Crude Petroleum Imports

Reductions in the vessel operating costs for Corpus Christi's foreign crude petroleum imports were calculated based on the difference in transportation costs between the without-project and with-project conditions. Transportation costs and savings were calculated for crude petroleum import tonnages using the fleet distributions that were presented in Table 17. Transportation savings benefits were calculated for approximately 50 percent of Corpus Christi's 1998/2000-tonnage base. Application of the trade route forecast to Corpus Christi showed that 79 percent of 2006-56 crude petroleum import tonnage could benefit from a project depth in excess of 45 feet. For the 50-foot channel, this percentage would decrease to 77 percent and to 66 percent for the 52-foot project. The expected increase is tied to the trade route forecasts. The distribution of 1996-98 Corpus Christi crude oil import tonnage by origin port is presented in Table 18. The 1996-98 records show that an estimated 54 percent of crude oil imports are shipped from ports with depths over 45 feet. Approximately 35 percent of 1996-2000 tonnage was transported in vessels with loaded draft of 40 feet or greater. Review of Corpus Christi's 2000 records indicated continued trade with the ports listed in Table 19.

Methods of shipping crude oil are direct, lightered, lightened, and transshipped. Distribution of 1996/99 tonnage by method of shipment (direct, lightered, transshipped) is presented in Table 19. Direct shipment, as the name implies is the transfer of tonnage by vessel between two coastal ports. Lightering involves the transfer of tonnage at an offshore location from a larger vessel, called a VLCC (Very Large Crude Carrier), onto one or more shuttle vessels. With lightering, the VLCC does not enter the coastal receiving port. Transshipping occurs at one of several Caribbean port locations, and like lightering, it involves the full discharge of a VLCC. The advantage of transshipping is that vessel turnaround is faster than with lightering; however, the frequency of transshipping has decreased in recent years due to its relative high cost in comparison to lightering. The current percentage of Corpus Christi transshipped tonnage is very small in comparison to lightering. A frequent alternative to either direct shipment or lightering is lightening. The term lightening describes the process where enough cargo is offloaded from a tanker to permit the light-loaded vessel to enter a confined channel system. The format of the USCE's WCSC's shipping records, which are obtained by the USCE through the Bureau of Census, do not provide sufficient information to distinguish lightened tonnage from direct or

Table 18
1996-98 Total Crude Oil Import Total Tonnage by Channel Depth
Likely to Utilize Deeper Depths at Corpus Christi

Port Name	1996-98 Total Tonnage	Country	Depth Information (ft)
ARZEW	199,808	Algeria	76
SKIKDA	1,597,314	Algeria	45.9
ALL OTHER ALGERIA PORTS	85,661	Algeria	76 at Arzew; 46 at Skikda
FREEPORT, GRAND BAHAMA I	130,188	Bahamas	76
ALL OTHER BRAZIL PORTS N OF RECIFE	59,288	Brazil	75 at Itaqui.
ALL OTHER COLOMBIAN CARIBBEAN PORTS	4,287,316	Colombia	56 at several Atlantic Coast Colombian Ports
SHELLHAVEN	6,117,431	England	47.9
TALLINN	91,570	Estonia	54
WILHELMSHAVEN	107,856	Germany	66
HIGH SEAS,GULF OF MEXICO	4,213,112	Gulf of Mexico	76
CAYO ARCAS	5,927,615	Mexico	72.2
DOS BOCAS	8,368,171	Mexico	89.9
ORANGESTAD	75,496	Netherland Antilles	76
SAN NICOLAS BAY	1,889,282	Netherland Antilles	76
ROTTERDAM	21,786	Netherlands	74.3
BONNY	2,938,120	Nigeria	74.8
KWA IBO TERMINAL	11,220,474	Nigeria	85.3
STURE	3,644,545	Norway	75.4
RAS TANURA	4,614,099	Saudi Arabia	61-65
ALL OTHER SAUDI ARABIA PORTS	79,852	Saudi Arabia	61-65 at Ras Tanura
LOME	3,654,977	Togo	45.9
POINT A PIERRE	47,126	Trinidad	52
RIO HAINA	1,338,047	Trinidad	58
PUERTO LA CRUZ	17,903,154	Venezuela	46 to 50
EL PALITO	138,507	Venezuela	46 to 50
ALL OTHER VENEZUELA PORTS	2,215,552	Venezuela	55 at Puerto La Cruz
Total for Port Depths Over 45 feet	49,624,998		
Total Tonnage for 1996-98	79,324,154		
% of 1996-98 Total	54%		

Less likely to Utilize Deeper Depths at Corpus Christi

VANCOUVER	93,851	Canada	Panama Canal Restriction
ALL OTHER CHILE PORTS	57	Chile	Panama Canal Restriction
ALL OTHER REPUBLIC OF CHINA PORTS	116,042	China	Panama Canal Restriction
DALIAN	1,656,009	China	57.4, Panama Canal Restriction
LA LIBERTAD	221,396	Ecuador	Panama Canal Restriction

CONTINUED NEXT PAGE

Table 18 (continued)

Port Name	1996-98 Total Tonnage	Country	Depth Information (ft)
ALEXANDRIA	461,214	Egypt	35.0
MADRAS	204,283	India	36 to 40
MURMANSK	383,191	Former USSA	37.4
GEORGETOWN	1,178,169	Guyana	33.0
PULAU SAMBU	304,993	Indonesia	41-45
ASHDOD	3,220,275	Israel	42.6
ALL OTHER MALAYSIA PORTS	453,933	Malaysia	Panama Canal Restriction
ALL OTHER SINGAPORE PORTS	47,937	Malaysia	Panama Canal Restriction
ALTAMIRA	331,102	Mexico	42.0
COATZACOALCOS a/	116,254	Mexico	42.0
PAJARITOS a/	783,695	Mexico	42.0
TUXPAN	88,905	Mexico	42.0
VERACRUZ	782,782	Mexico	30.8
CALABAR	570,512	Nigeria	26 to 30, planned improvements at Calabar
LAGOS	188,888	Nigeria	21 to 25
LEIXOES	105,844	Portugal	44.6
SINGAPORE	43,578	Singapore	66-70
ALL OTHER TURKEY MED.REGION PORTS	39,587	Turkey	Generally less than 40
ISTANBUL	1,428,975	Turkey	39.4
FUJAIRAH	91,806	United Arab Emirates	36 to 40
AMUAY BAY	396,819	Venezuela	41 to 45
LA GUAIRA	11,055,751	Venezuela	19.7
PUERTO MIRANDA	12,333,308	Venezuela	39.5
Total for Depths Under 45 feet	36,699,156		
Total Tonnage for 1996-98	79,324,154		
% of 1996-98 Total	46%		

a/ Located in the same region as the offshore Cayo Arcas, Mexico's offshore oil terminal. Cayo Arcas can load vessel drafts of up to 76 feet.

Source: National Imagery and Mapping Agency, 2000 World Port Index, Pub. 150; Lloyds, Ports of the World, 1995; USACE, Waterborne Commerce 1996-98 detailed records.

Table 19
Corpus Christi Channel Crude Petroleum Imports
Distribution of Tonnage by Method of Shipment and Trade Route

Trade Route	2000 Distribution 45-ft	2006-56 Distribution 45-ft	47-ft	48-ft	49-ft	50-ft	52-ft
Mexico and Eastern S America							
Direct	97%	100%	100%	100%	100%	100%	100%
Lightered or Lightened	3%	0%	0%	0%	0%	0%	0%
Europe/Africa/Mediterranean							
Direct Shipments	44%	50%	50%	50%	50%	50%	50%
Lightened and	56%	50%	50%	50%	50%	50%	50%
Middle East							
Direct	0%	0%	0%	0%	0%	0%	0%
Lightered or Lightened	100%	100%	100%	100%	100%	100%	100%
Far East							
Direct	2%	0%	0%	0%	0%	0%	0%
Lightered or Lightened	98%	100%	100%	100%	100%	100%	100%

Source: USACE, Waterborne Commerce of the U. S.; Application of USEIA 1999-2010 trade route crude oil and product forecasts to Corpus Christi.

lightered tonnage. Industry personnel and additional Bureau of Census and pilots records showed indicated that lightening is common for shipments from Africa and Europe. The tanker sizes associated with lightening on the Texas Coast generally range from 120,000 to 175,000 dwt. Tankers larger than 175,000 dwt are normally lightered. Shipments from Europe/North Sea/Africa trade route are usually transported in tankers between 80,000 and 175,000 dwt, with direct shipments generally using tankers between 80,000 and 120,000 dwt. Tankers larger than 175,000 dwt are normally lightered. Shipments from Europe/North Sea/Africa trade route are usually transported in tankers between 80,000 and 175,000 dwt, with direct shipments generally using tankers between 80,000 and 120,000 dwt. The primary size vessel used on the Mexico/Eastern South America route for shipments into Corpus Christi and other U. S. Gulf Coast ports is 80,000 to 100,000 dwt; however, vessels up to 120,000 dwt are not uncommon. Review of the 1999 Fairplay Tanker Register showed that the design drafts associated with tankers of 80,000 to 100,000 dwt generally range from 40 to 51 feet, with the average being 44 feet. The limited volumes of direct shipments from the Middle East are usually shipped in vessels between 80,000 and 120,000 dwt.

Regardless of trade route, the vessel sizes utilized are also related to the way crude petroleum is sold. Currently, crude petroleum is sold in parcels of 500,000 barrels. A 500,000-barrel parcel converts to approximately 75,000 short tons. The most economical size vessel for a 75,000-ton parcel is between 75,000 and 100,000 dwt. For 150,000-ton parcels, the most efficient size is between 150,000 and 175,000 dwt. Ninety-four percent of the 100,000 to 140,000 dwt vessels in the world fleet have design drafts in excess of 45 feet, and 32 percent of the vessels between 75,000 and 100,000 dwt have design drafts over 45 feet. The with project condition was formulated assuming that the maximum ship size for both direct shipments and lightered vessels would be 175,000 dwt. Vessels over 100,000 dwt would continue to be light-loaded under the with project condition; however, there would be a reduction in the number of feet light-loaded. Gulf Coast industry personnel indicated that parcel size and associated ship size is primarily a function of the existing channel dimensions and that an increase in channel dimensions would likely result in a shift to larger parcel sizes and larger vessels.

The trade route specific costs for the Mexico/Eastern South America, Europe/North Sea/Africa, and Middle East/Indian Subcontinent trade routes were analyzed in order to determine why lightering or lightening is not used as the exclusive shipping method. Table 20 displays a comparative summary of transportation cost by method of shipment and channel depth alternative for the major trade routes. The sensitivity of the transportation cost benefits relates vessel size employed and to logistical factors associated with offshore transfer arrangements. Due to the lack of published documentation, industry inquiries were made and risk and uncertainty software was utilized. The @Risk software was used to evaluate the output of multiple spreadsheets containing probability distributions. The critical variable affecting the probability distributions is the number of hours it takes to set-up and complete offshore transfers. The costs generated from the trade route specific offshore transfer probability functions were compared to the cost for direct shipment for the purpose of determining which shipment method was most efficient. The probability functions were also used to determine if methods of shipment might change if the Inner Harbor Channel was deepened. The probability functions served to verify the rationale for a shipper's decision to choice direct shipment or offshore transfer.

