippon, Maersk to Canada, Mexico, Bloomberg January 13, 2005.

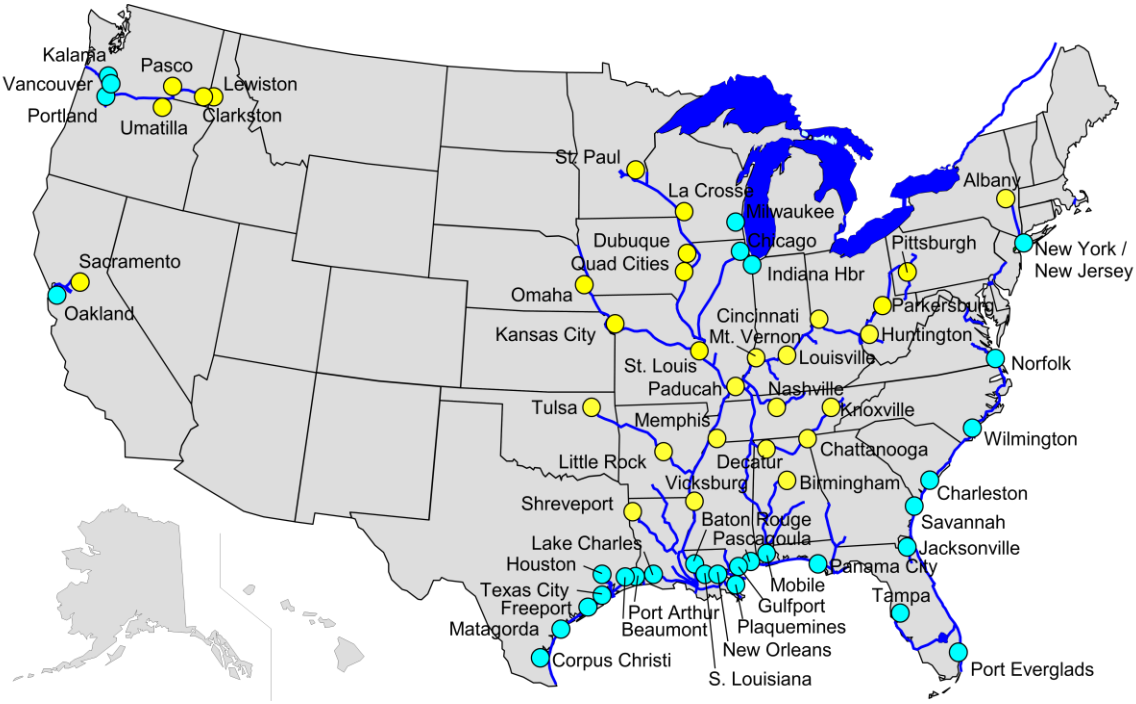
[15] Remarks of Chairman Richard A. Lidinsky, Jr. Federal Maritime Commission at the Canada Maritime Conference Montreal, Canada September 21, 2011

[16] U.S. Army Corps of Engineers, Institute for Water Resources. *IWR Container Ports Capacity Report 2012 (draft).*

53-foot channel depth and proximity to Southeast ports. The 2012 Port Capacity Analysis indicates that Freeport has adequate capacity to handle future growth. Container Yard capacity appears to be its most constrained facility resource. However, the faster transshipment turnover it provides to carriers encourages future volume growth and improved berth capacity utilization.

Inland Waterways and Their Role in U.S. Export Trade

The inland waterways comprise rivers, waterways, canals, and the locks and dams that provide some 12,000 miles of commercially navigable waters. The flotillas of towboats and barges that operate on this system carry approximately 15 percent of the nation's domestic freight. Figure 22 shows how the inland waterways link the heartland of the U.S. to the coast.



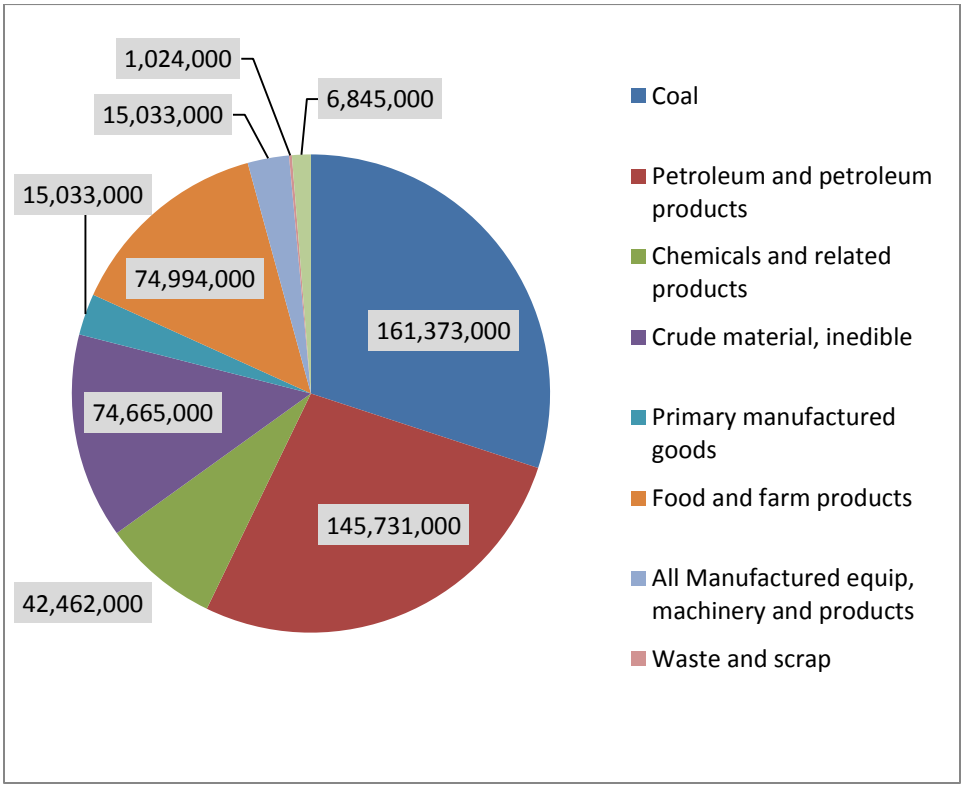
Source: USACE Institute for Water Resources

Figure 22: The Inland Waterway Connection: Linking the Heartland to the Coasts

The biggest role of inland waterways in the export market has been in the global trade for grains and coal. U.S. producers of these commodities face stiff global competition. Investments in competing world ports are tapping production regions that were previously expensive to reach or nearly inaccessible. Examples include coal mines in Mongolia, deep water ports in Brazil for the export of soybeans, and rail lines from eastern coalfields in Colombia to the Pacific Ocean.

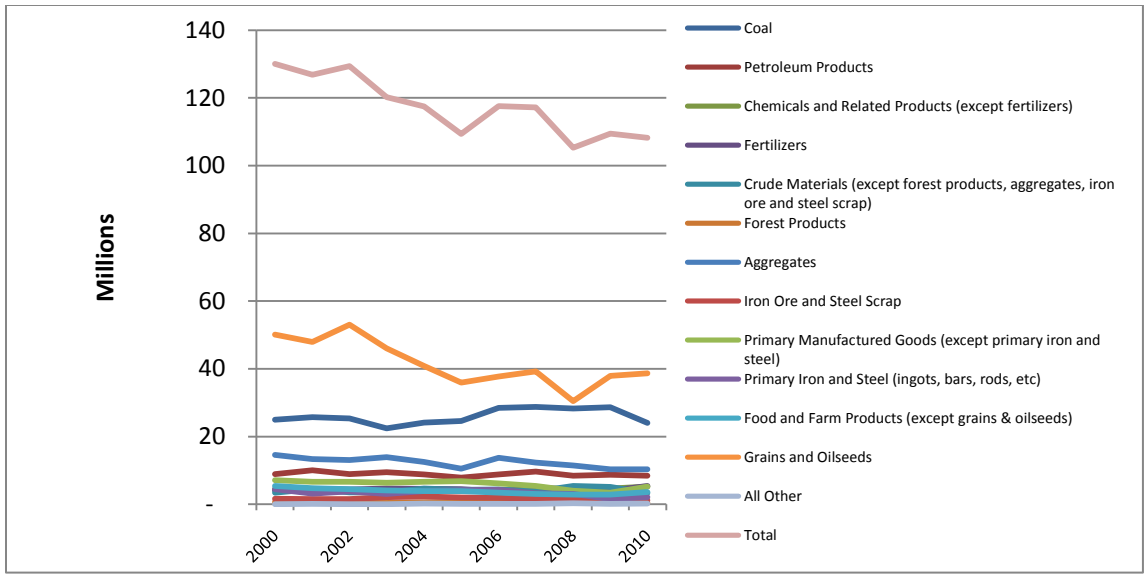
Shallow draft river systems handled 523 million short tons of cargo in 2009, while coastal systems handled an additional 168 million short tons. Including lake, intraport and intraterritorial movements, the system moved some 857 million short tons—actually a decrease

in activity due to the severe recession during that year. The system typically handles more than a billion tons per year. The cargoes are mostly bulk commodities and raw materials such as coal (28% of the tonnage), petroleum (37%), grain and farm products (10%), chemicals (5%), aggregates, steel, and fertilizer (Figure 23). The Mississippi River System is the primary conduit for cargoes from the nation's Midwest grain belt to Gulf ports. Figure 24 shows traffic on the Mississippi has been declining over the last decade.



Source: USACE Institute for Water Resources, Waterborne Commerce Statistics Center

Figure 23: Total 2009 U.S. Internal Traffic by Commodity (short tons)



Source: USACE Institute for Water Resources, Waterborne Commerce Statistics Center, Waterborne Commerce Statistics

Figure 24: Tonnage (short tons) by Commodity Shipped on the Mississippi River 2000-2010

U.S. government export forecasts indicate near term growth in grain and coal exports that level off over the next 20 years[17]. These forecasts indicate that the U.S. will remain the single largest participant in the global grain trade, while U.S. coal producers will continue to hold a marginal position in the global market. Grain producer forecasts see most of their exports being shipped from the Center Gulf region around New Orleans, with about one-half of the increase in grain exports transiting the Panama Canal[18].

A Strong Intermodal System

The challenge will always be wise stewardship – maintenance and enhancements that anticipate future needs and uses. Foresighted planning, policy and investment are all required. The railroad industry responded to Staggers Act de-regulation in the 1980s by trimming capacity and becoming more efficient and more profitable. This return to profitability allowed railroads to invest heavily in main line expansion and terminal capacity; however, concerns persist over the railroads' ability to match demands. Public-private partnerships (like the Heartland Corridor Project (see Figure 31 on page 41) have already occurred and more partnerships of this nature may be required in the future.

A healthy trucking industry is vital to the freight transportation network, often accounting for the first and last leg of each freight shipment. These legs have become longer as railroads abandoned rural country elevators and coal load outs in favor of fewer and larger terminals capable of handling unit and shuttle trains. This has meant more miles travelled by trucks on rural roads, faster deterioration of roads and bridges, and more maintenance expense for public

[17] USDA 2011

[18] Panama Canal Expansion: Impact on U.S. Agriculture, Informa Economics, September 2011.

highway agencies. Repair work on the nation's highways and bridges was given a boost from American Reinvestment and Recovery Act funds, but experts suggest many more billions of dollars are required to bring the system up to safe and efficient standards.

Inland waterways in the U.S. are the most advanced and extensive in the world, greatly aiding in the economic development of vast expanses of interior North America and conferring benefits to U.S. consumers of electricity, agricultural products, construction materials, petroleum products and steel – nearly everyone. The inland waterways complement a web of highways and rail lines to form a national multi-modal freight transportation system – an engineering and logistical marvel built, redesigned, improved and expanded throughout the Nation's history. As a national freight network, it efficiently serves the largest and the smallest communities in the U.S. from coast to coast and allows goods produced far from ocean ports to reach and compete in global markets. Like any other piece of infrastructure, the freight network goes largely unnoticed until it becomes unreliable or is no longer there. The flexibility of the U.S. freight network has allowed each mode to cover for the other during service interruptions. Many segments of the freight community are concerned that this capability is largely played out just at a time when new opportunities are opening in the global market place.

U.S. Ports Served by Inland Waterways

Many of the major coastal ports in the U.S. are located on or connected to inland waterways. Ports served by inland waterways exported 346 million tons in 2010.[19] The Gulf Intracoastal Waterway (GIWW) and the Lower Mississippi River (including Lake Charles off the Calcasieu River) served ports that accounted for 72 percent of inland waterborne exports in 2010.

The Port of New York, NY and NJ and ports on or served by the Columbia-Snake, Great Lakes and Tennessee-Tombigbee-Black Warrior waterways account for most of the remaining share of exports from ports served by inland waterways. Ohio, Upper Mississippi, McClellan-Kerr-Arkansas (MKARNS), and Missouri river ports do not export directly, but reach the export market through ports on the Lower Mississippi River. Ports served by the GIWW – Houston, Corpus Christi, Texas City, Beaumont and others – are dominated by the petroleum and petrochemical trades; the Port of New York by containers; Great Lakes by ports; Mobile, the Lower Columbia River and the Lower Mississippi ports by dry bulk trades like coal, grains and ores, along with a wide variety of other commodities. When viewed from the perspective of the ability of inland waterways to support enhanced export opportunities that a global fleet of larger ocean going vessels represent, those inland waterways that serve a hinterland with desirable export commodities are of particular interest. This directs focus to the Upper Mississippi, Illinois, Ohio (and its tributaries), and the Columbia-Snake rivers and the Great Lakes and the ports they serve.

[19] These major ports are selected from among the top 150 ports by tonnage as identified by the USACE Waterborne Commerce Statistics Center.

Port and Waterway Infrastructure

The state of port infrastructure at both the point-of-shipment in the U.S. and at the point of destination can be limiting factors. For grains, Pacific Northwest, Center Gulf (Lower Mississippi River) and Texas Gulf terminals are capable of accommodating the loading of large vessels of any size. Each is configured to handle grain in large volumes by rail and river at the PNW, largely by rail in the Texas Gulf, and mostly by river in the Center Gulf region. Ports in Northeast Asia receiving grains are currently maintained at depths compatible with current Panama Canal depths and the depths of nearly all U.S. ports. Though capital investments are planned for some of these ports, at the current time they act as a limiting factor to the same extent as the depth of U.S. ports.

Deep draft ports handling ores and coal in Northeast Asia are designed to handle the largest ore and coal carriers. Only LA/Long Beach, Oakland, and Seattle/Tacoma on the West Coast and Baltimore and Norfolk on the East Coast have depths of 50 feet or more, limiting the potential use of fully loaded vessels drafting 50 feet to these four ports. In fact, the new Panama Canal locks are too small to handle the largest of the ore and coal carriers, making it a limiting factor on an Atlantic or Gulf Coast trade route to Asia. China continues to propose projects and make investments in ports (a deepwater bulk port in Brazil) and overland infrastructure (a rail connector proposed for linking Colombian coal fields on the Atlantic side of the country to a Pacific port) in South America that allow them to maximize their use of these vessels. These investments improve the competitive position of Brazil as an ore and soybean exporter and Colombia as a coal exporter relative to the U.S.

Interestingly, the reliability of lock and dam structures is linked to both highway and rail performance in a demonstration of the interconnected nature of the transportation system. Lock outages at the Nation's aging system of locks and dams have experienced a sharp increase over the last 20 years. Much of this is related to outages either for scheduled or unscheduled lock repairs. Carriers face lost opportunities and increased costs due to these disruptions that delay service, while shippers face potential disruptions to their operations and increased transportation costs as they seek ways to work around lock facilities either closed to traffic or experiencing major congestion as traffic moves through smaller auxiliary chambers (when available). During closure events, shippers will seek alternative overland routes, which can cause congestion on these routes (rail or truck).

Surface Transportation System

The maritime aspects of trade, whether domestic or foreign, inland vessel or ocean going ship, are part of a multi-modal system for the movement of bulk commodities from point of production to point of consumption. A complete examination of the inland system's capability to accommodate future flows of traffic also needs to consider the capability of other parts of this multi-modal system. Whether truck, rail, barge, Lake Vessel or ocean freighter, each mode

is dependent upon the other if the system is to operate efficiently. When this occurs, more markets are available to producers and the nation enjoys the benefit of the efficiencies incurred.

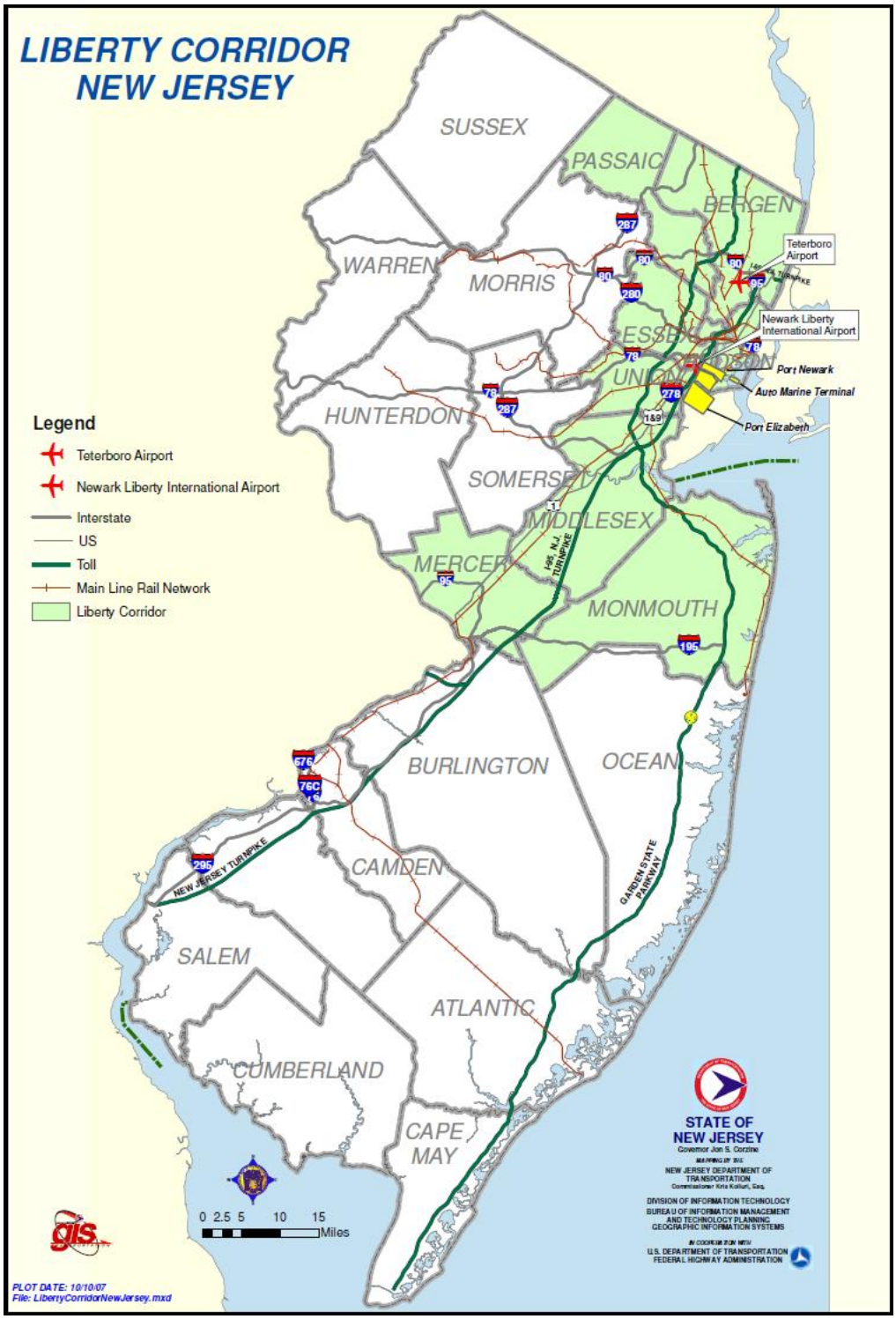
Much of the information presented in this discussion relies upon the *Study of Rural Transportation Issues,* a report prepared for the U.S. Department of Agriculture and the U.S. Department of Transportation and published in 2010.

Truck

The trucking industry carries nearly three quarters of all agricultural products and is the sole mode of freight service for more than 80 percent of all communities in the U.S. Trucks are critical to the efficient movement of goods in the U.S., often making the first and/or last move in most supply chains, including those for coal and grains. This highly competitive industry has over 691,000 companies (over half of which own one truck), keeping truck rates relatively low. Operating costs are 95 percent of revenue, making trucking firms' rates sensitive to increases in operating costs, whether from fuel prices or operating requirements stemming from a patchwork of local, state and Federal regulations.

The capacity of this mode is dependent upon: 1) drivers, 2) trucks and 3) roads. The availability of drivers can in the short run be constrained due to the need for training and licenses. National laws dictate driver requirements, such as daily hours in service, licensing, or identification and security requirements. Trucks are currently available in great numbers; some 3,000 trucking companies went out of business during the recession. Carrying capacities are determined by payload dimensions and highway and bridge weight restrictions. The Federal government sets weight and size restrictions on the Interstate Highway System and fixes the maximum width, while placing limits to the restrictions that states can place on highways designated as part of the National Highway Network.

To increase capacity and remove bottlenecks, states are developing "corridor" projects. In New Jersey, the Liberty Corridor of New Jersey is a multi-modal transportation system tying ports, highways, airports and rail lines together to make critical connections and clear chokepoints. Figure 25 below depicts the Liberty Corridor.



