

**APPENDIX G**

**CORPUS CHRISTI SHIP CHANNEL –CHANNEL IMPROVEMENT PROJECT  
ECONOMIC APPENDIX**

**CORPUS CHRIST SHIP CHANNEL ECONOMIC BENEFIT ANALYSIS**  
**ECONOMIC APPENDIX**  
**4 APRIL 2003**

***Introduction***

This appendix presents the economic evaluation of project modifications to the Corpus Christi and La Quinta channels. The project benefits were calculated based on reductions in transportation costs. Benefits were evaluated for the following alternatives: Corpus Christi depths of 48, 50 and 52 feet; deepening the existing Federal portion of the La Quinta Channel; extension of the La Quinta Channel Federal project; and widening Corpus Christi Bay Channel 400- and 500-foot reaches to 530 feet. In addition to widening of the bay channel, benefits were evaluated for a barge shelf in the 400-foot reach. The barge shelf would extend from 200 feet on each side from the toe of the proposed 530-foot channel.

An initial screening analysis of the plan alternatives was completed in January 2000. The screening results were presented at the 4 April 2000 Feasibility Scoping Meeting (FSM). The analysis showed that a Corpus Christi channel depth of 52 feet produced the highest net excess benefits for the deepening plans evaluated for the main channel. The results also suggested that additional studies were necessary to conclude if widening of the bay reach and extension of the La Quinta channel was in the Federal interest. An additional recommendation of the FSM was to further investigate deepening the La Quinta Channel beyond the existing project depth of 45 feet. In regard to channel widening, the non-Federal sponsor and pilots association expressed a strong interest in widening of the bay reach due to safety concerns along with associated vessel delays and self-imposed vessel meeting restrictions. The recommendation for widening the entire bay reach to 530 feet was based on the Engineering Research and Development Center (ERDC) findings and the safety interest of Port Aransas Pilots Association. The pilots presently limit vessel meetings to combined beam width up to 251 feet in the 400-foot reach and to combined loaded draft limit of 80 feet.

The project benefits were calculated for a 2006-2056 economic evaluation period and are based on the Fiscal Year (FY) 2003 Federal Discount rate of 5.875 percent and FY 2002 vessel operating costs (EGM 02-06). The EGM 02-06 was released in the Fall of 2002 and the next release will likely be in 2004. A 1998-2000 base period is displayed in the cost savings Tables. Some early release data for calendar years 2001-02 is also displayed in the presentation Tables; however, because its availability is not complete, evaluation is generally limited to review of its effects on the forecasted trendlines. This appendix consists of five sections. The first section

presents the commodity forecasts and the next three sections contain the Corpus Christi Inner Harbor deepening and the widening benefits and the La Quinta Channel deepening and channel extension analysis. The last section contains a sensitivity of the channel deepening benefits.

### *Commodity and Fleet Forecast.*

Due to the magnitude of the ocean-going tonnage transported through the Corpus Christi navigation system, historic trends were initially assessed for the purpose of determining the commodity groups currently or anticipated to be limited by the constraints of the existing and the without-project future channel dimensions. Within the context of this framework, channel constraints were defined to exist when some percentage of the tonnage associated with a commodity group is currently or anticipated to be transported in vessels that cannot be fully loaded. The historic transit data analysis revealed that at least some of the vessels used in the transport of crude petroleum, petroleum products, and grain are transported in draft-constrained vessels. Review of the historical transit data and vessel fleet trends resulted in detailed analyses for crude petroleum; petroleum products; and bulk grain. The detailed analysis included examination of port depths and associated trade route constraints. Tonnage associated with the remaining ocean-going commodity groups, which were found either not to be transported in draft constrained vessels at the current time or were of limited volumes, was analyzed in the aggregate. Barge traffic forecasts generated by the USCE for the Institute for Water Resources' "Inland Waterway Reports" were utilized to estimate the study area's 2006-56 shallow-draft barge movements.

The tonnage forecasts were developed using multiple-regression equations that incorporated data for the most recent 20 to 40 year period. The vessel fleet projections are based on analysis of existing fleet utilization and anticipated trends and the premise that vessel utilization will gravitate to the most efficient vessel sizes for a specific channel depth given port depth and trade route constraints. The project benefits reflect the inclusion of risk-based evaluation parameters. Probability distributions were calculated for the traffic forecasts. Risk based distributions were also used to calculate the estimated percentage of tonnage expected to utilize project depths over 45 feet.

The commodity and fleet projections prepared for the major commodity groups were primarily based on forecasts published in the U. S. Department of Energy's 2003 Annual Energy Outlook, January 2003; the U. S. Department of Commerce's 1996 Bureau of Economic Analysis

projections<sup>1</sup>; and the February 2002 U. S. Department of Agriculture projections; and indices developed from historical trend data. The forecast data were assessed in relationship to the study area's historical commodity specific tonnage flows for the purpose of evaluating the relationship between historical U.S. tonnage volumes and study area tonnage. Assessment of the statistical variables associated with U. S. and study area tonnage provided the analytical support needed to determine which forecast would furnish the best long-term estimation of future study area tonnage flows. Total ocean-going tonnage for the 50-year period of analysis was established using the premise that the commodity groups that have historically represented the majority of foreign and coastwise tonnage, specifically, crude petroleum, petrochemical, and bulk grain would continue to dominate total tonnage in the future. A separate forecast of La Quinta container traffic was conducted.

### ***Crude Petroleum***

Corpus Christi crude petroleum imports exhibited a general upward trend during the nineteen nineties after the downturn experienced in the early eighties. Imports for the period 1991-00 averaged 29,908,000 short tons compared to 12,520,000 for the period 1981-90. In 2000, Corpus Christi imported 35,830,000 short tons. Table 1 displays 1965-2000 Corpus Christi and U. S. imports and production statistics. Analysis of the national and regional crude petroleum import volumes revealed a significant degree of correlation between study area and U. S. tonnage levels. The regional and national growth rates generally follow the same general trends, however, regional growth is characteristically higher than national growth. Average U. S. import levels increased by 72 percent from the nineteen-eighties to the nineties, and Corpus Christi imports increased by 139 percent. Corpus Christi and U. S. crude oil import trends are also correlated with U.S. production.<sup>2</sup> Increasing import levels for the study area and the nation parallels declines in domestic oil production. Average 1991-00 production for both the "lower 48 states" and Alaska was down 22 percent from 1981-90 levels.

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<sup>1</sup> For use in this document, the 1996 base associated with the Bureau of Economic Analysis projections was expanded to include records for 1997-2000. The BEA projections were used as input into regression equations, and the effect of the regression equation forecasts reflect the inclusion of the 1997-2000 expanded base. The BEA projections were used for Corpus Christi's grain export forecast.

<sup>2</sup> Regression analysis using Corpus Christi 1960-2000 crude oil imports as a function of U.S. Production generated an R Square of .64. The t-value and F statistics significant at the .001 level. The R Square estimated from the equation using Corpus imports as a function of U. S. imports for the same period is .92.

**Table 1**  
**United States and Corpus Christi 1960-2000**  
**Crude Petroleum Imports and Production (1000's of short tons)**

Year	Imports		Production	
	Corpus Christi	United States	Lower 48 States	Alaska
1960	92	55,703	385,827	84
1965	0	67,806	425,245	1,668
1970	222	72,494	514,636	12,532
1975	9,183	224,727	447,659	10,466
1980	11,060	288,924	382,881	88,671
1981	12,864	240,705	380,868	88,025
1982	8,769	190,982	380,346	92,757
1983	7,445	182,284	381,495	93,749
1984	8,894	188,092	392,559	94,479
1985	9,001	175,245	390,914	99,850
1986	13,092	228,747	372,723	102,109
1987	15,060	255,888	349,415	107,302
1988	15,563	280,351	335,860	110,627
1989	18,240	319,914	313,951	102,509
1990	16,269	322,708	305,346	97,014
1991	16,261	316,580	307,341	98,368
1992	17,365	333,951	299,341	94,018
1993	18,395	371,585	287,985	86,550
1994	29,756	386,711	279,141	85,269
1995	27,183	395,822	277,655	81,179
1996	36,737	412,176	278,165	76,435
1997	41,627	450,345	282,041	70,882
1998	39,886	476,638	277,723	64,273
1999	36,029	477,999	264,304	57,431
2000	35,840	484,584	266,099	53,234
2001	32,226	483,249	267,174	52,979
1981-90 Average Tonnage	12,520	238,492	360,348	98,842
1991-00 Average Tonnage	29,908	411,220	281,980	76,764
% Change	139%	72%	-22%	-22%
Average Annual Growth Rates				
1981-90	2.6%	3.3%	-2.4%	1.1%
1990-91	9.2%	4.8%	-1.6%	-6.6%

Source: U.S. Army Corps of Engineers, Waterborne Commerce of the United States 1965-00 and U. S. Dept. of Energy, Energy Information Administration website, January 2003.

