IWR White Paper

December 2008

The Implications of Panama Canal Expansion to U.S. Ports and Coastal Navigation Economic Analysis

US Army Corps of Engineers®

IWR

www.iwr.usace.army.mil

The proposed expansion of the Panama Canal will have significant impacts on shipping routes, port development, cargo distribution and a host of others to the U.S. maritime system.

One of its greatest impacts will be felt in the fast-growing container trade where expansion will enable larger vessels to transit the canal. Vessel calls on the East and Gulf Coasts are also expected to increase significantly as cargo shifts away from the congested West Coast.

The challenge is predicting the timing and extent of the impacts as well as the location of the impacts on fleets and cargo, i.e., which ports will be impacted? Many Corps planners and decision makers are concerned about these uncertainties and are seeking guidance in developing their assumptions, forecasts and data needs for their navigation studies.

This paper summarizes the experiences in the field along with the challenges given the Panama Canal Expansion project. The paper also provides several recommendations for follow-up studies, which should ultimately lead to standardized assumptions and a revised framework for National Economic Development analyses considering the canal's expansion.

This white paper was prepared at the request of HQUSACE and ASA(CW) to address the impacts the proposed Panama Canal's expansion will have on the Corps' planning community, particularly with respect to economics of deep draft navigation projects.

IWR White Paper

December 2008

The Implications of Panama Canal Expansion to U.S. Ports and Coastal Navigation Economic Analysis

Kevin Knight
Institute for Water Resources

US Army Corps of Engineers®

IWR

www.iwr.usace.army.mil

Preface

This white paper was prepared at the request of HQUSACE and ASA(CW) to address the impacts the proposed Panama Canal's expansion will have on the Corps' planning community, particularly with respect to economics of deep draft navigation projects. This work was performed by the Institute for Water Resources (IWR), under the direction of Robert A. Pietrowsky, in support of Headquarters U.S. Army Corps of Engineers. Mr. Harry Kitch is the Headquarters proponent and Lillian Almodovar is the IWR Program Manager. Kevin Knight served as the author of the white paper and can be contacted for more information at (703) 428-7250. Ian Mathis, Keith Hofseth, David Moser and David Grier, served as advisors and technical reviewers of this white paper.

Disclaimer

This paper represents the views of the author. It does not purport to be official policy by the Department of the Army.

Table of Contents

Background....1

Panama Canal....1

The Expansion Project....3

- Capacity of the Expanded Canal....5
- Cargo Growth....5
- Shipbuilding Trends....5
- Vessel Itineraries Given the Limitations at the Panama Canal....7
- Vessel Itineraries Post-Expansion of the Panama Canal....8
- Possible Service Patterns of the All-Water Panama Links....9

Assumptions Used in Corps Economic Analyses....10

Additional Challenges Concerning the Panama Canal....11

Concerns and Recommendations for Future IWR Studies....13

I. Concerns about congestion at the Panama Canal....13
II. Concerns about toll structure & pricing....13
III. Concerns about alternate ports....14
IV. Concerns about the reliability of water....15
V. Which U.S. ports are likely to benefit from the Canal's expansion?....16
VI. How much cargo would leave the congested West Coast ports for East Coast (presumably at a lower cost)?....16
VII. What influence will the Canal's expansion have on new shipbuilding trends?....17

What to Do Until Then?....18

Summary....22

References....25

Appendix

Container Terminal Infrastructure, U.S. West Coast....27

Figures

Figure 1: Panama Canal 1
Figure 2 Historic Growth in Vessel Sizes (Prior to Expansion Plans).....2
Figure 3: Panama Canal Market Share of the Container Segment on the Asia to the U.S. East Coast Route 2
Figure 4: Post-Panamax Container Vessel Fleet 3
Figure 5: Containership Composition at U.S. Ports.....3
Figure 6: Components of Third Set of Locks Project.....4
Figure 7: Maximum Sustainable Capacity of the Canal Expanded with the Third Set of Locks.....5
Figure 8: Classes of Post-Panamax Vessels 6
Figure 9: Ten Largest Containerships, listed by TEU Category 6
Figure 10: Comparison between Panamax and Post-Panamax Container Vessels 7
Figure 11: Far East—Suez Canal—U.S. East Coast Pendulum 8
Figure 12: Containerization International Map 11
Figure 13: Ports of Entry for New England TEUs.....12
Figure 14: Cost Comparison 13
Figure 15: Terminal Infrastructure, Canadian West Coast 15
Figure 16: Ports Potentially Impacted by Canal's Expansion (based on controlling depths).....19
Figure 17: US Waterborne Container Traffic Ranked by Loaded TEUs.....20
Figure 18: Major US East Coast Container Port TEU Volumes 2001 – 2006 21

Background

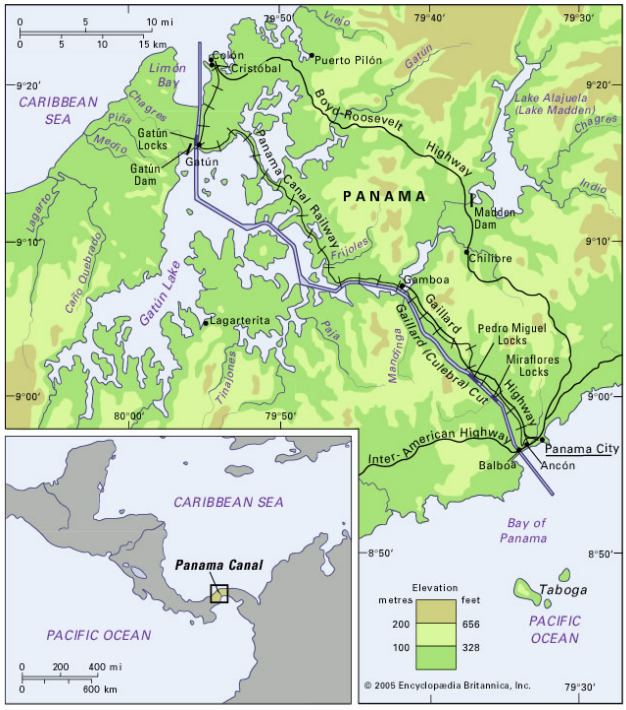
The proposed expansion of the Panama Canal will have significant impacts on shipping routes, port development, cargo distribution and a host of others to the US maritime system. One of its greatest impacts will be felt in the fast-growing container trade where expansion will enable larger vessels to transit the canal. Vessel calls on the East and Gulf Coasts are also expected to increase significantly as cargo shifts away from the congested West Coast. The challenge is predicting the timing and extent of the impacts as well as the location of the impacts on fleets and cargo, i.e., which ports will be impacted? Many Corps planners and decision makers are concerned about these uncertainties and are seeking guidance in developing their assumptions, forecasts and data needs for their navigation studies.

This paper summarizes the experiences in the field along with the challenges given the Panama Canal Expansion project. The paper also provides several recommendations for follow-up studies, which should ultimately lead to standardized assumptions and a revised framework for National Economic Development analyses considering the canal's expansion.

Panama Canal

Since its opening in 1914, the Panama Canal has been hugely successful in linking ship traffic between the Pacific and Atlantic Oceans. The man-made canal is approximately 50 miles long and is comprised of a system of artificial lakes, channels and locks (Figure 1).

Figure 1: Panama Canal



In a given year, more than 14,000 ships pass through the canal, carrying more than 275 million tons of cargo. Approximately 70 percent of the canal's $100 billion containerized cargo is either destined to or coming from the United States. In recent years, canal throughput climbed sharply as increased globalization and congestion in the US West Coast forced shippers to embrace all-water services (Figure 2). As a result, the Panama Canal has gained a sizable share of container traffic headed to the US East Coast (Figure 3).

