



Transportation Study on the Grain Market Segment and the Panama Canal

Estudio del Transporte del Segmento de Mercado de Granos y el Canal de Panamá

Nathan Associates, Inc.

9 de septiembre de 2003

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Resumen Ejecutivo

FINAL REPORT

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Volume 1: Main Report

SUBMITTED TO
Autoridad del Canal de Panamá

SUBMITTED BY
Nathan Associates Inc.,
Arlington Virginia

IN ASSOCIATION WITH
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London

UNDER CONTRACT NO.
SAA-81851

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Executive Summary

Agricultural commodities are one of the important products in world trade that are also shipped extensively through the Panama Canal. In 2001, nearly 39 million metric tons of grains and oilseeds were shipped through the Panama Canal comprising 18 percent of world trade for these commodities.

OBJECTIVE AND SCOPE

The Transportation Study on the Grain Market Segment and the Panama Canal is part of a larger set of studies to examine the feasibility of expanding the capacity of the existing Canal to permit the transit of larger vessels. The grains market segment study will:

- Assess the Canal's potential market for grains trade,
- Determine the economic advantages of using the Canal versus existing and expected alternative transport options,
- Devise a market strategy that attracts the grains business to the extent that the Canal's earnings are maximized under existing and expanded lock conditions, and
- Forecast traffic, transit, and revenue flows through 2025, and associated risks, for the Existing and Expanded Canal.

WORLD GRAIN TRADE FORECAST

Macroeconomic Scenarios

The study has been conducted using three global macroeconomic and trade scenarios to the year 2025 prepared by DRI-WEFA for the Autoridad de Canal de Panamá.¹ The macroeconomic scenarios provide forecasts of GDP, population, per capita income, government and private consumption, investment, and trade of goods and services. The three macroeconomic scenarios—most probable case scenario, best case and worst case—incorporate varying assumptions on world economic performance, geopolitical conditions, international trade policies, and environmental issues.

Future North America Production Levels and Patterns

There are numerous factors impacting changes in production in the next 25 years. These include: changes in yield (in response to technical improvements) and changes in area planted in part in

¹ DRI-WEFA, Global Macroeconomic and Trade Scenarios to 2025, Volume I: Most Probable Case, prepared for the Panama Canal Authority (Contract No. SAA75897BGP), March 2002.

response to farm programs and returns per acre. During this period it is expected that area planted will evolve gradually toward those crops providing the greatest returns per acre.

Data on yields and acres were projected by year to 2025 and used to derive production estimates and changes in production by region and crop to 2025. Some of the important findings are:

- Corn production is expected to increase mostly in the three dominate regions: Eastern Corn Belt (increase of 9 million metric tons from 2002), Western Corn Belt (increase of 7.5 million metric tons) and the Central Plains (increase of 5 million metric tons). Soybeans will increase primarily in the Eastern Corn Belt (increase of 6 million metric tons) and the Western Corn Belt (increase of 5.3 million metric tons). Wheat will increase in each of Saskatchewan, Central Plains and the Northern Plains by about 2 million metric tons each.
- Changes in production in all other crops and regions are expected to be minimal and typically in the range of less than 1 million metric tons.

An important change in US consumption is that related to corn use for ethanol. This industry has been expanding during the past decade, and its rate of expansion is expected to accelerate in the coming decade. These results indicate that as a result of the accelerated ethanol demand for corn, that

- Corn consumption will increase another 13 percent by 2010 and 11 percent by 2025, versus what would otherwise be natural consumption growth;
- Most of the growth in ethanol consumption will be concentrated in Central and Northern Plains, and the Western Corn Belt.

Brazil Soybean Production Trends

Soybean production in Brazil has expanded rapidly in the traditional southern production region, increasing from less than 2 million hectares in 1970, to nearly 8 million hectares in 1975. Since then, area planted in this region has remained in the 6-7 million hectares level. The regions in which most of the expansion is occurring is in the Central West, and North. Area planted in these regions has increased from nil through the mid-1970s, and now has more than 7 million hectares planted, exceeding that in the traditional south. The average level of production in these regions during the period 1995-1999 was: Brazil South, 14 million metric tons; Brazil Center-West, 12 million metric tons; and Brazil North, 3 million metric tons.

- Production is expected to increase from 31 million metric tons in 1999 to 50 million metric tons in 2003 and to 108 million metric tons by 2020.
- Most of the increase in production is due to the prospect of increasing area under production, i.e., by bringing new lands under cultivation.
- Most of the increase is expected to be concentrated in the Northerly states in Brazil. Specifically, production is expected to increase by 66 percent in 2005 in Brazil North, and by 31 percent in Brazil South. By 2020, these values would represent increases in production of 467 percent and 157 percent respectively.

