

Bayonne Bridge Air Draft Analysis

Prepared for

The Port Commerce Department
The Port Authority of New York and New Jersey



Prepared by

United States Army Corps of Engineers
New York District

September 2009



US Army Corps
of Engineers®
New York District

EXECUTIVE SUMMARY

The Port Authority of New York and New Jersey (PANYNJ) commissioned the New York District of the U.S. Army Corps of Engineers to examine the commercial consequences of and the economic benefits generated by potential remedies for the air draft restriction imposed by the current height of the Bayonne Bridge. The air draft beneath the Bayonne Bridge varies with the tide between 151 and 156 feet. As more container ships of relatively large dimensions enter the world fleet, the frequency with which the Bridge will be an obstacle for large vessels to access container terminals west of the Bridge has the potential to increase. As a consequence, the Bayonne Bridge could become a detriment to the commercial attractiveness of the Port of New York and New Jersey.

The focus of the study is to assess whether these negative economic effects will occur (and if so, to what extent and when) in order for the PANYNJ to consider whether this issue warrants the conduct of further planning and environmental analysis that will inform future PANYNJ decisions. The major study findings are:

1. At its current height, the Bayonne Bridge is an obstruction to large container vessels (*i.e.*, most vessels greater than 7,000 TEUs) that might otherwise call the Port of New York and New Jersey within the 50-year planning horizon.
2. The economic benefits from removing the Bridge are independent of (*i.e.*, above and beyond) the benefits of providing 50-foot access to the container facilities throughout the harbor.
3. Preliminary estimates indicate that all of the proposed engineering alternatives considered in this report to deal with the air draft problem would result in considerably favorable benefit-to-cost ratios (BCR), on a National Economic Development basis (See summary table below).

The remainder of this paper follows as closely as practical the analytical path that the Corps of Engineers utilizes for deep-draft navigation studies. As a decision document, it is analogous to a Corps reconnaissance report, rather than a feasibility report, in that it does not include a recommended project or a cost-sharing plan. The purpose of a Corps reconnaissance report is to determine whether there is a water resource problem with an engineering solution that requires more detailed planning and environmental analyses to determine a specific project recommendation. In this case, the scope of the Corps' review was expanded beyond the scope of a typical Corps of Engineers reconnaissance study to meet the needs of the PANYNJ's project planning and decision-making process. The report suggests that further planning and environmental analyses by the PANYNJ are warranted for the identification of a preferred project alternative.

Summary of the Benefits to Costs

Alternative	Year Improvement in Place	Break Even Year	BCR	IRR	Total Net Benefit
Jack to 215	2019	2033	3.0	10.7%	\$3,270,679,702
New at 215	2022	2039	2.1	8.4%	\$2,821,542,529
Bored Tunnel	2024	2042	1.9	7.7%	\$2,585,424,669
Immersed Tunnel	2024	2051	1.4	6.1%	\$1,517,453,940

Source: Costs from The Port Authority of New York and New Jersey TB&T; Construction cost estimates assume engineering and design begins in 2010.

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I. STUDY PURPOSE

This study assesses the commercial consequences of the failure to eliminate the air draft restriction caused by the Bayonne Bridge and quantifies, to the extent practicable and within reasonable but not excessively narrow confidence intervals, the most likely level of economic and other benefits associated with modifying or replacing the Bayonne Bridge. The New York District of the United States Army Corps of Engineers (USACE or "the Corps") has undertaken this effort on behalf of The Port Authority of New York and New Jersey (PANYNJ or "the Port Authority") through the Corps' Interagency and International Services Program as codified at 31 U.S.C. 6505¹ which states, in pertinent part:

The President may prescribe statistical and other studies and compilations, development projects, technical tests and evaluations, technical information, training activities, surveys, reports, documents, and other similar services that an executive agency is especially competent and authorized by law to provide. The services prescribed must be consistent with and further the policy of the United States Government of relying on the private enterprise system to provide services reasonably and quickly available through ordinary business channels.

The Corps was asked to perform this effort in such a manner as to maintain comparability with the methods and procedures used in the economic analysis portion of the New York and New Jersey Harbor Navigation Study² (HNS), completed in 1999. That effort included a comprehensive analysis of alternatives and the preparation of an Environmental Impact Statement and resulted in the Report of the Chief of Engineers on the New York and New Jersey Harbor Navigation Study³ (*Chief's Report*). All of these efforts were preceded by a reconnaissance report that recommended that the comprehensive analysis of the alternatives be conducted as a cost-shared feasibility study. The *Chief's Report* recommended deepening the navigation channels in the Port of New York and New Jersey (PONYNJ, or "the Port") to 50 feet. This 50-foot deepening was authorized as the "*Port of New York and New Jersey, New York and New Jersey*" (Harbor Deepening Project, HDP) in the Water Resources Development Act of 2000⁴ and amended for consolidated implementation by the *Conference Report for the Fiscal Year (FY) 2002 Appropriations Act*.⁵

The Recommended Plan of the HDP was based on reasonable maximization of the National Economic Development (NED)⁶ benefits that could accrue from deepening the navigation channels leading to the Port. The benefits are based on transportation costs avoided by using

¹ The Interagency and International Services Program is authorized by §211 of the Water Resources Development Act of 2000 (P.L. 106-541), 114 Stat. 2592 (11 December 2000), as amended by §109 of the Energy and Water Development Appropriations Act of 2002 (P.L. 107-66) and codified as 31 U.S.C. 6505.

² *New York and New Jersey Harbor Navigation Study Feasibility Report*, December 1999.

³ *Report of the Chief of Engineers on the New York and New Jersey Harbor Navigation Study*, May 2, 2000.

⁴ P.L. 106-541, 11 December 2000.

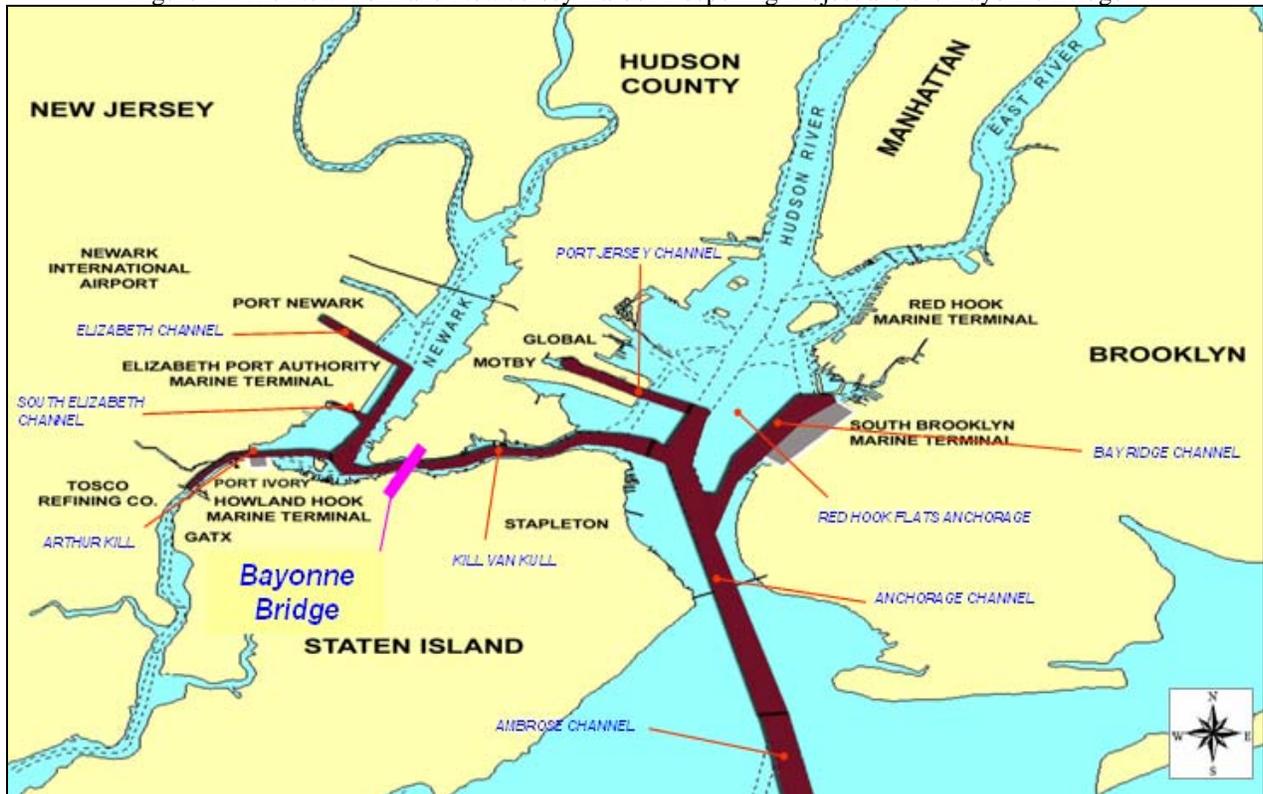
⁵ U.S. Congress, House. *Conference Report on the Energy and Water Appropriations Act of 2002*, 17th Cong., 1st Ses., 2002. H. Rpt. 107-258.

⁶ *Economics and Environmental Principles & Guidelines for Water and Related Land Resources Implementation Studies (P&G)*, Water Resources Council, 1983.

larger ships to carry the commerce forecasted for the New York and New Jersey catchment area - the domestic hinterlands served by the Port. They are based on transportation cost savings for waterborne transport - using larger ships to carry the projected commerce. The reader who would like to become more familiar with the HNS and HDP should consult the summary of its findings and recommendations, presented in *Appendix A, Summary of Findings and Recommendations of the New York and New Jersey Harbor Navigation Study* or, for even greater detail the *New York and New Jersey Harbor Navigation Study Feasibility Report*, December 1999.

In 1999, the Recommended Plan of the 50-foot study was forecasted to produce \$238,500,000 in total NED benefits discounted and annualized over the 50-year planning horizon. The benefit/cost ratio was 1.4. In 2004, in forecasting the effects of consolidated implementation, NED benefits were reevaluated and forecasted to be \$244,200,000 after discounting and annualizing.⁷ The source of the increase in NED benefits was greater than anticipated commerce growth in the intervening 5 years. Those benefits are associated with the elimination of water draft limitations for ships up to 7,000 TEU's whereas the benefits of the current study are associated with the elimination of air draft limitations, which mostly affect ships greater than 7,000 TEU's.⁸

Figure 1 - The New York and New Jersey Harbor Deepening Project and the Bayonne Bridge



⁷ *New York and New Jersey Harbor Navigation Study Post Authorization Economic Reevaluation*, September 2004.

⁸ As will be explained in a later section of this document, and more rigorously in the *Appendix B, Sensitivity and Alternative Scenario Analyses*, there are cases when a vessel smaller than 7,000 and with keel-to-mast-heights that under normal loading conditions would be able to transit beneath the Bayonne Bridge will height restricted.

To remain consistent with the prior economic analyses, this Bayonne Bridge air draft analysis focused exclusively on NED benefits. In a typical Corps deep-draft navigation study, NED benefits are those benefits that accrue to the Nation from the transportation cost savings derived from the project. In the HDP and this study, the benefits are attributable to the economies of scale that may be realized by using larger vessels to carry cargo destined for the markets served by the PONYNJ. They do not include increases in market share that might result from taking cargo from another facility. The benefits are the transportation cost savings derived from getting those goods to and from their local destinations and origins in the most economically efficient manner. NED benefits differ from Regional Economic Development (RED) benefits because they do not consider impacts that are limited in their effects to the particular region, for example, local jobs retained or created, toll revenue collected or air quality impacts generated by using regional roadways, or increases in local tax bases or property values. These real, but regional benefits - and any "multiplier effects" attributable to them - are the subject of a forthcoming study to be conducted by the Port Authority and can be added to the NED benefits for a more complete description of benefits that would be attributable to removing the obstruction. While an appendix to this document will quantify the extra truck miles and costs that could occur if some of the cargo bound for a destination within the PONYNJ catchment area had to be diverted to a neighboring port, in this case, Norfolk - this should be seen solely as a departure point for further analyses⁹ and not a conclusion.

II. PROBLEM IDENTIFICATION

The Bayonne Bridge crosses the Kill van Kull, one of the busiest shipping channels in the world. The Bridge connects the southern tip of the Bayonne Peninsula in New Jersey to Port Richmond on Staten Island, New York. The Kill van Kull is the access channel from the sea to the Newark Bay,¹⁰ where the vast majority of the PONYNJ's container throughput capacity lies. In 2008, the PONYNJ accommodated 2,671 vessel calls carrying 5,265,053 TEU's. Terminals in the PONYNJ requiring transit beneath the Bayonne Bridge accommodated 2,185 of those vessel calls and 4,654,567 of the TEU's carried.¹¹ At mean high water (MHW), the tide condition in which air draft is most limited, the Bayonne Bridge limits the air draft available for vessels transiting the Kill van Kull to 151 feet.¹²

With the forthcoming 50-foot channel, the keel to mast height (KTMH) of ships traversing the Kill van Kull will be limited to 204 feet; however, the loading, design, and operation of vessels may further restrict access to Newark Bay because a ship transiting with a 204-foot KTMH must be perfectly loaded at a 48-foot draft, leaving two feet for underkeel clearance. As container

⁹ For example, extra truck miles also produce extra truck emissions, which may be correlated with increased incidence of pulmonary disease. Increased incidence of pulmonary disease may correlate to more missed work days, which will have an effect on the labor market.

¹⁰ The Newark Bay Complex includes the Port Newark and Elizabeth container terminals in Newark Bay as well as the New York Container Terminal on the Arthur Kill.

¹¹ Note that while 2008 throughput was lower than previous years, it is used here because it the most current information available. This number, and the benefits derived from rebasing the commerce forecast on it, are still of a magnitude that produces a high level of net benefits even if they are considered a conservative base for the commerce forecast used in this study.

¹² The air draft is 156 feet at mean low water, the least restrictive condition.

vessel sailing drafts are a function of a variety of factors, only one of which is design draft - other factors (including fleet deployment, loading patterns, ship schedules, and prior port-next port considerations) would all have to align perfectly to assume that vessels would arrive in the Port consistently at 48 feet. In fact, vessel entry data into the PONYNJ used for this study has shown that perfect loading is rarely practiced.

Figure 2 - The Air Draft of the Bayonne Bridge

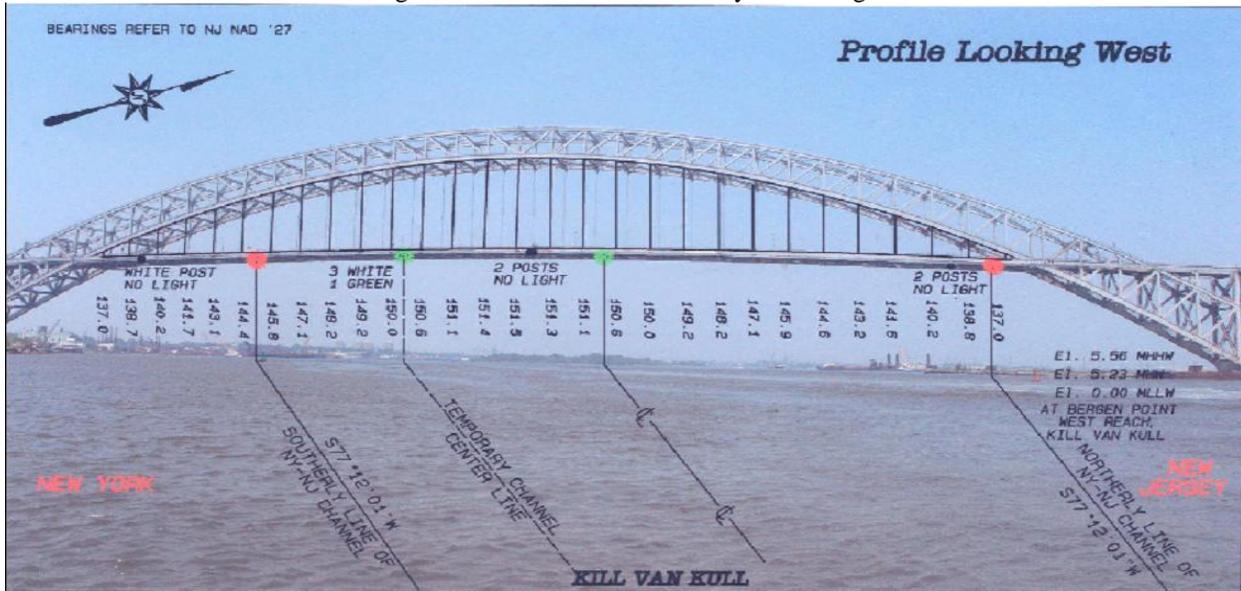
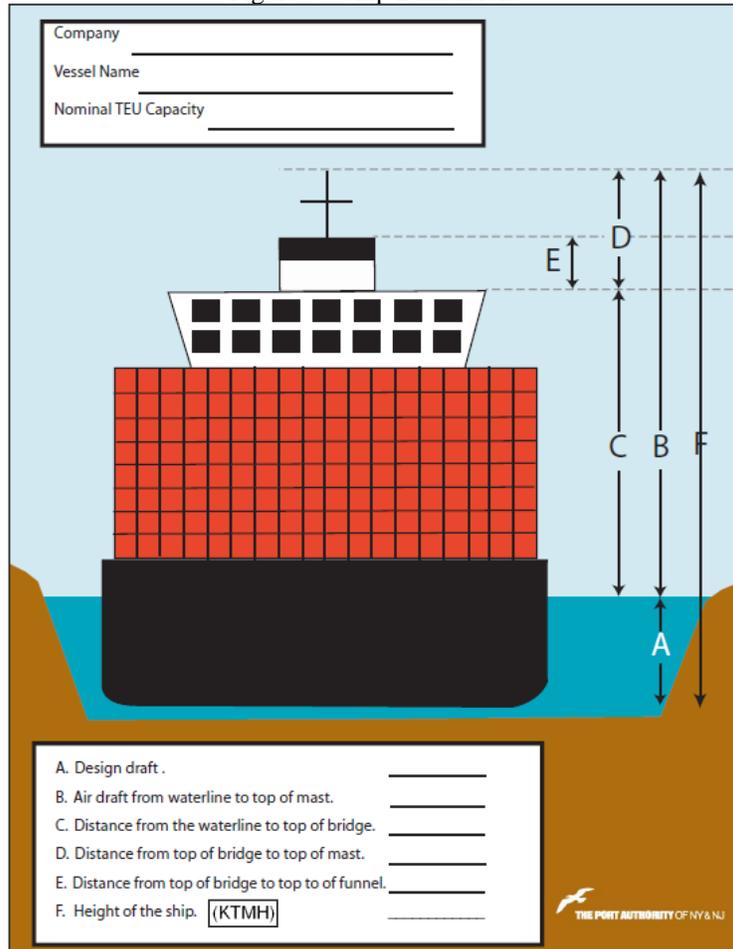


Figure 3 - Ship Dimensions



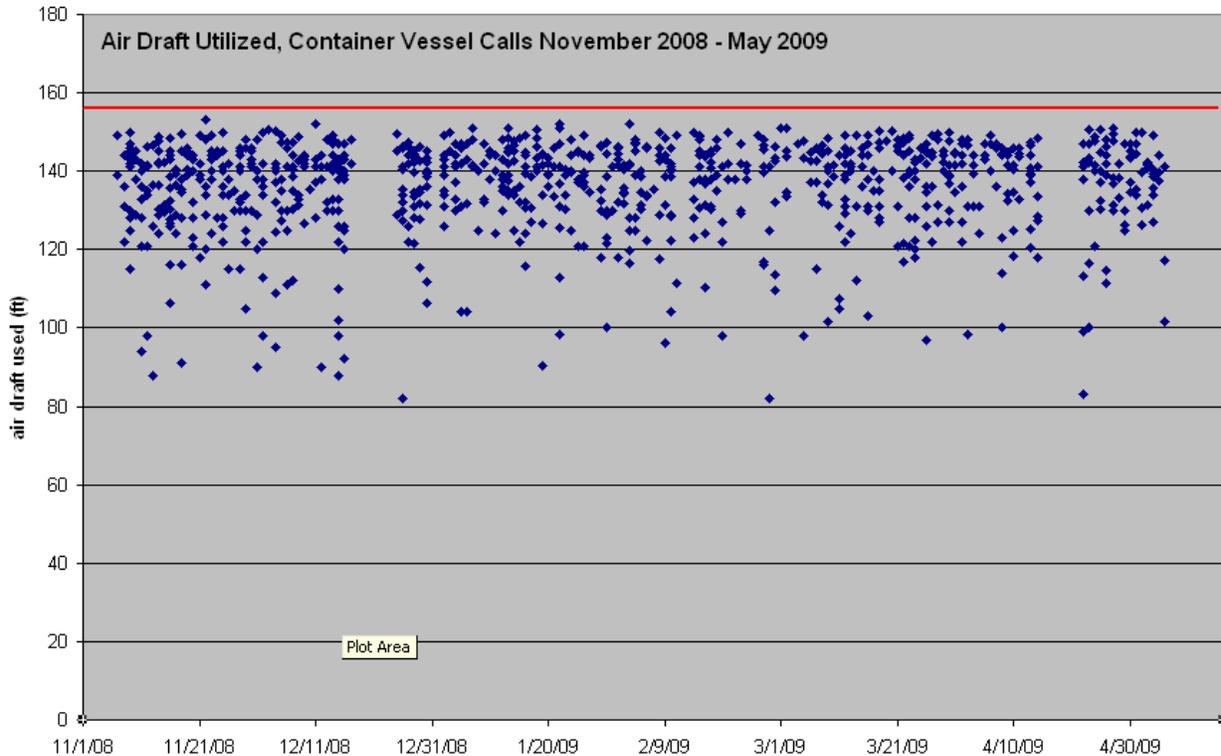
Corps deepening studies rely on the concept of a design vessel to guide the planning and design processes. The HNS used the *Regina Maersk* (now the *Maersk Kure*) as its design vessel. The design vessel is a hypothetical or real ship with dimensions of the largest vessels that the navigation project is designed to accommodate.¹³ When fully loaded and underway, the *Regina Maersk* had a dynamic draft of 48 feet and has a KTMH of 198 feet. On July 22, 1998 - in the midst of the HNS - the *Regina Maersk* made an inaugural call at Newark Bay. At that time, the channels into New York and New Jersey Harbor were only dredged to 40 feet so the ship arrived carrying only 20% of her 6,418 TEU capacity and was timed to arrive at high tide so that she could transit the channels leading to Newark Bay without encountering depth limitation. As a result, the ship rode higher in the water and the communications mast had to be detached and lowered in order for the ship to clear the Bayonne Bridge. With the mast down, the distance between the bottom of the bridge span and the top of ship's funnel was reported to be approximately 5 feet.¹⁴ Ships regularly traverse the Kill van Kull with that level of air draft

¹³ EM 1110-2-1613, Hydraulic Design of Deep Draft Navigation Projects

¹⁴ Frank, Al. "It's a Close Call for the Regina." Newark Star Ledger 23 July 1998.

clearance, as evidenced by the record of vessel air drafts of container vessels calling the PONYNJ recorded by the Sandy Hook Pilots between November 2008 and May 2009.¹⁵

Figure 4 - PONYNJ Vessel Calls and Air Drafts, November 2008 to May 2009



During the course of the 1999 HNS, the *Regina Maersk* was considered the leading edge of container ship size. The *Regina Maersk's* size was the first real jump in TEU capacity since American President Lines introduced the post-Panamax *President Truman* and her sisters in 1988. While *Regina Maersk's* 1998 call was mainly ceremonial, it showed the commercial navigation planning community in the Port what it would be expected to accommodate in the future. Any doubt that ships the size of the *Regina Maersk* or larger would call the PONYNJ regularly has been removed by subsequent events. The maritime community is already on notice that the operators of even larger ships would like to use them on services calling PONYNJ. The volume of commerce has grown far faster than anticipated in the 1999 HNS and the shipbuilding industry has kept pace with this development. Two of the largest vessels in service today are the *Emma Maersk* and *MSC Daniela*, which hold 12,508 to 14,000 TEU's and have KTMH's of 251 and 221 feet, respectively.¹⁶ This document considers the use of ships the size of the *Regina Maersk*, appropriately loaded, as part of the without-project condition. Benefits from alteration, replacement, or removal of the Bayonne Bridge are limited to those benefits derived from ships

¹⁵ This data was gathered by the Sandy Hook Pilots as a courtesy to the study team. This was a significant undertaking and while not entirely comprehensive, it does include specific transit details for 1,008 of the 1,049 container vessel calls during that six month period.