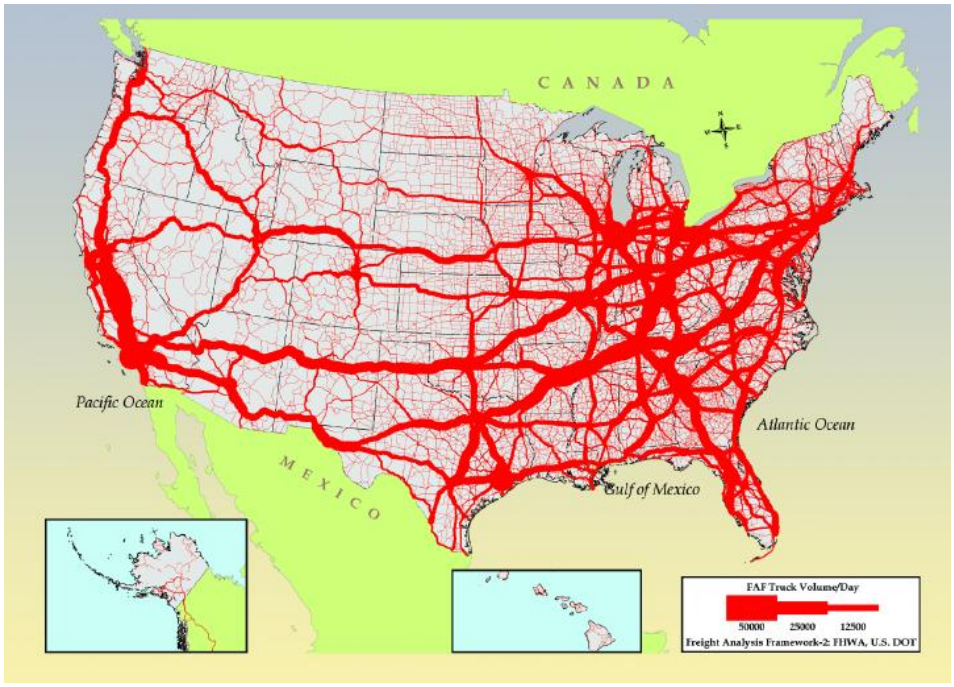
Source: New Jersey DOT

Figure 25: Liberty Corridor, New Jersey

Road condition, which can lead to the weight restrictions mentioned above, and congestion are also limiting factors on the mode's capacity. The U.S. Department of Transportation, Federal Highway Administration's *2010 Status of the Nation's Highways, Bridges, and Transit: Conditions*

& Performance, January 2010, reported that over half of all vehicle miles travelled are on highway pavement providing less than good rides and more than a quarter of the Nation's bridges are structurally impaired or obsolete.

Most observers do not report roadway congestion as a problem for grain and coal shippers, since most miles are travelled in rural areas. Congestion issues can become an issue for grain and coal shippers when hauling long distances to terminals near urban areas and could be a major issue in the event of lock outages should the shipper decide to truck around the obstacle and need to take a route through urban areas like St. Louis, MO or Cincinnati, OH. (See Figure 26, for a description of average daily long-haul truck traffic.)



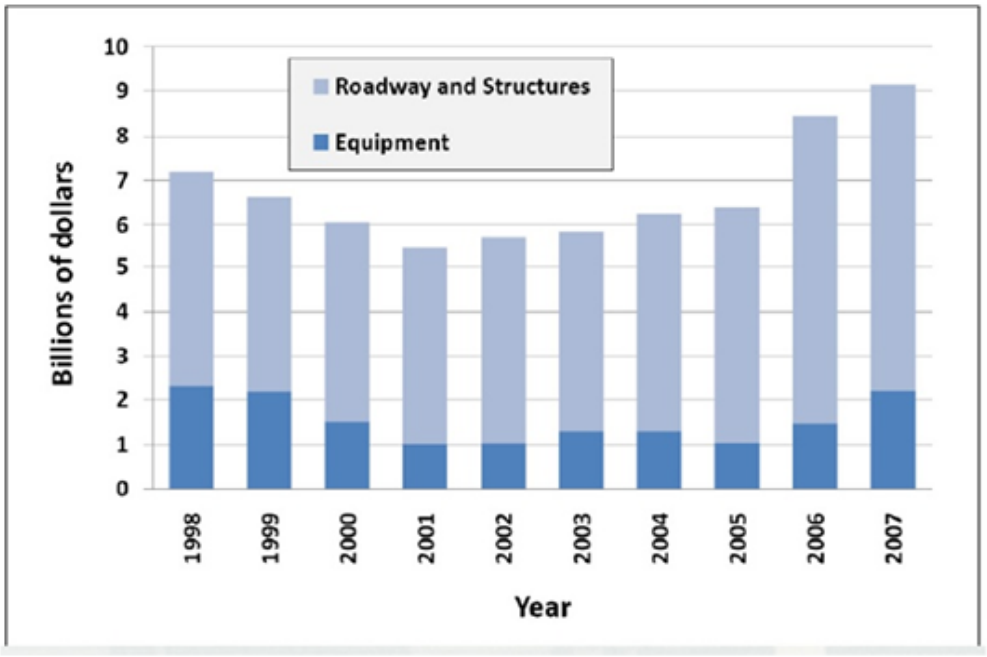
Source: U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework, Version 2.2. 2007

Figure 26: Estimated Average Daily Long-Haul Truck Traffic on the National Highway System (2005)

Rail

U.S. railroads have steadily increased investments in both road and equipment. The $9 billion invested by the railroads in 2007 was a 27 percent increase over what was invested in 1998. Western railroads, spurred by growth in Northeast Asia, increased capital expenditures by nearly a third over this timeframe (see Figure 27). These investments build capacity and improve performance of their land bridge between West Coast ports and production areas in the interior and consumer markets in the Midwest and East Coast. These investments allow West Coast ports to compete with Gulf Coast ports for grain (and potentially coal) export shipments out of the U.S. to Asia and improve the overall U.S. position globally in both the grain and coal export markets. Proposed coal terminal facilities on the Columbia River near Portland in Oregon and

Washington and at Cherry Point in Washington State (each with planned annual throughput capacity of roughly 30 million tons and representing an investment in excess of $500 million) are indicators of the private sector's view of the potential that exists in the Asian coal market. These terminal facilities would provide the capability of handling coal in the volumes required by *Panamax* or *post-Panamax* vessels of any kind. Railroad investments are made possible by the financial health of the major rail carriers. A return to profitability for the industry was made possible by the Staggers Act of 1980, which deregulated railroads. Deregulation allowed the railroads to abandon low revenue lines, initiate mergers that removed redundancies, change terms of service, and initiate differential pricing for service. With the elimination of excess capacity and introduction of efficiencies like the shuttle train, railroads' return on investment improved dramatically, allowing them to invest in high-use, high-return rail lines. Revenues rose while rates fell over the 20 years following Staggers. It was only in the early 2000s that rates began to rise as traffic grew at a pace faster than railroads could add capacity. Rates continued to increase until the recession that began in December 2007.



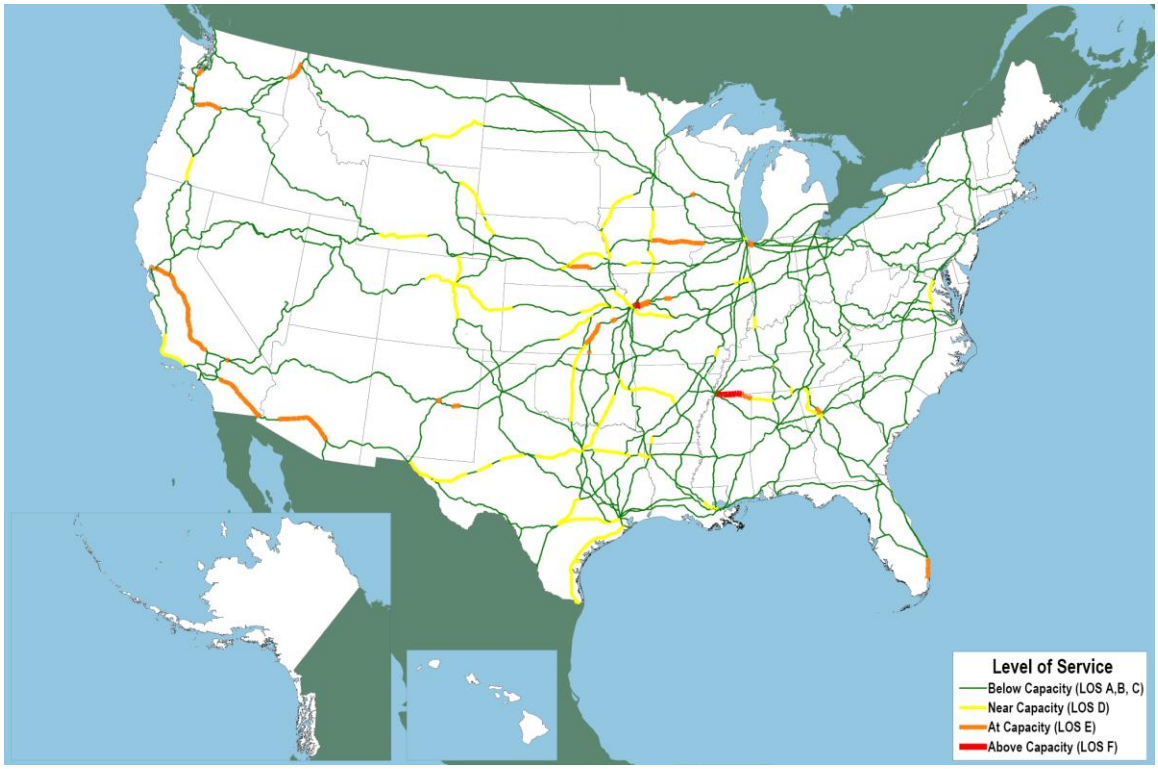
Source: AAR, Analysis of Class I Railroads

Figure 27: Class I Railroad Capital Expenditures

Railroad service and pricing revolve around the railroads' efforts to improve speeds and efficiency, and to shift costs. They have done this by investing in access lanes to the ports (like the Alameda Corridor), in more equipment, more track, and more unit and shuttle trains, and by abandoning some feeder lines. Some of the cost risks have been shifted to the shipper. In the coal market entire trains are now owned by the shipper, while grain shippers often own the cars. Collection costs have been shifted to the coal producer and to the farmer, leading some of them to move goods by truck a longer distance on rural roads to terminals that load out unit and shuttle trains. In addition to placing an additional cost burden on the producer, state and

local governments need to cover the additional maintenance costs on rural highways. A similar phenomenon is occurring with the relatively new container trade for grains where farmers must travel to find empty containers and then transport them to often distant assembly points near large population centers.

Efficiency gains allowed railroads to move 171 percent more traffic than in 1980 despite having fewer miles of track. The railroads have made massive investments, and have adequate locomotives, cars and operators. The map below (Figure 28) shows major rail lines and the capacity of each relative to the traffic each carried in 2007. Many lines in the grain producing area are near capacity, with a number of connecting lines at capacity and one line along the Tennessee-Mississippi border over capacity. With economic recovery and the return of higher traffic volumes, many of these near capacity lines could become bottlenecks, particularly if the Panama Canal expansion and advent of larger oceangoing vessels encourages the movement of grains to the Gulf. Eastern railroads do not indicate widespread capacity issues with one important exception in Virginia.



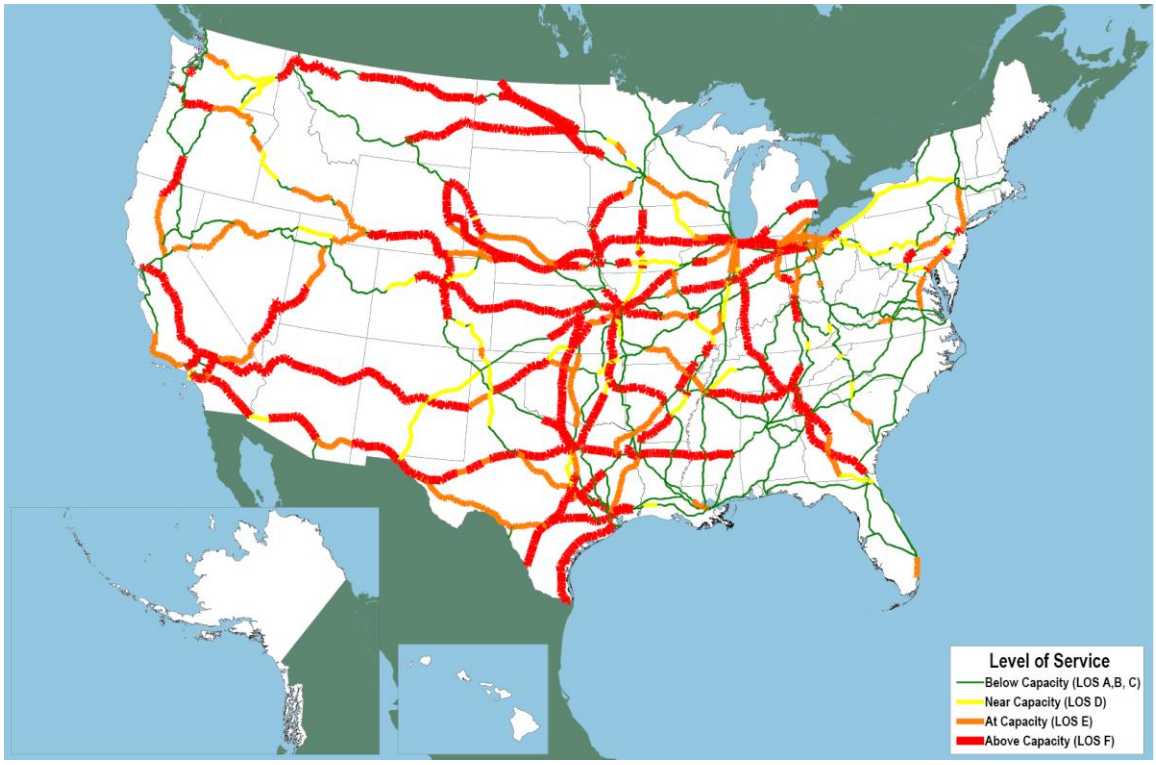
Note: Level of Service (LOS) A through F approximates the conditions described in Transportation Research Board, *Highway Capacity Manual 2000*

Source: "National Rail Freight Infrastructure Capacity and Investment Study"-Cambridge Systematics, Inc. 2007

Figure 28: 2007 Rail Performance

Some analysts project major bottlenecks throughout the system by 2035, others see rail demand easing. Nevertheless, it is apparent that periods of bottlenecks, especially for grain given the seasonal nature of its movement, may occur are likely unavoidable and reason for

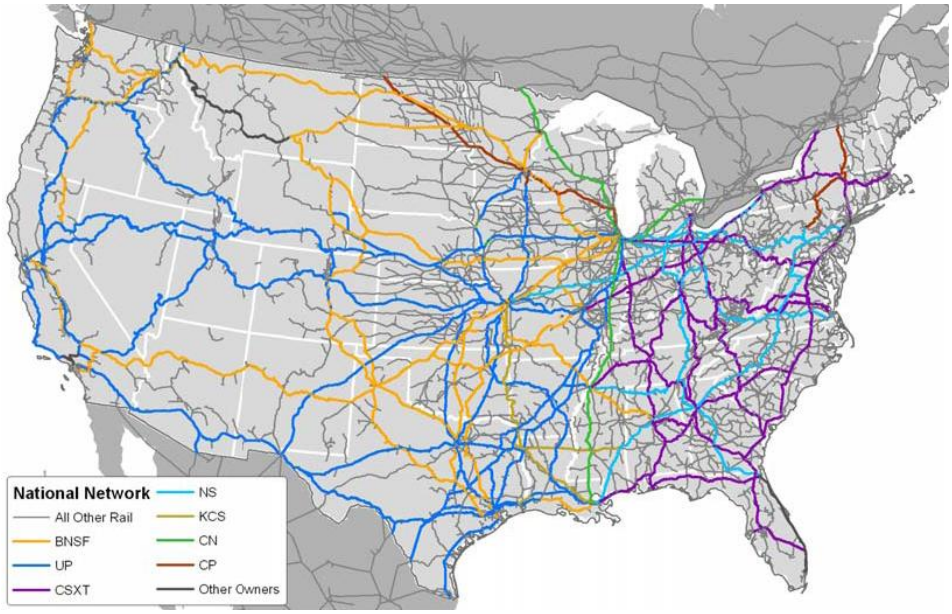
concern if the U.S. is to remain a reliable supplier of grain to the world. Without rail capacity improvements, Cambridge Systematics, Inc. projected widespread rail congestion by 2035 (Figure 29). This analysis shows that 45 percent of primary corridor mileage will be below capacity, 25 percent near or at capacity, and 30 percent above capacity. The analysis is dependent upon traffic forecasts and trade volumes that return to rates of growth experienced before the recession of 2008/2009. It is important to note that peak or seasonal flows are not considered.



Note: Level of Service (LOS) A through F approximates the conditions described in Transportation Research Board, *Highway Capacity Manual 2000.*

Source: "National Rail Freight Infrastructure Capacity and Investment Study"-Cambridge Systematics, Inc. 2007

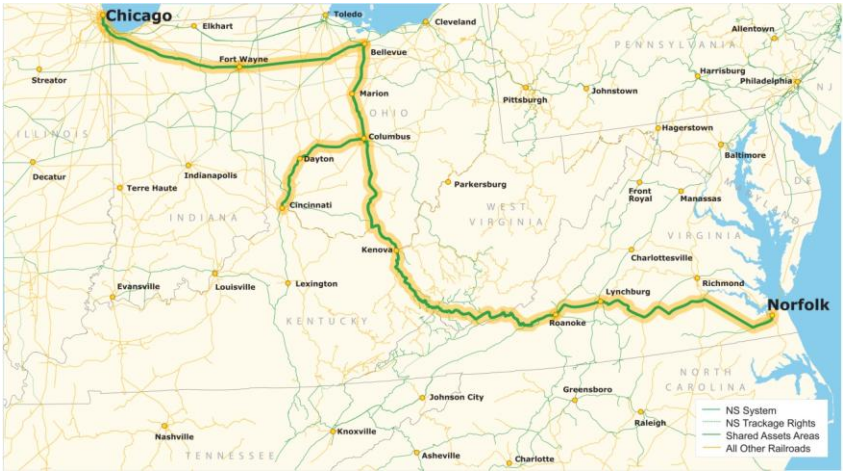
Figure 29: Potential Rail Performances in 2035



Source: "National Rail Freight Infrastructure Capacity and Investment Study"-Cambridge Systematics, Inc. 2007

Figure 30: Railroad Freight Network

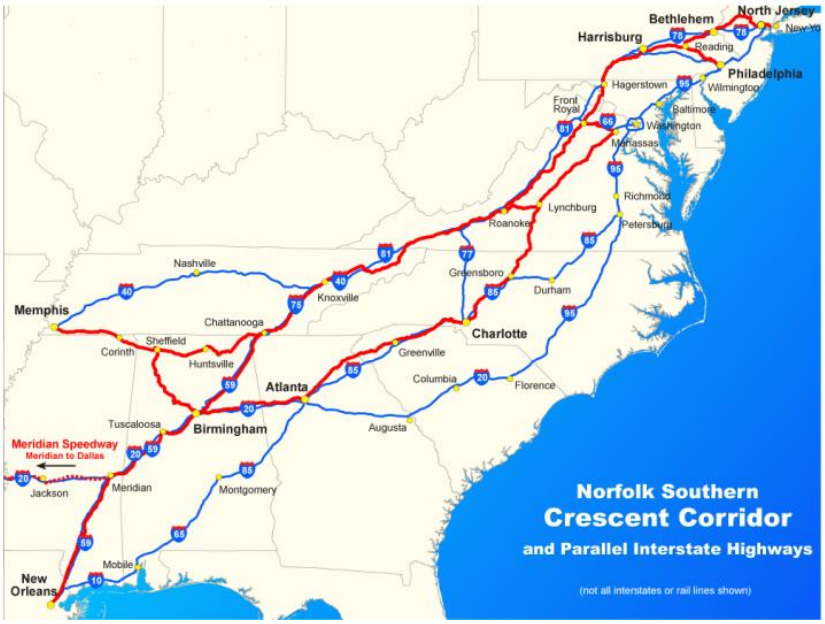
Figure 30 describes the national railroad freight network. The Heartland Corridor (Figure 31) is a public-private partnership between the Norfolk Southern Railway (NS) and the Federal Highway Administration and three U.S. states to improve railroad freight operations.[20] The plan was developed to facilitate more efficient travel on NS rail lines between the Norfolk, VA port region to Columbus, OH and Chicago, IL. The project goals increase tunnel clearances to permit the operation of double-stacked. The Crescent Rail Corridor (Figure 32) is also operated by the Norfolk Southern Railway. The Crescent Corridor will run along Interstate 81 and will be an intermodal corridor between Louisiana and New Jersey.



Source: Norfolk Southern (MARAD Panama Canal Expansion, Phase 1 Report)

Figure 31: Heartland Corridor

[20] Norfolk Southern opens Heartland Corridor. Railway Gazette International, September 9, 2010.



Source: Norfolk Southern (MARAD Panama Canal Expansion, Phase 1 Report)

Figure 32: Crescent Corridor

Chapter 3: Evaluating Capacity Maintenance and Expansion

The desirability for maintenance and expansion of the Nation's navigation transportation capacity is derived from the demand for transportation services. This demand is tied to population and income, as shown in chapter 1. Forecast growth of population and income imply growth in trade and the demand for transportation services. However, it is difficult to predict the extent of this future growth, and when and where it will happen.

As suppliers of transportation services compete, they seek economic advantage. Advantage is gained in deep draft navigation through more efficient vessels, cargo handling techniques, and inter-modal connectors. The greatest manifestation of this has been the innovation of containerized cargo and the container vessel.

Since the introduction of the container in 1956,[21] containerized trade has grown to tens of millions of TEUs per year. This growth in containerized trade has led to the building of vessels designed to carry them. The increase in the size of container vessels can only be described as phenomenal—growing from a fleet size of just 6.375 million TEUs in 1990 to an estimated 32.185 million TEUs in 2012.[22] Maximum vessel size has increased from about 7600 TEUs in 2000 to about 14,000 TEUs in 2012 with 18,000 TEU vessels on order for delivery in 2013. These large vessels present economic efficiencies largely through reduced fuel consumption per ton mile. This becomes also an environmental opportunity as reduced fuel consumption per TEU results directly in reduced emission per TEU.

This chapter reflects on the future need for capacity at the Nation's ports and inland waterways resulting from the deployment of *post-Panamax* vessels in the world fleet. It qualitatively considers the likely forecast scenarios to impact each port or region and considers the scenario most likely to prevail in the future given our current understanding of the industry and whether a port or region has a need for additional maintenance or expansion to be able to meet the needs of the forecast scenario.

Market Responses

The Panama Canal expansion is expected to be completed in 2014. The expansion has been called a "game changer." Its influence will be great, yet there is uncertainty regarding the

[21] Levinson, Marc. 2006. The Box – How the Shipping Container Made the World Smaller and the World Economy Bigger. Chapter 1, page 1.

[22] World Container Traffic - Drewry Annual Reports; End Year Fleet Size - CI Market Analysis: Container Leasing Market 2010 as quoted in World Shipping Council, Container Supply Review May 2011.

specifics of how and when the game will change. There are three primary responses expected from the expansion. [23]

West Coast Diversions

West Coast ports serve as an alternative to the Panama Canal. The intermodal land bridge formed by the rail connections to West Coast ports provides a faster connection from and to Asian markets. Typically the land bridge is estimated to be five to six days faster, an advantage that can't be entirely made up on an all-water route through an expanded Panama Canal. However, with the expansion of the Panama Canal, the cost of using the all-water route from Asia to the East Coast is reduced and may be enough to off-set the increased transit time and result in traffic diverting from West Coast to East Coast ports in some cases.