Figure 2: Historic Growth in Vessel Sizes[1] (Prior to Expansion Plans)

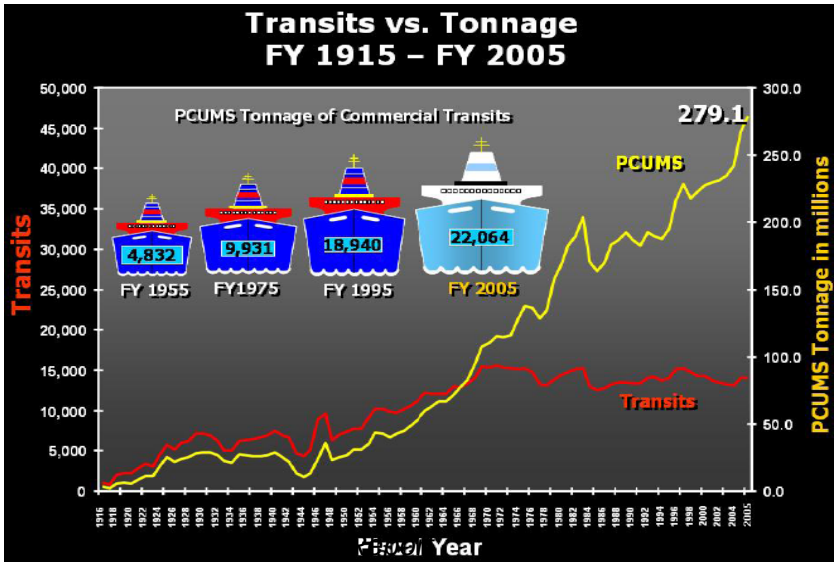
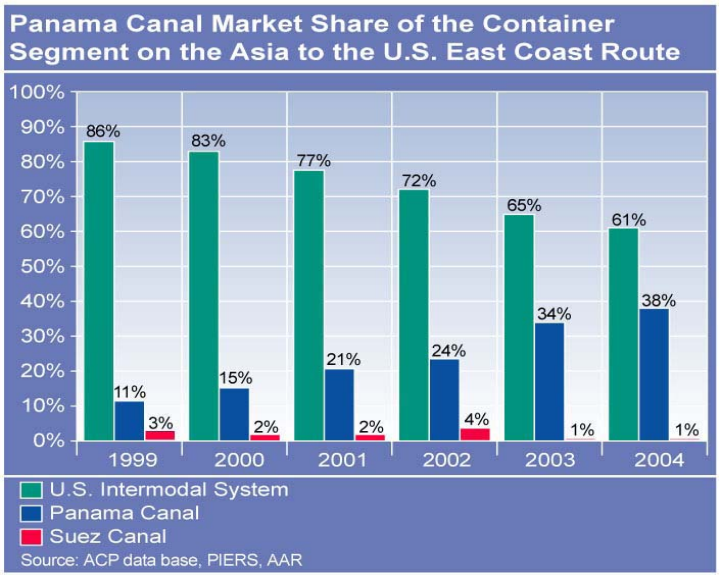


Figure 3



During the high season, it is not uncommon for vessels to wait 10 days before transiting the canal. It can cost shippers as much as $50,000 per day to sit idle, which has resulted in a complex bidding system. In 2006, a British oil tanker paid $220,000 (not including transit fees) to jump ahead of 83 other ships. Moreover, a sizable portion of today's containerships are too large for the canal. Figure 4 shows the existing fleet and new orders of Post-Panamax vessels. Figure 5 shows the changing composition of vessels calling at U.S. ports.

[1] PCMUS is an acronym for Panama Canal Universal Measurement System. A PCMUS is used by the Canal to establish tolls and measures volumetric capacity. A PCUMS is equivalent to approx. 100 ft^3 of cargo space; a 20 ft long container is equivalent to 13 PCUMS tons.

Figure 4

Post-Panamax Container Vessel Fleet

Shipping Company	Existing Post-Panamax Vessel Fleet (Feb. 2006)			New Orders forPost-Panamax Container Vessels			Total Fleet in 2011	
	Total Capacity of existing Post-Panamax Vessels	TEU Range	Total Existing Post-Panamax Vessels	Total Capacity of New Orders	TEU Range	Total Post-Panamax Vessels on order	Number of Post-Panamax Vessels	TEU Capacity
Maersk Line*	409,066	3,700 - 9,200	62	388,108	12,000 - 6,500	42	104	797,174
Mediterranean Shipping (MSC)	146,525	9,200 - 5,500	20	95,000	9,200 - 5,500	13	33	241,525
CMA-CMG	107,074	9,160 - 5,700	16	42,920	9,160 - 8,200	5	21	149,994
Evergreen Mar. Co.	151,310	5,364 - 7024	27	57,241	7,024	8	35	208,551
Hapag Lloyd Cont.	45,916	8,600 - 7,180	6	50,600	8,600 - 8,100	6	12	96,516
China Shipping	81,712	8,468 - 5,618	14	52,230	9,580 - 8,530	6	20	133,942
Hanjin Shipping Co.	37,126	5,308	7	52,000	6,500	8	15	89,126
APL	92,030	5,500 - 4,300	20				20	92,030
Coscon	84,978	5,270 - 5,576	16	80,000	10,000	8	24	164,978
Nippon Yusen Kaisha (NYK)	79,179	6,492 - 4,743	13	123,600	8,200 - 6,500	16	29	202,779
Mitsui O.S.K.	71,537	4,708 - 6,350	13	80,350	8,100 - 6350	11	24	151,887
OOCL	115,632	8,063 - 4,960	20	32,252	8,063	4	24	147,884
K"Line"	78,220	5,500 -5,624	14	87,546	8,120 - 5,624	12	26	165,766
Yang Ming	55,132	5,512	10	73,000	8,000	9	19	128,132
Hamburg Sud	33,312	5,552	6	55,560	5,500	10	16	88,872
Hyundai	32,315	4,411 - 5,700	6	116,400	8,600 - 6,800	15	21	148,715
Others	895,884	4,330 - 9,449	135	680,083	9,580 - 5,527	89	224	1,575,967
Total	**2,516,948**		**405**	**2,066,890**		**262**	**667**	**4,583,838**

*Includes vessels from P&O Nedlloyd, now Maersk Line.
Source: Shipping Intelligence Network, 1 February 2006, Clarkson Research Services

Figure 5: Containership Composition at U.S. Ports

Vessel Size (TEUs)	2001	2002	2003	2004	2005	2006
<1,000	675	566	626	443	394	330
1,000-1,999 (Panamax)	4,975	4,097	3,492	3,463	3,600	3,800
2,000-2,999 (Panamax)	4,434	4,032	4,032	4,470	4,330	3,881
3,000-3,999 (Panamax)	3,464	4,129	4,050	3,959	3,704	3,404
4,000-4,999 (Panamax)	2,574	3,186	3,945	4,210	4,226	4,782
>5,000 (Post-Panamax)	972	1,128	1,142	1,734	2,288	3,312
Total	17,076	17,138	17,287	18,279	18,542	19,509
TEUs per call	2,801	3,020	3,144	3,241	3,321	3,505

Source: American Association of Port Authorities and Terminal Operators

The Expansion Project

Throughout its long history, expansions have been proposed, but not until recently have the plans ever been formalized. On September 3, 2007, the Panama Canal Expansion Project officially began. According to the Panama Canal Authority (ACP), the project is expected to be completed in 2014 and will coincide with the 100th anniversary of the canal. Details of the expansion project include the following integrated components (Figure 6):

- Construction of two lock complexes — one on the Atlantic side and another on the Pacific side — each with three chambers, which include three water-saving