Corpus Christi's crude petroleum tonnage forecast was calculated using the EIA 2003 Annual Energy Outlook reference case 2000-25 projections. The EIA is projecting world oil demand to increase from 76 million barrels per day in 2001 to 123 million barrels per day in 2025, representing an average annual growth rate of 2 percent. The projected increase is due to growing petroleum demand in the U. S. as well as the Middle East, the former Soviet Union, the Pacific Rim developing countries, and China. OPEC oil production is expected to reach 60.2 million barrels per day (mbd) in 2020, representing a 123 percent increase over the 2001 and 2002 respective averages of 28 and 26 mbd. Foreign imports of crude oil have replaced domestic production for both the U. S. and Corpus Christi. The EIA notes that U. S. crude oil production is projected to decline at an average annual rate of 0.4 percent from 2001 to 2025. Advances in domestic exploration and production are not expected to offset declining oil resources. The share of demand met by net imports is projected to increase from 51 percent in 1999 to 68 percent in 2020. The EIA's current forecast shows U. S. imports increasing from 9 mbd in 2000 to 12.7 mbd in 2020 and to 13.1 mbd in 2025.

During the eighties, significant volumes of Alaskan crude petroleum was shipped to U. S. Gulf Coast ports in Post-Panama tankers from Chiriqui Grande, Panama. The Alaskan crude was shipped from Alaska to the western side of the Panama Canal where it was pipelined to Chiriqui Grande for distribution to the U. S. Gulf and East coasts. Alaskan crude is presently not shipped into Corpus Christi, nor other U. S. Gulf or East Coast ports, and shipments are not forecasted to resume in the future. Receipt of coastwise crude oil tanker vessels into Corpus Christi was low during the nineties and is expected to remain so for the foreseeable future. The EIA (January 2003) forecast shows a steady decline in Alaskan crude petroleum production from .99 million barrels per day in 2000 to .68 million barrels in 2011, followed by an increase to 1.23 million barrels per day in 2020 and decline to 1.17 million in 2025.

Corpus Christi's 2006-56 import volumes were estimated using a regression equation derivation with 1960-2000 Corpus Christi imports as a function of U. S. imports. The t value and F statistic for the equation are significant at the 99.9 percent level and the R square is .93. Figure 1 shows the trendlines for U. S. and Corpus Christi crude oil imports.

**Figure 1**  
U. S. and Corpus Christi Crude Petroleum Imports 1960-2000 (short tons)

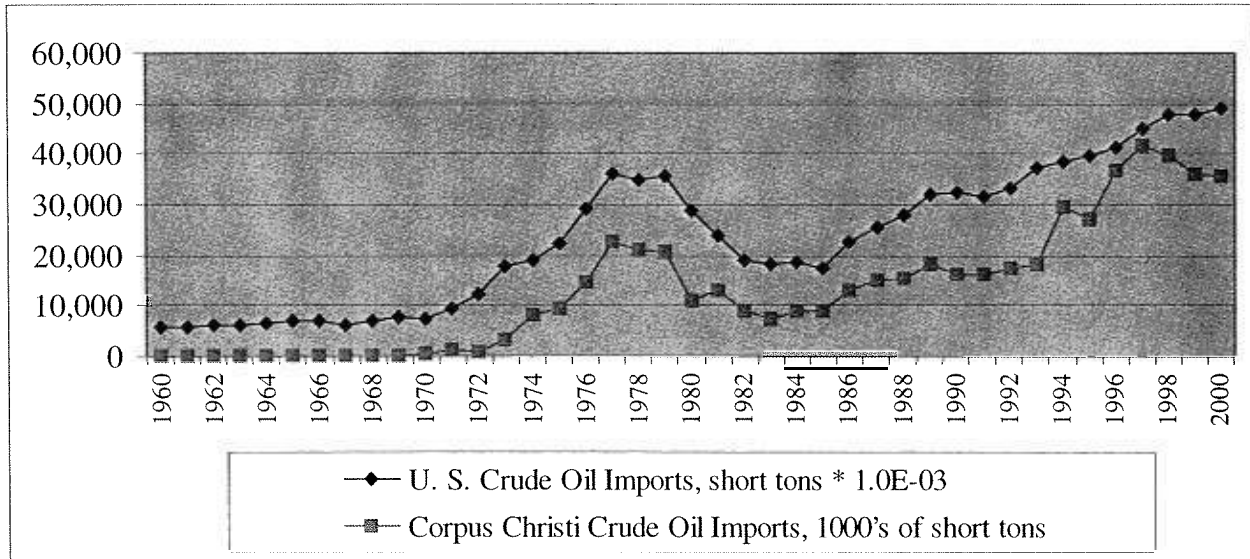


Table 2 displays the U. S. Corpus Christi tonnage forecasts. The 99 percent confidence interval associated with the estimated equation shown in Table 2 represents a relatively narrow upper and lower band of import levels. The standard error of the y estimate showed that Corpus Christi estimated tonnage is well within one standard error of the y estimate.

***Petroleum Product Import Forecast***

Table 3 presents Corpus Christi and U. S. petroleum import and export tonnage data. Corpus Christi refined products imports increased from an average of 4,863,000 short tons for the period 1981-90 to 8,335,000 for the period from 1991-00. In 2000, Corpus Christi imports were up by 27 percent from 1999 and U. S. levels were up 13 percent. Distribution of Corpus Christi and U. S. 1990-2000 product imports by major group is displayed in Table 4. Analysis of the historical national and regional product import volumes showed that, on average, study area imports increased at a higher rate than the national average. Regional growth was significantly higher for the 1981-90 period than between 1991-00. In recent years, regional growth has slowed and is

**Table 2**  
Corpus Christi Crude Petroleum Import Tonnage Forecast (1998-2056)  
1000's of Short Tons

Year	Corpus Christi Crude Petroleum Imports			
	U. S. Imports	95% Confidence Interval		
	EIA Reference Forecast	Base Case Imports a/	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%

**Corpus Christi Crude Petroleum Imports = f(U. S. Imports) 1960-2000**

**Regression Equation Output**

Multiple R	0.959
R Square	0.919
Adjusted R Square	0.917
Standard Error	3,512
Observations	40

**Analysis of Variance Table**

	df	SS	MS	F Statistic	Significance F
Regression	1	5.3E+09	5.3E+09	4.3E+02	2.4E-22
Residual	38	4.7E+08	1.2E+07		
Total	39	5.8E+09			
	Coefficients	Standard Error	t Stat	Lower 95%	Upper 95%
Intercept	-7327	1105	-6.6	-9564	-5090
U. S. Imports	0.087	0.004	20.8	0.078	0.095

a/ Corpus 2006 imports = -7327 + (U. S. 2006 Imports in BTUs \* .087). The EIA 1998-2000, 2005, 2010, 2020 and 2025 respective import volumes are 18.9, 19.0, 19.7, 20.3, 22.3, 25.1, 26.9, 27.6, and 28.5 quadrillion Btu per year. The corresponding short tons equivalents are 476, 478, 490, 556, 570, 626, 688, and 709 thousand, respectively.

b/ The 2020-2025 growth rate of 2.9% was used to estimate gross domestic product for 2025-56.

Source: Application of the U. S. Department of Energy (DOE/EIA), 2003 Annual Energy Outlook, reference case forecast, January 2003.



