FINAL
FINAL
Submitted w/ Chief's Report
Recvd from COE 6.11.03

U.S. Army Corps
of Engineers

Galveston District
Southwestern Division

Corpus Christi Ship Channel, Texas
Channel Improvement Project

Volume I

Final Feasibility Report
and
Final Environmental Impact Statement

April 2003

DEPARTMENT OF THE ARMY
GALVESTON DISTRICT, CORPS OF ENGINEERS
P.O. BOX 1229
GALVESTON, TEXAS 77553-1229

REPLY TO
ATTENTION OF

Corpus Christi Ship Channel, Texas

Channel Improvement Project

Feasibility Report

And

Environmental Impact Statement

April 2003

Syllabus

This report makes recommendations for authorizing improvements to the Corpus Christi Ship Channel (CCSC) and La Quinta Channel projects in Texas. The study responds to a congressional resolution adopted August 1, 1990, by the Committee on Public Works and Transportation, U.S. House of Representatives. The Port of Corpus Christi Authority is the non-Federal sponsor for the navigation improvements and the environmental restoration components.

The results of these studies show that channel improvements to include widening and deepening of the CCSC, extending the La Quinta Channel, and construction of barge lanes flanking the upper bay portion of the CCSC, along with the proposed placement plan recommended in this report, to be the plan that maximizes net economic benefits, consistent with the Administration's policy for protecting the Nation's environment.

In response to the desires of the Sponsor, State, and resource agencies for using the dredged materials for beneficial uses and the Federal policy for environmental restoration, the plan recommended for implementation in this report consists of navigation improvements and environmental restoration improvements. Based on the economic, engineering, and environmental factors considered, the navigation portion of the selected plan includes deepening of the CCSC from Viola Basin in the Inner Harbor to the end of the jetties in the Gulf of Mexico to 52 feet, deepening of the remainder of the channel into the Gulf of Mexico to 54 feet, widening of the Upper Bay and Lower Bay reaches to 530 feet, construction of parallel, 12 feet deep, barge shelves across the Upper Bay portion of the CCSC, and extending the La Quinta Channel approximately 7,400 feet at a depth of 39 feet. Dredged material management incorporates the use of existing placement areas, as well as newly designated placement areas including several beneficial use (BU) sites. BU sites will be constructed to create several hundred acres of shallow water habitat throughout the bay system. New work dredging will create approximately 41 million cubic yards of material, while it is estimated that maintenance over the 50-year period of economic evaluation will generate approximately 208 million cubic yards of material. The environmental restoration portion of the Selected Plan consists of the construction of an offshore breakwater and a shoreline revetment to protect and enhance existing habitat.

The different components of the selected plan were evaluated for impacts to tide, salinity, and current. Modeling of these parameters suggests insignificant changes in the ranges of these parameters, during both wet and dry periods.

The widening and deepening of the CCSC will generate annual benefits of $32,607,000 with annual costs of $12,305,000, producing a benefit-cost ratio of 2.6. The creation of the barge

shelves in the Upper Bay portion of the CCSC will have annual costs of $84,600 and annual benefits of $134,000, and a benefit-cost ratio of 1.6. Annual benefits produced by the extension of the La Quinta Channel will be $9,264,500 while annual costs will be $4,996,000, generating a benefit-cost ratio of 1.8. The project benefits presented in this report are for a 2006-2056 period of economic evaluation and are based on a Federal Discount (FY) 2002 rate of 5 7/8 percent and Fiscal Year 2000 vessel operating costs.

The Project Cost of all project components, minus inflation and interest during construction, totals $136,510,500. The NED Investment Cost of all components totals $242,835,000, and includes $136,510,500 in Project Costs, $18,911,000 in interest during construction for project components, $26,031,000 in deep-draft utility relocation costs, $5,022,000 in removal costs, $49,672,500 in bulkhead and berthing modification costs, and $6,688,000 in interest during construction for associated activities. Total average annual costs for the project are $17,386,000. Fully Funded Cost of the projects, which includes Project Costs and expected escalation totals, is $145,625,000.

Project costs for navigation and environmental restoration will be allocated according to the cost sharing provisions in the Water Resources Development Act of 1986, as amended. Based on these provisions and calculated in current dollars, $70,771,000 will be apportioned to the Federal Government, while $146,465,000 will be non-Federal expenditures.

Ecosystem restoration costs are $4,283,000. The ecosystem restoration benefits consist of protecting a 1,200-acres system of sand flats and wetlands, and 45 acres of sea grass beds. Based on these provisions, $2,784,000 will be apportioned to the Federal government, while $1,499,000 will be non-Federal expenditures.

The recommended navigation improvements maximize National Economic Development benefits and the recommended environmental restoration improvements optimize habitat outputs based on incremental cost principles. The requirements of Section 404(r) of Public Law 92-500, as amended, have been met.

TABLE OF CONTENTS

Volume I - Main Report

TABLES

FIGURES

PLATES

APPENDICES

CORPUS CHRISTI SHIP CHANNEL - CHANNEL IMPROVEMENT PROJECT FEASIBILITY REPORT

I. INTRODUCTION

The Corpus Christi Ship Channel (CCSC) provides deep-water access from the Gulf of Mexico to the Port of Corpus Christi, via Aransas Pass, through Redfish Bay and Corpus Christi Bay. Access points include the La Quinta Channel, the Gulf Intracoastal Waterway (GIWW), and the Rincon Canal. The 1969 Rivers and Harbors Act changed this project, formerly known as the Port Aransas-Corpus Christi Waterway, Texas, to the Corpus Christi Ship Channel, Texas. This Act was a consolidation of old improvements in Port Aransas, Texas, and channel improvements from Aransas Pass to Corpus Christi, Texas. Aransas Pass connects Corpus Christi Bay with the Gulf of Mexico. The waterway extends from deep water in the Gulf through the Aransas Pass jettied entrance, then westerly 20.75 miles to and including a turning basin at Corpus Christi, then westerly 1.75 miles through Industrial Canal to and including a turning basin at Avery Point, then westerly 0.9 miles to and including the Chemical Turning Basin, then 3.3 miles to and including a turning basin near Tule Lake, then northwesterly 1.8 miles to the Viola Turning Basin. The La Quinta Channel extends off of the CCSC near Ingleside, Texas, and runs parallel to the eastern shoreline of Corpus Christi Bay for 5.5 miles to the La Quinta Turning Basin (Figure 1).

The existing authorized depth for both the CCSC and the La Quinta Channel is 45 feet. Project width of the CCSC ranges from 700 feet in the entrance channel to 200 feet at locations in the Inner Harbor. The La Quinta Channel measures 300 to 400 feet wide. Construction of the existing 45-foot project on both the Corpus Christi and La Quinta Channels was completed in 1989.

The size of ships has steadily increased such that vessels have to be light-loaded to traverse the waterway. The current channel depth requires that large crude carriers remain offshore and transfer their cargo into smaller crude tankers for the remainder of the voyage.

This comprehensive navigation study investigates the feasibility of improving the CCSC and La Quinta Channel. This section of the report identifies the study authority, scope, participants and coordination, related studies, and study process. The study area is shown on Figure 1. A series of 13 plates attached to this report details the entire project in plan view. Any project component not specifically detailed by figure in the report can be viewed in those plates.

PURPOSE AND AUTHORITY

The purpose of this study is to develop and evaluate alternatives for navigation problems that directly affect the CCSC and La Quinta Channel within the Corpus Christi Bay system. To allow for a more effective, safe, and efficient waterway, the study is focused on eliminating the major problems contributing to inefficiencies on the waterway, such as insufficient depth and width, as determined by fleet forecasts, the requirement for one-way traffic in portions of the channel, and the need for safe barge shelves. The study also identifies new economic benefits associated with proposed channel modifications and recommends alternatives that maximize these benefits.

This feasibility study is being conducted to determine if an improved navigation project is in the Federal interest and to provide the documentation needed to recommend Congressional authorization and funding for construction of that project. The study responds to a congressional resolution adopted August 1, 1990, by the Committee on Public Works and Transportation, U.S. House of Representatives. The resolution reads:

> Resolved by the Committee on Public Works and Transportation of the United States House of Representatives, That the Board of Engineers for Rivers and harbors, is requested to review the reports on the Port Aransas-Corpus Christi Ship Channel, Texas (45-Foot Project) published as House Document 99, 90th Congress, Second Session, and other pertinent reports to determine the feasibility of modifying the Corpus Christi Ship Channel, with particular emphasis on the La Quinta Channel and on Harbor Island, in the interest of commercial navigation and related purposes."