Transshipment

Ports in the U.S. and Caribbean that are currently capable of receiving the largest of the *post-Panamax* vessels, when fully loaded, become deepwater transport hubs for vessels of all sizes. On the West Coast, these large vessels can call at Seattle, Oakland and LA/LB. On the East Coast, large vessels can or will be able to call at Norfolk, New York/New Jersey, Baltimore and Miami. These ports and *post-Panamax* ready ports in the Caribbean serve as transport hubs. The largest vessels unload at the hub and smaller feeder vessels deliver to ports with less channel capacity.

Agricultural Exports

The Panama Canal enlargement may make shipment of Midwest grains and other goods through Gulf ports to Asian markets more attractive than existing routes. That may, or may not, increase total U.S. exports of these products. However, it would increase barge traffic down Mississippi tributaries to the Gulf of Mexico.

There is uncertainty in these market responses. Details of when *post-Panamax* vessels will arrive in large numbers, at which ports they will call, how deep vessels will draft and, consequently, how deep and wide navigation channels and other related navigation infrastructure must be are uncertain. Another key uncertainty is the future Panama Canal Authority (ACP) toll structure. It should be noted that deepening U.S. ports to service *post-Panamax* vessels that transit the Panama Canal enhances the ability of the ACP to benefit through increases in its toll structure. In fact, it may be possible for the ACP to extract a majority of the transportation cost savings benefits on routes that use the canal, limiting the cost savings associated with the use of larger vessels through the canal that will be available to carriers, shippers, producers or consumers. A careful understanding of this is required when choosing which ports to deepen and how to finance the project.

[23] This scenario discussion in this chapter owes a great debt of gratitude to the work presented in the MARAD *Panama Canal Phase I* report.

Another key uncertainly is the role that transshipment hubs in the Caribbean or on U.S. shores could play in transferring freight from large vessels to smaller feeder vessels. Transshipment might offer cost savings to cargo headed for ports that are not *post-Panamax* ready. However, transshipment hubs add time and extra handling and additional exposure to the harbor maintenance tax, costs that may exceed the benefits of using a larger vessel.

As noted, reduced costs for an all-water route from Asia to the East Coast could cause a shift of some market share from the West Coast ports to the East Coast. However, given the expected overall increase in trade, it is not a zero sum game. Even if West Coast ports were to lose some market share, they will still see an increase in cargo moving through their ports. Moreover, West coast ports and their rail partners are investing heavily to increase the capacity and efficiency of the intermodal land bridge to ensure it remains competitive and retains market share.

It should be remembered that the opportunities for reduced costs available to U.S. agricultural exports through the use of larger bulk carriers are also available to its competitors in international markets.

Impact Scenarios

Impact scenarios have been derived by varying the three expected market responses. Using non-quantified descriptors of high and low for each response, eight scenarios were developed.

Table 7: Impact Scenarios

Post-Panamax Vessel Impact Scenarios			
	West Coat Diversion	Transshipment	Agricultural Exports
Scenario 1	H	H	H
Scenario 2	H	H	L
Scenario 3	H	L	H
Scenario 4	H	L	L
Scenario 5	L	H	H
Scenario 6	L	L	H
Scenario 7	L	L	L
Scenario 8	L	H	L

Scenario One – Under this scenario significant traffic is diverted from the West Coast ports and the intermodal land bridge to the East Coast ports. Transshipments are high, either at *post-Panamax* ready U.S. ports or Caribbean ports. The impact on agricultural exports is also high resulting in more grain being exported through U.S. Gulf ports.

Scenario Two – Under this scenario significant traffic is diverted from the West Coast ports and the intermodal land bridge to the East Coast ports. Transshipments are high, either at *post-Panamax* ready U.S. ports or Caribbean ports. The impact on agricultural exports is low with little impact on grain being exported through U.S. Gulf ports.

Scenario Three - Under this scenario significant traffic is diverted from the West Coast ports and the intermodal land bridge to the East Coast ports. Transshipments are low, large vessels use *post-Panamax* ready U.S. ports but other ports are served by smaller vessels. The impact on agricultural exports is also high resulting in more grain being exported through U.S. Gulf ports.

Scenario Four - Under this scenario significant traffic is diverted from the West Coast ports and the intermodal land bridge to the East Coast ports. Transshipments are low, large vessels use *post-Panamax* ready U.S. ports but other ports are served by smaller vessels. The impact on agricultural exports is low with little impact on grain being exported through U.S. Gulf ports.

Scenario Five - Under this scenario little traffic is diverted from the West Coast ports and the intermodal land bridge to the East Coast ports. Transshipments are high, either at *post-Panamax* ready U.S. ports or Caribbean ports. The impact on agricultural exports is also high resulting in more grain being exported through U.S. Gulf ports.

Scenario Six - Under this scenario little traffic is diverted from the West Coast ports and the intermodal land bridge to the East Coast ports. Transshipments are low, large vessels use *post-Panamax* ready U.S. ports but other ports are served by smaller vessels. The impact on agricultural exports is also high resulting in more grain being exported through U.S. Gulf ports.

Scenario Seven - Under this scenario little traffic is diverted from the West Coast ports and the intermodal land bridge to the East Coast ports. Transshipments are low, large vessels use *post-Panamax* ready U.S. ports but other ports are served by smaller vessels. The impact on agricultural exports is low with little impact on grain being exported through U.S. Gulf ports.

Scenario Eight - Under this scenario little traffic is diverted from the West Coast ports and the intermodal land bridge to the East Coast ports. Transshipments are high, either at *post-Panamax* ready U.S. ports or Caribbean ports. The impact on agricultural exports is low with little impact on grain being exported through U.S. Gulf ports.

Over time the uncertainties with the market response to the Panama Canal improvements will be reduced as experience replaces expectation. IWR does not consider transshipment hubs likely to serve as the primary avenue of foreign imports or exports. As shown in Figure 33, the all-water route to the East Coast already adds 8 to 12 days to delivery. The Panama Canal toll

will take a part of the transportation cost savings. A transshipment hub would add more cost and further increase delivery time. As noted in Chapter 2, the railroads are investing heavily, which will help maintain their competitiveness. These factors seem to weigh against the development of any substantial transshipment hub. In the absence of transshipment centers, *post-Panamax* vessels will call at the ports that are able to accommodate them, and the number of times that they call at each of these ports, their sailing drafts and other dimensions will become known.

However, this kind of a hub and spoke model has reduced airline passenger costs and air freight costs, so the option may be deserving of more analysis. Overall, it could be more economical for some routes and would involve less Federal spending and fewer adverse environmental impacts. The potential barriers include the cost to alter port facilities to accommodate transshipment, additional cargo handling costs, higher shipping costs due to cabotage, and the harbor maintenance tax.[24]

Source: Parsons Brinckerhoff, 2011 (MARAD Panama Canal Expansion, Phase 1 Report)

Figure 33: Travel time comparisons from Asia to Pacific and Atlantic Coast destinations

Getting Ready for *post-Panamax* Vessels

The U.S. population is expected to increase 32 percent from 313.4 million people in 2011 to 412.2 million in 2042, as shown in chapter 2. The two regions expected to grow the most by

[24] GAO, Freight Transportation: Short Sea Shipping Shows Importance of Systematic Approach to Public Investment Decisions, GAO-05-768 (July 2005).

2030 are the South at 43 million and the West at 29 million. IHS-GI has forecast U.S. imports to grow from $2,666 billion in 2011 to $12,444 billion in 2042 to support this population growth. Exports are projected to increase from $2,088 billion to $14,831 billion over the same time period.

San Pedro Bay TEU traffic, representative of West Coast port expectations, is expected to grow to 36.7 million TEUs by 2030. On the East Coast containerized tonnage is expected to grow from 65.66 million tons in 2012 to 146.3 million tons by 2029.

Gulf Coast containerized tonnage is expected to grow from 29.6 million tons in 2012 to 64.6 million tons by 2029.

One-half of the growth in Center Gulf bulk exports is expected to use the Panama Canal and it is projected that the Center Gulf will increase its share of total U.S. exports over the next 10 years. These exports will transit the Mississippi River to the Port of New Orleans.

Carriers are expanding their fleet of vessels with larger ships to serve the current and future global demand. By 2030 p*ost-Panamax* vessels could represent 62 percent of the total TEU capacity of the container vessel fleet. *Post-Panamax* vessels are already calling at some U.S. ports and will call with increasing regularity in the future. The challenge is to invest in capacity expansion in the right places, at the right time, and in the right way in response to the Panama Canal improvements.

The term "*post-Panamax* ready" has to be defined for individual ports. Even as the *post-Panamax* fleet varies in length, width and sailing draft, so too will the required land side facilities, turning basins, channel depths and widths vary at each port to accommodate the characteristics of the specific fleet calling at that port. It is not necessary to be able to accommodate the larger classes of *post-Panamax* vessels to be considered *post-Panamax* ready.

For this report, a port is be considered "*post-Panamax* ready" if it has a channel depth of about 50 feet net of allowances for usable tide, as well as sufficient dock and crane capacity. U.S. West Coast ports at Seattle, Oakland, Los Angeles and Long Beach all have 50-foot channels. Northeastern U.S. ports at Baltimore and New York have or will soon have 50-foot channels. On the Southeast coast, Norfolk has a 50-foot channel. Below Norfolk along the U.S. Southeast and Gulf Coasts, there are no ports with 50-foot channels, although Charleston with a 45-foot channel depth and nearly 5 feet of tide can accommodate most *post-Panamax* vessels. This is also a region with high forecast population and the associated potential for trade growth. To respond to these needs, Miami is deepening their channel and will soon have 50-foot channel depth.

In order to prevent ports from becoming the limiting component of the navigation system, the vision for the system must extend beyond the major ports to include lower tier ports. New, large vessels are typically deployed on the longest and largest trade service – Asia to Northern Europe. The "smaller" vessels on that service are forced to re-deploy to the next most efficient service for that vessel size. This cascading continues until the most marginal vessels in the fleet

are forced to be scrapped. Cascading typically increases average vessel size for each trade service, placing demands on the port infrastructure to support larger capacity vessels. For U.S. ports to be ready to take advantage of *post-Panamax* vessel opportunities, major ports not only need to be "*post-Panamax* ready," but second tier ports need to be "cascade ready" as they in turn have the opportunity to take advantage of larger vessels that begin to service their trade. For the purposes of this report IWR defines "cascade ready" as a channel depth of 45 feet.

Table 8 shows major U.S. ports and their channel depth tidal range by region.

Table 8: U.S. Ports with Channel Depths and Tidal Range by Region

State	Project	Coast	Region	Depth, ft	Neap Tidal Range, ft	Present Container Port	Post-Panamax Ready
MA	BOSTON HARBOR, MA	Atlantic	NE	40	8.7	Yes	N
MD	BALTIMORE HARBOR AND CHANNELS	Atlantic	NE	50	0.6	Yes	Y
ME	PORTLAND HARBOR	Atlantic	NE	35	8.3	Yes	N
NJ	NEWARK BAY (HACKENSACK AND PASSAIC RVS) NJ	Atlantic	NE	50	4.5	Yes	Y
NY	BAY RIDGE AND RED HOOK CHANNELS, NY	Atlantic	NE	40	4.0	Yes	N
NY	BUTTERMILK CHANNEL	Atlantic	NE	40	4.0	Yes	N
NY	EAST RIVER	Atlantic	NE	40	6.5	Yes	N
NY	HUDSON RIVER CHANNEL	Atlantic	NE	45	4.0	Yes	N
NY	NEW YORK HARBOR	Atlantic	NE	50	4.0	Yes	Y
NY	NYNJ CHANNELS (ARTHUR KILLKILL VAN KULL)	Atlantic	NE	50	4.2	Yes	Y
PA	DELAWARE RIVER, PHILADELPHIA TO THE SEA	Atlantic	NE	40	5.0	Yes	N
PR	SAN JUAN HARBOR, PR	Atlantic	NE	39	0.6	Yes	N
RI	PROVIDENCE RIVER AND HARBOR	Atlantic	NE	40	4.0	No	N
VA	CHANNEL TO NEWPORT NEWS, VIRGINIA	Atlantic	NE	50	2.1	Yes	Y
VA	NORFOLK HARBOR, VIRGINIA	Atlantic	NE	50	2.1	Yes	Y
VA	THIMBLE SHOAL CHANNEL, VA	Atlantic	NE	50	2.2	Yes	Y
	DEL R PHILADELPHIA TO TRENTON	Atlantic	NE	40	7.3	Yes	N

	DELAWARE RIVER AT CAMDEN	Atlantic	NE	40	5.7	Yes	N
FL	CANAVERAL HARBOR FL	Atlantic	SE	41	2.9	Yes	N
FL	JACKSONVILLE HARBOR FL	Atlantic	SE	40	1.7	Yes	N
FL	MIAMI HARBOR FL	Atlantic	SE	42	2.2	Yes	N
FL	PORT EVERGLADES HARBOR	Atlantic	SE	42	2.2	Yes	N
GA	BRUNSWICK HARBOR, GA	Atlantic	SE	36	6.0	No	N
GA	SAVANNAH HARBOR	Atlantic	SE	42	6.3	Yes	N
NC	MOREHEAD CITY HARBOR NC	Atlantic	SE	45	2.7	No	N
NC	WILMINGTON HARBOR NC	Atlantic	SE	42	3.9	Yes	N
SC	CHARLESTON HARBOR SC	Atlantic	SE	45	4.7	Yes	With tide
AL	MOBILE HARBOR	Gulf	Gulf	45	1.3	Yes	N
FL	MANATEE HARBOR	Gulf	Gulf	40	0.9	Yes	N
FL	PANAMA CITY HARBOR	Gulf	Gulf	36	1.2	Yes	N
FL	TAMPA HARBOR FL	Gulf	Gulf	43	0.9	Yes	N
LA	CALCASIEU RIVER AND PASS	Gulf	Gulf	40	0.6	No	N
LA	MISS RIVER BATON ROUGE TO GULF	Gulf	Gulf	45	1.2	Yes	N
MS	GULFPORT HARBOR, MS	Gulf	Gulf	36	1.4	Yes	N
MS	PASCAGOULA HARBOR	Gulf	Gulf	42	1.2	Yes	N
TX	BARBOUR TERMINAL SHIP CHANNEL	Gulf	Gulf	42	1.0	Yes	N
TX	BAYPORT SHIP CHANNEL	Gulf	Gulf	42	1.0	Yes	N
TX	BRAZOS ISLAND HARBOR	Gulf	Gulf	42	1.0	No	N
TX	CORPUS CHRISTI SHIP CHANNEL	Gulf	Gulf	45	1.0	No	N
TX	FREEPORT HARBOR	Gulf	Gulf	45	1.0	No	N
TX	GALVESTON HARBOR AND CHANNEL	Gulf	Gulf	45	1.0	No	N
TX	HOUSTON SHIP CHANNEL	Gulf	Gulf	45	1.0	Yes	N
TX	SABINENECHES WATERWAY	Gulf	Gulf	42	0.6	No	N
TX	TEXAS CITY CHANNEL	Gulf	Gulf	45	1.0	No	N
AK	ANCHORAGE HARBOR, AK	Pacific	Pacific	35	23.2	Yes	N
CA	LOS ANGELESLONG	Pacific	Pacific	53	2.2	Yes	Y

	BEACH HARBORS						
CA	OAKLAND HARBOR	Pacific	Pacific	50	3.1	Yes	Y
CA	PORT HUENEME	Pacific	Pacific	36	1.9	No	N
CA	SAN DIEGO HARBOR	Pacific	Pacific	47	2.4	No	With tide
CA	SAN FRANCISCO HARBOR	Pacific	Pacific	40	2.4	N/A	N
OR	COLUMBIA RIVER AT MOUTH, OR AND WA	Pacific	Pacific	48	4.9	Yes	Y
OR	COOS BAY OR	Pacific	Pacific	37	3.8	Yes	N
WA	C AND LW RIVERS BELOW VANCOUVER WA AND PORTLAND OR	Pacific	Pacific	43	1.8	Yes	N
WA	GRAYS HARBOR, WA	Pacific	Pacific	36	4.9	Yes	N
WA	SEATTLE HARBOR, WA	Pacific	Pacific	50	4.0	Yes	Y
WA	TACOMA HARBOR	Pacific	Pacific	51	4.4	Yes	Y

Source: USACE Institute for Water Resources

The need for capacity expansion is likely to be the most critical along the U.S. Southeast and Gulf Coasts. This is indicated by the growth in population and trade as well as the lack of current capacity. South of Norfolk there are no ports that are fully *post-Panamax* ready. The ports of Savannah, Charleston and Miami are at various stages of capacity expansion. Successful development at these ports would fill the critical need on the Southeast coast. However, there may be a need for "cascade ready" expansion at some of the smaller ports.

There are 10 deep draft navigation projects along the Gulf Coast with container yards and related infrastructure. Depths of these projects range from 36 to 47 feet. None of these ports is considered *post-Panamax* ready. Several ports in the Gulf are under study to deepen their channels to be better prepared for larger drafting vessels, including the Mississippi River from Baton Rouge to the Gulf and the Texas ports of Freeport, Corpus Christi and Island Harbor in Brownsville. A recently completed study of a proposal for Sabine Neches estimated that deepening its channel to 50 feet would cost more than $1 billion and would yield a positive economic return. On the Gulf coast the lack of channel depth is exacerbated by the small tidal window, which is generally one to two feet.

There may also be opportunities at other ports around the country to increase the width of channels and turning basins to accommodate the longer, wider design of new container vessels.

How Much Depth Is Needed?

In the past, larger vessels have always meant deeper drafts. This is the nature of bulk vessels and for a time held for container vessels as well. However, recent designs in container vessels have tended towards longer, wider vessels with "U" shaped as opposed to "V" shaped hulls. Maersk, the largest carrier in the world, has recently introduced two classes of these new

designs. The *Maersk Triple E*, scheduled to begin deployment in 2013 will carry 18,000 TEUs. Its physical dimensions are 1,300 feet long, 194 feet wide with a design draft of 47.6 feet. This compares to the *Emma Maersk*, formerly the largest containership in the world, a 15,000 TEU capacity vessel with a 51 foot draft. The second vessel design may be of more interest. Maersk's SAMMAX vessel, designed to take advantage of the expanded Panama Canal for the South American trade, was designed to carry 7,450 TEUs.[25] Maersk has ordered 16 of these vessels. Two were put into service in 2011. The vessels measure 984 feet long and have a beam of 147 feet. Their design draft is only 39 feet. Maersk claims these vessels are 8 percent more efficient than other vessels of similar capacity. If these designs prove to be effective there will likely be other intermediate sizes designed for other markets.

Weight Trade and Volume Trade Services

The maximum capacity of container vessels can be limited by either the maximum vessel sailing draft or by the number of containers they can carry. Depending upon the weight of cargo in the containers, this limit can either be by weight (maximum draft) or volume (slot capacity). That is, lighter cargo will draft less than heavier cargo for the same number of containers. This can be measured by cargo density, i.e., the average weight per container on a vessel expressed as metric tons per TEU. Cargo density is expected to vary dependent upon the commodities handled by different trade routes. Vessels operating on trade routes from foreign ports that typically ship lighter commodities are expected to have lower cargo densities and thus will arrive at U.S. ports drafting less than their design draft. Other factors that can affect containership loading include limitation due to line of site and lashing requirements.

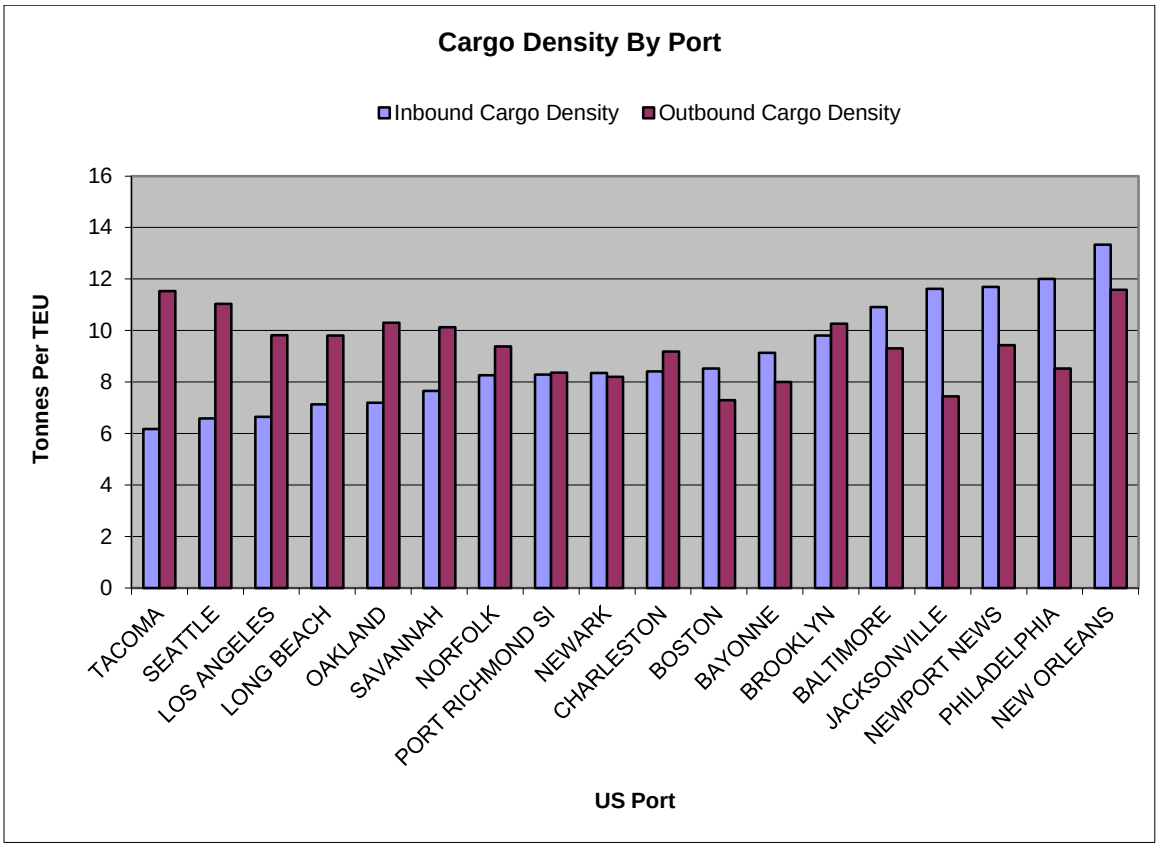
IWR has performed an analysis of vessel trade data for U.S. ports to examine the issues of cargo density by port, trade route and vessel class. The methodology involved use of two comprehensive data sources: 1) information collected on waterborne commerce by IWR's Waterborne Commerce Statistics Center (WCSC) and 2) automated identification system (AIS) data on global container vessel movements, previously acquired from the private maritime data provider Lloyd's Register–Fairplay, now IHS Fairplay. AIS data allows analysis of container vessel movements over time to determine trade routes, but does not contain any information on cargo transfers. WCSC data supports analysis of cargo transfers by weight and volume at U.S. ports, but does not provide information on global vessel movements. Combined, the two data sources provide a picture of historical vessel movements and can be used to estimate cargo density of container vessels by vessel class and trade route.