¹⁶ Note that the KTMH of the *MSC Daniela* is significantly lower than that of the *Emma Maersk*. This is because the *MSC Daniela* has a split bridge, which is an innovation that will be discussed further later in the main text. Nonetheless, it will not fit beneath the Bayonne Bridge at its current height.

that could not pass beneath the Bridge without such measures being taken for vessels with air drafts greater than the *Regina Maersk*.

With a 50-foot channel, 151 feet of air draft at MHW, and a 198 foot KTMH - a ship like the *Regina Maersk/Maersk Kure* will be physically able to call the PONYNJ under certain loading conditions; however, on March 8, 2009 the *NYK Nebula* (4,886 TEU's and KTMH of 197 feet) attempted to call the New York Container Terminal (Howland Hook) on the Arthur Kill and could not enter Newark Bay because it was riding too high to pass beneath the Bayonne Bridge.¹⁷ While the *NYK Nebula* calls the Port frequently,¹⁸ in this instance the ship had to go to Norfolk to add containers, then return to deliver her New York bound TEU's. This diversion was reported by industry sources to have cost approximately \$80,000, not including the inventory costs of the goods the late call delayed. The *NYK Nebula* incident illustrates that ships that would not be considered limited by KTMH may not be able to call the PONYNJ under certain loading conditions. The loading pattern and its relevance to the benefits calculation is discussed in further detail in a later section of this document. The benefits derivation does not include cases like the *NYK Nebula* which is limited in some situations, depending on loading, but potential impacts of these cases to the benefits stream is discussed in *Appendix B, Sensitivity and Alternative Scenario Analyses*.

At the inception of this study, the Corps consulted the United States Coast Guard (USCG) to begin to derive the frequency of allisions between the current PONYNJ fleet and the Bayonne Bridge. Over the ten year period before the study began for which data was provided, there were a total of ten events reported through the Coast Guard Marine Information for Safety and Law Enforcement (MISLE) system that could have been related to Bayonne Bridge height.¹⁹ This number of incidents appeared low given the frequency of arrivals with close margins between the height of the ship and the air draft of the ship reported by the Sandy Hook Pilots in the prior figure as well as anecdotal reports of contact between ship antennae and the bottom of the road deck.²⁰ While the *NYK Nebula* incident provided some empirical information about the costs of diversion, the most insightful evidence about the frequency of the problem was derived from a series of interviews with the carriers using the Port.

Early in the study process, the containership carriers serving the PONYNJ were sent an introductory letter stating the purpose of this study and asking for dimensional details of each class of that carrier's fleet of post-Panamax vessels, as well as the number of ships of that size

¹⁷ The *NYK Nebula* does not have a collapsible mast.

¹⁸ The *NYK Nebula* called New York 4 times within the 6 months of entrance data provided by the Pilots. The carrier is now having problems with the Bayonne Bridge for all ships on this string. According to NYK's vessel operations staff, to trim that ship in the stern (by the mast), it must take on 55 tons of ballast water to enter and leave New York Harbor. That ballast water must be taken for 200 miles out at sea because of regulatory requirements, so that ballast water remains for a large part of the journey adding to overall fuel consumption for the voyage.

¹⁹ The MISLE data did not specify clearly whether the incident was a collision with the Bayonne Bridge. From the list of events provided by the Coast Guard, incidents for which the PANYNJ also has a record were counted, then any listed incident specifically characterized as a head-on allision over the ten year period. Incidents not listed as head-on were not subtracted from the pool, even if they included barges since there is some anecdotal record of barge mounted cranes hitting the underside of the Bridge. This estimate should be considered to have a positive bias, if any.

²⁰ As of this writing, the most recent incident occurred on 18 July 2009 when the antenna of the *MSC Tokyo* hit the underside of the Bridge upon entrance into the PONYNJ.

that they operate.²¹ Of the 17 major carriers serving the PONYNJ, 15 responded to the survey,²² a clear indication that the height of the Bridge is a pressing issue. Carrier surveys were completed through a series of in-person interviews that revealed that the USCG reported frequency of allisions is not an accurate representation of the situation. The frequency of the problem is far greater than reported because it is being masked by clever operational techniques being employed by the carriers.²³

By carefully using the tide cycles the vessel can gain some combination of extra underkeel clearance and less over the mast clearance (or *vice-versa*) that totals approximately five feet. There are two additional ways make a ship that is "calling it close" fit under the Bayonne Bridge. The first is to alter the ship itself by taking down equipment. For example, the *Regina Maersk* had her communications mast detached so that she could pass. In other cases, carriers have been reported to deliberately sacrifice GPS units or antennae. The second set of solutions is loading based. They involve practices like adding cargo - the remedy used in the *NYK Nebula* incident - or taking on ballast water or bunker to make a ship heavier so that it will sit lower in the water. These trimming solutions add cost to the movement of goods. In the case of overloading, carrying extra cargo costs the carrier fuel and may add inventory delay in the delivery of containers. In the case of taking on ballast water, the extra weight adds to fuel consumption and adds environmental risk to the ship operation. Both are sub-optimal situations.

Furthermore, these operational methods are less effective as KTMH increases. For the purposes of this study, the most relevant dimension of the future fleet is its KTMH. KTMH information provided by the carriers was analyzed to determine trends in vessel height and correlations with vessel size and capacity. Plotting KTMH against the most commonly reported dimension of size of a containership, nominal TEU capacity, reveals a clear positive correlation between increasing size in terms of TEU capacity and corresponding overall vessel height, as represented in Figure 5, below.²⁴

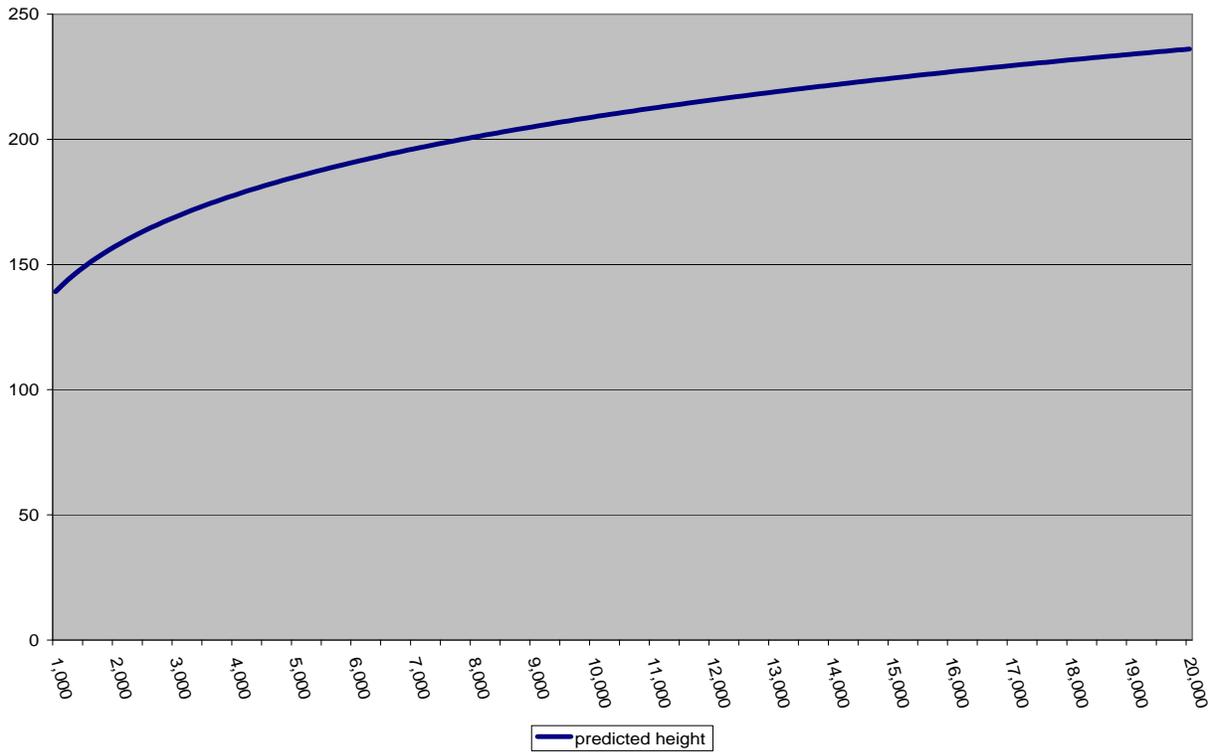
²¹ Some carriers also provided information about ships on order.

²² Individual carrier responses are not included with this submission as carriers were told that their information would only be used in summary form.

²³ A vessel like the *NYK Nebula*, with a design draft of 44 feet, would have to be loaded to 43 feet or greater, which only happens about 1% of the time. The reason there are few incidents of the *NYK Nebula*, or ships like her, hitting the Bayonne Bridge is that the operators are taking measures to manipulate the ships air draft, such as taking on ballast water or installing a collapsible mast.

²⁴ The specification estimated was $KTMH = e^{\alpha} \times TEU^{\beta}$. Notice that while it is true that there are ships, most notably the *MSC Daniela*, with approximately the same number of TEU's as the *Emma Maersk*, that do not conform to this relationship in the overwhelming majority of container vessels in operation today, KTMH increases with TEU capacity.

Figure 5 - Correlation of Vessel Size and KTMH

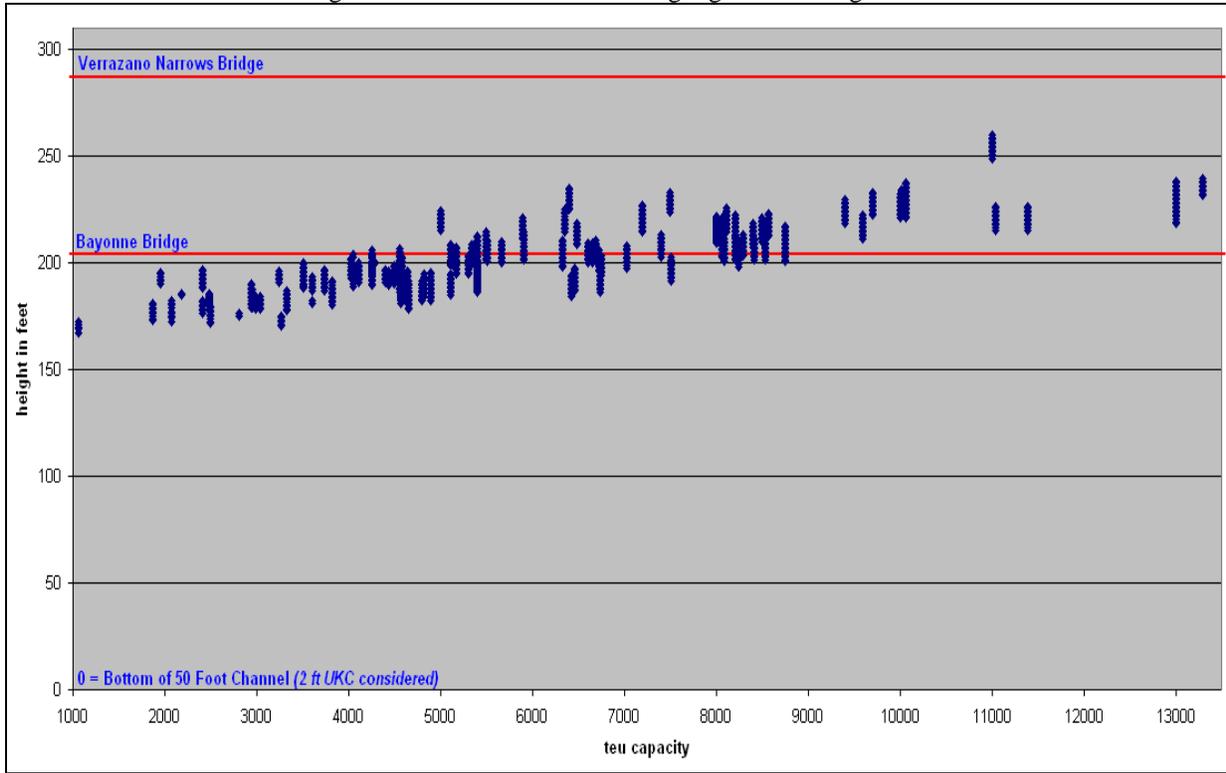


Ship height data was collected from the carrier surveys and supplemented by Lloyds Register represented over 600 existing vessels, approximately 10% of the existing world fleet.²⁵ The vessels in the sample were plotted by their varying loading pattern to show the impacts of the Bayonne Bridge air draft restriction. In the figure, the horizontal lines represent the Bayonne Bridge and the Verrazano Narrows Bridge at mean low water (MLW) to illustrate what segment of the fleet can fit under those bridges.²⁶

²⁵ The study team tested the null hypothesis that the 616 vessel sample world fleet was not drawn from or representative of the entire world fleet by comparing the design drafts of the sample with the design drafts of the population. Specifically, the null hypothesis tests is that the sample mean is not equal to the population mean, $H_0 : \bar{x} \neq \mu$. The study team could reject the null hypothesis at the 95% confidence level.

²⁶ Note that even the largest vessels of the existing container fleet will not have trouble getting under the Verrazano Narrows Bridge.

Figure 6 - Variation in Vessel Height given Loading Pattern



Further analysis of this data shows that only 57% of the hulls in this sample would be able to fit under the Bayonne Bridge at low tide with 22% of the hulls within that vessel pool being within 5 feet of the bottom of the road deck when passing beneath it which may precipitate some delay to wait for favorable tide conditions. Of the sample, which has been verified to be representative of the entire fleet, 43% would not be able to transit the channel solely because of the Bayonne Bridge restriction.²⁷

Looking at this same sample in terms of world TEU capacity, only 38% is able to serve terminals in the PONYNJ west of the Bayonne Bridge. From the sample, all of the vessels larger than 10,000 TEU, 92% of the world fleet of vessels between 8,000 and 9,999 TEU, and 56% of the world fleet of vessels between 6,000 and 7,999 TEU could not call Newark Bay with the current height of the Bayonne Bridge. This translates to more than 62% of total existing world TEU capacity physically restricted from calling the terminals in Newark Bay and along the Arthur Kill. This is represented graphically in figures 6 and 7, below. The middle bands indicate vessels whose ability to pass beneath the Bayonne Bridge is dependent on tide conditions.

²⁷ This assumes that ships that might otherwise draft more than 48 feet are considered to be light-loaded so as not to hit the channel bottom; however, in practice these vessels would be impeded by the Bayonne Bridge even if there was further channel deepening that would allow them to utilize their full design draft.

Figure 7 - Proportions of the Existing World Fleet limited by the Bayonne Bridge by Hulls

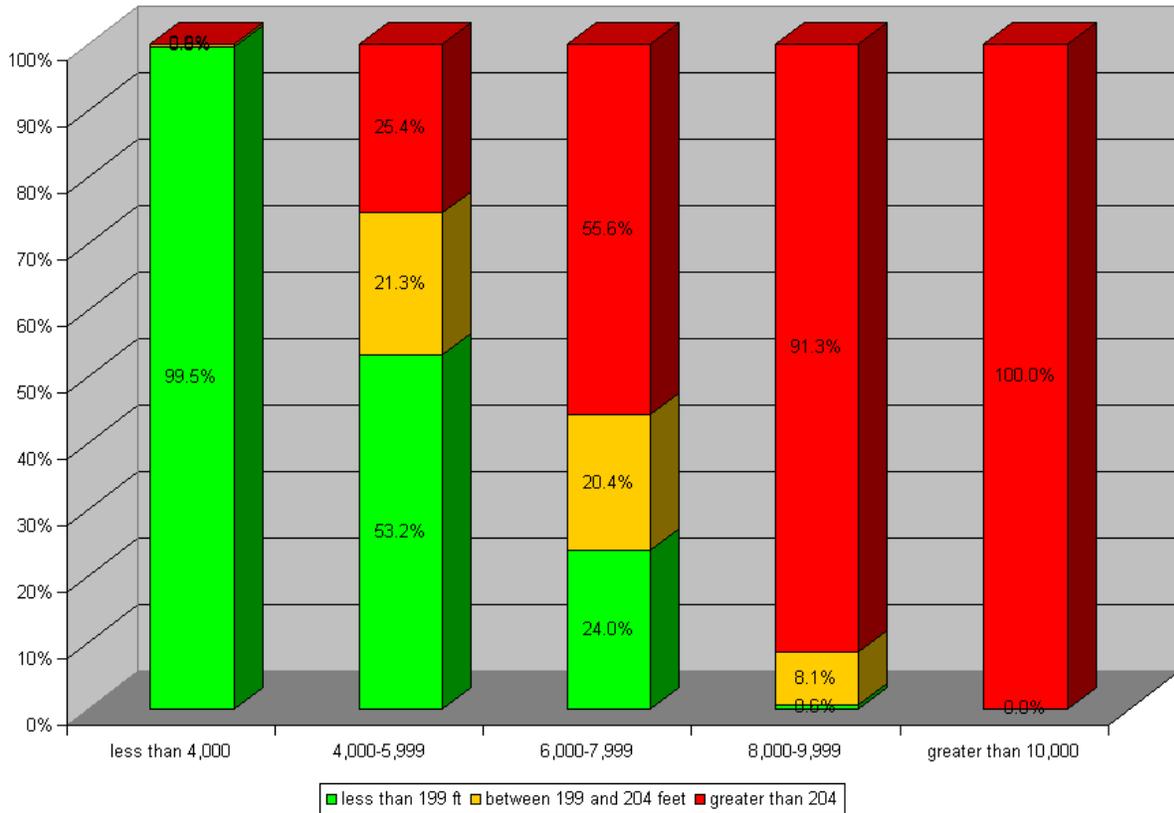
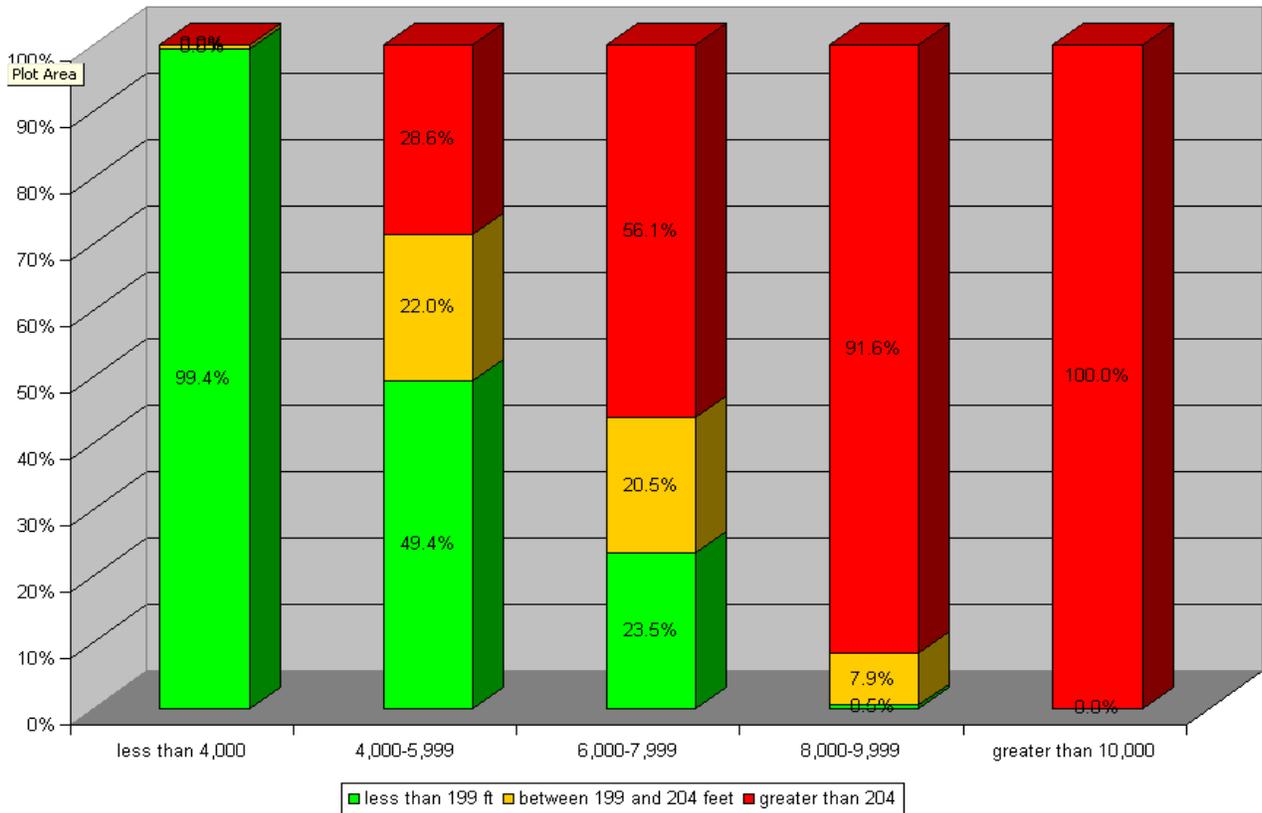


Figure 8 - Proportions of the Existing World Fleet limited by the Bayonne Bridge by TEU's



The interviews revealed information that helped to illustrate the magnitude of the obstruction caused by the Bayonne Bridge air draft restriction and the relative importance it has in their future deployment planning. Of primary importance to the carriers was the question of whether the PONYNJ would be able to support the larger vessels they would like to deploy on Far East – United States East Coast (USEC) routings once the Panama Canal expansion is complete.²⁸ The expansion of the Panama Canal will allow carriers to deploy larger vessels on major routings which may have the effect of allowing fewer ships to carry the projected commerce (an NED benefit) and has the potential to upset the current land-bridge arrangement by which cargo arrives at a United States West Coast (USWC) port and is transloaded onto the U.S. rail network to be carried nearer to its ultimate destination, which could have the effect of adding demand for all-water Far East - USEC routed vessels. Many carriers reported that they intend to deploy 10,000 TEU vessels on these routings once the Canal enlargement is complete. These vessels are far taller than the vessels currently used on these routes and the ship-based and loading solutions will not be adequate to remedy the Bayonne Bridge restriction.

The Bayonne Bridge is clearly an obstacle, but it might not be a restriction on the realization of benefits. For example, the Bayonne Bridge does not restrict container handling capacity at terminals on the east side of the Bridge, namely those terminals on the Port Jersey peninsula so benefits of bridge alteration or removal can only be counted after full utilization of facilities at Port Jersey.²⁹ It would also not be a restriction on the realization of benefits if there were one or more other restrictions west of the Bridge that would limit the realization of benefits. Some examples of possible restrictions would be insufficient rail capacity, insufficient roadway capacity, insufficient crane capacity in terms of number and outreach, insufficient berthing space, or insufficient yard capacity. The analysis presented below shows that the Bayonne Bridge is restricting the realization of deep-draft NED benefits beyond what was estimated in the HNS.

III. ANALYSIS

The analysis used to determine the NED benefits attributable to the removal of the Bayonne Bridge air draft obstruction had three distinct components. First, the extent to which the Bayonne Bridge will restrict the realization of NED benefits was evaluated at the global and local levels. At the global level, it had to be shown the extent to which the Bayonne Bridge is the most restrictive height constraint faced by ships that call the PONYNJ. At the local level, it had to be determined that the Bayonne Bridge is, in fact, the only constraint within the port limiting the full realization of NED benefits. Second, benefits were calculated by the same method as in the HNS and included the commerce forecast, fleet forecast, and loading patterns.

²⁸ This is expected to occur in 2015.

²⁹ In its current configuration, Port Jersey is only 8% of the container terminal acreage in the Port. Red Hook Terminal in Brooklyn provides another 5%. Even with huge productivity increases on their current footprints, these facilities would not be able to handle more than about 12% of PONYNJ bound commerce (not 13% as might be inferred by adding acreages because Red Hook has other constraints). Carrier interviews also revealed that, in fact, the existing capacity at Global Terminal in Port Jersey is already nearly exhausted. However, the PANYNJ has indicated that plans are already underway to expand capacity at this location by 70 acres in the next several years.

The commerce was loaded onto the fleet that could call with and without the Bayonne Bridge air draft restriction (the with- and without-project conditions) and the vessel operating costs of the with-project fleet were subtracted from those of the without-project fleet. The difference in vessel operating costs of these fleets is the economic benefit of the air draft restriction removal. Third, these benefits were compared to the costs of potential alteration and replacement alternatives to derive a benefit cost ratio and estimate net benefits to the Nation.