DESCRIPTION OF THE STUDY AREA

The CCSC is located in Corpus Christi Bay on the southern portion of the Texas coast, 180 miles southwest of Galveston and 132 miles north of the mouth of the Rio Grande. The project study area is situated in Nueces and San Patricio Counties.

Physiography

Corpus Christi Bay is a large, shallow body of water about 14 miles long oriented in a northeast-southwest direction and is about 12 miles wide at its widest part. Mustang Island separates Corpus Christi Bay from the Gulf of Mexico on the east. Redfish Bay to the northeast, Nueces Bay to the west, and Oso Bay to the south are smaller arms of the main embayment. Laguna Madre, a narrow coastal bay, extends southward from Corpus Christi Bay. The Nueces River with its tributaries, the Frio and Atascosa Rivers, is the prime source of freshwater to the Corpus Christi Bay system. The entrance channel for the CCSC is the primary outlet from Corpus Christi Bay to the Gulf of Mexico that maintains water circulation and provides a migratory route for fish and crustaceans. Corpus Christi Pass, Newport Pass, and Packery Channel are historic natural passes located near the southern end of Mustang Island. These inlets as well as the man-made Fish Pass are open only for a short time following a hurricane or tropical storm. The mean diurnal tide variation in the Corpus Christi Bay system is about 0.7 feet. This variation can be significantly modified by winds from cold fronts in winter and tropical storms in the summer season.

The study area is located on the coastal prairies physiographic region of the Texas Coastal Plain. Land elevation in the area ranges from about 150 feet above sea level in northwestern Nueces County to sea level along Corpus Christi Bay, but the shoreline has been cut back by wave action to form steep cliffs, ranging in height from 15 to 35 feet along the southern and western shorelines of the bay. Most of the area lies on the nearly level coastal plain, while a much smaller area is composed of tidal flats and barrier islands. Area soils are generally sandy or clay loams. A saline clay is present in the coastal plain areas and fine to medium grained sand is found in the tidal flats and barrier island areas.

Geologic units of the study area consist of Pleistocene age sediments of the Beaumont Formation and Recent age sediments of bay, barrier island, and alluvial deposits. The Inner Harbor portion of the CCSC was originally excavated along the south side of Nueces Bay. Nueces Bay is the drowned Nueces River Valley that was flooded during the last few thousand years by a rise in sea level. The original valley had been eroded to an average elevation of about -45 feet mean low tide, and in some points down to –100, before being drowned. The bay has since been substantially filled with soft recent deposits transported by the Nueces River and by material eroded from the bay shore.

Climate

The climate of the CCSC area is humid subtropical with warm to hot summers and mild winters. The dominant air mass in summer is marine tropical in which sea breezes moderate afternoon heat. Occasional showers or thunderstorms are common during this season. Winters are mild with considerable day-to-day variation between the marine tropical air mass and modified continental polar and marine polar air masses. Periods of freezing temperatures are infrequent and usually last no longer than two or three days.

Rainfall averages about 29 inches annually at Corpus Christi. The annual rainfall distribution is greater for the early summer and fall periods and least for the winter and late summer. Two principal wind regimes dominate the area and include persistent, southeasterly winds occurring from March through November and strong, short-lived northerly winds from December through February. Severe weather occurs periodically in the area in the form of thunderstorms, tornadoes, and tropical storms or hurricanes.

Fish and Wildlife Resources

The CCSC study area contains estuarine, upland, and wetland areas that support a varied population of fish and wildlife resources. The area contains an abundance of game and non-game wildlife resources. The area also supports a productive sport and commercial fishery and provides recreational opportunities that are intensively utilized during the year.

Aquatic Resources

Aquatic resources in the project area include the open waters of Nueces and Corpus Christi Bays, tidal flats and channels, and freshwater ponds in the Nueces River delta. Nueces Bay and Nueces River delta are considered integral parts of the overall Nueces-Corpus Christi Bay ecosystem. Corpus Christi Bay is one of the deepest bays along the Texas coast with natural depths of 11 to 13 feet. Nueces Bay has a 2- to 6-foot range of water depths, with an average depth of 3 feet. Bottom sediment types in Nueces and Corpus Christi Bays include sand, silts, and clays of varying proportions. Salinities in the bays range from fresh conditions during periods of heavy rainfall or river flooding to hypersaline conditions (greater than 40 parts per thousand) during prolonged drought.

The lower food chain in Nueces and Corpus Christi Bays consists of phytoplankton, zooplankton, and benthic organisms. The metabolism of the Nueces-Corpus Christi Bay ecosystem is based primarily on phytoplankton and zooplankton. Benthic organisms are the largest and most diverse group of organisms inhabiting the Nueces-Corpus Christi Bay estuary

system. Benthic populations in Nueces Bay have been classified as river-influenced assemblages where turbidity is relatively high and salinity normally at reduced levels. Benthic organisms in the bay system include polychaetes, mollusks, and arthropods.

The Nueces and Corpus Christi Bay estuarine areas provide important nursery and feeding habitat for numerous species of sport and commercial fish and shellfish. Common commercial and sport species of fish in Nueces Bay include black drum, red drum, menhaden, spot , Atlantic croaker, spotted seatrout, and, southern flounder.

Important commercial crustaceans occurring in the Nueces-Corpus Christi Bay system include brown and white shrimp, and blue crab. Nueces Bay is a prime nursery area for white shrimp. A major portion of Nueces Bay has been designated a shrimp nursery area and closed to shrimping by the State of Texas. Reefs and scattered areas of the American oyster occur in Nueces and Corpus Christi Bays.

The Corpus Christi Bay system is a productive and very important estuarine system to the Texas commercial fishery. This system has ranked high in total production of seafood products among the Texas bay systems. The project area receives heavy recreational fishing use throughout the year. Sport fishing activities in the area are particularly heavy during the seasonal runs of flounder, spotted seatrout, red drum, and black drum.

Terrestrial Resources

Upland habitat types occurring in the project study area include pasture, brushland, Gulf cordgrass, cropland, and existing vegetated placement areas (PAs). These habitats support a diverse population of wildlife species. About 50 species of terrestrial mammals have been documented in the general study area. Mammals occurring in upland areas include rabbits, rats, raccoons, coyotes, mice, fox, and white-tailed deer. The brushland area probably contains the greatest diversity and abundance of mammals. Pasture and Gulf cordgrass are grazed by cattle and are also inhabited by small mammals and various passerine birds. Lands in Nueces and San Patricio Counties used as cropland have sparse ground cover and provide poor quality habitat for wildlife. Over 50 species of reptiles and about 20 species of amphibians inhabit the general study area.

Wetland Resources

Wetland vegetation important in the Corpus Christi-Nueces Bay area include seagrasses and intertidal and fresh-water marshes. Seagrasses presently occur along the northeast (Redfish Bay) and southwest (Laguna Madre) margins of the bay system. The seagrasses develop in shallow,

clear waters along the bay margins. Tidal marshes are present on portions of the mainland shoreline and the bay side of the barrier islands and peninsulas. Marsh habitats also occur in the Nueces River delta and along the south shore of Nueces Bay. The Nueces River delta contains tidal and freshwater marshes and is a large and diverse area of high value to fish and wildlife. Marsh habitats include sea oxeye marsh, low marsh, freshwater marsh, saltflat grass marsh, and mud flats. High biological productivity is an important feature of marshes since they contribute substantial amounts of biomass and nutrients to the estuarine food chain. Tidal marshes also serve as nursery areas for various species of finfish and shellfish and for numerous shore and wading birds.

Threatened And Endangered Species

There are several species that may occur in the project study area that are listed by the U.S. Fish and Wildlife Service and National Marine Fisheries Service as threatened and endangered. They are protected under provisions of the Endangered Species Act of 1973, as amended.

The brown pelican occurs in the vicinity of the Upper Bay portion of the ship channel. One of the major nesting colonies on the Texas coast, Brown Pelican Island, is an emergent bank of dredged material in Corpus Christi Bay south of the CCSC. Brown Pelican Island contains a primary brown pelican nesting area in a mound at the northeastern corner of the island. Pelicans usually nest in this area between 1 March and 30 August. The arctic peregrine falcon is a migrant that moves through the area in spring and fall. The piping plover is also a migrant that can be found along the Texas coast from fall through spring.