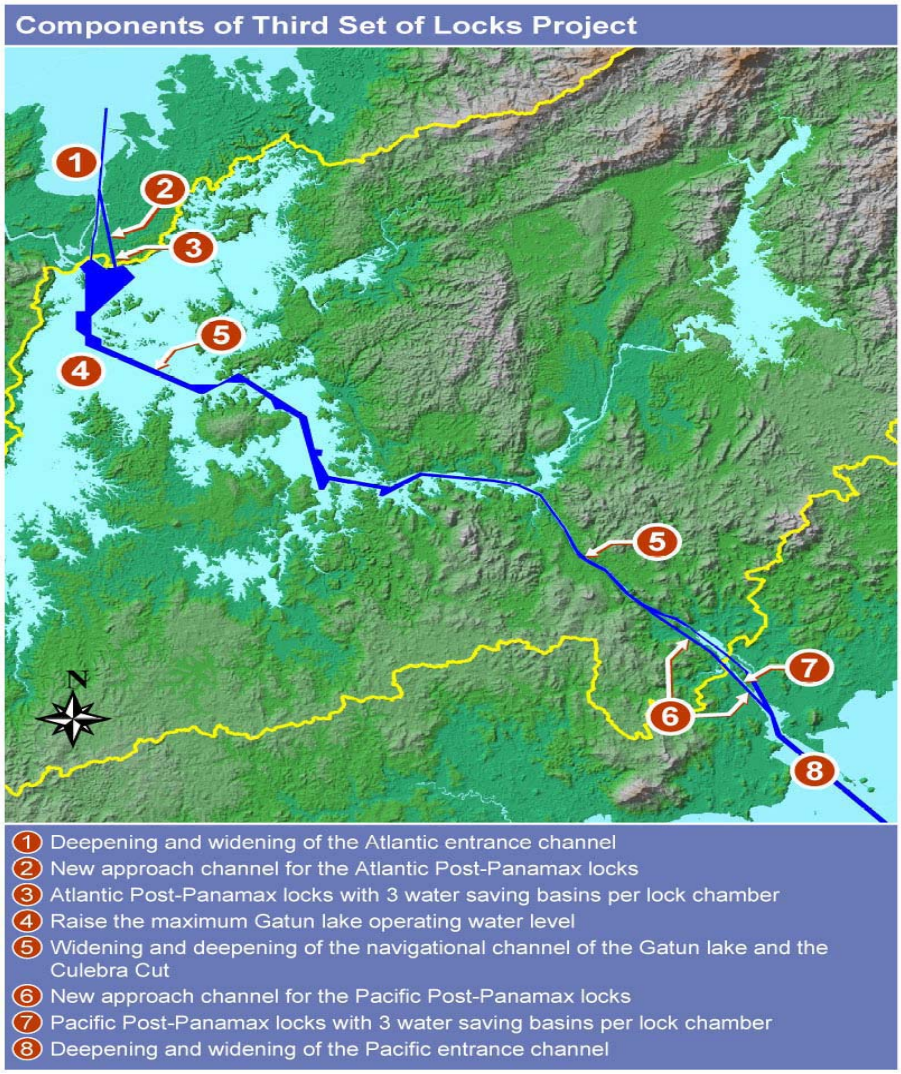
basins (in other words, a new shipping lane);

- Excavation of new access channels to the new locks and the widening of existing navigational channels; and,

- Deepening of the navigation channels and the elevation of Gatun Lake's maximum operating level.

The expansion project is expected to cost approximately $5.2 billion and will be financed through a sophisticated toll system as well as foreign credit[2].

Figure 6

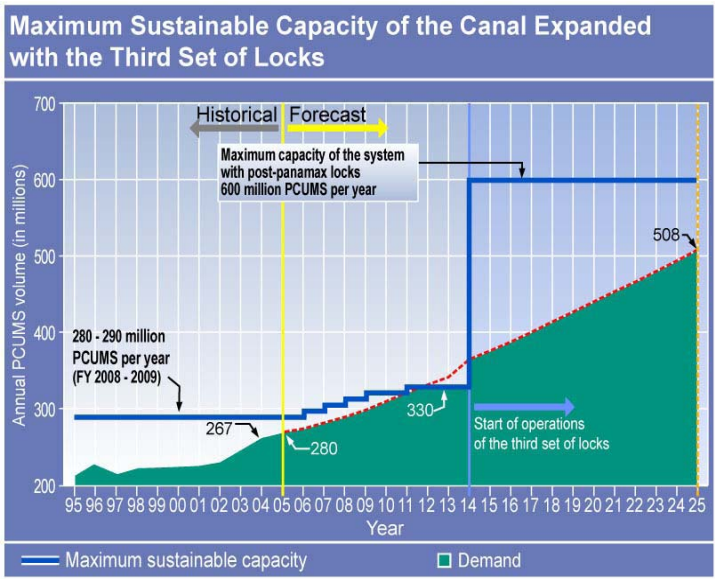


[2] Although the US helped build the canal, it ceded control to the Panamanians in 1999.

Capacity of the Expanded Canal

Global Insight's forecast through 2025 of Canal transits, revenues, PCUMS, and cargo long tons shows that the forecasts are consistent with the trade flows assumptions from the World Trade Model, expectations of toll rates over time, changes in the fleet including competition from containers, and route-switching costs. Several reports have demonstrated that by constructing a third set of locks the canal could reasonably take in 600 million PCUMS, which is nearly double its present maximum sustainable capacity (Figure 7).

Figure 7



Source: ACP Expansion Report, Global Insight

Cargo Growth

In the most probable demand scenario developed by the ACP, cargo volume is expected to increase by an average of 3 percent per year, doubling the 2005 tonnage by 2025. This rate closely mirrors the world trade projections, but is far lower than the expected 6.9 percent annual growth in container trade over the next 20 years[3].

Shipbuilding Trends

While it is well known that increased world trade, particularly with Asia, has been a main catalyst for the Canal's expansion, the other is the ongoing changes to the shipping industry, which continues to deploy larger vessels. Ironically, it was the *decreased* reliance on the Panama Canal that played some role in the rapid growth in the size of containerships. The trans-Pacific Asian trades along with double-stacked railroad cars made the US "land bridge" a successful alternative to the canal. At the same time, deep west coast ports attracted newer, larger generations of vessels. Finally, ocean carriers formed partnerships as a means of sharing slots and co-investing in terminals and new vessels, which were almost always larger.

The maximum size vessel that is able to use the Panama Canal is known as "*Panamax" vessel.* It was designed to fit the chambers of the canal, which are 965 feet long, 106 feet wide and only allow for about 39.5 feet of draft. Upon the completion of the expansion project, a larger class of vessel, known as a "Post-Panamax" vessel would be able to safely move through the canal. Post Panamax containerships generally move about 5,000 to 8,000 containers and have widths of 14 to 20 containers. Some "Super Post Panamax" ships have capacities of 9,000 containers and beyond.
The shipbuilding industry now categorizes separate classes of Post-Panamax vessels which include K, S, G and E classes (Figure 8). The Emma Mærsk, an E-

[3] This rate may be adjusted slightly lower given the present economic slowdown.

Class vessel, is presently the world's largest containership based on twenty-foot equivalent unit (TEU) capacity[4], but she does not stop in the US. In fact, most of the world's largest containerships are exclusively used in the Far East to Europe pendulum (Figure 9). The third set of locks would accommodate E Class vessels, which contain design drafts of 50-51 feet (Figure 10).