A. OPERATIONAL CONSTRAINTS THAT COULD LIMIT BENEFITS

There are two levels at which these operational constraints could occur. Outside of the PONYNJ, benefits could be limited by obstructions on major ship routings that impact ships calling PONYNJ. Those obstructions would limit the benefits that could be counted by this study. These are referred to below as global constraints. Operational constraints within the port, such as berths, cranes, rail and roadway capacity, and throughput are referred to as local constraints.

1. Global Constraints

A bridge as an operational constraint in marine commerce is not a new problem facing the shipping community. As infrastructure of older port cities ages and capital replacement is considered, ports around the world have had to consider how to cope with larger and taller ships. The PONYNJ is not the only port that faces an air draft constraint, but the constraint it faces is, by far, the most restrictive.

Table 1 - Port Facilities with Significant Height Obstructions to Large Ships³⁰

Location	Obstruction	Height of Restriction MHW
Hong Kong	Stonecutters Bridge	241 ft. ³¹
Suez Canal, Egypt	Mubarak Peace Bridge	230 ft.
New York & New Jersey	Verrazano Narrows Bridge	219 ft.
San Francisco/Oakland	Golden Gate Bridge	225 ft.
Oakland	Oakland Bay Bridge	220 ft.
Panama Canal	Bridge of the Americas	201 ft.
Los Angeles	Vincent Thomas Bridge	185 ft.
Yokohama	Yokohama Bay Bridge	184 ft.
Savannah	Talmadge Bridge	185 ft.
Hamburg	Kolnsbrucke	174 ft.
Long Beach	Gerald Desmond Bridge	156 ft (to 200 ft.) ³²
New York & New Jersey	Bayonne Bridge	151 ft.

³⁰ This list is compiled from the top 50 container ports, by volume, plus well known navigational choke points. The Ports of Halifax, Philadelphia, and Charleston also have air draft restrictions, but are not in this list because they are not among the top 50 container ports, by volume.

³¹ The air draft beneath Tuen Mun, the bridge leading from the Port of Hong Kong to the river terminals, is 203 feet.

³² The Port of Long Beach has indicated that the Gerald Desmond Bridge will be raised to provide an air draft of 200 feet; however, no specific timeline has been given. Furthermore, it poses less of a restriction to the Port of Long Beach than the Bayonne Bridge does to the PONYNJ because Long Beach has a large amount of terminal capacity in areas that do not require transit under the Gerald Desmond Bridge.

Of the world's largest container ports, by volume, there are a number that have air draft restrictions. The Suez Canal is restricted by the Mubarak Peace Bridge, which rises 230 feet over the waterway. The Bridge of the Americas, in Balboa, Panama, which links the northern and southern shores of the Panama Canal, has a height of 201 feet at MHW. These facts are relevant to the question of how to limit benefits because of how liner services are operated. Unlike airlines, which generally run on a hub-and-spoke model, container vessels operate on rotations, which allow carriers to call multiple ports with the same ship at scheduled intervals. What this means is that the same ship could be calling PONYNJ and Norfolk, transiting the Panama Canal, then calling Long Beach, Oakland, and Hong Kong, then returning to the west coast of the United States, back through the Panama Canal, and again to Norfolk and PONYNJ on a single voyage. A carrier puts multiple ships on this loop, each at a different stage within it, so that each port on the rotation can have weekly service. While the journey itself may take 30 days for a container to arrive at the PONYNJ from Hong Kong compared to 18 days if it was moved with direct point-to-point service because of the multiple calls between the origin and destination - the shipper is assured that his cargo is loaded at its point of origin and unloaded at its destination at weekly intervals. The extra transaction cost for this forced delay (*i.e.*, inventory cost) is ultimately built into the price of the goods once it reaches the consumer.

What this means is that alteration of the Bayonne Bridge could not accrue the same level of benefits if, in fact, there was another constraint outside of the Port that limited the fleet that could call the Port. For example, many of the liner services serving the PONYNJ pass beneath the Bridge of the Americas over the Panama Canal. For this reason, NED benefits attributable to ships requiring an air draft larger than the height of the Bridge of the Americas cannot be counted for ships on Panama routings.³³ In the same vein, the overall limitation to benefits accruing to ships calling the PONYNJ can only be attributed to ships that can pass beneath the Verrazano Narrows Bridge at the entrance to the PONYNJ.

2. Constraints at the Port of New York and New Jersey

Benefits to removal or alteration of the Bayonne Bridge might also be curtailed by constraints within the PONYNJ. To comprehensively assess the without-project condition, the Corps had to consider factors that could potentially limit the benefits of Bayonne Bridge alteration or removal. These fell at three levels - the rail and roadway network, the channel, and the wharf. Assumptions used in the benefits calculations, and the reasoning behind them, are summarized below.

³³ In the period between the completion of the HNS, when benefits were originally calculated for the 50-foot deepening, and this study - a deepening and widening of the Panama Canal was proposed and is now well underway. This deepening effort will allow ships with a 160 foot beam, 1200 foot length, and 50 foot draft (allowing approximately 12,000 TEU's, but dependent on loading) to transit the Canal. The enlarged Panama Canal is expected to open to traffic in 2015. The effect of this may be that the shippers that use current Post-Panamax vessels to move goods from the Far East to the West Coast of the United States, then to ultimate East Coast destinations using rail or truck could choose to move those goods all-water from the Far East; however, this depends on whether rail rates can keep pace with this development by making it price competitive for those TEU's to remain on the land-bridge. Because this is yet undetermined, the extent of the "Panama Bump" in commerce coming directly to the PONYNJ is not included in the benefits calculation directly, but is included in the sensitivity analysis accompanying this report.

a. Land-Side Movements

Rail

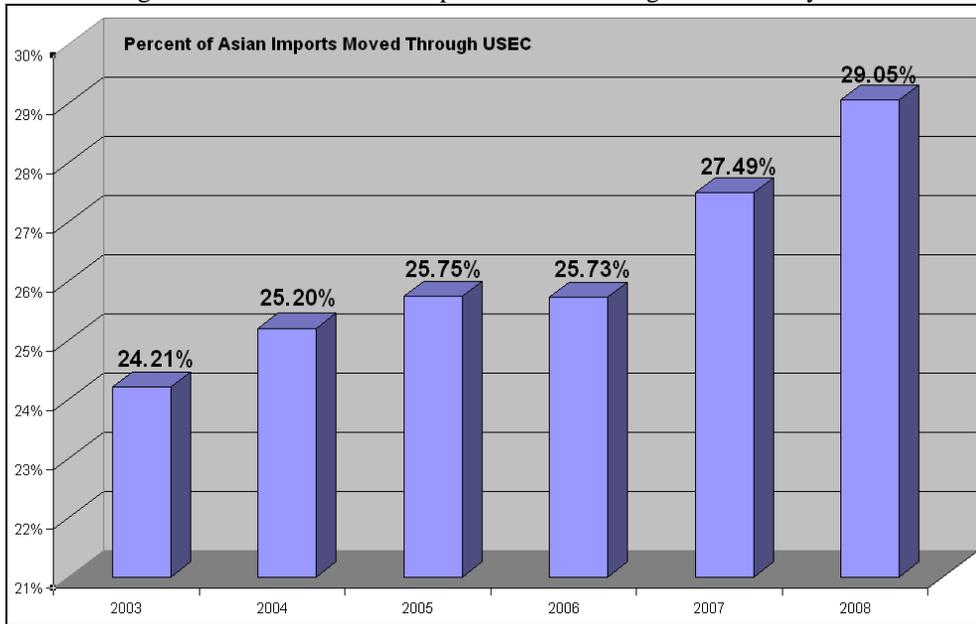
Capacity limitations on US railroads could affect the benefits to alteration or removal in a number of ways. If rail capacity from the USWC was limited, all water routes would become relatively more attractive, especially if there was idle or underutilized rail capacity from the USEC to move goods into the Midwest. Even with limited rail access out of the New York metropolitan area, there could be significant cargo moving by all water routes to the USEC as most of what comes through the PONYNJ stays in the 31-county metropolitan area surrounding the Port.³⁴

Rail capacity could be limited by a number of factors. The ones most likely to specifically affect the PONYNJ are capacity of on-dock or near-dock facilities, limitations in line haul capacity, traffic constriction at various junctions within the system, and competition for rolling stock from other goods. Goods that are taken by rail to East Coast and Midwest destinations, which might otherwise have traveled to the USEC by all water routes are generally landed at the USWC ports of Los Angeles/ Long Beach (LA/LB), Seattle, and Tacoma.³⁵ The proportion of Asian imports moved through the USEC versus the USWC is increasing, as evidenced below.

³⁴ The 31-county metropolitan area was one of the delineations of catchment area used in the 1999 Study. Those 31 counties are those counties within the 25-mile radius from the Statue of Liberty and those counties bordering them. At that time, it was determined that approximately 70% of containerized cargo moving through the Port was destined for or originated in the 31-County metropolitan area. This area consists of 31 counties, includes 14 counties in southern New York State (five in New York City, two in Long Island, and seven in the Mid-Hudson region); 14 counties in northern New Jersey; and three counties in southwestern Connecticut. The US Census estimated the total population of these counties to be 22,281,153 in 2008. This was the narrowest of the four definitions of PONYNJ hinterland used in that document. The HNS also considered the 260-mile radius from the Port used by the New York Shipping Association from which approximately 82% of the containerized cargo that moved through the Port was destined for or originated at the time of that writing and the 17-state region extending from New York to Missouri and Maryland to Maine that could be serviced by the Port of New York for less cost and within a reasonable time disadvantage than from the Ports of Los Angeles and Long Beach. The remaining 31 of the lower 48 states were considered secondary economic hinterlands for which the Port of New York and New Jersey has a minor share of international trade but over which it actively competes with other ports for market share.

³⁵ This is known as *mini-land bridge* which is an intermodal movement in which the shipment is moved from a foreign country to the U.S. by water and then moved across the U.S. by railroad to a destination that is a port city, or vice versa for exports from a U.S. port city. *Land bridge* refers to the movement of containers by ship-rail-ship on Japan-to-Europe moves; ships move containers to the U.S. Pacific Coast, rails move containers to an East Coast port, and ships deliver containers to Europe. *Micro-land bridge* refers to an intermodal movement in which the shipment is moved from a foreign country to the U.S. by water and then moved across the U.S. by railroad to an interior, non-port city, or vice versa for exports from a non-port city.

Figure 9 - Percent of Asian Imports Moved Through the USEC by Year



There could be several reasons for this increase, including demographic shifts and issues of rail infrastructure in and around Chicago, the locus of the U.S. rail network. Rail capacity is not the primary subject of this report and was not critically analyzed beyond determining the extent to which rail constraints within the PONYNJ could limit benefits to Bayonne Bridge alteration. Rail is not expected to constrain NED benefits. Furthermore, interviews with rail industry stakeholders³⁶ indicate that the 1999 HNS estimates of the Port's economic hinterland are likely to be conservative given the current state of east-west rail infrastructure and the demands upon it. The proportion of commerce bound for East Coast and Midwest destinations landed at USWC ports could decline further as a result of the expansion of the Panama Canal, which is likely to make all water service between the Far East and USEC more attractive to shippers. This report assumes in its calculations that the rail industry will undertake any structural changes that would allow it to remain competitive with all-water service, which is a bias against project justification and does not constrain benefits because of rail capacity limitations. More information on rail and the PONYNJ may be found in *Appendix C, Notes on Rail Transit as a Partial Substitute for All Water Routes*.

Roadways

Following the 1999 HNS there was a multi-stakeholder assessment of potential land side constraints to the movement of goods. This effort, the *Comprehensive Port Improvement Plan*, determined that the Port's container handling capacity, including roadways, would not be exceeded by the volume of containerized commerce until at least 2037. Because this is far enough into the future, the net present value of the costs of any improvements are not likely to

³⁶ Interviews with the American Association of Railroads (AAR) and a number of intermodal carriers have illuminated many of the rail issues that will have effects on the Port of New York and New Jersey. This anecdotal information has been checked for consistency using other sources.

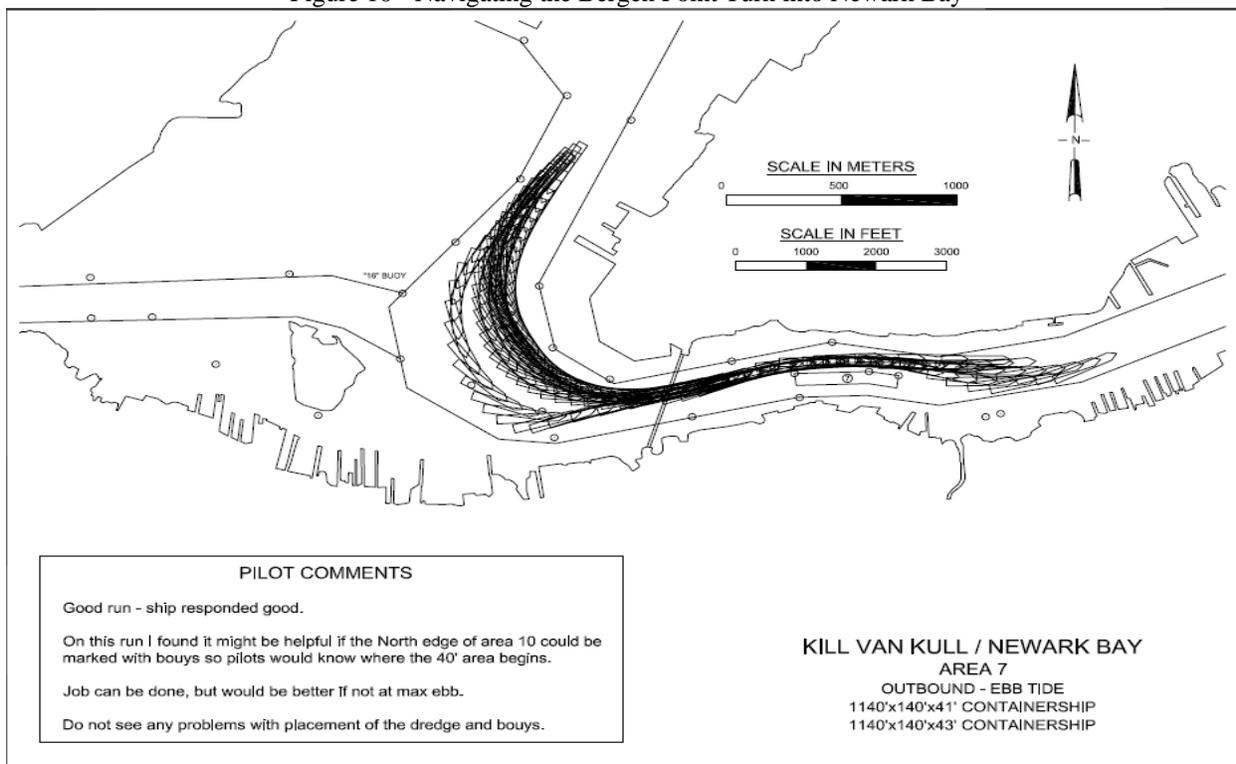
significantly alter the evaluation of the benefits stream, it is assumed that roadway capacity will not constrain the benefits presented here.³⁷

b. Channel Constraints [Modeling Report Summary]

Bergen Point Turn

Between the Bayonne Bridge and the container terminals in Newark Bay is Bergen Point, New Jersey. Bergen Point lies immediately to the west of the Bayonne Bridge on the northern shore of the Kill van Kull at the southern tip of the Bayonne Peninsula. Once ships have transited beneath the Bayonne Bridge, they must make a 135 degree turn around Bergen Point to enter Newark Bay.

Figure 10 - Navigating the Bergen Point Turn into Newark Bay



To rule out the Bergen Point Turn as a constraint, the District employed the Corps' Engineer Research and Development Center (ERDC) in Vicksburg, Mississippi. ERDC performs channel

³⁷ The Port Authority of New York and New Jersey partnered with the States of New York and New Jersey, the City of New York, the US Environmental Protection Agency, US Army Corps of Engineers, and Federal Highways Administration, in the first ever multi-agency effort to create a long-term port development plan that is both economically efficient and environmentally sustainable. This effort, referred to as the Comprehensive Port Improvement Plan (CPIP), identified specific water and landside infrastructure development scenarios and recommends associated transportation enhancements that are required to accommodate growing cargo demand out to the year 2060. CPIP was funded by the States of New York and New Jersey, using the bi-state dredging fund, the Port Authority and the City of New York. The CPIP and the accompanying Environmental Assessment provided a framework for the consideration and evaluation of future regional port improvement projects.

design simulations and modeling for Corps deepening studies and is used regularly by the HDP with input from the New York Harbor Pilots³⁸ and the Coast Guard to design the navigation channels in the Port. Simulations using *Emma Maersk*-sized vessels³⁹ occurred in May and June 2009. The modeling determined that while the Bergen Point Turn is awkward for a very large vessel, it is not insurmountable as larger, more modern vessels are generally equipped with more powerful bow and stern thrusters, which allow for greater maneuverability. When necessary, an extra tug boat could be employed to help the inbound or outbound ship. The extra expense for the added tug is minimal compared to the transportation cost benefit from bringing in a larger ship. Modeling results are summarized in *Appendix D, Vessel Simulations*.

Channel Dimensions

The design of Corps of Engineers deep draft navigation channels is guided by Engineering Manual 1110-2-1613 (EM 1613). The Corps generally uses a beam multiplier of 5.5 for preliminary design for two-way traffic and a beam multiplier of 3 for one-way traffic for a trench channel with moderate currents like the Kill van Kull.⁴⁰ This is similar to the guidance provided by the World Association for Waterborne Transport Infrastructure (PIANC) for channel design.

Figure 11 - Corps of Engineers Channel Width Design Guidance
EM 1110-2-1613
31 May 06

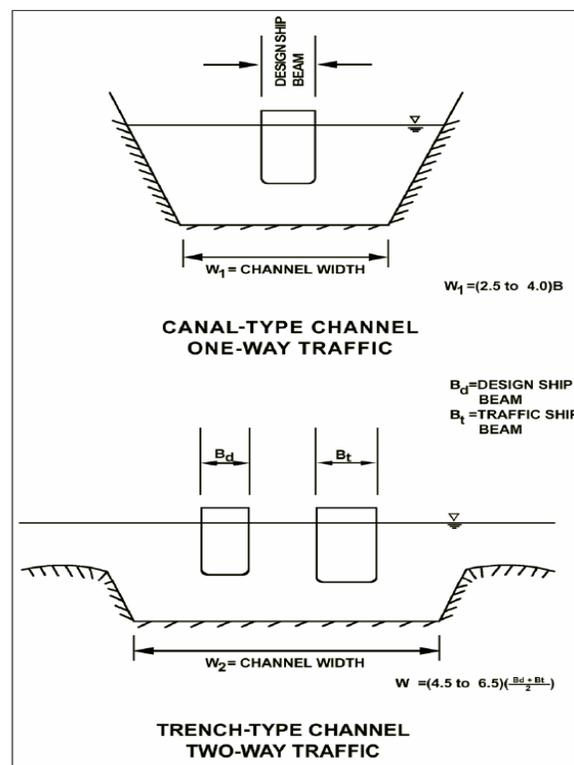


Figure 8-2. Channel design width

³⁸ This term refers to the Sandy Hook Pilots, whose data was cited earlier, the Metropolitan Pilots, and McAllister Pilots.

³⁹ The *Emma Maersk*, lightly loaded, was assumed to be the largest ship to potentially traverse the Kill van Kull at its future 50-foot depth.

⁴⁰ See EM 1110-2-1613, Table 8-3.

Nonetheless, the guidance itself says that the standard is conservative. Detailed design is based on simulator studies. The ultimate decision of whether ships can pass is left to the pilots, although the Coast Guard can supersede the pilot's decision if it foresees a safety threat. The Coast Guard manages the Vessel Traffic System (VTS) and can use it to determine whether traffic needs to be limited to one way at specified times or on demand, but this is generally an operational decision rather than a policy one.

The Kill van Kull is the narrowest channel leading from the sea to Newark Bay. At its narrowest point, the Kill van Kull is 800 feet wide and in that area the channel is bank-to-bank. During construction of the 50-foot channel some of excavation of the sideslopes resulted in impacts to the littoral zone.⁴¹ As of this writing, the *Emma Maersk*, with a static draft of 51 feet, is the largest foreseeable ship to transit the Kill van Kull, albeit lightly loaded. The beam of the *Emma Maersk* is 185 feet. This is greater than one-fifth the width of the channel, which might result in a restriction to one-way traffic while she is transiting. The benefits analysis presented here assumes that a ship the size of the *Emma Maersk* will be allowed to use the channel and that given the frequency of vessel arrivals of that size, there would be few situations when two vessels of that size will be required to pass. In situations when two ships of that size had to pass, it is assumed that one would be held in Newark Bay or on the east side of the channel until the other is through the narrowest part of the Kill van Kull. In summary, the benefits calculations assume channel dimensions are not a limiting factor.

c. Handling Constraints - Cranes, Berths, and Yard Capacity

Cranes

A ship the size of the *Emma Maersk* requires 22-box outreach cranes for efficient unloading. Currently, the Maher and APM have cranes that have a 22-box outreach and the berths at Elizabeth and Port Newark are strong enough to support cranes of that size if needed in the future. For this reason, it is assumed that crane capacity does not limit benefits. (See Figure 12 for a view of the cranes.)

Berths

Berths at terminals in Newark Bay were reinforced to 52 feet as a requirement of the HDP. The combination of the 50-foot channel, plus tide, plus an adequately deepened berth would allow the *Emma Maersk* or a similar ship to be operated in the Port in at least half of its loading conditions. These conditions are assumed in the benefits calculation so it is assumed that berths do not constrain benefits to Bayonne Bridge replacement or alteration.

⁴¹ The littoral zone is the area from mean low water seaward to six feet deep at mean low water. The littoral zone has a complex biological and ecological function and impacts to it are regulated stringently at the State level.

Figure 12 - Cranes at Maher Terminal



Terminal Capacity

Concurrent with this effort, the PANYNJ undertook a Strategic Business Assessment of the Port. To retain consistency between the two studies, assumptions about current and future terminal capacity were given to the study team by the Port Authority. The assumptions are as follows:

Table 2 - Terminal Capacity Assumptions

	Terminal Size	Lifts/Acre/Year	Anticipated Expansion	Lifts/Acre/Year EXPANDED	Total Available Acreage	Total Available Annual Throughput (LIFTS)	Total Available Annual Throughput (TEU's)
Port Newark/Elizabeth	975	4500	80	5000	1055	4,787,500	8,138,750
Howland Hook	180	4500	40	6000	220	1,050,000	1,785,000
Port Jersey Peninsula	100	4500	70	6000	170	870,000	1,479,000
Red Hook	66	4500	0	6000	66	297,000	504,900

Using these assumptions it was determined that terminal capacity will be a constraint under the current commerce forecast [described in the next section] beginning in Newark Bay in 2030 and in the Harbor overall (*i.e.*, including capacity improvements expected on the Port Jersey peninsula) in 2032. To remedy this, the Port Authority will need to make increases in terminal capacity in increments of 600,000 lifts/year in Newark Bay in each of 2030, 2035, 2040, and 2042 or in the Port overall in 2032, 2036, 2039, and 2042.⁴² These improvements may add to

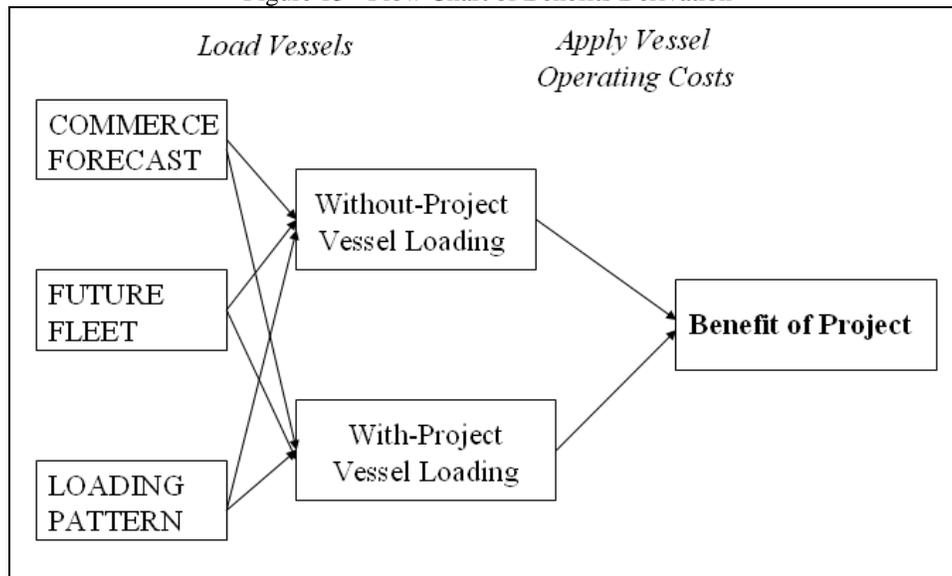
⁴² These increases in terminal capacity are calculated assuming that throughput is 6000 lifts/acre/year, the highest terminal capacity increases predicted in the planned improvements. These improvement levels are stated in

project cost,⁴³ but they are so distant that their net present value is not likely to change the benefits calculation presented here.