Five species of sea turtle have been reported along the Texas coast, including the Kemp's ridley, loggerhead, green, hawksbill, and leatherback. All species of sea turtles on the National Marine Fisheries Service list might occur in Corpus Christi Bay; however, there are no known aggregation sites or important feeding areas in the immediate project vicinity.

The following species are on the State of Texas Protected Nongame list (equivalent to threatened) and occur in the project area: reddish egret, white-faced ibis, wood stork, least tern, Texas tortoise, and Texas horned lizard.

Cultural Resources

Potentially significant archeological and historic sites have been documented in the Corpus Christi study area. Limited cultural resource investigations in the Corpus Christi area have revealed cultural remains from Paleo-Indian to Historic times. Common aboriginal remains include burial sites and shell middens represented by Archaic Aransas phase and Late Prehistoric

Rockport phase materials. Aboriginal sites are found in great concentration along the bluff north of Nueces and Corpus Christi Bays and their minor tributaries. Erosion, urban and industrial development, and agricultural practices have affected many of these sites. Remains of early Spanish, Mexican, and Anglo-American activities and settlements are also present in the Corpus Christi area.

Socioeconomic Considerations

The CCSC project area lies within Bureau of Economic Analysis Economic Area 143, a 17-county area that includes such cities as Corpus Christi, Laredo, and Kingsville. The economy of the Corpus Christi area is broadly based in manufacturing, agriculture, military, and fishing. The development of improved port transportation facilities along the CCSC has allowed greater export of agricultural products. The Port of Corpus Christi handles large volumes of commodities including crude petroleum and petroleum products, aluminum ores, and agricultural products. Industrial development in the area consists of plants devoted to processing agricultural products, producing and refining petroleum and petroleum products, petrochemicals, and chemical derivatives; manufacturing; fishing and offshore service vessels; drilling rigs; offshore producing platforms; offshore service equipment; and reducing ores to produce aluminum, zinc, and chrome products. The discovery of oil and natural gas in the area promoted a broad industrial base and aided in the development of industries such as oil refining, chemicals, and primary metals, which also rely on port facilities.

The Corpus Christi area is a popular recreational area, and tourism is an important aspect of the local economy. Tourists and retired people are attracted to the area, which is the gateway to the Padre Island National Seashore and other area public and private recreational facilities, the Gulf of Mexico, and nearby lakes. Fishing, boating, and other water related activities are very popular, and both Corpus Christi and Port Aransas have fairly large sport fishing fleets. The diversity of coastal habitats in the Corpus Christi area supports a large diversity of shore birds, while the large number of adjacent shallow bays and grain fields create an ideal habitat for waterfowl. This situation provides for moderate hunting of waterfowl and a large amount of bird watching in the Corpus Christi area.

Nueces and San Patricio Counties lie in the Coastal Bend region of Texas. Land use within this two-county region is divided principally among agricultural land, range-pasture land, industrial land, urban-residential and urban-commercial land, recreational land, park and recreational facilities, military installations, and marshlands. Water use includes mineral production, commercial and sport fishing, recreation, and transportation. Several factors have contributed to this diversified land and water use. This area has a high population concentration. It is an area endowed with extensive mineral resources that support major petroleum refining and

petrochemical processing. Also, it is an area with fertile and productive lands that support extensive agricultural uses. Finally, it contains major port facilities that have led to a high volume flow of imports and exports.

Nueces County has an area of 1,166 square miles with a 1990 population of 291,145 persons. This represents an increase of 8.5% over the 1980 population of 268,215. Total employment consists of a work force of 121,837 with 8.5 percent unemployed in 1990. The 1980 employment figure is 114,780 resulting in a growth rate of 6.1% over the 10-year period. Nueces County has a diversified economy, which includes petroleum processing and production, agriculture, tourism, coastal shipping, manufacturing, and a military complex located in the County. The largest family income group belongs to the range between $35,000 and $49,999. Family median income is $29,177.

San Patricio County is 707 square miles in area with a 1990 population of 58,749 persons. This represents an increase of 1.3% over the 1980 population. Total employment consists of a work force of 22,339 with 2,281 unemployed in 1990. The 1980 employment figure is 22,189 resulting in a growth rate of less than 1 percent over the 10-year period. San Patricio County is also a diversified economy, which includes an oil center, a petrochemicals center, agribusinesses, and a manufacturing complex located in the County. The largest family income group belongs to the range between $15,000 and $24,999. Family median income is $25,607.

PROJECT AREA DESCRIPTION

The authorized Federal navigation project consists of channels and turning basins suitable for oceangoing vessels, and associated rubble-stone jetties. Two project channels, the Corpus Christi Ship Channel and La Quinta Channel, were evaluated in this study. The Corpus Christi Ship Channel begins in deep water in the Gulf of Mexico about 3 miles offshore, passes through the jettied inlet, and extends about 21 miles westward to Corpus Christi. The project is geographically divided into four segments; the Entrance Channel, Lower Bay and Upper Bay reaches, and the Inner Harbor.

The Gulf of Mexico and the Inner Basin bound the Entrance Channel. The jetties that protect the Entrance Channel are 11,190 and 8,610 feet long and extend into the Gulf from San Jose (formerly St. Joseph's) and Mustang Islands, respectively, and stabilize the natural inlet at Aransas Pass.

The Lower and Upper Bay reaches extend west from the Inner Basin to the Harbor Bridge, and are separated by the La Quinta Channel junction. These two reaches differ in that the Lower Bay reach is largely landlocked while the Upper Bay segment is located in the center of the bay with

no adjacent islands or protective structures (Figure 1). Continuing west from the Harbor Bridge, the channel extends about 8.5 miles through the Inner Harbor area before terminating at the Viola Turning Basin. The Inner Harbor is entirely landlocked and is the location of the majority of port facilities. The channel connects a series of turning basins, including the Corpus Christi, Avery Point, Chemical, Tule Lake, and Viola Basins. Access in the Inner Harbor can be restrictive due to two bridges that cross the channel; the Harbor Bridge, a large fixed span bridge at the entrance to the Inner Harbor, and the Tule Lake Lift Bridge located midway to the Viola Turning Basin.

The La Quinta Channel extends from the Corpus Christi Ship Channel at the La Quinta Junction (Figure 1) adjacent to Ingleside Point, which is about half-way between the Gulf of Mexico and Corpus Christi. The La Quinta Channel measures approximately 5.5 miles and currently ends in the La Quinta Turning Basin. This channel is protected from large stretches of open water by the mainland and existing PAs adjacent to the channel.

Initial estimates showed that approximately 70 pipelines cross the existing channels, and further evaluation was necessary to refine that number and determine which lines would need to be moved, should a widening or deepening project be recommended.

The existing project dimensions are shown in Table 1.

Available PA's are located throughout the project area and include upland contained, partially contained, and dispersive sites. Several upland contained sites are available in the Lower Bay, Inner Harbor, and La Quinta Channel. These include Mustang Island (PA 6), PA 10, and PA 4 in the Lower Bay, PA 13 adjacent to the La Quinta Channel, and several Inner Harbor Placement Areas (IH-PA's) including Suntide (IH-PA 8), Tule Lake (IH-PA 6), South Shore (IH-PA 3), Rincon (IH-PA 2), IH-PA 1, IH-PA 4, and IH-PA 5.

Two partially contained sites are located in the Entrance Channel and Lower Bay portion of the project. These are located on San Jose Island (PA 2) and on the south side of the CCSC, west of Port Aransas (PA 5).

Several uncontained sites are also available along the channel. Dredged Material Placement Area (DMPA) 1 is located near the channel in the Gulf of Mexico. PA's 7 and 8, also known as Pelican Island has been used for the beneficial placement of material in the past to maintain this high quality bird habitat. PA's 14A, 14B, 15A, 15B, 16A, 16B, 17A, 17B, and 18 are located adjacent to the CCSC in the Upper Bay reach.