World Grain Import Demand

Key findings regarding forecast of grain import demand include:

- **World import demand** for all grains is expected to increase about 47 percent for the 2000-2025 period. The increase in world import demand is due mainly to what would appear to be optimistic projections of world income growth for the period by DRI-WEFA.
- **Barley.** Aggregate import demand for barley is expected to increase 55 percent for the 2001-2025 period. Increases in individual country's import demand ranges from 6 percent in Korea to 1800 percent in other South America. Import demand for barley is the largest in Middle East with an increase of 31 percent, followed by China with an increase of 119 percent.
- **Corn.** Aggregate import demand for corn is expected to increase about 26 percent for the 2001-2025 period. Japan is the largest importer of corn, followed by North Africa and S. Korea in 2001. However, China will be the second largest importer in 2025 with an import of 9.9 million metric tons. It is expected that Japan and South. Korea will import more meat rather than feed grains to raise livestock for the period. Under a freer trade environment, beef production in the countries may not be competitive. China is expected to produce as much meat as possible to meet rapidly increasing domestic demand for meat rather than importing the shortages from major meat producing countries. Because of this, China's imports of corn are expected to increase rapidly.
- **Rice.** Aggregate import demand for rice is expected to increase much faster than those for barley and corn. Average increase in rice consumption would be 51 percent over the 2001-2025 period. This is due to (1) increasing trend in consumers' preference and taste of rice over wheat, and (2) much higher income elasticity on rice. Middle East is the largest rice importing region with an increase of 81 percent for the period, followed by West Africa with an increase of 58 percent. Under a freer trade environment, Philippines, Korea and Malaysia are expected to increase their imports faster than other countries for the period.
- **Sorghum.** As a minor crop, major importers are Mexico and Japan. Mexico is the largest importer, followed by Japan. These countries' imports are expected to increase 63 percent and 20 percent, respectively, for the 2001-2025 period. Average increase in import demand is 45 percent for the period.
- **Soybean.** Average increase in import demand for soybeans is expected to be about 49 percent for the 2001-2025 period. The largest soybean importer was the EU, followed by Japan. However, China will be the largest importer of soybeans in 2025. China is expected to import about 30 million metric tons of soybeans in 2025. China is expected to produce as much meat as possible to meet its rapidly increasing domestic demand for meat rather than importing meet directly from major exporters. The European Union was the largest importer of soybeans in 2001, but the second largest importer with import volume of 19.9 million metric tons in 2025.
- **Wheat.** Aggregate import demand for wheat is expected to increase over 61 percent for the 2001- 2025 period. Largest importers are Middle East, followed by North Africa for the 2001-2025 period. However, China's import will increase faster than other countries and will be the third largest importer of wheat in 2025, with an import volume of about

15.7 million metric tons. This is mainly due to continuous decrease in wheat production in China rather than increase in consumption.

POTENTIAL PANAMA CANAL TRANSITS

Table E-1 summarizes potential laden transits in terms of cargo tons, DWT, numbers of transits and PCUMS for both the Existing and Expanded Canals and for all cases. For the Most Probable Cases, grains cargo transits for the Existing Canal are estimated to increase by 67 percent from 47 million tons in 2001 to over 79 million tons in 2025 and for the Expanded Canal by 77 percent to almost 84 million tons. For the Existing Canal similar percentage increases are projected for transits in terms of DWT and PCUMS. However because of the expected continuing trend towards the utilization of larger vessels, the total number of transits is forecast to increase by about 54 percent for the Existing Canal, from 1,205 in 2001 to 1,852 in 2025.

Table E-1. Potential Laden Transits in Cargo Tons, DWT, Number of Transits and PCUMS, Existing and Expanded Canal, No Tolls, All Cases

Case	Existing Canal						Expanded Canal			
	2001	2005	2010	2015	2020	2025	2010	2015	2020	2025
Cargo (000 long tons)										
Most Probable	47,400.1	48,305.0	62,195.0	66,576.1	73,130.2	79,230.6	64,210.2	69,858.8	77,547.1	83,941.2
Best	47,400.1	49,438.9	63,819.7	70,929.1	75,947.1	83,133.5	65,425.3	72,780.7	81,737.2	87,768.2
Worst	47,400.1	53,691.1	56,098.7	59,579.9	58,626.5	60,824.0	57,559.8	60,259.3	62,573.9	62,233.0
Vessel Size (000 dwt)										
Most Probable	57,204.3	58,204.9	75,217.5	80,636.5	88,651.1	96,104.7	73,778.5	80,208.5	89,006.3	96,284.7
Best	57,204.3	59,581.6	77,215.3	85,932.7	92,259.4	100,948.8	75,177.4	83,575.8	93,837.9	100,687.5
Worst	57,204.3	65,070.2	68,020.6	72,151.6	71,090.3	74,000.6	66,048.3	69,080.9	71,712.1	71,322.4
Transits (no.)										
Most Probable	1,205.1	1,216.4	1,505.5	1,577.1	1,721.7	1,851.8	1,467.8	1,559.0	1,751.5	1,910.0
Best	1,205.1	1,245.3	1,549.2	1,706.4	1,776.5	1,963.2	1,499.9	1,651.5	1,859.6	2,028.4
Worst	1,205.1	1,278.3	1,292.8	1,357.6	1,305.5	1,333.2	1,238.5	1,281.7	1,300.5	1,263.1
PCUMS (000)										
Most Probable	28,828.0	29,436.1	37,871.5	40,482.5	44,470.6	48,195.2	37,162.0	40,249.9	44,692.5	48,382.4
Best	28,828.0	30,126.6	38,860.4	43,142.1	46,159.3	50,583.3	37,858.3	41,979.0	47,045.6	50,578.9
Worst	28,828.0	32,561.5	34,051.4	36,167.7	35,563.1	36,890.7	33,088.2	34,651.4	35,858.6	35,546.8

Source: Richardson Lawrie Associates

For the Expanded Canal the projected growth in transits in terms of DWT and PCUMS remains at around 68 percent. This is less than the rate of growth in cargoes of 77 percent because of the improved utilization that would result from an enlarged Canal. The number of transits would grow by 59 percent overall as the result of both greater utilization levels and the trend towards larger vessel sizes.