B. BENEFITS CALCULATIONS

This flow diagram presents the method of benefits calculations used in this study.

Figure 13 - Flow Chart of Benefits Derivation



The commerce over the 50-year project horizon is calculated and the with- and without-project future New York fleet projected. In this case, the without-project condition is that the Bayonne Bridge remains at its current height and the New York fleet is limited to vessels that are not height limited by it. The with-project condition assumes there is some modification that will allow larger vessels to pass beneath the Bridge. The forecasted commerce is loaded onto each of the two fleets according to observations of the loading pattern. The result is an estimate of how many trips and container miles of transportation will be required to carry that commerce in both the with- and without-project conditions. Then, the vessel operating costs are used to estimate the cost of the marine transportation produced to carry the commerce in the with- and without-project condition. The difference between these two costs of production is the NED benefit to the project. In order to compare bridge alternatives that have different time patterns in their construction, the NED benefits need to be discounted to a common base year⁴⁴ before they are arrayed over the sum of the construction costs (with interest)⁴⁵ and the net discounted costs of project operation and maintenance. The inputs to this calculation are summarized, below.

lifts/year so as not to imply land creation is essential for them to occur. Given efficiency improvements in yard machinery, it is possible that these improvements will occur without land creation or land acquisition.

⁴³ They add to project costs in the sense that they are investments necessary for the realization of all benefits.

Assuming that the Bayonne Bridge had been removed as an obstacle prior to 2030, these terminal capacity increases would be separable incremental investments assumed to be financially self-sustaining.

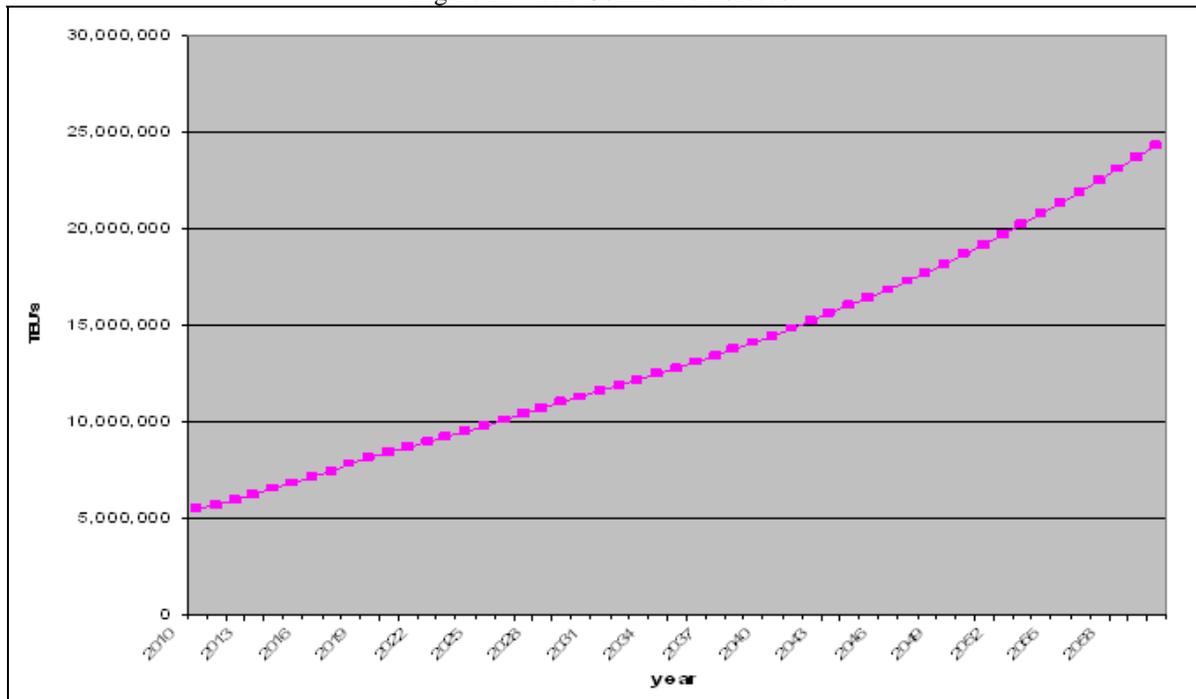
⁴⁴ The base year is the first year benefits can be realized.

⁴⁵ Interest during construction is not a transaction for which money changes hands, but rather an accounting of the time value of the potential other uses of the resources being used for this effort.

1. Commerce Forecast

To maintain consistency of method with the 1999 Study, the commerce forecast was derived by applying the growth rates used in the HNS and applied to the observed commerce coming through the Port. At the time of modeling, the most recent observation was for annual TEU's was from 2008 (5,265,053). The ten-year average annual growth rate (AAGR) used in the 1999 HNS Study is applied to that number and calibrated to become the 2010 base forecast, 5,538,626 TEU's, and for each year afterward, the AAGR from prior ten year span is applied.⁴⁶

Figure 14 - The Commerce Forecast



The values generated by other analytical approaches were within the range of those expected by concurrent Halcrow and Cambridge Systematics commerce forecasts, which are being produced independently and by other methods for other PONYNJ studies.⁴⁷

2. The Future Fleet

The expected future fleet was provided by the Port Authority. It was compiled by taking the number of service strings for the last known year by trade route⁴⁸ and projecting the growth rates

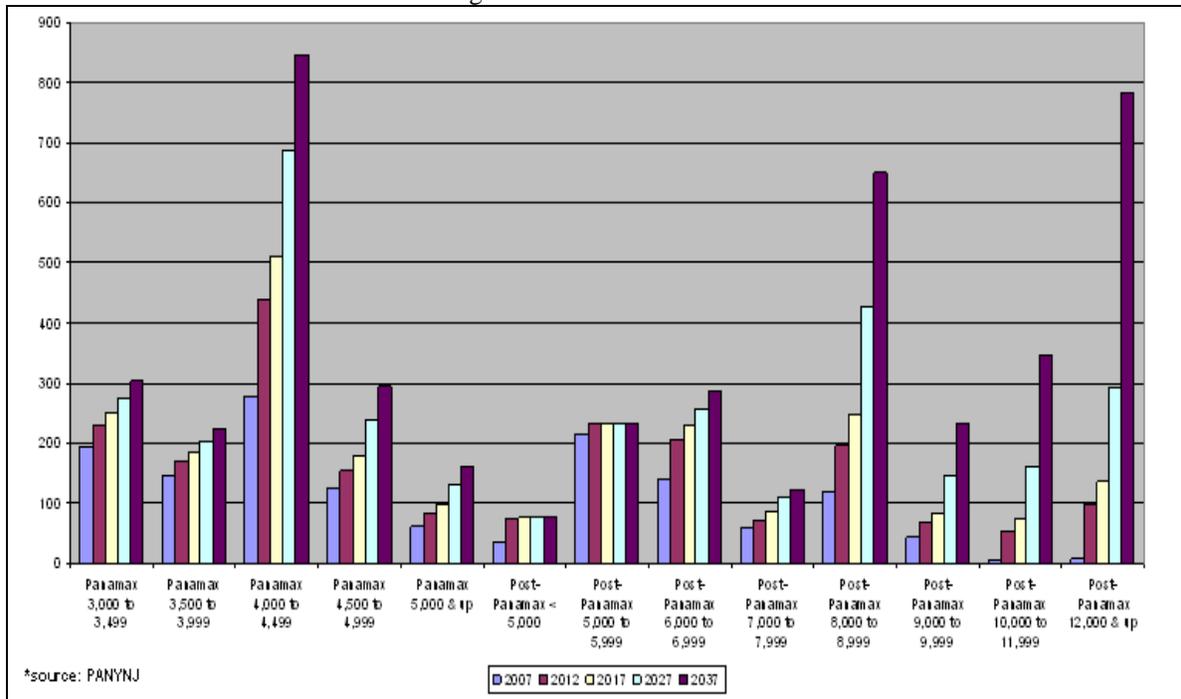
⁴⁶ The 1999 forecast was based on the World Trade Model, which at that time was the state-of-the-art method used for commerce forecasting for harbor deepening efforts Corps-wide.

⁴⁷ The Study Team met with members of the Halcrow and Cambridge Systematics teams (employed by the Port Authority and New York City Economic Development Corporation respectively) on 16 January 2009 to compare commerce forecasts. At that time, it was confirmed that the forecasts presented by the three parties essentially similar one another.

⁴⁸ In this case, the last known year was 2008.

in commerce on each route provided by the quarterly forecast prepared by Global Insight⁴⁹ onto those regions. From this projection, the number of larger and/or extra vessels, then extra strings to meet that demand is estimated. It takes into consideration the number of vessels on order.⁵⁰

Figure 15 - The Future Fleet



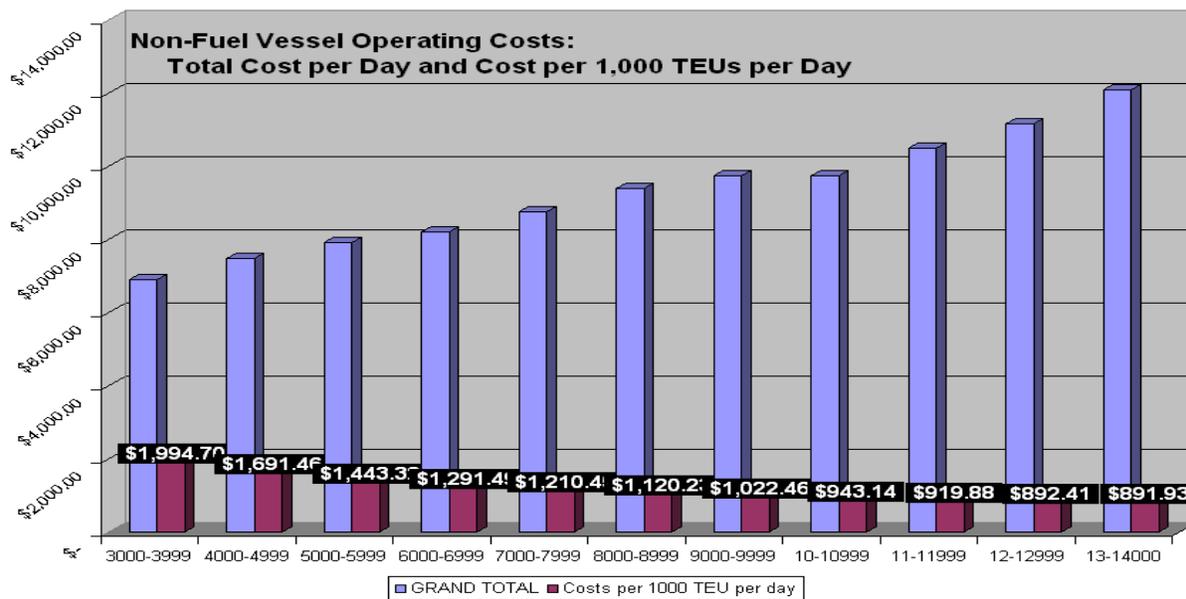
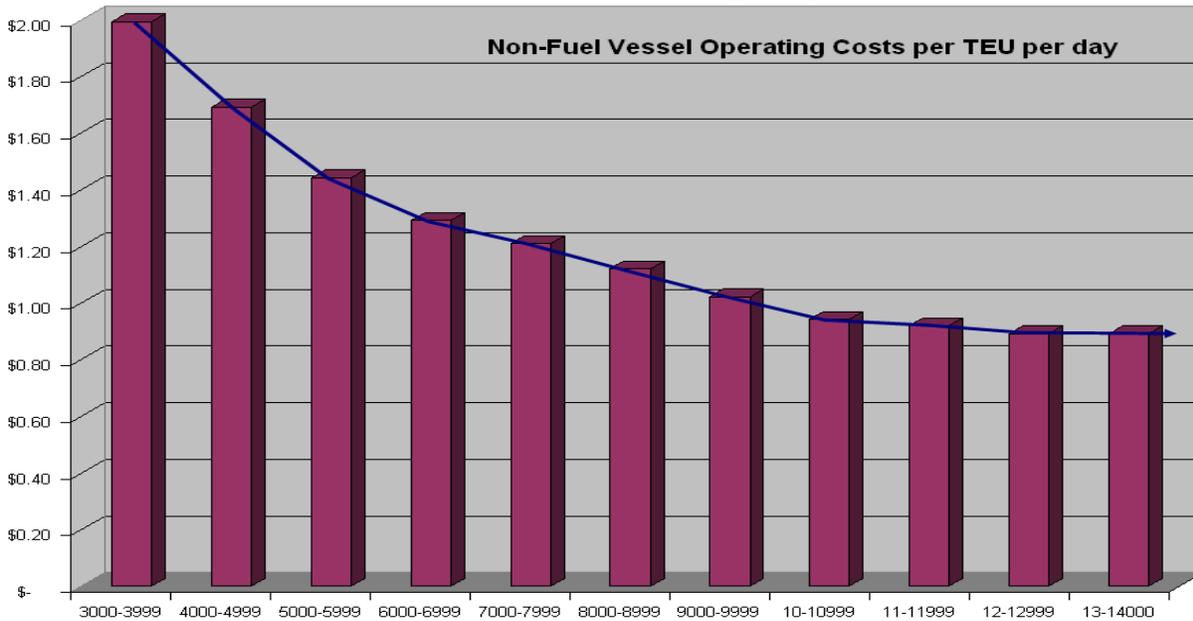
Like a channel depth restriction, the Bayonne Bridge impedes the carriers' ability to realize economies of scale associated with the use of economically efficiently loaded larger vessels, which adds to the transportation cost associated with the Port. While the average cost of operating any class of containership will increase as the size of vessel and, presumably, capacity increase,⁵¹ vessel operating costs decrease on a per TEU basis with the size of vessel. This is because large and small vessels have similar crewing requirements and because larger, longer vessels are generally more fuel efficient because their hydrodynamics allow them to operate at a higher speed for the same amount of power resulting in less fuel expended per TEU so long as the volume of commerce carried remains sufficient.

⁴⁹ Global Insight is an econometrics consulting firm.

⁵⁰ It is important to note that the fleet used here was derived in late 2008, before a large number of vessel cancellations were made in response to the slowing economy. As determined in Section 9 of *Appendix B - Sensitivity and Alternative Scenario Analyses*, placing a two-year delay on orders or cancelling half of all ships on order in July 2008 does not change the result of the benefits calculation enough to give any of the alternatives considered an NED BCR less than 1.0. As fleet construction is driven by carrier demand, the benefits to utilization of larger ships - our concern in this document - is driven by the commerce forecast. The Corps' commerce forecast does not specifically account for the current economic slowdown because, as with all Corps reports, it is based on a 50-year planning horizon. Because of the length of the planning period, there will be multiple ups and downs, even large ones, in the economy that are subsumed in the general trend. For instance, the current economic downturn is, in fact, the 12th depression since the end of World War II according to the National Bureau of Economic Research's business cycle dating methods.

⁵¹ Independent of fuel costs, larger ships cost more to operate in terms of total cost but unless there are very few containers, they cost less on an average per TEU basis.

Figures 16 & 17 - Non-Fuel Vessel Operating Costs

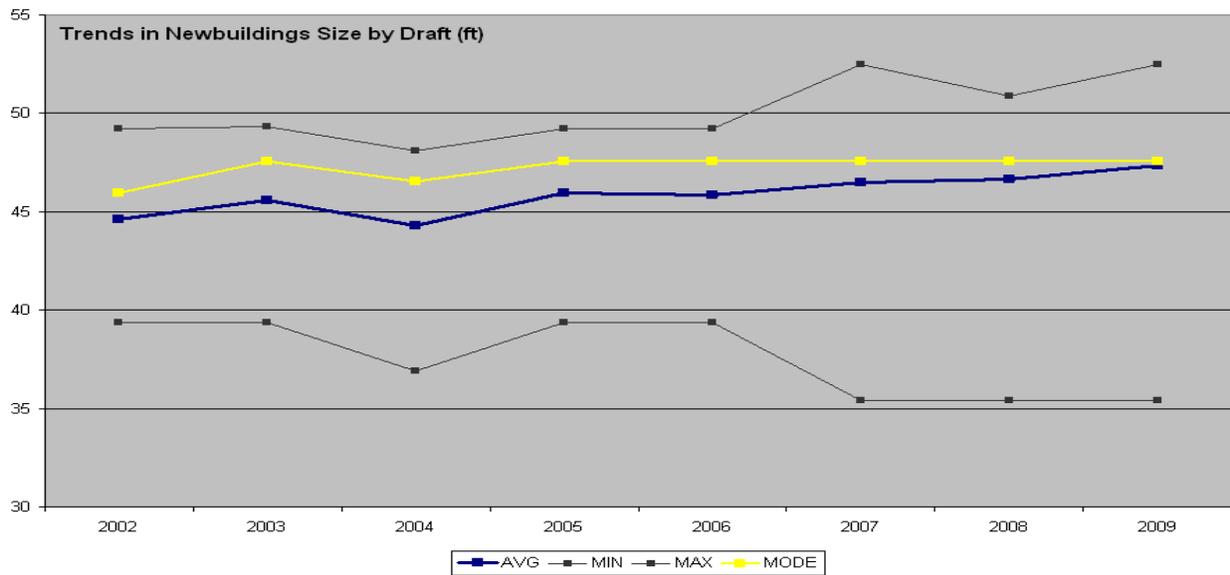
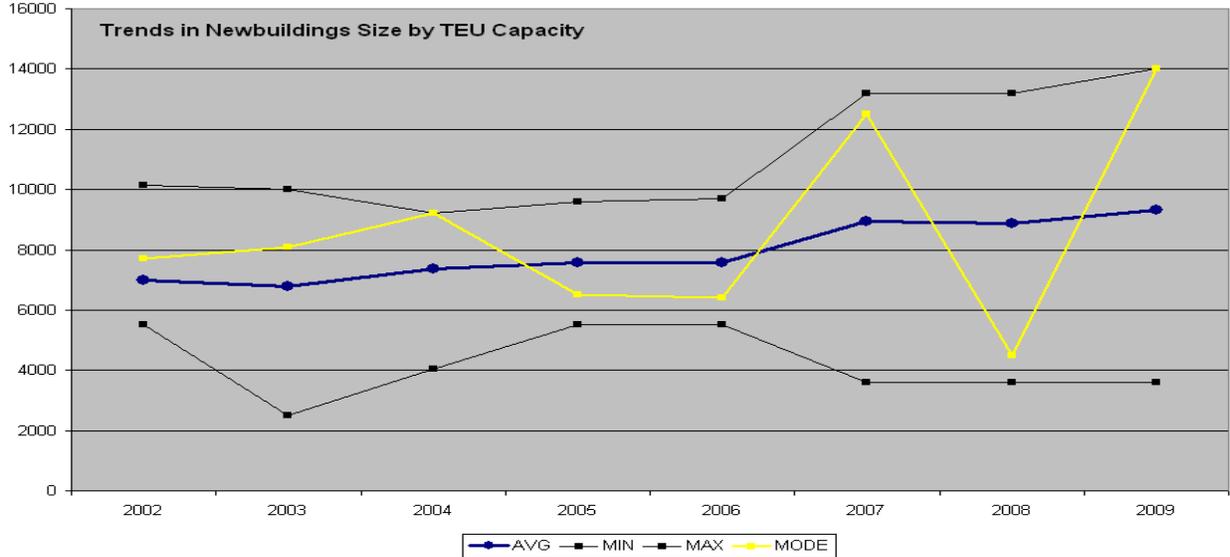


This fact is evidenced by data collected for new buildings orders.⁵² Over the period 2002 to 2009, total fleet capacity has increased greatly. The average TEU capacity per ship ordered has increased from just less than seven thousand to ninety-three hundred TEU's, and with average TEU capacity for new vessel orders increasing each year, in spite of variation in year-to-year

⁵² This is Lloyds Newbuildings data provided by the PANYNJ.

trends of the most popular ship size.⁵³ Average values for dead weight tons, length overall, beam, and design draft for new containership orders all increased each year over the same period, as evidenced by the figure, below.

Figure 18 & 19 - Trends in Newbuildings



Carriers were also asked during the interview process about the extent to which they had used or intended to use ship-based solutions to the Bayonne Bridge air draft restriction, for example, collapsible masts or retractable antennae. The general consensus gathered from those interviews was that these are solutions that are used in some cases now but which only add a few feet of clearance and will not serve as a long-term solution given the size of the ships that will most

⁵³ For example, from 2002 to 2004, most orders were for 8000 and 9000 TEU vessels, but in 2005 and 2006 it was the 6500 TEU vessels. In 2007 and 2009, the most popular size for a new vessel was 12,500 TEU's and 14,000 TEU's, respectively, but in 2008 a smaller vessel, 4,500 TEU's, was most commonly ordered.

efficiently carry the projected future commerce on major east coast routes.⁵⁴ In an innovative response to the set of design problems associated with larger container vessels, the Mediterranean Shipping Company launched the *MSC Daniela* in December 2008. At 14,000 TEU's, the *MSC Daniela* has greater nominal TEU capacity than the *Emma Maersk*, but has a significantly shorter KTMH because it has split accommodations to allow more containers on the deck with increased visibility and to allow further use of high-cube containers. Furthermore, this split accommodation is designed to better protect the fuel tanks in light of increased environmental regulation.⁵⁵ Even with these innovations, the *MSC Daniela* has a KTMH of 221 feet and would not fit under the current Bayonne Bridge under any loading condition.

Table 3 - Comparison of the *Emma Maersk* to the *MSC Daniela*

	<i>Emma Maersk</i>	<i>MSC Daniela</i>
TEU Capacity ⁵⁶	12,508	14,000
Length Over All (LOA)	1306 feet	1201 feet
Beam	185 feet	168 feet
Design Draft	52.5 feet	52.5 feet
KTMH	251 feet	221 feet
Deadweight Tonnage	156,907	156,301

Finally, carriers were asked what their future deployment plans were for East Coast routes, especially in light of the expanded Panama Canal. All of the carriers revealed that they are consistently looking to use newer, larger, more fuel efficient vessels in an effort to keep their costs low and operate optimally. Upon the completion of the Panama Canal expansion in 2015, the carriers that are currently using the Canal intend to deploy a set of larger vessels on trans-Panama routes in order to take advantage of the economies of scale afforded by the larger vessels. Ships built to operate within the dimensions of the new locks⁵⁷ are designated new-Panamax vessels.

Many of the carriers propose to use larger vessels, usually vessels of sizes ranging from 5,500 to 8,600 TEU's on East Coast routes. It is likely that these larger vessels will not call as many East Coast ports as current services with smaller vessels do now. The larger vessels are either new or existing vessels that will be shifted from transpacific services as even larger vessels are introduced on those routes. The carriers agree that there will be a great deal of competition for berths at Port Jersey facilities to service these vessels as these facilities are not height encumbered. Eleven of the 15 carriers interviewed say that they may need to bypass the

⁵⁴ Carriers were asked whether deployment of a specially built Bayonnemax vessel was considered in their capital plans; however, deployment plans for such a vessel was limited to 1 carrier, with other carriers using those ships under vessel sharing agreements.