Table 1
Corpus Christi Ship Channel Dimensions

CHANNEL SEGMENT	DEPTH (ft)	WIDTH (ft)	LENGTH (mi)
Entrance Channel			
Aransas Pass Outer Bar Channel	47	600-700	2.8
Aransas Pass Jetty Channel	45-47	600	1.3
Inner Basin at Harbor Island	45	600-1559	0.6
Lower Bay Reach			
Inner Basin Main Channel	45	600	0.6
Humble Basin to Junction at La Quinta Channel	45	500-600	10.0
Upper Bay Reach			
La Quinta Junction to Beacon 82	45	400	9.7
Inner Harbor			
Beacon 82 to Corpus Christi Turning Basin	45	300-400	0.9
Corpus Christi Turning Basin	45	300-800	1.2
Industrial Canal	45	400	0.6
Avery Point Turning Basin	45	400-975	0.5
Tule Lake Channel	45	200-400	3.8
Chemical Turning Basin	45	400-1200	0.5
Tule Lake Turning Basin	45	300-1200	0.4
Viola Channel	45	200-300	1.7
Viola Turning Basin	45	700-900	0.3
La Quinta Channel			
Channel to La Quinta	45	300-400	5.5
La Quinta Turning Basin	45	1200	0.4

NON-FEDERAL SPONSOR AND COORDINATION

The District Engineer, Galveston District, U.S. Army Corps of Engineers (USACE), is responsible for the overall management of the study and report preparation. The Port of Corpus Christi Authority is the non-Federal sponsor for the study. The study is being coordinated with

interested Federal, State, and local agencies, and the public. The following are some of the agencies and groups that provided input during preparation of the report:

Federal Agencies

- U.S. Fish and Wildlife Service
- U.S. National Marine Fisheries Service
- U.S. Environmental Protection Agency
- U.S. Coast Guard

State Agencies

- Texas Commission on Environmental Quality
- Texas General Land Office
- Texas Parks and Wildlife Department
- State Historic Preservation Officer
- Texas Department of Transportation
- Texas Railroad Commission

Regional, County, and Local Agencies

- Port of Corpus Christi Authority

Other Interests

- Coastal Bend Bays and Estuaries Program
- Aransas – Corpus Christi Pilots

A Regulatory Agency Coordination Team (RACT), made up of representatives from many of these agencies, was established to provide guidance on matters relating to the evaluation of environmental impacts of this project. Several technical workgroups, composed of members of the RACT, were established to focus on specific, environmentally related issues of the project.

In addition, representatives of numerous firms involved in navigation as well as special interest groups and individuals provided input to the study.

PRIOR AUTHORIZATIONS

The initial Federal involvement in navigation improvements in the Corpus Christi Bay area began with the Rivers and Harbors Act of June 18, 1878. This authorization provided for the first survey and cost estimates for the channel improvements. The Rivers and Harbors Act of March 3, 1879 authorized the first improvements. This authorization provided for deepening the channel across the outer bar of Aransas Pass to 12 feet and the protection of the head of Mustang Island up to and beyond Turtle Cove. This work was completed in April 1885.

The 1899 Rivers and Harbors Act authorized the acquisition of the north jetty that had been constructed by private interests. Significant improvements on the CCSC began in earnest with the passing of the Rivers and Harbors Act of 1910. The following is a summary by date of authorization of the major improvements that have been made to the Channel and vicinity.

June 1910 - 12-foot X 100-foot channel through Turtle Cove Channel and Corpus Christi Bay, between Aransas Pass and Corpus Christi.

September 1922 - 25-foot X 200-foot from Port Aransas through Turtle Cove to the shoreline near Corpus Christi.

July 1930 - 30-foot X 200-foot with passing lanes from Port Aransas through Turtle Cove to the east side of the Corpus Christi breakwater.

August 1935 - 32-foot channel from Port Aransas to and including a 1000-foot x 3000-foot turning basin at Corpus Christi. An industrial canal 30-foot x 150-foot and an 800-foot x 1200-foot turning basin at Avery Point.

June 1938 - The main turning basin at Corpus Christi was extended 2,500 feet west at 32-foot.

June 1938 - Deepening the Industrial Canal and turning basin to 32 feet and extend the canal 32-foot X 150-foot westward along Nueces Bay shore to a turning basin 32-foot X 900-foot X 1,000-foot near Tule Lake.

March 1945 - 34-foot depth in all project channels and basins, 250-foot width from Port Aransas to breakwater at Corpus Christi, 200-foot width in Industrial Canal and the channel between Avery Point and Tule Lake turning basins, and widen Avery Point turning basin to 1,000 feet.

June 1948 - 38-foot depth from the Gulf to the outer end of the jetty; 38-foot decreasing to 36-foot to station 90 on the north jetty; and 36-foot in all other channels and basins except the

2,000-foot undredged part of the inner basin at Harbor Island, and 400-foot width in the channel from Port Aransas to the maneuvering basin at Corpus Christi.

September 1954 - The La Quinta Channel, 32-foot X 150-foot and a turning basin 32-foot X 800-foot in the vicinity of La Quinta.

July 1958 - The La Quinta Channel to 36-foot X 200-foot. The turning basin to 36-foot X 800-foot X 1,000-foot. The channel entrance was flared and curves were widened. Entrance Channel to 42-foot from the Gulf to the outer end of the jetty; 40-foot in all other channels and basins except the undredged northward extension to the inner basin at Harbor Island and the La Quinta Channel; the Industrial Channel to 400-foot width with flared entrances to Corpus Christi and Avery Point turning basins; a channel 40-foot X 200-foot extending 2.2 miles from Tule Lake turning basin to a turning basin 40-foot X 700-900-foot X 1,000-foot at Viola.

August 1968 - 45-foot depth in existing channels and basins, a deep-draft turning point, a deep-draft mooring area and mooring facilities, and widening of the channels and basins at certain locations. The Act also deauthorized the undredged northward extension of the Inner Basin at Harbor Island and the undredged west turnout (Wye connection) between the La Quinta Channel and the main channel of the waterway.

STUDY AND REPORT PROCESS

In September 1994, the Galveston District completed a Reconnaissance Report for the CCSC. This report concluded that channel modifications that would improve the efficiency and safety of the channels appeared feasible. The report recommended detailed studies to quantify the magnitude of the costs and benefits associated with several types of improvements.

This feasibility study follows the recommendations given in the Reconnaissance Report. It includes detailed analyses of a range of improvements and their effectiveness at improving efficiency and safety by allowing the use of larger, more efficient vessels and reducing delays and vessel casualties. It also includes detailed assessments of environmental, social, and local economic effects of those improvements determined to be most viable from a national economic perspective. Results of this study form the basis for a decision on project implementation, including preconstruction design studies.

The study process provided for a systematic preparation and evaluation of alternate plans which address study area problems and opportunities. The process involved all of the six functional planning steps:

Specify Problems and Opportunities
Inventory and Forecast Conditions
Formulate Alternative Plans
Evaluate Effects of Alternative Plans
Compare Alternative Plans
Select Recommended Plan

The earlier Reconnaissance Report emphasized problem identification and formulation of alternatives. Emphasis in this Feasibility Report is on evaluation of alternatives, assessment of impacts, and selection of a recommended plan.

II. PROBLEM IDENTIFICATION

Existing water resources problems and needs in Corpus Christi Bay were identified through coordination with Federal and State agencies, area residents, waterway users, and the non-Federal sponsor. Most of the identified problems are not unique to Corpus Christi Bay but are common to many of the bays and estuaries in Texas.

NAVIGATION AND COMMERCE

The CCSC was the first waterway in Texas to be completed to a depth of 45 feet. This channel ranks fifth in the Nation for tonnage shipped on deep-draft vessels, and in Texas only the Houston Ship Channel handles more tonnage. Since the completion of the 45-foot project, the size of ships using the waterway has steadily increased so that many vessels currently have to be light-loaded to traverse the waterway. The percentage of total 1998 tonnage shipped in vessels that could be loaded to depth greater than 45 feet was 22 percent. Exclusion of barge tonnage would increase the percentage of draft restricted tonnage to 27 percent.

The Upper Bay segment is only 400 feet wide and is subject to strong cross winds and currents, while the Lower Bay reach is 500 feet wide and is semi-protected by emergent dredged material PAs. As part of the 45-foot project, a mooring area was constructed near Ingleside. This facility consists of six breasting structures and ten mooring structures. It was designed to hold inbound ships at Ingleside while other large ships were crossing the open water area from the Harbor Bridge to Ingleside. This facility has not functioned as designed and is in disrepair. Shippers would rather wait offshore and time their entrance so that passing occurs in the 500-foot reach rather than go through the trouble and expense to get tug assistance to moor and wait with a pilot on board and tugs standing by to release them from the moorings. The Galveston District is currently evaluating removal of these structures. Widening the Upper Bay reach would increase the safety factor for this area and would reduce the shipping delays for the project, especially since shipping trends indicate a movement toward the use of larger vessels. The ultimate size of vessels using the channel is restricted by the 138-foot vertical clearance of both the Harbor Bridge and the Tule Lake Lift Bridge. However, the clearance is sufficient to accommodate the present fleet of vessels using the project.