The most salient features of the southbound transits are the stronger than average increases in the 50,000-60,000 DWT size range encompassing the modern Handymax sizes and in the 70,000-80,000 DWT size range encompassing the modern Panamax and representing the limit of most grain port capabilities. Specifically:

- The substitution of vessels in the 20,000-30,000 DWT size ranges by, in the first instance vessels of 30,000-50,000 DWT.
- After 2010 vessels of 30,000-40,000 DWT decline year on year at an accelerating rate while transits of vessels between 40,000 and 50,000 DWT continue to increase at numbers which are similar to the overall average.
- Meanwhile, the DWT of vessels of 50,000-60,000 DWT incorporating the newer Handymax sizes are forecast to increase substantially. This trend is at its most acute in the short term as transits through the Canal reflect more closely changes in the world fleet and thereafter growth rates which vary between nearly twice and 3.5 times the average DWT growth.
- As would be expected the share of the traditional Panamax size range of 60,000 - 70,000 DWT declines - from 33 percent to 23 percent - as the share of the 70,000 - 80,000 DWT range consequently increases from 21 percent to 36 percent.

In the case of the Expanded Canal, despite the likelihood that larger vessels will transit the Canal in this case, total DWT actually declines in the earlier years of the forecast compared to the Existing Canal case as the utilization levels of size ranges up to 80,000 DWT improve and inefficiencies are removed from the global shipping system. In the second half of the forecast period, the total DWT through the Canal southbound increases compared to the Existing Canal with increased use of vessels up to 100,000 DWT. Specifically:

- While there are fluctuations in individual time periods, the overall usage of the 60,000-70,000 DWT size range is fairly flat;
- While the share of the 70,000-80,000 DWT range continues to increase, this is to a lesser degree than in the Existing Canal as this is the size range which benefits most from improvements in vessel utilization.
- Vessels in excess of 80,000 DWT would be expected to land cargo in the Far East, particularly in China, South Korea and Taiwan.

COMPARISON OF ACP REPORTED GRAIN TRAFFIC WITH STUDY ESTIMATES

The forecasts of potential Panama Canal grain trade presented in this Volume are not directly comparable to ACP reported grain traffic for several reasons. First, as already mentioned the definition of potential Panama Canal grain trade is based on the assumption of no Panama Canal tolls. Second, the forecast of potential transits is for dry bulk vessels only and does not include grains that may transit the Canal on non-dry bulk vessels².

² However, we have prepared and provided the ACP with a forecast of such cargo carried aboard non-dry bulk vessels to be incorporated in other market segment studies.

It is important to recognize that this study was designed not to prepare independent forecasts of potential Panama Canal grain trade. Accordingly, the study did not use ACP-reported Canal traffic as the basis of the forecast. Rather the study developed the potential trade forecast from other sources of production, consumption and trade of each grain.

Table E-2 presents a comparison of ACP reported grain traffic for 2001 with forecasts prepared in this study. The upper portion of the table shows that in 2001 total ACP reported grain traffic was 38.5 million tons. To be comparable to the study's forecast, the amount of grain carried on non-dry bulk vessels is subtracted (1.6 million tons in 2001). The remaining ACP-reported grain traffic on dry bulk vessels totaled 36.9 million tons in 2001.

Table E-2. Comparison of ACP Reported Grains Traffic with Study Forecasts, 2001 (thousands of long tons)

Item	2001
Grains Trade from ACP data	
ACP reported grains commodities traffic a/	38,489
Less: Grain commodities on non-dry bulk vessels b/	1,599
Subtotal grains traffic from RLA	36,890
Grains Trade prepared by Study	
Potential Canal grain trade forecast with zero tolls c/	48,459
Less: Grains trade in non-dry bulk carriers d/	1,059
Potential Canal grains trade in dry bulk vessels	47,400
Less: Traffic diverted with actual ACP tolls e/	9,266
Forecast of grains bulk traffic on dry bulk vessels	38,134

a/ From Volume 2, Appendix K, Table K-1.

b/ From Volume 2, Appendix K, Table K-1.

c/ From Grains Transit model, Table XB1graintradedeforecast.xls

d/ From Grains Transit model, Table XB3grains.xls

e/ From Volume 4, Table 4-2.

Source: as noted.

The lower portion of Table E-2 shows the estimates of grain trade prepared by the study. From the global trade forecasts prepared by the study, we identified the amount of grain trade on trade routes where the Panama Canal is the least-cost routing assuming no Canal tolls. The result is the forecast of potential Panama Canal grain trade with zero tolls of 47.4 million tons as reported in this volume.

However, again this estimate includes grain trade carried on non-dry bulk vessel (1.1 million tons in 2001). Also to be compared with ACP-reported traffic, the amount of potential dry bulk trade that is not captured due to Panama Canal tolls needs to be subtracted (79.3 million tons in 2001). The result is an estimate of 38.1 million tons of grains on dry bulk vessels that would use the Panama Canal. This is 1.2 million tons or 3.4 percent above the figure derived from ACP records. The results are quite close given the entirely independent and separate method used to prepare the forecast.

