US Army Corps of Engineers
Galveston District

Document No. 070175
Job No. 441901

VOLUME I

FINAL

ENVIRONMENTAL IMPACT STATEMENT

FREEPORT HARBOR CHANNEL IMPROVEMENT PROJECT
BRAZORIA COUNTY, TEXAS

U.S. Army Corps of Engineers, Galveston District
2000 Fort Point Road
Galveston, Texas 77550

September 2012

FINAL ENVIRONMENTAL IMPACT STATEMENT FOR THE PROPOSED FREEPORT HARBOR CHANNEL IMPROVEMENT PROJECT BRAZORIA COUNTY, TEXAS

The U.S. Army Corps of Engineers, Galveston District (USACE), under the authority of Section 216 of the 1970 Flood Control Act, proposes to deepen and selectively widen the Freeport Channel system.

This Environmental Impact Statement (EIS) was prepared as required by the National Environmental Policy Act (NEPA) to present an evaluation of potential impacts of the proposed Freeport Harbor Channel Improvement Project. The proposed project includes deepening and selective widening of the Freeport Harbor Channel and associated turning basins (except Brazos Harbor), from the Outer Bar and Jetty channels, through the Lower Turning Basin up to the Brazosport and Upper turning basins, and upstream through the Stauffer Channel to the Stauffer Turning Basin. The EIS addresses the potential impacts of the proposed project on the human environment, as identified during the public interest review, including placement of dredged material. All factors that may be relevant to the proposed project were considered, including the following: dredged material management, air quality, shoreline erosion, economics, general environmental concerns, historic resources, protected species, navigation, recreation, water and sediment quality, energy needs, hazardous materials, and, in general, the welfare of the people. This EIS provides relevant information to the public on the potential impacts of the proposed project. Public and agency comments received during the Draft Environmental Impact Statement (DEIS) comment period are addressed in this EIS. The public and agency comments on the findings of the EIS will be addressed in the Record of Decision (ROD).

Comments on this EIS must be postmarked by:

October 9, 2012
Date

For further information, contact:

Janelle Stokes
U.S. Army Corps of Engineers, Galveston District
P.O. Box 1229
Galveston, Texas 77553-1229
Phone: 409.766.3039
e-mail: janelle.s.stokes@usace.army.mil

Volume I Contents for Final Environmental Impact Statement

Volume II Contents for Final Environmental Impact Statement Appendices:

Appendices:

ES.1 INTRODUCTION

The U.S. Army Corps of Engineers, Galveston District (USACE) joined in an agreement with the Brazos River Harbor Navigation District (now named Port Freeport) to conduct a feasibility study and prepare an Environmental Impact Statement (EIS) for proposed improvements to the Freeport Harbor Channel. The Freeport Harbor Channel Improvement Project (FHCIP) proposes to deepen and selectively widen the Freeport Harbor Channel and associated turning basins (except Brazos Harbor Turning Basin), up to and including the Stauffer Turning Basin to eliminate existing operational constraints. The USACE is the lead agency for this project, with no cooperating agencies. This EIS was prepared as required by the National Environmental Policy Act to present an evaluation of potential impacts associated with the proposed FHCIP.

ES.2 PURPOSE AND NEED

The purpose of the proposed project is to deepen and selectively widen the Freeport Harbor Channel to eliminate existing operational constraints, including one-way traffic, daylight-only operations for larger vessels, and restrictions when winds exceed 20 knots or crosscurrents exceed 0.5 knot. Maximum ship dimensions currently permitted by the Brazos Pilots Association (BPA) are 825 feet length overall, 145-foot maximum beam, and 42-foot draft. Currently, large crude carriers calling at the port remain offshore for lightering operations, where cargo is transferred to smaller crude tankers to enter Freeport Harbor Channel and deliver product. Current shipping projections suggest that crude imports are on the increase and will continue to increase in the future. Increases in imports will also increase the number of lightering operations, adding to shipping delays, congestion, and the risk of collision or spill.