The cargo density analysis was carried out utilizing AIS 2006 to 2008 data and WCSC 2006 to 2009 data. AIS data was matched with WCSC data for the period 2006-2008 to provide cargo transfer information that could be analyzed at the service level. WCSC data for the full period of availability (2006-2009) was analyzed at the trade region level for movements between U.S. regions, Asia and Europe.

[25] Save the Cape, Inc. Panamax, Post-Panamax, and Sammax. A Primer on Ship Size.

The analysis was oriented towards examination of cargo density and arrival drafts. The results confirm the existence of weight and volume trades.

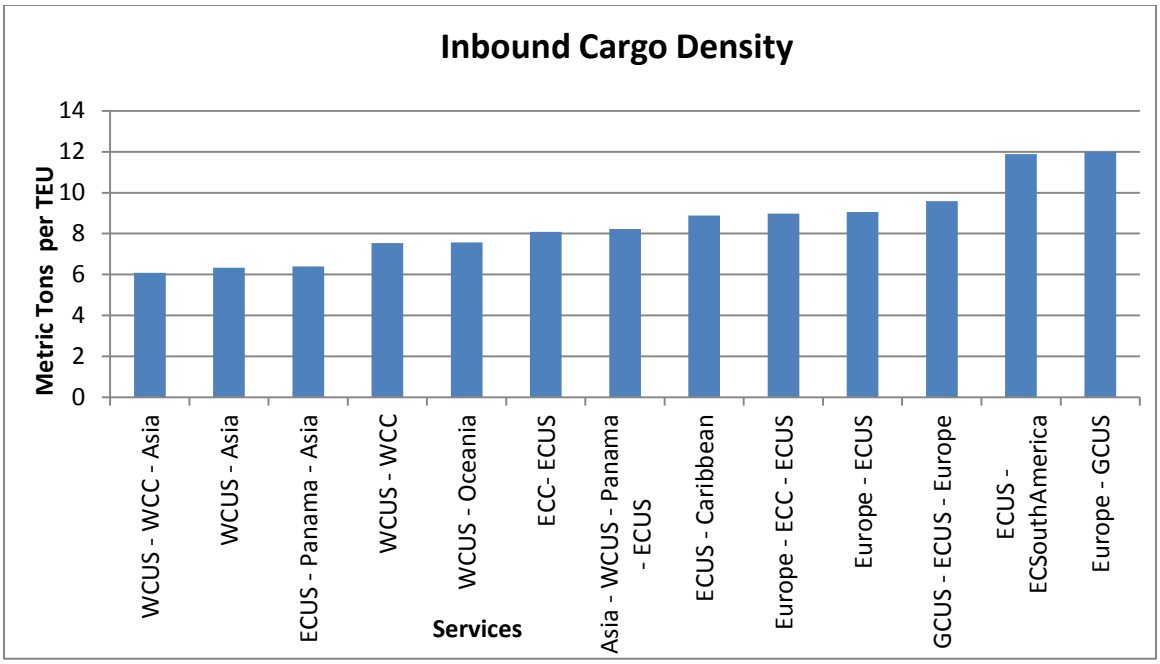
Figure 34 shows the average cargo density, in metric tons per TEU, based on WCSC data from 2006 through 2008, at a selection of U.S. ports. As can be seen from the figure, inbound cargo density is significantly lower at the West Coast ports, where traffic is primarily from Asia. This suggests that vessels arriving at these ports are volume limited, rather than weight limited.



Source: USACE Institute for Water Resources

Figure 34: Cargo Density at U.S. Ports

Using AIS data, it is possible to characterize vessel movements as being part of services, depending upon where they travel. As shown in Figure 35, there is a clear indication of volume and weight trades, based on inbound cargo density, with volume trade predominant on the West Cost – Asia services and weight trade predominant on East Coast / Gulf Coast – Europe services.



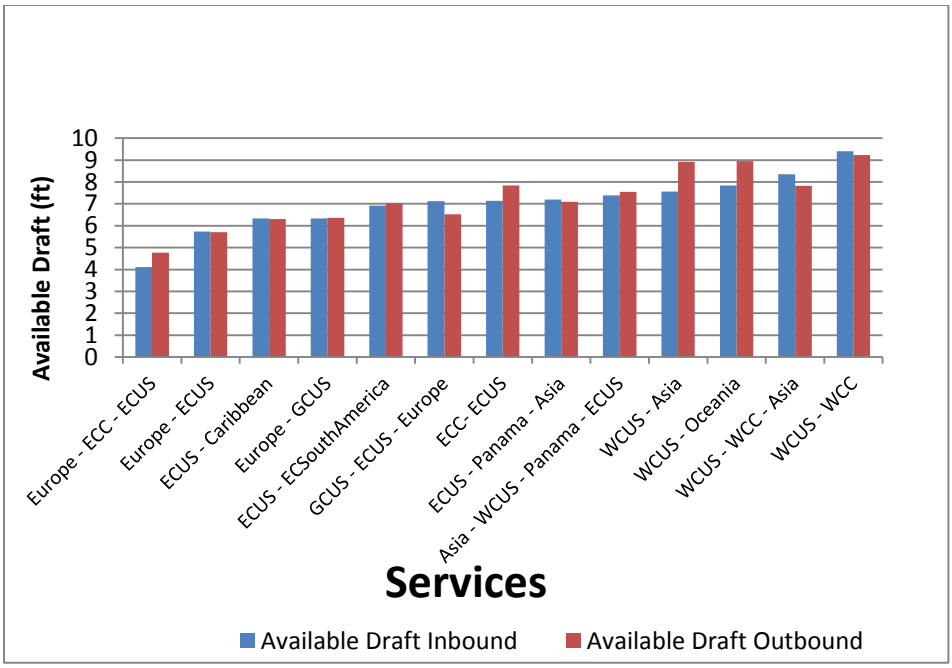
Source: USACE Institute for Water Resources

Figure 35: Average Cargo Density by Service

Trade regions in Figures 35 and 36 are abbreviated as follows:

- WCUS – West Coast United States
- WCC – West Coast Canada
- ECUS – East Coast United States
- ECC – East Coast Canada
- GCUS – Gulf Coast United States

In order to further explore the issue of weight vs. volume trades, the arrival and departure draft of the vessels making calls at U.S. ports for which services were identified was compared with the maximum draft of the particular vessel, leading to an "available draft," i.e. the maximum draft less the arrival or departure draft. This serves as an indication of the degree to which the particular vessel is utilizing all of its draft. As can be seen from Figure 36, services for U.S. East Coast ports tend to have lower available draft on arrival and departure than do services using West Coast ports. The increased available outbound draft for West Coast ports is likely due to returning empty boxes. WCSC data does not provide information on shipment of empties, so this cannot be verified through the currently available data, but is consistent with expectations.



Source: USACE Institute for Water Resources

Figure 36: Available Draft (maximum design draft less average sailing draft) by Service

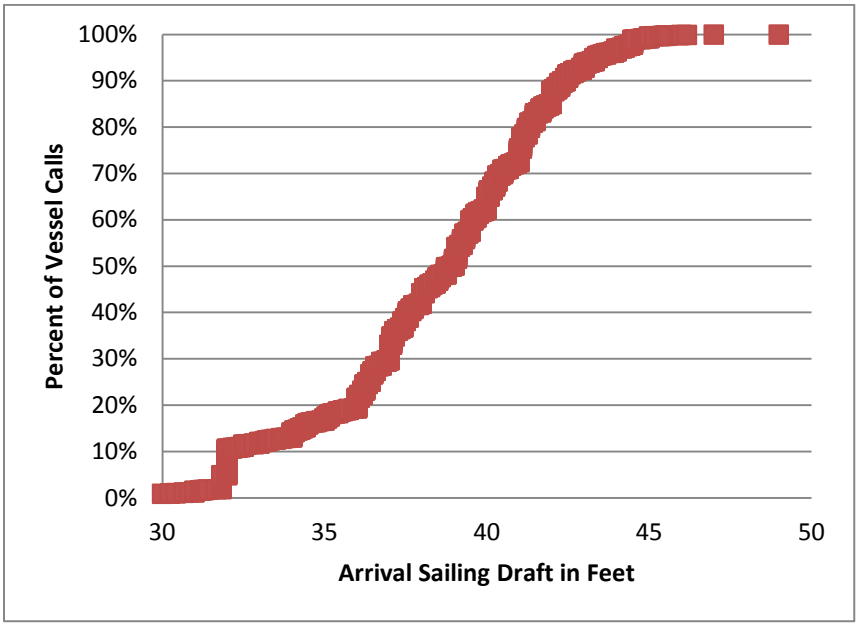
Examining direct trade between U.S. ports and Europe and Asia, using WCSC data, as shown in Table 9, the inbound cargo density is lowest for the West Coast – Asia trade, highest for the East Coast – Europe Trade. Deployment of the largest vessels on the West Coast - Asia Trade is also seen.

Table 9: Cargo Density and Available Draft By Trade Region, WCSC Data

Number of Calls	Vessel Class	Average Cargo Density (tonnes/TEU)	Average Available Draft (ft)	U.S. Port Trade Region	Foreign Port Trade Region
1483	Post-Panamax Generation 2	5.76	8.54	West Coast North America	Asia
268	Post-Panamax Generation 1	6.02	8.25	U.S. Atlantic	Asia
3383	Post-Panamax Generation 1	6.11	8.09	West Coast North America	Asia
3019	Panamax	6.16	6.25	West Coast North America	Asia
1093	Panamax	6.23	6.1	U.S. Atlantic	Asia
743	Sub-Panamax	6.46	3	West Coast North America	Asia
410	Post-Panamax Generation 1	8.48	7.35	U.S. Atlantic	Europe
1947	Panamax	9.07	4.71	U.S. Atlantic	Europe
1191	Sub-Panamax	9.39	2.86	U.S. Atlantic	Europe

Source: USACE Institute for Water Resources

To illustrate the importance of cargo density to sailing draft, Figure 37 shows the arrival draft for 2,479 *post-Panamax* vessel calls at the San Pedro Bay ports from 2006 through 2008. Only 12 vessel calls recorded an arrival draft of greater than 45 feet in the WCSC data.



Source: USACE Institute for Water Resources, Waterborne Commerce Statistics Center

Figure 37: Arrival Drafts of *post-Panamax* Vessels at LA/LB from Asia

Analysis of both the WCSC and AIS data sets clearly shows the existence of weight and volume trades, with vessels arriving at the West Coast of the U.S. from Asia at lower cargo densities than vessels arriving on the East Coast from Europe. Vessels arriving from Asia to the West Coast show greater available draft, most likely due to the lower cargo density.

Inland Waterways

USACE supports the safe, reliable, efficient, and environmentally sustainable movement of vessels on 12,000 miles of inland and intracoastal waterways. The waterways are the primary artery for half of the nation's grain and oilseed exports, 20 percent of coal for utility plants, and 22 percent of domestic petroleum movements.[26] USACE's role includes maintaining the 191 commercially active lock sites with 238 chambers that allow tows to "stair-step" through the nation's heartland.

This Center Gulf region, served by the Mississippi River and its navigable tributaries, could be a beneficiary of an expanded Panama Canal for exports. The Lower Mississippi is currently maintained to a depth of 45 feet. A 50-foot deep Panama Canal will allow current *Panamax* vessels transiting the Canal to be loaded to their full draft of 42 feet to 45 feet, a significant improvement over the current 39.5 feet. For the vessels with a 45 foot draft leaving New

[26] Grier, David. USACE Institute for Water Resources, The Declining Reliability of the U.S. Inland Waterway System.

Orleans at 39.5 feet heading for Asia, transportation cost saving gained by loading to 45 feet will be about $0.05 per bushel.

USACE completed the UMR-IWW System Navigation Feasibility Study in December 2004. In 2008, the *Re-evaluation of the Recommended Plan: UMR-IWW System Navigation Study – Interim Report*, a re-evaluation of the feasibility report recommended plan, was completed. Economic models of the river system were developed as part of this study and were used to assess the ability of the current system to handle potential increases in river traffic resulting from shift of mode benefits to Asia.

Informa Economics, Inc. estimates that the larger, more efficient *Cape* class ships reduce the cost of the movement of grains to northeast Asia by an all-water Panama Canal route by $0.31 to $0.35 per bushel of grain.[27] Assuming the Informa grain forecast and the re-evaluation report non-grain forecasts (163 million short tons in 2020), not all potential demand could be accommodated in 2020 with the current system infrastructure. However, using the alternative analysis assuming the Informa grain forecast and no growth in non-grain (87 million short tons), all potential traffic could be accommodated without waterway infrastructure efficiency improvements.

Beyond the sensitivity to non-grain traffic growth, several points regarding the accommodated/ unaccommodated traffic conclusions should be emphasized: (1) The time horizon for these conclusions is 2020. With additional traffic growth beyond 2020 there would be a greater magnitude of unaccommodated traffic (in the case of Informa grain and re-evaluation report non-grain), or an eventual state where at least some traffic would no longer be accommodated (in the case of Informa grain and no growth in non-grain). (2) The only constraint to traffic accommodation that has been considered is inland waterway infrastructure. In particular, landside infrastructure and deep-water port infrastructure have not been addressed in making inland waterway accommodated/unaccommodated traffic conclusions. (3) The determination that traffic can be accommodated in the future does not mean that it will be accommodated at existing cost levels. Given the willingness to pay for water transportation, some increases in cost can be incurred before shippers make the decision to no longer use the waterway. Any increase in traffic over the lock and dam portion of the system will result in additional congestion and cost. (4) The implementation timeframe for the subset of authorized UMR-IWW improvements that is sufficient to address improved waterway efficiency and "capacity" from a system perspective is no earlier than the mid 2020s.

Summary

The deployment of *post-Panamax* vessels will have impacts throughout the Nation's freight transportation system. To prepare for these vessels, ports will seek to widen and/or deepen

[27] Panama Canal Expansion: Impact on U.S. Agriculture, Informa Economics, September 2011. Note: This estimate of transportation cost savings assumes a Cape class vessel.

their channels and turning basins. Whether the port is preparing to be *post-Panamax* ready or cascade ready will depend on the specific needs and opportunities of the individual port. An analysis of population and trade growth, coupled with a survey of current port capacities, has shown the Nation's most critical needs are along the Southeast and Gulf Coasts.

The export of agricultural and other bulk commodities depends on the inland waterways. A comparison of the current system capacity with forecast increases in agricultural exports indicates adequate capacity through 2020 and possibly beyond. To take advantage of these export opportunities will require the maintenance of inland waterway capacity that serves these exports. The impact of *post-Panamax* vessels is not anticipated to necessitate the expansion of inland waterway locks.

Chapter 4: Environmental Impacts of Capacity Expansion

Chapter Purpose and Approach

The purpose of this chapter is to describe the existing environmental footprint of ports, waterways, and intermodal links to inform future possibilities and then compare modernization impact possibilities in regions of the United States that are most likely to be adversely impacted.

Potential environmental impacts and mitigation needs are important aspects of planning for port and waterway modernization in response to increasing international freight transport, intermodal container-based shipment in larger oceanic vessels, and Panama Canal enlargement. Although much investigation of modernization needs has transpired, as attested to in previous chapters, the environmental impacts have received much less attention. Mitigation costs can be substantial. At the Port of Savannah, for example, mitigation costs are about 45 percent of the total estimated harbor expansion cost.[28] Environmental rules and permit requirements have become more stringent as their benefits became clearer. Emphasis on effective environmental impact mitigation is expected to continue, if not increase, and to be an essential consideration in determining modernization costs and net benefits.

Possible adverse environmental impacts are based on indicators of potential impact sources and vulnerabilities of human populations and natural and cultural resources. Consistent with environmental goals established in the National Environmental Policy Act (NEPA), the vulnerability metrics were selected to indicate potential impacts on public health and safety (including the social inequity of many impacts), the sustainability of important resource heritage, and environmental services that support commercial, recreational, and other uses of natural marine, estuarine, freshwater and shore resources. The impact-source metrics indicate regional rates of freight transport growth based on regional population growth over the next three decades, the unused capacity of ports compared to percent growth in regional population, harbor expansion needs for acceptance of the largest *post-Panamax* vessels, and possible effects of Panama Canal enlargement. While specific port and waterway environmental assessments and impact statements were consulted, they were not uniformly available or comparable across regions. The Indicators were selected based on their national comparability across regional ports, reliability (mostly Federal databases), and representativeness. More detailed information can be found in a supporting IWR report.[29]

[28] Mayle, M. C. and M. Landers. 2012. Corps, GPA: Deepen river to 47 feet. Savannah, GA: Savannah Morning News, April 12, 2012.

[29] Cole, R. A., J. Y. Chung and S. B. Komlos 2012. The past environmental footprint and possible future environmental impact mitigation needs of port and waterway modernization in the United States.

The Environmental Footprint

Despite much improvement of impact mitigation since more stringent and comprehensive environmental laws were passed, the cumulative effects of adverse impacts from transportation system development and operations have left a significant environmental footprint. These impacts also interact with other sources of impact to degrade environmental quality. In the following subsections, the environmental footprint is first placed in perspective by geographic comparison to other sources of impact. Then the nature of past sources of the environmental footprint is summarized.

The Environmental Footprint

Much of the conterminous United States has been altered by land and water development and use. The change has been beneficial for the most part, but a large fraction of the Nation's natural environment has been replaced with substantially different qualities that have compromised important natural services in support of human welfare. About 13 percent of the conterminous United States is now reserved for light use in parks, wildlife refuges, and wilderness areas where most natural qualities prevail.[30] Another 56 percent is more intensively used for forest management, grazing and other use that sustains many natural qualities except where management is lax. Many natural qualities have been lost from the 27 percent used for intensive crop culture and rural residential development. The remaining 4 percent is densely urban or used for rural transportation. It includes the geographical area of landside port, highway and railroad impact, which is about 1.6 percent in total. Relatively few natural qualities remain in the footprint of these densely impacted areas.

Despite many benefits, human use and transformation of the landscape has come at significant environmental cost. It has cumulatively degraded some commercial and recreational use of resources.[31] It has contributed to health and safety concerns[32] and to probable or possible extinction of at least 240 American species, and the decline of many more.[33] While the freight transportation system has directly impacted a small percent of the total impacted area of the conterminous United States, the effects often are intense, extend well beyond directly impacted areas, and sometimes interact synergistically with other sources of adverse environmental impact.

The geographical impact of land and water use described above provides a high-altitude perspective that misses the growing scarcity of wetland and open-water environments, which are disproportionately impacted by ports and waterways. Wetlands have been reduced from

[30] Lubowski, R. N., M. Vesterby, S. Bucholtz, A. Baez, and M. J. Roberts. 2006. *Major Uses of Land in the United States, 2002/EIB-14* Economic Research Service/USDA, Washington D. C.
[31] Millennium Ecosystem Assessment. 2005. Ecosystems and human well-being: Synthesis report. Island Press, Washington DC.
[32] Frumkin, H. Editor. 2010. Environmental health: From global to local. John Wiley & Sons, Inc. San Francisco, CA.
[33] Master, L. L., B. A. Stein, L. S. Kutner, and G. A. Hammerson. 2000. Vanishing Assets. Chapter 4 *In* B. A. Stein, L. S. Kutner, and J. S. Adams (Editors). Precious Heritage: The status of biodiversity in the United States. Oxford University Press, New York, NY

about 11.1 percent to about 5.3 percent.[34] During the past decade, tidal wetlands have been further reduced by the cumulative effects of rising sea level, channelization, sediment deprivation, other human impact, and hurricanes.[35] Now they are especially scarce, making up only 0.3 percent of the conterminous United States.

Open waters comprise 5.3 percent of the conterminous United States, including the American portion of the Great Lakes and coastal oceanic waters to the 12-mile territorial limit.[36] Without the Great Lakes and artificial reservoirs, the non-tidal inland waters of the conterminous U. S. amount to less than 1 percent of the total, much of that in lakes. The remaining free-flowing streams and rivers have become increasingly scarce and are now about 0.5 percent of the total area.[37]

Despite improvements in recent decades, freshwaters have been hit hard by physical, chemical and biological changes. Reservoir construction has increased the Nation's total open-water area in total while reducing the area of free-flowing water. Numerous non-native aquatic species are well established and some have costly effects.[38] Nearly 50 percent of streams and lakes remain unnaturally contaminated with nutrients, sediment, heavy metals and synthetic organic compounds.[39] As a consequence of these changes, about five times as many freshwater species as terrestrial species went extinct.[40] [41] Species extinction and imperilment is concentrated in areas with active ports and waterways, especially along the Pacific Coast, Southeastern Coast, and in states bordering the Ohio, Tennessee and Mississippi waterways.[42] [43]

Impacts of Transportation System Infrastructure

Development of highways, railroads and other land transportation infrastructure converted about 50,000 square miles (1.6 percent) of natural landscape to uninhabitable area for native species.[44] Freight transport has diverse environmental impacts.[45] Perhaps more damaging than

[34] Dahl, T. E., and G. J. Alford. 1996. History of Wetlands in the conterminous United States. Pages 19-26 In J.D. Fretwell, J. S. Williams and P. J. Redman (Editors). National water summary on wetland resources. U. S. Geological Survey Water Supply Paper 2425. Washington D. C.

[35] Dahl, T. E. 2012. Status and Trends of Wetlands in the Conterminous United States 2004 to 2009. U. S. Fish and Wildlife Service. Washington, DC

[36] U. S. Census Bureau. 2012a: Table 358. Land and water area of states and other entities, 2008. 2012 Statistical Abstract of the United States. Department of Commerce. Washington, DC

[37] See Cole et al. 2012 for documentation

[38] Pimentel, D., S. McNair, S. Janecka, J. Wightman, C. Simmonds, C. O'Connell, E.Wong, L. Russel, J. Zern, T. Aquino and T. Tsomondo. 2001. Economic and environmental threats of alien plant, animal and microbe invasions. Agriculture, Ecosystems and Environment 84:1-20.