**Table 3**  
**U. S. and Corpus Christi 1965-2000 Petroleum Products**  
**Imports and Exports (1000's of short tons)**

Year	United States a/		Corpus Christi b/	
	Imports	Exports	Imports	Exports
1960	43,843	10,614	444	141
1965	67,252	10,070	148	2
1970	114,617	13,409	29	1
1975	106,732	11,133	55	67
1980	90,304	14,136	287	73
1981	87,483	20,062	666	290
1982	88,896	31,658	1,717	1,097
1983	94,197	31,459	3,705	1,293
1984	110,304	29,651	4,655	1,444
1985	102,095	31,556	4,776	1,143
1986	111,895	34,496	6,187	1,675
1987	109,622	33,536	5,287	1,952
1988	125,913	36,232	6,135	1,844
1989	121,297	39,233	7,389	1,631
1990	116,152	40,918	8,112	1,901
1991	100,899	48,402	7,913	2,813
1992	98,999	47,226	8,441	2,393
1993	100,298	49,479	7,316	2,774
1994	105,742	46,142	10,527	2,451
1995	87,816	46,755	7,818	2,042
1996	108,170	47,762	8,350	3,092
1997	106,470	49,001	8,388	3,241
1998	109,760	45,659	7,495	2,815
1999	116,340	44,960	7,627	2,699
2000	131,160	54,307	9,702	3,112
2001	139,390	52,441	8,304	3,483
1981-90 Average	106,785	32,880	4,863	1,427
1991-00 Average	106,565	47,754	8,335	2,667
% Change	-0.2%	45%	71%	87%
Average Annual Growth Rate				
1981-90	3.2%	8.2%	32.0%	23.2%
1991-00	3.0%	1.3%	2.3%	1.1%

a/ U. S. Department of Energy, Energy Information Administration, January 2003.

b/ USACE, Waterborne Commerce of the United States, 1965-2000, Part 2.

**Table 4**  
**Corpus Christi and United States**  
**Major Petroleum Product Imports (1000's of short tons)**

**Corpus Christi Petroleum Product Foreign Imports, Major Groups**

	1990	1995	1996	1997	1998	1999	2000
Gasoline	0	0	0	0	0	0	96
Kerosene	0	0	0	60	141	142	0
Naphtha & solvents	1,940	1,964	5,410	5,719	4,610	2,846	1,129
Distillate fuel oil	0	228	196	195	711	2,487	1,608
Residual fuel oil	4,824	4,846	1,973	1,415	1,017	1,315	5,024
Lube oil	1,228	780	728	999	957	835	1,794
Sub-group total	7,992	7,818	8,307	8,388	7,436	7,625	9,651
Total Product Imports	8,112	7,818	8,350	8,388	7,495	7,627	9,652
Sub-group %	99%	100%	99%	100%	99%	100%	100%

**United States Petroleum Product Foreign Imports, Major Groups a/**

	1990	1995	1996	1997	1998	1999	2000
Gasoline	19,156	12,121	21,522	19,802	16,077	17,260	24,367
Kerosene	4,134	4,102	4,304	5,087	5,674	6,317	7,383
Naphtha & solvents	14,034	11,140	15,497	14,131	12,572	14,329	17,999
Distillate fuel oil	14,477	14,509	17,774	16,986	21,543	24,179	21,294
Residual fuel oil	44,035	29,113	30,940	29,844	32,676	33,040	40,711
Lube oil	13,298	10,738	9,758	11,390	11,780	10,224	9,118
Sub-group total	109,134	81,724	99,794	97,240	100,321	105,348	120,873
Total Product Imports a/	116,152	87,816	108,170	106,470	109,760	116,340	131,160
Sub-group %	94%	93%	92%	91%	91%	91%	92%

Source: U. S. Army Corps of Engineers, Waterborne Commerce of the U. S., 1990-2000, and U. S. Department of Energy, Energy Information Administration.

generally comparable to national growth patterns. In spite of the recent plateau in national growth, with a .2 percent decline between the 1981-90 and 1991-00 averages (Table 2), the EIA is projecting future growth in refined product import volumes. Projected demand is expected to outpace anticipated refinery capacity expansions. The EIA notes that in spite of seeming stability in product imports, significant structural shifts occurred over the last few decades in the mix of products that the U. S. imports. Residual fuel oil imports are projected to decline and be replaced by unfinished gasoline and gasoline blending components. The EIA is forecasting increases in petrochemical feedstock imports, such as naphtha and gas oils. It is noted that the Gulf Coast imports significant amount of feedstock to support its role as the main U. S. refining

and petrochemical center. The EIA reference forecast shows imports of gross refined products, which includes blending components, increasing from 1.32 million barrels per day in 2000 to 5.32 million barrels per day in 2025. The forecast shows unfinished product imports, other than crude oil, increasing from 1.05 million barrels per day in 2000 to 2.51 million barrels per day in 2025.

The EIA forecasted growth is expected to effect imports of naphtha, distillate fuel oil, and kerosene. Corpus Christi oil company transportation analysts verified that an increase in refined product imports would be necessary to meet processing needs and associated demand. Refined products are expected to comprise a low of 29 percent to a high of 39 percent of net petroleum imports in 2025, as compared to 19 percent in 2000. The EIA noted that falling demand for petroleum and the deregulation of the domestic refining industry in the 1980s led to 13 years of decline in U. S. refinery capacity. During the late 1990s, domestic distillation capacity increased. It was noted in the 2002 Annual Energy Outlook (AEO) that financial and legal constraints would make it unlikely that anticipated refinery expansion can met future demand; however, it is noted in the 2003 AEO, released January 2003, that additions at existing refineries are expected to increase total U.S. refining capacity. The EIA notes that distillation capacity is projected to grow from the 2001 year-end level of 16.8 million barrels per day to 19.8 million barrels per day in 2025 in the reference case, 19.6 million barrels per day in the low economic growth case, and 20.4 million barrels per day in the high growth case, compared with the 1981 peak of 18.6 million barrels per day. Almost all the capacity additions are projected to occur on the Gulf Coast. Existing refineries are expected to continue to be utilized intensively (91 to 95 percent of operable capacity) throughout the forecast. The 2001 utilization rate was 93 percent, well above the lows of 69 percent during the 1980s and 88 percent during the early 1990s but consistent with capacity utilization rates since the mid-1990s. Additional “downstream” processing units are expected to allow domestic refineries to produce less residual fuel, which has a shrinking market, and more of the higher value “light products,” such as gasoline, distillate, jet fuel, and liquefied petroleum gas.

Table 5 summaries U. S. crude petroleum refinery data for the period 1965-2000. The data presented in Table 5 shows that refinery utilization increased in the nineteen nineties after several years of decline. The U. S. Gulf Coast leads the nation in refinery capacity, with more than twice the crude oil distillation capacity. The Gulf Coast is the nation’s leading supplier in refined products. Products, such as gasoline, heating oil, diesel, and jet fuel, are transported

from the Gulf Coast to the East Coast and the Midwest. As of January 2001, Texas petroleum refineries were operating at 99.3 percent of capacity. In calendar year 2000, Texas Gulf Coast capacity was 93.4. Data presented in the Petroleum Supply Annual shows that in 1999 Texas refinery atmospheric crude oil distillation capacity was 4,282,430 barrels per day and operating capacity 4,265,430. Fifteen percent of Texas crude oil refinery capacity is presently located in Corpus Christi.

**Table 5**  
**United States 1965-1999**  
**Refinery Capacity and Utilization**

Year	Number of Operating Refineries	Refinery Capacity Barrels/Day	Gross Input to Distillation Barrels/Day	Operable Refineries Utilization Rate
1965	293	10,419,851	9,535,395	91.5%
1970	276	12,021,273	11,491,018	95.6%
1975	279	14,960,710	12,873,296	86.0%
1980	319	17,988,121	13,802,736	76.7%
1985	223	15,658,769	12,137,936	77.5%
1990	205	15,571,966	13,579,314	87.2%
1991	202	15,675,627	13,477,804	86.0%
1992	199	15,696,155	13,607,175	86.7%
1993	187	15,120,630	13,820,256	91.4%
1994	179	15,034,160	14,000,343	93.1%
1995	175	15,434,280	14,087,230	91.3%
1996	170	15,333,450	14,344,353	93.5%
1997	164	15,451,785	14,804,822	95.8%
1998	163	15,711,000	15,079,207	96.0%
1999	159	16,261,290	15,052,213	92.6%
2000	158	16,510,000	15,310,000	92.6%
1980-90 Average	249	16,406,285	13,173,329	80.5%
1990-00 Average	178	15,618,213	14,287,520	91.5%
% Change	-28%	-5%	9%	14%

Source: U. S. Department of Energy, Energy Information Administration, Annual Energy Outlook, 2003, website data.