The project need is to better facilitate the control and flow of ship traffic and reduce shipping costs. Currently, light-loading, one-way traffic, and daylight-only operation for larger vessels result in significantly higher costs to Port Freeport users. Port Freeport has decided to move forward with a permit project to widen the Freeport Harbor Channel Outer Bar and Jetty channels to 600 feet (Widening Project). As part of the permitted Widening Project, Port Freeport seeks Federal assumption of maintenance for channel improvements. Since the Widening Project is likely to be constructed prior to authorization of the FHCIP, it is expected that constraints associated with the 400-foot channel width would be reduced or eliminated. Deepening the channel will address other needs by allowing larger vessels to navigate the channel, reducing costs and delays associated with lightering and lightening operations. Port Freeport experienced strong tonnage growth over the past decade, with national statistics showing Port Freeport ranking 26th in 2008 in the Nation in terms of total tonnage, compared to 38th in the early 1990s. Although general cargo and containerized cargo are handled at Port Freeport, crude petroleum imports account for the majority of throughput. The proposed channel improvement project would allow the economic benefits that will result from an improved channel to be realized.

ES.3 TIDAL DATUM CONVERSION

All elevations referred to in this report, unless specifically noted otherwise, are based on USACE Galveston District's local Mean Low Tide (MLT) datum. This project is a compilation of National Geodetic Vertical Datum of 1929 (NGVD 29) and the newer North American Vertical Datum of 1988 (NAVD 88). Final plates are shown in North American Datum (NAD 83, Texas State Plane Coordinate System, South Central Zone).

USACE has an established survey control network along the Freeport Harbor Channel. To comply with the guidance on referencing tidal datums using Mean Lower Low Water (MLLW), as required by current guidance, USACE took vertical survey measurements at tide gages and benchmarks to estimate the relative difference between MLT and MLLW datums along the Freeport Channel. The objective was to maintain an effective water depth of 55 feet while correctly referencing resulting water surface level in MLLW. At Freeport Channel, datum values for MLLW are +1 foot above MLT. However, this does not result in increased water depth, as the additional +1 foot of nominal depth is actually +1 foot above the normal surface water level. Therefore, the actual water depths are equivalent between a 55-foot MLT channel template and a 56-foot MLLW channel template. As the study and its documentation were completed using MLT, references to MLT have been maintained throughout this document. As the project moves to Preconstruction, Engineering, and Design phase, tidal data references will be documented as MLLW.

ES.4 DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

Alternatives evaluated for the proposed project include different channel depth and width alternatives and alternatives for placement of the dredged material. Five alternatives were identified and suggested in the 2002 Galveston District Reconnaissance Report Section 905(b) Analysis. Formulation of alternative alignments and selection of dredged material placement areas (PAs) included an evaluation and analysis of historical and projected shoaling rates, erosion causes and rates, and general structural and nonstructural alternatives applicable for conditions specific to the project area. Channel widths and depths were determined by ship simulations based on information from the BPA and Engineer Research and Development Center and operational input from Port Freeport.

The existing Freeport Harbor Channel system begins approximately 5.7 miles seaward of the coastal jetty tips at the 47-foot depth contour in the Gulf of Mexico (Gulf), and continues upstream through the Freeport Harbor Outer Bar and Jetty channels, and winds westward for approximately 5.5 miles into Freeport to the Stauffer Channel Turning Basin. The Stauffer

Channel and Turning Basin was deauthorized in 1974. An analysis of jetty stability indicated that the maximum channel width should not exceed 600 feet. Thus, 500- and 600-foot channel widths were considered with depths ranging between 50 and 60 feet.