Table 20
Corpus Christi Crude Petroleum Imports
Transportation Cost by Method of Shipment for Representative Trade Routes

Channel	Mexico			Venezuela			Africa and Mediterranean			Middle East		
Depth	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
						Direct Shipment						
45	$1.78	$1.71	$1.84	$4.18	$4.00	$4.35	$10.91	$10.46	$11.40	$18.77	$17.94	$19.64
47	$1.69	$1.62	$1.75	$3.93	$3.76	$4.09	$10.22	$9.80	$10.68	$17.56	$16.80	$18.39
48	$1.65	$1.58	$1.70	$3.81	$3.66	$3.97	$9.90	$9.50	$10.35	$17.01	$16.28	$17.82
50	$1.58	$1.52	$1.62	$3.61	$3.47	$3.76	$9.33	$8.95	$9.75	$16.02	$15.33	$16.78
52	$1.50	$1.46	$1.53	$3.40	$3.30	$3.45	$8.72	$8.46	$8.85	$14.95	$14.50	$15.17
						Lightened						
45	$3.99	$2.78	$4.48	$5.54	$4.21	$6.14	$10.45	$8.74	$11.49	$14.98	$12.92	$16.46
47	$3.93	$2.75	$4.42	$5.48	$4.18	$6.11	$10.38	$8.71	$11.45	$14.92	$12.90	$16.46
48	$3.93	$2.75	$4.42	$5.48	$4.18	$6.11	$10.38	$8.71	$11.45	$14.92	$12.90	$16.34
50	$3.92	$2.74	$4.39	$5.47	$4.17	$6.11	$10.37	$8.70	$11.43	$14.91	$12.89	$16.34
52	$3.92	$2.74	$4.39	$5.47	$4.17	$6.11	$10.37	$8.70	$11.43	$14.91	$12.89	$16.34
						Lightered						
45	$5.71	$2.40	$8.50	$6.81	$3.49	$9.59	$10.29	$6.97	$13.07	$15.92	$12.50	$18.60
47	$5.71	$2.36	$8.50	$6.81	$3.46	$9.59	$10.29	$6.94	$13.07	$15.92	$12.46	$18.60
48	$5.10	$2.35	$7.57	$6.19	$3.44	$9.59	$9.98	$6.92	$12.15	$15.20	$12.45	$17.67
50	$5.10	$2.31	$7.57	$6.19	$3.41	$9.59	$9.98	$6.89	$12.15	$15.20	$12.41	$17.67
52	$5.10	$2.31	$7.57	$6.19	$3.41	$9.59	$9.98	$6.89	$12.15	$15.20	$12.41	$17.67

It was found through industry inquiries and additional review of vessel documentation that lightening is often a preferable alternative to lightering for North Sea/Africa/Mediterranean movements. For purposes of analysis, the geographic region that includes North Sea, Africa, and Mediterranean, is referred to as "Region 2" in this analysis. Review of the vessel traffic records showed that for the period 1997-98, approximately 44 percent of North Sea/Africa/Mediterranean movements to Corpus Christi were shipped direct and the remaining 56 percent was lightered or lightened. The results of the risk analysis verified that the 1997-98 shipment methods were reasonable. The analysis also verified the economic rationale for the method of shipment choices for Mexico, Venezuela, Middle East, and Far East. For the years 1996-97, less than ten percent of movements from Mexico and Venezuela were lightered/lightening and over 90 percent of movements from the Middle East and Far East were lightered. There is large variability associated with the time it takes to lighter and the lower the cost difference between direct versus offshore transfer costs, the higher the probability of direct shipment becomes. Industry personnel indicated that the number of days to completely lighter a VLCC normally ranges from 4 to 10 and that the average number of days to completely lighter 200,000 to 300,000 dwt vessels is 5.5; however, it was noted that 2 weeks is not uncommon.

Five and a-half days equate to 1.5 times the in-port unloading rate. Utilization of the upper limit of 2 weeks appears to relate to a less than optimal number of shuttles and shuttle turnaround rate. The range of costs shown in Table 20 was calculated using a probability distribution of number of hours to lightered. The minimum costs are associated with optimal sized mother and shuttle vessels given the channel depth constraint. Both the minimum and maximum cost functions were defined using the same range of vessels. The vessels used in the analysis were defined on a channel specific basis. The mother vessel sizes of 120,000 to 150,000 dwt were used for the 45-foot channel lightening costs and vessels up to 175,000 dwt were used for the 48- to 52-foot channel depths. The associated shuttle sizes were defined based on cost efficiencies.

Due to its relatively small volume and decreasing use, transshipping costs and, the uncertainty associated with average transshipping conditions were not assessed, nor were a comparative assessment made for Western South American tonnage. Nearly all Western South America tonnage is shipped direct. Western South America tonnage and direct shipments from the Far East are normally transported via the draft-restricted Panama Canal. The maximum loaded draft that can be accommodated through the Canal is 39 feet and the maximum beam width is 106 feet. As shown in Table 20, only 13 percent of 1998-99 Far East tonnage shipped direct. The mother vessels originating in the Far East and associated with Far East-to-U. S. Gulf Coast lightering normally arrive in the Gulf via the Suez Canal or the Cape of Good Hope.

The cost data summarized in Table 20 shows that for tonnage from Mexico and Eastern South America, direct shipment is clearly the least cost alternative and that for tonnage from the Middle East and Indian Subcontinent, lightering is clearly the least cost alternative. Lightering would also be the least cost alternative for Far East tonnage. Comparison of direct shipment cost with those for lightering or lightening for the Europe/North Sea/Africa route presented in Table 20 indicated that while the average cost for both lightering or lightening is less than the average cost for shipping direct, the percentage difference between direct shipment costs and the offshore alternatives are considerably less than for the Mexico and Mideast routes. The relative closeness in the costs between shipping methods for Europe/North Sea/Africa tonnage, and the variance associated with the number of days necessary to complete the offshore transfer process, contribute to this relatively high percentage of direct shipment for this route. A high historical delay frequency, in association with the relative closeness in costs between shipping methods, contributes to a proportion of direct shipments that is higher than what might occur if the variance associated with the cost of lightering did not overlap with the cost of shipping direct. Examination of the cost data indicated that an increase in channel dimensions would probably result in an increase in direct shipment movements for Europe, North Sea, and Africa shipments. The maximum size vessels used for Nigerian crude oil are in the 80,000 to 130,000 dwt range. Vessels over 200,000 dwt are used for some North Sea movements and would continue to be associated lightering operations under the with project condition.

Comparison of the method of shipment costs for the Eastern South America and Persian Gulf routes did not indicate that the proposed project design would provide an incentive to switch from one method of shipment to another. Lightening is not cost effective for tonnage on the Persian Gulf trade route because the economies of scale associated with existing practices result in a lower cost for lightering than what would be attained through lightening. The reason lightering is cheaper than lightening for Persian Gulf/Indian Subcontinent shipments is because the magnitude of the mileage component of the per ton cost is large enough to offset the relatively large fixed cost attribuTable to having the mother vessel remain offshore for 5.5 days. For similar reasons, the relative short distance and high fixed costs associated with either lightening or lightering, eliminates any incentive for Mexico/Eastern South America shipments to shift to lightening. Despite the clear lack of economic rationale for lightering Mexico/Eastern South America tonnage or shipping Persian Gulf/Indian Subcontinent tonnage direct, relatively inefficient shipping methods are used for some shipments on these trade routes. The decision to lighter Mexico/Eastern South America tonnage or ship Persian Gulf/Indian Subcontinent tonnage direct results from less than perfect world market conditions. The crude petroleum transportation savings benefits are displayed in Tables 21-23. Table 24 presents the distribution of crude petroleum imports by trade route and the proportion expected to benefit from channel depths over 45 feet.

Foreign Petroleum Product Tonnage

Transportation savings benefits were calculated for Corpus Christi petroleum product import and export tonnage. Benefits were calculated for 30 percent of 2005-56 petroleum product imports and 10 percent of export tonnage. The percentage of future petroleum product movements expected to benefit from channel depths over 45 feet was identified based on examination of vessel sizes, vessel loads, foreign port depths associated with Corpus Christi's 1996-99 petroleum product imports and exports and the Department of Energy's U. S. and the World Fleet Forecast's U. S. Gulf Coast product trade forecasts.

Table 21

Corpus Christi Crude Petroleum Imports Transportation Cost and Savings by Channel Depth

Depth	45 ft.	47 ft.	48 ft.	49 ft.	50 ft.	52 ft.
Transportation Cost for Direct Shipments by Year						
2000	$37,669,998	$35,412,835	$34,398,911	$33,481,425	$32,563,938	$30,629,126
2006	$33,923,002	$31,904,022	$30,997,833	$30,178,160	$29,358,486	$27,634,220
2016	$41,082,022	$38,637,299	$37,540,041	$36,547,547	$35,555,054	$33,467,349
2026	$45,973,638	$43,246,121	$42,022,390	$40,915,699	$39,809,008	$37,483,707
2036	$49,766,759	$46,830,957	$45,514,696	$44,324,727	$43,134,758	$40,639,785
2046	$54,607,020	$51,401,906	$49,965,794	$48,667,866	$47,369,939	$44,653,781
2056	$60,614,500	$57,072,347	$55,486,081	$54,052,827	$52,619,573	$49,625,210
Transportation Savings by Channel Depth						
2000		$2,257,163	$3,271,087	$4,188,573	$5,106,059	$7,040,872
2006		$2,018,980	$2,925,169	$3,744,842	$4,564,515	$6,288,782
2016		$2,444,723	$3,541,981	$4,534,475	$5,526,968	$7,614,673
2026		$2,727,517	$3,951,248	$5,057,939	$6,164,630	$8,489,931
2036		$2,935,802	$4,252,063	$5,442,032	$6,632,000	$9,126,974
2046		$3,205,114	$4,641,226	$5,939,154	$7,237,081	$9,953,239
2056		$3,542,153	$5,128,419	$6,561,673	$7,994,927	$10,989,290
2006-56 @ 5.875%		$2,575,791	$3,731,409	$4,776,485	$5,821,561	$8,017,177

Table 22

Corpus Christi Crude Petroleum Imports Transportation Cost and Savings by Channel Depth

Depth	45 ft.	47 ft.	48 ft.	49 ft.	50 ft.	52 ft.
Transportation Cost for Lightered and Lightened Shipments by Year						
2000	$47,852,856	$47,820,739	$47,740,031	$47,688,638	$47,637,245	$47,637,245
2006	$57,383,717	$57,355,915	$57,257,006	$57,195,362	$57,133,718	$57,133,718
2016	$95,432,200	$95,398,348	$95,231,498	$95,129,021	$95,026,545	$95,026,545
2026	$109,681,371	$109,645,053	$109,452,744	$109,334,943	$109,217,143	$109,217,143
2036	$114,203,604	$114,167,546	$113,966,862	$113,844,146	$113,721,429	$113,721,429
2046	$119,303,530	$119,267,135	$119,057,133	$118,928,873	$118,800,614	$118,800,614
2056	$124,954,079	$124,916,738	$124,696,522	$124,562,120	$124,427,718	$124,427,718
Transportation Savings by Channel Depth						
2000		$32,117	$112,825	$164,218	$215,611	$215,611
2006		$27,802	$126,711	$188,356	$250,000	$250,000
2016		$33,852	$200,702	$303,179	$405,655	$405,655
2026		$36,318	$228,628	$346,428	$464,228	$464,228
2036		$36,057	$236,741	$359,458	$482,175	$482,175
2046		$36,395	$246,397	$374,657	$502,916	$502,916
2056		$37,341	$257,557	$391,959	$526,361	$526,361
2006-56 @ 5.875%		$34,084	$199,142	$300,587	$402,032	$402,032

Table 23
Corpus Christi Crude Petroleum Imports
Transportation Cost and Savings Summary

Depth	45 ft.	47 ft.	48 ft.	49 ft.	50 ft.	52 ft.
		Transportation Cost for Total Movements by Year				
2000	$85,522,854	$83,233,574	$82,138,942	$81,170,063	$80,201,183	$78,266,371
2006	$91,306,719	$89,259,937	$88,254,839	$87,373,522	$86,492,204	$84,767,938
2016	$136,514,222	$134,035,647	$132,771,539	$131,676,568	$130,581,598	$128,493,894
2026	$155,655,009	$152,891,174	$151,475,134	$150,250,643	$149,026,151	$146,700,850
2036	$163,970,362	$160,998,503	$159,481,558	$158,168,873	$156,856,187	$154,361,214
2046	$173,910,550	$170,669,041	$169,022,927	$167,596,740	$166,170,552	$163,454,395
2056	$185,568,579	$181,989,085	$180,182,603	$178,614,947	$177,047,291	$174,052,928
		Transportation Savings by Channel Depth				
2000		$2,289,280	$3,383,912	$4,352,791	$5,321,671	$7,256,483
2006		$2,046,782	$3,051,880	$3,933,197	$4,814,515	$6,538,781
2016		$2,478,575	$3,742,684	$4,837,654	$5,932,624	$8,020,328
2026		$2,763,835	$4,179,875	$5,404,367	$6,628,858	$8,954,159
2036		$2,971,859	$4,488,804	$5,801,490	$7,114,175	$9,609,149
2046		$3,241,509	$4,887,623	$6,313,811	$7,739,998	$10,456,155
2056		$3,579,494	$5,385,976	$6,953,632	$8,521,288	$11,515,651
		Equivalent Annual Savings 5.857%				
2006-56 @ 5.875%		$2,609,875	$3,930,551	$5,077,072	$6,223,593	$8,419,209

The vessels sizes and port depths associated with Corpus Christi's 1996-99 product imports showed that 20 percent of imports were shipped in vessels with design drafts over 50 feet and were 33 percent of imports were shipped from ports with depths in excess of 50 feet. The vessel sizes associated with these import movements range from 80,000 to 150,000. Table 25 presents the 1996-98 distribution of petroleum product import and export tonnage by origin port. Examination of the vessel size data showed that 6 percent of existing product exports tonnage was shipped in vessels with design drafts in excess of 45 feet and 4 percent of tonnage was shipped to foreign ports with depths in excess of 50 feet. The vessel sizes associated with these export movements presently range from 80,000 to 100,000. Application of the trade route forecasts to Corpus Christi showed that 10 percent of 2006-56 product export tonnage could benefit from a project depth in excess of 45 feet.