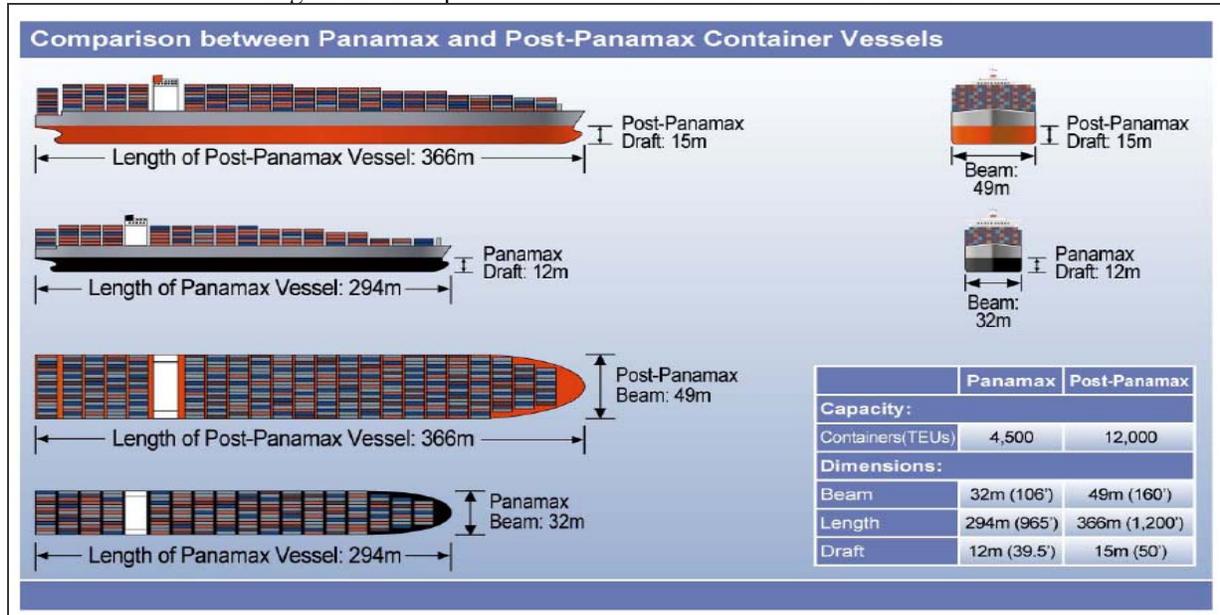
⁵⁵ The most relevant example of this is the addition of Regulation 12A on oil fuel tank protection to Annex I of the International Maritime Organization's (IMO) Convention for the Prevention of Pollution from Ships (MARPOL). This amendment applies to all ships delivered on or after 1 August 2010 with an aggregate oil fuel capacity of 600m³ and above. It includes requirements for the protected location of fuel tanks.

⁵⁶ These are latest Lloyd's *World Shipping Encyclopedia* figures. Maersk rates TEU's at 14t/TEU, which would give the *Emma Maersk* 11,000 TEU and the *MSC Daniela* 10,640 TEU.

⁵⁷ Maximum draft of 50 feet, 160 foot beam, and length of 1200 feet

PONYNJ in the future if the Bayonne Bridge remains a restriction.⁵⁸ The only carriers who are not citing the Bayonne Bridge as a problem are carriers for which the Panama Canal is not currently a limiting factor for vessels deployed.

Figure 20 - Comparison of Panamax and New-Panamax Vessels⁵⁹



3. Loading Pattern

As described in the prior section entitled *Global Constraints*, the worldwide distribution system of containerized cargo is characterized by a model of regularly scheduled service. Because of the commercial importance of schedule keeping, vessels will not delay their departures in order to leave in a fully loaded condition. A vessel may be constrained on one voyage, but not constrained on the next, resulting, over time, in a statistically discoverable loading pattern. This is why examination of KTMH is the clearest characteristic to use to determine whether a ship may be constrained by the Bayonne Bridge.

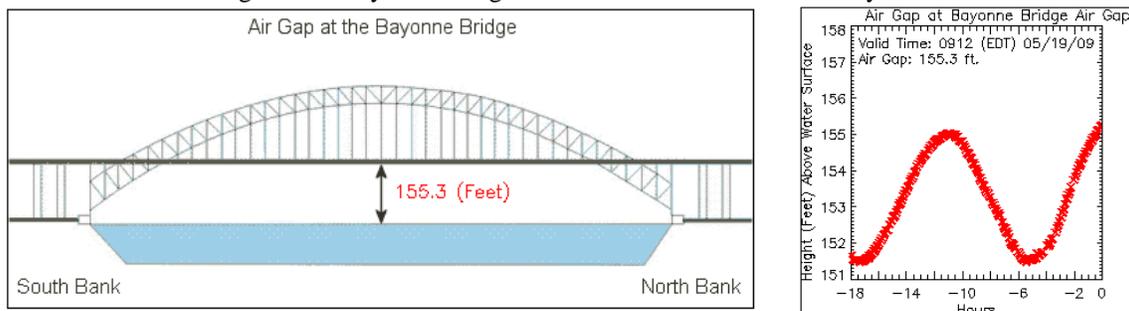
A useful way to think about the restriction imposed by the Bridge is to consider the analogy of a needle. The space between the bottom of the channel and the bottom of the roadway of the Bridge is the eye of the needle through which the ship must thread. Unlike deepening efforts where the distance to the channel bottom is the main consideration and when the restriction is generally limited to the direction for which loading is heaviest - the restriction imposed by the Bayonne Bridge is added to the restriction of the channel bottom. While a ship that is only depth limited could operate sub-optimally, entering or exiting the PONYNJ either light-loaded or riding the tides, the existence of the Bayonne Bridge limits passage in two dimensions. Beyond

⁵⁸ While this is a PANYNJ Study and this effort presents an opportunity for the carriers to make such threats, the reality is that the economic logic of carrier and vessel economics makes the prospect credible.

⁵⁹ From *Autoridad del Canal de Panama*, <http://www.pancanal.com/eng/plan/documentos/propuesta/acp-expansion-proposal.pdf>. Note that while this diagram document uses the term "Post-Panamax," this text uses Post-Panamax to refer to ships that cannot transit the Panama Canal under current conditions (*i.e.*, pre-expansion).

ruling out passage of ships that have a KTMH greater than the sum of the channel depth and the air draft clearance, it also precludes the passage of ships that might otherwise fit given KTMH if they were loaded to their design draft but which, given current loading, are riding too high to pass beneath the Bridge. This was the case of the *NYK Nebula* presented earlier in this document.

Figure 21 - Bayonne Bridge Air Draft Variation with Tidal Cycles



It is for this reason that the loading pattern is integral to this benefits calculation. NED benefits are derived not only from the use of ships that absolutely cannot call with the Bridge in place, but which would be expected to call if it were to be removed, but they also accrue in situations where a ship can only enter or clear the Newark Bay Complex under specific loading conditions. To develop an accurate representation of how vessels are being operated on New York calls, the record of operating drafts for all vessel entrances into New York Harbor was collected.⁶⁰ From this data set, a "New York Fleet" compiling all container vessels calling New York Harbor twenty or more times in the five-year period between 1 January 2002 and 31 December 2006⁶¹ was developed.

For each of the 7,211 calls made by the 220 ships in the New York fleet during this period, the percent of the ship's design draft utilized was plotted against call date. This produced a series of curves that was used to verify that, indeed, the percentage of available design draft used increased over time, but that on average a ship will use about 86% of its design draft on each call and this is the load factor used in the benefits calculations. This is the load factor at the end of the period for which data is available and produces a conservative bias, if any, in the calculations.⁶² This statistic is analogous to the Federal Reserve's capacity utilization statistics

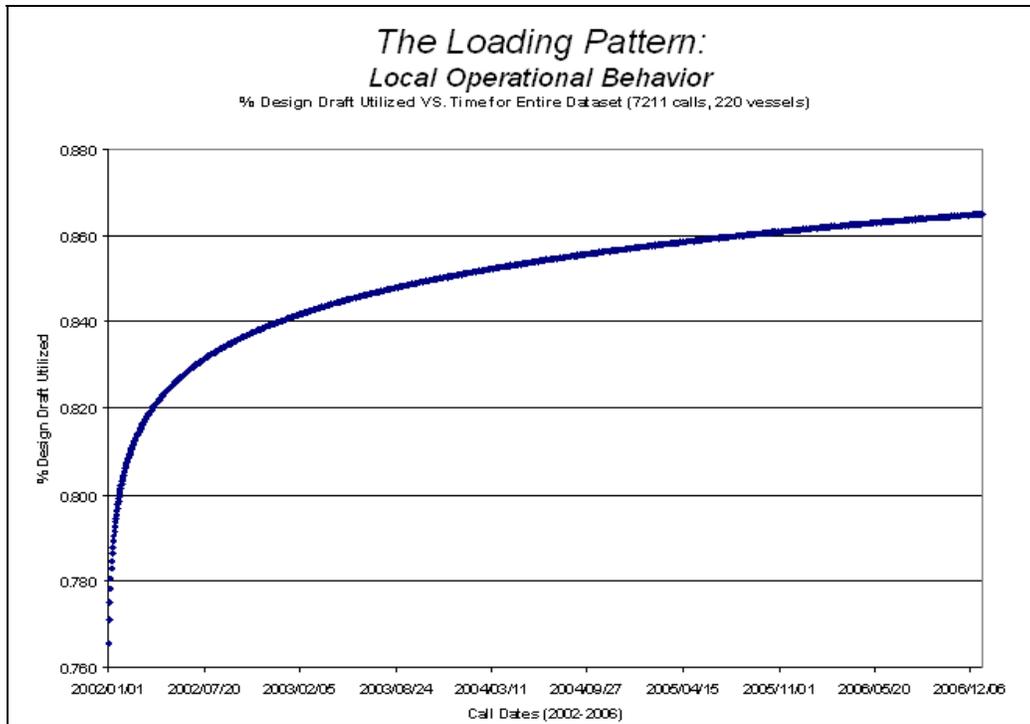
⁶⁰ This data set was developed from Corps of Engineers Institute for Water Resources Navigation Data Center (NDC) records. The NDC collects U.S. Customs Bureau data on vessel entries, clearances, and cargo for all U.S. commercial ports. At the time of writing, 2006 entrances were the latest available from the NDC.

⁶¹ This allowed the study team to determine what changes, if any, occurred as a result of effective change in available channel depth from 38 to 43 feet marked by the availability 45 feet of depth in the Kill van Kull beginning in November 2004. This type of operational change was assumed to occur again with the availability of 50-foot access in 2013.

⁶² Although arguably outside the scope of the present study, one potential extension that this statistic suggests is the use of a leading indicator approach to predicting when a larger ship will be added to a rotation. In this study, the deployment of a larger ship is expected to occur when commerce "overflows" from the existing fleet. This method of fleet deployment is described in the next section but the availability of a fairly complete record of call data and desktop processing software may allow the use of current empirical observations in projecting when larger ships will be deployed on specific routes.

that measure how much of the Nation's installed, productive capacity is being used.⁶³ The summary curve is presented below.

Figure 22 - The Loading Pattern

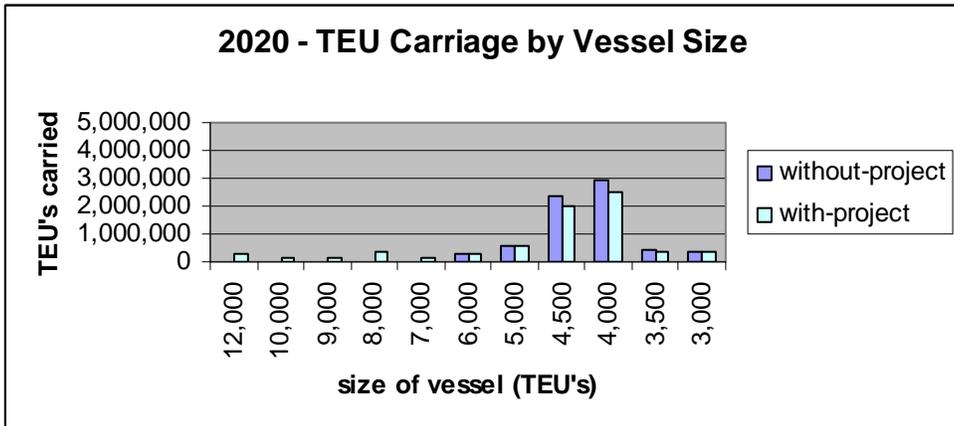
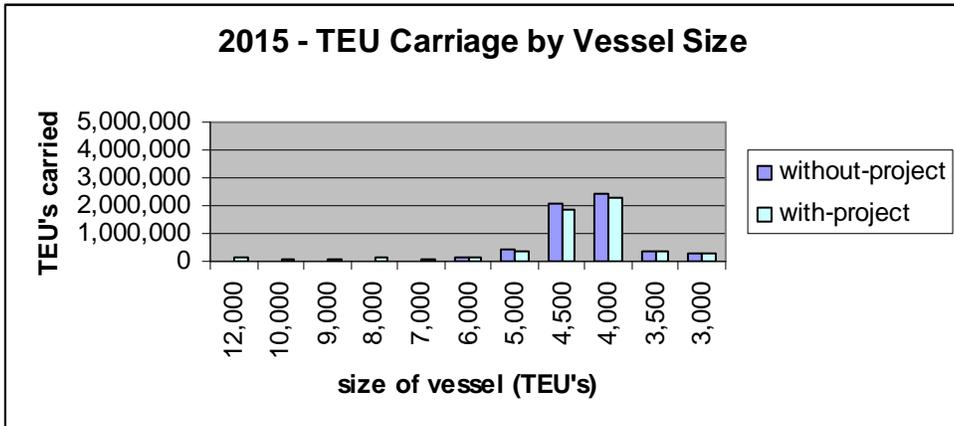
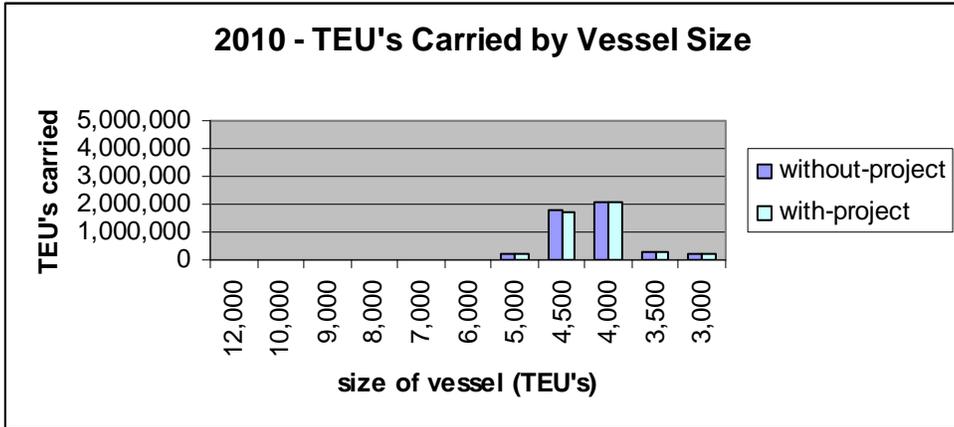


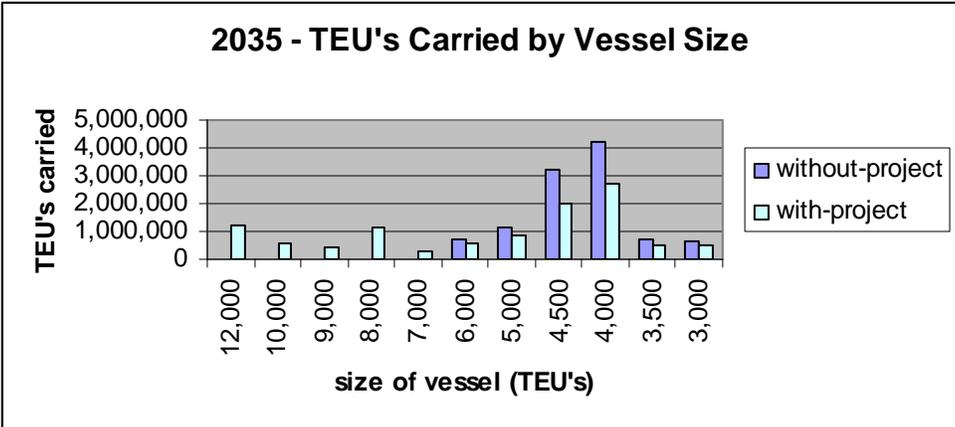
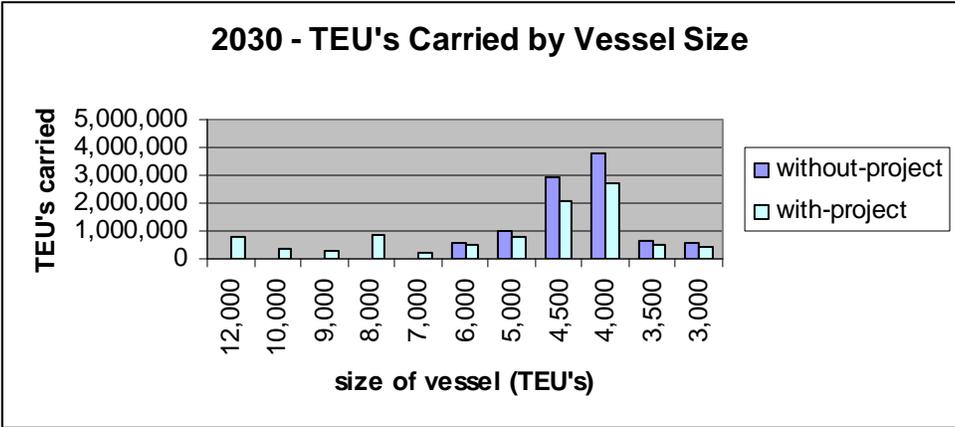
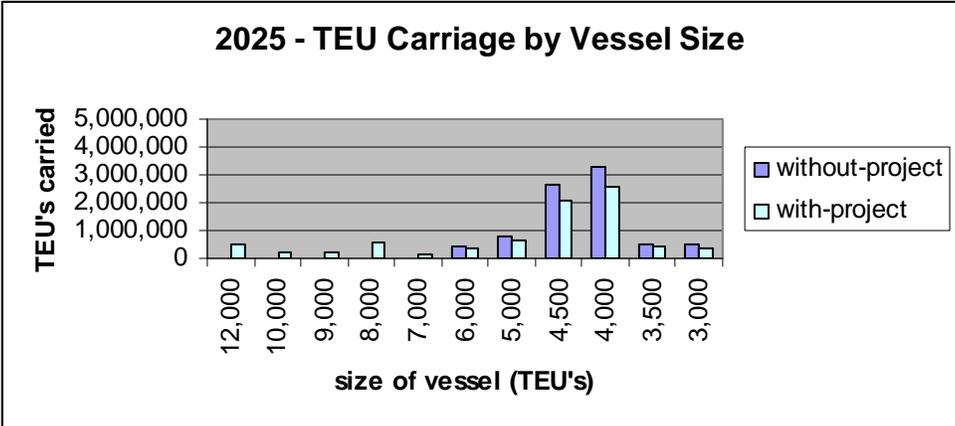
4. Fleet Deployment

The methodological objective of the Bayonne Bridge Air Draft study thus far has been to maintain maximum comparability with the 1999 HNS. The HNS used what is commonly referred to as "The Overflow Method" to determine benefits to the project. The Overflow Method takes the commerce forecast, the fleet forecast, and the loading pattern and loads commerce onto the fleet by the loading pattern. As commerce grows, each year's forecasted current commerce beyond what was forecasted for the previous year is loaded proportionally onto the expected with and without project fleet. Recall from earlier in this section that the fleet will differ depending on the with- and without-project condition.

⁶³ Capacity Utilization data can be found on the Federal Reserve Board's (FRB) website at <http://www.federalreserve.gov/releases/g17/Current/table7.htm>. The rate of capacity utilization in the goods producing part of the macroeconomy is called the "total index" in the FRB survey. From 1986 to the present (see the historical tables at the FRB website), the total index has reached peaks of 85.1 (January, 1989) and 84.9 (January, 1995). This suggests that the rate of utilization of vessel design draft at the end of 2006 is probably at the high end of the scale. The idea behind looking at capacity utilization is that when it reaches high levels, it is a harbinger of an increase in the capital stock. In the case of containerships, this would, presumably, take the form of replacing the current fleet with larger units. The flurry of orders of large containerships in the 2007-2008 period is evidence supporting this hypothesis.

Figures 23 -Distribution of Cargo by Vessel Size by Year



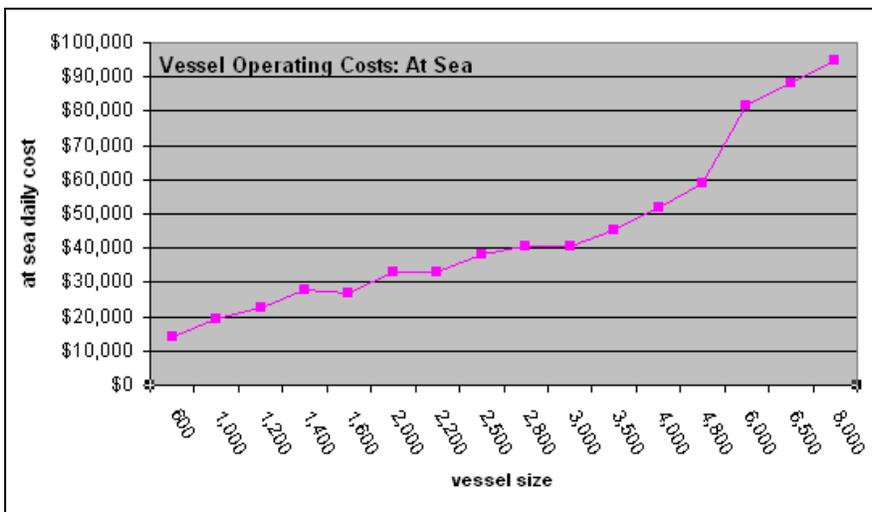
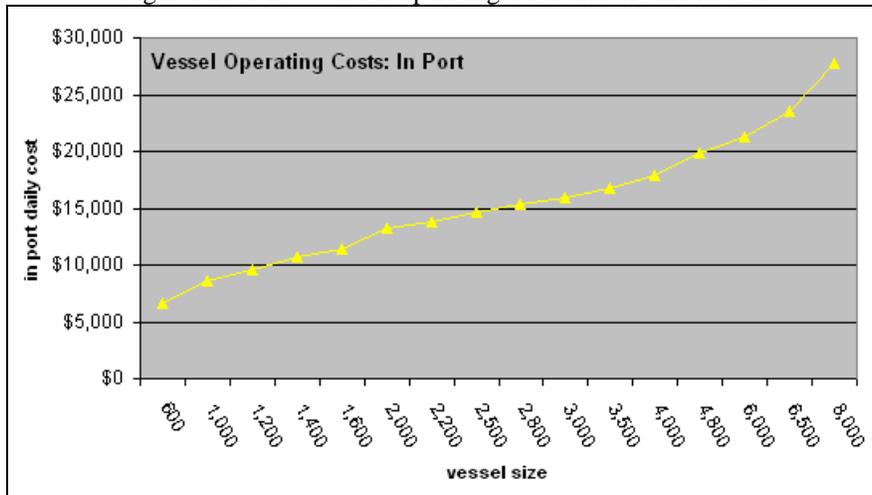


5. Vessel Operating Costs

Vessel operating costs (VOC's) are supplied by the Corps' Institute for Water Resources (IWR). For Corps navigation studies, IWR supplies a series of VOC's for each size and type of vessel forecasted to call in the with- and without-project condition. Because these large vessels are relatively new, IWR has not had the opportunity to develop specific VOC's for this study. Instead, the study team relied on the VOC's generated for the Corps' most current ongoing deep-

draft study focusing on container vessels, Savannah Harbor.⁶⁴ Because the vessels presented for that study were limited to those carrying up to 8000 TEU's, operating costs for larger vessels were extrapolated from the curve produced by the empirical data from IWR.⁶⁵ These VOC's were then applied to the with- and without-project New York fleets.

Figures 24 & 25 - Vessel Operating Costs In Port and At Sea



6. Calculation of Project Benefits

The with- and without-project conditions produce two different ways by which the commerce projected to pass through the PONYNJ will be carried. In the without-project condition, the commerce is carried in smaller, less economically efficient vessels that are not constrained by the Bayonne Bridge. In the with-project condition, the New York fleet is unrestricted by air draft and as the composition of the world fleet gets taller and commerce grows, larger vessels are added to New York routes. The difference in cost between operating the with- and without-project New York fleet carrying the projected commerce is the benefit of the project. It will

⁶⁴ VOC's are from 2008.