Table 6 presents Corpus Christi's 2006-56 petroleum product import forecast. The forecast was estimated using a regression equation with 1960-2000 Corpus Christi petroleum product imports as a function of U. S. petroleum product imports and U. S. gross domestic product. Other variables, such as petroleum production, and energy consumption were tested; however, the

**Table 6**  
U. S. and Corpus Christi Petroleum Product Import Forecast (1998-2056)  
Thousand of Short Tons

Year	U. S. Gross Domestic Product Billions of \$96	US/EIA Product Imports		Corpus Christi Petroleum Product Imports		
		Reference Case	High Growth	Base Case Forecast Application a/	99% Confidence Interval	
					Lower Range	Upper Range
1998	8,509	109,760	109,760	7,495	7,495	7,495
1999	8,859	116,340	116,340	7,627	7,627	7,627
2000	9,191	131,160	131,160	9,702	9,702	9,702
2006	10,713	141,651	169,986	12,975	5,693	20,258
2016	14,702	189,573	301,585	19,472	10,240	28,703
2025	18,917	229,405	404,253	26,614	15,528	37,699
2026	19,447 b/	231,111	410,762	27,596	16,340	38,852
2036	25,632 b/	248,883	481,897	39,124	25,921	52,328
2046	33,784 b/	268,021	565,352	54,429	38,740	70,118
2056	44,529 b/	288,632	663,260	74,720	55,842	93,597
Average Annual Growth Rates						
2000-2025	2.9%	2.3%	4.6%	3.9%	1.7%	5.3%
2000-2056	2.9% b/	1.4%	2.9%	3.6%	3.1%	4.0%

**Corpus Christi Petroleum Product Imports = f (U. S. Petroleum Product Imports and U. S. Gross Domestic Product)**

Multiple R	0.93
R Square	0.87
Adjusted R Square	0.86
Standard Error	1,373
Observations	41

**Analysis of Variance Table**

	df	SS	MS	F Statistic	Significance F
Regression	2	4.7E+08	2.4E+08	1.3E+02	1.9E-17
Residual	38	7.2E+07	1.9E+06		
Total	40	5.4E+08			
	Coefficients	Standard Error	t Stat	Lower 99%	Upper 99%
Intercept	-4138.5	890.1	-4.65	-5940.39	-2336.58
U.S. Product Imports	-0.026	0.009	-2.742	-0.045	-0.007
Gross Domestic Prod.	1.938	0.129	15.071	1.678	2.198

a/ Corpus 2006 imports = -5871.0 + (U. S. 2006 GDP \* .17732). The EIA 2000, 2001, 2005, 2010, 2020 and 2025 respective export volumes are 2.04, 2.08, 1.79, 2.59, 3.82, 5.02 and 6.76 million barrels per day. The respective short tons equivalents are shown in the Table above. The 2001-25 gross domestic product average annual growth rate presented in the EIA forecast ranges from is 3.0% in 2001/05 to 2.8% in 2020/25. The EIA shows GDP peaking at 3.4% in 2005/10. Gross Domestic Product (1996 dollars) for the years 1998-2000 was \$8,509, \$8,859, and \$9,191.

b/ The 2020-2025 growth rate of 2.9% was used to estimate gross domestic product for 2025-56.

Source: Application of the U. S. Department of Energy (DOE/EIA), 2003 Annual Energy Outlook, January 2003.

equation using U. S. product imports and gross domestic product generated the most significant t values and F statistic. These statistics are significant at the 99.9 percent level. The average annual growth rate for the period 2000-56 is estimated at 3.8 percent (Table 6) and the growth rate for 2000-25 is 4.6 percent. The study area's estimated average annual 2000-25 growth rate of 4.6 percent is higher than the EIA's 2000-25 average annual growth rate of 2.3 percent for U. S. petroleum product imports. Examination of the study area's historical trendline and the concentration of petroleum processing and distribution on the U. S. Gulf Coast suggests that a higher growth rate for the study area should not be surprising.

### ***Petroleum Product Export Forecast***

Corpus Christi refined products exports increased from an average volume of 1,244,000 short tons during the period 1980-89 to 2,622,000 tons between 1990-99. As shown in Table 3, Corpus Christi export volumes ranged from a low of 1,901,000 in 1990 to a high of 3,241,000 in 1997. In 2000, both Corpus Christi exports were up by 153 percent from 1999 and U. S. export levels were up by 21 percent. Corpus Christi experienced higher growth than the nation; however, both regional and national growth rates during the nineteen-nineties were generally low particularly in comparison to petroleum product import rates. The EIA is forecasting relatively modest growth for product exports over the period 2000-25. Exports of refined products are forecasted to increase at an average annual rate of .6 percent with an overall increase from .99 million barrels in 2000 to 1.10 million barrels in 2025.

Distribution of Corpus Christi and U. S. product exports by major group is presented in Table 7. During the period 1990-99, Corpus Christi product exports primarily consisted of petroleum coke, distillate fuel oil, and residual fuel oil. For the period 1990-99, petroleum coke comprised 38 percent of the total petroleum product exports; distillate fuel oil represented 26 percent, and gasoline 15 percent. Due to logistical, regulatory, and quality considerations, the Gulf Coast exports some lower quality gasoline to Latin America while the U. S. East Coast imports higher quality gasoline from Europe. Examination of 1996-98 petroleum export vessel routings showed that 26 percent of petroleum product were transported in vessels with design drafts over 43 feet and 18 percent in vessels with drafts over 46 feet. The larger vessels are used for the shipment of coke, fuel oil and gasoline. Eighty percent of 1996-98 petroleum coke exports were shipped to Northern Europe, 6 percent to North Africa and Mediterranean ports, and the remaining 14 percent were exported to South and Central America.

**Table 7**  
**Corpus Christi and United States**  
**Major Petroleum Product Exports (1000's of short tons)**

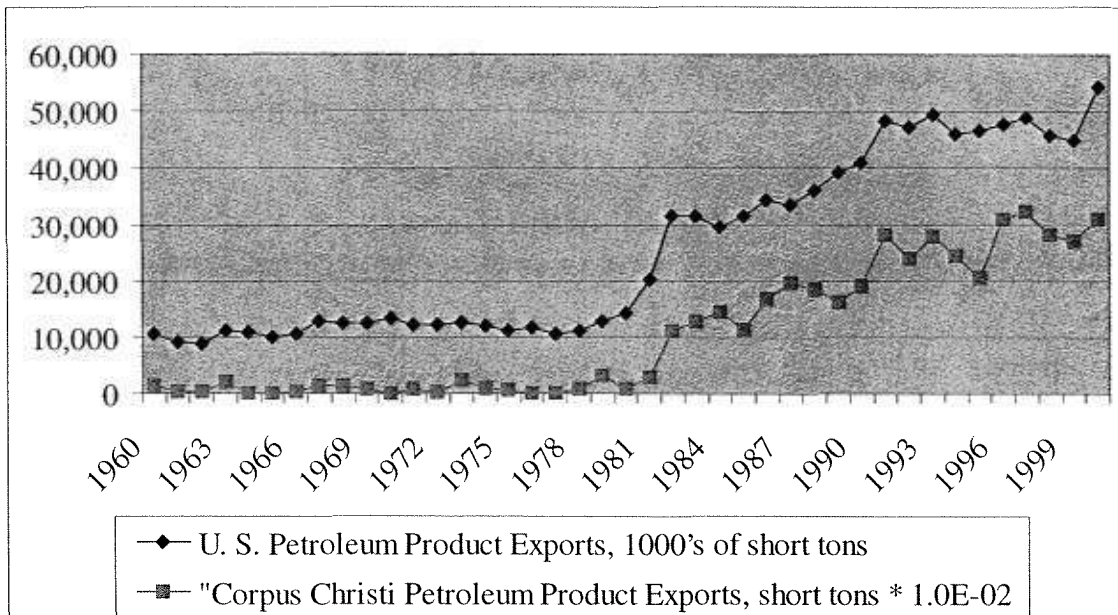
<b>Corpus Christi Petroleum Product Foreign Exports, Major Groups</b>							
	1990	1995	1996	1997	1998	1999	2000
Petroleum coke	770	828	1,015	926	1,401	1,008	1,012
Naphtha & solvents	86	0	0	0	0	0	74
Distillate fuel oil	511	411	926	1,046	635	613	903
Residual fuel oil	52	395	386	220	294	276	38
Lube oil & greases	0	144	76	0	0	0	0
Kerosene	7	94	118	223	53	2	341
Asphalt	100	0	84	163	77	71	0
Gasoline	298	137	413	539	335	729	744
Sub-group total	1,824	2,009	3,018	3,117	2,795	2,700	3,112
Total Product Exports	1,901	2,042	3,092	3,241	2,815	2,699	3,112
Sub-group %	96%	98%	98%	96%	99%	100%	100%