Table 24
Corpus Christi Crude Petroleum Tonnage (1000's of short tons)

	2000	2006	2016	2026	2036	2046	2056
Direct Shipment Tonnage Used for Channel Deepening Benefits							
South America & Mexico	7,605	7,377	8,952	10,464	12,227	14,287	16,694
Mexico a/	3,123	3,820	4,635	5,418	6,331	7,398	8,644
Latin America a/	4,483	3,557	4,317	5,046	5,896	6,889	8,050
Africa & North Sea	2,044	1,493	1,893	1,995	1,988	2,060	2,206
N Sea	1,224	328	310	302	266	234	207
Africa	820	1,165	1,583	1,694	1,722	1,825	1,999
Middle East	0	0	0	0	0	0	0
Far East	0	0	0	0	0	0	0
Sub-Total	9,649	8,871	10,846	12,459	14,214	16,346	18,900
Lightered Tonnage Used for Channel Deepening Benefits							
South America & Mexico a/	0	0	0	0	0	0	0
Europe/Africa/Med	0	228	277	324	378	442	516
Middle East	204	1,493	1,893	1,995	1,988	2,060	2,206
Far East	977	3,768	6,627	7,721	8,151	8,614	9,110
Sub-Total	1,298	419	539	517	452	397	351
Total Tonnage for Deepening Calculation							
Applicable Tonnage	12,129	14,779	20,182	23,015	25,182	27,859	31,084
Total Tonnage	35,121	42,037	51,023	54,050	53,093	57,488	59,821
% of Total Tonnage	35%	35%	40%	43%	47%	48%	52%

Source: USACE, Waterborne Commerce of the U. S., and USDOE/EIA 2003 Annual Review application.
a/ Excludes movement to Western Mexico and South America.

After identifying the percentage range of tonnage constrained by the 45-foot Corpus depth, the trade routes associated with these movements were evaluated in relationship to the USEIA and WFF trade route forecasts. Examination of Corpus Christi's 1996-99 routings showed that tonnage associated with larger vessels moving to deepwater ports is primarily associated with Northern Europe and the Persian Gulf. Total project tonnage and the volumes and associated trade route shares used to calculate project benefits for Corpus project depths over 45 feet are displayed in Tables 26 and 27. The USEIA and WFF forecasts show that refined product import and export trade between the U. S. regions and Northern Europe and Persian Gulf locations will continue for the period 2006 to 2025/50.

Table 25
Corpus Christi Petroleum Product Import and Export Tonnage (1996-98)

Petroleum Product Exports

Port and Country	Total	Depth Information (ft)
AMSTERDAM, HOLLAND	12,375	46 to 50
ANTWERP, BELGIUM	210,240	55
BILBAO, SPAIN	75,147	Over 50
ROTTERDAM, NETHERLANDS	101,801	Over 50
Grand Total Restricted Tonnage	399,564	
3-year total tonnage, 1996-98	9,153,116	
Percent of Total	4.4%	

Petroleum Product Imports

Port and Country	Total	
ABIDJAN, COTE D'IVORIE	109,568	66 to 70
ALL OTHER SAUDI ARABIA PORTS	434,631	Over 50
AMSTERDAM, HOLLAND	72,999	46 to 50
ARZEW, ALGERIA	758,727	76
FREEPORT, GRAND BAHAMA ISLAND	56,484	76
MINA ABD FAHL, KUWAIT	410,502	51 to 55
ORANGESTAD, NETH. ANT.	100,124	76
RAS TANURA, SAUDIA ARABIA	3,434,828	76
ROTTERDAM, NETHERLANDS	70,505	Over 50
SAN NICOLAS BAY, NETH. ANT.	78,325	76
TALLINN, ESTONIA	140,283	54
TARRAGONA, SPAIN	75,902	55
Grand Total Restricted Tonnage	5,794,792	
3-year total tonnage, 1996-98	17,569,540	
Percent of Total	33.0%	

Source: National Imagery and Mapping Agency, 2000 World Port Index, Pub. 150; Lloyds, Ports of the World, 1995; USACE, Waterborne Commerce 1996-98 detailed records.

The Corpus Christi share was estimated based on the assumption that percentage of these draft-constrained movements would be continue to move through U. S. Gulf Coast ports. The U. S. Gulf Coast 1998/99 to 2050 projections shows increasing volumes of tonnage moving in large vessels. Table 28 presents the U. S. Gulf Coast distribution of petroleum product tonnage by vessel class and the Corpus Christi application. Tables 29 and 30 display the transportation cost savings benefits for petroleum product import and export tonnage.

Table 26
Corpus Christi Petroleum Product Imports by Trade Route

	2000	2006	2016	2026	2036	2046	2056
Corpus Christi Petroleum Product Import Tonnage Total by Trade Route a/							
Latin America & Caribbean	2,425,500	5,415,093	11,263,655	15,305,290	18,759,353	21,852,447	28,181,910
Western S. America	291,060	601,677	1,052,547	1,700,588	2,084,373	2,428,050	3,131,323
Europe & Africa	5,142,060	3,447,108	2,728,426	2,932,048	3,593,746	4,186,292	5,398,833
Persian Gulf	1,552,320	1,754,891	5,041,657	7,297,542	8,944,434	10,419,217	13,437,096
Far East	291,060	1,190,819	1,423,527	1,628,916	1,996,525	2,325,718	2,999,352
Total Tonnage	9,702,000	12,409,588	21,509,813	28,864,383	35,378,431	41,211,724	53,148,515
Corpus Christi Petroleum Product Import Total by Trade Route (%) a/							
Latin America & Caribbean	25%	44%	52%	53%	53%	53%	53%
Western S. America	3%	5%	5%	6%	6%	6%	6%
Europe & Africa	53%	28%	13%	10%	10%	10%	10%
Persian Gulf	16%	14%	23%	25%	25%	25%	25%
Far East	3%	10%	7%	6%	6%	6%	6%
Total (%)	100%	100%	100%	100%	100%	100%	100%
Draft Restricted Tonnage a/							
Europe	1,501,972	2,031,318	3,458,943	4,808,033	5,893,099	6,864,769	8,853,119
Persian Gulf	438,428	1,691,558	3,053,692	3,851,282	4,720,430	5,498,748	7,091,435
Total Tonnage	1,940,400	3,722,876	6,512,635	8,659,315	10,613,529	12,363,517	15,944,555
% of Total Imports	20%	30%	30%	30%	30%	30%	30%

Source: USACE, Waterborne Commerce of the U. S. and U. S. Department of Energy, December 2000 application.

a/ Port depth, trade route, and historical vessel utilization data were used to identify the percentage of tonnage anticipated to benefit from the Corpus Christi proposed depth increases. The benefit calculations were limited to Europe, Mediterranean, and Middle East trade routes.

Table 27
Corpus Christi Petroleum Product Exports by Trade Route a/

	2000	2006	2016	2026	2036	2046	2056
Corpus Christi Petroleum Product Export Tonnage Total by Trade Route							
Latin America & Caribbean	1,786,288	1,070,833	1,288,521	1,360,703	1,369,947	1,353,071	1,354,793
Western S. America	34,232	106,878	165,906	211,494	228,181	228,609	228,854
Europe & Africa	1,173,224	1,107,088	1,170,646	1,124,896	1,081,033	1,111,405	1,156,205
Persian Gulf	62,240	89,832	111,995	120,608	134,232	146,989	153,852
Far East	56,016	199,293	251,581	303,181	327,823	335,326	339,498
Total Tonnage	3,112,000	2,573,924	2,988,649	3,120,882	3,141,216	3,175,400	3,233,201
Corpus Christi Petroleum Product Export Total by Trade Route (%)							
Latin America & Caribbean	57%	42%	43%	44%	44%	43%	42%
Western S. America	1%	4%	6%	7%	7%	7%	7%
Europe & Africa	38%	43%	39%	36%	34%	35%	36%
Persian Gulf	2%	3%	4%	4%	4%	5%	5%
Far East	2%	8%	8%	10%	10%	11%	11%
Total (%)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Draft Restricted Tonnage							
Europe	114,880	257,392	298,865	312,088	314,122	317,540	323,320
Persian Gulf	0	0	0	0	0	0	0
Total Tonnage	114,880	257,392	298,865	312,088	314,122	317,540	323,320
% of Total Exports	3.7%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%

Source: USACE, Waterborne Commerce of the U. S., and World Fleet Forecast, U. S. Gulf Coast application.
a/ Port depth, trade route, and historical vessel utilization data were used to identify the percentage of tonnage anticipated to benefit from the Corpus Christi proposed depth increases.

Table 28
Petroleum Product Tonnage Distribution by Vessel Class, Imports and Exports
U. S. Gulf Coast Petroleum Product Tanker Imports
Tonnage from Europe and the Persian Gulf

DWT Class 1000's	1998	2006	2016	2026	2036	2046	2056
<16.5	6.0%	6.4%	7.2%	7.6%	7.5%	7.3%	7.3%
16.5 to 25	4.6%	5.9%	9.7%	12.4%	14.0%	14.9%	15.2%
25 to 45	45.8%	42.8%	40.6%	39.2%	38.0%	37.1%	36.8%
45 to 80	19.6%	17.8%	19.0%	20.1%	20.9%	21.4%	21.6%
80 to 160	13.7%	12.9%	14.1%	15.3%	16.3%	16.9%	17.1%
>160	10.2%	14.2%	9.5%	5.5%	3.4%	2.4%	2.1%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

U. S. Gulf Coast Petroleum Product Tanker Export Tonnage to Europe

DWT Class 1000's	1998	2006	2016	2026	2036	2046	2056
<16.5	12.6%	12.2%	11.9%	11.7%	11.3%	10.8%	10.7%
16.5 to 25	12.9%	13.0%	12.2%	10.9%	9.6%	8.5%	8.2%
25 to 45	30.5%	29.6%	29.0%	28.0%	26.3%	24.7%	24.1%
45 to 80	25.1%	24.8%	23.9%	22.3%	20.3%	18.4%	17.7%
80 to 160	16.9%	15.9%	18.5%	23.7%	30.0%	35.5%	37.5%
>160	1.9%	4.5%	4.5%	3.5%	2.6%	2.1%	1.9%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Corpus Christi 1996/98 and average 2006-56 Refined Petroleum Products by Vessel Class

	Imports				Exports			
DWT Class 1000's	1996	1997	1998	2006/56	1996	1997	1998	2006/56
< 80	58.3%	66.7%	63.7%	50.0%	97.5%	94.3%	95.1%	86.0%
80 to 100	19.0%	11.0%	15.3%	23.0%	2.5%	5.7%	4.9%	10.0%
100 to 150	22.8%	22.4%	21.0%	25.0%	0.0%	0.0%	0.0%	4.0%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: World Fleet Forecast, U. S. Gulf Coast application.
Port depth, trade route, and historical vessel utilization data were used to identify the percentage of tonnage anticipated to benefit from the Corpus Christi proposed depth increases.