Incremental cost analysis and consideration of potential economic, environmental, and social impacts resulted in the identification of the National Economic Development (NED) Plan Alternative, which is referred to as the 60-x-540-foot project because the width of the Jetty Channel would be restricted to 540 feet. This alternative proposes to extend the Outer Bar Channel (Channel Extension) 3.2 miles farther into the Gulf at a depth of 62 feet (−63 MLLW) and a width of 600 feet, deepen the existing Outer Bar Channel to 62 feet (−63 MLLW) and the Jetty Channel to 60 feet (−61 MLLW), deepen the Lower Turning Basin and Main Channel through Station 132+66 (just above the Brazosport Turning Basin) to 60 feet (−61 MLLW) and widen the Brazosport Turning Basin to 1,200 feet, deepen the channel from Station 132+66 through the Upper Turning Basin to 50 feet (−51 MLLW), deepen and widen the Lower Stauffer Channel to 50 feet (−51 MLLW) by 300 feet, and dredge the Upper Stauffer Channel to 25 feet (−26 MLLW) deep by 200 feet wide in lieu of restoring its previously authorized dimensions of 30 feet (−31 MLLW) by 200 feet. Construction of the NED Alternative would generate approximately 20.4 million cubic yards (mcy) of dredged material. Maintenance of the deepened and widened channel is expected to generate a total of 190.5 mcy of maintenance dredged material over the 50-year evaluation period.

Port Freeport prefers the smaller and less costly 55-x-600-foot plan, referred to as the Locally Preferred Plan (LPP) Alternative. This alternative proposes to extend the Outer Bar Channel (Channel Extension) 1.3 miles further into the Gulf at a depth of 57 feet (−58 MLLW) and a width of 600 feet, deepen the existing Outer Bar Channel to 57 feet (−58 MLLW) and the Jetty Channel to 55 feet (−56 MLLW), deepen the Lower Turning Basin and Main Channel through Station 132+66 (just above the Brazosport Turning Basin) to 55 feet (−56 MLLW) and widen the Brazosport Turning Basin to 1,200 feet, deepen the channel from Station 132+66 through the Upper Turning Basin to 50 feet (−51 MLLW), deepen and widen the Lower Stauffer Channel to 50 feet (−51 MLLW) by 300 feet wide, and dredge the Upper Stauffer Channel to 25 feet (−26 MLLW) deep by 200 feet wide in lieu of restoring its previously authorized dimensions of 30 feet (−31 MLLW) by 200 feet. Construction of the LPP Alternative would generate approximately 14.4 mcy of new work dredged material. Maintenance of the deepened and widened channel would generate an anticipated 175.9 mcy of maintenance dredged material over the 50-year evaluation period. Although the benefits associated with this plan are slightly less, less dredged material is generated and this plan meets specific operational (business) objectives set forth by Port Freeport for specific competitive advantages; therefore, the USACE has selected the LPP Alternative as the Preferred Alternative for implementation.

New work material dredged from the Outer Bar and Jetty channels during construction would be placed in the existing New Work Ocean Dredged Material Disposal site (New Work ODMDS), and the remainder of the new work material would be placed in existing upland confined PA 1 and proposed PAs 8 and 9. Material dredged from the Outer Bar and Jetty channels and the Lower Turning Basin during maintenance cycles would be placed in the existing Maintenance Material ODMDS (Maintenance ODMDS), and maintenance material from the remainder of the channel would be placed in PAs 1, 8, and 9.

In addition to the NED and LPP alternatives, two no action alternatives are evaluated in this EIS. A traditional No Action Alternative assumes that the present conditions associated with the project would continue into the future. For the FHCIP, however, two possible future conditions could occur. Port Freeport is pursuing widening to 600 feet but not deepening of the Outer Bay and Jetty channels (Widening Project) by permit, and it is assumed that channel widening will likely be completed prior to construction of the proposed Federal FHCIP. Therefore, the first Future Without-the-Project (FWOP) Alternative (FWOP-1) assumes that the Widening Project has been constructed and is part of the future condition. However, in the event Port Freeport does not construct the Widening Project, a second FWOP condition must be considered. The second FWOP Alternative (FWOP-2) was formulated to describe future project conditions if the permit action did not occur. In this discussion, FWOP-1 is used as the basis for comparing other project alternatives, while FWOP-2 is described only for scenario purposes and will not be carried forward as a basis for comparison.