Figure 8: Classes of Post-Panamax Vessels

	Class	TEU	Approx Max Draft
1st generation	"K"	~6,000 TEU	47.5'
2nd generation	"S"	~6,600 TEU	47.6'
2nd generation	"G"	~7,500 TEU	48.0'
3rd generation	"E"	~11,000 TEU	51.0'

Figure 9: Ten Largest Containerships, listed by TEU Capacity

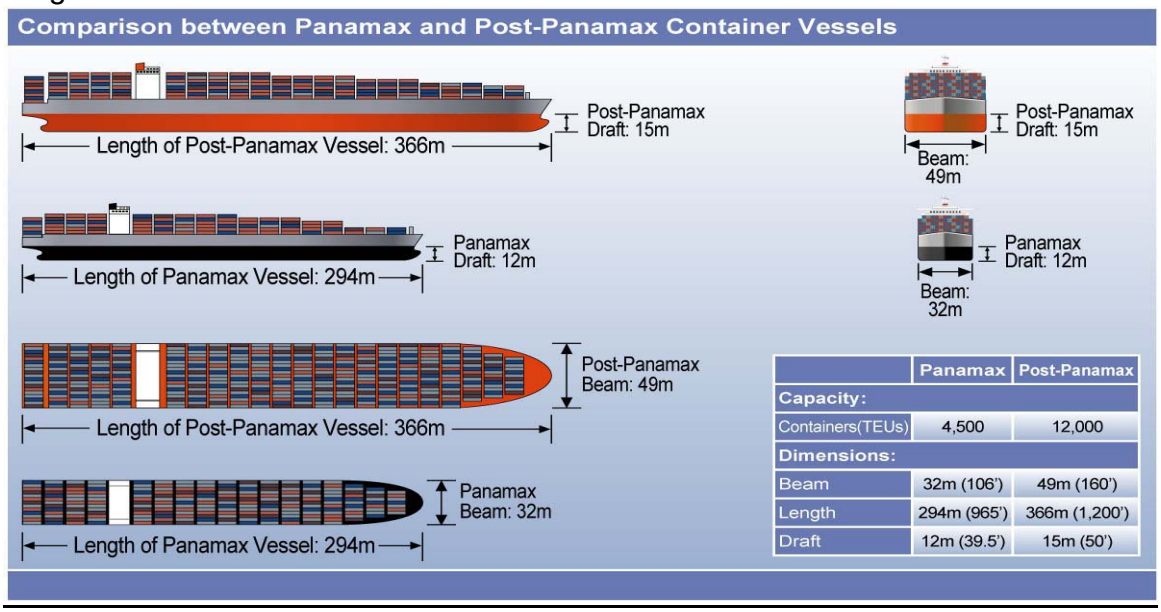
Built	Name	Length	Beam	Maximum TEU	Max Draft	Deadweight Tons	US Ports Called at
2006	Emma Mærsk	1300'	180'	>11,000	51'	156,907	None
2005	Gudrun Mærsk	1200'	140'	10,150	48'	115,700	None
2006	Xin Los Angeles	1100'	150'	9,600	48'	112,488	None
2006	COSCO Guangzhou	1150'	140'	9,450	46'	107,000	None
2006	CMA CGM Medea	1150'	140'	9,415	48'	113,964	None
2003	Axel Mærsk	1156'	140'	9,310	44'	109,000	None
2006	NYK Vega	1100'	150'	9,200	48'	94,000	None
2005	MSC Pamela	1100'	150'	9,178	48'	107,849	None
2006	MSC Madeleine	1140'	140'	9,100	48'	108,637	Los Angeles
2006	Hannover Bridge	1100'	150'	9,040	47'	99,214	None

Source: Lloyd's Register, News Release (2006)

Historically, the newest mega-ships are first deployed on the Far East (Singapore) through Suez Canal to Northern Europe (Rotterdam) service. After several years, as the vessel class expands, the shipping companies often add a Far East-to-US West Coast string but only when it becomes economical to do so (i.e., the demand for cargo is great enough on that route).

[4] A twenty-foot equivalent unit (or TEU) is an inexact unit of cargo capacity used to describe the capacity of container ships. It is based on the volume of a 20-foot long shipping container, a standard-sized metal box which can be easily transferred between ships, trains and trucks.

Figure 10



Source: ACP Report

Shipbuilders are presently toying with the possibility of even larger vessels, but there are theoretical limits because of two main passageways. The Suez Canal could take in a hypothetical “Suezmax” vessel capable of carrying 14,000 TEUs while the Straits of Malacca (separating Malaysia and Indonesia) could support a "Malaccamax" vessel carrying 18,000 TEU. Engineers from Delft University in the Netherlands have already designed an 18,000 TEU vessel. The biggest constraint of this design would be the propeller(s) needed for power. Other constraints, such as time in port and flexibility of service routes are similar to the constraints that eventually limited the growth in size of supertankers.

Vessel Itineraries Given the Limitations at the Panama Canal

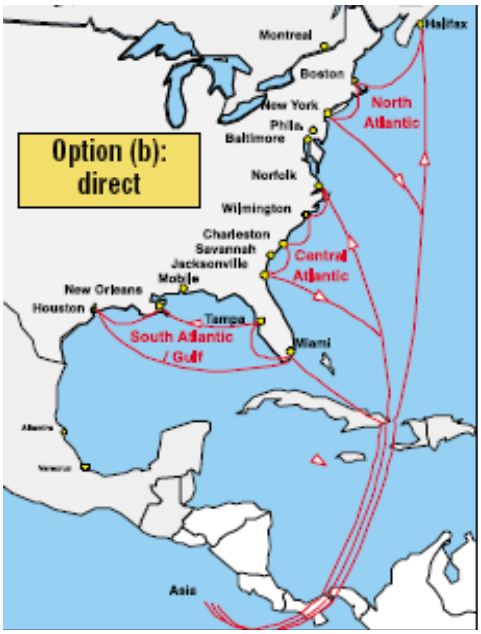
While working on the Port Everglades Deepening Study, the Jacksonville District discovered that the major container lines have generally adopted “pendulum” deployment services to compensate for Post-Panamax vessels unable to transit the Panama Canal. Under a pendulum rotation, a string of vessels will call different port ranges in a back and forth type of deployment. In some instances, the ports called will be the same in both directions; in other instances different ports may be mixed or substituted in the forward and backward deployments. Some of the rotations include: Far East through Suez to U.S. East Coast (Figure 11); European Union to East Coast to Gulf of Mexico; and Round-the-World through Panama Canal (albeit with smaller, Panamax vessels). Rotations may involve swings as long as 50 days between departing and returning to the origin port. The largest vessels to be deployed tend to only frequent the Far East, U.S. West Coast and several European ports.

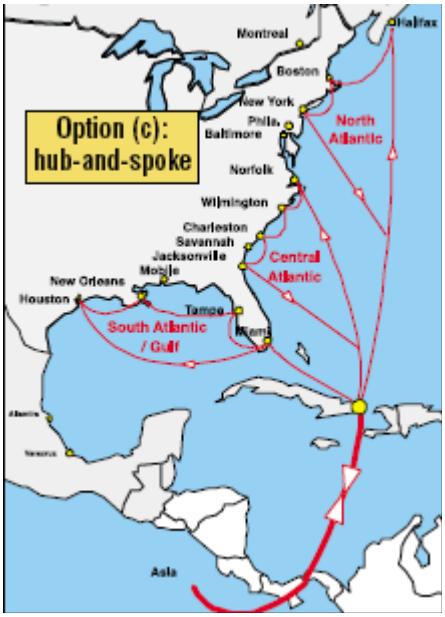
Figure 11: Far East—Suez Canal—U.S. East Coast Pendulum

Vessel Itineraries Post-Expansion of the Panama Canal

Upon its completion, the expanded Panama Canal would reasonably accommodate the largest vessel that presently exists, but not the hypothetical "Suezmax" or "Malaccamax" vessels. It is still unknown what impact the expansion will have on these present pendulum services. Empirical evidence suggests an increased frequency of Round the World routes with the larger, Post-Panamax vessels. The following diagrams reveal four possible service patterns of the all-water Panama links following the canal's expansion.

Possible Service Patterns of the All-Water Panama Links





Option (a): Traditional = A single service that covers the entire Atlantic region

Option (b): Regional Specialization = Three separate services, each focusing on a different USEC region

Option (c): Hub and Spoke = the same, but based on three short regional feeder loops.

Option (d): Global Grid= based on the fourth revolution with counter-rotating ERTW services, handling both the Asian and Mediterranean trades.