⁶⁵ At sea and in port operating costs were estimated separately as there was no reason for fixed costs to vary with vessel size.

require fewer but larger vessels in the with-project condition to carry the same amount of commerce as is carried in the without-project conditions. The difference in total operating costs, discounted as described earlier, of these fleets required to carry that amount of commerce is the NED benefit of the deepening derived from altering or removing the Bayonne Bridge.

Table 4 - Summary of Costs and Benefits

Alternative	Year Improvement in Place	Break Even Year	BCR	IRR	Total Net Benefit
jack to 215	2019	2033	3.0	10.7%	\$ 3,270,679,702
new at 215	2022	2039	2.1	8.4%	\$ 2,821,542,529
bored tunnel	2024	2042	1.9	7.7%	\$ 2,585,424,669
immersed tunnel	2024	2051	1.4	6.1%	\$ 1,517,453,940

Source: Costs from Port Authority of New York and New Jersey, TB&T; Construction includes engineering and design and begins in 2010.

C. COSTS OF POTENTIAL SOLUTIONS

Beyond the no-build alternative, which would be to maintain the Bayonne Bridge at its current height, there were four alternative solutions considered which included alteration of the present bridge, new bridge construction, and replacing the existing roadway with a tunnel. The alternative solutions were, including no-build, in order of scale:

No-Build - The no-build alternative would be to keep the Bayonne Bridge in place at its current height. The costs associated with this alternative would be the operation and maintenance of the existing facility as well as any safety upgrades required.

Jacking Arch - This alternative would keep the existing steel arch structure but raise the piers and rebuild the roadway at 215 feet.⁶⁶ (See Figure 26)

New Bridge - This alternative is based on construction of an entirely different bridge. This alternative would keep the existing steel arch of the current Bayonne Bridge, but remove the roadway. The two bridges would be adjacent to one another. (See Figure 27)

⁶⁶ Different heights were considered in *Appendix B, Sensitivity and Alternative Scenario Analyses*

Figure 26 - Jacked Arch Alternatives Increase the Air Draft of the Existing Structure



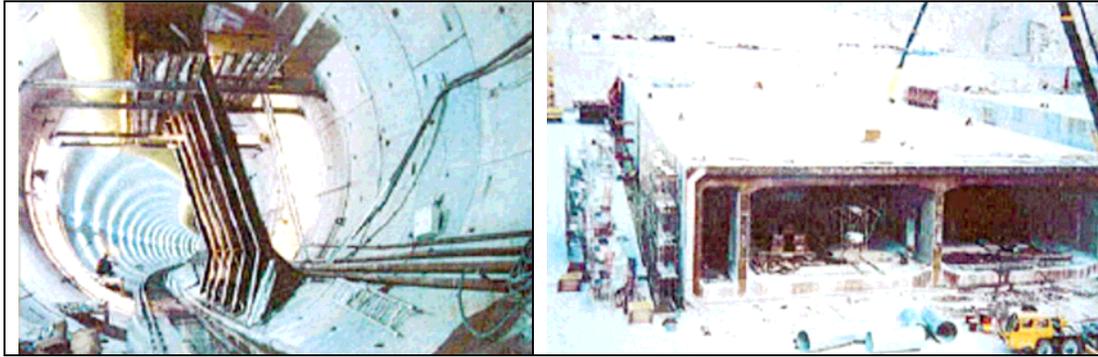
Figure 27 - New Bridge with Existing Arch Remaining



Bored Tunnel - This alternative consists of removing the roadway of the existing bridge, keeping the superstructure in place, and diverting road traffic to a newly constructed bored tunnel.

Immersed Tunnel - This alternative consists of removing the roadway of the existing bridge, keeping its superstructure in place, and diverting road traffic to a newly constructed immersed tunnel.

Figure 28 - Bored Tunnel and Immersed Tunnel



Costs of options for the four types of measures options were provided by the Port Authority's Tunnels, Bridges, & Terminals Department and are presented below and include discounted future operation and maintenance of the alternative as well as the pieces of the existing Bayonne Bridge that remain in place. Scenario analyses for the heights initially considered for the "jacking" and "new bridge" options are included in Appendix B, *Sensitivity and Scenario Analyses*.

Table 5 – Comparative Costs of Alternatives⁶⁷

	Const- ruction duration ⁶⁸	Total yearly construction costs ⁶⁹	Total yearly costs with IDC applied	Total IDC	Total O&M costs over project life	Total discounted O&M costs	Total NPV of Construction + IDC + O&M costs	Average Annual Costs Over 50-Year Project Life
Costs in Millions \$								
NO BUILD	0	0	\$ -	\$ -	\$494.20	\$209.46	\$209.46	\$ 10.82
Jack 215	9	\$1,316.17	\$1,504.21	\$188.03	\$277.10	\$99.26	\$1,603.46	\$82.79
New Bridge 215	12	\$2,155.40	\$2,517.15	\$361.74	\$361.74	\$88.56	\$2,564.16	\$132.40
Bored Tunnel	14	\$2,208.76	\$2,753.85	\$545.08	\$545.08	\$127.92	\$2,881.76	\$148.80
Immersed Tunnel	14	\$3,096.48	\$3,849.37	\$752.89	\$752.89	\$100.36	\$3,949.73	\$203.94
all at t=0, 50 year project life								
Costs provided by the Port Authority of New York and New Jersey, TB&T; Construction includes engineering and design and begins in 2010; Dollar amounts are nominal.								

D. SUMMARY OF NED COST/BENEFIT ANALYSIS

⁶⁷ The no-build alternative is integral to Corps of Engineers benefits calculations and serves as a base of comparison of alternatives. In this case, no-build does not mean doing nothing but rather retaining the existing facility.

⁶⁸ The construction duration includes the removal of the existing bridge deck in the jacking and new bridge alternatives.

⁶⁹ Includes all costs associated with construction including engineering/design and financial expense.

The net benefits of the alternatives and other pertinent details are presented below. All cases assume that detailed engineering and design start in 2010 and physical construction follows when that phase is complete. There is no onset of benefits until construction of the alternative is completed and the existing impediment, the roadway at its current height, is removed from the channel.

Table 6 (repeat of Table 4) - Summary of Costs and Benefits

Alternative	Year Improvement in Place	Break Even Year	BCR	IRR	Total Net Benefit
jack to 215	2019	2033	3.0	10.7%	\$ 3,270,679,702
new at 215	2022	2039	2.1	8.4%	\$ 2,821,542,529
bored tunnel	2024	2042	1.9	7.7%	\$ 2,585,424,669
immersed tunnel	2024	2051	1.4	6.1%	\$ 1,517,453,940

Source: Costs from Port Authority of New York and New Jersey, TB&T; Construction includes engineering and design and begins in 2010.

The "year in place" column is based on the anticipated construction duration. For those years until construction is complete and the existing obstruction is removed, benefits cannot be realized and must be considered foregone. The "break even year" is when the net present value of the benefits realized first overtakes the net present value of the cost of the project. That happens earlier in the less expensive alternatives - the jacked and new bridges - than in the more costly ones as the costs that need to be recouped are smaller. The internal rate of return is the discount rate that renders the present value of the cash inflows and cash outflows equal. It is presented so that these alternatives can be compared to other investments the Port Authority may consider making. Strict application of the NED analysis would lead the evaluator to select the jacking option, but there are other considerations that need to be recognized.

IV. CONCLUSIONS

This analysis was scoped in such a way as the method by which benefits were calculated would remain consistent with the 1999 and 2004 deepening studies and for that reason it is focused on NED benefits. Like the prior studies of New York Harbor, those benefits are transportation cost savings to the nation that are attributable to the economies of scale that may be captured using larger vessels. They do not include increases in market share that might result from taking cargo from another facility, which may be a future scenario for the Port as a result of the current widening and deepening of the Panama Canal which will allow larger ships to pass through it and which may add some cargo volume that would otherwise have arrived in the New York economic hinterland via mini-land bridge from the West Coast had the Canal expansion not occurred. Potential benefits that might result from additional cargo landing at the USEC are considered below and described in further detail in *Appendix B, Sensitivity and Alternative Scenario Analyses*.

This effort has determined that removal or alternation of the Bayonne Bridge would produce NED benefits of a magnitude that would justify the cost of doing so. It was performed by the Corps of Engineers so that it could be compared to benefits calculation performed for the HNS and to ensure that the NED benefits that were estimated to accrue to the HDP are not restricted

by the existence of the Bayonne Bridge.⁷⁰ The design vessel for the HNS, the 198-foot KTMH *Regina Maersk*, while fully loaded and with a 50-foot channel is able to call the terminals west of the Bayonne Bridge. Therefore, all of the benefits presented in the HNS are still fully attributable to the HDP. All of the NED benefits described in this study are attributable to vessels larger than the *Regina Maersk* and are in addition to the HDP benefits. This study concludes that the removal of the Bayonne Bridge would produce \$169 million in average annual net benefits over the 50-year project life for the jacking option, \$148 million in average annual net benefits over the 50-year project life for the new bridge option, \$150 million in average annual net benefits over the 50-year project life for the bored tunnel, and \$93 million in average annual net benefits for the immersed tunnel. These benefits outweigh the cost of each alternative considered in the base case as well as in each of the alternative scenarios examined.

V. OTHER MATTERS AFFECTING THE PORT AUTHORITY'S DECISION PROCESS

There are considerations outside of the original scope of this effort that will inform the Port Authority's decision of whether, how, and when to address the restriction imposed by the Bayonne Bridge.

A. REGIONAL ECONOMIC DEVELOPMENT BENEFITS AND LOCAL IMPACTS

NED benefits are different from Regional Economic Development (RED) benefits because they do not consider effects felt in one region, but counterbalanced by opposite effects felt elsewhere. As mentioned earlier, examples might be local jobs retained or created, toll revenue or air quality impacts generated by using regional roadways, or increases in local tax bases or property values. These real, but regional benefits - and any "multiplier effects" attributable to them - are the subject of a future study being conducted by the Port Authority and can be added to the NED benefits for a more complete description of benefits that could accrue to the region if the obstruction is removed. Those RED benefits would be considered additive to the NED benefits from the decision-making point of view of the PANYNJ.

B. POTENTIAL NED BENEFITS NOT COMPREHENSIVELY CONSIDERED HERE

Transportation cost savings, as derived here, are a relatively conservative estimate of the impact of a project even at the national level, but they are often used to justify Corps deepening efforts because they are easier to estimate than other sources of benefit. One obvious source of additional benefit that is not comprehensively quantified here is the alternative cost of movement if, in fact, carriers were to decide not to call the PONYNJ but instead to call a substitute port and move goods to the PONYNJ catchment area by truck. There would be multiple potential detrimental impacts to such a scenario occurring both at the regional and national levels. While regional scenarios of port substitution will be discussed in a document being produced separately by the Port Authority, the national consequences of such a scenario are worth some discussion.

⁷⁰ If the Bridge had been discovered to be an impediment to realization of 50-foot benefits, then its alteration should have been considered part of the cost of the 50-foot project.

Figure 29 - Relative Efficiencies of Ship versus Truck



A potential consequence of substituting another port, say the Port of Norfolk, for the PONYNJ for locally destined goods could be the extra truck miles required to transport that cargo from Port of Norfolk to its local destination. As ships are more energy efficient on a per TEU basis than trucks, the detrimental emissions and their health effects caused by carrying those TEU's through an alternative port and consequently producing a net increase in truck miles driven. These costs are very hard to quantify to a narrow confidence interval in a study of this scale. Nonetheless, the study team did provide sample calculations of the extra truck miles and costs that would be incurred if cargo destined for select locations was diverted to the Port of Norfolk because of the Bayonne Bridge air draft restriction. These calculations are included as *Appendix E, Port Cargo and Truck Diversion Analysis*.

C. OTHER BENEFICIARIES

While this report uses the general terms "Port of New York and New Jersey" or "PONYNJ" throughout, it should be made clear that the Port is comprised of multiple stakeholders including ocean carriers, terminal operators, labor interests, land-side transportation providers, and regional consumers. These parties will be impacted by any decision about or remedy for the Bayonne Bridge air draft obstruction. This study was commissioned by the PANYNJ in its role as public authority responsible for many of the facilities in the Port. The scope of that responsibility includes decision-making about the Bayonne Bridge; however, any remedy will have multiple stakeholder beneficiaries.

VI. NEXT STEPS

The Corps' Civil Works mission⁷¹ does not take a direct role in bridge alteration except to the extent to which such alterations were an incrementally justified part of a channel deepening project. In case where allisions have occurred, the US Coast Guard has authority to take action through their Truman-Hobbs authority.⁷² Nonetheless, the Coast Guard only has record of seven

⁷¹ Deep-draft navigation is considered a Civil Works mission. The Corps might have a different role if the Bayonne Bridge was an obstruction to military-related navigation. This situation was explored and it was determined that the Bayonne Bridge at its current height is not an obstruction to military vessels that might deploy from the Port in the near future. More details may be found in *Appendix G, National Security Implications*.

⁷² 33 U.S.C. 511 *et seq.*

such collisions, all of which were reported to produce relatively slight damage. The study team has been advised that it is unlikely that the Coast Guard would replace the Bayonne Bridge under its Truman-Hobbs authority. If the PANYNJ were to pursue replacement or modification of the Bridge, the Coast Guard would act as the lead Federal regulatory agency. Likely environmental considerations associated with alternatives beyond the no-build condition are catalogued in *Appendix F, Regulatory Considerations for Bridge Alteration*.

LIST OF APPENDICES -

Appendix A, Summary of Findings and Recommendations of the New York and New Jersey Harbor Navigation Study

Appendix B, Sensitivity and Alternative Scenario Analyses

Appendix C, Notes on Rail Transit as a Partial Substitute for All Water Routes

Appendix D, Vessel Simulations

Appendix E, Port Cargo and Truck Diversion Analysis

Appendix F, Regulatory Considerations for Bridge Alteration

Appendix G, National Security Implications

Appendix H, Acronyms

Bayonne Bridge Air Draft Analysis
APPENDIX A

**Summary of Findings and Recommendations of the
New York and New Jersey Harbor Navigation Study**

The Recommended Plan in the *Feasibility Report*, identified as the National Economic Development (NED) Plan, formed the basis of the *Report of the Chief of Engineers*,¹ and was authorized for construction by Congress as “Port of New York and New Jersey, New York and New Jersey” in §101(a)(2) of the WRDA of 2000.² It consisted of the following channel deepening, environmental compliance, and project implementation components:

- Construction of a 53 ft Mean Low Water (MLW) navigation channel to deepen the entire length of the existing Ambrose Channel;
- Construction of a 50 ft MLW (52 ft in rock or otherwise hard material) navigation channel to deepen portions of the existing Anchorage Channel, from the Narrows to 1000 feet past its juncture with the Port Jersey Channel;
- Construction of a 50 ft MLW (52 ft in rock or otherwise hard material) navigation channel to deepen the existing Port Jersey Channel, from its juncture with Anchorage Channel to the Global Terminal and Military Ocean Terminal-Bayonne (MOTBY) facilities;
- Construction of a 50 ft MLW (52 ft in rock or otherwise hard material) navigation channel to deepen the existing Kill Van Kull, from its juncture with Anchorage Channel to the Arthur Kill;
- Construction of a 50 foot MLW (52 ft in rock or otherwise hard material) navigation channel to deepen the existing Newark Bay Channel, from its juncture with the Kill Van Kull to the juncture with the Elizabeth Channel, and including deepening the existing Elizabeth, South Elizabeth, and Elizabeth Pierhead Channels to 50 ft MLW (52 ft in rock or otherwise hard material);
- Construction of a 50 ft MLW (52 ft in rock or otherwise hard material) navigation channel to deepen the existing Arthur Kill, from its juncture with the Kill Van Kull and Newark Bay to the southernmost berth at the Howland Hook marine terminal; and
- Construction of a 50 ft MLW (52 ft in rock or otherwise hard material) navigation channel to deepen the existing Bay Ridge Channel, from its juncture with Anchorage Channel to the South Brooklyn Marine Terminal, subject to commitment to rehabilitate the South Brooklyn Marine Terminal and transportation infrastructure needed to realize project benefits.
- Implementation of mitigation measures for unavoidable impacts, to include the restoration of 11 acres of intertidal wetlands, and construction of 7.6 acres of littoral habitat.

It was further recommended that the District be granted the authority to utilize innovative measures in its design, management, and execution, including alteration of the types of contracts entered into and the administration of those contracts, as necessary in order to expedite the construction of the project, and thereby maximize the value of the Federal investment.

¹ *Report of the Chief of Engineers on the New York and New Jersey Harbor Navigation Study*, May 2000.

² P.L. 106–541, 11 December 2000.

Bayonne Bridge Air Draft Analysis
APPENDIX B

Sensitivity and Alternative Scenario Analyses

As with any estimate, there are multiple sources of uncertainty. For this reason, the study team decided to consider alternative scenarios. This appendix catalogues a number of alternative scenarios that attempts to quantify the extent to which they would affect the benefits of the project. The base case to compare all of these scenarios to is:

Alternative	Year Improvement in Place	Break Even Year	BCR	IRR	Total Net Benefit	Average Annual Benefits	Average Annual Net Benefits
jack to 215	2019	2033	3.0	10.7%	\$ 3,270,679,702	\$ 251,675,320	\$ 168,880,864
new at 215	2022	2039	2.1	8.4%	\$ 2,821,542,529	\$ 280,235,090	\$ 147,835,233
bored tunnel	2024	2042	1.9	7.7%	\$ 2,585,424,669	\$ 298,674,770	\$ 149,875,612
immersed tunnel	2024	2051	1.4	6.1%	\$ 1,517,453,940	\$ 298,674,770	\$ 94,731,166

Scenario 1 - Commerce forecast is too high or too low

To maintain consistency of method with the 1999 Study, the commerce forecast used by the Corps was generated by applying the out-year growth rates used in the HNS and calibrating them to the observed commerce coming through the Port. At the time of modeling, the most recent observation of annual TEU's passing through the PONYNJ was from 2008 (5,265,053). The ten-year average annual growth rate (AAGR) used in the 1999 HNS Study is applied to that number to become the 2010 base forecast, 5,538,626 TEU's, and for each year afterward, the AAGR from prior ten year span is applied.¹ The Study Team met with members of the Halcrow and Cambridge Systematics teams on 16 January 2009 to compare commerce forecasts. At that time, it was confirmed that the forecasts presented by the three parties tracked very closely with one another over the commerce period so there is little to be gained by repeating this sensitivity analysis using those forecasts as a basis.

Nonetheless, a forecast is solely a prediction based on assumptions, not the least of which is that the future will be like the past. The benefits calculations were performed again to determine what benefits to alteration of the Bayonne Bridge would be if the commerce forecast varied widely from its central tendency. This analysis found that if the commerce forecast fell by 30% below forecast (*i.e.*, each year had 30% fewer TEU's than predicted in the base case) starting in 2010, the only alternative that would not have a BCR greater than 1.0 would be the immersed tunnel. If the commerce forecast dropped by 50% starting in 2010, the jacking options would still have a BCR of greater than 1.0. Commerce would have to drop by 55% starting in 2010 for none of the alternatives to have a BCR greater than 1.0

A more likely circumstance would be that commerce grew faster than predicted starting in 2015 with the opening of the Panama Canal. In order to remain comparable with the method used in the 1999 HNS, the forecast model kept the same growth rates as were predicted in 1999, before the Panama Canal Expansion was considered. For that reason, the commerce forecast used here

¹ That forecast was based on the World Trade Model which is a large-scale macroeconomic econometric approach used for commerce forecasting for many harbor deepening studies Corps-wide.

Bayonne Bridge Air Draft Analysis
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did not consider an increase in commerce attributable to Far East imports being carried by all water routes to the USEC rather than by mini-land bridge from the USWC.

The tables below present the impact to the benefits calculations from increases in commerce coming to the PONYNJ on Far East routings as a result of the expansion of the Panama Canal. The level of increase is in the top left corner of the table. Comparisons should be made with the first table in this appendix.

10%	Year Improvement in Place	Break Even Year	BCR	IRR	Total Net Benefit	Average Annual Benefits	Average Annual Net Benefits
jack to 215	2019	2033	3.1	10.8%	\$3,385,384,780	\$257,598,093	\$174,803,637
new at 215	2022	2039	2.1	8.6%	\$2,948,679,416	\$286,799,776	\$154,399,920
bored tunnel	2024	2042	1.9	7.8%	\$2,713,502,012	\$305,648,799	\$156,849,641
immersed tunnel	2024	2050	1.4	6.2%	\$1,645,531,283	\$305,648,799	\$101,705,195

20%	Year Improvement in Place	Break Even Year	BCR	IRR	Total Net Benefit	Average Annual Benefits	Average Annual Net Benefits
jack to 215	2019	2032	3.2	11.0%	\$3,500,089,857	\$263,520,865	\$180,726,409
new at 215	2022	2038	2.2	8.7%	\$3,075,816,304	\$293,364,463	\$160,964,607
bored tunnel	2024	2042	2.0	7.9%	\$2,841,579,355	\$312,622,828	\$163,823,670
immersed tunnel	2024	2049	1.4	6.3%	\$1,773,608,626	\$312,622,828	\$108,679,224

30%	Year Improvement in Place	Break Even Year	BCR	IRR	Total Net Benefit	Average Annual Benefits	Average Annual Net Benefits
jack to 215	2019	2032	3.3	11.1%	\$3,614,794,934	\$269,443,638	\$186,649,182
new at 215	2022	2038	2.2	8.6%	\$3,202,953,191	\$299,929,150	\$167,529,293
bored tunnel	2024	2041	2.0	8.1%	\$2,969,656,697	\$319,596,857	\$170,797,699
immersed tunnel	2024	2049	1.5	6.4%	\$1,901,685,968	\$319,596,857	\$115,653,253

50%	Year Improvement in Place	Break Even Year	BCR	IRR	Total Net Benefit	Average Annual Benefits	Average Annual Net Benefits
jack to 215	2019	2032	3.4	11.4%	\$3,844,205,089	\$281,289,184	\$198,494,727
new at 215	2022	2037	2.3	9.1%	\$3,457,226,966	\$313,058,523	\$180,658,667
bored tunnel	2024	2041	2.1	8.3%	\$3,225,811,383	\$333,544,915	\$184,745,756
immersed tunnel	2024	2047	1.5	6.6%	\$2,157,840,654	\$333,544,915	\$129,601,311

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Scenario 2 - Manufacturing continues to migrate from the Far East to the Southeast and South Asia

The base case of this document is predicated on the assumption that the process of an eastward movement of containers from the USWC will remain competitive with all-water routes upon completion of the Panama Canal expansion. Migration of manufacturing from the Far East to Southeast and South Asia would have the likely result of shifting cargo from Panama to Suez routes since the USEC is closer to those origins via the Suez. The result of such a migration would be that the effect of the expansion of the Panama would have little effect on the volume of commerce coming from the Far East to the USEC - as assumed in the base case. For that reason, the base case could be considered to implicitly encompass this scenario. That said, *Appendix C - Notes on Rail Transit as a Partial Substitute for All Water Routes*, presents some likelihood that, in fact, there will be some "bump" attributable to a switch from mini-land bridge to all-water routes from the Far East. The effect of that, even with some manufacturing shift to Southeast and South Asia presents a situation like what would occur with one of the smaller bumps in cargo coming directly to the PONYNJ on Far East routings, presented at the end of *Scenario 1*, above.

Scenario 3 - Project cost estimates are too low or too high

Costs for each of these options were provided by the Port Authority's Tunnels, Bridges, and Terminals Department (TB&T). Presented below is the effect on benefits if those estimates are low or high.