Table 29
Corpus Christi Petroleum Product Imports Transportation Cost and Savings

Depth	45 ft.	47 ft.	48 ft.	49 ft.	50 ft.	52 ft.
Transportation Cost by Year						
2000	$54,325,255	$51,179,659	$49,626,015	$48,458,986	$46,789,815	$44,838,113
2006	$57,851,741	$54,497,789	$52,842,047	$51,594,599	$49,815,604	$47,721,737
2016	$95,420,050	$89,631,910	$87,700,961	$85,308,756	$82,636,659	$77,866,152
2026	$135,811,555	$127,558,102	$124,196,941	$120,821,779	$117,046,809	$110,116,338
2036	$190,297,019	$178,732,713	$173,992,654	$169,267,272	$163,975,171	$154,283,810
2046	$262,445,467	$246,496,388	$239,927,647	$233,414,389	$226,112,823	$212,766,627
2056	$359,223,605	$337,391,862	$328,385,923	$319,472,061	$309,476,061	$291,216,306
Transportation Savings						
2000		$3,145,596	$4,699,240	$5,866,269	$7,535,441	$9,487,142
2006		$3,353,952	$5,009,693	$6,257,142	$8,036,137	$10,130,004
2016		$5,788,140	$7,719,089	$10,111,294	$12,783,391	$17,553,898
2026		$8,253,453	$11,614,614	$14,989,776	$18,764,746	$25,695,217
2036		$11,564,306	$16,304,365	$21,029,747	$26,321,849	$36,013,210
2046		$15,949,079	$22,517,821	$29,031,079	$36,332,645	$49,678,841
2056		$21,831,743	$30,837,682	$39,751,544	$49,747,544	$68,007,299
Equivalent Annual Savings						
2006-56 @ 5.875%		$7,361,546	$10,302,120	$13,284,971	$16,731,076	$22,669,722

Table 30
Corpus Christi Petroleum Product Exports Transportation Cost and Savings

Depth	45 ft.	47 ft.	48 ft.	49 ft.	50 ft.	52 ft.
Transportation Cost by Year						
2000	$1,402,589	$1,337,206	$1,299,261	$1,292,114	$1,285,359	$1,272,903
2006	$3,436,339	$3,273,563	$3,179,096	$3,161,304	$3,144,488	$3,113,478
2016	$3,960,981	$3,756,864	$3,633,595	$3,600,847	$3,569,879	$3,512,731
2026	$4,297,017	$4,075,321	$3,941,435	$3,905,868	$3,872,232	$3,810,162
2036	$4,661,551	$4,420,785	$4,275,383	$4,236,755	$4,200,227	$4,132,817
2046	$5,058,144	$4,796,632	$4,638,700	$4,596,744	$4,557,068	$4,483,850
2056	$5,489,173	$5,205,112	$5,033,562	$4,987,989	$4,944,892	$4,865,361
Transportation Savings						
2000		$65,383	$103,328	$110,475	$117,230	$129,686
2006		$162,776	$257,242	$275,035	$291,851	$322,861
2016		$204,117	$327,386	$360,133	$391,102	$448,250
2026		$221,696	$355,581	$391,149	$424,784	$486,855
2036		$240,766	$386,168	$424,795	$461,324	$528,733
2046		$261,513	$419,445	$461,400	$501,077	$574,295
2056		$284,061	$455,611	$501,184	$544,281	$623,812
Equivalent Annual Savings						
2006-56 @ 5.875%		$211,116	$337,525	$369,036	$398,833	$453,813

Bulk Grain Exports

Corpus Christi bulk grain transportation costs were estimated using the grain export tonnage and fleet data presented in the commodity and fleet forecast sections. The percentage of future grain export tonnage expected to benefit from channel depths over 45 feet was identified based on examination of vessel sizes, vessel loads, foreign port depths. Examination of 1996-99 Corpus Christi grain showed that 7.5 percent of 1996-99 tonnage was shipped in vessels that could be loaded to depths over 45 feet. The port depths for Corpus Christi's 1996-98 grain exports were examined in relationship to channel depth published in the National Imagery and Mapping Agency's 2000 World Port Index and Lloyds' 1995 Ports of the World. These publications provide well defined depth data for crude petroleum and product carriers; however, the accommodating depths for grain carriers are less definitive. However, examination of the origin-destination pairings indicated that approximately 8.5 percent of 1996-98 of Corpus Christi's grain exports were shipped to world ports which could accommodate grain carriers with loaded depths over 45 feet.

The annual transportation savings associated with the proposed channel deepening alternatives are presented in Table 31. An estimated 12 percent of 2006-56 tonnage is projected to use vessels with loaded drafts in excess of 45 feet. For the 50-foot channel, this percentage would decrease to 7 percent and to 3 percent for the 52-foot project. The bottom part of Table 31 displays Corpus Christi's grain export forecast. The tonnage projected to benefit from increased channel depths in Corpus Christi is restricted to movements to Europe and the Middle East. Transportation savings benefits were calculated for vessels in the 70,000 to 150,000 dwt range. Eighty-eight percent of the benefits are associated with vessels in the 70,000 to 90,000 dwt range and the remaining 12 percent with vessels over 100,000 dwt.

Table 31
Grain Exports Annual Transportation Cost and Savings

	45	47	48	49	50	52
Transportation Cost for Grain Exports						
2000	$1,131,354	$1,065,319	$1,048,781	$1,033,203	$1,025,881	$1,020,312
2006	$1,534,297	$1,444,743	$1,422,314	$1,401,189	$1,391,259	$1,383,707
2016	$2,253,740	$2,122,193	$2,089,248	$2,058,217	$2,043,631	$2,032,537
2026	$2,608,304	$2,456,062	$2,417,934	$2,382,021	$2,365,140	$2,352,302
2036	$3,223,312	$3,035,173	$2,988,055	$2,943,674	$2,922,813	$2,906,947
2046	$4,530,688	$4,266,240	$4,200,011	$4,137,629	$4,108,306	$4,086,005
2056	$4,709,904	$4,434,995	$4,366,147	$4,301,297	$4,270,814	$4,247,631
Transportation Savings						
		47	48	49	50	52
2000		$66,035	$82,573	$98,150	$105,473	$111,041
2006		$89,554	$111,982	$133,108	$143,038	$150,590
2016		$131,547	$164,492	$195,523	$210,109	$221,203
2026		$152,242	$190,370	$226,283	$243,164	$256,003
2036		$188,139	$235,257	$279,638	$300,499	$316,365
2046		$264,448	$330,677	$393,059	$422,382	$444,683
2056		$274,909	$343,757	$408,607	$439,090	$462,273
2006-56 Annual Savings, 5.875%		$145,145	$181,495	$215,734	$231,828	$244,068

Corpus Grain Exports	**2000**	**2006**	**2016**	**2026**	**2036**	**2046**	**2056**
Depths Over 45 Feet	105,297	142,800	211,776	244,786	302,036	423,726	440,416
% of Total tonnage	7.5%	12.0%	12.1%	12.1%	12.1%	12.1%	12.1%
Total Tonnage	1,404,000	1,190,000	1,748,000	2,023,000	2,500,000	3,514,000	3,653,000

Channel Deepening Benefit Summary

Table 32 displays a summary of the project deepening benefits.

Table 32
Corpus Christi Main Channel Deepening Benefits 2006-56
by Commodity and Channel Depth

Commodity	47	48	49	50	52
Crude Oil Imports	$2,609,875	$3,930,551	$5,077,072	$6,223,593	$8,419,209
Product Imports	$7,361,546	$10,302,120	$13,284,971	$16,731,076	$22,669,722
Product Exports	$211,116	$337,525	$369,036	$398,833	$453,813
Bulk Grain Exports	$145,145	$181,495	$215,734	$231,828	$244,068
2006-56 Equivalent Annual Savings 5.875 %	$10,327,682	$14,751,691	$18,946,813	$23,585,330	$31,786,812

Channel Widening Benefits

Benefits were calculated for widening the Corpus Christi Bay Channel 400- and 500-foot reaches to 530 feet. In addition to widening of the bay channel, benefits are being evaluated for a barge shelf in the 400-foot reach. The barge shelf would extend from 200 feet from the toe of the proposed 530-foot channel.

The benefits associated with widening the bay reach to 530 feet were calculated based on the probability of vessel meetings and potential delays. The Port Aransas Pilots Association vessel meeting criteria is that vessels with combined beam widths of 251 feet or more cannot meet in the 400-foot reach. An additional criterion is that meetings are not permitted between vessels with combined loaded drafts in excess of 80 feet. The pilots noted that the 80-foot combined draft limit was invoked in the early nineteen nineties. The 45-foot channel deepening project became operational in the late eighties and at that time, crude oil tankers with loaded drafts up to 45 feet mean low water (MLW) were not uncommon. Presently, few crude oil vessels are loaded to more than 41 feet. Examination of the vessel records showed that some petroleum coke vessels are presently loaded to depths up to 45 feet MLW. The Pilots said that they would allow dry cargo, such as petroleum coke, to be loaded to deeper depths than liquid cargo. The general policy is that vessels should have 3 feet or underkeel clearance. Examination of 1996-99 transit records showed that loaded drafts over 41 feet are infrequent, particularly for liquid cargo. Comparison of 1990 traffic data compiled for the 1994-reconnaissance report with recent traffic data showed that 1 foot of underkeel or less was not uncommon for liquid cargoes during the early nineties.

Benefits for widening the bay reach was calculated based on reductions in delays due to the combined beam width restriction. Benefits were not calculated for easement of the underkeel clearance policy as the pilots indicated that there would not be a change in the policy to maintain an average minimum of 3 feet of underkeel clearance.

Table 33 presents the distribution of 1997-2000 Corpus Christi deep-draft vessel transits by beam width. Table 33 also presents summary data associated with the probability of vessel meetings for combined beam widths of 251 feet or more and combined loaded drafts over 80 feet in the 400-foot wide 12-mile reach of Corpus Bay. Based on a random arrival pattern and a distance of 25 miles across Corpus Bay, it was determined that there was a 48 percent chance of vessels meeting in the 12-mile reach. The value of .48 was applied to the probability of combined beam width meetings. Analysis of the 1997-2000 indicated that the probability of meetings between beam widths of 251 feet ranged from 6 percent in 1994 to 21 percent in 2000. The future probability of meetings in the 12-mile reach was estimated to range from 3 percent for 1994 to 10 percent in 2000. Port Aransas Pilot log records for the period January 1, 2000 through September 30, 2001 generated similar, however slightly more conservative, findings; however, the pilot records showed that for a 9-month sample period 75 vessels were delayed. The pilots said they may not of recorded every vessel delay. Application of the sample data indicates that 94 vessels would be delayed annually with an expected annual cost due to beam width delays of $227,000. Use of the statistically generated random arrival data generates an annual delay cost of $243,856. The average annual cost base of $243,856 was calculated based on 94 to 106 vessels delayed annually, EGM 02-06 foreign-flag tanker vessel operating costs corresponding to the delayed vessels, and an average delay duration of 1.77 hours. The number of hours delayed was calculated from the January through September pilot data. The pilots said that vessels that presently incur delays in the 400-foot reach are not restricted in the 500-foot reach and they said that the channel widening improvement would essentially reduce all of the present delay cost.

Table 33

Corpus Christi Ship Channel

1994-2000 Distribution of Vessel Trips by Vessel Beam Width (feet)

Beam Range (feet)	Average Beam	1994	1995	1996	1997	1998	1999	2000
<99	72	34.0%	32.3%	34.6%	38.0%	35.7%	37.9%	30.5%
100-104	102	32.5%	29.0%	28.6%	7.3%	6.9%	2.7%	3.3%
105	105	7.6%	10.0%	5.8%	7.8%	5.2%	2.8%	5.0%
105-107	106	5.6%	6.4%	9.0%	14.8%	15.8%	17.1%	21.0%
108-112	108	0.1%	0.1%	0.1%	0.2%	0.0%	0.6%	0.3%
113-114	113	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
115-122	118	0.5%	1.4%	0.8%	1.3%	1.3%	1.3%	1.1%
123-127	125	0.3%	0.3%	0.5%	0.7%	0.9%	2.0%	1.6%
128-140	136	13.8%	14.0%	15.0%	20.4%	23.7%	26.9%	26.6%
141-153	146	5.7%	6.1%	5.8%	9.3%	10.3%	7.8%	9.9%
>153	161	0.1%	0.3%	0.0%	0.2%	0.2%	0.8%	0.8%
Total		100%	100%	100%	100%	100%	100%	100%
Total One-Way Trips								
		984	1007	826	1091	1121	1056	1065
Probability of Combined Beams Greater than 251 feet Meeting in Corpus Bay								
		6.3%	7.0%	6.5%	15.6%	18.3%	17.7%	20.8%
Probability of Combined Beams Greater than 251feet Meeting in 400-foot Wide 12-mile Reach								
		3.0%	3.3%	3.1%	7.5%	8.8%	8.5%	10.0%
Estimated Number of Vessels Delayed in the 400-ft Reach								
		30	34	26	81	98	90	106

The interview and log data were used to formulate probability distributions that incorporated the range of delay times obtained from the data the interviews. The project benefits were based on reductions in delays presently incurred due to the channel dimensions. The annual reduction in delay costs is summarized in Table 34. Total vessel trips were projected to increase at an average annual rate of 1 percent for the period 2000 through 2056 and the rate of growth for draft restricted vessels was projected to increase at an annual rate of 2 percent between 2000-26 and by 1 percent for the remainder of the economic evaluation period. Determination of the vessel trip growth rate was based on examination of historical growth. It was found that vessel sizes have increased and the average tons per trip have risen. Vessel trip growth has been slower than tonnage growth due to utilization of larger vessels. The results of the analysis showed that an annual growth rate of – should be expected.

In addition to beam width delays, the pilots said that channel widening and deepening would likely result bay transit time savings of 6 to 20 minutes for all vessels with beam widths over 80 feet. The pilots noted that these timesavings would occur for the entire 25-mile bay reach. A 6 to 8 minute timesavings noted from examination of ERDC vessel simulation data. The pilots contended that the timesavings would likely be between 15 and 20 minutes. An average savings of 13 minutes (the midpoint between 6 and 20) was used to calculate project induced hydraulic time savings for vessels with beams over 80 feet. The transit timesavings for 1994-2000 traffic are displayed in Table 35 and the equivalent annual 2006-56 benefits are displayed in Table 36.