The current channel depth requires that large crude carriers remain offshore and transfer their cargo into smaller crude tankers for the remainder of the voyage. This lightering operation takes place in the Gulf of Mexico where the two ships, the mother ship and the lightering ship, come together so that the cargo transfer can take place. Although this operation has been going on for

years, the possibility for a collision, oil spill, fire, or other adverse environmental consequences is always present. Deepening the channel will reduce the number of lightering operations.

Current projections suggest that crude imports will increase throughout the period of evaluation. As the imports increase, the number of lightering vessels and product carriers will also increase, adding to the shipping delays and congestion. Since the most frequent shipping accidents result from collisions between ships and inland tows, the towing industry and channel industries are concerned that restrictions may be placed on the tows to limit these costly and environmentally damaging events.

The approximately 111 commercial terminals are isolated in two areas, specifically the Inner Harbor and La Quinta Channel. Barge terminals make up a large number of these facilities and barge traffic must compete with ship traffic in the CCSC and La Quinta Channel.

No deep-water access exists from the end of the existing La Quinta Channel to the proposed container terminal. Extension of the channel would allow benefits to be achieved while enhancing the economy of the region.

The remaining capacity of the current upland PAs as well as the continued suitability of bay PAs has been examined and a bay-wide plan for the future needs was developed that encourages the use of dredged material for beneficial uses.

Shoreline erosion is occurring along the ship channel in the Port Aransas area. Ship wakes may be contributing to this problem, and resolution of the erosion problem was requested to be included in this study.

The Tule Lake Lift Bridge is a concern because the channel width in this reach restricts ship movements. The lift bridge in this area allows limited access, however, there are considerations being given to removal and/or replacement of this bridge.

ENVIRONMENTAL

Many of the problems such as pollution are caused by anthropogenic activities around the bay system and in the contributing watershed while others such as shoreline erosion are both a result of anthropogenic activities, e.g., shipping, and natural processes including normal wind-generated waves and hurricanes. The environmental concerns identified during the reconnaissance study included the following items.

The increasing potential for environmental harm as a result of shipping accidents is a major concern. In the absence of adequate channel widening, one-way traffic versus two-way traffic should be considered as a means to reduce this threat.

Oil spill recovery and defining the liabilities associated with the clean-up are important to both the environmental community and the oil shipping business. This understanding is necessary to assure that the clean-up activities are started immediately and are completed as quickly as possible to limit the damages. However, response to spills would not change based on modifications to the width or depth of the channels in the region. Because of this, spill recovery is considered outside the scope of this study and further analysis is not necessary.

Sediment quality in the Inner Harbor is a concern and needs to be evaluated.

The ship channel and PAs in the bay have impacts on circulation and salinity levels within the bay. In addition, open bay placement presents potential problems for the benthic community, circulation, shrimping, and the need for redredging.

There are several areas of concern that could possibly be addressed from channel modification or mitigation of the unavoidable impacts. Water interchange between Corpus Christi Bay and the Laguna Madre could be improved, specifically in the vicinity of the Kennedy Causeway and the GIWW. Other potential opportunities include construction of oyster reefs in and around the Corpus Christi area, enhancement of Redfish Bay, and development of bird rookery islands in Nueces Bay.

PROBLEM SUMMARY

The depth and width of the existing channel system remains restrictive due to the size of the current world fleet in operation. Beam width restrictions continue to cause delays for larger ships wishing to enter Corpus Christi's port facilities. Increased channel depths would reduce the need for lightering and lightening. Access to additional facilities would also allow the Port of Corpus Christi to utilize facilities for future development. A project addressing shipping delays while increasing safety for both the industry and the environment is needed.

III. FORMULATION OBJECTIVES, CONSTRAINTS, AND CRITERIA

NATIONAL OBJECTIVES

The fundamental national objective of Federal participation in water resources development projects is to assure that an optimum contribution is made to the welfare of all people. The Water Resources Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies dated March 1983 and the National Environmental Policy Act of 1969 (NEPA) provide the basis for Federal policy for planning Federal water resources projects. These authorities have established the procedures for formulation and evaluation of water resources projects. Additional policies and regulations, derived from executive and legislative authority, further define the criteria for assessment of plan impacts, risk analysis, review and coordination procedures, and project implementation.

Current Federal policy dictates that National Economic Development (NED) is the primary national objective in water resources planning. NED objectives stress increasing the value of the Nation's output of goods and services and improving economic efficiency on a national level. Planning objectives designed to improve NED are concerned with the value of increased output of goods and services resulting from external economics associated with a plan.

The Federal objective of water and related land resources planning is to contribute to NED in a manner that is consistent with protecting the Nation's environment. Consequently, the resource's condition should be more desirable with the selected plan than under the without-project condition.

National objectives are designed to assure systematic interdisciplinary planning, assessment, and evaluation of plans addressing natural, cultural, and environmental concerns, which will be responsive to Federal laws and regulations. In addition to the selected NED plan, the proposed project includes environmental restoration features that will protect and enhance valuable habitat identified during the study.

PLANNING OBJECTIVES

The primary objective of Federal navigation activities is to contribute to the Nation's economy while protecting the Nation's environmental resources in accordance with existing laws, regulation, and executive orders. More specific planning objectives were identified by area residents and concerned State and Federal agencies or suggested by existing opportunities for

improving the quality of life. Plans were formulated and evaluated with the following objectives in mind:

1) To improve the efficiency and safety of the deep-draft navigation system, and

2) To maintain or enhance the quality of the area's coastal and estuarine resources.

PLANNING CONSTRAINTS

Plans must be formulated with regard to addressing the problems and needs of the area, taking into consideration future without-project conditions. The plans should identify tangible and intangible benefits and costs from economic, environmental, social, and regional perspectives. Institutional implementation constraints should also be identified. The formulation framework requires the systematic preparation and evaluation of alternative solutions to the recognized water resource-related problems within the study area. The process also requires that impacts of the proposed action be measured and results displayed or accounted for in terms of contributions to: NED, Environmental Quality, Regional Economic Development, and Other Social Effects.

Interaction with other interests must be maintained throughout the planning process to avoid duplication of effort, minimize conflicts, obtain consistency, and assure completeness. The following constraints apply to this feasibility study:

- Fish and wildlife habitat affected by a project plan should be preserved, if possible;
- The study process and plans developed must comply with Federal laws and policies; and
- Alternative plans that resolve problems in one area should not create or amplify problems in other areas.

Current guidance specifies that the Federal objective of planning is to contribute to NED consistent with protecting the Nation's environment. The following general criteria are applicable to all water resource studies. They have generally guided the formulation of this study. Technical, economic, environmental, and social criteria have been established to guide the project development process. These criteria are discussed below.

TECHNICAL CRITERIA

Technical criteria require the preservation of adequate project dimensions to provide safe passage of commercial navigation traffic through this reach of the waterway while minimizing environmental impacts. These criteria require plans to be compatible with navigation needs and consistent with the requirements of the navigational equipment using this portion of the waterway and to provide a long-term plan for the placement of dredged materials in order to continue maintenance of the waterway in the future. These plans must be consistent with specific environmental conditions of the area including soil conditions, topography, and terrestrial and aquatic ecosystems. Formulation of alternative alignments, and dredged material placement alternatives and their evaluation was accomplished by analysis of historical and projected shoaling rates, erosion causes and rates, and general structural and non-structural alternatives applicable for conditions which are specific to this area. Technical information, both historical data and specific information prepared for this project, used during this study included, but was not limited to, salinity model data, ship simulation results, aerial photography, historical dredging records, and previously published scientific reports related to this area.

ECONOMIC CRITERIA

The economic criteria require that tangible benefits attributable to projects exceed project costs. Project benefits and costs are reduced to average annual equivalent values and related in a ratio of benefits to costs (Benefits-to-Cost ratio or BCR). This ratio must exceed unity to meet the NED objective. Selected plans, whether structural, nonstructural, or a combination of both, should maximize excess benefits over costs; however, unquantifiable features must be addressed subjectively. These criteria are used to develop plans that achieve the objective of NED and provide a base condition for consideration of economically unquantifiable factors which may impact on project proposals.