Alternative	Year Improvement in Place	Break Even Year	BCR	IRR	Total Net Benefit
jack to 215	2019	2033	3.0	10.7%	\$ 3,270,679,702
cost -20%		2031	3.8	12.2%	\$ 3,591,372,219
cost -10%		2032	3.4	11.4%	\$ 3,431,025,961
cost +10%		2034	2.8	10.0%	\$ 3,110,333,443
cost +20%		2035	2.5	9.5%	\$ 2,949,987,185
new at 215	2022	2039	2.1	8.4%	\$ 2,821,542,529
cost -20%		2036	2.6	9.8%	\$ 3,342,684,677
cost -10%		2038	2.3	9.1%	\$ 3,082,113,603
cost +10%		2041	1.9	7.9%	\$ 2,560,971,455
cost +20%		2042	1.7	7.4%	\$ 2,300,400,381
bored tunnel	2024	2042	1.9	7.7%	\$ 2,585,424,669
cost -20%		2039	2.4	8.9%	\$ 3,161,776,987
cost -10%		2041	2.1	8.3%	\$ 2,873,600,828
cost +10%		2044	1.7	7.2%	\$ 2,297,248,510
cost +20%		2046	1.6	6.8%	\$ 2,009,072,351
immersed tunnel	2024	2051	1.4	6.1%	\$ 1,517,453,940
cost -20%		2045	1.7	7.2%	\$ 2,307,400,404
cost -10%		2047	1.5	6.6%	\$ 1,912,427,172
cost +10%		2055	1.3	5.6%	\$ 1,122,480,708
cost +20%		2060	1.2	5.3%	\$ 727,507,476

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Scenario 4 - Jacking and new bridge options occurred at different heights

The initial analysis included jacking and new bridge options at 185' and 200'. In those scenarios, some of the largest ships that might otherwise call terminals in Newark Bay continued to be limited by air draft. The benefits for all cases, including the lower heights of the new spans:

Alternative	Year Improvement in Place	Break Even Year	BC R	IRR	Total Net Benefit
jack to 185	2019	2042	1.5	6.8%	\$ 721,013,143
jack to 200	2019	2038	2.0	8.2%	\$ 1,446,703,944
jack to 215	2019	2033	3.0	10.7%	\$ 3,270,679,702
new at 185	2022	2072+	1.0	4.5%	\$ (47,548,670)
new at 200	2022	2050	1.3	6.0%	\$ 789,086,243
new at 215	2022	2039	2.1	8.4%	\$ 2,821,542,529
bored tunnel	2024	2042	1.9	7.7%	\$ 2,585,424,669
immersed tunnel	2024	2051	1.4	6.1%	\$ 1,517,453,940

Scenario 5 - The NYK Nebula Effect

The *NYK Nebula* (4,886 TEUs) incident of 8 March 2009 presented a situation in which a ship that would have been able to call at a facility west of the Bayonne Bridge under most loading conditions was air draft limited because it was light-loaded on that particular call and riding higher in the water than usual. While the base case for benefits presented above and throughout the document assumes that benefits generated by remedy of the Bayonne Bridge air draft restriction is limited to ships 7000 TEU's or greater, the study team used empirical loading pattern information to estimate additional benefits that might be attributable to removal of the obstruction for ships smaller than 7000 TEU's.

Consistently limited vessels <7000 TEU's	Year Improvement in Place	Break Even Year	BCR	IRR	Total Net Benefit	Average Annual Benefits	Average Annual Net Benefits
jack to 215	2019	2032	3.3	11.3%	\$ 3,739,951,589	\$ 275,906,076	\$ 193,111,620
new at 215	2022	2038	2.3	9.0%	\$ 3,333,606,409	\$ 306,675,401	\$ 174,275,545
bored tunnel	2024	2041	2.1	8.2%	\$ 3,101,922,586	\$ 326,477,023	\$ 177,677,864
immersed tunnel	2024	2048	1.5	6.5%	\$ 2,033,951,857	\$ 326,477,023	\$ 122,533,418

If there was no tide-riding	Year Improvement in Place	Break Even Year	BCR	IRR	Total Net Benefit	Average Annual Benefits	Average Annual Net Benefits
jack to 215	2019	2031	3.6	11.9%	\$ 4,155,281,647	\$ 297,351,557	\$ 214,557,101
new at 215	2022	2037	2.5	9.5%	\$ 3,786,486,298	\$ 330,059,760	\$ 197,659,904
bored tunnel	2024	2040	2.2	8.6%	\$ 3,558,773,857	\$ 351,047,923	\$ 202,248,765
immersed tunnel	2024	2046	1.6	6.9%	\$ 2,490,803,128	\$ 351,047,923	\$ 147,104,319

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If 2 foot over - mast clearance was required	Year Improvement in Place	Break Even Year	BCR	IRR	Total Net Benefit	Average Annual Benefits	Average Annual Net Benefits
jack to 215	2019	2031	3.7	12.1%	\$ 4,305,296,965	\$ 305,097,566	\$ 222,303,110
new at 215	2022	2036	2.5	9.7%	\$ 3,950,121,787	\$ 338,509,044	\$ 206,109,188
bored tunnel	2024	2039	2.3	8.8%	\$ 3,723,857,198	\$ 359,926,727	\$ 211,127,568
immersed tunnel	2024	2045	1.7	7.0%	\$ 2,655,886,469	\$ 359,926,727	\$ 155,983,122

Scenario 6 - The discount rate changes

The benefits calculations developed throughout the course of the study incorporated a discount rate that is provided to the Corps in annual guidance in accordance with 42 U.S.C. 1962d-17. This rate is obtained by the Corps from the U.S. Treasury and is composed of the average yield on interest-bearing marketable securities of the United States having 15 or more years to maturity. This discount rate allows benefits and costs of projects being evaluated against each other to be compared on a common time basis.

The discount rate used for the calculations presented in this report was 4^{5/8} %, which was the discount rate for Federal water resource projects in FY 2009, the study period. Because this is not currently considered to be constructible as a Corps project, it may not be the case that the various project alternatives would be evaluated using this discount rate but rather a rate that is higher or lower reflecting the cost of capital at the time the investment decision is made. Presented below are benefit-cost ratio summaries calculated at different discount rates.

Discount rate 3%	Year Improvement in Place	Break Even Year	BCR	IRR	Total Net Benefit	Average Annual Benefits	Average Annual Net Benefits
jack to 215	2019	2031	4.4	10.7%	\$ 5,380,498,813	\$ 270,008,157	\$ 187,213,701
new at 215	2022	2037	3.0	8.4%	\$ 5,068,309,034	\$ 294,649,998	\$ 162,250,142
bored tunnel	2024	2039	2.8	7.7%	\$ 4,890,299,853	\$ 310,231,607	\$ 161,432,449
immersed tunnel	2024	2044	2.1	6.1%	\$ 3,915,499,038	\$ 310,231,607	\$ 106,288,003

Discount rate 4%	Year Improvement in Place	Break Even Year	BCR	IRR	Total Net Benefit	Average Annual Benefits	Average Annual Net Benefits
jack to 215	2019	2032	3.5	10.7%	\$ 3,968,763,163	\$ 258,617,490	\$ 175,823,034
new at 215	2022	2038	2.4	8.4%	\$ 3,571,604,997	\$ 285,726,153	\$ 153,326,297
bored tunnel	2024	2041	2.2	7.7%	\$ 3,360,193,360	\$ 303,093,378	\$ 154,294,219
immersed tunnel	2024	2048	1.6	6.1%	\$ 2,327,734,709	\$ 303,093,378	\$ 99,149,774

Discount rate 5%	Year Improvement in Place	Break Even Year	BCR	IRR	Total Net Benefit	Average Annual Benefits	Average Annual Net Benefits
jack to 215	2019	2033	2.8	10.7%	\$ 2,905,609,910	\$ 247,600,456	\$ 164,806,000
new at 215	2022	2040	1.9	8.4%	\$ 2,425,672,196	\$ 276,993,139	\$ 144,593,283
bored tunnel	2024	2043	1.7	7.7%	\$ 2,173,496,676	\$ 296,056,517	\$ 147,257,359
immersed tunnel	2024	2054	1.3	6.1%	\$ 1,084,239,656	\$ 296,056,517	\$ 92,112,913

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Discount rate 6%	Year Improvement in Place	Break Even Year	BCR	IRR	Total Net Benefit	Average Annual Benefits	Average Annual Net Benefits
jack to 215	2019	2035	2.3	10.7%	\$ 2,090,033,102	\$ 237,136,818	\$ 154,342,362
new at 215	2022	2042	1.6	8.4%	\$ 1,529,227,918	\$ 268,602,645	\$ 136,202,788
bored tunnel	2024	2047	1.4	7.7%	\$ 1,230,120,099	\$ 289,246,989	\$ 140,447,831
immersed tunnel	2024	2070	1.0	6.1%	\$ 83,711,055	\$ 289,246,989	\$ 85,303,385

Discount rate 7%	Year Improvement in Place	Break Even Year	BCR	IRR	Total Net Benefit	Average Annual Benefits	Average Annual Net Benefits
jack to 215	2019	2036	1.9	10.7%	\$ 1,452,620,921	\$ 227,346,589	\$ 144,552,133
new at 215	2022	2047	1.3	8.4%	\$ 812,488,199	\$ 260,663,191	\$ 128,263,334
bored tunnel	2024	2055	1.1	7.7%	\$ 460,892,839	\$ 282,758,295	\$ 133,959,137
immersed tunnel	2024	2074+	0.8	6.1%	\$ (743,841,388)	\$ 282,758,295	\$ 78,814,691

Discount rate 8%	Year Improvement in Place	Break Even Year	BCR	IRR	Total Net Benefit	Average Annual Benefits	Average Annual Net Benefits
jack to 215	2019	2038	1.5	10.7%	\$ 945,089,241	\$ 218,296,008	\$ 135,501,552
new at 215	2022	2057	1.1	8.4%	\$ 226,757,053	\$ 253,242,799	\$ 120,842,942
bored tunnel	2024	2074+	0.9	7.7%	\$ (182,620,946)	\$ 276,652,617	\$ 127,853,459
immersed tunnel	2024	2074+	0.7	6.1%	\$ (1,447,430,580)	\$ 276,652,617	\$ 72,709,013

Discount rate 9%	Year Improvement in Place	Break Even Year	BCR	IRR	Total Net Benefit	Average Annual Benefits	Average Annual Net Benefits
jack to 215	2019	2042	1.3	10.7%	\$ 533,436,127	\$ 210,007,729	\$ 127,213,273
new at 215	2022	2072+	0.9	8.4%	\$ (262,388,027)	\$ 246,375,360	\$ 113,975,504
bored tunnel	2024	2074+	0.8	7.7%	\$ (734,802,228)	\$ 270,965,097	\$ 122,165,938
immersed tunnel	2024	2074+	0.6	6.1%	\$ (2,061,864,580)	\$ 270,965,097	\$ 67,021,492

Scenario 7 - Delay in start of detailed design and construction

The report assumes that detailed design and construction begins in 2010. The durations of these phases were provided by the PANYNJ's TB&T department. As with any construction effort, especially one requiring extensive environmental review, there is always threat of delay. For this reason, the study team considered the time by which the specific action had to begin detailed design and construction to maximize net benefits of that action. The results are presented below. The optimal year to begin is highlighted.

	jacking	new	bored tunnel	immersed tunnel
year	NET BENEFITS	NET BENEFITS	NET BENEFITS	NET BENEFITS
2010	\$ 2,177,302,527	\$ 1,640,064,577	\$ 1,541,316,930	\$ 974,212,871
2011	\$ 2,198,348,718	\$ 1,664,980,891	\$ 1,562,880,977	\$ 1,020,846,035

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2012	\$ 2,213,386,437	\$ 1,687,902,931	\$ 1,576,487,843	\$ 1,058,413,823
2013	\$ 2,222,636,584	\$ 1,702,987,072	\$ 1,582,315,669	\$ 1,087,143,368
2014	\$ 2,221,800,013	\$ 1,710,400,478	\$ 1,580,538,215	\$ 1,107,255,252
2015	\$ 2,220,107,588	\$ 1,710,308,629	\$ 1,571,327,105	\$ 1,118,965,849
2016	\$ 2,211,665,358	\$ 1,702,873,184	\$ 1,557,304,820	\$ 1,124,940,418
2017	\$ 2,196,592,388	\$ 1,688,254,195	\$ 1,539,171,310	\$ 1,125,919,791
2018	\$ 2,175,008,185	\$ 1,669,063,090	\$ 1,517,126,597	\$ 1,122,143,066

Scenario 8 - Container handling capacity is increased in areas of the PONYNJ that do not require transit beneath the Bayonne Bridge

The following analysis puts aside the practicalities of actually finding places where a container handling facility could be located east of the Bayonne Bridge within the PONYNJ to estimate what size increment of added capacity would have to be added for specific air draft increasing alternatives not to be justified on an NED basis. In this analysis, capacity increments were added east of the Bridge in 100 acre increments. The analysis shows that there would need to be 400 acres of terminal capacity with 6000 lifts/year added east of the Bridge for the most expensive alternative, the immersed tunnel, to have a BCR of 1.0. Results are presented, below:

ADD 100 acres	Year Improvement in Place	Break Even Year	BCR	IRR	Total Net Benefit	Average Annual Benefits	Average Annual Net Benefits
jack to 215	2019	2034	2.8	10.1%	\$ 2,886,106,703	\$ 231,817,973	\$149,023,517
new at 215	2022	2040	1.9	8.0%	\$ 2,393,328,713	\$ 258,124,359	\$125,724,502
bored tunnel	2024	2044	1.7	7.3%	\$ 2,154,060,114	\$ 275,109,136	\$126,309,978
immersed tunnel	2024	2054	1.3	5.7%	\$ 1,086,089,385	\$ 275,109,136	\$ 71,165,532

ADD 200 acres	Year Improvement in Place	Break Even Year	BCR	IRR	Total Net Benefit	Average Annual Benefits	Average Annual Net Benefits
jack to 215	2019	2035	2.6	9.6%	\$ 2,557,781,811	\$ 214,864,986	\$132,070,530
new at 215	2022	2042	1.8	7.5%	\$ 2,027,745,963	\$ 239,247,570	\$106,847,713
bored tunnel	2024	2046	1.6	6.9%	\$ 1,785,787,456	\$ 254,990,240	\$106,191,082
immersed tunnel	2024	2058	1.2	5.4%	\$ 717,816,727	\$ 254,990,240	\$ 51,046,636

ADD 300 acres	Year Improvement in Place	Break Even Year	BCR	IRR	Total Net Benefit	Average Annual Benefits	Average Annual Net Benefits
jack to 215	2019	2036	2.4	9.2%	\$ 2,274,205,613	\$200,222,588	\$117,428,132
new at 215	2022	2043	1.7	7.1%	\$ 1,711,989,927	\$ 222,943,573	\$90,543,716
bored tunnel	2024	2048	1.5	6.5%	\$ 1,467,708,130	\$237,613,428	\$88,814,270
immersed tunnel	2024	2063	1.1	5.0%	\$ 399,737,401	\$ 237,613,428	\$33,669,824

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ADD 400 acres	Year Improvement in Place	Break Even Year	BCR	IRR	Total Net Benefit	Average Annual Benefits	Average Annual Net Benefits
jack to 215	2019	2037	2.3	8.8%	\$ 2,026,813,309	\$187,448,538	\$104,654,082
new at 215	2022	2045	1.6	6.8%	\$ 1,436,523,884	\$ 208,719,941	\$ 76,320,085
bored tunnel	2024	2050	1.4	6.2%	\$ 1,190,215,245	\$222,453,871	\$ 73,654,712
immersed tunnel	2024	2070	1.0	4.8%	\$ 122,244,516	\$222,453,871	\$18,510,267

Scenario 9 - The fleet does not come on line as predicted

During the study period, there were many reports of ship orders being cancelled or delivery postponed. Sensitivity analysis was performed on the benefits calculations to account for the potential results of these cancellations. They are presented below.

If half of the ships on order in July 2008 were altogether cancelled, the benefits would be:

Alternative	Year Improvement in Place	Break Even Year	BCR	IRR	Total Net Benefit	Average Annual Benefits	Average Annual Net Benefits
jack to 215	2019	2037	2.3	8.8%	\$ 2,020,104,506	\$ 187,102,131	\$ 104,307,675
new at 215	2022	2045	1.6	6.8%	\$ 1,438,690,188	\$ 208,831,798	\$ 76,431,941
bored tunnel	2024	2050	1.4	6.2%	\$ 1,194,181,663	\$ 222,909,682	\$ 74,110,524
immersed tunnel	2024	2070	1.0	4.8%	\$ 126,210,934	\$ 222,909,682	\$ 18,966,078

If there was a 24 month interruption in deliveries, the benefits would be:

Alternative	Year Improvement in Place	Break Even Year	BCR	IRR	Total Net Benefit	Average Annual Benefits	Average Annual Net Benefits
jack to 215	2019	2033	2.9	10.5%	\$ 3,048,922,371	\$ 240,224,926	\$ 157,430,470
new at 215	2022	2039	2.0	8.2%	\$ 2,543,066,818	\$ 265,856,055	\$ 133,456,198
bored tunnel	2024	2043	1.8	7.5%	\$ 2,296,578,330	\$ 281,960,464	\$ 133,161,306
immersed tunnel	2024	2053	1.3	5.9%	\$ 1,228,607,601	\$ 281,960,464	\$ 78,016,860

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Notes on Rail Transit as a Partial Substitute for All Water Routes

The Bayonne Bridge Air Draft Study uses as its base case the assumption that rail is not a constraint for the Port of New York and New Jersey. While it is clear from interviews with players within the intermodal industry that this is the case, it also became evident over the course of the study process that, in fact, market share for rail from the west coast of the United States (USWC) is likely to decrease over the analysis period because of likely transfers of goods from mini-land bridge¹ from the USWC to all-water services.² There are multiple reasons for this, specifically -

1. The expansion of the Panama Canal will make it less expensive for ships to use all -water routing from Far East manufacturing centers to the USEC.³ This enlargement will allow carriers to utilize larger ships on Far East - USEC voyages.
2. Demographic changes within the economic hinterland of New York and New Jersey defined as the 17-County Metropolitan Area, the markets within a 260-mile radius of the Port, and a 17-state region have served to make the New York metropolitan area more of a consumer population base than it was in the original 1999 analysis as a result of population growth attributable to migrants coming from outside of the 1999 delineations of the Port's economic hinterland.⁴

¹ This is known as *mini-land bridge* which is an intermodal movement in which the shipment is moved from a foreign country to the U.S. by water and then moved across the U.S. by railroad to a destination that is a port city, or vice versa for exports from a U.S. port city. *Land bridge* refers to the movement of containers by ship-rail-ship on Japan-to-Europe moves. In these cases, ships move containers to from the Far East to USWC ports, rails move containers to an east coast port where those containers are loaded onto another ship which deliver them to Europe. *Micro-land bridge* refers to an intermodal movement in which the shipment is moved from a foreign country to the U.S. by water and then moved across the U.S. by railroad to an interior, non-port city, or vice versa for exports from a non-port city.

² Indeed, market share for rail from the USEC may increase as some goods may arrive at USEC ports by water then move closer to their inland destinations by westbound micro-land bridge.

³ The economies of scale captured by using larger ships will decrease transportation costs of all-water routes. The Panama Canal Authority will charge the profit maximizing rent for use of this resource, which may, in fact be close to what the rail carriers charge or it could be significantly less, in which case rail carriers would have to keep the price of service between the USWC and eastern destinations such that the change in mode and extra lifts required to move from ship to rail remain favorable in light of the decreased cost of trans-Panama movements.

⁴ The 31-County metropolitan area was one of the delineations of catchment area used in the 1999 Study. At that time, it was determined that approximately 70% of containerized cargo moving through the Port was destined for or originated in the 31-County metropolitan area. This area consists of 31 counties, includes 14 counties in southern New York State (five in New York City, two in Long Island, and seven in the Mid-Hudson region); 14 counties in northern New Jersey; and three counties in southwestern Connecticut. This was the most narrow of the four definitions of PONYNJ hinterland used in that document. The HNS also considered the 260-mile radius from the Port used by the New York Shipping Association (for purposes of its "Unit Assessment" charged to containerized cargo) from which approximately 82% of the containerized cargo that moved through the Port was destined for or originated at the time of that writing and the 17-state region extending from New York to Missouri and Maryland to Maine that could be serviced by the Port of New York for less cost and within a reasonable time disadvantage than from the Ports of Los Angeles and Long Beach. The 17 states are New York, New Jersey, Massachusetts, Rhode Island, New Hampshire, Vermont, Connecticut, Maine, Pennsylvania, Delaware, Maryland, Ohio, Michigan, Indiana, Illinois, Iowa, and Missouri. While referred to solely as the "17 states" as a demarcation, Washington, D.C. is generally included in this calculation. This differs slightly from the 17 state definition used by the Port Authority in other materials in which it adds Virginia, but excludes Iowa and Missouri and considers Washington, D.C. a

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3. The availability of on- or near-dock rail facilities will affect the PONYNJ in two ways. The most obvious is the recognition by the shipping community that PANYNJ's \$600 million investment in rail infrastructure is in fact facilitating the movement of containers out of the PONYNJ by rail. This \$600 million program rail will produce 1.1 M in lift capacity port-wide by 2010 and will grow to 1.4 M lifts by 2013 (including a new Global ICTF and expanded PNCT rail facility). There should also be an additional +300K lift capacity, port-wide, by 2030 with the final expansion of the Corbin Street Yard and full build out of ExpressRail Staten Island. Of less obvious benefit, but of particular importance, is the fact that the Ports of Los Angeles (LA) and Long Beach (LB) are limiting land-side expansion in response to community complaints and environmental issues. Permitting for facility expansion at the Ports of LA and LB is arduous and slow and is anecdotally reported to have essentially stopped. Limited on-dock and near-dock capacity adds to the cost of moving goods through the USWC. Added on-dock near-dock capacity at the PONYNJ should make it more attractive to move some of the goods through the PONYNJ that might otherwise have traveled by land bridge from the USWC. Indeed, in some situations cargo that presently comes to, say St. Louis via LA/LB might come via the Panama Canal and the PONYNJ via rail once the Canal is expanded.

4. The two rail carriers serving the Ports of LA/LB are currently undertaking major line haul improvements;⁵ however, line haul capacity is likely to be a problem in the Pacific Northwest. Since many of the goods destined for the New York market come by rail via the Ports of Seattle and Tacoma, limitations in line haul capacity from the Pacific Northwest are likely to make the movement of some goods through the PONYNJ more attractive.

5. At-grade rail crossings in Chicago present a large problem for the land bridge system. Currently, rail hubs in Chicago are tied up by the existence of at-grade rail crossings, which ensnare both rail and road traffic. While rail is generally favored at these junctions, trains still have to move at very slow speeds and at some points are forced to stop for switching.⁶ The railroads are waiting for improvements to the highway system, which are to be publicly funded but which may be slow to occur even in spite of the recent infusion of American Recovery and Reinvestment Act funding. Chicago rail traffic affects both goods coming from the east and goods coming from the west, but because the land bridge transit is more highly utilized coming from west to east, the Chicago tie-up may make all water routes through the Port of New York and New Jersey to inland destinations more attractive to shippers.

6. While reported to be a major problem by mainstream media, it is empirically unclear what effect the increase in the volume of coal moved by rail is having on the movement of containers by rail. In the United States, the vast majority of coal moves from Wyoming to power plants in the Midwest. Since 2000, there has been \$2-3 billion invested in track in Nebraska, Iowa, and

"state." The remaining 31 of the lower 48 states were considered secondary economic hinterlands for which the Port of New York and New Jersey has a minor share of international trade but over which it actively competes with other ports for market share.

⁵ The Burlington Northern Santa Fe (BNSF) is increasing capacity from 70-80 to 100 trains per day (each train has approximately 250 cars). The Union Pacific (UP) will be adding 50 trains to their main line per day in 2010 and 2011.

⁶ "Freight Train Network Suffers Lack of Modernization." PBS NewsHour, 21 April 2009.

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Illinois for added line capacity for coal. Still, coal and containers are in direct competition for engines. While rail engines have a short lead time from the point when they are ordered to the time they come on-line and this potential shortage of trains is likely to be overcome in the long term, demand from the coal industry may help to drive up the price of movement by rail.

In spite of these factors that seem theoretically likely to shift the mode balance of TEU carriage from mini-land bridge rail to ship on Far East-USEC routes, this report assumes that the USWC-USEC land bridge remains an integral part of the domestic transportation network. This is done purposefully so as to retain a bias, if any might exist, against project justification throughout the benefits calculations. The sensitivity analysis presented with this document considers the effects of more containers arriving at the Port of New York from Asia by all water services.

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Summary of Vessel Simulations

The full report on the navigational simulations was not available at the time of publication of this report but will be available from the Army Corps at a later date.