[39] U.S. Environmental Protection Agency, U.S. Army Corps of Engineers. 2007. The Role of the Federal Standard in the Beneficial Use of Dredged Material from U.S. Army Corps of Engineers New and Maintenance Navigation Projects. EPA842-B-07-002. Office of Water, U.S. Environmental Protection Agency, Washington, DC 20460

[40] Ricciardi and Rasmussen 1999

[41] Cole, R. A. 2009. The sustainability of freshwater species and water resources policy in the United States. USACE Institute for Water Resources 09-R-9. U. S. Army Corps of Engineers, Alexandria, VA

[42] Master et al. 2000

[43] Stein, B. A., L. S. Kutner, G. A. Hammerson, L. L. Master, and L. E. Morse. State of the states. Chapter 5 *In* B. A. Stein, L. S. Kutner, and J. S. Adams (Editors). Precious Heritage: The status of biodiversity in the United States. Oxford University Press, New York, NY

[44] Lubowski et al 2006

lost area of natural habitat is the habitat fragmentation that contributes to declines of numerous terrestrial and semi-aquatic species.[46] [47] [48] Highways have greater impact than railroads because they cover more miles and a much greater area. Highways in particular alter hydrology and contribute to contaminated runoff.[49] [50]

The geographical footprint of harbor and waterway infrastructure is much less than land-based transportation infrastructure. Over 926 harbors and 12,000 miles of waterways have been developed and are maintained by the U.S. Army Corps of Engineers.[51] The estimated total footprint is about 3,000 square miles. The estimate provides a basis for comparison despite uncertainty.[52] The estimated total geographical footprint is about 10 percent of the estimated 29,000 square miles of free-flowing rivers, natural lakes other than the Great Lakes, and estuarine wetlands, but many effects were temporary.[53]

Many lock and dam effects are permanent. The adverse effects of navigation reservoirs on species survival are well established. [54] [55] [56] Waterway impoundments cover about 500 square miles of natural river channel with deeper, slower water. Impoundment effects on river hydraulics are frequently cited as among the major factors contributing to the decline of riverine species, but especially freshwater mollusks.[57] [58] Many of these species are protected under the ESA.

Another 7,000 miles of river and coastal shore was disturbed by excavation, dredged material disposal, and boat and barge use—about 400 square miles altogether. About 300 square miles of harbor channels were similarly disturbed. Annual maintenance dredging ranged up to 300

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[45] Hecht, J. 1997. The environmental effects of freight. Presented to the Joint Session of Trade and Environment Experts, Organisation for Economic Co-operation and Development. Paris, France http://www.oecd.org/dataoecd/14/3/2386636.pdf

[46] Fahrig, L., Pedlar, J. H., Pope, S. E., Taylor, P. D., and Wagner, J. F. 1995. Effect of road traffic on amphibian density. Biological Conservation 73:177-182.

[47] Forman, R. T. T., and Alexander, L. E. 1998. Roads and their major ecological effects. Annual Review of Ecology and Systematics 29:207-231.

[48] Trombulak, S. C., and C. Frissell. 2000. Review of ecological effects of roads on terrestrial and aquatic communities. Conservation Biology 14(1):18-30.

[49] Gjessing, E., E. Lygren, L. Berglind, T. Gulbrandsen, and R. Skanne. 1984. Effect of highway runoff on lake water quality. Science of the total environment 33:247-257.

[50] Jones, J.A., F.J. Swanson, B.C. Wemple and K.U. Snyder. 2000. Effects of roads on hydrology, geomorphology, and disturbance patches in stream networks. Conservation Biology 14:76-85.

[51] USACE (U. S. Army Corps of Engineers). 2010. U. S. waterway system facts. Washington, DC http://www.ndc.iwr.usace.army.mil//factcard/fc02/factcard.htm

[52] see Cole et al. 2012 for methods

[53] Allen, K.O. and Hardy. J. W. 1980 Impacts of Navigational Dredging on Fish and Wildlife: A Literature Review FWS/OBS-80/07. U.S. Department of the Interior, Fish and Wildlife Service. Washington, D.C.

[54] Neves, R. J., A. E. Bogan, J. D. Williams, S. A Ahlstedt,and P. W. Hartfield. 1997. Status of aquatic mollusks in the southeastern United States: a downward spiral of diversity. Pages 43-85 *in* G. W. Benz and D. E. Collins, eds. Aquatic fauna in peril: the Southeastern perspective. Special Publication 1, Southeastern Aquatic Research Institute, Lenz Design and Communications, Decatur, GA.

[55] Parmalee, P. W. and A. E. Bogan. 1998. The freshwater mussels of Tennessee. The University of Tennessee Press, Knoxville, TN

[56] Cole 2009

[57] Parmalee and Bogen 1998, Neves et al. 1997

[58] Watters, G. T. 1999. Freshwater mussels and water quality: A review of the effects of hydrologic and instream habitat alterations. Pages 261-274, Proceedings of the First Freshwater Mollusk Conservation Society Symposium.

million cubic yards/year[59] since the waterways were virtually completed 40 years ago and averaged perhaps half of that rate during the time period most modern waterways were developed from 1930 to 1970. Deposited to a depth of 10 feet, material from maintenance dredging would cover about 1,800 square miles of aquatic and upland habitat. About 10 percent of the disposed dredged material was severely contaminated with toxic materials.[60] Environmental laws now require proper treatment and containment.

Numerous studies of dredging effects completed after NEPA and the Clean Water Act were passed were reviewed by Allen and Hardy.[61] In general, dredging temporarily reduced bottom organism abundance except in highly altered environments, such as contaminated sediment and deep channels where depressed productivity and altered species composition often persist. Sediment toxicity effects bottom organisms, fish and other predators and humans at the end of the food chain.[62] Deepening channels in estuaries can allow saline water to penetrate deeper into freshwater ecosystems where it may damage wetlands and contaminate water supplies.[63] [64] Rising sea level associated with global warming may worsen these effects. Dredging in some scarce ecosystems has had more persistent adverse effects on productivity and species composition, including unavoidable take of threatened and endangered species[65] in shallow estuary wetlands[66] and coral reefs. Dredging impacts on threatened and endangered species have improved significantly. Sea turtle take, for example, has been reduced to about 35 per year, which is a small fraction of total human-caused mortality. Past disposal on land created new habitat that could be more or less desirable than original habitat, depending on the site and its management. Islands created incidentally from dredged material disposal provided beneficial refuges for birds[67] before dredged material was intentionally used for that and other beneficial purposes.

Following institution of strong laws and executive orders, Corps policy in recent decades has emphasized protection of healthy wetlands and effective containment and treatment of contaminated sediments. In 1992, the Corps was authorized to beneficially use dredge material

[59] Francingues Jr., N. R., M. R. Palermo, C. R. Lee, and R. K. Peddicord. 1985. Management strategy for disposal of dredged material: Contaminant testing and controls. Miscellaneous Paper D-85-1. U. S. Army Corps of Engineers, Engineer Research and Development Center. Vicksburg, MS.

[60] Francinques et al.1985

[61] Ibid.

[62] Burton, G. A. and P. F. Landrum. 2005. Toxicity of sediments. Pages 478-571 *In* G. V. Middleton, M. J. Church, M. Carigilo, L. A. Hardie, and F. J. Longstaff (Editors). Encyclopedia of sediments and sedimentary rocks. Springer-Verlag. New York, NY

[63] PIANC Working Group no. 6. 1993. Problems caused by saltwater infiltration. Appendix 3: Summary of saltwater intrusion problems due to inland navigation channels in the United States. Permanent International Association of Navigation Congresses. Brussels, Belgium

[64] Savannah District Corps of Engineers. 2011. Draft tier II environmental impact statement for the Savannah Harbor expansion: Chatham County, Georgia and Jasper County, South Carolina. U. S. Army Corps of Engineers. Savannah, GA

[65] U. S. Army Corps of Engineers. 2006. USACE sea turtle data warehouse. Washington, DC. http://el.erdc.usace.army.mil/seaturtles/intro.cfm

[66] Ray, G. L. 2007. Ecological Functions of Shallow, Unvegetated Estuarine Habitats and Potential Dredging Impacts (with emphasis on Chesapeake Bay). ERDC TN-WRAP-05-3. U. S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, MS.

[67] Landin, M. C. and R. F. Soots. 1978. Colonial bird use of dredged material islands: A national perspective. Proceedings of the Colonial Waterbird Group:Volume 1. Waterbird Society, Waco, TX http://www.jstor.org/stable/1520902

for environmental improvement. About 20 to 30 percent of dredged material is now being used beneficially.[68]

Impacts of Transportation System Operations

For many people, the transportation system impacts of greatest concern are the adverse effects of atmospheric emissions associated with fuel consumption, including greenhouse gas emissions. Fuel efficiency is an important consideration in seeking the most beneficial combination of transport modes, including atmospheric impacts. The land- and water-based freight transportation system consumes 8.6 percent of the total energy used.[69] While large ocean-going vessels in general are highly fuel efficient,[70] smaller vessels, such as those used for waterway barge transport, are substantially less so. Separate assessments by USDOF [71]and OEE[72] indicate that freight trains and smaller freight vessels have similar fuel efficiencies, but that trains and trucks have been improving while waterway vessels have not. Trucks consume over 72 percent of freight-transport energy used, largely because of fuel inefficiency.[73] Greenhouse gas emissions from the different transport modes exhibit similar ratios.[74] Reducing truck traffic in favor of train and barge is often promoted but difficult to accomplish. Trucks need to be used at points of freight origin and delivery and, despite higher fuel costs, are the most cost-effective mode for short freight hauls.[75]

Because property values are typically lower near sources of pollution, congestion, and unpleasant appearance, people with low income are more likely to be impacted. This inequitable impact is inconsistent with national environmental policy and recent presidential emphasis on executive order 12898 on environmental justice.

Among other effects of operations, vessel wakes contribute to shoreline erosion, including wetland and bottom community changes.[76] [77] [78] Vessel-caused turbulence also disturbs bottom communities and contributes to turbidity,[79] which deprives submerged plants and sight-feeding species of necessary light. However, this is a minor source of turbidity compared to nutrient enrichment and sediment runoff resulting from human caused changes in watersheds. Vessel,

[68] U.S. Environmental Protection Agency, U.S. Army Corps of Engineers. 2007
[69] U. S. Department of Engergy. 2012. Transportation energy data book. 30th Edition. http://cta.ornl.gov/data/index.shtml
[70] Economic Development Research Group, Inc. 2012. Panama Canal Expansion Study Phase 1 Report: Developments in Trade and National and Global Economies. *Prepared for:* The United States Department of Transportation, Maratime Administration. Washington, DC
[71] IBID
[72] OEE (Office of Energy Efficiency). 2011. Energy use handbook tables (Canada). Natural Resources Canada. Ottawa, Ontario
[73] USDOF 2012
[74] OEE 2011
[75] Economic Development Research Group, Inc. 2012
[76] Koch, E. W. 2002. Impact of boat-generated waves on seagrass habitat. Journal of Coastal Research 37: 66-74
[77] Bishop, M. J. 2005a. Displacement of epifauna from seagrass blades by boat wake. Journal of Experimental Marine Biology and Ecology 354:111-118
[78] Bishop, M. J. 2005b. Joint effects of boat wake and dredge spoil disposal on sediments and assemblages of macro-invertebrates. Estuaries, 28: 510–518
[79] Allen and Hardy 1980

port, train and truck operations often are sources of oil, metals, and other water pollutants.[80] Vessel cargo and ballast water have been major vectors for non-native invasive species with adverse environmental effects.[81] [82] Trucks and trains are major means for nonnative species invasion of inland areas.[83] All modes contribute to inequitable exposure of low income and minority groups to unhealthy pollutants and noise.[84] Intermodal trucks contribute to vehicular traffic congestion. Ports have been addressing these problems, but according to critics can improve further.[85] [86]

Impacts of Accidents

Accidents not only threaten human safety and health, but scarce ecosystems and species as well. Accidents often receive attention disproportionate to their contribution to all transportation system impacts, but can be locally to regionally costly as signified by large oil spills, which are most associated with vessel collisions and pipeline breaks.[87] Accidents in and around ports are a function of increasing traffic rates and counteractive measures.[88] Vessel collision with endangered whales, sea turtles, fish and other species is a concern in a number of port areas.[89] [90] Recently imposed regulation of vessel speeds may reduce that source of mortality. Vehicular traffic is a threat to some endangered species.[91]

Future Environmental Impact Vulnerabilities and Possibilities

Given the uncertainty about where and what form and extent transport system modernization actually takes place, regional forecasts of adverse impact and mitigation needs are uncertain. Other environmental and social changes only amplify that uncertainty, including the potential effects of sea level change on *post-Panamax* depth requirements and associated adverse impacts. Instead of specific forecasts, indicators of human and resource vulnerabilities and possible sources of adverse impacts were used to discuss regional differences and similarities.

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[80] Bailey, D., T. Plenys, G. M. Solomon, T. R. Campbell, G. R. Feuer, J. Masters, and B. Tonkonogy. 2004. Harboring pollution: The Dirty Truth about U.S. Ports. Natural Resources Defense Council, Washington DC

[81] NRC (National Academies of Science) 1996. Stemming the tide. Controlling introductions of nonindigenous species by ships' ballast water. National Academies of Science. Washington DC

[82] Corn, M. L., E H. Buck, J. Rawson, A. Segarra, and E.Fischer. 2002. *Invasive Non-Native Species: Background and Issues for Congress.* CRS Report RL30123 Congressional Research Service, Washington, DC

[83] Greenberg, D.H., S.H. Crownover, and D.R. Gordon. 1997. Roadside soil: a corridor for invasion of xeric scrub by nonindigenous plants. Natural Areas Journal 17:99-109.

[84] Rhodes, E. L. 2003. Environmental Justice in America. Indiana University Press: Bloomington, IN

[85] Bailey et al. 2012

[86] Cannon, J. S. Undated. U.S. Container Ports and Air Pollution: A Perfect Storm. Energy Futures, Boulder, CO http://s3.amazonaws.com/energy-futures.com/port_study_ef.pdf

[87] Etkin, D.S. 2001. Analysis of oil spill trends in the United States and worldwide. *Proceedings,* 2001 International Oil Spill Conference. American Petroleum Institute, Washington, DC.

[88] Etkin 2001

[89] Vanderlann, A. S. M. and C. T. Taggart. 2006. Vessel collisions with whales: The probability of lethal injury based on vessel speed. Marine Mammal Science 23:144-156.

[90] Laist, D. W. and C. Shaw. 2006. Preliminary evidence that boat speed restrictions reduce deaths of Florida manatees. Marine Science 22:472-479.

[91] Fahrig et al. 1995

Environmental assessments and environmental impact statements for individual actions were consulted, but varied greatly in coverage and were difficult to compare directly across regions. Eleven quantified indicators of environmental vulnerability and sources of modernization impact were used. The indicators were selected based on environmental impact history data, comparability across regions, quantification, reliability and representativeness. All data were gathered by authorized Federal agencies.

Potential Environmental Impacts at Ports

The indicators of the potential regional impact of future modernization and need for mitigation are shown in Table 10 with footnotes about each metric used. The metrics indicate environmental vulnerabilities in the vicinity of port locations. They include vulnerabilities of human populations (air emission fractions, water discharge permits, superfund sites, and low income and minority groups), cultural and natural resources of important heritage value (official reserves, wetlands, and endangered species), and beneficial uses of natural resources (commercial fishing, sport fishing and public beach area). Cole et al. (2012) describe the indicator metrics in detail. Three other general metrics were used to indicate the potential for significant environmental impacts of modernization on vulnerable people and resources. These include potential impact from harbor expansion, increased operations associated with greater freight movement, and port expansion to increase capacity. The modernization impact metrics indicate general sources of impact while the vulnerability metrics indicate the relative significance of the populations and resources that may be impacted.

Port harbors vary in their readiness to accept *post-Panamax* vessels and increased freight traffic. A fully ready harbor is assumed to allow any vessel to call once it has passed through the new Panama Canal locks, which will have 50-foot depths upon completion. The difference between 50 feet and existing depth times the main channel length is used as an indicator of harbor expansion impact. Landside port expansion needs and associated infrastructural and operations impacts are indicated by the differences between the average unused port capacity and projected 30-year regional population growth rates, both expressed as percentages. In general, less port modernization is needed where unused capacity exceeds forecast population growth by significant amounts. However, modernization for the largest *post-Panamax* vessels may require changes in freight transfer equipment and berth dimensions. The 30-year growth of the region served by the ports indicates environmental impacts associated with freight transport growth and associated operations effects, such as from pollution emissions and accident frequency. These impacts could be moderated by transporting the freight on fewer but larger vessels.

Table 10. Regional Indication of Potential Environmental Impact for the Four Most Important Container-port Regions. The raw data for individual metrics were normalized to values between 0 and 100 to allow regional comparison and summation.

Indicators	Port Regions[1]			
	Northeast Atlantic	Southeast Atlantic	Gulf	Pacific
Vulnerabilities				
Health, Safety & Equity[2]	44.2[8]	35.7	45.7	48.9
Heritage Loss[3]	11.9	33.7	26.2	20.3
Economic Loss[4]	27.7	25.9	22.1	34.0
Subtotal	83.8	95.3	94.0	103.2
Modernization Sources				
Harbor Expansion[5]	33.2	16.6	29.8	0
Freight Transport[6]	17.8	73.7	43.3	76.0
Port Expansion [7]	44.0	90.6	60.2	74.6
Subtotal	128.0	180.9	133.3	150.6
Total	211.8	276.2	227.3	253.8

1. Port selection was based on main channel depth and freight volume. The Northeast Atlantic includes Boston, New York-New Jersey, Philadelphia, Wilmington, and Baltimore. The Southeast Atlantic includes Norfolk, Wilmington, Charleston, Savannah, Jacksonville, Port Everglades and Miami. The Gulf includes Tampa, Mobile, New Orleans, and Houston. The Pacific region includes Los Angeles, Long Beach, Oakland, and Tacoma.
2. Health and safety vulnerabilities are indicated for an area within 10 km of ports by 1) number of days air pollution exceeded limits for respiratory illness, 2) number of permitted waste water discharges, and 3) number of superfund sites (EPA 2012 a and 2012b). Potential for environmental injustice is indicated by the percentages below poverty level and in non-white minority groups within 5 km of the port. (Census Bureau (United States Census Bureau). 2011. 2010 public use microdata areas (PUMAs). Department of Commerce, Washington DC http://www.census.gov/geo/puma/puma2010.html)
3. Vulnerability to loss of important local and national heritage is indicated for an area within 10 km of the port by 1) the percentage of wetlands. (USGS (United States Geological Survey) 2010.) National land cover database. (U.S. Department of the Interior. Washington DC http://www.mrlc.gov/index.php); 2) the area encompassed in parks and other preserves. (USGS (United States Geological Survey) 2012). USGS gap analysis program. (U.S. Department of the Interior. Washington DC http://gapanalysis.usgs.gov/data/padus-data/); and 3) the number of species listed as threatened or endangered (FWS 2012).
4. Vulnerability to a loss of natural resource economic value is indicated by 1) the state commercial fish dockside value divided by state shoreline length (NOAA 2012). Annual commercial landings by Group (year 2010). NOAA Fisheries, National Oceanographic and Atmospheric Administration. Washington, DC http://www.st.nmfs.noaa.gov/st1/commercial/landings/gc_runc.html) and Census Bureau 2012a, 2) state saltwater fishing days divided by state shoreline length (FWS, (U. S. Fish and Wildlife Service and the U.S. Department of Commerce, and U.S. Census Bureau) 2006. National Survey of Fishing, Hunting, and Wildlife-Associated recreation. FHW/06-NAT. U. S. Department of Interior. Washington, DC**)** and (Census Bureau 2012a), and 3) area of public beaches within 10 km of the port (EPA (United States Environmental Protection Agency). 2012c. Watershed assessment, tracking & environmental results. USEPA. Washington, DC http://www.epa.gov/waters/data/downloads.html#BEACH Datasets (EPA BEACHES dataset)). State data were divided by shoreline length to account for large differences in the dispersal of fishing access along shore and away from ports.

5. Harbor channel expansion needed to accept the largest post-Panamax vessels is indicated by the difference between existing depth and 50 feet times existing channel lengths. This metric indirectly indicates potential excavation and maintenance impacts.
6. Future rate of freight transport through ports is indicated by the 30-year population growth in states within 500 miles of the port. This metric indirectly indicates possible impacts from emissions and other operations effects.
7. Port expansion needs and potential impacts are indicated by the differences between percentage population growth over the next 30 years and the mean percentage of unused capacity for 1) berth size for vessels calling at the ports, 2) number of berths serving calling vessels, 3) freight transfer cranes, 4) port storage space, and 5) average vessel utilization.

Total vulnerability scores were slightly lower than average in the Northeast largely because of low heritage impacts associated with endangered species and preserves. The Pacific Region vulnerability was higher than average because of greater potential health and economic impacts. The sum of vulnerability differences among regions is smaller than differences in potential need for modernization and its associated environmental impacts. No region was consistently more or less vulnerable across all indicators. This suggests that modernization is likely to incur significant costs for required environmental impact avoidance, minimization, and compensatory mitigation, regardless of the region modernized. However, mitigation cost would vary widely among ports within regions depending on their specific vulnerabilities and impact extents and intensities.

Potential modernization and freight transport impacts are especially high in the Southeast and Pacific regions where regional population growth is nearly equally high and port capacities are most used. The higher score of the southeastern region is due largely to less harbor and port capacity The harbors at two major ports in the Northeast are, or soon will be, ready for *post-Panamax* vessel use, but the amount of dredging required at ports that are not ready makes potential harbor expansion impacts the highest among regions. However, actual population growth and percent growth is quite low in the Northeast compared to the other regions, making future modernization needs the lowest. The Gulf Region has a somewhat less unused capacity and more anticipated regional growth, but substantially less than in the southeastern and Pacific regions.

When vulnerability and potential modernization scores are totaled, the Southeastern region is highest and the Pacific region a close second. Metric scores are not likely to be proportional to mitigation costs, however. The Northeast Region ranks lowest. The physical need for harbor expansion in the Southeast Region is low compared to other regions, for example, but heritage vulnerability to harbor expansion impact is comparatively high.

While the impacts of harbor expansion could be substantial, there are potential environmental benefits from increasing capacity for *post-Panamax* vessels if, as expected, it moderates impacts on air and water quality impact per ton of freight shipped. Assuming that freight transport rates will increase regardless of average vessel size calling at the ports, harbor expansion could reduce anticipated increases in emission impacts on human health, including inequities among minority and low income groups near the ports. Other effects are harder to judge. While the frequency of ship passages may decrease, possibly lowering the number of harmful collisions with scarce species and other costly accidents, the increased size of the vessels may increase the likelihood of collisions when a vessel passes through the area. Regulations to slow vessel speeds

may moderate any difference in potential effect. Accidents involving freight losses and oil and other spills may be more costly on larger vessels because more freight is lost and more harmful pollutants are released.