Table 34
Corpus Christi Ship Channel, Annual Deep-Draft Vessel Widening Benefits
Delays Due to Combined Beam and Draft Restrictions, and Tug Availability

Year	Annual One-Way Trips	Hourly Cost	Annual Trips Delayed	Annual Delay Cost
2000	1,084	$1,205	100	$243,856
2006	1,197	$1,205	122	$258,287
2016	1,323	$1,205	149	$395,293
2026	1,461	$1,205	181	$481,859
2036	1,614	$1,205	200	$532,273
2046	1,783	$1,205	221	$587,960
2056	1,969	$1,205	244	$649,474
2000-56 Average Annual Growth Rate	1.7%	2006-56 Equivalent Annual Benefits 5.875 %		$417,660

Table 35
Corpus Christi Transit Time Savings Due to Deepening and Widening a/

Average Beam (ft)	At Sea Hourly Cost	1994	1995	1996	1997	1998	1999	2000
72	$672	$0	$0	$0	$0	$0	$0	$0
102	$751	$52,068	$47,505	$38,460	$13,037	$12,548	$4,726	$5,704
105	$829	$13,492	$18,169	$8,635	$15,291	$10,434	$5,397	$9,534
106	$835	$10,056	$11,687	$13,408	$29,172	$32,072	$32,796	$40,588
108	$884	$96	$288	$96	$384	$0	$1,151	$575
113	$909	$0	$0	$0	$0	$0	$197	$0
118	$934	$912	$2,837	$1,317	$2,837	$3,040	$2,837	$2,432
125	$1,031	$559	$783	$895	$1,790	$2,237	$4,698	$3,803
136	$1,099	$32,314	$33,507	$29,453	$53,182	$63,436	$67,729	$67,491
146	$1,238	$14,977	$16,522	$12,895	$27,133	$31,163	$22,029	$28,208
161	$1,434	$311	$934	$0	$622	$622	$2,489	$2,489
Total Delay Annual Cost		$124,786	$132,232	$105,159	$143,449	$155,553	$144,051	$160,825

a/ Calculated using EGM 00-06 Deep-Draft Vessel Operating Costs. Application of the EGM 02-06 costs would reduce these delays by 1 to 2 percent. The saving presented in Table 36 reflect EGM 02-06 costs.

Table 36
Corpus Christi Transit Time Savings Due to Deepening and Widening 2000-56
Energy Savings Benefits a/

Year	Vessel Trips	Annual Savings
2000	740	$158,497
2006	786	$168,248
2016	868	$185,850
2026	958	$205,294
2036	1,059	$226,772
2046	1,170	$250,498
2056	1,292	$276,705
Equivalent Annual Benefits 5.875%		$200,572

a/ The Port Aransas Harbor Pilots said these benefits could not be exclusively allocated as widening or deepening specific. The combination of widening and deepening was projected by the pilots to facilitate reduction in energy force as the vessel moves through the channel.

Corpus Christi Barge Shelf Analysis

The Corpus Christi Ship Channel's inner bays segment (mile 12 to mile 22) is characterized by intersection of deep draft ship traffic coming from the Gulf of Mexico and inland waterway tug and barge traffic traveling on the Gulf Inter-Coastal Waterway (GIWW). Congestion in the waterway has brought about traffic management rules governing maximum beam and draft avoid collisions. The cost of this operating regime is manifested in vessel delays affecting deep-draft ocean-going vessels and shallow-draft tow barges. Barge shelves are proposed to separate the traffic and reduce the congestion induced delay cost. This section of the report examines the economic feasibility of the barge shelves.

The existing Inner Bay section of the Corpus Christi Ship Channel is 45 x 400 feet. Traffic delays have four sources. The largest is the beam restriction. Vessels are not allowed to pass if their combined beam is greater than 251 feet. One vessel must delay in a safe area until the other vessel has passed. Tugs are required to assist vessels operating the inner harbor, when tugs are not available, vessels must wait. The restricted draft results in large vessels waiting for adequate traffic conditions. The final source of delay, and the one that would be affected by a barge shelf, is the delay caused when towboats and ships are expected to meet at specific points in the inner bay segment of the ship channel. An example is the turn in the channel at light #44. Pilots avoid meeting tow operators at this point by delaying. The Port Aransas Pilots have provided an approximation of these delays based on a group consensus. The pilots estimate the incident of delays to be one out every three ship movements. The average delay time was noted as approximately 15 minutes. For the year 2000, 1254 incidents where estimated for a total of 313.5 hours delay time[5].

Existing Condition Delay Cost for Deep-Draft Vessels. To estimate the annual delay cost of barge congestion delays a weighted vessel operating cost per hour was developed. In the year 2000, 3762 vessels traversed the Corpus Christi Ship Channel inner bay segment. The predominate vessel type was foreign flag tankers followed by bulk and general cargo vessels. Based on the movements in 2000, the weighted average vessel operating cost was estimated at $800 per hour. Multiplying this time the 313.5 hours delay estimated by the pilots yields an annual delay cost of about $250,000. There has been no cost associated with allisions, collisions and groundings that would be alleviated by the barge shelf. However, pilots report "near misses" occur on nearly every movement. While these near misses have no monetary cost, they produce great anxiety and suggest a future with either collisions, or more likely, more operating rules and procedures designed to prevent accidents.

The reductions in transportation cost associated with the barge shelf feature were calculated using the annual delay reduction of $250,000. Under this scenario the incident of delay remains at one per three movements. Vessel traffic is forecasted to increase by one to two percent per year. The equivalent annual benefits for the 50-year economic evaluation period were estimated at $311,787 ($207,650 for deep-draft vessels and $104,137 for shallow-draft vessels). The

[5] Letter dated October 9, 2001 from the Port Aransas Pilots association to the Galveston District.

consensus of the deep-draft pilots was that two-thirds of the delay cost that they incur due to barge traffic would be alleviated by widening the deep-draft channel to 530 feet and one-third of the delays that the deep-draft vessels would be used by the barge shelf alone.

Existing Condition Delay Cost for Tow Barges. Representatives of three major tow operating companies that regularly use the Corpus Christi Ship Channel were interviewed concerning the interaction between towboats and deep-draft vessels in the bay reach of the Corpus Channel. Of the three operators, two said that tow vessels delay of "hold up" due to deep-draft vessel traffic between 30 and 33 percent of the time. The third company representative said that their operators indicated that they delay movements about 5 percent of the time. The estimated delay times for the 3 companies interviewed ranged between 10 and 15 minutes. This information suggests that annual towboat delays are approximately $23,597. The annual delay cost was calculated use a 2-barge tow consisting of tow 195- by 35-foot barges and a 1,200 horsepower towboat and the annual tow trip forecast presented in Table 37. Examination of the barge fleet associated with study region transits showed that this tow size is representative of average tow dimensions. The hourly operating cost for this tow is approximately $175 per hour (EGM 00-05 FY2000 shallow-draft vessel operating cost).

Table 37
Corpus Christi Cut B
Annual Towboat Trips and Barge Shelf Savings

Year	1996	1997	1998	2006	2016	2026	2036	2046	2056	2006-56 Equivalent Annual Savings
Towboat Trips	2570	2610	2814	3048	3366	3719	4108	4537	5012	5.875%
Annual Benefits			$23,597	$25,552	$28,225	$31,179	$34,440	$38,044	$42,024	$30,461

Source: USACE, dock-to-dock records. Growth for 1998-2056 was estimated at 1% per annum.

Channel Widening and Barge Shelf Summary

Table 38 presents a summary of the total benefits from the barge shelf and from channel widening. The benefits were calculated using probability distributions, which were defined from delay records and interview data. The range associated with the equivalent annual widening benefit of $819,837 is $615,170 to $1,377,835. The range associated with the barge shelf benefits of $134,598 is $101,710 to $354,942. Incorporation of these ranges into an @risk triangular distribution shows that there is a 75 percent probability that widening benefits are higher than $819,837, a 1 percent probability that they are lower than $672,129. The risk evaluation shows that there is an 87 percent probability that the barge shelf benefits are higher than $134,157 and a 1 percent probability that the benefits are lower than $110,829.

Table 38
Summary of Channel Widening Benefits and Barge Shelf Benefits

	Widening	**Channel Widening & Deepening**			**Barge Shelf**		
Year	Delays to Deep-Draft Vessels Due to Beam & Draft Restrictions, And Tug Availability a/	Transportation Cost to Deep-Draft Vessels From Resistance Reductions b/	Deep-Draft Vessel Delays from Ship-Barge Delays c/	**Widening Total**	Deep-Draft Vessel Delays from Barge Induced Delays	Shallow-Draft Vessel Delays From Deep-Ship Induced Delays	**Barge Shelf Total**
2000	$240,326	$158,497	$164,090	$562,913	$82,291	$23,597	$105,888
2006	$254,548	$168,248	$174,185	$596,981	$87,354	$25,552	$112,906
2016	$389,571	$185,850	$192,409	$767,830	$96,493	$28,225	$124,718
2026	$474,884	$205,294	$212,538	$892,716	$106,588	$31,179	$137,767
2036	$524,568	$226,772	$234,775	$986,115	$117,740	$34,440	$152,180
2046	$579,449	$250,498	$259,338	$1,089,285	$130,058	$38,044	$168,102
2056	$640,073	$276,705	$286,469	$1,203,247	$143,665	$42,024	$185,689
		Equivalent Annual Savings 2006-56					
5.875%	$411,615	$200,572	$207,650	$819,837	$104,137	$30,461	$134,598

a/ Reductions in year 2000 transportation cost associated with tug availability delays were estimated at $33,775 or 6 percent of the $562,913 total.
b/ The pilots noted that the benefits could not be exclusively allocated as widening or deepening specific. The combination of widening and deepening was projected by the pilots to facilitate reduction in energy force as the vessel moves through the channel.
c/ The pilots noted that channel widening would facilitate a reduction in deep-draft delay frequencies associated with time lost to avoid the possibility of meeting tows at critical points.

La Quinta Channel

This section presents the La Quinta Channel analyses. The project alternatives investigated were deepening the existing Federal portion of the La Quinta Channel and extension of Federal project.

Deepening of the Existing Federal Project

Examination of the vessel sizes and trade routes associated with tonnage transported through the existing 45-foot channel showed that only a small number of vessels were loaded to drafts in excess of 40 feet. Additional analyses indicated that the port depths at shipping and receiving ports were and would continue to remain a constraint. Comparison of the project construction costs to deepening the existing channel to depths over 45 feet with potential reductions in transportation costs associated with more deeply loaded vessels did not produce a benefit-to-cost ratio above unity.

Extension of the Federal Project

Determination of the Federal interest in the extension of the existing limits of the La Quinta was evaluated based on the results of a multiport analysis. The purpose of the analysis was to determine if La Quinta offered a competitive advantage over existing and anticipated container facilities such as the Port of Houston's Barbours Cut and Bayport projects and the Texas City Shoal Point project.

Currently, a dedicated containerized cargo handling facility does not exist at any locale or landside terminal supported by the existing Corpus Christi Channel System (CCCS). The governing non-Federal port authority for the harbor has decided to undertake studies to determine the economic viability of establishing a new terminal northward of the terminus of the existing La Quinta Channel and vessel turning basin. A critical consideration for the establishment of such facilities is whether incremental or marginal extension of the existing waterway can be justified to support the movement of vessel services to dockside facilities proposed for construction at the identified location of the new terminal.

Initially, three sites were considered for establishment of containerized cargo facilities. These locales included the site presently identified for terminal development that is situated on the northern shore estuarine area northwestward of the terminus of the channel. The other locations are further southeastward, also along the northern or eastern shoreline and within reach of the existing channel system. It was found that the other two sites were excluded from further consideration due to costs of acquisition, development, and limitations imposed by proximity to landside rail linkages and arable land readily suiTable for related development.

Studies for the placement of new facilities in the vicinity of La Quinta Channel emphasize the application of multi-port analyses. While multi-port studies are a mandated consideration under USACE planning guidance for all deep-draft or coastal harbor navigation studies, the requirement and extent to which such efforts are undertaken is dependent upon the influence of conditions unique to proposed waterway improvements on alternative ports and terminals (and modes of transportation) and the potential of such influences to structure plan formulation. While many studies do include some components of multi-port analysis, most do not emphasize multi-port efforts as existing waterway systems already have a baseline or captive market and marginal realignment of tonnage from a alternative is either not considered viable or sufficiently significant to marginally alter plan formulation or development at alternative locales or facilities of (potential) concern.