<b>United States Petroleum Product Foreign Exports, Major Groups</b>							
	1990	1995	1996	1997	1998	1999	2000
Petroleum coke	13,883	17,508	18,206	19,115	17,715	16,773	22,948
Naphtha & solvents	1,827	3,712	3,216	3,126	3,559	3,989	1,851
Distillate fuel oil	4,701	5,742	5,508	5,291	4,214	3,881	4,835
Residual fuel oil	11,592	8,790	8,016	7,667	8,520	9,385	12,390
Lube oil & greases	2,245	1,563	1,794	1,496	1,294	1,481	1,557
Kerosene	2,109	1,133	2,068	1,478	820	930	1,461
Asphalt	1,083	2,916	3,154	3,564	3,066	2,520	57
Gasoline	2,113	3,336	3,773	5,207	4,432	3,874	6,281
Sub-group total	39,552	44,701	45,735	46,944	43,620	42,831	51,379
Total Product Exports	40,918	46,755	47,762	49,001	45,659	44,960	54,307
Sub-group %	97%	96%	96%	96%	96%	95%	95%

Source: U. S. Army Corps of Engineers, Waterborne Commerce of the U. S., 1990-2000, and U. S. Department of Energy, Energy Information Administration.

The study area's petroleum product export forecast was estimated based on evaluation of historical trends and the EIA tonnage forecasts. Determination of the specific forecast was made based on analysis of the statistical parameters associated with trendlines and the EIA petroleum product export forecast. Analysis of 1960-2000 Corpus Christi and U. S. product exports showed a strong statistical relationship between the study area and the nation. Figure 2 displays the trendlines for U. S. and Corpus Christi product exports. The t value and the F statistic associated with the equation using Corpus exports as a function of U. S. exports is significant at the 99.9 percent level. The R square is .96. The standard error of the y estimate shows that Corpus Christi's estimated tonnage is well with one standard error of the y estimate. Table 8 displays the export forecast and regression equation outputs.

**Figure 2**  
U. S. and Corpus Christi Petroleum Product Exports 1960-2000 (short tons)



As noted in Table 8, the Corpus Christi average annual growth rate for the period 2000-56 is .9 percent and the growth rate for 2000-25 is 1.1 percent. The study area's estimated average annual 2000-25 growth rate of 1.1 percent is comparable to the EIA's 2000-25 average annual growth rate of 1.2 percent for U. S. petroleum product imports. Review of the study area's historical trendline and the EIA national forecasts support the expectation that Corpus Christi future export volumes are likely to continue to reflect the Department of Energy forecasted national trend toward modest growth in refined product exports.



**Table 8**  
Corpus Christi Petroleum Product Export Tonnage (1998-2056)  
1000's of Short Tons

Year	Corpus Christi Petroleum Product Exports			
	U. S. Exports	95% Confidence Interval		
	EIA Reference Forecast	Base Case Imports a/	Lower Range	Upper Range
1998	45,659	2,815	2,815	2,815
1999	44,960	2,699	2,699	2,699
2000	54,307	3,112	3,112	3,112
2006	50,869	2,860	2,366	3,354
2016	56,827	3,286	2,755	3,816
2025	60,341	3,537	2,985	4,089
2026	60,790 b/	3,569	3,014	4,123
2036	65,465 b/	3,876	3,298	4,455
2046	70,499 b/	4,210	3,607	4,814
2056	75,920 b/	4,573	3,946	5,201
Average Annual Growth Rates				
2000-2025	1.2%	1.1%	0.4%	1.7%
2000-2056	0.9% b/	0.9%	0.7%	1.2%

**Regression Equation Output**

**1960-00 Corpus Christi Petroleum Product Imports = f(U. S. Product Exports)**

Multiple R	0.981
R Square	0.963
Adjusted R Square	0.962
Standard Error	226.2
Observations	41

**Analysis of Variance Table**

	df	SS	MS	F Statistic	Significance F
Regression	1	5.13E+07	5.13E+07	1002	1.99E-29
Residual	39	2.00E+06	5.12E+04		
Total	40	5.33E+07			
	Coefficients	Standard Error	t Stat	Lower 95%	Upper 95%
Intercept	-769.1	67.8	-11.4	-952.5	-585.6
x Variable	0.0714	0.0023	31.6505	0.0653	0.0775

a/ Corpus 2006 imports = -769.1 + (U. S. 2006 Imports \* .0714). The EIA 2000, 2001, 2005, 2010, 2020 and 2025 respective export volumes are .99, .95, .91, 1.00, 1.03, 1.06, and 1.10 million barrels per day. The corresponding short tons equivalents are 45.0, 54.3, 49.9, 54.9, 56.5, 58.1, and 60.3 thousand, respectively. b/ Based on EIA's 2020-25 average annual growth rate for product exports.

Source: Application of the U. S. Department of Energy (DOE/EIA), 2003 Annual Energy Outlook, reference case forecast, January 2003.

## ***Bulk Grain Exports***

During the nineteen nineties, Corpus Christi bulk grain exports ranged from a low of 668,000 tons in 1992 to a high of 1,654,000 in 1993, averaging 1,098,300 tons during over the 10-year period. Corpus Christi's 2000 bulk grain export total of 1,484,000 short tons consists of wheat (63.7%), sorghum (35.6%) and corn (.6%). The 2000 export level represents 1.7 percent of the U. S. total. For the 1991-00 period, wheat comprised 55 percent of Corpus Christi's grain exports, sorghum comprised 35 percent, and corn the remaining 10 percent. Wheat and corn exported from Corpus Christi is railed in from the Midwest. The majority of sorghum is grown within 150 miles of Corpus Christi. During the nineteen nineties, 40 percent of grain exports were shipped to Mexico and Central America, 34 percent to Africa, and the remaining 26% to Europe. Grain exports for the most recent decade are markedly low in comparison to the peak volumes of the nineteen seventies. Corpus Christi's highest export volumes were reported in 1973 when exports peaked at 4.9 million short tons. Table 9 displays Corpus Christi's historical bulk grain exports, growth rates, and the major variables evaluated in the formulation of the study area's grain export forecast. The growth rates show that Corpus Christi exports, particularly 1991-00 levels, were characteristically high in comparison to national levels.

The export forecast was formulated based on evaluation of a series of regression equations incorporating 1970-2000 U. S. grain production, gross domestic product, and U. S. and regional employment and income variables. Additional variables, including U. S. grain exports and world population were initially evaluated but dropped from consideration as they proved to be weak indicators of historic growth. Evaluation of Corpus Christi and U. S. grain exports revealed low correlation between regional and national trends. Comparison of the U. S. and Corpus Christi bulk 1991-00 grain export growth rates showed an annual growth rate of 7.4 percent and a U. S. rate of -1.5 percent. Comparison of 1991-00 annual changes for all years showed an average yearly increase of 15 percent for Corpus Christi and 2 percent for the nation. The study region's 1991-00 relatively higher growth shows Corpus Christi exports, at least historically, to follow a more accelerated trend line than national levels.