WORLD FLEET DEVELOPMENT BY SIZE

The potential growth in the world fleet and the potential impact of an Expanded Canal on its development are important background to the projection of changes in the allocation of cargo to different size ranges of vessel in the Canal transit forecasts. Forecasts of the world fleet by size range for the Existing and Expanded Canals have been developed based on future expectations of world trade growth in dry bulk commodities, changing preferences for ordering particular vessel sizes, the age distribution of the existing fleet and projected scrapping by size range.

The main difference between the Existing and Expanded Canal conditions is that under the latter conditions, the 70,000–80,000 DWT size range would be expected to peak at around 79 million DWT in 2018 before declining to just under 65 million DWT in 2025. This compares with a steady rise to nearly 109 million DWT under Existing Canal conditions. In contrast, with an Expanded Canal, the 80,000–90,000 DWT size range would increase to 54 million DWT instead of about 5 million DWT in the former case. There would also be an approximately 4 million DWT increase in the size of the 90,000–100,000 DWT size range by the end of the forecast period.

ANALYSIS OF FUTURE SHIP COSTS AND FREIGHT COSTS

For the purpose of this study we define freight costs as the freight paid by the shipper to the ship owner or operator. While these represent the cost to the shipper these are not the same as operating costs (capital, fixed and variable) borne by the owner. Capital costs comprise capital repayments plus interest charges. Fixed operating costs include manning, repairs and maintenance, insurance, stores and supplies and overheads. Variable costs cover bunkers, port charges and Canal dues, where applicable.

Estimates of freight costs—expressed in terms of US\$ per cargo ton—have been developed through voyage estimates by route and deadweight (DWT) size range for:

- All vessels transiting the Canal,
- By pass routes
- Routes that represent alternatives to the Existing Canal, and
- Routes where cargo moves in vessels that could transit the Existing Canal but are precluded from so doing by current toll policies.

Freight costs by vessel size and trade have been calculated for all grains movements involving transit of the Panama Canal (excluding tolls) together with the costs for alternative routes and by pass routes via the Suez Canal, Cape of Good Hope and Cape Horn for all years from 2000 through 2025. The main differences in the rates between the Existing and Expanded Canals are, of course, the use of larger vessels on certain routes and improved utilization in the latter case.

- In comparing the Canal with least cost alternative routes under Existing Canal conditions, weighted average freight costs from the US Gulf to the Far East through the Canal have an approximately \$2.65 per ton to \$5.00 per ton advantage.

- The greatest saving is for Japan, then South Korea, China and Taiwan. By contrast, a similar comparison for exports from North Brazil indicates differentials in favor of the Canal ranging from just \$0.16 per ton to \$2.50 per ton.
- For exports to South East Asia from the US Gulf the Canal enjoys an advantage of between \$0.10 per ton and about \$2.40 per ton although only into the Philippines is the differential significant and for Malaysia the Canal would not be the favored route even at zero tolls.
- For North Brazil the Canal is not competitive at all for exports to South East Asia. Not surprisingly, the Canal is most competitive for relatively short hauls on intra Western Hemisphere trades.

For the Expanded Canal the conclusions tend to be broadly the same, except that the differentials are, if anything, slightly smaller.

- Expansion of the Panama Canal would reduce weighted average freight costs from the US Gulf to the Far East by between \$1.00 per ton and \$1.60 per ton. Similar reductions would be seen from the US Gulf to South East Asia. These generally represent the greatest savings offered by an Expanded Canal. Freight costs from Brazil to the Far East would be reduced by around \$0.50 per ton.

ECONOMIC VALUE OF THE PANAMA CANAL

The determination of the economic value of the Canal involves comparing the total cost of transporting grain commodities over routes transiting the Panama Canal and over alternative routes. For each potential Canal route involving grain commodities, we first identified all current and projected viable alternative routes and then identified the least cost alternative route.

The definition of the least-cost alternatives takes into account the following factors:

- Mileage, if necessary, at a port level where more than one port might be considered representative of a particular origin or destination.
- Size and characteristics of vessels forecast to be operating on specific commodity–route pairs for all-water alternative routes
- Current and projected draft of ports that serve the Canal and alternative routes. These include the ports of origin and destination, as well as intermediate ports.
- Current and projected capacity constraints in the transportation system, including bottlenecks and congestion at ports, limits of the land transport system, and the capacity of the Panama Canal under Existing and Expanded Canal scenarios.
- Commodity market forecasts that look at production and consumption trends and developments that will help identify current and future geographic and product competition.
- Timing. Route structures may change during the projection period, as improvements in the transportation system and other developments are implemented. Typically, if one expects trade on a specific route to grow over the forecast period, then, all other things being equal, cargo sizes will increase and there is also the possibility that the incidence of

“parceling” of cargoes will increase to the utilization of larger vessels as has been seen in the coal and iron ore trades.

- Typical cargo sizes that may be determined not by transportation considerations but by industrial requirements and trade volumes.
- Inventory costs for the additional time required for shipping over the longer distances associated with least cost alternative routes.

Table E-3 summarizes the total economic values calculated for both the Existing and Expanded Canal, through to 2025. Under Existing Canal conditions, the economic value of the Canal is estimated to remain within the range of the equivalent of \$4.93 per ton to \$5.67 per ton in \$2002 terms. Translated into total economic value, this results in a steady increase from \$259 million in 2001 to \$390 million in 2025.