ES.5 POTENTIAL ENVIRONMENTAL IMPACTS

The EIS addresses the potential impacts of the proposed project on human and environmental resources identified during the public interest review, including placement of dredged material. All factors that may be relevant to the proposed project were considered, including the following: dredged material management, air quality, shoreline erosion, economics, historic resources, protected species, recreation, water and sediment quality, energy needs, hazardous materials, and, in general, the welfare of the people. The following provides a brief description of potential impacts that were identified. Impacts between the NED and LPP alternatives were essentially equivalent, unless otherwise noted.

Environmental Setting

The existing Freeport Harbor Channel 45-Foot Project extends from deep water in the Gulf and continues landward into the inner channel reaches of Freeport Harbor. Freeport Harbor is located on the Old Brazos River Channel, which dead-ends farther upstream near State Highway 288, a major transportation corridor. The waterway is heavily developed with industrial and commercial properties, including petrochemical manufacturing, warehousing, and related businesses. The waterway serves as a major transportation corridor for waterborne commerce including tankers, freighters, tugs, barges, and offshore supply boats, as well as recreational vessels. The inner channel reaches are relatively low in biological productivity and are largely devoid of natural habitats. Existing vegetation is sparsely distributed, and no significant or sensitive terrestrial or aquatic habitats exist within or along the project area.

Water and Sediment Quality

No water or sediment quality concerns were identified in a review of historic and current data. Potential impacts from ballast water releases would be slightly increased because channel improvements are likely to provide the opportunity for additional growth at Port Freeport resulting in increased ship traffic. Texas Commission on Environmental Quality (TCEQ) has concurred that there is reasonable certainty that the proposed project would not violate water quality standards and has provided water quality certification for the Preferred Alternative.

Air Quality

The Preferred Alternative is expected to increase air emissions in the Houston-Galveston-Brazoria Air Quality Control Region, which is currently classified as a severe nonattainment area for ozone. An analysis of estimated emissions associated with proposed channel improvements indicates that there may be short-term impacts on air quality in the immediate vicinity of the project area, but no long-term impacts are expected. However, the estimated project emissions of nitrous oxides (NO_X) are expected to exceed the conformity threshold of 25 tons per year (945 peak estimated tons per year for the NED Alternative and 883 peak estimated tons per year for the LPP Alternative). Pursuant to Section 176 of the Clean Air Act Amendments of 1990, a Draft General Conformity Determination has been filed and coordination initiated with TCEQ and the U.S. Environmental Protection Agency (EPA) to determine whether the proposed action is compliant with the State Implementation Plan (SIP). The Draft General Conformity Determination was noticed with the Draft Environmental Impact Statement in December 2010.

Based on the General Conformity Concurrence letter provided by TCEQ, USACE has prepared a Final General Conformity Determination (Appendix C) to document that emissions that would result from the proposed FHCIP are in conformity with the Texas SIP for the Houston-Galveston-Brazoria (HGB) nonattainment area. A Notice of Availability of this document was published in the newspaper of general circulation in Brazoria County concurrent with the EIS and was submitted to TCEQ, EPA, and the Brazoria County Health Department, the local air pollution control program.

The TCEQ and USACE’s determination of conformity is based on the emissions information and project schedule proposed at the time. Once a final project schedule is completed, USACE will provide an update of the General Conformity documentation to TCEQ and EPA for review and concurrence that the updated emissions and schedule will still be conformant with the currently approved Houston-Galveston area SIP.

Noise

Noise impacts associated with the proposed action are expected to be short term and would be only slightly higher than those that occur during current maintenance dredging for the existing channel. Reauthorization of Stauffer Channel and Turning Basin would result in slightly elevated noise levels at sensitive receptors near the turning basin.

Geology, Mineral Resources, and Soils

Construction of PA 9 would convert approximately 250 acres of prime farmland to a Dredged Material Placement Area (DMPA). Additionally, approximately 132 acres of prime farmland is included in an area that would be preserved as part of the proposed mitigation. Because these areas would no longer be available for use as farmland in the future, preservation is considered an impact to prime farmland. The AD-1006 form was completed by the Natural Resources Conservation Service for both areas, and no additional coordination regarding these impacts is needed (Appendix A-4).