Assumptions Used in Corps Economic Analyses

IWR contacted several districts which had recently completed or were undertaking deep draft studies. Some of the districts acknowledged the fact that the Panama Canal would be expanded and provided some form of a sensitivity analysis in their feasibility studies. Other districts did not consider the expansion, since their economic analyses were undertaken before the decision was made to expand the canal. IWR found a lack of consistency among the districts with respect to the vessel behavior following the expansion.

For one study, it was assumed that the improved Panama Canal would come on line in 2015. In addition, they assumed that carriers, given the present 8-year lead time, would make necessary adjustments in their respective vessel fleets to take advantage of the expanded canal to maximize its throughput. The district pointed out that the practice "has been illustrated in historic operations (i.e., maximizing vessel size through the canal) and was further supported by the carrier interviews performed both in 2003 and in 2006". To bolster this assumption, they showed that existing vessel orders for the benefiting carriers were largely comprised of Post-Panamax vessels. Accordingly, they assumed that by 2015, four services using the Panama Canal will shift their existing vessel fleet to an all Post-Panamax fleet. And since these vessels naturally had never used the Panama Canal, the District developed a proxy to estimate the sailing draft distribution for future Post-Panamax vessel calls through the Panama Canal. (Specifically, the District applied the present non-Panama Canal services: East Coast US—Europe—Gulf; and Far East—Suez—East Coast US; as a proxy for the Panama Canal services following the canal's expansion).

While this assumption (maximizing vessel size through the canal based on historical practice) has some merit, past transitions had been made over a much longer time period. Secondly, there is a high degree of uncertainty given carrier interview data. Finally, there is uncertainty associated with using a non-Panama canal fleet as a proxy for vessel behavior in the expanded canal.

For another study, a district assumed one carrier would immediately switch to Post-Panamax vessels once the expansion is completed. They based this assumption on interviews with shippers, who claimed that they would "deploy 8,000 TEU vessels through the canal as early as 2015", but the District ended up applying a smaller class of containership, a more conservative 5,600 TEU vessel, in their model. The number of trips was relatively small compared to other routes (averaging 250,000 boxes per year), yet this particular service did make a difference in the project's overall optimization. Much of the project's benefits are derived from savings in landside (trucking) costs as the improvements would likely divert cargo away from other ports.

Additional Challenges Concerning the Panama Canal

- If the manufacturing centroid shifts from Northeastern China to Western India, as a recent Global Insight report suggests, a shipping route to New York would be 3,308 miles closer via the Suez Canal, or alternatively, 3,308 miles further from the Panama Canal. This might favor ports in the Northeast as a first port of call.

- Recent climate models indicate the Northwest Passage could be ice-free for up to 9 months by the year 2030. Instead of using the Panama Canal, carriers could bring cargo from Northeast Asia directly to the US East Coast via the Passage. This again might favor the Northeast ports as a first port of call and de-emphasize ports in the Southeast and Gulf. It remains to be seen whether shippers will actually practice this, as it remains quite speculative.

- In a widely publicized article in *Containerization International*, there is a strong possibility that Freeport, Bahamas would increase its standing as a trans-shipment port. With a depth of 52 feet, Freeport could become much like a hub airport-- large Post-Panamax vessels could arrive at Freeport and then transfer cargo onto smaller vessels destined for other US ports (Figure 12). Other Caribbean ports such as Puerto Caucedo in the Dominican Republic are also seriously considering expansions to become hub ports. This suggests that the US may not need to deepen as many ports as it believes, or perhaps not as deep.

Figure 12

Source: Containerization International

- Previous projections for new Post-Panamax containerships may have been overly-optimistic. Given the recent credit tightening and sluggish trade as well as rise in the cost of steel, some shipping companies have cancelled their orders for new containerships[5].

- It is also important to note that even following the expansion, there will still be a significant number of Panamax vessels transiting the Panama Canal. Panamax vessels offer a flexible alternative to filling up large containerships. Transshipment services continue to be converted into direct call stings, increasing the availability of more Panamax ships cascading from primary east/west services. In addition, the relatively rapid increase in the container fleet has meant that container ships are, on average, significantly younger than other major components of the world fleet (UNCTAD, 2007). Many of those new vessels are Panamax vessels, which are unlikely to be replaced soon.

- According to the Boston Harbor Feasibility Study, as many as 30 percent of the containers that reach New England originated from the Ports of Los Angeles/Long Beach (Figure 13). This suggests that transit time, inventory costs or value of the cargo may play more prominent roles in the cargo's ultimate destination. These factors should be given adequate consideration in economic analysis.

Figure 13: Ports of Entry for New England TEUs (Proportion of Import TEUs)

Port	2003	2004	2005	2006
PONYNJ	42%	34%	35%	37%
LA/LB	30%	28%	27%	26%
Boston	7%	17%	15%	10%
Others	21%	21%	23%	27%
Total	100%	100%	100%	100%

Source: Boston Harbor Feasibility Report--Economic Appendix (2008)

[5] Furthermore, even the largest containerships have not been drawing the depths they had anticipated after they were built. For example, the deepest the Emma Maersk has ever drafted was 46 feet and that only happened on two occasions. This suggests that vessels are carrying empty containers and/or are carrying less dense cargo such as textiles and electronics.

Concerns and Recommendations for Future IWR Studies

Based on discussions with the districts as well as HQUSACE, this white paper identified the following concerns and their associated recommendations. IWR is proposing to take the lead in completing these studies.

I. Concerns about congestion at the Panama Canal

Capacity for all-water services via the Panama Canal is extremely tight. According to Drewry Shipping Consultants, the Panama Canal can accommodate at most five new liner services by the end of 2008, when it will reach capacity and effectively cut off growth on a key route for all-water services from Asia to the US East Coast. Further, even with the expansion, it is unlikely that all post-Panamax ships will replace the Panamax ships which presently transit the canal. While the project entails constructing an additional lock, the ACP is planning to continue using the existing locks. This suggests that the size of vessels, while important, may not be as critical as the increased traffic brought on by globalization.

Recommendation: Examine the functional capacity of the expanded canal to develop a reasonable estimate on the number of Post-Panamax vessel transits through the Canal in a given year.

II. Concerns about toll structure & pricing

According to Global Insight, the three stage toll increases on containerships that the ACP began phasing in May 2005 has brought the canal's tolls closer to those of the Suez Canal. The cost of expansion could have a significant effect on routing. In its own analysis, Global Insight concluded that if the Panama Canal raised tolls significantly to pay off the debt used to finance expansion, alternate shipping routes like the Suez Canal will become more attractive.

Figure 14 compares the cost of vessels using the Suez Canal versus the Panama Canal for cargo originating in Hong Kong, assuming a 7,482 TEU vessel (50,000 net metric tons). It shows that the Suez Canal could actually be cheaper, even though the voyage is longer[6].

Figure 14: Cost Comparison

	Panama Canal	Suez Canal
Length of Trip		+12 hours
Toll for Ballast	$377,093	$206,301
Toll for Laden	$471,366	$242,351
Additional Costs (at sea)		$231,623
Total Cost	**$848,459**	**$680,275**

[6] The recent run-up in oil costs could certainly change this comparison, however.

Carriers have already been considering new all-water services from East Asia to the US East Coast through the Suez Canal within the next few years. The Suez has fewer restrictions (daytime vs. nighttime) as well. This alone may dampen the forecasts of the traffic through the Panama Canal.

In addition, the existing twin set of Panama locks will continue to be used to accommodate Panamax vessels while the larger locks are expected to accommodate Post-Panamax vessels. The toll system will likely narrow the cost advantage of Post-Panamax vessels; however, the ACP will likely have two different toll structures depending on the vessel size.

Recommendation: Evaluate the toll structure and determine the breakpoints between Panama and the Suez Canals. In addition, examine the tolls and price advantages associated with the new Post-Panamax vessels.