A strong correlation was, however, found for U. S. grain production of wheat and sorghum; and production was, subsequently, included in the final equation. Table 10 presents the USDA's 1999-2010 grain production and export forecast. The U. S. Department of Agriculture (USDA) is currently forecasting modest growth in grain production and exports. Wheat and sorghum exports are projected to increase at an average annual rate of 1.7 percent between 2000 and 2012 and corn exports are expected grow at an annual rate of 2 percent.

**Table 9**  
**Corpus Christi Grain Exports and Forecast Evaluation Variables**

Year	Corpus Bulk	U.S. Grain		U. S. Grain Exports		Earnings millions \$87		Gross Domestic Product Million \$96
	Grain Exports	Production		Millions Bushels		Corpus MSA	U. S. Farm	
	1000's short tons	Millions bushels	Millions bushels	Wheat	Sorghum	Transportation And Utilities	Earnings	
1970	1,879	1,352	683	741	885	\$207	\$48,628	\$3,578
1975	4,404	2,127	754	1,173	1,405	\$313	\$58,705	\$4,084
1976	3,692	2,149	711	950	1,204	\$420	\$48,094	\$4,312
1977	3,356	2,046	781	1,124	1,347	\$367	\$43,711	\$4,512
1978	4,622	1,776	731	1,194	1,384	\$395	\$47,185	\$4,761
1979	4,059	2,134	807	1,375	1,705	\$436	\$46,220	\$4,912
1980	3,048	2,381	579	1,514	1,807	\$444	\$28,521	\$4,901
1981	1,910	2,785	876	1,771	2,031	\$383	\$34,572	\$5,021
1982	1,094	2,765	835	1,509	1,719	\$345	\$28,307	\$4,919
1983	1,000	2,420	488	1,429	1,674	\$303	\$17,826	\$5,132
1984	1,547	2,595	866	1,424	1,721	\$306	\$33,132	\$5,505
1985	2,064	2,425	1,120	915	1,093	\$304	\$31,876	\$5,717
1986	1,110	2,091	942	1,003	1,228	\$250	\$32,034	\$5,912
1987	958	2,108	938	1,598	1,829	\$226	\$38,424	\$6,113
1988	1,588	1,812	731	1,419	1,729	\$214	\$35,755	\$6,368
1989	1,070	2,037	577	1,233	1,537	\$204	\$43,444	\$6,592
1990	728	2,730	573	1,069	1,301	\$202	\$41,850	\$6,708
1991	725	1,980	585	1,282	1,574	\$197	\$37,138	\$6,676
1992	668	2,467	875	1,354	1,631	\$204	\$40,058	\$6,880
1993	1,654	2,396	534	1,228	1,430	\$207	\$36,499	\$7,063
1994	1,027	2,321	646	1,188	1,411	\$215	\$35,700	\$7,348
1995	773	2,183	459	1,241	1,439	\$228	\$27,353	\$7,544
1996	954	2,277	795	1,002	1,207	\$279	\$35,832	\$7,813
1997	1,417	2,481	634	1,040	1,252	\$216	\$32,345	\$8,160
1998	1,404	2,547	520	1,090	1,287	\$223	\$29,979	\$8,509
1999	1,633	2,299	595	1,125	1,381	\$222	\$29,644	\$8,859
2000	1,484	2,232	471	1,098	1,485	\$226	\$30,130	\$9,191
Average Annual Growth Rates								
1971-80	7.8%	3.9%	-4.0%	9.5%	9.4%	7.4%	-5.1%	2.9%
1981-90	-9.2%	-0.2%	-4.2%	-4.9%	-4.4%	-6.2%	1.9%	2.9%
1991-00	7.4%	1.2%	-2.1%	-1.5%	-0.6%	1.4%	-2.1%	3.2%

Source: USACE, Waterborne Commerce of the U. S.; USDA, Agricultural Statistics; U. S. Department of Commerce, Bureau of Economic Analysis. Note: Calendar Year 2000 exports for Corpus Christ were 950,000.

**Table 10**  
**United States Export and Production Forecast (millions of bushels)**

U. S. Grain Production by Major Bulk Grain Type a/					U. S. Grain Exports by Major Bulk Grain Type			
Year	Wheat	Sorghum	Corn	Total	Wheat	Sorghum	Corn	Total
1980/81	2,381	579	6,639	9,599	1,514	293	2,408	4,215
1990/91	2,730	573	7,934	11,237	728	232	1,725	2,685
1999/00	2,299	595	9,437	12,331	1,090	250	1,935	3,275
2000/01	2,232	471	9,968	12,671	1,061	240	1,940	3,241
2001/02	1,958	536	9,430	11,924	1,025	240	2,050	3,315
2002/03	2,190	595	9,735	12,520	950	250	1,925	3,125
2003/04	2,210	580	9,855	12,645	975	250	1,950	3,175
2004/05	2,235	590	10,115	12,940	1,025	255	2,000	3,280
2005/06	2,275	595	10,310	13,180	1,075	255	2,050	3,380
2006/07	2,315	600	10,505	13,420	1,100	260	2,100	3,460
2007/08	2,335	605	10,555	13,495	1,150	265	2,175	3,590
2008/09	2,395	620	10,750	13,765	1,200	270	2,275	3,745
2009/10	2,435	625	10,875	13,935	1,225	275	2,325	3,825
2010/11	2,475	635	11,075	14,185	1,250	285	2,375	3,910
2011/12	2,500	640	11,200	14,340	1,275	290	2,425	3,990
2000-2011/12 Average Annual Growth Rate								
	1.0%	2.8%	1.1%	1.1%	1.7%	1.7%	2.0%	1.9%

Source: U. S. Department of Agriculture, Economic Research Service (ERS), USDA Agricultural Baseline Projections to 2010, February 2002.

a/ Grain production statistics for 1999/00 through 2002/03 were obtained from data ERS, January 2003 report. The January 2003 report contains a short term forecast through 2003. The 1980/81 and 1990/91 statistics were obtained from earlier USDA reports. The 2002/03 to 2011/12 grain exports figures were obtained from the February 2002 forecast (Agricultural Baseline Projections to 2011/12).

The basis for final selection of the variables included in the regression equation was made based on the relative magnitude of the R squared values, the significance of the t-values, and the smallest standard error of the y coefficient. Analysis of the historic indicators demonstrated that Corpus Christi metropolitan statistical area transportation and utility earnings, U. S. farm earnings, U. S. wheat and sorghum production, and gross domestic product were good statistical predictors of the study area's 1970-2000 grain exports. Historically, Corpus Christi grain exports were very strongly tied to both U. S. farm income and Corpus Christi MSA transportation and utility earnings. The output of the regression analysis showed that the income variables produced higher t values than grain production and gross domestic product; however, all variables were significant at the 99 percent confidence level. The relationship between

income and Corpus Christi grain exports is illustrated in Figure 3.