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Port Cargo and Truck Diversion Analysis

Over long distances, the cost of moving goods by ship is less expensive than moving those goods by rail, which is less expensive than moving those goods by truck, or, generally:

$$C_{\text{movement by ship}} < C_{\text{movement by rail}} < C_{\text{movement by truck}}$$

This assumes, of course, that all three modes - ship, truck, and rail - are available to the shipper for getting a good from its origin to its destination. In reality, there are practical limitations imposed by geography to this inequality. For example, where there is no water, a good cannot be moved by ship and where there are no rail lines, a good could not be moved via rail. On the USEC, because of the limitations of the rail system and the fact that the distance from USEC ports to warehouses or intermediate destinations is not far enough to warrant the extra handling associated with the rail system, the most likely substitute for ship movement is movement by truck.¹

This analysis quantifies the effects of substitution of ship for truck routing into and out of the PONYNJ hinterland in three discrete ways.

1. It calculates the demarcation between the destinations at which the shipper would prefer to ship through the PONYNJ as against through the Port of Norfolk (ORF), the most likely competitor Port under specific conditions. It also shows the line of destinations where the shipper would be indifferent between the PONYNJ and ORF.
2. It calculates the extra truck miles and the costs of those extra truck miles that would occur on a per FEU² basis for containers headed to specific destinations.

The HNS used different hinterlands for different analytical purposes as appropriate to the questions to be answered by that effort. Because the data being analyzed for the purposes of this appendix is based on mileage, this appendix uses three distances in its analysis. The first is the 260-mile radius from the Port used by the New York Shipping Association from which approximately 80 to 82% of the containerized cargo that moved through the Port was destined for or originated from at the time of that writing. The 260-mile catchment area is based on the observation that for a rail transfer to be a cost effective mode shift (*i.e.*, considering the extra lift required going from ship to rail to truck v. ship to truck), the distance covered by the less expensive per mile mode must be sufficiently long for the extra handling expense to be covered.³ This is also the distance at which the International Longshoremen's Association assessment on loaded containers changes. Within 260 miles of the Port, the ILA assessment on a container moved by truck is \$110; after 260 miles, the assessment is \$21 per container. For all rail moves,

¹ Over some longer distances, a barge may be an appropriate substitute; however, those cases are very limited.

² While generally waterborne containers are discussed in terms of TEU's, trucking is based on the FEU basis. For this reason, this section uses FEU's as its base of calculation.

³ If the extra handling is treated as a fixed cost, then $\frac{FC}{(P - AVC)} = 260$, where FC is the fixed cost for extra handling and P is the per ton-mile charge by rail.

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the assessment is \$10/container. It also considers an intermediate distance of 400 miles. At distances greater than 400 miles, freight is often carried by rail. The 400-mile radius is the point at which rail becomes cost competitive with truck from the PONYNJ. The gap between the 260 and 400-mile radii makes up the bulk of the PONYNJ's discretionary market. The third zone of analysis is the 17-state region extending from New York to Missouri and Maryland to Maine that could be served by the Port of New York for less cost and within a reasonable time disadvantage than from the Ports of Los Angeles and Long Beach.⁴

Truck mileage for the journeys considered in this Appendix are generated using PC Miler software. PC Miler is trucking industry mapping software that generates point-to-point routes for truck trips. In these calculations, PC Miler used distances and driving routes that a driver would normally take to minimize time and cost. The model addresses the tradeoff between taking the most direct path and staying on major, high quality highways by giving interstate highways a higher priority than toll roads, which, in turn, are given a higher priority than secondary highways.

1. In this calculation, a container of 2 TEU's or 1 FEU has to go from Busan to somewhere in the mid-Atlantic. Because the PONYNJ is air draft limited, the largest ship that can call can carry 6,500 TEU's. In this case, we assume the average ship calling Norfolk (ORF) is 10,000 TEU's. According to carrier schedules, the difference in travel time on the water between Busan and ORF and versus Busan and PONYNJ and ORF is one day at sea and one day in port. From the vessel operating costs extrapolated from IWR data and used in the base report, the per TEU cost on a 10,000 TEU vessel is \$279.17 while the per TEU cost on a 7,000 TEU vessel is \$305.85. This difference, \$26.65, is multiplied by 2 to get per FEU cost = \$53.30 per FEU. The calculation assumes that the fees are similar leaving each facility, and that the customer does not care about when the container is delivered, provided that it is within a certain relatively low number of days.

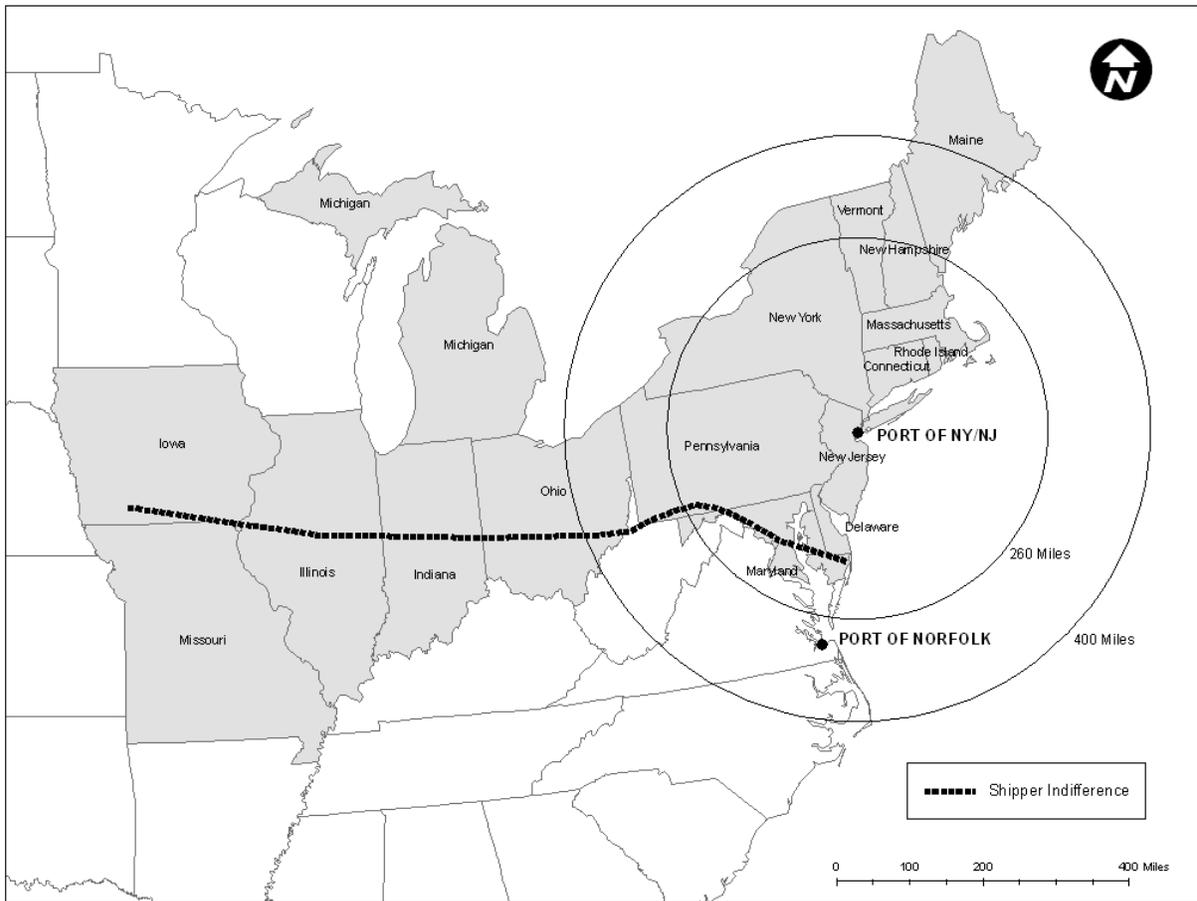
While the shipper saves \$53.30 on that FEU from Busan just going to the dock by going through Norfolk, the container needs to get from the Port to its destination. If the container has to go by truck to its destination, and trucking costs \$1.73/mile,⁵ that \$53.30 saved by having the container dropped in ORF is lost to added trucking expense incurred if the distance from the Port of ORF to destination is more than 30.8 miles further from Norfolk than it is from the PONYNJ. The shipper will prefer to have the container moved through the PONYNJ in cases in which the distance from ORF is greater than 30.8 miles than it is from the PONYNJ. The shipper is indifferent in cases when $[\text{distance}_{\text{orf}} * \text{rate}] - \$53.30 = \text{distance}_{\text{PONYNJ}} * \text{rate}$, provided that all other expenses are the same.

⁴ The 17 states are New York, New Jersey, Massachusetts, Rhode Island, New Hampshire, Vermont, Connecticut, Maine, Pennsylvania, Delaware, Maryland, Ohio, Michigan, Indiana, Illinois, Iowa, and Missouri. While referred to solely as the "17 states" as a demarcation, Washington, D.C. is generally included in this calculation. This differs slightly from the 17 state definition used by the Port Authority in other materials in which it adds Virginia, but excludes Iowa and Missouri and considers Washington, D.C. a "state."

⁵ American Transportation Research Institute, December 2008. The costs included in this are fuel-oil, lease or purchase payments, repair and maintenance, fuel taxes, truck insurance premiums, tires, licensing and overweight-oversize permits, tolls, driver pay, driver benefits, and driver bonus payments.

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The figure below shows the Eastern United States and the line at which the shipper is indifferent to whether his goods are shipped through the PONYNJ and ORF. At points on this line, the transportation cost from BUSAN (ship plus truck) of shipping through PONYNJ and ORF were the same, given the conditions presented above. North of the line, it will cost less to go through the PONYNJ. South of the line, it will cost less to ship through ORF. The line is not straight because routes are not "as the crow flies" but rather must follow established freight roads. For example, there are places in southwestern Pennsylvania (Blue Ridge Summit), which are closer to ORF than to the PONYNJ. Similarly, Dover Air Force Base in Delaware is only 31.8 miles closer to the PONYNJ than it is to ORF, by roadway.



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2. The table below shows that the added truck cost of moving those TEU's through another facility, assuming that the cost to transit the facility is the same in both cases, is high enough that it easily overcomes any cost savings relating to economies of scale from larger vessels that might be able to call a competing port. To the extent cargo is destined for points above the indifference line, there is not likely to be a significantly large diversion to Norfolk or other facilities.

	Road Miles From		Extra truck miles from ORF	Additional truck cost from ORF	Additional transportation cost per FEU from ORF
	PONYNJ	ORF			
Newark, NJ	6.10 ⁶	348.6	342.5	\$593.53	\$540.23
Cranbury, NJ	34.5	314.3	279.8	\$484.05	\$430.75
Dover, DE	155.1	189.6	34.5	\$59.69	\$6.35
Boston, MA	230.5	579.9	349.4	\$604.5	\$551.16
Pittsburgh, PA	361.8	428.1	66.3	\$114.70	\$61.40
Columbus, OH	526.5	567.0	40.5	\$70.07	\$16.77

⁶ This figure is from the PONYNJ to zip code 07102.

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Regulatory Considerations for Bridge Alteration

Regulatory considerations that may apply to Bayonne Bridge alteration and construction of the potential alternatives include, but are not limited to the following:

National Environmental Policy Act of 1969, P.L. 91-190 and 42 U.S.C. §4321 et seq. - The National Environmental Policy Act, commonly referred to as NEPA, requires the Federal Government to undertake an assessment of effects of proposed actions prior to making decisions. Federal involvement in Bayonne Bridge alteration and construction of any of the proposed alternative will require NEPA documentation that evaluates the environmental, social, economic impacts of reasonable alternative actions. More information on NEPA may be found at www.nepa.gov .

Coastal Zone Management Act, P. L. 92-583, 16 U.S.C. 1451-1456 - The Coastal Zone Management Act, CZMA, is administered by the National Oceanic and Atmospheric Administration's Office of Ocean and Coastal Resource Management. The objectives of CZMA are to manage the Nation's coastal resources by balancing economic development with environmental conservation in the coastal zone. Bayonne Bridge alteration and construction of any of the proposed alternatives will need to be assessed for coastal zone impacts. More information on the CZMA is found at http://coastalmanagement.noaa.gov/czm/czm_act.html

Clean Air Act, P.L. 101-549, 42 U.S.C. 85 - The Clean Air Act is the law that defines EPA's responsibilities for protecting and improving the Nation's air quality and the stratospheric ozone layer. Impacts to air quality that may result from Bayonne Bridge alteration or construction of any of the proposed alternatives will require examination under the Clean Air Act. More information on the Clean Air Act may be found at <http://www.epa.gov/air/caa/> .

Clean Water Act, P.L. 92-500, 33 U.S.C. 1251-1387 - The Clean Water Act employs a variety of regulatory and non-regulatory tools to sharply reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. These tools are employed to achieve the broader goal of restoring and maintaining the chemical, physical, and biological integrity of the nation's waters so that they can support "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water." Any action relating to alteration or construction of a proposed alternative for the Bayonne Bridge may be subject to evaluation for Clean Water Act compliance. More information on the Clean Water Act may be found at <http://www.epa.gov/watertrain/cwa/>

National Historic Preservation Act of 1966, as amended, P.L. 89-665; 16 U.S.C. 470 et seq. - The National Historic Preservation Act, NHPA, establishes preservation as a national policy and directs the Federal government to provide leadership in preserving, restoring and maintaining the historic and cultural environment of the Nation. Preservation is defined as the protection, rehabilitation, restoration, and reconstruction of districts, sites,

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buildings, structures, and objects significant in American history, architecture, archeology, or engineering. Section 106 of the NHPA requires a Federal Agency to take into account the effect of any undertaking on any district, site, building, structure or object that is included in or eligible for inclusion in the National Register of Historic Places. 36 CFR Part 800: Protection of Historic Properties, are the regulations governing the Section 106 Review Process, including the coordination between a Federal Agency, the appropriate State Historic Preservation Office and the Advisory Council of Historic Places, when necessary. Alteration of the Bayonne Bridge will require NHPA review. More information is found at <http://www.nps.gov/archeology/tools/laws/NHPA.htm> .

Executive Order 11593, Protection and Enhancement of the Cultural Environment - This Executive Order (E.O.) requires Federal agencies to administer cultural properties under their control and direct their policies, plans, and programs in such a way that federally owned sites, structures, and objects of historical, architectural, or archeological significance were preserved, restored, and maintained. Moreover, the E.O. directed agencies to reconsider any plans to transfer, sell, demolish, or substantially alter any property determined to be eligible for the National Register and to afford the Council an opportunity to comment on any such proposal. Finally, the E.O. required agencies to record any listed property that may be substantially altered or demolished as a result of Federal action or assistance and to take necessary measures to provide for maintenance of and future planning for historic properties. Federal elements of modification of the existing Bayonne Bridge will require compliance with E.O. 11593. More information may be found at <http://www.achp.gov/book/sectionVI.html> .

Fish and Wildlife Coordination Act, P.L. 85-624; 16 U.S.C. 661 et seq. - The Act of March 10, 1934 **as amended**, authorizes the Secretaries of Agriculture and Commerce to provide assistance to and cooperate with Federal and State agencies to protect, rear, stock, and increase the supply of game and fur-bearing animals, as well as to study the effects of domestic sewage, trade wastes, and other polluting substances on wildlife. Under the Act, Federal agencies involved in water resource are to consult with the U.S. Fish and Wildlife Service and with the agency exercising administration over wildlife resources of the particular state wherein the proposed project is to be constructed or action taken. Action regarding the major alteration of the existing structure or construction of a proposed alternative may require this coordination. More information may be found at <http://www.fws.gov/laws/lawsdigest/fwcoord.html> .

Endangered Species Act, P.L. 93-205; 16 U.S.C. 1531 et seq. - The purposes of the Endangered Species Act, ESA, are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved and to provide a program for the conservation of such endangered species and threatened species and establishes a policy that all Federal departments and agencies seek to conserve endangered species and threatened species and utilize their authorities in furtherance of the purposes of the Act. Federal involvement in Bayonne Bridge alteration and construction of any of the proposed alternative will require ESA compliance. More information on the ESA may be found at <http://www.fws.gov/laws/lawsdigest/ESACT.html> .

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Executive Order 11990, Protection of Wetlands; 42 F.R. 26961 -

Executive Order 11990 requires Federal agencies, in planning their actions, to consider alternatives to wetland sites and limit potential damage if an activity affecting a wetland cannot be avoided. Federal elements of modification of the existing Bayonne Bridge will require compliance with Executive Order 11990. More information on wetlands protection may be found at <http://www.epa.gov/wetlands/regs/eo11990.html> .

Estuary Protection Act, P.L. 90-454; 16 U.S.C. 1221 et seq. -

This Act authorizes the Secretary of Interior, in cooperation with the States, Secretary of the Army and other Federal agencies, to conduct an inventory and study of the Nation's estuaries, to facilitate estuary protection, conservation and restoration in a manner that maintains the balance between conserving the natural resources and natural beauty of the Nation and the need to develop these estuaries for further growth and development of the Nation. The Act requires Federal agencies, in planning for the use or development of water and related land resources, to give consideration to estuaries and their natural resources. All plans and projects submitted to Congress shall include a discussion by the Secretary of Interior of such estuaries and resources, and the potential impact of the proposed project on them, as well as his recommendations thereon. Bayonne Bridge alteration and construction of proposed alternatives may be subject to this Act. More information on the Estuary Protection Act may be found at <http://www.fws.gov/laws/lawsdigest/ESTUARY.HTML> .

Magnuson-Stevens Fishery Conservation and Management Act with Essential Fish Habitat Amendment, 16 U.S.C. 1801 et seq. -

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) and its Essential Fish Habitat (EFH) Amendment is the primary law governing marine fisheries management in United States federal waters. The purpose of this Act is to conserve and manage the fishery resources found off the coasts of the U.S. Federal action relating to alteration to the Bayonne Bridge and construction of proposed alternatives will require assessment of compliance with MSA and EFH policy. Text of the Act may be found at <http://www.nmfs.noaa.gov/sfa/magact/> .

Executive Order 12898, Environmental Justice; 59 CFR 7629, 62 CFR 18377, 60 CFR 33896 -

Executive Order (E.O.) 12898 for Environmental Justice applies to all Federal projects and programs. Its purpose is to ensure that Federal activities do not have a disproportionately high and adverse affect on a minority or low-income populations. Each Federal agency uses its own regulations to comply with environmental justice legislation. Federal elements of alteration to the Bayonne Bridge and construction of proposed alternatives will require compliance with E.O. 12898. The text of the E.O. is here:
http://el.erdc.usace.army.mil/emrrp/emris/emrshelp5/executive_order_12898_legal_matters.htm

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Section 4(f) of the Dept of Transportation Act of 1966; P.L. 89-670, 80 Stat. 931, 49 U.S.C. 1653(f) -

The Department of Transportation Act (DOT Act) of 1966 included this provision which stipulated that the Federal Highway Administration (FHWA) and other DOT agencies cannot approve the use of land from publicly owned parks, recreational areas, wildlife and waterfowl refuges, or public and private historical sites unless the following conditions apply, first - there is no feasible and prudent alternative to the use of land, and second - the action includes all possible planning to minimize harm to the property resulting from use. More information may be found at <http://www.environment.fhwa.dot.gov/4f/index.asp>

Executive Order 11988, Floodplain Management; 42 F.R. 26951 amended by E.O. 12148 -

The purpose of Executive Order (E.O.) 11988 is to avoid the long- and short-term adverse impacts associated with the occupancy and modification of floodplains, and to restore and preserve the natural and beneficial values served by floodplains. The text of this E.O. may be found at <http://www.archives.gov/federal-register/codification/executive-order/11988.html>

Noise Control Act of 1972; P.L. 92-574, 86 Stat. 1234, 42 U.S.C. 4901 et seq. -

This Act initiated a Federal program of regulating noise pollution with the intent of protecting human health and minimizing annoyance of noise to the general public. Federal involvement in Bayonne Bridge modification or construction of any proposed alternative would be subject to Federal statutes on noise control. More information on Federal noise regulation may be found at <http://www.ehso.com/ehshome/regslaws40noise.php>

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National Security Implications

The text presented below was provided on 5 May 2009 by the Army's Surface Deployment Distribution Command Transportation Engineering Agency in response to a Port Authority and Corps request for assessment of the potential national security implications of Bayonne Bridge alteration and replacement.

Problem

The Surface Deployment Distribution Command Transportation Engineering Agency (SDDCTEA) was contacted by the United States Coast Guard (USCG) on behalf of the Port Authority of New York and New Jersey to participate in a feasibility study concerning the Bayonne Bridge. Currently the air draft under the Bayonne Bridge is 151 ft at mean high water and is the main limiting factor for access to the Port Newark and Port Elizabeth Terminals.

Specifically, SDDCTEA was asked to evaluate the national security implications of several future construction options on the table related to the Bayonne Bridge. These options include leaving the bridge unchanged, removing the bridge and replacing with a tunnel or bridge and raising the bridge.

Background/Analysis

To gain a better understanding of the issue we spoke with the ACOE in the NY/NJ region. Based upon that conversation, it appears as though this study is a result of the ongoing improvements to the Panama Canal and its three locks. When these improvements are completed (approximately 2014/2015) the canal will be capable of allowing "Next Generation" container vessels also known as "Post Panamax" to pass through. These improvements to the Panama Canal will likely result in an increase in the number of port calls along the east coast by these commercial vessels. Obviously the Port of NY/NJ will likely be a desired destination for these ships. The anticipated problem is that the Air Draft of these Post Panamax ships may prevent them from sailing under the Bayonne Bridge in its current configuration.

As part of our analysis, TEA set out to study the existing MSC fleet. Approximately 5% (6 of 118) of the current MSC fleet have air drafts (ballast or loaded greater than 151 feet) that prevent them from passing under the Bayonne Bridge as it is today. SDDC Pamphlet 700-4 was used for this analysis.

TEA also reviewed meeting minutes that are on file from the 2003 visit to the Port of NY/NJ. According to these minutes, it has been approximately 10 years since the last significant deployment out of the port. Most deployments in this region over this time frame have come out of the Port of Philadelphia.

Conclusion

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Based upon the data collected, it appears as though the effect on the Department of Defense's (DOD) ability to deploy military forces will be minimal regardless of what is done with the Bayonne Bridge. There will, however, be some factors that should be looked at based upon each of the options presented:

Option A – Do nothing and leave the Bayonne Bridge as is.

- If the Bayonne Bridge remains unchanged then there would be minimal to no affect to DOD deployment activities from NYNJ.

Option B – Raise the Bayonne Bridge.

- Raising the bridge would allow more ships (including MSC's bigger ones) access to PPO facilities. This could present a few drawbacks.
 1. Access to the port facilities would need to be maintained during construction.
 2. Allowing bigger commercial ships to the port could reduce the availability to DOD of those same facilities.

Option C – Remove the Bayonne Bridge and replace it with a tunnel.

- Replacing the Bayonne Bridge with a tunnel would not alter DOD's ability to deploy from the Port of NYNJ assuming:
 1. Minimum draft limits are maintained post construction.
 2. Access to the port facilities would need to be maintained during construction.

It should be noted that allowing bigger commercial ships to the port could reduce the availability to DOD of those same facilities.

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Acronyms

AAGR	Average Annual Growth Rate
BCR	Benefit-to-Cost Ratio
CPIP	Comprehensive Port Improvement Plan
CZMA	Coastal Zone Management Act
DOD	Department of Defense
ERDC	Energy Research and Development Center (US Army Corps of Engineers)
FEU	Forty-foot Equivalent Unit
GPS	Global Positioning System
HDP	50 ft. Harbor Deepening Project
HNS	New York and New Jersey Harbor Navigation Study
IDC	Interest During Construction
IMO	International Maritime Organization
IRR	Internal Rate of Return
IWR	Institute for Water Resources (US Army Corps of Engineers)
KTMH	Keel-to-Mast Height
MHW	Mean High Water
MISLE	Marine Information for Safety and Law Enforcement
MLW	Mean Low Water
NED	National Economic Development
NEPA	National Environmental Policy Act of 1969
NHPA	National Historic Preservation Act
NPV	Net Present Value
O&M	Operations and Maintenance Costs

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ORF	Port of Norfolk
PANYNJ	The Port Authority of New York and New Jersey
PONYNJ	Port of New York and New Jersey
RED	Regional Economic Development
SDDCTEA	Surface Deployment Distribution Command Transportation Engineering Agency
TEU	Twenty-foot Equivalent Unit
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
USEC	United States East Coast
USWC	United States West Coast
VOCs	Vessel Operating Costs
VTS	Vessel Tracking System (US Coast Guard)
WRDA	Water Resources Development Act