Nine petroleum pipelines were identified that cross Freeport Harbor Channel and proposed DMPAs. At this time, the Galveston District has determined that all pipelines are deep enough so that no pipeline relocations are needed.

Groundwater Hydrology

Potential impacts to groundwater could occur from accidental spill of petroleum products from equipment used during construction. Use of Best Management Practices during construction would minimize this potential. No impacts to water wells are expected because of the nature of the aquifer system and the difference in depth between the FHCIP depth (about 60 feet) and the shallowest well in the area (about 240 feet).

Hazardous, Toxic, and Radioactive Waste

The proximity of industrial facilities increases the potential for encountering hazardous material. A Hazardous, Toxic, and Radioactive Waste (HTRW) survey was conducted that included a thorough database review, review of historic aerial photography, a site visit, and interviews with local persons knowledgeable of the area. No known HTRW sites were identified in the project area footprint, and no active enforcement actions were under way at the time of assessment. The relatively impermeable nature of the new work material (clay) to contaminants, and previous sediment analyses indicate the probability of encountering contaminants at concentrations of concern during construction is unlikely to be an issue.

Vegetation and Wetlands

Construction of two new upland confined PAs, PAs 8 and 9, would convert approximately 418 acres of land, including 21 acres of forest and 39 acres of ephemeral wetlands, to a DMPA. Coordination with U.S. Fish and Wildlife Service (USFWS) and Texas Parks and Wildlife Department (TPWD) regarding these impacts has resulted in proposed mitigation that includes creation and maintenance of forested habitat and creation of wetland areas adjacent to impact areas.

Terrestrial and Aquatic Wildlife (Including Essential Fish Habitat)

No long-term impacts to terrestrial or aquatic species are expected. Temporary impacts may occur during construction from increased noise and turbidity. Benthic macroinvertebrate communities are likely to shift from the current composition to that of more-opportunistic species. Similar shifts in benthic community composition can be expected at the Maintenance ODMDS as now occurs. The benthic community at the New Work ODMDS is expected to recover over time following placement of the new work material. Impacts to Essential Fish Habitat are not expected to be significant.

Protected Species

Dredging activities could result in the incidental take of federally protected sea turtles that may occur in the project area. A Biological Assessment that incorporates the terms and conditions of the existing Gulf of Mexico Regional Biological Opinion dated November 19, 2003, has been prepared (Appendix I). Endangered Species Act Section 7 consultation will be required for this project. Impacts to other Endangered Species and piping plover critical habitat in the vicinity of the project area are not anticipated.

Cultural Resources

A thorough file review did not identify any National Register of Historic Places–listed or –eligible sites or State Archeological Landmarks within the project footprint. Research conducted for PAs 8 and 9 indicate potential Civil War remains in the vicinity of PA 9 that will be addressed under a Programmatic Agreement (PAg), negotiated with the Texas State Historic Preservation Officer (Appendix E). Compliance with the PAg places the project in compliance with Section 106 of the National Historic Preservation Act.

Land Use, Recreation, Aesthetics, and Socioeconomics

Minimal or no impacts to land use, recreation, aesthetics, or socioeconomics are expected to result from the proposed project. Reduced navigation restrictions and increased efficiency at the port is likely to have a positive economic benefit in the local community, which could result in increased development in the area.

Storm Surge

The proposed channel improvements are not expected to result in increased storm surge elevations inside the jetties. Likewise, the proposed channel improvements are not expected to have a substantial effect on the level of protection offered by the current levee system.

The proposed FHCIP would have only minor impacts to adjacent shorelines for 3 to 4 miles from the jetties. These minor changes would not be expected to differ from natural variation currently seen along these shorelines.

Aircraft Wildlife-Strikes

A Memorandum of Agreement was executed among the Federal Aviation Administration, the U.S. Air Force, the U.S. Army, EPA, USFWS, and the U.S. Department of Agriculture to address the potential for aircraft-wildlife strikes throughout the United States, regarding Federal projects occurring within 5 miles of an airport. There are no airports located within 5 miles of the proposed project area. Therefore, the risk of aircraft-wildlife strikes is considered to be negligible, and no further coordination is required.