III. Concerns about alternate ports

As global trade continues to expand and larger vessels become commonplace, alternatives to the Panama Canal have been becoming increasingly viable. Several ports in Mexico such as Manzanillo and Ensenada have been actively seeking expansion in response to overcrowding in West Coast ports (and to a lesser extent, recent labor disputes)[7].

Punta Colonet, located 150 miles south of San Diego, is hoping to handle 6 million containers a year with plans for a railroad line to the Mexican border cities of Mexicali or Nogales, or to Yuma, Arizona, or El Paso, Texas. Mexican ports handled a total 3.06 million TEUs in 2007.

At the same time, Prince Rupert in British Columbia is in a great position to capture more containerized cargo from the US West Coast. Although the Port is a relative newcomer to container operations, it sports the deepest, ice-free harbor in North America and is three days closer in sailing time to Asia than the Ports of LA/Long Beach. Moreover, Prince Rupert has a tremendous ability to expand its capacity and is connected to the some of the fastest and most efficient rail lines to the US Midwest, where much of the West Coast traffic is delivered (Figure 15)[8].

[7] In 2002 a labor dispute between the International Longshore and Warehouse Union (ILWU) and the terminal operators at the Los Angeles/Long Beach ports, caused an operational disruption that lasted several months. In 2004, when the cargo volume grew to about 19 million containers, there was also a severe shortage of both union and non-union workers in the terminals.

[8] In a recent press release, the port welcomed the COSCO-Long Beach, a 7,455 TEU vessel. Chicago and Memphis are the ultimate destinations for much of the US-bound cargo.

Figure 15: Terminal Infrastructure, Canadian West Coast

Port	Terminal Name	Dock Length (Ft)	Terminal Area (Acres)	Super Post-Panamax Cranes	Post-Panamax Cranes	Panamax Cranes	Depth Water (Ft)	On-Dock Rail Total Length (Ft)
Prince Rupert	Fairview	1,295	50	3		--	55.0	1,579
Vancouver	Centerm	2,133	72		5	--	50.9	745
	Vanterm	2,031	76	3	4	--	50.2	671
	Deltaport	2,198	160	7		--	52.0	1,067
Total or ave.		6,362	308	10	9	--	51.0	4,062

Source: American Association of Port Authorities and Terminal Operators

It was already mentioned that the hypothetical "Suez-Max" and "Malacca-Max" vessels, will exceed 55 feet in draft and would not fit through the improved Panama Canal, so further adjustments may be needed for those forecasts.

Another factor favoring Canadian or Mexican ports is avoiding the US Harbor Maintenance Tax, which could affect shipping economics for some cargoes.

Recommendation: Investigate likelihood and degree of traffic that would be rerouted from the US West Coast to these alternative ports. Also, recommend comparing the intermodal ("land-bridge") costs with the sailing costs.

IV. Concerns about the reliability of water

For years, the Panama Canal was fed by a series of artificial lakes and dams, ensuring a ready supply of water in a country where rainfall is highly seasonal. However, the expanded project will require a great deal more water for its locks, in spite of providing features which reuse water. Another recent problem is the erosion of the rainforest around the canal, which has, in turn, made it much harder to retain water during the dry seasons. The erosion has also exposed the area, such as the city of Colón, to the risk of flooding. And while the proposed toll system (which charges for water use) as well as draft restrictions may address some of the water shortages, the frequency and severity of water shortages is still unknown.

Recommendation: An evaluation of the likelihood of having an adequate water supply to meet the expected demand. This might have an impact on the number of vessel calls that can reasonably transit the canal, given the less than 100% assurance of water.

V. Which U.S. ports are likely to benefit from the Canal's expansion?

This represents a major concern for economists working on Corps navigation projects. It is certainly true that not all ports will benefit equally or immediately following the expansion. A 2005 report by Drewry Shipping Consultants of London examined the future of the Panama Canal and its effect on shipping and concluded that even 10 years after the Panama Canal is expanded, most US East ports will not have the capacity or the depths to accommodate the amount of Post-Panamax vessels. Already struggling to handle containerships carrying up to 6,000 TEUs, many ports are ill-equipped to deal with a new generation of vessels, soon to appear in the Pacific that will carry more than 8,000 TEUs each. Larger ships require the terminal to have longer docks, more storage area, deeper water at the dock, and a capacity to move containers from the terminal to truck or rail.

According to a white paper prepared by Gulf Engineers & Consultants, the East Coast ports most envisioned to be affected by the Panama Canal expansion are those serving as interstate retail distribution centers for Asian imports such as Norfolk, Charleston, and Savannah. South Florida ports are not geographically situated to serve a US Midwest hinterland compared to these ports.

By focusing on the key variables that drive shipper's behavior, we hope to ultimately develop useful assumptions. If, for example, Assumptions A, B and C are met, containers will be pushed to Ports X, and Z.

Recommendation: A study to assess the ports' capacity and ability to handle the increased arrivals of post-Panamax vessels. Additionally, the study will examine the key variables driving port choice and describe various assumptions would attract/divert containers to different ports.

VI. How much cargo would leave the congested West Coast ports for East Coast (presumably at a lower cost)?

This is difficult to predict. Despite all the congestion, the Ports of Los Angeles/Long Beach (LA/LB) have always managed to accommodate ever more volumes of cargo through productivity improvements, optimizing terminal space, daytime surcharges, medallions, and acquiring new landfills. According to the Port of Long Beach's Master Plan, if year 2020 trade volumes reach the high end of their forecast, the Port of Long Beach will acquire 450 acres of landfills which will support additional cargo handling facilities. LA/LB processed a combined 15 million TEUs in 2007, accounting for 40% of all freight entering the US, including 80% of imports from Asia. Nevertheless, at some point accommodation will be unsustainable.

Recommendation: A study that examines the potential of traffic diversion from LA/LB. This study should examine the intermodal costs and may be combined with the investigation of alternate ports in Mexico and British Columbia. This may be best handled by independent academic analysis such as the Transportation Research Board (TRB).

VII. What influence will the Canal's expansion have on new shipbuilding trends?

In the past, it was the size of the Panama Canal that directly dictated the size of the largest vessels, Panamax vessels. Nowadays, it is post-Panamax vessels that drive the optimization of most port projects. Therefore, a contractor should perform an accurate assessment of the economics that drive shipbuilding. Trade routes, trade volumes, costs including canal tolls should be considered. In addition, care must be taken to assess the effect the recent expansion has on new containership orders instead of rehashing the projected increases in the world fleet.

Recommendation: A study that examines the economics that drives new orders for containerships which will validate whether the expansion is having an influence on the number of Post-Panamax vessels.

What to Do Until Then?

- Account for Uncertainty

ER 1105-2-100, Appendix E, paragraph e5, states "the uncertainty in key variables should be analyzed." As we've seen, particularly with all the speculation surrounding the Panama Canal, coupled by the fact that the container industry is very dynamic, planners will need to acknowledge and incorporate uncertainty in their analyses. As it stands, there is still a lot of uncertainty regarding when the Post-Panamax vessels will actually deploy through the Panama Canal. Other variables subject to uncertainty include forecasted tonnages, vessel fleet composition, and loading practices. To perform successful uncertainty analyses, Districts should assign reasonable uncertainty distributions in their transportation models as a means of identifying the variables which most influence the overall project optimization.

- Enforce a System Approach to Navigation Projects

The Corps must ensure that economists adopt a "system approach" to navigation economic analysis in the same manner that watershed planning and regional sediment management has been encouraged. Far too often, Corps economists zero in on their District's port of study and hinterlands, irrespective to other ongoing deepening projects/studies. Multi-port and regional port analyses are generally viewed as too complex or with little payoff to the district.