As stated previously, analyses for extension of La Quinta Channel emphasized the application of multi-port analyses. This requirement is based on the determination from preliminary inquiries (and subsequent studies) that presently, subject facilities do not exist (nor would they foreseeably exist without some level or scope of waterway improvements) and that little or a relatively insignificant portion of the cargo throughput that would be handled by new facilities would be comprised of induced cargo movements unique to the new terminal. Consequently, studies required the assessment of tonnage movements currently handled or processed via some alternative port or terminal location in the absence of facilities proposed for La Quinta Channel.

The general approach of the multi-port analysis was to determine if facilities and supporting waterway improvements proposed for extension of La Quinta Channel would afford sufficient logistical or transportation cost efficiencies to allow attraction or cultivation of cargo throughput and business to economically justify the life-cycle costs of terminal development and waterway improvements over time.

Comparative or Alternative Port Facilities and Markets. With terminal facility location being the coast of Texas bordering the Gulf of Mexico, several ports represent potential or competitive alternatives to containerized cargo facilities located in Corpus Christi. With respect to imports and exports to\from the United States, the most noTable of these is Houston followed secondarily by other ports along the Gulf coast extending from Texas to perhaps as far eastward as Alabama. While ports eastward of Texas may offer significantly less competition to tonnage destined to/from Texas, they are nonetheless included in studies because the tonnage that these ports handle collectively influences the nature of vessel services and logistics which serve Gulf coast domestic ports.

In addition to competitive consideration of domestic Gulf coast ports, investigations also reveal that facilities in Corpus Christi would also be favorably located to compete with port facilities in Mexico, notably Altamira which presently handles a variety of non-perishable containerized cargo destined for U.S. ports outside the Gulf and other foreign nations.

Comparative or Alternative Modes of Transport. Integral to multi-port facility studies is the requirement for multi-mode transport analysis. The requirements for such studies as they related to proposed development for LaQuinta involves consideration of both landside and waterborne forms of transport with the former largely comprised of the alternatives of rail or truck (with little or no emphasis on air transport given the nature of cargo probably involved). Multi-mode transport analysis is also often part of economic study efforts to determine transportation cost efficiencies from origin to destination of a unit of cargo with consideration of ultimate origin and destination as practical study requirements and associated budgetary and time constraints allow.

Data from the Journal of Commerce Port Import/Export Research System/Service (JoC-PIERS) was combined with data compiled by the Waterborne Commerce Statistics Center of the U.S. Army Corps of Engineers (WCSC-USACE) and supplemented with data for respective vessel physical characteristics (length, breadth, draft, capacity, etc.) to assess the geographic flow or distribution patterns of cargo moving by deep-draft waterborne trade via the Gulf coast region. The combined data product rendered a comprehensive database for origin and destination (reasonably determined as available data permitted), general inferences on trade routings and ports of process or handling, magnitude of movement, probable mode and scale of landside and waterborne transport, and similar or additional information which could be applied for transportation cost analysis concerning proposed and alternative port facilities. With data analyzed from a geographical perspective, procedures to analyze total transportation costs both landside and waterborne could be undertaken and the economically rational range(s) of market(s) for port hinterlands could be reasonably determined to ascertain the potential market and market share for La Quinta facilities. Particular to landside transport costs, efforts involved the research of rail and trucking rates according to scale and frequency of movement, and hinterland or port origin/destination with an emphasis of geographic market thresholds where the Port of Corpus Christi would be competitively positioned based on such costs.

Potential or Viable Markets. Studies to-date indicate that the most favorable geographic markets for containerized cargo terminal facilities situated in Corpus Christi are some market hinterlands which are presently served regionally by the port of Houston (domestically) and containerized cargo handling facilities in Altamira (Mexico). Further, analysis of available information also indicates that containerized facilities in Corpus Christi may also render a competitive transportation cost efficiency to land bridging of selected movements to\from the west coast (via such ports as Los Angeles\Long Beach) which are currently moving through the Panama Canal. The primary trade partners or markets which existing Gulf coast ports serve (with noTable reference to Houston and Altamira) and which Corpus Christi would also likely serve include South America, the Caribbean basin, Europe and potentially some limited coastwise movements to and from the eastern seaboard of the United States. Corpus Christi offers an advantage of existing facilities in Houston because terminal capacity in Houston is near capacity. Container throughput in the Port of Houston has been reported at levels between 900,000 and 1,000,000 TEUs including empties. The Executive Summary of Phase 2, Conceptual Development Study for Shoal Point described the Port of Houston's maximum practical capacity at 1.2 million TEUs and its sustainable capacity at approximately 900,000 TEUs. In response to the need for future terminal capacity several terminal projects are being pursued including projects at Bayport, Galveston and Texas City. However, it is not clear at this time that these projects will succeed or that those that do succeed will provide sufficient capacity for long-term market growth. In addition, the Houston area is facing significant challenges in the areas of traffic congestion and pollution. The terminal development in Corpus Christi may provide a portion of the incremental capacity needed to serve Texas markets without potential pollution and congestion problems. In addition, Corpus offers a mileage advantage over Houston for landbridge movements from the U. S. West Coast and Texas. Corpus Christi offers a 50-mile over Houston for movements from West Texas and the U. S. West Coast and a 193-mile advantage for movements from Brownsville. Furthermore, Corpus Christi has a relatively better position for serving the growing Northeast Mexico market. Corpus Christi offers a mileage and time savings advantages over Altamira, Mexico for several locations in Northern Mexico. In some cases mileage differentials were less than 5 miles; however, there was a timesavings of over 2 hours due to relatively more advantageous roads. Specific to waterborne transport, review and analysis of vessel classes or sizes currently employed for container trade along the U.S. Gulf coast indicates that vessels ranging in size from approximately 1,800 to 2,200 twenty-foot equivalent unit (TEU) capacity would form the lower bound of fleet service with the upper bound typically supported by vessels of 2,400-3,700 TEUs augmented by vessels of Panamax class with capacities of approximately 3,900 to 4,850 TEUs. Presently available information indicates vessels of Post-Panamax design would not routinely or significantly service proposed facilities, at least in the immediate and interim term of the port assuming a base period of analysis beginning in 2005 to 2006. Respective to vessel utilization, it is largely anticipated that containerized cargo carriers which serve Corpus Christi will be employed with similar utilization and loading patterns and resulting transit drafts, though it is also anticipated the progression of vessel services will exhibit some time lag behind those comprehensively employed to serve the port of Houston. In addition, as with other Gulf coast containerized services, the utilization (both loading and service frequency) of upper class carriers will be influenced prior and post ports of call and considerations of transit time to transit the Gulf.

With review of such considerations and data for transit draft(s) as exhibited for vessel services serving the port of Houston, prevailing and foreseeable transit patterns indicate that containerized vessel service in the region to/from foreign destinations can be viably supported with transit drafts (and commensurate vessel loadings) of 30 to 35 feet which may serve as a threshold level of service sufficient to justify initial placement and ongoing operation of proposed terminal facilities. Due to the significant value of NED benefits associated with threshold development of facilities it is conceivable that typical NED economic optimization of channel depth could result in authorized reference depths of less than 37.0-39.0 feet. However, the typical process is often applied to existing waterways and harbor reaches for which proposed improvements and development constitute a marginal or incremental measure (and which often do not derive a predominant share of NED benefits from realignment of landside transportation) as opposed to the establishment of new facilities design to garner applicable market share and economic viability through realignment of landside transportation as much as (or more than) improvements to waterborne vessel operation(s). In addition, it is anticipated that transit draft will increase over time as vessel classes are more intensively utilized commensurate with expected growth in trade. Accordingly it appears economically and technically rational to analyze the potential for Federal interest in proposed waterway improvements from a two-stage process; optimization based on initial placement of facilities and supporting transport services (threshold level of activity for placement and economic return) and secondary or final optimization for waterway improvements based on foreseeable changes or efficiencies in vessel service commensurate with marginal improvements beyond threshold or initial placement requirements. This would allow optimization of Federal interest to be based primarily on efficiencies for vessel services (as typically encountered with other studies) and avoid the probable need of the sponsor to immediately request another study to justify depths practically needed to service evolving vessel services supporting the Gulf of Mexico. To require pursuit of an additional study effort or authority to justify marginal depth that may be reasonably justified at the time of initial project placement would likely impose marginal costs detrimental to the Federal interest of economic efficiency and impose a developmental lag on development of non-Federally sponsored facilities.

Assuming a process based on incremental optimization of vessel operations, the primary foreign trade partners and level of TEU throughput (including allowances for repositioning or prepositioning of empty containers) is illustrated in Table 39 for container movements for which NED benefits are derived, notably Europe, Latin America, and the Caribbean Basin while Table 40 summarizes the approximate NED benefits for betterments to landside transportation (on an average annual equivalent for trade partners listed in Table 39 and respective flows or origins/destinations of movement. Table 40 summarizes the NED markets and benefits and calculates the total NED benefits for the POCC the base year. Table 41 presents the 2006-2056 annual landside transportation savings benefits anticipated as a result of La Quinta site transportation efficiencies. The benefits are derived from the net landside transportation cost savings that La Quinta could provide over alternative existing and anticipated container port sites. Table 42 summarizes total NED benefits and project construction cost according to depth.

Table 39
TEUs Per Call Including Empties by Market

Europe	2 Weekly Services	714	74,297
Latin America (Based on 75% of Latin America)	2 Weekly Services	366	38,082
Central America/Caribbean (Based on 25% of Latin America)	2 Weekly Service	122	12,694
		Total Annual TEUs	125,073

Table 40
Summary of NED Annual Benefits for Annual NED Throughput of 25,978 TEUs

	POCC NED TEUs	Savings/ Benefit	Total Savings/Benefits	Percent of Total
Southwest Texas	6,990	$ 107.54	$ 751,705	38.5%
Landbridge	14,423	$ 47.22	$681,017	34.9%
NE Mexico	3,136	$ 50.00	$156,793	8.0%
Asia-Latin America	1,430	$252.94	$ 361,577	18.5%
Total Annual TEUs	25,978		$1,951,092	

Table 41
La Quinta Channel Extension Landside Transportation Cost NED Benefits

Base Year	$1,951,092
2006	$2,350,004
2016	$4,696,234
2026	$7,346,718
2036	$10,392,186
2046	$14,143,507
2056	$15,999,160
2006-56 Equivalent Annual Benefits 5.785%	$6,152,960

Table 42
Ocean-Going Transportation Equivalent Annual Cost Savings Thousands of dollars

Channel Depth	First Cost	Average Cost	O&M Cost	Total Cost	Average Benefits	B/C Ratio	Net Benefits
37	$23.578	$1.470	$532	$2.002	$2.817	1.4	$814
38	$23,920	$1,491	$533	$2,025	$3,077	1.5	$1,053
39	$23,968	$1,494	$535	$2,029	$3,112	1.5	$1,083
40	$24,016	$1,497	$536	$2,033	$3,085	1.5	$1,052
41	$24,418	$1,522	$541	$2,063	$2,993	1.5	$930
Total Transportation Cost Savings Benefits							
Ocean-Going Costs and Landside Transportation Cost Savings							
37	$23,578	$1,470	$532	$2,002	$9,059	4.5	$7,056
'38	$23,920	$1,491	$533	$2,025	$9,319	4.6	$7,295
39	$23,968	$1,494	$535	$2,029	$9,354	4.6	$7,325
40	$24,016	$1,497	$536	$2,033	$9,327	4.6	$7,294
41	$24,418	$1,522	$541	$2,063	$9,235	4.5	$7,172

La Quinta Channel Associated Costs

This section presents analysis of the costs associated with the development of the La Quinta container facility and provides a comparison of the project's associated costs with the expected transportation savings benefits and revenue. According to the port's preliminary master plan, the terminal will be built in three phases. Table 43 displays a summary of the project's site development and equipment costs. As noted in Table 43, the estimated average annual equivalent cost, which includes engineering supervision, administration and contingencies, is $21,773,932. Phase 1 will be built in conjunction with the channel extension and will cost approximately $211 million. The first cost of $211 is in addition to the channel deepening cost $24 million. Phases 2 and 3 will proceed as need arises and will each cost approximately $68 million. Phase I cost includes wharf construction, container rails, site grading and paving, a 94-acre container terminal, 3 container cranes, 10 gantry cranes, 30-yard hostlers, reefer connections, and other yard equipment. The site development costs were annualized over the 50-year economic evaluation period for evaluation in relationship the equivalent annual benefit stream anticipated from the proposed facility.