All structural and nonstructural measures for navigation projects should be evaluated using the appropriate period of analysis and the currently applicable interest rate. Total annual costs should include amounts for operation, maintenance, major replacements, and mitigation, as well as amortization and interest on the investment.

ENVIRONMENTAL CRITERIA

The general environmental criteria for navigation projects are identified in Federal environmental statutes, executive orders, and planning guidelines. It is the national policy that fish and wildlife resource conservation be given equal consideration with other study purposes in the formulation and evaluation of alternative plans. The basic guidance during planning studies

is to assure that care is taken to preserve and protect significant ecological, aesthetic, and cultural values, and to conserve natural resources. These efforts also should provide the means to maintain and restore, as applicable, the desirable qualities of the human and natural environment. Alternative plans formulated to improve navigation should avoid damaging the environment to the extent practicable and contain measures to minimize or mitigate unavoidable environmental damages. Particular emphasis was placed on the following:

- Protection, preservation, and improvement of the existing fish and wildlife resources along with the protection and preservation of estuaries and wetland habitats and water quality;

- Consideration in the project design of the least disruptive construction techniques and methods;

- Mitigation for project-related unavoidable impacts by minimizing, rectifying, reducing or eliminating, compensating, replacing, or substituting resources;

- Preservation of significant historical and archeological resources through avoidance of effects. This is the preferable action to any other form of mitigation since these are finite, non-renewable resources.

SOCIAL AND OTHER CRITERIA

Plans proposed for implementation should have an overall favorable impact on the social well-being of affected interests, and have overall public acceptance. Structural and nonstructural alternatives must reflect close coordination with interested Federal and State agencies and the affected public. The effects of these measures on the environment must be carefully identified and compared with technical, economic, and social considerations and evaluated in light of public input.

PLAN FORMULATION RATIONALE

The rationale for formulating and developing alternative solutions is discussed in the following paragraphs. The planning framework requires the systematic preparation and evaluation of alternative ways of addressing problems, needs, concerns, and opportunities while considering environmental factors. The criteria and broad planning objectives previously identified form the basis for subsequent plan formulation, screening, and ultimately plan selection.

The planning process for this study has been driven by the overall objective of developing a comprehensive plan that would allow safe, two-way barge and ship traffic along the CCSC. Secondary objectives have been to address other related water resources problems in the study area. The first phase of this process was to establish the magnitude and extent of the problems and then to develop and evaluate an array of alternative solutions to meet the existing and long-range future needs of the area.

During the feasibility phase, lines of communications were opened with Federal, State, and local agencies, private groups, and the affected public. Through scoping and other coordination meetings, public involvement activities were continued throughout the planning process.

The expected future without-project scenario was first developed for comparison with other alternatives. Nonstructural and structural plans were developed to address the planning objectives. For the structural plans, an array of channel modifications and dredged material placement alternatives were developed, evaluated, and screened. The modifications were investigated as to possible means to satisfy the objectives of a safer, more efficient CCSC.

Through a two-phased screening process, a plan was ultimately selected. A long-term dredged material placement plan was also developed for the selected plan. Further preliminary design refinements were accomplished for the selected plan prior to developing a baseline cost estimate for this plan.

IV. PLAN FORMULATION

WITHOUT PROJECT CONDITION/NO ACTION

The USACE planning guidance requires analysis of a "without" project plan as one of the alternatives. Also, to comply with the requirements of the NEPA, a "no action" plan must be included in the alternative array. The "without project" plan is synonymous with the No Action Plan. The "without project" plan also forms the basis against which all other alternative plans are measured.

The Without Project Condition would retain a 45-foot deep navigation channel with its periodic maintenance dredging program. Use of the channel by multiple vessels would be limited because of the current 400-foot width of the Upper Bay portion of the channel. As vessels increase in draft and beam, the restrictive depth and width of the CCSC would prevent some vessels from entering with full loads, or prevent the use of the channel complex altogether by large vessels. This need for lightering and light loading would increase costs and decrease efficient use of vessels wishing to use the port facilities.

NON-STRUCTURAL MEASURES

One non-structural opportunity available is the continued use of beam width restrictions within the channel. Current restrictions prevent two ships with a total beam width greater than 251 feet from passing in the channel. This alternative would only maintain current operations, with increased costs and delays. Another non-structural measure is use of lightering and lightening vessels. This is another practice already in use and would offer no additional benefits. Therefore, non-structural alternatives were not considered feasible or did not fully address the problems.

STRUCTURAL MEASURES

Structural alternatives considered include dredging to widen and deepen the existing CCSC and the La Quinta Channel as well as an extension of the La Quinta Channel. This alternative allows existing ships to more fully utilize the proposed channel. It also creates a situation where ships can avoid delays due to the ability to meet more safely in a wider channel. However, dredging creates the need for the placement of dredged material. Any plan considered should ensure that placement alternatives address the needed capacities as well as the need to ensure minimal impacts to the environment. Because structural alternatives address all of these needs, the alternatives considered were all of a structural nature.

Potential structural restrictions exist at both the Harbor Bridge and Tule Lake Lift Bridge. These structures have set clearance requirements and may prevent ships of a certain size from entering the Inner Harbor portion of the channel. However, the vertical clearance of the bridge is sufficient to accommodate the present fleet of vessels using the project. The project deepening is not forecasted to result in the introduction of larger vessels; thus, none of the benefits identified are for vessels that cannot currently pass under either bridge. The Tule Lake Lift Bridge may be removed or replaced; however, this may occur under both the without and with project future. The Texas Department of Transportation (TxDOT) has been funded to study the Harbor Bridge replacement. The TxDOT selected an engineering group last year to perform the study. Proposed channel improvements will not affect the foundations of the existing bridges.

V. PLAN ASSESSMENT AND SCREENING OF ALTERNATIVES

The ultimate objective of the feasibility study is to arrive at a selected plan after a full range of alternatives has been analyzed. This involves a comparison between each alternative and the future without-project condition consequences, considering economic, environmental, and social impacts.

SCREENING PROCESS

A general screening process was first used to determine which structural plan would result in the objective of providing safe and efficient navigation at the least cost while minimizing environmental impacts. A total of 23 alternatives were initially evaluated for more detailed consideration. These alternatives included:

- Widening only across Corpus Christi Bay with no deepening (1 alternative).
- Deepening to 48, 50, or 52 feet from the Gulf of Mexico to the Viola Turning Basin, without widening and with widening to 470, 500, or 530 only across the Upper Bay portion of the channel (12 alternatives).
- Each of the widening alternatives would include barge shelves on each side of the channel (1 alternative).
- Deepening the La Quinta Channel to 48, 50, and 52 feet with and without the La Quinta Channel extension (3 alternatives).
- Extending the La Quinta Channel at depths of 36, 38, 40, 42, and 45 feet (5 alternatives).
- No Action Plan (1 alternative).

Benefits and costs, detailed in Table 2, were developed for all of these alternatives. These numbers were used to reduce the number of alternatives to be considered during more detailed evaluation. Mitigation was not considered when screening alternatives, but was given due consideration during development of the selected plan. Cost factors such as levee construction, dredging, and pipeline relocations/removals were included in this cost analysis. The evaluation was performed to put all the alternatives on an equal basis without the mitigation costs. Costs were developed for all of the alternatives; however, benefits were determined only on certain alternatives.

Table 2

Initial Costs and Benefits for All Considered Alternatives

Corpus Christi Ship Channel Widening and Deepening					
Depth (ft)	Width (ft)	Benefits ($000)	Cost ($000)	BCR	Net Benefits ($000)
45	500	650	1,024	0.6	-374
48	400	37,855	6,567	5.8	31,288
48	470	–	7,519	–	*
48	500	38,505	7,821	4.9	30,683
48	530	–	8,056	–	*
50	400	49,758	7,834	6.4	41,924
50	470	–	8,847	–	*
50	500	50,408	9,075	5.6	41,333
50	530	–	9,375	–	*
52	400	60,483	9,168	6.6	51,316
52	470	–	10,248	–	*
52	500	61,133	10,553	5.8	50,581
52	530	–	11,088	–	*
La Quinta Channel Deepening					
Depth (ft)	Width (ft)	Benefits ($000)	Cost ($000)	BCR	Net Benefits ($000)
48	300	482	847	0.57	-365
50	300	702	887	0.79	-184
52	300	702	888	0.79	-186
La Quinta Channel Extension					
Depth (ft)	Width (ft)	Benefits ($000)	Cost ($000)	BCR	Net Benefits ($000)
36	300	8,979	1,549	5.80	7,430
38	300	9,245	1,598	5.78	7,648
40	300	9,280	1,604	5.79	7,676
42	300	9,253	1,658	5.58	7,595
45	300	9,159	1,760	5.20	7,398
Barge Shelves					
Depth (ft)	Width (ft)	Benefits ($000)	Cost ($000)	BCR	Net Benefits ($000)
12	200	133	81	1.64	52

* Benefits were not computed for these widths because the ship simulation study was used to determine the preferred width of the channel. It was not necessary to compute a BCR for each depth and width combination, but only to determine the best depth alternative for a common width.