Alternatively, the Corps could decide to perform an independent study that investigates the impacts of navigation improvements in a system context. For example, if Harbor X is deepened and not Harbor Y, what would be the total cost of delivering cargo to and from the US? This could be repeated for other ports and combinations of ports. However, given the dynamics of the shipping industry, this would require a tremendous amount of manpower and would require constant updates to be of any use. Yet another approach is to finance a corporate multi-port model that produces baseline forecasts of tonnage and TEUs by port or group of ports. This information could be regarded as the "official" forecasts for planners working on deep draft navigation projects.

- Districts (PDTs) Makes the Decision

Using information collected by IWR's Navigation Data Center, districts could make educated guesses on which ports would likely benefit from an expanded canal. Various metrics such as controlling depth (Figure 16), loaded traffic (Figures 17 & 18) and others could be considered in their overall decision. This likely to be resisted, however since it entails sweeping generalizations of industry behavior. It will also be difficult to determine the *degree* of benefit for each port.

Figure 16: Ports Potentially Impacted by Canal's Expansion (based on controlling depths)

Port[1]	Main Channel Depth	Entrance Channel (Approach) Depth
Long Beach	55'	76'
LA Harbor	53'	81'
Norfolk	50'	55'
Oakland	50'	55'
NY/NJ	50'	53'
Seattle	50'	N/A
Port Everglades, FL	49'	54'
San Juan, PR	46'	66'
Port Freeport, TX	45'	47'
Houston	45'	45'
Mobile Bay	45'	47'
Charleston	45'	47'
Honolulu	45'	50'
Tampa	43'	45'
Portland, OR	43'	48'
Miami[2]	42'	44'
Wilmington	42'	44'
Savannah[3]	42'	42'
Boston[4]	40'	47'
Jacksonville, FL[5]	40'	42'

[1] There is also a proposal for an offshore container terminal at the mouth of the Mississippi River that could handle maximum drafts and then move containers upriver by barge.
[2] GRR recommended -50 feet
[3] GRR studying 44-48 feet
[4] Feasibility Study investigating -45 feet
[5] GRR studying -45 feet

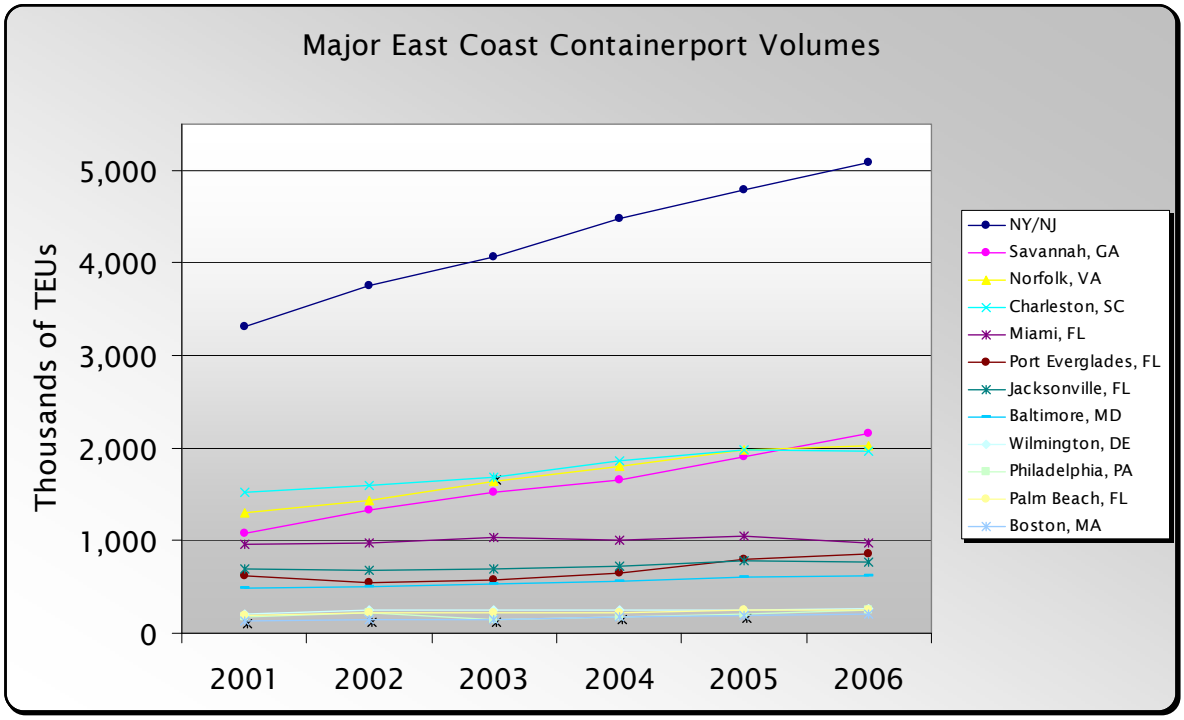
Figure 17: US Waterborne Container Traffic Ranked by Loaded TEUs

Port Waterway	Loaded TEUs (2006)
Los Angeles, CA	5,572,000
Long Beach, CA	5,043,000
New York (and NJ)	3,811,000
Oakland, CA	1,579,000
Savannah, GA	1,574,000
Norfolk Harbor, VA	1,492,000
Charleston, SC	1,482,000
Seattle, WA	1,380,000
Tacoma, WA	1,379,000
Houston, TX	1,316,000
Honolulu, HI	890,000
Miami, FL	740,000
San Juan, PR	690,000

Source: COE, Navigation Data Center Waterborne Commerce Data

Figure 18: Major US East Coast Container Port TEU Volumes 2001 – 2006
(Thousands of TEUs)

Port	2002	2003	2004	2005	2006	Annual Growth
NY/NJ	2,931	3,132	3,409	3,581	3,811	6.78%
Savannah, GA	997	1,129	1,309	1,486	1,574	12.2%
Norfolk, VA	1,119	1,211	1,308	1,436	1,492	7.46%
Charleston, SC	1,220	1,250	1,423	1,514	1,482	4.98%
Miami, FL	804	765	818	778	740	-2.05%
Port Everglades, FL	352	417	502	591	633	15.8%
Jacksonville, FL	687	568	749	582	512	-7.19%
Baltimore, MD	404	423	444	481	483	4.57%
Wilmington, DE	173	183	150	162	170	-0.04%
Philadelphia, PA	72	88	115	131	148	19.7%
Boston, MA	109	120	135	160	158	9.73%
Palm Beach, FL	115	111	131	139	124	1.90%
Source: Corps of Engineers, Navigation Data Center Waterborne Commerce Data						



Summary

As aforementioned, the economic assumptions surrounding the Panama Canal's expansion remain inconsistent throughout the field. Predicting the expansion's impact as well as the timing and location of the impacts on fleets and cargo is very challenging. On top of that, unknowns such as availability of water, development at competing ports, and the melting of the Arctic passage creates a great deal of uncertainty for planners.

In order to foster increased knowledge of the impacts which may ultimately lead to standardized assumptions, HQUSACE should consider the following recommendations for follow-up study:

1. Validate the functional capacity of the expanded Panama Canal.

While the dimensions of the new canal are widely known, estimates of the Post-Panamax vessel calls through the Canal need to be developed. Assumptions (and resulting NED benefits) in many of the Corps navigation analyses will be based on the future Post-Panamax vessel calls to a particular port.

2. Evaluate the toll structure and determine the breakpoints between Panama and the Suez Canal. In addition, examine the tolls and price advantages associated with the new, Post-Panamax vessels

A toll and cost analysis, in conjunction with the functional capacity analysis, should result in more accurate forecasts of the traffic through the Suez and Panama Canals, particularly with respect to Post-Panamax vessels.

3. Perform an evaluation of the likelihood of having an adequate water supply at the Panama Canal to meet the expected demand.

There is still a strong degree of uncertainty regarding the availability of water, despite the project's plans to recycle much of it along with other safeguards (tolls and draft restrictions). An evaluation will help to establish a threshold of potential traffic through the canal given such uncertainty.