The results of analysis shown in Table 10 could be significantly altered by the effects of Panama Canal expansion, which may reduce the transport costs of freight with eastern destinations that now enter through Pacific ports. Panama Canal enlargement could result in a significant shift in transport-cost advantages at Southeastern ports, especially if they are able to accept *post-Panamax* vessels. That could also reduce transport system atmospheric emissions because of the higher fuel efficiencies of large vessels. If the scenario plays out, freight transport rates through southeastern ports could be elevated above the rates indicated by forecasts of future population growth in the southeastern region. Highway and rail transport from southeastern ports into areas in the U. S. interior now served by Pacific ports may somewhat reduce projected freight movement through Pacific ports based on regional population growth alone. That prospect could redistribute the intensity of adverse emissions impacts from west to east and further support harbor enlargements with their associated potential impacts on valued resources.

Another possibility could alter the picture. Existing *post-Panamax* ports on the East Coast and international ports in the Caribbean have potential for becoming deepwater transport hubs for vessels of all sizes. That may favor smaller feeder vessel delivery of transferred freight to East Coast ports that are not ready for *post-Panamax* vessels.[92] If that happened, freight transport rates and pollutant emissions may increase above regional population predictions, but the environmental impacts from harbor expansion may be largely avoided. Atmospheric emissions from vessels would increase because emissions, per ton of freight transported increases as vessel size decreases.[93]

Improved performance of rail and highway freight transport from West Coast ports could also moderate a Panama Canal effect. Pacific ports are better prepared than eastern and Gulf ports to accept *post-Panamax* vessel sizes and container traffic, have transport-time advantages, are projected to serve rapidly growing populations west of the Appalachians, and may become more competitive by cutting their costs.[94] Such advantages could result in relatively little change in the proportion of freight moving into east and west ports despite Panama Canal enlargement. Cost cutting strategies like container stacking on railroad cars and increased truck-trailer lengths could significantly reduce the growth in atmospheric emissions per ton of freight transported, but perhaps not enough to make up for the much greater efficiency of large vessels entering the eastern U.S. through East Coast ports. The tradeoffs among different scenarios are complicated by numerous unknowns and by harbor enlargement impacts at

[92] Economic Development Research Group, Inc. 2012

[93] Notteboom, T.E. and B Vernimmen. 2009. The effect of high fuel costs on liner service configuration in container shipping. Journal of Transportation Geography 17:325-337.

[94] Economic Development Research Group, Inc. 2012

Southeastern ports and local air quality degradation and port congestion at some West Coast ports that are already stressed.

Regional summaries do not reveal the substantial variation in vulnerability and modernization need that occurs among sites within each region. The results indicated in Table 6 are preliminary, given the variation in the data, incomplete representativeness of the impacts, and uncertainty in various national and world transportation decisions. But the results are of strategic interest because they reinforce the uncertainties that signal a need for an adaptive approach to port and waterway modernization investment and "flag" potential impacts for specific attention in future environmental impact studies.

Potential Environmental Impacts at Waterway Locks

Panama Canal enlargement may make shipment of grains and other goods out of the Midwest to Gulf ports and Asian markets more attractive than existing routes. That could increase barge traffic down the upper Mississippi and Illinois Rivers and on to the Gulf. Potential environmental impacts are most associated with lock rehabilitation to maintain reliability.

Lock rehabilitation would largely occur in areas of relatively low human population density where health and safety concerns are relevant but less likely to affect people to the extent probable around ports. Atmospheric emissions would increase as barge and intermodal transport increased, but maintaining lock reliability through rehabilitation would moderate the increase by reducing barge congestion in the lock vicinity. The main alternative to barge transport is rail or truck transport directly to Gulf ports, which would circumvent the need for a shipment transfer. Barge shipment no longer has an environmental advantage over railroads because railroads are now about equally efficient.[95] Truck transport remains more versatile, but much less fuel efficient.

The upper Mississippi and Illinois rivers are home to a number of freshwater mussels and other threatened and endangered species, but, in general, adverse impacts on them are likely to be small. Our analysis indicates that 62 percent of the 100 meter riparian strip next to locks and dams on the upper Mississippi is wetland based on data from FWS,[96] which would require compensatory mitigation. On the Illinois River, 42 percent is wetland. No critical habitat of endangered species is expected to be impacted, but at least 1 endangered riparian species lives in each of the counties where most locks are located. The resource uses most likely to be impacted are agricultural and residential.

Summary

[95] USDOF. 2012. OEE 2011

[96] U. S. Fish and Wildlife Service. 2012. Environmental Conservation Online System. U. S. Department of the Interior. Washington DC http://ecos.fws.gov/ecos/indexPublic.do

A small area of the conterminous United States has been transformed by the land and water transportation system, but the adverse impacts on humans, ecosystems and wild species are significant despite major improvements in mitigating impacts. The environmental footprint of the transportation system indicates that future environmental impact from transportation system modernization could be associated with degraded human health and safety (including inequitable impacts on low income and minority groups), loss of important natural and cultural heritage, and loss of economically important natural resources. Impacts could come from changes in air and water quality, harbor and port expansion, and intermodal links. A regional assessment of potential impact sources and human population and resource vulnerabilities reveals the potential for somewhat greater environmental impact in the Southeast Atlantic and Pacific Regions, largely because these are the areas where freight transport growth is expected to be greatest. The effects of Panama Canal expansion have potential to redistribute some freight transport growth from Pacific ports to Southeast Atlantic ports. Adverse impacts from possible lock rehabilitation in the Upper Mississippi and Illinois Rivers are expected to be relatively minor except for potential need to mitigate for loss of riparian wetlands. In general, the uncertainties point to the need for an adaptive approach to future investment in port and waterway modernization. In that approach, port and waterway use would be monitored and modernized systematically as more certain information about freight movement, environmental impacts, and public benefits becomes available.

> "Factoring in environmental and public health costs needs to be part of the decision making process at every step in order to ensure future sustainability of our ports, our coastline, and our population."
>
> -Environmental Defense Fund

Chapter 5: Financing Options for Funding U.S. Port and Inland Waterway Infrastructure Needs

To remain competitive in a changing global trade market, the U.S. would need to continue making the justified investments necessary to maintain and improve its navigation transportation infrastructure, where it is appropriate and efficient to do so. Understanding the current funding challenges and making long-term plans for operations and maintenance (O&M) and justified investments are critical to developing an effective vision for a competitive navigation system.

USACE Civil Works appropriations to address waterside infrastructure has averaged about $1.5 to $2 billion per year for the last decade. These expenditures have been used to maintain, construct and improve the most highly justified inland and coastal navigation infrastructure projects, and reflect the Nation's most efficient navigation investment strategy.

To accommodate expected increase in agricultural exports through the Gulf, the current inland waterways must be adequately maintained through maintenance dredging and justified major rehabilitation.

USACE currently has 17 active studies investigating possible port improvements, most associated with the desire to be *post-Panamax* ready. One such study at the Port of Savannah is nearing completion and indicates an economically justified project that will cost about $652 million. It is likely that other studies will also show economically justified projects, either to become "*post-Panamax* ready" or "cascade ready." The preliminary estimate to expand some ports along these two coasts was about $3 to $5 billion. Specific investments in ports must be individually evaluated for their timing and economic and environmental merits.

Addressing "the critical need for additional port and inland waterway modernization to accommodate *post-Panamax* vessels" necessitates an examination of the current delivery mechanisms, the identification of issues and the offering of options for the future. Among the issues identified, securing funding sources to take advantage of modernization opportunities in a timely manner, given the constrained fiscal environment, was judged the most critical. A notional list of financing options is presented to initiate discussion of possible paths to meet this challenge—it is anticipated that a variety of options may be desirable, and in all cases individual project characteristics, including its economic merits, would need to be considered in selecting the optimal financing mechanisms. These options are illustrative only and do not necessarily represent any Administration, USACE or IWR position.

The Administration and Congress divide the U.S. Army Corps of Engineers budget into the broad categories of construction (which may include major rehabilitation) and operations, maintenance, repair, rehabilitation and replacement (O&M). For every dollar spent by USACE for harbor improvements (channel deepening and widening) a certain percent is appropriated from

general Federal revenues. The cost share, which varies by depth of the harbor, is paid by project sponsors, typically port authorities or states, over a 30-year period.[97] All harbor maintenance dredging up to 45 feet is paid with appropriations from the Harbor Maintenance Trust Fund (HMTF). Over 45 feet, there is a 50 percent non-Federal cost-share requirement.

The USACE budget for inland waterways improvements (construction) draws from the balance in the Inland Waterways Trust Fund (IWTF) for 50 percent of each appropriated dollar and general Federal revenues for the other 50 percent. Operations, maintenance and repair to the inland waterway channels and navigation locks and dams are funded entirely by general Federal revenues. (See Vocabulary of terms used in this chapter on page 88.)

There is a long-standing Federal funding commitment, manifested through the USACE budget, to harbor improvement and maintenance and inland waterway navigation system improvement and O&M. In recent decades some of this financial responsibility has been transferred to the beneficiaries of the projects in the form of increases in required cost share and as requirements to pay user fees and dedicated taxes into the two trust funds. Attention is now directed to whether Federal general revenue and trust fund appropriations are adequate to improve, operate and maintain inland waterways and assure that Gulf and East Coast harbors have the channel capacity to accommodate larger ships that will soon pass through an expanded Panama Canal.

The budgetary concern is for improvements to and maintenance of existing harbors and inland waterways and is not about the creation of "new" ports, channels, navigation locks or dams. The concern is over how the Nation can secure and then efficiently spend funds that will secure the future value of past valuable investments. Because of the historical role played by the Federal government through USACE, an associated question becomes "What is the role for USACE in assuring that future value?"

In recent decades USACE responsibilities have expanded to include environmental oversight and regulation of environmental impacts associated with improvements and O&M at harbors and on the inland waterway navigation system. Such improvements and O&M alter the geomorphic and hydrologic processes in coastal estuaries and along rivers and, in turn, habitat conditions and aquatic life. Other environmental concerns associated with this transportation system include finding acceptable means for disposal of contaminated dredged material, the disposal of ballast water and, as appropriate, the beneficial use of clean dredged material for habitat creation. (See Chapter 4 for discussion of environmental effects).

As part of its project evaluation of proposed improvements and O&M, USACE evaluates environmental impacts and determines how to avoid and minimize such impacts.[98] Where avoidance and minimization is not possible, the project budget includes funds that provide for

[97] Non-Federal cost share requirements are as follows: Harbor Depth less than 20 feet: 20%; Harbor Depth 20-45 feet: 35%; and, Harbor Depth > 45 feet: 60%

[98] These evaluations are made in compliance with the National Environmental Policy Act as well as other Federal or state government required assessments.

compensatory mitigation. The costs for compensatory mitigation can be a substantial part of the total costs of any improvement project. For example, about 45 percent of the total cost of the proposed channel deepening for Savannah harbor to 47 feet is for the mitigation requirements established within the USACE planning process. Even still, there have been challenges to the plan that assert that the mitigation is inadequate or even that the project should be abandoned because it has unacceptable environmental consequences.

Vocabulary

General Revenue Funding – Appropriations for the cost of construction, operations, maintenance and repair of harbors and waterways made from general revenues of Federal and non-Federal governments.

Beneficiary Based Funding – Payments for the cost of construction, operation, maintenance and repair of harbors, channels, locks and dams using revenues from user fees or from a dedicated tax source. A user fee is a charge paid voluntarily by the user of the harbor or waterway; failure to pay the charge results in exclusion from use (e.g., a lock passage fee or a wharf access fee). In contrast, a dedicated tax is a required payment to a government entity, enforced by threats of sanction for nonpayment rather than by denial of a use (e.g., a tax on fuel). Revenues from user fees and dedicated taxes are often deposited to a government managed trust fund.

Trust Fund – A government established and managed account that accumulates the revenues from user fees and dedicated taxes. The managers of the fund make decisions about the disbursements from the fund.

Cost Sharing – A legally mandated sharing of the costs for construction, operations, maintenance and repair for harbor and waterway improvements and OMR between the Federal government and a non-Federal entity. Cost-sharing is a requirement for Federal budgetary participation in harbor and inland waterway improvements.

Cost Recovery – A requirement that all costs for construction, operation, maintenance and repair costs incurred over a period of time be matched by general tax revenues and receipts from user fees and dedicated taxes. Since benefits are realized over time, payments toward cost recovery may be received over several years. Upfront costs will typically require sale of bonds; repayment of bond debt would be spread over some period of project life.

Financing – The advancement of funds from a public, quasi-public or private entity to an entity initially responsible for the costs of improvements and OMR at harbor and waterway facilities. The responsible entity then uses a combination of general revenues, user fees and dedicated taxes to repay the incurred debt.

Infrastructure Bank – A chartered government institution that makes or guarantees loans for non-Federal infrastructure improvements in anticipation of repayment through future dedicated revenue streams, such as revenues from user fees or dedicated taxes.

Under the Clean Water Act the USACE regulatory program has responsibility, shared with the U.S. Environmental Protection Agency, to issue permits for the placement of fill material in U.S. waters. In reviewing these permits the regulatory program is obligated to be sure that the proposed action is needed, minimizes adverse environmental effects and then compensates through mitigation for any unavoidable adverse environmental consequences. In current planning and budgeting practice, USACE harbor and navigation business lines have the lead in planning for and implementing improvements and O&M and the regulatory program issues a permit if it affirms the environmental assessment and mitigation of the USACE planning process. Also, the 404 permit process requires that the states affirm the compatibility of any improvement or maintenance operation with state water quality standards, consistency with Coastal Zone Management Act plans if appropriate, and other environmental laws and regulations of both the state and Federal government.[99] Therefore, even if a non-Federal entity wishes to deepen a harbor (for example) with its own funds, USACE would still be involved in issuing the appropriate environmental permits. [100]

Harbor Funding (Maintenance and Construction)

Decisions on spending HMTF dollars for maintenance dredging are made through a hierarchical process that begins with requests made at the USACE district level and ends with allocations made in the President's budget. Modest adjustments have been made in the past during the congressional appropriations process.[101] Allocations made from the HMTF during the past five years have been less than the revenues earned; there is a balance in the HMTF account.

The principal concern regarding harbor maintenance is whether the level of collections and disbursements from the HMTF will be adequate to maintain harbors at levels sufficient [102] to provide reliable service to shippers. Looking forward, the question is whether revenues collected with the current HMTF fee system can keep pace with increasing costs of dredging over time even if all collected funds were allocated to maintenance (possible causes of increasing costs include increased shoaling, increases in unit costs of dredging).

[99] These requirements can be far-reaching and, for example, can extend to the evaluation of effects on local and regional air quality.

[100] Section 14 of the 1899 Rivers and Harbors Act (33 U.S.C. 408), often referred to as Section 408, requires any Federal entity wishing to make a modification to a project originally authorized by Congress and built by USACE to receive a permit from USACE to assure that the modification does not injure the public interest or impair the existing project's usefulness. Therefore, for most harbor projects and for channel or inland waterway improvements USACE would need to issue a 408 permit as well as a 404 permit even if there were no Federal funds involved in the modification.

[101] The Administration's fiscal 2013 budget calls for a 12 percent increase from fiscal 2012, rising funding to $848 million, representing about half the annual revenues deposited to the fund. The Administration argues that this level of funding has proven adequate to maintain the existing harbor infrastructure. Nonetheless, there has been some congressional legislation proposed to increase the amount expended from the trust fund.

[102] A sufficient channel is not necessarily going to be one that is maintained to its authorized width and depth. Sufficiency of the channel depends upon traffic utilization patterns and currently is determined by analysis of such patterns during the budget justification process.

Port expansions to accommodate *post-Panamax* vessels present a different set of concerns. Harbor channel capacities at Gulf of Mexico and Eastern U.S. ports currently do not accommodate fully laden *post-Panamax* vessels. Many of these ports are currently being studied or implemented by USACE or non-Federal interest under Sections 203 or 204 of WRDA 1986.[103] The challenge going forward is to identify funding mechanisms to take advantage these opportunities against the backdrop of a fiscally constrained environment.

Inland Waterways Funding

Over the past five fiscal years the total appropriations for lock and dam improvements and for O&M of inland waterway navigation structures and channels have been relatively constant. Of the total appropriations, a large percent are from general revenues.

Decisions on funding for inland waterways improvements are made based on a USACE economic justification analysis and are accompanied by an environmental evaluation and mitigation plan. Funds for waterway improvements are drawn from the balance in the IWTF and are cost shared with general Federal revenues on a 50/50 basis.

There have been concerns expressed in Congress and by the barge industry about the adequacy of funding for lock improvements and about delays in planning and implementing projects.[104] At present there is industry support for raising the fuel tax to increase the revenues flowing to the IWTF and for accompanying that raise with other reforms that change the share of total costs for waterway improvements paid from general revenues. The current Administration, as well as the previous Administration, proposed replacing the fuel tax with a lock passage fee that also includes changes in the share of total costs borne by general revenues.

Decisions on appropriations for operations, maintenance and minor repair are made through a process that begins with requests made at the USACE district level and ends with allocations made in the President's budget. Modest adjustments in annual appropriations have been made in the past during the congressional appropriations process.

Within this budget context, the issue of concern is whether the level of collections for and disbursements from the IWTF, combined with Federal general appropriations, will be adequate

[103] The Water Resources Development Act of 1986 (Sections 203 and 204) includes provisions for non-Federal interests to undertake feasibility studies for harbor improvements. These studies are to be in accordance with guidelines promulgated by the Secretary of the Army. The Secretary would review the study results and make a recommendation to the Congress on whether the proposed improvement would warrant Federal financial support under existing cost-sharing policy. If the Congress authorized the proposed harbor improvement, the non-Federal interest could make expenditures for improvements, subject to obtaining necessary permits, and later seek reimbursement for the federal share of the total cost, including study costs. These provisions might expedite the planning and implementation of harbor improvement projects, but would not necessarily increase Federal appropriations made to such projects. In effect, the nonfederal interest and the nation would realize the benefits of the improvement; however, there is no assurance that reimbursement for the Federal cost share would be forthcoming. This same process could be followed for making improvements to inland waterways.

[104] See footnote 23.

to improve, operate and maintain channel and lock and dam facilities at levels sufficient to provide reliable service. The focus of this discussion about this issue has been on the revenues collected with the current fuel tax, the level of Federal general revenue cost sharing and consideration of possibly increasing costs of improvements and O&M. [105]

Options for Harbor Improvement and Harbor Maintenance Funding[106]

Option 1: Business as Usual for Harbor Improvement and Continued Maintenance

Harbor improvements would continue to receive Federal funding from general revenue appropriations and from the project cost share partner. Currently cost share partners raise revenues to meet their cost share obligations using multiple strategies including landside facility fees, appropriations from general state revenues and more. Under this "business as usual" approach, funding for the next decade would remain consistent with that provided during the past five years. Allocation of funds for harbor improvement would be made according to Administration budget priorities, based on analyses of project justification provided through the existing USACE evaluation and justification processes.

Funding for channel maintenance would draw upon revenues from the HMTF with the fee structure which generates revenues for the fund remaining unchanged. Allocations from the fund to harbor maintenance would be made by the Administration in consideration of the need to maintain channels without regard to the size of the HMTF revenue stream. Because of the continuing revenue streams dedicated to the HMTF, and because of the reserves in that fund, financial support for maintenance of existing channels would be assured, at least for the near term. [107]

Option 2: Increase Appropriations from General Federal Revenues for Harbor Improvements

With this option Congress would follow the traditional model of support for harbor improvements but would *increase* general revenues appropriated for funding harbor improvement projects. The decision to increase appropriations would be based on USACE analyses showing that investment would be economically justified and environmentally acceptable, i.e., that the investment is a high priority when compared with other Federal investments and the investment fits within overall Federal fiscal limits. Federal funds still would be matched with cost sharing by project sponsors following existing cost-sharing rules.

[105] Possible causes of increasing costs include fragility of aging structures at an increasing rate with time and increases in unit costs of construction and O&M.
[106] The options presented are illustrative only and do not represent any administration position.
[107] One argument made for not fully expending revenues received by the HMTF is that appropriations are adequate to meet the maintenance dredging requirements. However, maintaining a balance in the fund, with no clear plan for spending that balance on harbor maintenance, has drawn the attention of the World Trade Organization. The fundamental concern is that if the fund maintains a surplus over time then it is no longer a fee for government service but is rather a tax or duty on imports. Options 4 or 5 would be a way to avoid this criticism.

Allocation of funds for harbor improvement would be made according to Administration budget priorities, based on analyses of project justification provided through the existing USACE evaluation and justification processes.

With this option, maintenance dredging would continue to be funded from revenues collected at the current level of user fee, deposited to the HMTF and allocated to harbors on an annual basis following current practice. For the reasons described under Option 1, it is likely that revenues received by the HMTF would prove adequate to maintain channels at least over the next decade.

Option 3: Modify Authority to Use HMTF Revenues as Appropriations for Harbor Improvements

An alternative to seeking additional general Federal revenues would be to raise the fees collected for the HMTF and then extend the allowable use of those increased funds from maintenance to include investments in harbor improvement. [108]

The logic is that the beneficiaries of the improvement projects can be readily identified and such an increase would be an application of the "beneficiary pays" principle. Under this option, the decision-making process would remain—that is, the USACE planning process would determine which projects were economically justified and environmentally acceptable and would then receive appropriations for managing the construction of such projects. Channel maintenance would continue to be funded from the revenue enhanced HMTF.

Option 4: Increase Cost Share Contributions to Harbor Improvements

This option would increase total revenues by increasing the non-Federal contribution for every dollar of Federal appropriation. Under this option the HMTF balances would continue to be used for maintenance.

As an illustration, the cost-share requirement of 35 percent might be raised to 65 percent for depths up to 45 feet and Federal participation in harbor deepening might cease at 45 feet; at depths greater than 45 feet the total cost for any further deepening would be paid 100 percent by the non-Federal sponsor. Variations on these differences can be imagined, but the basic objective would be to increase the share of harbor improvements paid by a non-Federal entity.

Under this option, as the non-Federal cost share approached 100 percent, the question would be whether or not the investment being made would still need to pass a Federal benefit-cost justification test. In fact, the willingness of the sponsor (port or the state) to provide a substantial share of the cost would be evidence that the benefits of the project do exceed the costs to the non-Federal sponsor. In effect, this is an application of the "beneficiary pays" principle and is a "market like" test of the justification for the investment. However, some form

[108] While increasing such charges and depositing them to the HMTF would be an application of the "beneficiary pays" principle, such action might be subject to challenge unless the funds were disbursed expeditiously for the purposes of harbor improvement and maintenance.

of planning and evaluation would still be required by USACE to establish the Federal interest in making a Federal appropriation and in determining how the proposed activity would meet environmental protection requirements. Cost share partners would need to raise additional funds using existing or new revenue sources.

Opportunities for non-Federal sponsors to raise funds for harbor improvements (as well as maintenance) are discussed further under Option 5 below.