Table E-3. Summary of Economic Value of Existing and Expanded Panama Canal, Most Probable Case, Selected Years 2001-2025

Year	Existing Canal				Expanded Canal				Margin Expanded vs. Existing Canal	
	Potential Panama Canal	Potential Panama Canal cargo (tons 000s)	Economic Value of Canal (\$/ton)	Economic Value of Canal (\$000s)	Potential Panama Canal	Potential Panama Canal cargo (tons 000s)	Economic Value of Canal (\$/ton)	Economic Value of Canal (\$000s)	Economic Value of Canal (\$/ton)	Economic Value of Canal (\$000s)
	Transits				Transits					
2001	1,202	47,339	5.48	259,522						
2005	1,213	48,238	5.67	273,674						
2010	1,502	62,114	5.21	323,405	1,464	63,186	6.01	379,903	0.81	56,498
2015	1,573	66,490	5.13	340,865	1,555	68,731	5.96	409,510	0.83	68,645
2020	1,717	73,036	5.06	369,893	1,748	77,449	6.05	468,557	0.99	98,664
2025	1,847	79,133	4.93	389,775	1,906	83,841	6.13	513,845	1.20	124,071

Source: Nathan Associates Inc.

For the Expanded Canal, the economic value is projected to increase from the equivalent of \$6.01 per ton in 2010 to \$6.13 per ton in 2025. Total economic value would rise from \$380 million to \$514 million. The margins between the Expanded Canal and the Existing Canal from 2010 to 2025 are estimated to increase from \$0.81 per ton to \$1.20 per ton, or from \$56 million to \$124 million.

ALTERNATIVE PANAMA CANAL MARKETING STRATEGIES

The terms of reference for the study state that the marketing strategy shall pursue the following objectives:

- Maximize Canal’s earnings
- Maximize the canal market share for the dry bulk segment, and
- Be non-discriminatory within the dry bulk segment

Based on our review of the Panama Canal Neutrality Treaty and of toll policies at comparable facilities, we believe there is ample scope to differentiate Panama Canal tolls by size of vessel and commodity. Accordingly, we identified alternative toll pricing options for analysis that had tolls

varying by size of vessel, and by commodity³. Toll options were also analyzed with tolls assessed by PCUMS and by ton of cargo carried. Toll pricing options included ACP tolls in effect prior to October 2002, from October 2002 through June 2003 and ACP tolls to take effect in July 1, 2003. The ACP tolls as of July 1, 2003 were used as the basis for examining a series of toll increases at 25 percent intervals from 25 percent increase through a 150 percent increase.

The detailed review of the Canal toll pricing options revealed the following findings.

- Approximately 15 percent of the potential transits (with no tolls) would be diverted to alternative routes once any non-insignificant Canal tolls were imposed. These involved routes North America Gulf to South East Asia, from Brazil North to Japan, and from South America East to South America West.
- A sizable number of transits and cargo would be diverted at certain pricing points for particular commodity-route pairs.
- After certain levels of toll increases, Canal revenues decline as the loss of toll revenue due to diverted transits is not offset by toll increases for the remaining Panama Canal transits.

Table E-4 presents summarized results of the 14 Canal toll pricing options for the Existing Canal and Expanded Canal, Most Probable Case for 2011. This table clearly shows the potential for the Panama Canal to increase toll revenues. In 2011, estimated Canal toll revenues for dry bulk vessels in the grain market segment under July 1, 2003 toll rates total \$86.5 million. The Canal captured 81 percent of potential transits in this market segment and 79 percent of potential grain dry bulk cargo. However, the Canal toll revenues of \$86.5 million only accounted for 26 percent of the estimated economic value of the Canal of \$327million. If tolls rate from July 1, 2003 were doubled, toll revenues for 2011 traffic would be \$150.4million, an increase of 74 percent. Even with tolls doubled, the Canal would still only capture 46 percent of the total economic value of the Canal⁴.

The demand for Canal services is inelastic relative to tolls. That is, a given percentage increase in tolls would result in a smaller percentage decrease in Canal transits and would generate higher Canal toll revenues. A review of Table E-4 provides an indication of the price inelasticity of demand. A 75 percent increase in tolls from July 1, 2003 levels reduces the forecast of Canal grain bulk transits in

³ As this market segment only deals with dry bulk carriers, Panama Canal toll pricing options by type of vessel were not analyzed.

⁴ For the Canal to capture 100 percent of the economic value of the Canal, it would have to have a toll pricing policy that charged each vessel transiting the full benefit of using the Canal over alternative routings. Such a policy is not administratively practical, nor consistent with the Panama Canal Neutrality Treaty.

Table E-4. Grains Market Segment: Summary of Panama Canal Toll Pricing Options, Existing and Expanded Canal, Most Probable Case, 2011