**Figure 3**  
Corpus Christi Bulk Grain Exports and Income Variables

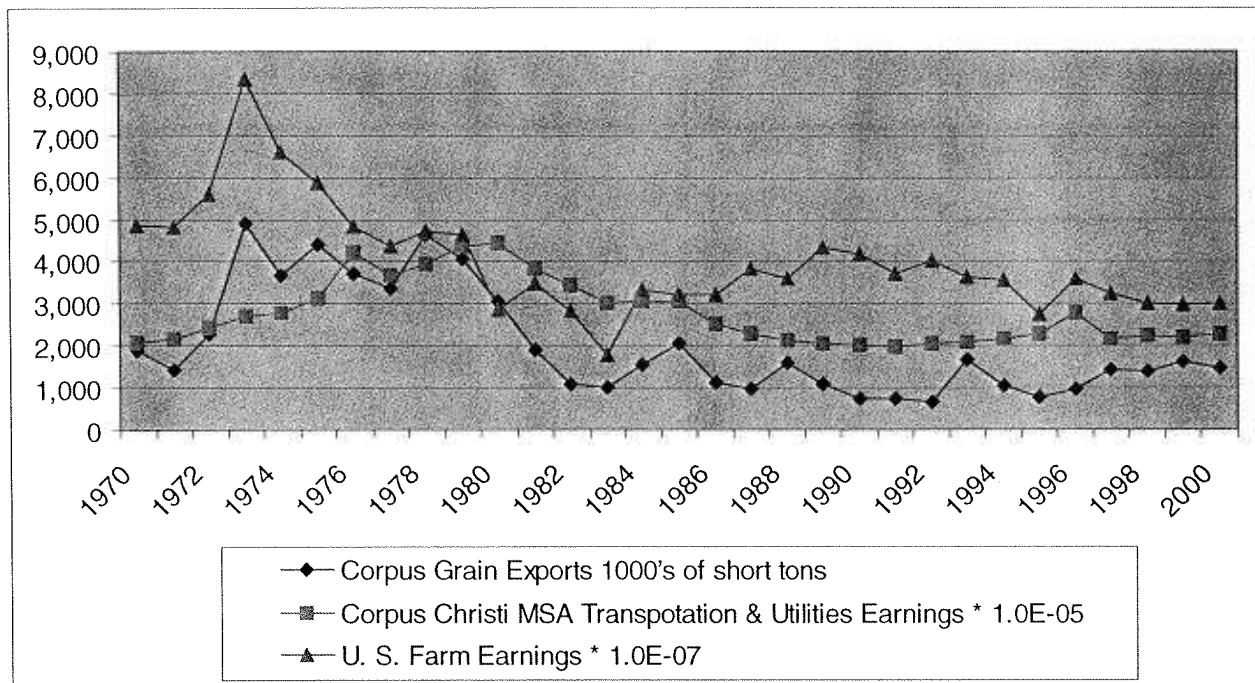


Table 11 displays the 2006-2056 baseline tonnage projections. The 2006-56 average annual growth rate generated from the regression equation is 2.3 percent. The growth rate generated from the regression equation is lower than the 1991-00 average annual rate of 7.4 percent; however, as noted, Corpus Christi grain exports were very strongly tied to U. S. farm income and Corpus Christi MSA transportation and utility income. Income was a strong variable in the regression equation. The USDA forecast shows an average annual decline of 1.3 percent between 2000-2012 in U. S. farm income. The USDA production and export forecast extends through 2012. The USDA forecast documentation notes that farm income supports that were available during the nineteen nineties are not expected for 2000-2006. The effect of the phasing-out of income supports contributed to the expected low rate of growth for Corpus Christi 2006-2056 grain exports. The other major driver in the equation was Corpus Christi MSA transportation and utility income. Income in this sector is projected to grow at an average annual rate of 1.0 percent between 2000-2012.

**Table 11**  
Corpus Christi Bulk Grain Export Forecast (1998-2056)  
1000's of Short Tons

Year	Base Forecast	95% Confidence Interval		Standard Error of the y Estimate		USDA Growth Rate Application a/
		Lower	Upper	Minus 1	Plus 1	
1998	1,404	1,404	1,404	1,404	1,404	1,404
1999	1,633	1,633	1,633	1,633	1,633	1,633
2000	1,484	1,484	1,484	1,484	1,484	1,484
2006	1,190	0	8,981	713	1,666	1,698
2012	1,678	0	10,121	1,202	2,154	1,881
2016	1,748	0	10,409	1,271	2,224	2,013
2026	2,023	0	10,966	1,546	2,499	2,388
2036	2,500	0	11,784	2,023	2,976	2,832
2046	3,514	0	13,280	3,038	3,991	3,359
2056	3,653	0	13,705	3,176	4,129	3,984
Average Annual Growth Rate						
2006-2056	2.3%	n/a	0.8%	3.0%	1.8%	1.7%

**Corpus Christi Grain Exports, 1970-2000 Based Regression Equation Output**

Multiple R	0.947
R Square	0.896
Adjusted R Square	0.876
Standard Error	451
Observations	31

**Analysis of Variance Table**

	df	SS	MS	F	Significance F
Regression	5	44,023,009	8,804,602	43.3	1.61E-11
Residual	25	5,084,799	203,392		
Total	30	49,107,809			

	Coefficients	Standard Error	t Stat	Lower 95%	Upper 95%
Intercept	-210,232	67,054	-3.135	-348,332	-72,132
Year	101.548	32.467	3.128	34.681	168.4
Corpus MSA Trans/Utilities Earnings	10.681	1.752	6.095	7.072	14.290
U.S. Farm Earnings	0.076	0.009	8.144	0.057	0.095
U.S. Farm Employment	1.939	0.867	2.236	0.153	3.724
U.S. Wheat and Sorghum Production.	-0.707	0.273	-2.588	-1.270	-0.144

Source: USACE, Waterborne Commerce of the U. S.; USDA, Agricultural Statistics; U. S. Department of Commerce, Bureau of Economic Analysis, Corpus Christi MSA and U. S. earnings, 1996; U. S. Department of Agriculture, Economic Research Service, Agricultural Baseline Projections to 2011/12, February 2002.

a/ The USDA/ERS 2000-2011/12 growth rates were applied to Corpus Christi's 1998-2000 average tonnage.

As shown in the Table 11, the forecast associated with the 95 percent confidence interval has extremely wide upper and lower limits. The range associated with the standard error of the y estimate is also presented. The application of this statistic, which measures the average deviation of the predicted values from the 1970-2000 observed values, generated a much narrower range of values. Table 11 also displays a sensitivity estimated by applying the USDA/ERS 2000-2011/12 average annual wheat, corn and sorghum export growth rates to Corpus Christi's 1998-2000 average tonnage. The lower and upper end standard error of the y estimate application was used for the sensitivity analysis.

**REDUCTION IN TRANSPORTATION COST BENEFITS**

Channel deepening benefits were calculated for Corpus Christi crude petroleum, petroleum products, and grain cargoes. The transportation savings benefits were calculated using a Federal discount rate of 5.875 percent and using Fiscal Year 2002 hourly operating costs. Transportation costs were calculated for 45- to 52-foot channel depth alternatives.

The transportation costs and the savings associated with the proposed project depth increases were calculated using commodity specific vessel class and trade route distributions. Transportation costs were calculated based on the channel depth alternatives and variables associated with vessel design drafts, maximum feet of light-loading, underkeel clearance, mileage traveled, and the number of hours to load and unload. Maximum vessel cargo capacities for crude oil, petroleum products, and grain were estimated using a range of load factors obtained from IWR Report 91-R-13, National Economic Development Procedures Manual Deep Draft Navigation, November 1991. The cargo capacity factors published in the deep draft manual for dry bulk carriers and tankers are shown in Table 12.

**Table 12**  
**Adjustments for Estimating Actual Vessel Capacity**

Vessel DWT	Dry	
	Bulk	Tanker
<20000	.90	.90
20-70000	.92	.92
70-120000	.95	.95
>120000	.97	.97

Source: IWR Report 91-R-13, National Economic Development Procedures Manual, Deep Draft Navigation, November 1991, p.77.

The basic procedure used to calculate transportation costs using a 120,000-dwt foreign flag tanker as an example is illustrated in Table 13. Similar computations were made for appropriate distances and vessel sizes for each of the channel depth alternatives. The resulting costs per ton computations were calculated over the relevant range of vessels projected for each channel depth improvement, and the associated savings per ton were measured using the net differences in costs between the existing 45-foot channel and the alternative channel depths. The computation presented is for a direct shipment. The in-port cost was based on an unloading rate of 30,000 barrels per hour. Unloading rates vary and it was found that offshore unloading rates are faster than in-port rates. The offshore rates average 40,000 barrels per hour. Unloading rates for refined products are significantly less than for crude oil. Industry noted that the same unloading rate and added that 5,000 to 10,000 barrels per hour is the standard unloading rate for product carriers.