Option 5: Individual Port Initiative

Under this option the HMTF would be phased out, as would the current fees dedicated to the fund. Individual port authorities would include the costs of maintenance in their overall cost structure and would levy fees in whatever form they deem appropriate for cost recovery for harbor improvements and maintenance at their own facilities.

Infrastructure Bank Financing

If an infrastructure bank is created under Federal authority, provisions could be made to allow ports to borrow from that bank and then repay the bank with user fees collected. USACE analyses could continue and inform bank due diligence, and underwriting, supporting the bank's determination of the strength of the potential revenue stream from a given project, and potential risks associated with such projections.

Individual port authorities could secure the initial funding for harbor improvements by entering into partnerships with shippers who would use the improved and maintained harbor, and/or by other financing means. The funds borrowed or otherwise advanced for purposes of construction would be repaid using revenues from the same kinds of user fees now currently in place for paying cost share. [109]

The shift of responsibility for securing funds and repayment (relative to Options 1 through 4) would be accompanied by a parallel shift of responsibility for evaluating the justification for harbor improvements and maintenance. Each individual harbor authority would establish whether the expenditure of funds was economically justified as opposed to relying on USACE analyses. The shift of decision responsibility on whether to deepen the harbor, by how much and what depths to maintain from the USACE-led planning process to the individual port is the fundamental difference between this option and simply raising the required cost share for the harbors (Option 4).

However, this option will not remove USACE from playing a central role in harbor improvement and maintenance decision-making. First, to the extent that a harbor improvement modifies a project that was historically built under Federal authority, USACE would need to issue a 408

[109] With this option the required revenues will exceed those now required for paying current cost share.

permit that would affirm that the actions being proposed by a non-Federal entity are consistent with the original authorized purposes of the project. The requirements that would be applied in making this 408 determination would need to be specified.

Perhaps of greater significance is the fact that the USACE regulatory program would maintain its permitting authority over any harbor improvement project or maintenance request. Currently the environmental evaluation that determines what environmental requirements must be met is a responsibility of the USACE planning process. Under this option, that responsibility would shift to a non-Federal entity[110] but the USACE regulatory program would retain the final decision authority as to whether or not the proposed harbor improvement or maintenance activity is environmentally acceptable.

Discussion: Harbor Improvement and Harbor Maintenance

Based on analyses elsewhere in this report, under Option 1 harbor improvement projects now underway or anticipated would be delayed due to a lack of funding. Determining the consequences of such delay would require further analysis. One possible response to Option 1 is that individual ports would choose to move forward without Federal support. In fact, there is no barrier to individual ports choosing to pursue option 5 on their own. For these individual ports, Option 5 becomes the operable financing and funding strategy.

Among the options that increase funding, option 2 is the most simple administratively and there is reason to believe that the non-Federal cost-sharing requirements triggered by an increase in Federal general revenue appropriations could be met. However, recent budget allocations and the extremely tight fiscal environment in the future makes reliance on this option for future funding.

Option 3 would require congressional action and it is not clear if it would be supported by the shipping industry. The fact that fees now collected for the HMTF are not fully appropriated back to harbor maintenance may create doubts about whether any newly increased revenues would be expeditiously appropriated to harbor improvements. Additionally, efforts to increase revenues would fall completely on imports (for legal reasons) and could draw the scrutiny of the World Trade Organization as being an unwarranted tariff on trade. Finally, if Option 3 resulted in increases in the level of fees for the HMTF, some shippers could divert to non-U.S. ports to unload cargo. The extent of this effect is unknown.

Options 4 and 5 would make changes to current policy to assure that all revenues collected from port users are used for harbor improvement and maintenance. Individual ports could choose their own user fees and taxes for covering costs. For example, a port could choose to levy charges on vessel draft instead of value of cargo, which would more directly relate to the cost of

[110] It may be possible for the USACE planning staff to offer this environmental assessment service on a cost reimbursable basis to the non-Federal entity.

providing the channel capacity. Option 4 would require legislative change that would demand (and so would need) Administration support and congressional action.

As cost share approaches 100 percent under Option 4, the financial difference between it and Option 5 (individual port initiative) narrows. In fact, modifications to the current Federal investment decision criteria might be modified as the Federal share of total costs decreases. The possible attractiveness of Option 4, relative to Option 5, is that USACE would continue to do the environmental analysis and have the responsibility to defend that analysis (and the compensatory mitigation it calls for) as being adequate and in the national interest.

Option 5 is the most direct application of beneficiary based funding. There are reasons to believe that the larger ports would be able to raise fees and taxes sufficient to recover costs of improvements and maintenance. Individual ports would collect their own fees, repay their own debt and make their own decisions. National port capacity would be determined through a system of decentralized decisions made at individual ports on where to dredge and by how much.[111] Individual ports would take into account their location in relation to trade patterns (volume and value of cargo) to assess the demand for additional depth, evaluate their costs of making channel improvements and providing maintenance, and make a final assessment of whether the demand for channel depth would be sufficient to support levels of user fees and taxes adequate to cover costs.

The resulting "market like" competition among the ports, constrained by the need to meet environmental requirements set by USACE permitting, could lead to more rapid decisions. The case for inter-port competition is that the result will be an efficient size and distribution of channel capacity. All harbors would not be at maximum depths for fully loaded ships. The network of ports, their channel capacity and origin-destination transport patterns would adjust such that some ports would accommodate heavily laden ships and other ports might become regional ports for light-loaded ships. Whether the result from this port competition model would yield the efficient allocation and capacity for the port network would need further evaluation.

This efficiency argument for Option 5 requires ports to base their user fees on the costs of dredging instead of a uniform tax rate on value of cargo. This would require shippers to bear the actual cost of improvements and maintenance and in so doing creates an incentive for shippers to favor the most cost-efficient ports. Of course, if ports begin to lose business as a result of this fee structure they would likely shift their revenue strategy to one that does not create an incentive for shipping to an alternative port. [112]

[111] State legislatures could have a role if sates choose to provide assistance.

[112] If individual harbors were to be responsible for their own deepening there is a risk that expenditures made for that deepening may not be recovered by user fees if those fees cause a change in shipment patterns. One way to address this for any given harbor would be to enter into a partnership agreement with the shipping company so that both parties are invested in the deepening activity and paying for the costs (perhaps repaying a loan) over a fixed period of time. Such a contract would be established between the harbor and one or more shipping companies.

Also, the efficiency case for inter-port competition will not apply for all harbors. At some harbors beneficiaries (users) by themselves may not be able to pay the full cost of improvements and operations over time, as required by Option 5. If Option 5 were followed in this situation, there may be a role for Federal general revenue subsidies on a case-by-case basis to supplement the tax and fee collections at those ports. Criteria and prioritization for establishing such subsidies would need to be developed, and should consider the characteristics of each project, including the economic merits.

A different perspective would challenge the efficiency case for Option 5. From this perspective, USACE-led planning is needed to define and then create an optimal allocation of harbor capacity across ports. [113] For Options 1 through 4, USACE could apply investment optimization models to recommend allocation of improvement funds to individual harbors in accord with minimizing the total costs of origin to destination transport of goods (or some other objective function). This model would replace individual harbor by harbor justification as is currently done now. The reality is that efforts at such multiport analysis have been attempted over many decades and proven to be both technically challenging and politically difficult to implement as a budget guide. [114]

Finally, in all options USACE would be responsible for the final determination of whether the proposed action is environmentally acceptable. Under Options 1 through 4, USACE would retain the responsibility for completing analyses needed for establishing the environmentally acceptable project, considering mitigation issues, and then would issue permits for the project instruction. In fact, the ability to navigate the regulatory process in ways that will expedite decision-making on harbor development is one of the principal reasons given for maintaining a significant USACE role in the planning and execution of harbor deepening projects. Under Option 5, the USACE role would be one of review of a ports application for a permit.

There remains a concern that environmental regulatory processes and permitting will continue to be a source of delay in all options (1-5). This concern may be addressed in part by the Administration's issuance of Executive Order 13604, “Improving Performance of Federal Permitting and Review of Infrastructure Projects” (March 22, 2012).

The expressed intent of the Executive Order is “…to significantly reduce the aggregate time required to make decisions in the permitting and review of infrastructure projects by the Federal Government, while improving environmental and community outcomes…” The Executive Order applies to reviews of “…improvements in Federal permitting and review

[113] There are efficiency arguments that can be made for centralized planning and investment and for inter-port competition. The arguments are complicated and would need to be considered in greater detail if Options 1-4 are being considered as an alternative to Options 5.

[114] A practical concern is that harbors investing on their own may not make justified investments (revenues prove inadequate to recover the cost of that advanced investment) and will seek assistance from Federal taxpayers even if the original investment was not nationally justified. For this reason, Option 4 would be a preferred response to the need for more funding relative to Option 5.

processes for infrastructure projects in sectors including surface transportation, aviation, *ports and waterways [*emphasis not in original], water resource projects, renewable energy generation, electricity transmission, broadband, pipelines…" The Executive Order sets in place a process to develop procedures to implement this expressed policy.

Options for Inland Waterways Improvements, Operations, Maintenance and Repair

Option 1: Business as Usual for Improvements and O&M

Appropriations for inland waterway improvements would continue to be from a combination of general Federal revenues and disbursements from the IWTF, and would be constrained by the revenues realized from the existing fuel tax revenue stream. Allocation of funds from these two sources would continue to be made according to Administration budget priorities in consultation with the Inland Waterways Users Board. Under this option total funding for the next decade would remain consistent with that provided during the past five years. Investments that drew upon either revenue source would continue to be based on analyses of project justification provided through the existing USACE evaluation and justification processes.

Financial support for maintenance and navigation lock and dam operations and repair would continue to be funded from general revenues at the same level as the average of the past five years.

Option 2: Increase Fuel Tax and Appropriations for Waterway Improvements and O&M

With this option the Administration and Congress would follow the traditional model of support for inland waterway improvements but authorize an increase in the fuel tax that increases the available balance in the IWTF.

At the same time, the Administration and Congress would provide increases in Federal appropriations to track with the increased revenues flowing into the IWTF. Depending upon the revenues from the fuel tax, they could reduce the share of total costs that is paid from general appropriations. The Administration and Congress would need to agree to an increase or decrease in the cost-share distribution. However, a requirement of this option would be that the total amount appropriated each year increases, even if the distribution between general revenues and withdrawals from IWTF change.

USACE analyses would continue to be the basis upon which expenditures for inland waterway improvements would be deemed economically justified and environmentally acceptable. [115]

[115] See the discussion of E.O. 13604 above.

A variation on this option would allow increases in the fuel tax revenues to be used in waterway O&M. The use of IWTF funds for O&M would represent a major change in the source of funds for maintenance. However if the additional revenues realized from increases in the fuel tax were dedicated to O&M, such increases could not replace current Federal appropriations if the total budget for O&M were to increase.

Option 3: Replace the Fuel Tax with a Vessel Use Fee and Increase Appropriations for Waterway Improvements and O&M

With this option the fuel tax would be eliminated and replaced with vessel user fees (lock passage fees or segment tolls)[116]. The user fees could be related to the costs of improving a lock, O&M at a lock, the size of the lock, the value of the cargo passing through the lock, the congestion at the lock (higher fees when the lock is congested) or any combination of the above. Special fees for recreational boats passing through the lock could be included.[117] The segment toll, however levied, would be related to the costs of maintaining and operating locks and channels of the waterway segment. (See further discussion of segment tolls under option 5, below). Revenues from the vessel user fees would continue to be deposited to the IWTF. Under this option the distribution of costs for waterway improvement and O&M that is paid from general revenues and the IWTF could be the same as under Option 1 (the current distribution) or could be modified to either increase or decrease the non-Federal share. However, a requirement of this option would be that the total amount appropriated each year increases, even if the distribution between general revenues and withdrawals from IWTF change.[118]

USACE analyses would continue to be the basis upon which expenditures for inland waterway improvements and O&M would be deemed economically justified and environmentally acceptable. [119]

Option 4: Maintain the Current Fuel Tax and add a Vessel User Fee to Increase Appropriations for Waterway Improvements and OMR&R[120]

With this option the fuel tax would be unchanged and a vessel user fees (as described above) would be assessed on an annual basis.

Revenues from the user fees would continue to be deposited to the IWTF. Under this option the distribution of costs for waterway improvement that is paid from general revenues and the IWTF would continue to be 50/50. However, a requirement of this option would be that the total amount appropriated each year increases.

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[116] A version of this option was included in the Administration's FY13 budget.
[117] Option 3 would redistribute the user fee burden to those who use the lock system in comparison to the fuel tax that is borne by all waterway users.
[118] This option could allow for the use of IWTF funds for O&M.
[119] See the discussion of E.O.13604 above.
[120] The Administration transmitted a legislative proposal to the Congress to reform the laws governing the Inland Waterways Trust Fund as part of the Jobs Bill proposal in September 2011.

USACE analyses would continue to be the basis upon which expenditures for inland waterway improvements and OMR would be deemed economically justified and environmentally acceptable.

Option 5: Public-Private Partnerships

The creation of Public-Private Partnerships (PPPs) has been proposed as a solution to supporting infrastructure modernization in a number of different venues. The success in forming such partnerships varies, but there are successes that can be pointed to for what has been termed "fixed guideway" infrastructure. However, a basic requirement for private participation in a PPP is assurance that there will be adequate revenues to allow the private entity to recover its costs and earn a return on investment from joining the partnership. Therefore, for a PPP to work in the inland waterway context it would require a commitment on behalf of the federal government to honor payment commitments made in the PPP contracts.

A PPP contract would define the sharing of risk from sources outside the control of either party (e.g., unexpected technical difficulties in executing the project) and the retention of other risks by the public entity (e.g., changes in regulatory rules or regulatory decisions that affect costs or technical feasibility[121]). Therefore, for a PPP to work in the inland waterway context would require contracts that address the sharing and assignment of these risks.

Option 3 addresses the problem of inadequate access to financial resources for making *immediate* improvements and for critical O&M on an aging infrastructure. USACE would divide inland waterways into segments (for current planning USACE recognizes 27 independent segments), recognizing the interconnectedness of certain those segments. The priorities for work on the segments would be defined principally by an assessment of the need for new investment and by the historic operation and maintenance costs per ton-mile traffic movement. One preliminary illustration of how this might be done is offered by the "*Inland Waterways Capital Development Plan*" that was prepared and submitted to Congress at the direction of the Inland Waterways Users Board in 2010. [122]

For priority segments, USACE would then issue requests for proposals for improvements and/or maintenance and repair over a fixed-term contract (say 30 years). In those requests for proposals USACE would specify what services were expected to be provided by the private partner, when the services would be realized, and would request a repayment schedule for the provision of those services.[123]

[121] See the discussion of E.O. 13604 above.
[122] The Inland Waterways User Board might be reconfigured in terms of its authority, membership and purpose to act in concert with USACE in participating in the PPP process.
[123] The PPP agreement would need to avoid and minimize effects on current non-commercial shipping waterway users. For example, recreational uses may need to be protected or accommodated or the reliability of water supply intakes. Even if these are not currently authorized purposes, accommodating such users may be necessary if the PPP is to be politically acceptable.

The private partner could be asked to design and/or build and/or operate and maintain channels and navigation locks and dams in return for an annual payment. USACE would provide support to[124] and oversight over the private partner, assuring that the terms of the contract with respect to lock operations and channel maintenance were honored. The private entity would secure all the necessary financing for waterway improvement or O&M.[125] The Federal government would agree to compensate a private partner for expenses incurred in segment improvements and maintenance. Revenues needed to honor the contracts could be derived from any or a combination of the following: general appropriations, raising the fuel tax, lock passage fees, lock congestion fees, or segment passage fees. [126] A segment passage fee would be relatively simple to administer with current technology. GPS tracking is now standard practice for all tows. It would be possible to determine when a tow has utilized the capacity of a particular segment. The charge for use of that segment would be in relation to the cost of operating, maintaining and repairing infrastructure for that segment and could be based upon a fixed ton-mile charge, perhaps adjusted for the value of the cargo.

The PPP contract would specify which of these revenue sources would be used by the Federal government to make payments to the private entity.

Discussion: Waterway Improvement and O&M

Options 2, 3, and 5 are similar in the sense that all seek to raise the level of initial funding for waterway improvements and O&M above "business as usual." The main difference is that under Option 5 the initial funding is secured through private partnership agreements allowing investments to move forward more quickly than they would under the current planning and budgeting process. The likelihood of such revenues coming from general Federal appropriations is low given current budget realities. Therefore, for Option 5 to be viable there is a need to increase revenues paid by the users. Especially important is that the added revenues are dedicated to honoring the contracts entered into with the private provider of improvement and maintenance services. It is this contractual commitment that makes this option attractive as a method for increasing funding. Specifically, the contractual commitment creates an expectation that all revenues collected and deposited to the IWTF will be used for the purposes of honoring

[124] A simple example is that USACE would continue to collect and report traffic volume, cargo type, as well as origins and destination of shipments.

[125] A public-private partnership contract that relies on beneficiary based revenues is unlikely to work for what have been termed "low use" waterway segments, unless there were a commitment of general revenue and a share of the dedicated fuel tax to the PPP contract. The case that would need to be made for continued improvement and maintenance of those segments that parallels the case that might be made for low-use harbors, as described above.

[126] Tax and fee collection is an example of another function that could be retained by USACE. The barge companies who are the immediate users of the waterways would seek to pass on the costs of any fees or taxes to their customers, the shippers of goods (grains, coal, fertilizer, etc.). The shippers in turn would seek to pass on costs to the buyers of their products. The final distribution of the burden of the fees and taxes would depend on the demand for the product (technically, in economics, the elasticity of demand) and the availability of alternative transportation modes.

the contracts and will be supplemented as needed by appropriations from the general budget appropriation process. [127]

[127] No current Congress can obligate a future Congress to a particular spending plan. However, there is experience that provides evidence that the Federal government would honor long-term contracts and that evidence may increase the confidence of the private entity that the agreed-to revenues would be forthcoming.

Chapter 6: Additional Considerations

National Intermodal Freight Transportation Strategy

A modernization strategy should be part of an overall national intermodal freight transportation strategy. While the three dominant freight carrier modes – water, rail and truck – compete for market share, there is a growing recognition of the need for multi-modal linkages and for infrastructure investments to be coordinated across the modes to ensure that they complement each other and ensure the best overall use of the available funds for the Nation. This can be supported by prioritizing navigation investment according to their multi-modal connectivity. On March 1, 2012 USACE signed a Memorandum of Understanding with the Department of Transportation on collaboration with a purpose to identify and capitalize on opportunities to improve the Nation's transportation infrastructure investments where shared equities exist.[128]

A national intermodal freight transportation strategy could also consider local sponsor commitment in terms of cost sharing and community support should be taken into consideration. Opportunities to contribute the Administration's initiative to increase exports, energy independence and enhance national security must be considered.

Adaptive Management

This report also recognizes the uncertainty held in future modernization actions – which depend on specific location, types of actions taken and other unknowns – indicate that an adaptive approach to modernization is a wise strategy. When infrastructure projects are planned, designed and implemented, they should explicitly include the concept of adaptive management (i.e., the identification of sequential decisions and implementation based on new knowledge and thresholds). It is an important concept that should be included in both the system modernization strategy and individual projects identified for implementation under that strategy. Adaptive management has been primarily used in improving environmental management policies and practices. However, it can also be applied to developing sustainable solutions in navigation.

Employing adaptive management techniques in the development of a modernization strategy and decisions on specific infrastructure investments makes sense given the complex nature of trade routing and inherent uncertainties and risks associated with forecasts, not only of economic future conditions, but physical future conditions such as climate change, sea level change and social future conditions such as population demographics and distributions.

[128] See appendix C for a copy of this MOU.

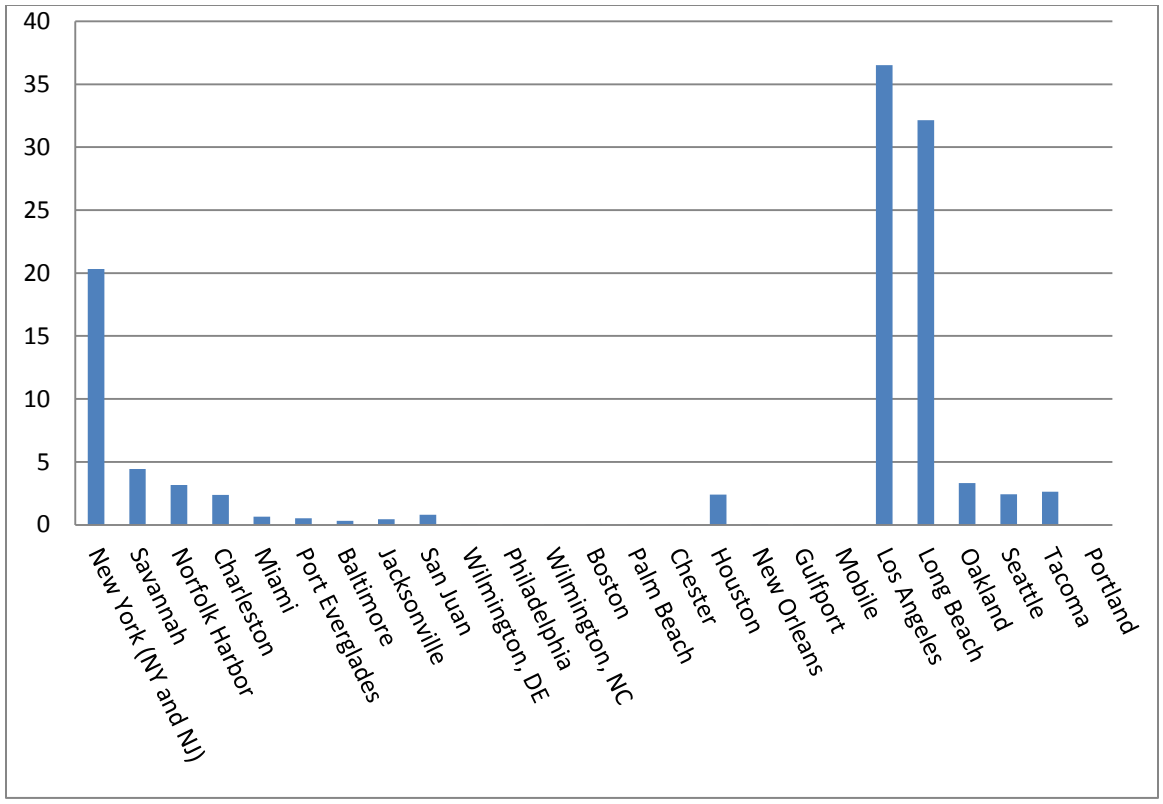
Within the context of navigation channels, adaptive management techniques could be adopted to allow channel and turning basin dimensions to be adjusted during normal maintenance dredging to adjust to actualized market conditions. This would resemble the approach of phased construction through the implementation of separable elements, but would allow conditional authorization of future elements that are currently economically unjustified. The NEPA documentation for the project would be required to cover the impacts of all the envisioned future elements. An example that illustrates this approach is the recently completed study for the Port of Savannah. The port sought a project depth of 48 feet. USACE economic evaluation techniques led the Division office to recommend a depth of 47 feet. Considerable time and energy was spent on this issue. If there is justification to deepen to 48 feet in the future, the Port of Savannah will have to start the entire process over from the beginning. An adaptive management approach have allowed the project to move forward with the 47 feet depth; if time shows justification for a 48-foot channel the deepening could be done as part of the regular maintenance cycle without the need to go through the entire planning process again. An adaptive management approach could reduce study time, reduce conflict and improve USACE responsiveness and product delivery.