Canal Scenario and Item	Panama Canal Toll Pricing Option												
	ACP tolls prior to Oct 2002	ACP tolls Oct 2002- June 2003	ACP tolls from July 2003	PCUMS Option 1 (25% increase)	PCUMS Option 2 (50% increase)	PCUMS Option 3 (75% increase)	PCUMS Option 4 (100% increase)	PCUMS Option 5 (125% increase)	PCUMS Option 6 (140% increase)	PCUMS Option 7 (150% increase)	Commodity Option 1 & PCUMS (100% increase)	Commodity Option 3 & PCUMS (100% increase)	Commodity Option 4 & PCUMS (100% increase)
Existing Canal													
Potential Panama Canal Transits (no.)	1,520	1,520	1,520	1,520	1,520	1,520	1,520	1,520	1,520	1,520	1,520	1,520	1,520
Potential Panama Canal Cargo (ton 000s)	63,071	63,071	63,071	63,071	63,071	63,071	63,071	63,071	63,071	63,071	63,071	63,071	63,071
Forecast Panama Canal Transits (no.)	1,233	1,233	1,233	1,198	1,198	1,198	1,106	1,095	1,095	945	1,143	1,143	1,106
Percent of Potential Transits	81.2%	81.2%	81.2%	78.9%	78.9%	78.9%	72.8%	72.1%	72.1%	62.2%	75.2%	75.2%	72.8%
Forecast Panama Canal Cargo (ton 000s)	49,900	49,900	49,900	48,283	48,283	48,283	43,183	42,786	42,786	34,571	45,249	45,266	43,183
Percent of Potential Cargo	79.1%	79.1%	79.1%	76.6%	76.6%	76.6%	68.5%	67.8%	67.8%	54.8%	71.7%	71.8%	68.5%
Economic Value of Canal for Potential Transits (\$000s)	326,825	326,825	326,825	326,825	326,825	326,825	326,825	326,825	326,825	326,825	326,825	326,825	326,825
Economic Value of Traffic Diverted Due to Tolls (\$000s)	9,997	9,997	9,997	13,182	13,182	13,182	29,125	30,623	30,623	63,595	22,799	13,416	29,125
Forecast Panama Canal Revenues (\$000s)	76,337	82,591	86,490	104,622	125,546	146,471	150,358	167,532	178,701	150,329	154,416	153,675	149,280
Average Toll Revenue per Forecasted Transit (\$000)	62	67	70	87	105	122	136	153	163	159	135	128	131
Average Toll Revenue per Ton of Forecasted Cargo (\$/ton)	1.53	1.66	1.73	2.17	2.60	3.03	3.48	3.92	4.18	4.35	3.41	3.19	3.31
Expanded Canal													
Potential Panama Canal Transits (no.)	1,483	1,483	1,483	1,483	1,483	1,483	1,483	1,483	1,483	1,483	1,483	1,483	1,483
Potential Panama Canal Cargo (ton 000s)	64,257	64,257	64,257	64,257	64,257	64,257	64,257	64,257	64,257	64,257	64,257	64,257	64,257
Forecast Panama Canal Transits (no.)	1,183	1,183	1,183	1,149	1,149	1,141	1,058	1,034	963	912	1,097	1,140	1,058
Percent of Potential Transits	79.8%	79.8%	79.8%	77.5%	77.5%	76.9%	71.3%	69.7%	64.9%	61.5%	74.0%	76.9%	71.3%
Forecast Panama Canal Cargo (ton 000s)	49,861	49,861	49,861	48,260	48,260	47,641	42,599	41,208	37,088	33,887	44,980	47,576	42,599
Percent of Potential Cargo	77.6%	77.6%	77.6%	75.1%	75.1%	74.1%	66.3%	64.1%	57.7%	52.7%	70.0%	74.0%	66.3%
Economic Value of Canal for Potential Transits (\$000s)	313,818	313,818	313,818	313,818	313,818	313,818	313,818	313,818	313,818	313,818	313,818	313,818	313,818
Economic Value of Traffic Diverted Due to Tolls (\$000s)	9,855	9,855	9,855	12,933	12,933	14,555	28,737	33,618	48,739	60,299	22,174	14,741	17,825
Forecast Panama Canal Revenues	72,774	78,733	82,447	99,708	119,649	137,865	142,312	154,891	149,908	142,718	146,604	144,658	141,224
Average Toll Revenue per Forecasted Transit (\$000)	62	67	70	87	104	121	134	150	156	156	134	127	131
Average Toll Revenue per Ton of Forecasted Cargo (\$/ton)	1.46	1.58	1.65	2.07	2.48	2.89	3.34	3.76	4.04	4.21	3.26	3.04	3.15

Source: Prepared by Nathan Associates Inc.

Preferred Canal toll pricing option

Alternative Canal toll pricing option

2011 from 1,233 vessels to 1,198 vessels, or only 2.9 percent. A 100 percent increase in tolls reduces the forecast of Canal grain bulk transits to 1,106 vessels or 10.3 percent.

Appendix C presents results of the Canal toll pricing options for both the Existing Canal from 2001-2025 and the Expanded Canal from 2010-2025. For all years and pricing options, the Existing Canal scenario is shown to generate more toll revenues than the Existing Canal for the grains market segment. While these results initially seem counter-intuitive, there are three factors that together fully explain these findings.

First, the total potential Panama Canal grain cargo under the Expanded Canal scenario of 63.3 million tons in 2010 is only slightly higher than the Existing Canal scenario of 62.2 million tons. Thus, the introduction of the Expanded Canal does not significantly impact the volume of grain trade that could potentially use the Canal.

Second, with the Expanded Canal, there is a trend toward using larger vessels and hence the number of grain vessels needed is reduced. The Expanded Canal scenario is shown to have 1,468 potential transits in 2010 versus 1,506 potential transits for the Existing Canal. As Canal tolls provide discounted rates for larger vessels, Canal toll revenues for the same annual volume of grain cargo will be less for the Expanded Canal versus the Existing Canal.