4. Undertake a study to assess the ports' capacity and ability to handle the increased arrivals of Post-Panamax vessels.

Ports often claim to have the capacity to handle the size and frequency of the future vessels, but in reality most are ill-equipped to handle such increases. An unbiased study, perhaps in partnership with the US Maritime Administration, will help to assess the capacity of each port and will help strengthen the argument for improvements. In addition, investigating the factors which drive shippers to various ports will help to better define the key assumptions when making forecasts for containership ports.

5. Complete a study that examines the potential of traffic diversion from LA/LB. This study should examine the intermodal costs and may be combined with the investigation of alternate ports in Mexico and British Columbia.

The results of this study will help planners better assess the throughput via the Panama Canal. Successful expansion at competing international ports could also potentially reduce the volume and frequency of Post-Panamax vessels reaching ports on the East Coast.

6. Perform a study that examines the new orders for Post-Panamax containerships given the new plans for expansion.

It has been two years since the decision to expand the canal was approved. By examining the order book for new containerships as well as interviewing shipbuilding companies, the contractor will validate whether additional Post-Panamax vessels will be added to the world fleet. This will presumably have an influence on the number of Post-Panamax calls at several US ports. In addition, an investigation of the basic economics that drive shipbuilding, growth in trade, costs of materials, shipping costs (including canal tolls), will help with assumptions relating to forecasts.

References

Ashar, A. "Revolution #4" *Containerization International*, 46-49

Bingham, P. and Hackett, B. (2007) Trends in World Economics and Trade, *Global Insight*, 17-22

ACP (2006) Proposal for the Expansion of the Panama Canal

Lloyd's Register News Release "Largest Containerships" (2006)

GEC Memo to Jacksonville District, 29 October 2007

Gallagher, J. (2005) "Not Big Enough: Adding capacity at Panama will not take pressure off need to expand at West Coast ports, rails" *Traffic World*, 48-49

Freebairn, W. and Martinez, A. "Mexico Starts $4.88 Billion West Coast Port Project" Bloomberg Report, 28 August 2008

Port of Rupert Sound website

Panama News Briefs website

Transportation Research Board, *Journal of the Transportation Research Board, No. 2062 "Ports and Waterways*", 25-31

Drewry Shipping Consultants, *Annual Container Market Review and Forecasts (2007)*

Personal Conversations and/or Correspondence with: Ken Claseman (HQUSACE), Jerry Diamentides (DMA), David Moser (IWR), David Grier (IWR), Kevin Horn (GEC), Jeff Strahan (NAO), Becky Moyer (LRD), Naomi Fraenkel (NAN), Dan Abecassis (SAJ), Ian Mathis (IWR) and Keith Hofseth (IWR).

Appendix

Container Terminal Infrastructure, U.S. West Coast

Port	Terminal Name	Dock Length (Ft)	Terminal Area (Acres)	Super Post-Panamax Cranes	Post-Panamax Cranes	Panamax Cranes	Water Depth (ft)	On-Dock Rail Total Length (ft)
Oakland	Maersk	3,200	148		5	3	45.9	
	Transbay	1,050	49			2	42.0	
	Trapac	1,075	33			3	42.0	
	Ben E. Nutter	2,192	58			4	42.0	
	Hanjin	2,400	120	4			49.9	
	Oakland Int.	3,600	146				49.9	
	APL	2,743	79				42.0	
Los Angeles	West Basin I	1,197	75				45.0	
	West Basin II	3,496	186	4		3	45.0	10,000
	Trans Pacific	4,051	173		11		44.0	
	Port of LA	2,181	86	12	3	1	50.0	32,255
	Yusen	5,799	185	4	2	2	40.0	18,432
	Seaside	4,700	205		8		42.0	
	APL-Gateway	3,998	292	12			50.0	10,000
	APM-Pier 400	7,190	484	14			55.0	30,000
Long Beach	Pier E	2,100	95				53.0	
	Pier T	5,000	345		14		48.0	
	Pier G-J	6,379	246				55.0	
	Pier F	2,750	102		7		55.0	
	Pier J-Pacific	5,800	256	6	7		50.0	
	Pier A	3,600	165	4	6		50.0	
	Pier C60	1,804	58			3	45.0	
Seattle	Terminal 5	2,900	182		6		49.2	1,800
	Terminal 18	4,440	196	4	6		49.2	1,630
	Terminal 25	1,200	35			3	49.2	
	Terminal 46	2,300	88	3	2	1	49.2	
Tacoma	APM	2,200	135	7	5		49.2	19,300
	Husky	1,900	93		4		50.9	26,750
	Olympic	1,100	54		3	1	50.9	26,750
	Pierce	2,260	171				50.9	25,200
	Washington	2,000	80	7			49.9	8,400
Portland	Terminal 6	2,851	200		3	5	40.0	6,152

Source: American Association of Port Authorities and Terminal Operators

U.S. Army Engineer Institute for Water Resources

The Institute for Water Resources (IWR) is a Corps of Engineers Field Operating Activity located within the Washington DC National Capital Region (NCR), in Alexandria, Virginia and with satellite centers in New Orleans, LA and Davis, CA. IWR was created in 1969 to analyze and anticipate changing water resources management conditions, and to develop planning methods and analytical tools to address economic, social, institutional, and environmental needs in water resources planning and policy. Since its inception, IWR has been a leader in the development of strategies and tools for planning and executing the Corps water resources planning and water management programs.

IWR strives to improve the performance of the Corps water resources program by examining water resources problems and offering practical solutions through a wide variety of technology transfer mechanisms. In addition to hosting and leading Corps participation in national forums, these include the production of white papers, reports, workshops, training courses, guidance and manuals of practice; the development of new planning, socio-economic, and risk-based decision-support methodologies, improved hydrologic engineering methods and software tools; and the management of national waterborne commerce statistics and other Civil Works information systems. IWR serves as the Corps expertise center for integrated water resources planning and management; hydrologic engineering; collaborative planning and environmental conflict resolution; and waterborne commerce data and marine transportation systems.

IWR provides managerial and technical support to the Civil Works Planning Community of Practice (CoP) in its execution of the Planning Excellence Program. This includes the management of the Planning Associates (PA) program, which is aimed to groom planning leaders capable of managing complex planning studies that lead to quality decision documents and who will provide water resources technical and professional leadership in the future. IWR also provides support to the local delivery of Planning Core Curriculum courses by the Corps MSCs. These seven courses provide the basic, full-performance training needed by entry level planners across the USACE as the means to accelerate their progress to the journeyman stage of their career development. These courses include: Civil Works Orientation, Planning Principles and Procedures, Environmental Considerations, Economic Analysis, H&H Considerations, Plan Formulation and Public Involvement and Team Planning.

In addition to the Planning CoP, the Institute plays a prominent role in the Economics CoP. The Corps Chief Economist is resident at the Institute, along with a critical mass of economists, sociologists and geographers specializing in water and natural resources investment decision support analysis and multi-criteria tradeoff techniques.

For further information on the Institute's activities associated with the Corps Economics Community of Practice (CoP) please contact Chief Economist, Dr. David Moser, at 703-428-6289, or via-mail at: david.a.moser@usace.army.mil. The IWR contact for the Corps Planning CoP activities is Ms. Lillian Almodovar at 703-428-6021, or: lillian.almodovar@usace.army.mil.

The Director of IWR is Mr. Robert A. Pietrowsky, who can be contacted at 703-428-8015, or via e-mail at: robert.a.pietrowsky@usace.army.mil. Additional information on IWR can be found at: www.iwr.usace.army.mil. IWR's National Capital Region mailing address is:

U.S. Army Engineer Institute for Water Resources
7701 Telegraph Road, 2nd Floor Casey Building
Alexandria, VA 22315-3868

US Army Corps
of Engineers®

IWR

www.iwr.usace.army.mil