From the analysis of the 23 alternatives, six alternatives were selected for further consideration. These alternatives included:

- Deepen to 50 and 52 feet from the Gulf of Mexico to the Viola Turning Basin and widen across Corpus Christi Bay (based on net benefits and safety reasons).
- Widen only across Corpus Christi Bay (non-Federal sponsor requested).
- Deepen the La Quinta Channel to 50 feet (non-Federal sponsor requested).
- Extension of the La Quinta Channel.
- Construction of barge shelves across the Upper Bay portion of the CCSC.

A detailed analysis of benefits and costs was performed for each of these six alternatives. This information is detailed in the following sections and is then used in selection of the plan.

VI. ECONOMIC EVALUATION

The project benefits were calculated based on reductions in transportation costs. The initial screening showed that a channel depth of 52 feet produced the highest net excess benefits for the deepening plans evaluated for the main channel. The screening analysis suggested that additional studies were necessary to conclude if widening of the bay reach and extension of the La Quinta channel were in the Federal interest. In addition, deepening the La Quinta Channel beyond the existing project depth of 45 feet was also investigated. The non-Federal sponsor and pilots association expressed a strong interest in widening of the bay reach due to safety concerns and associated vessel delays and self-imposed vessel meeting restrictions. The recommendation for widening the entire bay reach to 530 feet was based on the Engineer Research and Development Center (ERDC) findings and the safety interest of Aransas-Corpus Christi Pilots. The pilots presently limit vessel meetings to combined beam width up to 251 feet in the 400-foot reach and a combined loaded draft limit of 80 feet.

The project benefits are for a 2006-2056 economic evaluation period and are based on the FY 2002 Federal Discount rate of 5 7/8 percent and FY 2000 vessel operating costs (Economics Guidance Memo (EGM) 00-06). Vessel operating costs for tow vessels were obtained from EGM 00-05 FY 2000. A 1998-99 base was generally presented in the cost savings tables. Data from 1999 and 2000 were incorporated into tables and the effect that more recent years had on the commodity forecasts were evaluated. In general, the commodity forecasts were developed based on multiple-regression equations, which incorporated data for the most recent 20 to 30 year period.

CHANNEL DEEPENING BENEFITS

Channel deepening benefits were calculated for Corpus Christi crude petroleum, petroleum products, and grain cargoes.

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 Institute for Water Resources Report 91-R-13, National Economic Development Procedures Manual Deep-Draft Navigation, November 1991.

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 detailed in the Economic Appendix.

Methods of shipping crude oil are direct, lightered, lightened, and transshipped. Direct shipment, as the name implies is the transfer of tonnage by vessel between two coastal ports. Direct shipment savings were calculated for several project alternatives and are summarized in Table 3. 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 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 Waterborne Commerce Statistic Center's (WCSC) shipping records, which are obtained through the Bureau of Census, do not provide sufficient information to distinguish lightened tonnage from direct or lightered tonnage. Thus, combined lightering and lightening savings are summarized in Table 4. Industry personnel and additional Bureau of Census and pilot's records indicated that lightening is common for shipments from Africa and Europe. Savings for both shipment methods are summarized in Table 5.

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 (DOE) U.S. and World Fleet Forecast's (WFF) U.S. Gulf Coast product trade forecasts.

Table 3

Crude Petroleum Annual Transportation Savings for Direct Shipments

	47	48	49	50	52
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

Table4

Crude Petroleum Annual Transportation Savings for Lightered & Lightened Shipments

	47	48	49	50	52
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 5

Crude Petroleum Transportation Savings Summary

	47	48	49	50	52
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	$2,609,875	$3,930,551	$5,077,072	$6,223,593	$8,419,209

The vessel 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 33 percent of imports were shipped from ports with depths in excess of 50 feet. Examination of

vessel sizes and trade route data showed that 6 percent of existing products export 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. Application of the trade route forecasts to Corpus Christi showed that 10 percent of 2006-56 products export tonnage could benefit from a project depth in excess of 45 feet. For the 50-foot channel, this percentage would decrease to 7 percent and to 6 percent for the 52-foot project.

After identifying the percentage range of tonnage constrained by the current 45-foot project depth, the trade routes associated with these movements were evaluated in relationship to the DOE 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. The DOE 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 2020, and 2006 to 2050, respectively. The Corpus Christi share was estimated based on the assumption that percentage of these draft-constrained movements would continue to move through U.S. Gulf Coast ports. The WFF U.S. Gulf Coast 1998/99 to 2050 projections show increasing volumes of tonnage moving in large vessels. Tables 6 and 7 display the transportation cost savings for petroleum product import and export tonnage.

Table 6

Petroleum Product Imports Annual Transportation Savings

	47	48	49	50	52
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	$7,361,546	$10,302,120	$13,284,971	$16,731,076	$22,669,722

Bulk Grain Exports

The annual transportation savings for bulk grain transportation associated with the proposed channel deepening alternatives are presented in Table 8. Examination of 1996-99 Corpus Christi grain exports indicated that 7.5 percent of 1996-99 tonnage was shipped in vessels thatcould be loaded to depths over 45 feet. This percentage was based on actual tonnage shipped in vessels with loaded drafts between 41 and 45 feet; tonnage shipped in vessels with loaded drafts over 50

feet; and channel depth at the port of destination. The project benefits were calculated based on an estimated 12 percent of tonnage being transported in vessels with loaded drafts in excess of 45 feet. The percentage of future grain export tonnage expected to benefit from channel depths over 45 feet was based on vessel sizes, vessel loads, and foreign port depths.

Table 7

Petroleum Product Exports Transportation Savings

	47	48	49	50	52
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	$211,116	$337,525	$369,036	$398,833	$453,813

Table 8

Grain Exports Annual 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
Equivalent Annual Savings	$145,145	$181,495	$215,734	$231,828	$244,068

Channel Deepening Benefit Summary

Savings identified for all transportation commodity types are combined to identify benefits for channel deepening. Table 9 displays a summary of the project deepening benefits. The 52-foot channel depth provides the greatest equivalent annual transportation cost savings.

CHANNEL WIDENING BENEFITS

Benefits were calculated for widening the Corpus Christi Bay Channel 400- and 500-foot reaches to 530 feet. The benefits associated with widening the bay reach to 530 feet were calculated based on the probability of vessel meetings and potential delays. The Aransas-Corpus Christi Pilots 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 1990's. The 45-foot channel deepening project became operational in the late 1980's 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 of 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 with recent traffic data showed that 1-foot of underkeel clearance or less was not uncommon for liquid cargoes during the early 1990's.

Table 9

Corpus Christi Main Channel Deepening Benefits by Commodity

Channel Depth Alternative

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
Equivalent Annual Savings	$10,327,682	$14,751,691	$18,946,813	$23,585,330	$31,786,812

Benefits for widening the bay reach were 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 3 feet of underkeel clearance.

The interview and log data were used to formulate probability distributions that incorporated the range of delay times obtained from the interviews. The project benefits were based on reductions in delays presently incurred due to the channel dimensions. The projected annual

reduction in delay costs is summarized in Table 10. 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 period of economic evaluation (Economic Appendix pp. 26-30, 38, and 44).

Table 10

Corpus Christi Ship Channel, Annual Deep-Draft Vessel Widening Benefits

Delays Due to Combined Beam and Draft Restrictions

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
Equivalent Annual Benefits				$417,660

In addition to beam width delays, the pilots stated that channel widening and deepening would likely result in bay transit time savings of 6 to 20 minutes for all vessels with beam widths over 80 feet. The pilots noted that these time savings would occur for the entire 25-mile bay reach. A 6 to 8 minute time savings was noted from examination of ERDC vessel simulation data. The pilots contended that the time savings 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 equivalent annual 2006-56 benefits are displayed in Table 11.