Third, the Expanded Canal is shown to have a smaller total economic value than the Existing Canal. In 2010, the Expanded Canal has a total economic value of \$310.6 million as compared to \$323.4 million for the Existing Canal. The economic value of the Canal defined for study purposes is the transportation cost savings of the use of the Canal as compared to the least-cost alternative routing. Decisions on whether to use the Canal or an alternative route are made taking into account the shipping characteristics and corresponding costs of each routing. For the Existing Canal scenario, the decision is based on the shipping characteristics and costs associated with that scenario. These were described fully in *Volume 3: Vessel Transit and Fleet Analysis*. With the Expanded Canal scenario, again decisions to use the Canal are determined by the shipping characteristics and costs for the Canal and alternative routings associated with that scenario.

The reason that the economic value of the Canal is lower for the Expanded Canal scenario is that the cost differentials between the Expanded Canal and its least-cost alternative routings are lower than those estimated for the Existing Canal. With the Expanded Canal, there will be a trend toward use of larger vessels and some originating and receiving ports will develop facilities to accommodate the larger vessels. However, the use of larger vessel will reduce the transport cost of both Canal and least-cost alternative routings. As the mileages for the least-cost alternative routings are greater than for Canal routes, the cost saving of using larger vessels is greater in absolute terms. Thus the Expanded Canal has a smaller transportation cost differential or economic value between the Canal and the least-cost alternative routing⁵.

⁵ Please note that the treatment of economic used herein for the toll pricing analysis differs from that presented in *Volume 4: Economic Value of Panama Canal*. In Volume 4, the terms of reference called for a direct comparison of the economic value of the Existing Canal and Expanded Canal. Thus for that analysis, transportation costs of routes through the Existing and Expanded Canals were both compared to the transportation costs of the alternative routes under the Existing Canal scenario.

This finding directly impacts the results of the Canal toll pricing options for the Expanded Canal as more traffic is shown to be diverted from the Canal to alternative routings compared to the same toll level for the Existing Canal.

IDENTIFICATION OF PREFERRED PANAMA CANAL TOLL PRICING

All of the tolls pricing options analyzed were considered to be non-discriminatory within the grain bulk segment. Precedents set at comparable facilities allow for differentiation of tolls by size of vessel and by commodity as long as they are applied to all such vessels on a consistent basis. First priority was given to maximization of toll revenues, closely followed by maximization of Canal market share. A preferred Canal toll pricing option was identified for each year and each Canal scenario (Table E-5).

Existing Canal

For the Existing Canal, the preferred option for all years is PCUMS Option 3 which corresponds to Panama Canal tolls increased by 75 percent from July 1, 2003 levels. This pricing option allows the Canal to retain approximately 80 percent of total potential transits as compared to 83 percent under current tolls. Panama Canal toll revenues, however, increase by nearly 70 percent under PCUMS Option 3.

Table E-5. Preferred and Alternative Canal Toll Pricing Options, Existing and Expanded Canal , Most Probable Case, 2001-2025

Year	Existing Canal		Expanded Canal	
	Preferred Toll Pricing Option	Alternative Toll Pricing Option	Preferred Toll Pricing Option	Alternative Toll Pricing Option
2001-2009	PCUMS Option 3 (75% increase)	Commodity Option 2 tolls (100% increase with 10% discount for wheat and corn)	n.a.	n.a.
2010-2011	PCUMS Option 3 (75% increase)	Commodity Option 2 tolls (100% increase with 10% discount for wheat and corn)	Commodity Option 3 tolls (100% increase with 10% discount for wheat and 5% discount for corn)	PCUMS Option 3 (75% increase)
2012-2019	PCUMS Option 3 (75% increase)	Commodity Option 3 tolls (100% increase with 10% discount for wheat and 5% discount for corn)	Commodity Option 3 tolls (100% increase with 10% discount for wheat and 5% discount for corn)	PCUMS Option 3 (75% increase)
2020-2024	PCUMS Option 3 (75% increase)	Commodity Option 3 tolls (100% increase with 10% discount for wheat and 5% discount for corn)	Commodity Option 4 tolls (100% increase with 5% discount for wheat)	PCUMS Option 3 (75% increase)
2025	PCUMS Option 3 (75% increase)	Commodity Option 4 tolls (100% increase with 5% discount for wheat)	Commodity Option 4 tolls (100% increase with 5% discount for wheat)	PCUMS Option 3 (75% increase)

Source: Appendix C.

The preferred option is PCUMS Option 3 which corresponds to Panama Canal tolls increased by 75 percent from July 1, 2003 levels. This pricing option allows the Canal to retain approximately 80

percent of total potential transits (with not tolls) and in fact has additional diversions of around 3 percent of the forecasted transits under July 1, 2003 tolls. Panama Canal revenues, however, increase by nearly 70 percent under PCUMS Option 3.

While there are other Canal pricing options that yield up to 20 percent more revenue, they involve much higher levels of toll increases (140 percent increase over July 1, 2003 rates) and result in additional diversion of at least 10 percent more of potential transits.

Consideration for the preferred Canal pricing option was given to Panama Canal tolls with a 100 percent increase over July 1, 2003 rates. This generates up to 5 percent more revenue but also results in additional diversions of more than 6 percent of potential cargo. The dual objectives of maximizing earnings while maximizing Canal market share led us to select the 75 percent increase option as the preferred Canal pricing option.

Expanded Canal

For the Expanded Canal, the preferred option for 2010-2019 is Commodity Option 3 which corresponds to Panama Canal tolls increased by 100 percent from July 1, 2003 levels with a 10 percent discount for wheat and 5 percent discount for corn. This pricing option allows the Canal to retain approximately 72 percent of total potential transits in 2011 as compared to 77 percent under current tolls. Panama Canal toll revenues, however, increase by nearly 78 percent under Commodity Option 3.