Table 43
Summary of Average Annual Equivalent (AAEQ) Costs Associated With Placement of La Quinta Container Terminal Under With Project Conditions
5.875% unless otherwise noted

Cost Components	First Cost	AAEQ Cost
Off-Site Infrastructure	$ 1,070,880	$66,759
Site Preparation / Infrastructure	15,899,862	$991,198
Wharf and Marine Terminal	72,437,253	$4,515,739
Intermodal Yard	20,178,320	$1,257,917
Public Access Improvements	1,354,991	$84,470
Land Acquisition Cost	3,027,910	$188,760
Cargo-Handling Equipment Costs	96,924,628	$6,042,282
Phase I Subtotal(s)	$210,893,844	$13,147,125
Engineering Supervision & Administration (15%)	$31,634,077	$1,974,035
Engineering Contingency (15%)	$31,634,077	$1,974,035
Phase 1 Total Costs	$274,161,997	**$17,095,194**
Phase 2 and 3 Costs (assume to occur by year 10)	$136,000,000	**$4,678,738**
Total Average Annual Equivalent Cost	**n/a**	**$21,773,932**

Along with site development costs, the associated costs needed to realize the project benefits include daily facility operation expenses. Anticipated operation and maintenance costs for the facility were estimated using budget data for comparable ship terminals presently servicing dry cargo goods at other U. S. Gulf Coast ports. Additionally, the port's 1999 and 2000 annual reports were reviewed and pertinent data were pro-rated based on the expected throughput volume for the La Quinta facility. Operating expenses include direct and indirect costs for employee services, utilities, telephone, insurance, security, office equipment and administrative services. Table 44 summaries the annual operating expenses for the proposed facility. The combined estimated average annual equivalent associated costs for both site development and operation and maintenance totals $22,915,066 ($21,773,932 + 1,141,134).

Table 44
La Quinta Container Facility Expected Operating Cost

	Total Annual TEUs	Estimated Operating Expenses
2006	150,645 [a/]	$513,613
2016	238,632	$813,601
2026	386,001	$1,316,045
2036	568,568	$1,938,495
2046	786,419	$2,681,243
2056	906,657	$3,091,185
2006-56 Average Annual Equivalent Expenses 5.875%		$1,141,134

[a/] Opening the facility in the year 2000 was expected to generate an annual volume of 125,073 TEUs. Growth was expected to increase to 176,217 by the year 2006. The present construction schedule suggests that the year 2006 volume should be 150,645 TEUs.

La Quinta Channel Container Revenue

The revenue stream expected from the proposed container cargo facility was evaluated in relationship to total project cost. Expected revenue was used as a proxy for evaluating the port's ability to generate returns sufficient to cover the La Quinta channel extension costs and the associated site facility and operational costs. The port expects to find a private terminal operator to undertake these investments and operate the facility at a profit. There is expected to be little public investment in the entire La Quinta Terminal. Normal shipping costs, which include such things as terminal charges, berth charges, crane costs, yard storage costs, rail and truck costs can all be expected, whether containers move through La Quinta or any other facility. The independent market analysis conducted by the Corps shows that expected TEU throughput during the first year of service would increase from 150,645 TEUs in year 1 to 966,135 by year 50. The NED throughput for year one is expected to be 31,290 TEUs or 20.8 percent of annual throughput. Income revenue for the La Quinta facility was estimated based on tariffs paid to container companies presently operating at existing ports and from data published in the "Journal of Commerce". Current tariffs range from $181 for a 20-foot equivalent unit to $226 per 40-foot equivalent unit. Using 150,645 TEUs and a tariff of $200 per container, annual revenue is $30,129,000. Average annual equivalent revenue for the 50-year economic evaluation period is $78,653,863. The revenue associated with NED movements is $16,336,612. Table 45 presents the annual revenues that could the port could expect over the 50-year economic evaluation period.

Table 45
Corpus Christi Container Facility
Annual TEU Throughput and Estimated Annual Revenue

Year	Total Annual TEUs	NED TEUs [a/]	Revenue Based On Annual TEUs	Total Annual TEUs based on present schedule [b/]	Revenue based on present schedule
2000	125,073	25,978	$ 25,014,600		
2006	176,217	36,601	$ 35,243,345	150,645	$ 30,128,973
2016	301,048	62,528	$ 60,209,572	301,048	$ 60,209,572
2026	470,955	97,819	$ 94,190,952	470,955	$ 94,190,952
2036	666,182	138,368	$133,236,350	666,182	$ 133,236,350
2046	906,657	188,315	$181,331,362	906,657	$ 181,331,362
2056	1,025,612	213,022	$205,122,450	966,135	$ 193,226,948
2006-56 Average Annual Equivalent Revenue 5.875 %			**$ 80,335,686**		**$ 78,653,863**

La Quinta Project Construction and Associated Cost and Benefit Evaluation

As displayed in Table 42, the 39-foot depth generates the highest net excess benefits for the La Quinta Extension. The first cost for construction of the La Quinta 39-foot channel extension is $23,968,000 and average annual equivalent project costs, which include channel operation and maintenance, is $2,029,000. The expected annual transportation cost savings benefits for the 39-foot channel depth are $9,354,000. The benefit-to-cost ratio based on the equivalent annual benefits of $9,354,000 and annualized project cost of $2,029,000 is 4.6. Inclusion of the average annual associated costs increases the equivalent annual cost from $2,029,000 to $24,944,066. Revenue generated from container traffic will be used to payback the sponsor's site investment costs. Comparison of the combined channel construction and landside facility cost of $24,944,066 with the revenue of $78,653,863 produces a return of 3.2. Calculation of the rate of return for the NED throughput and the full facility cost is 0.7. Comparison of the Phase I construction cost and the NED throughput represents a relatively "worst case" test condition as it is based on the low cargo throughput and maximum project cost. The cost needed to realize the NED benefits would be less than the full facility cost. The cost difference would be reflected in the cargo handling equipment cost. The cargo handling equipment cost represents 36 percent of facility cost. It should be noted that the port would be less inclined to construct the facility if they did not anticipate capturing the higher volumes identified in the market analyses; however, the associated cost analysis suggests that the transportation cost benefits and associated tariff generated revenues are sufficient to cover the water and landside construction and maintenance cost based on the Port's expected tonnage throughput.

Corpus Christi and La Quinta Channels Benefit Summary

Table 46 displays a summary of the NED benefits for deepening the Corpus Christi Channel, widening the bay reach, and extending the La Quinta Channel. The project benefits were calculated at 5.875 percent interest and are for the period 2006-56. The NED plan for the Corpus Christi Main Channel is the 52- by 530-foot alternative. The NED plan for the La Quinta extension is 39 feet. The barge shelf feature has a benefit-to-cost ratio of 1.3 and justified as a stand-alone feature.

Table 46

Construction Cost and Benefit Summary 2006-2056 and AAEB 5.875%

	First Cost	Average Annual Cost	O&M Cost	Total Cost a/	Annual Benefits	B/C Ratio	Net Excess Benefits
Corpus Christi Channel Beneficial Use Plans Deepening, Widening							
48x530	$109,687,247	$6,837,904	$947,809	$7,785,713	$15,571,529	2.0	$7,785,816
50x530	$143,475,000	$8,944,233	$1,303,607	$10,247,840	$24,405,167	2.4	$14,157,327
52x530	$156,984,000	$9,786,384	$1,669,900	$11,456,284	$32,606,650	2.8	$21,150,365
Corpus Christi Barge Shelf							
	$1,257,000	$78,361	$26,982	$105,343	$134,598	1.3	$29,255
La Quinta Channel Deepening of Existing 45-foot Project							
48	$12,683,000	$790,658	n/a	$790,658	$482,169	0.6	($308,489)
50	$13,279,000	$827,813	n/a	$827,813	$702,502	0.8	($125,311)
52	$13,297,700	$828,979	n/a	$828,979	$702,502	0.8	($126,477)
La Quinta Channel Extension of Existing Project							
36 a/	23,195,000	$1,445,692	$546,850	$1,992,542			
37 d/	23,557,500	$1,468,575	$547,824	$2,016,398	$8,913,620	4.4	$6,897,222
38 a/	23,920,000	$1,491,173	$548,797	$2,039,970	$9,230,160	4.5	$7,190,190
39 d/	23,968,000	$1,494,165	$550,306	$2,044,471	$9,264,460	4.5	$7,219,989
40 a/	24,016,000	$1,497,158	$551,815	$2,048,973	$9,238,000	4.5	$7,189,027
41 d/	24,418,000	$1,522,218	$556,424	$2,078,642	$9,145,880	4.4	$7,067,238
42 a/	24,820,000	$1,547,279	$561,032	$2,108,311	$9,145,880	4.3	$7,037,569

a/ Provided by Cost Estimating Branch, December 2001 unless otherwise noted.
b/ The 48-foot project cost was estimating by applying the December 1999 to 2001 price change factor to the December 1999 costs provided by the Cost Estimating Branch.
c/ The cost for deepening of the existing La Quinta Channel were done by Cost Estimating in December 1999 and reflect 1999 prices.
d/ The costs for La Quinta 37-, 39-, and 41-foot depths were interpolated.

DEEP-DRAFT TRANSPORTATION SAVINGS SENSITIVITY ANALYSIS

Introduction

Sensitivities were evaluated for crude petroleum and petroleum product imports. The sensitivity effects were assessed in relationship to the benefit-to-cost ratios, net excess benefits, and NED plan. The tonnage ranges used for the sensitivities were based on the upper and lower range of the projection levels displayed in Tables 2 and 6. The percentage of tonnage expected to utilize Corpus Christi channel depths beyond the existing 45-foot depth was also evaluated for the crude petroleum and petroleum product import sensitivities. An additional criteria used for crude petroleum was evaluation of the alternative distributions of direct shipment versus offshore transfer for North Sea and Africa tonnage. As discussed previously and outlined in the following section, there is a relatively large degree of variance in transportation cost for this route.

Crude Petroleum Imports

Two crude petroleum sensitivity scenarios were developed using the lower and higher range crude petroleum import forecasts and alternative percentage distributions of direct versus lightering or lightening. Lightering and lightening are referred to as offshore transfer. As discussed in detail in the main portion of the appendix, lightering involves the transfer of tonnage at an offshore location from a larger vessel, called a VLCC (Very Large Crude Carrier), onto one or more shuttle vessels. With lightering, the VLCC does not enter the coastal receiving port.

Total tonnage used for the low and high range scenarios was displayed in Table 2 and is summarized in Table 47. Besides the percentage of tonnage expected to utilize increased Corpus Christi channel depth, the most sensitive variable affecting the crude petroleum import benefits is the distribution of direct shipments versus offshore transfer. As discussed on pages 30-32 and presented in Table 20, direct shipment is the least cost method for shipments from Mexico and South America and offshore transfer is the least cost shipping method for the North Sea, Africa, and the Middle East. The cost analyses showed that a long duration offshore transfer process due to demurrage, the less cost effective offshore transfer is. The range of demurrage used for offshore transfer sensitivity was defined to range from a minimum of 1.0; average 1.8; and maximum of 2.5. The range was identified based on industry input. As noted in the main portion of the appendix, industry personnel indicated that the number of days to completely lighter a VLCC is normally from 4 to 10 and the average number of days to completely lighter 200,000 to 300,000 dwt vessels is 5.5; however, it was noted that 2 weeks is not uncommon.

Five and a-half days equate to 1.5 times the in-port unloading rate. Utilization of the upper limit of 2 weeks relates to a less than optimal shuttle turnaround.

Table 47
Corpus Christi Crude Petroleum Import Tonnage Forecast (1998-2056)
1000's of Short Tons

		Corpus Christi Crude Petroleum Imports		
	U. S. Imports		95% Confidence Interval	
Year	EIA Reference Forecast	Base Case Imports	Lower Range	Upper Range
1998	476,638	33,931	33,931	33,931
1999	477,999	34,049	34,049	34,049
2000	484,584	35,121	35,121	35,121
2006	570,286	42,037	32,601	51,474
2016	674,092	51,023	40,414	61,631
2025	709,060	54,050	45,835	62,264
2026	719,939	53,093	42,216	63,970
2036	838,342	55,247	44,098	66,398
2046	976,218	57,488	46,063	68,917
2056	1,136,769	59,821	48,117	71,532
		Average Annual Growth Rates		
2000-2025	1.5%	1.7%	1.1%	2.3%
2000-2056	1.5%	1.0%	0.6%	1.3%

Source: Application of the DOE/EIA 2003 Annual Review Forecast.

The minimum cost per ton for offshore transfer is based on a factor difference between on-shore and offshore demurrage of 1.0. The mean and maximum costs are based on a triangular distribution of 1 as a minimum, 1.8 as the mean, and 2.5 as the maximum. The factor of 1.8 is slightly higher than the factor difference between the on-shore and offshore average and 2.5 is less than the maximum factor difference between two weeks and on-shore loading rates. The latter factor difference is 3.5. It is recognized that offshore transfer rates are characteristically faster than on-shore rates. Recent discussions with industry indicated that offshore transfer rates average 40,000 barrels per hours, whereas on-shore rates average 25,000 to 35,000. These transfer rates were used for the main report analysis and for this sensitivity.