**Table 13**  
**Transportation Cost Calculation**  
**Mexico to Houston (Direct Shipment)**

---

DWT: 120,000
Design Draft: 52 feet
Cargo Capacity: 114,000 dwt (120,000*.95)
Immersion Factor (tons per inch): 247
Maximum Load on 45-ft Channel given 4-foot underkeel clearance: ((120,000*.95)-(247 x 11 feet light x 12 in/ft = 81,396 tons
Hourly Cost at Sea: \$1,160
Hourly Cost in Port: \$ 908
Hours to Load and Unload for 45-ft load: 36 a/
Round Trip Mileage: 1400 miles
Speed: 15 knots
Cost for Voyage: (1400 miles/15 knots)*(\$1,160) = \$108,267
Voyage Cost/Ton for 45-ft Channel: (\$108,920/81,396 tons) \$1.33/Ton
Loading & Unloading Cost/Ton for 45-ft Channel: (36 hrs x \$908) / (81,396 tons) = \$.42/ short ton
Voyage Cost/Ton for 52-ft Channel:(\$108,920/(102,144 tons) \$1.07/Ton
Loading & Unloading Cost/Ton for 52ft Channel a/ (45 hrs x \$908) / (102,144) = \$.40/short ton

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a/ Based on a loading and unloading rate of 4,500 tons per hour.



Table 14 presents representative round trip mileage for the trade routes or junction points used for the transportation savings computations. Tables 15 and 16 presents the Fiscal Year 2002 operating cost data. Foreign flag tankers were used to calculate the transportation costs for foreign imports of crude petroleum and petroleum product imports and exports. Foreign flag bulk carriers are used for grain export tonnage. The vessel fleet projections are based on analysis of existing fleet utilization and anticipated trends and the premise that vessel utilization will gravitate to the most efficient vessel sizes for a specific channel depth given port depth and trade route constraints.

**Table 14**  
**Representative Round Trip Mileage to Corpus Christi**

Coatzacoalcos, Mexico	1,360
U. S. Gulf Coast Lightering/Lightening Zone	160
Venezuela	3,934
Panama Canal	3,132
Salvador, Brazil	9,606
Rotterdam, Netherlands	10,318
Sture, Norway	11,172
North Africa, Algiers	10,556
West Africa (Nigeria and Angola)	13,030
Persian Gulf and Indian Subcontinent via Suez Canal	19,824
Persian Gulf and Indian Subcontinent via Cape of Good Hope	25,066
Singapore via Panama Canal	24,248
Singapore via Cape of Good Hope	26,304

### ***Trade Route Forecast***

The foreign trade route forecasts used in this analysis are summarized in Table 17. The crude oil and petroleum product import trade route forecasts are based on EIA (2003) projections; the petroleum product export forecast is based on the World Fleet Forecast (1998-2050) projections. The grain export forecast was based on USDA forecasts presented in the commodity forecast section of this appendix. Reduction in transportation cost benefits from proposed Corpus Christi channel deepening were calculated for a portion of crude petroleum, petroleum product and grain tonnage. The percentage of tonnage expected to accrue benefits from deeper channel depths was identified based examination of vessel sizes, vessel loads, foreign port depths and constraints such as the Panama Canal. Port depth, trade route, and historical vessel utilization data were

**Table 15**  
**Foreign Flag Tankers**  
**Fiscal Year 2002 Vessel Operating Costs**

Design Draft(ft)	DWT	Maximum Cargo	Immersion Factor	Hourly Operating Cost		Hrs in Port to Load or Unload a/
				at Sea	in Port	
30	20,000	18,000	79	\$673	\$542	7
32	25,000	22,500	91	\$698	\$561	9
35	35,000	31,500	113	\$753	\$601	12
40	50,000	45,000	141	\$833	\$664	18
42	60,000	54,000	159	\$888	\$704	22
44	70,000	63,000	175	\$938	\$743	25
46	80,000	76,000	191	\$988	\$783	29
47	90,000	85,500	206	\$1,033	\$818	33
52	120,000	114,000	247	\$1,160	\$908	43
55	150,000	145,500	285	\$1,294	\$1,005	55
58	175,000	169,750	315	\$1,412	\$1,096	65
60	200,000	194,000	343	\$1,525	\$1,183	74
66	265,000	257,050	411	\$1,816	\$1,401	100
70	325,000	315,250	468	\$2,015	\$1,537	120

Source: Economic Guidance Memorandum 02-06, Deep-Draft Vessel Operating Costs.

a/ Presentation is based on a loading and unloading rate of 5,250 tons per hour or 35,000 barrels per hour. As discussed in the text, the rate used for the cost calculations depends on the cargo and the location.

**Table 16**  
**Foreign Flag Bulk Carriers**  
**Fiscal Year 2002 Vessel Operating Costs**

Design Draft(ft)	DWT	Maximum Cargo	Immersion Factor	Hourly Operating Cost		Hrs in Port to Load or Unload a/ a/
				at Sea	In Port	
27	15,000	13,500	65	\$520	\$379	6
32	25,000	23,000	89	\$567	\$410	11
35	35,000	32,200	110	\$605	\$437	15
37	40,000	36,800	119	\$624	\$450	17
40	50,000	46,000	137	\$655	\$481	21
42	60,000	55,200	154	\$708	\$508	26
44	70,000	64,400	169	\$757	\$544	30
46	80,000	76,000	184	\$805	\$579	34
48	90,000	85,500	198	\$861	\$624	38
50	100,000	95,000	211	\$916	\$669	45
52	120,000	114,000	236	\$1,028	\$755	50
54	135,000	128,250	254	\$1,060	\$769	54
56	150,000	142,500	272	\$1,092	\$782	62

Source: Economic Guidance Memorandum 02-06, Deep-Draft Vessel Operating Costs.

a/ Based on a unloading rate provided by the Corpus Christi grain elevator.

**Table 17**  
**Corpus Christi Ship Channel**  
**Trade Route Forecast 2000 through 2056**  
**Percentage of Tonnage by Trade Route for the Major Commodity Groups**

	2000	2006	2016	2026	2036	2046	2056
<b>Crude Petroleum Imports a/ c/</b>							
Latin America & Caribbean	34%	41%	39%	41%	44%	46%	49%
Europe & Africa	39%	25%	21%	19%	18%	17%	16%
Persian Gulf	22%	31%	37%	37%	36%	35%	34%
Far East	6%	3%	3%	2%	2%	2%	1%
Total	100%	100%	100%	100%	100%	100%	100%
<b>Petroleum Product Imports a/ b/ c/</b>							
Latin America & Caribbean	28%	63%	67%	66%	63%	64%	61%
Europe & Africa	53%	22%	15%	15%	17%	18%	19%
Persian Gulf	16%	8%	13%	13%	13%	14%	14%
Far East	3%	7%	6%	5%	6%	6%	6%
Total	100%	100%	100%	100%	100%	100%	100%
<b>Petroleum Product Exports b/ c/</b>							
Latin America & Caribbean	58%	46%	49%	51%	51%	51%	49%
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%	100%	100%	100%	100%	100%	100%
<b>Bulk Grain Exports c/</b>							
Latin America & Caribbean	33%	29%	32%	32%	32%	32%	32%
Europe & Africa	57%	41%	39%	39%	39%	39%	39%
Persian Gulf	9%	7%	7%	7%	7%	7%	7%
Far East	1%	23%	22%	22%	22%	22%	22%
Total	100%	100%	100%	100%	100%	100%	100%

a/ Application of USEIA 1999-2010 trade route crude oil and product forecasts to Corpus Christi.

b/ Application of World Fleet/McGraw-Hill 1999-2050 petroleum product export trade route forecast.

c/ 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.

used to identify the percentage of tonnage anticipated to benefit from the Corpus Christi proposed depth increases. Corpus Christi will not accrue deepening benefits for movements associated with Western South America trade route nor for most movements from the Far East due to the vessel beam width constraint of 106 feet and the depth constraint of 39.6 feet. Some crude oil shipped from the Far East is shipped in post-Panamax vessels and these vessels arrive in the Gulf of Mexico from by way of the Suez Canal or the Cape of Good Hope. Post-Panamax, Suez, and small VLCC vessels used for crude oil could realize cost savings from increased channel depths in Corpus Christi and the benefit calculations reflect this inclusion.