From 2020-2025, Commodity Option 4 (100 percent increase with a 5 percent discount for wheat) was selected as the preferred Canal toll pricing option. During these years, the elimination of the discount for corn and the reduction in the discount for wheat from 10 percent to 5 percent generates additional Canal toll revenue without no further diversion of transits⁶.

FORECAST OF PANAMA CANAL TRANSITS, TOLL REVENUE AND CARGO

Table E-6 and Table E-7 present comparisons of Panama Canal transits, cargo and laden toll revenues under the preferred toll pricing option and current Panama Canal tolls for the Existing Canal and Expanded Canal scenarios.

For the Existing Canal under the preferred toll pricing option, forecasted Canal transits increase from 968 vessels in 2001 to 1,188 vessels in 2010 and reach 1,365 vessels by 2025. Forecasted canal revenues increase from \$112 million in 2001 to \$144 million in 2010 and \$170 million by 2025. Throughout the period Canal toll revenues under the preferred toll pricing option are approximately 70 percent above those forecast under current Canal tolls.

⁶ The only minor exception is in 2020, when 17 transits are diverted under Commodity Option 4 as compared to Commodity Option 3. However, toll revenues are still higher under Commodity Option 4 that year.

Table E-6. Panama Canal Laden Transits, Cargo and Revenue under Preferred Toll Option and Current Canal Tolls Existing Canal, Most Probable Case, 2001-2025

Year	Forecast with Preferred Tolls			Forecast with Current Tolls		
	Transits (no.)	Cargo (ton 000s)	Toll Revenue (\$'000)	Transits (no.)	Cargo (ton 000s)	Toll Revenue (\$'000)
2001	968	36,792	112,202	1,001	38,314	66,749
2002	973	37,102	113,131	1,006	38,633	67,295
2003	979	37,411	114,092	1,013	38,951	67,860
2004	985	37,720	115,049	1,019	39,270	68,422
2005	991	38,029	116,002	1,025	39,588	68,983
2006	1,030	39,941	121,694	1,064	41,512	72,255
2007	1,070	41,854	127,391	1,104	43,436	75,530
2008	1,110	43,766	133,093	1,144	45,360	78,808
2009	1,150	45,678	138,802	1,184	47,284	82,090
2010	1,188	47,590	144,497	1,223	49,208	85,364
2011	1,198	48,283	146,471	1,233	49,900	86,490
2012	1,209	48,976	148,445	1,244	50,592	87,616
2013	1,219	49,669	150,419	1,254	51,285	88,743
2014	1,230	50,362	152,393	1,265	51,977	89,869
2015	1,241	51,055	154,366	1,276	52,669	90,995
2016	1,256	51,831	156,621	1,292	53,507	92,388
2017	1,273	52,606	158,931	1,310	54,345	93,814
2018	1,292	53,382	161,286	1,330	55,183	95,264
2019	1,311	54,157	163,644	1,350	56,021	96,717
2020	1,330	54,933	166,006	1,371	56,859	98,172
2021	1,337	55,235	166,913	1,379	57,275	98,883
2022	1,343	55,537	167,823	1,388	57,692	99,596
2023	1,350	55,838	168,736	1,397	58,108	100,310
2024	1,357	56,140	169,651	1,407	58,524	101,026
2025	1,365	56,442	170,569	1,416	58,940	101,744

Source: Appendix C.

For the Expanded Canal under the preferred toll pricing option, forecasted Canal transits increase from 1,074 vessels in 2010 to 1,380 vessels by 2025. Forecasted canal revenues increase \$138 million in 2010 to \$184 million by 2025. Canal toll revenues under the preferred toll pricing option are approximately 70 percent above those forecast under current Canal tolls in 2010 increasing to 83 percent above current tolls by 2025.

Table E-7. Panama Canal Laden Transits, Cargo and Revenue under Preferred Toll Option and Current Canal Tolls Expanded Canal, Most Probable Case, 2010-2025

Year	Forecast with Preferred Toll Pricing Option			Forecast with Current Canal Tolls		
	Transits (no.)	Cargo (ton 000s)	Toll Revenue ('\$000)	Transits (no.)	Cargo (ton 000s)	Toll Revenue ('\$000)
2010	1,074	43,516	137,899	1,174	49,176	81,428
2011	1,122	46,511	146,429	1,183	49,861	82,447
2012	1,131	47,195	148,457	1,193	50,545	83,467
2013	1,141	47,878	150,484	1,202	51,230	84,487
2014	1,151	48,562	152,511	1,212	51,915	85,507
2015	1,164	49,244	154,543	1,235	53,155	87,395
2016	1,203	51,067	160,072	1,260	54,166	89,045
2017	1,228	51,874	162,656	1,288	55,177	90,718
2018	1,253	52,681	165,249	1,317	56,188	92,395
2019	1,279	53,488	167,849	1,347	57,199	94,077
2020	1,290	54,217	174,334	1,377	59,141	95,765
2021	1,321	55,630	178,665	1,394	59,748	96,739
2022	1,334	56,020	179,936	1,411	60,356	97,716
2023	1,349	56,410	181,216	1,430	60,964	98,698
2024	1,364	56,801	182,505	1,448	61,572	99,683
2025	1,380	57,191	183,804	1,468	62,180	100,674

Source: Appendix C.