The maximum cost calculations used both for the sensitivity and the main portion of the appendix reflect utilization of some less than optimal vessels; however, the same range of vessels were used for the mean and maximum cost calculations. The direct shipment costs, like the costs for offshore transfer, reflects utilization of the most efficient range of vessel sizes given the Corpus Christi channel depths and trade route constraints.

Analysis of the Middle East transportation costs showed that, even with long duration offshore transfer periods, direct shipment is more costly than lightering. Review of shipping records for 2000 indicates no direct shipments for Middle East crude oil. The cost difference between lightening and direct shipment for the North Sea and Africa route is relatively small and there is an overlap in the costs between the two methods of shipment. The overlap appears to contribute to a significant portion of North Sea and Africa crude oil imports being shipped direct. Table 48 displays the mean, minimum and maximum cost by method of shipment cost for direct, lightening, and lightening for Africa and North Sea movements. Crude petroleum shipped from Africa and the North Sea is normally transported in Suezmax vessels, which characteristically range between 126,000 and 158,000 dwt. The median design drafts for Suezmax vessels exceed 50 feet. Crude shipped from the Persian Gulf is usually shipped in VLCCs and ULCCs (ultra large crude carriers). The VLCCs and ULCCs remain offshore and transfer oil to shuttle vessels. VLCCs are characteristically between 200,000 and 350,000 dwt.

The benefit calculations for the *low range* crude petroleum import sensitivity are based on 100 percent of Africa and North Sea crude oil imports using offshore transfer. The historical data shows that approximately 50 percent of Africa and North Sea is presently shipped direct and the remainder is lightered or lightened. The *higher range* crude petroleum import scenario assumes the same distribution of direct versus offshore transfer as the base case scenario but has 75 to 85 percent of tonnage utilizing the increased channel depth instead of the 50 percent used for the base case. Table 49 displays the base case tonnage distribution. The tonnage for the low and high range sensitivities were calculated from these base tonnages.

Table 50 presents the low and high range for the crude petroleum import benefits. For comparative purposes, the benefits for the base case as presented in Tables 21-23 are also summarized in Table 50.

Table 48
Corpus Christi Crude Petroleum Imports
Transportation Cost by Method of Shipment for Representative Trade Routes

Channel	North Sea & Africa			Africa		
Depth	Mean	Min	Max	Mean	Min	Max
			Direct Shipment			
45	$9.80	$9.44	$10.38	$10.91	$10.46	$11.40
47	$9.17	$8.79	$9.66	$10.22	$9.80	$10.68
48	$8.89	$8.50	$9.36	$9.90	$9.49	$10.35
50	$8.38	$8.01	$8.79	$9.33	$8.95	$9.76
52	$7.83	$7.57	$7.98	$8.72	$8.46	$8.85
			Lightened			
45	$9.80	$9.44	$10.38	$10.91	$10.46	$11.40
47	$9.17	$8.79	$9.66	$10.22	$9.80	$10.68
48	$8.89	$8.50	$9.36	$9.90	$9.49	$10.35
50	$8.38	$8.01	$8.79	$9.33	$8.95	$9.76
52	$7.83	$7.57	$7.98	$8.72	$8.46	$8.85
			Lightered			
45	$9.89	$7.87	$12.68	$10.68	$8.66	$13.47
47	$9.89	$7.85	$12.68	$10.68	$8.64	$13.47
48	$9.28	$7.64	$11.75	$10.68	$8.43	$12.54
50	$9.28	$7.64	$11.75	$10.68	$8.43	$12.54
52	$9.28	$7.64	$11.75	$10.68	$8.43	$12.54

Petroleum Product Imports

The sensitivity evaluation for petroleum product imports was based on the lower and upper ends of the tonnage projections presented in Table 6. Total tonnage used for the low and high range scenarios as displayed in Table 6 and is summarized in Table 50. The transportation savings for the base case assume 30 percent utilization of the channel depths over 45-feet. The low range sensitivity assumes 15 percent, and the high range assumes 50 percent. Table 51 summarizes the base case transportation savings benefits and the low and high range sensitivities.

Summary of Sensitivity Findings

Table 52 summarizes the effects of the sensitivities on the benefit-to-cost ratios, net excess benefits, and subsequent determination of the NED plan. The indication from the sensitivities evaluated is that the is no change in the NED plan.

Table 49
Recommended Plan
Deep-Draft Tonnage Used for Channel Deepening Benefits
Method of Shipment & Trade Route

Direct Shipments	2000	2006	2016	2026	2036	2046	2056
South America & Mexico	7,377	7,377	8,952	10,464	12,227	14,287	16,694
Mexico	3,820	3,820	4,635	5,418	6,331	7,398	8,644
Latin America	3,557	3,557	4,317	5,046	5,896	6,889	8,050
Europe/Africa/Med	1,347	1,493	1,893	1,995	1,988	2,060	2,206
N Sea	406	328	310	302	266	234	207
Africa	941	1,165	1,583	1,694	1,722	1,825	1,999
Middle East	0	0	0	0	0	0	0
Far East	0	0	0	0	0	0	0
Total Direct	8,724	8,871	10,846	12,459	14,214	16,346	18,900
Lightered / Lightened							
South America & Mexico	0	228	277	324	378	442	516
Europe/Africa/Med	1,347	1,493	1,893	1,995	1,988	2,060	2,206
Middle East	2,052	3,768	6,627	7,721	8,151	8,614	9,110
Far East	208	419	539	517	452	397	351
Total Lightered	3,607	5,909	9,336	10,557	10,968	11,512	12,183
Total Used For Benefits	12,331	14,779	20,182	23,015	25,182	27,859	31,084
Total Tonnage	35,121	42,037	51,023	54,050	53,093	57,488	59,821
% of Total Tonnage	35%	35%	40%	43%	47%	48%	52%

Table 50

Corpus Christi Crude Petroleum Imports
Transportation Savings Sensitivity Comparison

	47-ft	48-ft	49-ft	50-ft	52-ft
		Base Case (Table 23)			
2006	$2,046,782	$3,051,880	$3,933,197	$4,814,515	$6,538,781
2016	$2,478,575	$3,742,684	$4,837,654	$5,932,624	$8,020,328
2026	$2,763,835	$4,179,875	$5,404,367	$6,628,858	$8,954,159
2036	$2,971,859	$4,488,804	$5,801,490	$7,114,175	$9,609,149
2046	$3,241,509	$4,887,623	$6,313,811	$7,739,998	$10,456,155
2056	$3,579,494	$5,385,976	$6,953,632	$8,521,288	$11,515,651
2006-56 @ 5.875%	$3,579,494	$5,385,976	$6,953,632	$8,521,288	$11,515,651
		Low Range Scenario			
2006	$656,194	$2,790,606	$3,305,923	$3,767,302	$4,527,226
2016	$1,007,594	$3,300,435	$4,015,331	$4,673,580	$5,762,280
2026	$1,147,215	$3,562,471	$4,352,969	$5,085,200	$6,303,779
2036	$1,289,651	$3,898,699	$4,767,786	$5,575,457	$6,933,798
2046	$1,456,247	$4,315,463	$5,277,337	$6,173,325	$7,695,173
2056	$1,650,272	$4,823,076	$5,893,497	$6,892,132	$8,604,269
2006-56 @ 5.875%	$1,037,565	$3,464,803	$4,198,761	$4,873,460	$5,996,204
		High Range Scenario			
2006	$5,628,616	$6,694,142	$8,904,925	$11,167,258	$15,724,407
2016	$8,359,568	$8,437,373	$11,472,623	$14,635,950	$21,015,107
2026	$8,743,580	$8,868,917	$12,045,902	$15,356,132	$22,010,144
2036	$8,652,477	$9,313,938	$12,546,186	$15,893,659	$22,579,614
2046	$8,584,550	$9,900,293	$13,212,794	$16,619,159	$23,376,740
2056	$8,536,264	$10,636,770	$14,052,332	$17,536,708	$24,399,917
2006-56 @ 5.875%	$7,954,421	$8,507,407	$11,472,128	$14,543,200	$20,713,112

Table 51
U. S. and Corpus Christi Petroleum Product Import Forecast (1998-2056)
Thousand of Short Tons
Corpus Christi Petroleum Product Imports

Year	Base Case Forecast Application	Lower Range	Upper Range
1998	7,495	7,495	7,495
1999	7,627	7,627	7,627
2000	9,702	9,702	9,702
2006	12,975	5,693	20,258
2016	19,472	10,240	28,703
2025	26,614	15,528	37,699
2026	27,596	16,340	38,852
2036	39,124	25,921	52,328
2046	54,429	38,740	70,118
2056	74,720	55,842	93,597
		Average Annual Growth Rates	
2000-2025	3.9%	1.7%	5.3%
2000-2056	3.6%	3.1%	4.0%

Source: Application of the DOE/EIA 2003 Annual Review Forecast.

Table 52

Corpus Christi Petroleum Product Imports
Transportation Savings Sensitivity Comparison

	47-ft	48-ft	49-ft	50-ft	52-ft
	Petroleum Product Base Case (Table 29)				
2006	$3,353,952	$5,009,693	$6,257,142	$8,036,137	$10,130,004
2016	$5,788,140	$7,719,089	$10,111,294	$12,783,391	$17,553,898
2026	$8,253,453	$11,614,614	$14,989,776	$18,764,746	$25,695,217
2036	$11,564,306	$16,304,365	$21,029,747	$26,321,849	$36,013,210
2046	$15,949,079	$22,517,821	$29,031,079	$36,332,645	$49,678,841
2056	$21,831,743	$30,837,682	$39,751,544	$49,747,544	$68,007,299
2006-56 @ 5.875%	$7,361,546	$10,302,120	$13,284,971	$16,731,076	$22,669,722
	Petroleum Product Low Range Scenario				
2006	$735,801	$1,099,044	$1,372,713	$1,762,995	$2,222,355
2016	$1,521,943	$2,029,670	$2,658,681	$3,361,286	$4,615,651
2026	$2,443,496	$3,438,592	$4,437,834	$5,555,442	$7,607,259
2036	$3,830,876	$5,401,102	$6,966,467	$8,719,566	$11,929,997
2046	$5,675,902	$8,013,562	$10,331,478	$12,929,933	$17,679,530
2056	$8,157,978	$11,523,273	$14,854,160	$18,589,416	$25,412,631
2006-56 @ 5.875%	$2,178,438	$3,047,847	$3,932,866	$4,947,094	$6,720,818
	Petroleum Product High Range Scenario				
2006	$8,727,599	$13,036,143	$16,282,233	$20,911,504	$26,360,131
2016	$14,220,161	$18,964,068	$24,841,180	$31,405,922	$43,125,988
2026	$19,366,523	$27,253,405	$35,173,139	$44,031,013	$60,293,193
2036	$25,778,593	$36,344,905	$46,878,498	$58,675,395	$80,278,909
2046	$34,243,924	$48,347,527	$62,332,003	$78,009,039	$106,664,368
2056	$45,578,730	$64,380,678	$82,990,391	$103,859,316	$141,980,709
2006-56 @ 5.875%	$17,277,019	$24,180,927	$31,173,689	$39,279,953	$53,162,995

Table 53

Construction Cost and Benefit Summary 2006-2056 and AAEB 5.875%

Plan	First Cost	Average Annual Cost	O&M Cost	Total Cost a/	Annual Benefits	B/C Ratio	Net Excess Benefits
			Base Case (Table 46) Corpus Christi Channel Beneficial Use Plans Deepening, Widening				
48x530	$109,687,247	$6,837,904	$947,809	$7,785,713	$15,571,529	2.0	$7,785,816
50x530	$143,475,000	$8,944,233	$1,303,607	$10,247,840	$24,405,167	2.4	$14,157,327
52x530	~~$156,984,000~~	~~$9,786,384~~	~~$1,669,900~~	~~$11,456,284~~	~~$32,606,650~~	~~2.8~~	$21,150,365
			Low Range Scenario Corpus Christi Channel Beneficial Use Plans Deepening, Widening				
48x530	$109,687,247	$6,837,904	$947,809	$7,785,713	$7,851,507	1.0	$65,794
50x530	$143,475,000	$8,944,233	$1,303,607	$10,247,840	$11,271,052	1.1	$1,023,212
52x530	$156,984,000	$9,786,384	$1,669,900	$11,456,284	$14,234,742	1.2	$2,778,457
			High Range Scenario Corpus Christi Channel Beneficial Use Plans Deepening, Widening				
48x530	$109,687,247	$6,837,904	$947,809	$7,785,713	$34,027,191	4.4	$26,241,478
50x530	$143,475,000	$8,944,233	$1,303,607	$10,247,840	$55,273,651	5.4	$45,025,811
52x530	$156,984,000	$9,786,384	$1,669,900	$11,456,284	$75,393,826	6.6	$63,937,542