Coastal Port Service Area

One factor the Congress has asked IWR to consider in this report is the current and projected population trends that distinguish regional ports and ports that are immediately adjacent to population centers.

To examine this issue IWR developed a port index of regional trade. This index can be used to gain insight into the degree a port serves a local catchment area or a larger regional community.[129] The index was developed for container ports. It considers the population adjacent to the port and the total number of TEUs moving through the port for the years 2005-2009. The results are presented in Figure 38 below. The index reveals three distinct categories of ports. The ports with the largest indices could be called “national ports.” They are Los Angeles, Long Beach and New York. The second category is “regional ports.” Regional ports include: Savannah, Oakland, Norfolk Harbor, Tacoma, Charleston, Houston and Seattle. Local ports include Miami, Port Everglades, Baltimore, Jacksonville, San Juan, Wilmington DE, Philadelphia Wilmington NC, Palm Beach, Chester, New Orleans, Gulfport, Mobile and Portland. The index shown in Figure 40 was developed based on freight traffic measured in TEUs.

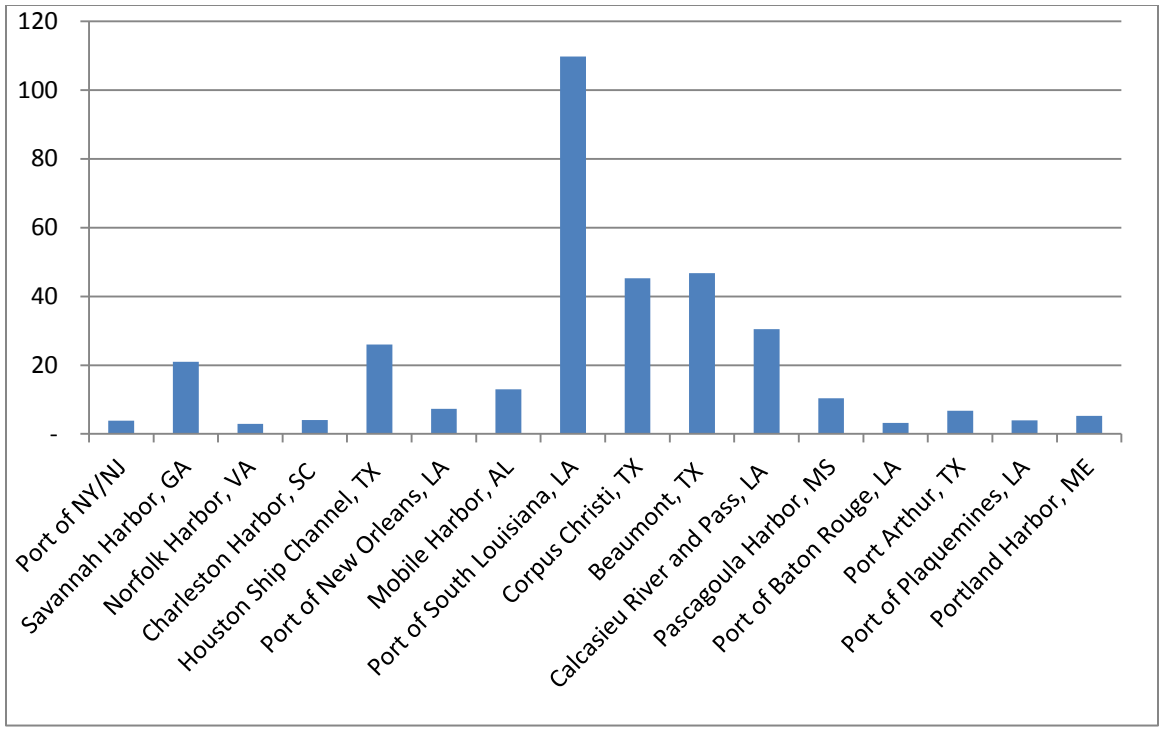
[129] USACE Institute for Water Resources



Source: USACE Institute for Water Resources

Figure 38: IWR Port Index of Regional Trade – Traffic Measured in TEUs

A similar analysis was conducted measuring freight traffic in tons for consideration of bulk ports. The results for selected ports are presented in Figure 39. This index shows the Port of South Louisiana to be a "national" port. Regional ports are Savannah, Houston Ship Channel, Corpus Christi, Beaumont and Calcasieu River and Pass.



Source: USACE Institute for Water Resources

Figure 39: IWR Index of Regional Trade – Traffic Measured in Tons

As a general observation it may be surmised that investments in "national" or "regional" ports will have a wider distribution of benefits than those that serve a local catchment area. Preference may be given to investments in ports that serve a broader community as part of a national transportation strategy.

Report Observations and Findings

The main observations and findings of the report are as follows:

- World trade and U.S. trade is expected to continue to grow.
- Post-Panamax size vessels currently call at U.S. ports and will dominate the world fleet in the future.
- These vessels will call in increasing numbers at U.S. ports that can accommodate them.
- Along the Southeast and Gulf coast there may be opportunities for economically justified port expansion projects to accommodate post-Panamax vessels.
    - This is indicated by an evaluation of population growth trends, trade forecasts and an examination of the current port capacities. As well as completed and ongoing Corps feasibility studies.
    - Investment opportunities at specific ports will need to be individually studied.

- The potential transportation cost saving of using post-Panamax size vessels to ship agricultural products to Asia, through the Panama Canal may lead to an increase in grain traffic on the Mississippi River for export at Gulf ports.
    - An analysis indicated the current Mississippi River capacity is adequate to meet potential demand if the waterways serving the agricultural export market are maintained.
    - A need for lock capacity expansion is not indicated.
- Despite the uncertainty in market responses to the deployment of post-Panamax vessels and the expansion of the Panama Canal, individual investment opportunities for port expansion can be identified using established decision making under uncertainty techniques. Adaptive management techniques can also be used to address uncertainty issues. Preliminary estimates indicate the total investment opportunities may be in the $3-$5 billion range.
- Environmental mitigation costs associated with port expansion can be significant and will play an important role in investment decisions.
- The primary challenge with the current process to deliver navigation improvements is to ensure adequate and timely funding to take advantage of potential opportunities.
    - A notional list of financing options is presented to initiate discussion of possible paths to meet this challenge—it is anticipated that a variety of options may be desirable, and in all cases individual project characteristics, including its economic merits, would need to be considered in selecting the optimal financing mechanisms.

A Final Thought

There is uncertainty in the navigation industry regarding the expected impacts from the deployment of *post-Panamax* vessels. Current fiscal conditions and budget priorities suggest the Federal government's role may become more limited than in the past. Within the navigation program there is competition between maintenance of our current projects and capacity expansion.

Maintaining the capacity of our major ports and waterways and expanding port capacity when, where, and in a way that best serves this Nation will require leadership at all levels of government, and partnership with ports and the private sector. The main challenges are to continue to maintain the key features of our current infrastructure, to identify when and where to expand coastal port capacity, and to determine how to finance its development. Congress, by directing the preparation of this report, and the Administration, by proposing a White House task force on navigation, have demonstrated a coincident interest in this topic, indicating an opportunity to jointly develop appropriate guidelines, methods, and legislation to establish a national investment strategy.

Appendices

Appendix A

Organizations providing written comments:

Port of Seattle

Port of Tacoma

Port of Virginia

Port of Houston

Port Miami

Port of Baltimore (Maryland Port Administration)

Port Authority of NY and NJ

American Association of Port Authorities

South Carolina State Port Authority

Florida Port of Council

Texas Transportation Institute

Pacific Northwest Waterways Association

GICA (Gulf Intracoastal Association)

Lake Carriers Association

Dredging Contractors of America

National Waterways Conference

Fifth Coast Guard District

EPA

USACE NAN

USACE, NAO

Broward County

Big River Coalition

NRDC (Natural Resources Defense Council)

National Wildlife Federation/ Sierra Club

Center for a Sustainable Coast

Taxpayers for Common Sense

Environmental Defense Fund

Izaak Walton League of America

Chip Meador

Paul Pollinger

Appendix B

Term	Definition
Beneficiary Based Funding	Payments for the cost of construction, operation, maintenance and repair of harbors, channels, locks and dams using revenues from user fees or a dedicated tax source. A user fee is a direct charge paid voluntarily by the user of the harbor or waterway; failure to pay the charge results in exclusion from use (e.g., a lock passage fee or a wharf access fee). In contrast, a dedicated tax is a required payment to a government entity, enforced by threats of sanction for nonpayment rather than by denial of a use (e.g., a tax on fuel). Revenues from user fees and dedicated taxes are often deposited to a government managed trust fund. This "beneficiary pays" funding strategy has been advocated for assuring the efficient use of funds for investment and maintenance. However efficiency requires more than just collecting revenues from beneficiaries; efficiency requires that expenditure of those funds be the responsibility of those entities who pay for the service. Otherwise, fees and dedicated systems cannot be distinguished from general revenues.
Berths	Berth is the term used in ports and harbors for a designated location where a vessel may be moored, usually for the purposes of loading and unloading. Berths are designated by the management of a facility (e.g., port authority, harbor master). Vessels are assigned to berths by these authorities. Most berths will be alongside a quay or a jetty (large ports) or a floating dock (small harbours and marinas). Berths are either general or specific to the types of vessel that use them in the process. The size of the berths varies from 5-10m for a small boat in a marina to over 400m for the largest tankers.
Bulk cargo	Bulk cargo is commodity cargo that is transported unpackaged in large quantities. This cargo is usually dropped or poured, with a spout or shovel bucket, as a liquid or as a mass of relatively small solids (e.g. grain, coal), into a bulk carrier ship's hold, railroad car, or tanker truck/trailer/semi-trailer body. Smaller quantities (still considered "bulk") can be boxed (or drummed) and palletised. Bulk cargo is classified as liquid or dry.
Cascade	Cascading refers to the shifting of vessels from one trade service to another that occurs when new, large vessels are deployed on the longest and largest trade service – Asia to Northern Europe. The displaced "smaller" vessels on that service are forced to re-deploy to the next most efficient service for that vessel size, in turn displacing another set of vessels, and so on.
Container	A shipping container is a container with strength suitable to withstand shipment, storage and handling. Shipping containers range from large reusable steel boxes used for intermodal shipments to the ubiquitous corrugated boxes. In the context of international shipping trade, "container" or "shipping container" is virtually synonymous with "(standard) intermodal freight container" (a container designed to be moved from one mode of transport to another without unloading and reloading).

Cost Recovery	A requirement that all costs for construction, operation, maintenance and repair costs incurred over a period of time be matched by general tax revenues and receipts from user fees in dedicated taxes. Since benefits are realized over time, payments toward cost recovery may be received over several years. Upfront costs will typically require sale of bonds; repayment of bond debt would be spread over some period of project life.
Cost sharing	A legally mandated sharing of the costs for construction, operations, maintenance, repair, rehabilitation or replacement for harbor and waterway improvements between the Federal government and a non-Federal entity. Cost-sharing is a requirement for Federal budgetary participation in harbor and inland waterway improvements.
Cube trade	See "Volume Trade"
Docks	See "Wharf"
Financing	The advancement of funds from a public, quasi-public or private entity to an entity initially responsible for the costs of improvements and O&M at harbor and waterway facilities. The responsible entity then uses a combination of general revenues, user fees and dedicated taxes to repay the incurred debt.
General Revenue Funding	Appropriations for the cost of construction, operations, maintenance and repair of harbors and waterways made from general revenues of Federal and non-Federal governments.
Hinterland	The area from which products are delivered to a port for shipping elsewhere is that port's hinterland.
Infrastructure	Infrastructure is basic physical and organizational structures needed for the operation of a society or enterprise, or the services and facilities necessary for an economy to function. It can be generally defined as the set of interconnected structural elements that provide framework supporting an entire structure of development. It is an important term for judging a country or region's development. The term typically refers to the technical structures that support a society, such as roads, water supply, sewers, electrical grids, telecommunications, and so forth, and can be defined as "the physical components of interrelated systems providing commodities and services essential to enable, sustain, or enhance societal living conditions." Viewed functionally, infrastructure facilitates the production of goods and services and also the distribution of finished products to markets, as well as basic social services such as schools and hospitals; for example, roads enable the transport of raw materials to a factory. In military parlance, the term refers to the buildings and permanent installations necessary for the support, redeployment and operation of military forces.
Infrastructure Bank	A chartered government institution that makes or guarantees loans for non-Federal infrastructure improvements in anticipation of repayment through future dedicated revenue streams, such as revenues from user fees or dedicated taxes.

Inland waterway	The U.S. Army Corps of Engineers (USACE) is responsible for 12,000 miles (19,000 km) of the waterways. This figure includes the intracoastal waterways such as the Gulf Intracoastal Waterway and the Atlantic Intracoastal Waterway. Most of the commercially important inland waterways are maintained by USACE, including 11,000 miles (18,000 km) of fuel taxed waterways. Commercial operators on these designated waterways pay a fuel tax, deposited in the Inland Waterways Trust Fund, which funds half the cost of new construction and major rehabilitation of inland waterways infrastructure.
Intermodal	Intermodal freight transport involves the transportation of freight in an intermodal container or vehicle, using multiple modes of transportation (rail, ship and truck), without any handling of the freight itself when changing modes.
Jetty	A jetty is any of a variety of structures used in river, dock and maritime works that are generally carried out in pairs from river banks or in continuation of river channels at their outlets into deep water; or out into docks and outside their entrances; or for forming basins along the sea-coast for ports in tideless seas. The forms and construction of these jetties are as varied as their uses (directing currents or accommodating vessels), for they are formed sometimes of high open timber-work, sometimes of low solid projections, and occasionally only differ from breakwaters in their object.
Long ton	Long ton is the name for the unit called the "ton" in the U.K. system of measurement. One long ton is equal to 2,240 pounds (1,016 kg), 1.12 times as much as a short ton. It has some limited use in the U.S. and is often used to measure the displacement of ships. (see “Short Tons” for a more in-depth discussion of the term “ton.”
Multi-modal	See "Intermodal"
Panamax	*Panamax* refers to vessels sized to the maximum allowed by the dimensions of the pre-expansion Panama Canal.
Post-Panamax	*Post-Panamax* refers to vessels that are too large to fit through the channels and locks of the pre-expansion Panama Canal. Several classes of vessels would be appropriately called *post-Panamax*. With the expansion of the Canal expected to be complete in 2014, several classes of *post-Panamax* vessels will be able to transit the Canal. Those vessels sized to the maximum allowed by the new dimensions of the expanded canal have been dubbed "New Panamax" and larger vessels have been dubbed "Neo Post-Panamax" or “Super Post-Panamax.”
Short ton	The short ton is a unit of measurement equal to 2,000 pounds (907.18 kg). In the U.S. most references to “ton” refer to the short ton. There are other measurements of a ton including the metric ton (tonne) equal to 1,000 kilograms (2,204.62 lbs) or the long ton equal to 2,240 pounds (1,016.05 kg). There are some U.S. applications for which “ton” means long tons (e.g., Navy ships) or metric tons (e.g., world grain production figures). Both the long and short ton are defined as 20 hundredweights. In the U.S. system a hundredweight is 100 pounds but would be 112 pounds in the U.K. system (or approximately 100 kg).

TEU	The twenty-foot equivalent unit (often TEU or teu) is an inexact unit of cargo capacity often used to describe the capacity of container ships and container terminals. It is based on the volume of a 20-foot-long (6.1 m) intermodal container, a standard-sized metal box which can be easily transferred between different modes of transportation, such as ships, trains and trucks. One TEU represents the cargo capacity of a standard intermodal container, 20 feet (6.1 m) long and 8 feet (2.44 m) wide. There is a lack of standardization in regards to height, ranging between 4 feet 3 inches (1.30 m) and 9 feet 6 inches (2.90 m), with the most common height being 8 feet 6 inches (2.59 m). Also, it is common to designate 45-foot (13.7 m) containers as 2 TEU, rather than 2.25 TEU.
Transshipment	The transshipment of containers at a container port or terminal can be defined as the number (or proportion) of containers, possibly expressed in TEU, of the total container flow that is handled at the port or terminal and, after temporary storage in the stack, transferred to another ship to reach their destinations. The exact definition of transshipment may differ between ports, mostly depending on the inclusion of inland water transport (barges operating on canals and rivers to the hinterland). The definition of transshipment may: include only seaborne transfers (i.e., a change to another international deep-sea container ship) or include both seaborne and inland waterway ship transfers (sometimes indicated as water-to-water transshipment). Most coastal container ports in China have a large proportion of riverside “transshipment” to the hinterland. In both cases, a single, unique, transshipped container is counted twice in the port performance, since it is handled twice by the waterside cranes (separate unloading from arriving ship A, waiting in the stack, and loading onto departing ship B).
Trust fund	A government established and managed account that accumulates the revenues from user fees and dedicated taxes. The managers of the fund make decisions about the disbursements from the fund.
Volume trade	Services that tend to fill vessels to their volume capacity are considered "volume trade." They generally require channel depths providing clearance less than the vessel’s maximum draft.
Weight trade	Services that tend to fill vessels to their weight capacity are considered "weight trade." They require channel depths providing clearance of the vessel’s maximum draft.
Wharf	A wharf or quay is a structure on the shore of a harbor where ships may dock to load and unload cargo or passengers. Such a structure includes one or more berths (mooring locations), and may also include piers, warehouses, or other facilities necessary for handling the ships.

Appendix C

Memorandum of Understanding between U.S. Department of the Army and U.S. Department of Transportation

MEMORANDUM OF UNDERSTANDING
BETWEEN
U.S. DEPARTMENT OF THE ARMY
AND
U.S. DEPARTMENT OF TRANSPORTATION

I. PARTIES

This Memorandum of Understanding (MOU) confirms a collaborative relationship between the U.S. Department of Transportation (DOT) and the U.S. Department of the Army (Army), collectively referred to herein as "the Parties."

II. AUTHORITIES

Department of the Army:

1. 33 U.S.C. § 2281, which directs the Secretary of the Army to consider enhancements to U.S. economic development in planning water resources development projects.

2. 33 U.S.C. § 2323a, which permits the Secretary of the Army to engage in activities in support of other Federal agencies to address problems of national significance to the United States related to water resources, infrastructure development, and environmental protection.

Department of Transportation:

1. 49 U.S.C. § 301(3)&(4), which direct the Secretary of Transportation to:

   a. Coordinate Federal policy on intermodal transportation and initiate policies to promote efficient intermodal transportation in the United States; and
   b. Promote and undertake the development, collection, and dissemination of technological, statistical, economic, and other information relevant to domestic and international transportation.

III. PURPOSE

The purpose of the collaboration is to identify and capitalize on opportunities to improve the Nation's transportation infrastructure investments where shared equities exist.

IV. OBJECTIVE

The objective of the collaboration is to synchronize the Parties' strategies and coordinate and align infrastructure project proposal criteria and project evaluation and selection methodologies in support of a multimodal transportation network that improves the nation's economic competitiveness.

The information shared is not expected to include information about individuals (personally identifiable information PII "privacy protected" information), but could include business proprietary information (confidential business information—CBI) received from business entities.

Any information sharing must comply with applicable disclosure restrictions and practices (e.g., sharing of CBI may require the consent of, or notice to, the submitters of the information).

When the systems and information are known, each Party will prescribe appropriate restrictions on further dissemination and use, and appropriate labeling and handling instructions, for any information that is sensitive, to ensure the information remains confidential and to ensure each Party and/or the submitters retain control over the information.

VI. PERIOD OF AGREEMENT

The effectiveness of this MOU will commence upon full execution of the final signatures of the Parties, and will remain in effect indefinitely from the date of execution, unless the MOU is terminated by mutual agreement or by either side with thirty days notice.

VII. MODIFICATION

This MOU or subsequent annexes may be amended or modified at any time by mutual agreement of the Parties. Such modifications shall be in writing and will take effect upon execution by the Parties.

VIII. OTHER PROVISIONS.

Generally: All provisions of this MOU are subject to the availability of funds.

Severability: Nothing in this MOU or any related annex is intended to conflict with current statutes, regulations, orders, or directives of DOT, Army, or any other Federal agency or entity. If a provision of this MOU, or any annex, is determined to be inconsistent with such authority, then that provision will be invalid to the extent of such inconsistency, but the remainder of that provision and all other provisions, terms, and conditions of this MOU and any related annexes will remain in full force and effect.

Rights and Benefits: Nothing in this MOU is intended to diminish or otherwise affect the authority of any agency to carry out its statutory, regulatory or other official functions. This MOU is not a final agency action by any of the signatory agencies, and does not create any right or benefit, substantive or procedural, enforceable at law or equity by any party against the United States, its agencies or officers, State agencies or officers carrying out programs authorized under Federal law, or any other person. This MOU does not impose any legally binding requirements on Federal agencies, States, or the regulated public.

This MOU Does Not Involve Funding: This MOU is neither a fiscal nor funds obligation document. It does not obligate, commit or authorize the expenditure of funds and cannot be used as the basis for the transfer of funds. Any endeavor involving the reimbursement or contribution of funds between the Parties shall be in accordance with applicable laws, regulations, and procedures. Funding arrangements, if any, shall be the subject of separate agreements that will be subject to the availability of funds.

Disputes: Should disagreement arise in the interpretation of the provisions of this MOU, or related amendments and/or revisions, that cannot be resolved at the operating level, the area(s) of disagreement will be stated in writing by each Party and presented to the other Party for consideration. If agreement on interpretation is not reached within thirty (30) days, the Parties will forward the written presentation of the disagreement to respective higher level officials for appropriate resolution.

IX. CONTACT INFORMATION

For the purposes of exchanging information and coordinating activities under this MOU, the respective points of contacts for the Parties are as follows:

For Army: Chief of Operations, U.S. Army Corps of Engineers
For DOT: Chief Economist, Office of Transportation Policy

X. SIGNATURES

John Porcari, Deputy Secretary
U.S. Department of Transportation

Jo-Ellen Darcy, Assistant Secretary for the Army (Civil Works)
U.S. Department of the Army

U.S. Port and Inland Waterways Modernization:
Preparing for Post-Panamax Vessels

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