Table 11

Corpus Christi Transit Time Savings Due to Deepening and Widening

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		$200,572

Channel Widening Benefit Summary

Savings associated with a reduction in delays due to beam and draft restrictions, resistance reductions, and ship-barge traffic interaction was identified for channel widening. Table 12 displays a summary of the project widening benefits.

CORPUS CHRISTI BARGE SHELF ANALYSIS

The CCSC's Upper Bay 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 GIWW. Congestion in the waterway has brought about traffic management rules governing maximum beam and draft to avoid collisions. The cost of this operating regime is manifested in vessel delays affecting deep-draft ocean-going vessels and shallow-draft tow barges. A barge shelf is proposed to separate the traffic and reduce the congestion induced delay cost.

Table 12

Summary of Channel Widening Benefits

	Widening Only	**Widening& Deepening**		
Year	Delays to Deep-Draft Vessels Due to Beam & Draft Restriction	Transportation Cost to Deep-Draft Vessels From Resistance Reductions	Deep-Draft Vessel Delays From Ship-Barge Delays	**Widening Total**
2000	$240,326	$158,497	$164,090	$562,913
2006	$254,548	$168,248	$174,185	$596,981
2016	$389,571	$185,850	$192,409	$767,830
2026	$474,884	$205,294	$212,538	$892,716
2036	$524,568	$226,772	$234,775	$986,115
2046	$579,449	$250,498	$259,338	$1,089,285
2056	$640,073	$276,705	$286,469	$1,203,247
Equivalent Annual Benefits	$411,615	$200,572	$207,650	$819,837

The Upper Bay section of the CCSC is currently 45-foot x 400-foot. Traffic delays have four sources. The largest is the beam width restriction. Vessels are not allowed to pass if their combined beam width 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 in the Inner Harbor. When tugs are not available, vessels must wait. The restricted draft results in large vessels delaying for

adequate channel depth. 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 Upper Bay segment of the ship channel. An example is the turn in the channel approximately one mile west of the junction between the CCSC and La Quinta Channel (Station 594+00). Pilots avoid meeting tow operators at this point by delaying. The Port Aransas Pilots estimate the incident of delays to be one out of every three ship movements. The average delay time was placed at 15 minutes. For the year 2000, 1254 incidents were estimated for a total of 313.5 hours delay time[1].

The reductions in transportation cost for deep-draft vessels associated with the barge shelf feature were calculated using the annual delay reduction of $250,000 (Economic Appendix). Under this scenario the incident of delay remains at one per three movements. Vessel traffic is forecasted to increase by one percent per year. The equivalent annual benefits for the 50-year period of economic evaluation were estimated at $309,453. The consensus of the deep-draft pilots was that two-thirds of the delay costs 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 realize would be used by the barge shelf alone.

To determine savings 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 Upper Bay reach of the Corpus Channel. Of the three operators, two said that tow vessels delay, or "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 were between 10 and 15 minutes. This information suggests that annual towboat delays are approximately $23,600. The annual delay cost was calculated using a 2-barge tow consisting of 195- by 35-foot barges and a 1,200 horsepower towboat and the annual tow trip forecast presented in Table 13. Examination of the barge fleet associated with study region transits showed that this tow size is representative of average tow dimensions. Table 14 presents a summary of the total benefits from the barge shelf.

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

Table 13

Annual Towboat Trip and Barge Shelf Equivalent Annual Savings

Upper Bay Reach

Year	1996	1997	1998	2006	2016	2026	2036	2046	2056	Equivalent Annual Savings
Towboat Trips	2570	2610	2814	3048	3366	3719	4108	4537	5012	
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.

Table 14

Summary of Barge Shelf Benefits

Year	Deep-Draft Vessel Delays From Barge Induced Delays	Shallow-Draft Vessel Delays From Deep-Draft Induced Delays	**Barge Shelf Total**
2000	$82,291	$23,597	$105,888
2006	$87,354	$25,552	$112,906
2016	$96,493	$28,225	$124,718
2026	$106,588	$31,179	$137,767
2036	$117,740	$34,440	$152,180
2046	$130,058	$38,044	$168,102
2056	$143,665	$42,024	$185,689
Equivalent Annual Benefits	$104,137	$30,461	$134,598

LA QUINTA CHANNEL ANALYSIS

This section presents a summary of the La Quinta Channel analyses. The project alternatives investigated were deepening of the existing Federal portion of the La Quinta Channel and extension of the 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 port depths of 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 extending the existing limits of the La Quinta Channel was evaluated based on the results of a multi-port analysis. The analysis was to determine if La Quinta Channel 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. The PCCA performed 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 (Container Terminal Alternative Site Analysis, Final Report). 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 new terminal.

Initially, the PCCA considered three sites for establishment of containerized cargo facilities. These locales included the site presently identified for terminal development that is situated on the northern shore of an estuarine area, northwestward of the terminus of the channel. The other sites were located further southeastward, also along the northern or eastern shoreline and within reach of the existing channel system. The PCCA excluded these sites from further consideration due to costs of acquisition, development, and limitations imposed by proximity to landside rail linkages, vehicular access, capacity, and available land readily suitable for related development.

As stated previously, analyses for extension of La Quinta Channel emphasize the application of multi-port analyses. Preliminary inquiries and subsequent studies determined that presently, 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 assessed the 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 multi-port studies 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.

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 PCCA's preliminary master plan, the terminal will be built in three phases. Phase I will be built in conjunction with the channel extension and will cost approximately $211 million. The first cost of $211 million is in addition to the channel deepening cost of $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 estimated average annual equivalent cost, which includes engineering supervision, administration and contingencies, is $21,773,932. The site development costs were annualized over the 50-year period of economic evaluation for evaluation in relationship the equivalent annual benefit stream anticipated from the proposed facility.

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. The combined estimated average annual equivalent associated costs for both site development and operation and maintenance totals $23,534,546.

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 public, common carrier facility at a profit. There is expected to be little public investment in the entire La Quinta Terminal. Normal shipping costs, which include 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. Annual revenue expected from the container terminal is estimated at nearly $77.5 million. More detailed analysis of associated costs is included in the Economic Appendix.

La Quinta Project Construction and Associated Cost and Benefit Evaluation

As displayed in Table 15, 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 $2,044,471. The expected annual transportation cost savings benefits for the 39-foot channel depth are $9,264,460. The benefit-to-cost ratio based on the equivalent annual benefits of $9,264,460 and annualized project cost of $2,044,471 is 4.5. Inclusion of the average annual associated costs increases the equivalent annual cost from $2,044,471 to $25,579,017. 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 $25,579,017 with the combined annualized transportation cost savings of $9,264,460 and associated revenue of $77,495,120 produces a return of 3.4. Calculation of the rate of return for the NED throughput and the full facility cost is of 1.0. Comparison of the full facility 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 demonstrates 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 15 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.

Table 15

Construction Cost and Benefit Summary

	First Cost	Average Annual Cost	O&M Cost	Total Cost a/	Annual Benefits	B/C Ratio	Net Excess Benefits
Corpus Christi Channel Deepening and 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							
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							
36	23,195,000	$1,445,692	$546,850	$1,992,542			
37	23,557,500	$1,468,575	$547,824	$2,016,398	$8,913,620	4.4	$6,897,222
38	23,920,000	$1,491,173	$548,797	$2,039,970	$9,230,160	4.5	$7,190,190
39	23,968,000	$1,494,165	$550,306	$2,044,471	$9,264,460	4.5	$7,219,989
40	24,016,000	$1,497,158	$551,815	$2,048,973	$9,238,000	4.5	$7,189,027
41	24,418,000	$1,522,218	$556,424	$2,078,642	$9,145,880	4.4	$7,067,238
42	24,820,000	$1,547,279	$561,032	$2,108,311	$9,145,880	4.3	$7,037,569

a/ The 48-foot project cost was estimated by applying the December 1999 to 2001 price change factor to the December 1999 costs. The costs for deepening of the existing La Quinta Channel reflect 1999 prices. The costs for La Quinta 37-, 39-, and 41-foot depths were interpolated.

Based on the economic analysis, the NED plan includes deepening the CCSC from 45 to 52 feet, widening of the CCSC to 530-feet wide, barge shelves 200 feet wide on each side of the Upper Bay reach of the CCSC, and extension of the La Quinta Channel at a 39-foot depth. The CCSC widening only and La Quinta Channel deepening alternatives did not generate sufficient benefits for further consideration as part of the NED plan.