ES.6 MITIGATION

Mitigation refers to the avoidance, minimization, and rectification, reduction, or compensation of impacts resulting from implementation of an action. For the proposed FHCIP, the majority of potential project-related impacts were avoided. Thus, mitigation would be required only for impacts to forested and wetland habitats at the proposed new upland PAs.

Construction of two new upland PAs, PAs 8 and 9, would convert approximately 418 acres of land, including 21 acres (7.41 average annual habitat units [AAHUs]) of riparian forest and 39 acres (1.1 AAHUs) of ephemeral wetlands, to dredged material PAs. Coordination with USFWS and TPWD regarding these impacts has resulted in a proposed mitigation plan that includes creation and maintenance of riparian forest habitat (12 acres and 7.7 AAHUs) and creation of wetland areas (3 acres and 1.5 AAHUs) adjacent to the impact areas. These impacts and the proposed mitigation would be the same for both the NED and LPP alternatives (Appendix H). The mitigation monitoring and contingency plan is provided in Appendix H-2.

ES.7 COORDINATION AND PUBLIC INVOLVEMENT

Public involvement in the proposed project has occurred through public meetings and other outreach throughout the history of the project. The public, resource agencies, industry, local government, and other interested parties have been proactively informed about the project.

Public and agency concerns were identified at the public scoping meeting held January 15, 2004, at the Lake Jackson Civic Center, Lake Jackson, Texas. The purpose of the meeting was to inform stakeholders and interested parties about the proposed FHCIP, to outline the Corps Planning process, the proposed project schedule, and to solicit public comments. No oral comments were provided by Federal, State, or local resource agencies at the meeting, and the Galveston District received no subsequent written comments within the allotted comment period. In general, the public provided positive comments in support of the proposed project. However, one commenter expressed concerns regarding cumulative environmental impacts for the Gulf Coast region.

Two additional public information meetings were held in February 2006 and February 2008.

The DEIS was made available to all known Federal and state resource agencies as well as interested organizations and individuals on December 23, 2010. The comment period for the DEIS ended February 5, 2011. A public hearing was held during the comment period on January 13, 2011, in Freeport, Texas. A list of DEIS recipients is included in Section 13.4 of the EIS. Comments and corresponding responses from the DEIS comment period and public hearing have been addressed in this EIS.

Contents

Figures

Page

Tables

Page

Tables, cont'd.

Acronyms and Abbreviations

°F	degrees Fahrenheit
AAHU	average annual habitat unit
AOU	American Ornithologists' Union
B/C	benefit to cost
BA	Biological Assessment
BEG	Bureau of Economic Geology
BEPA	Bald Eagle Protection Act
BMP	Best Management Practice
BO	Biological Opinion
BPA	Brazos Pilots Association
BRHND	Brazos River Harbor Navigation District
BU	beneficial use
BWM	ballast water management
CAA	Clean Air Act
CAER	Community Awareness and Emergency Response
CAR	Fish and Wildlife Coordination Act Report
C-CAP	Coastal Change Analysis Program
CCC	Coastal Coordination Council
CEPRA	Coastal Erosion Planning and Response Act
CEQ	President's Council on Environmental Quality
CERCLIS	Comprehensive Environmental Response Compensation and Liability Information System Database
CFR	Code of Federal Regulations
cfs	cubic feet per second
cm	centimeters
cm/sec	centimeters per second
CO	carbon monoxide
CORRACT	RCRA Corrective Actions List
CR	County Road
CT	census tract
CWA	Clean Water Act
cy	cubic yards
dB	decibels
dBA	A-weighted sound level
DDE	dichlorodiphenyldichloroethylene, a breakdown of the pesticide DDT
DEIS	Draft Environmental Impact Statement
DERA	EPA Diesel Emission Reduction Program

DMPA	Dredged Material Placement Area
DO	dissolved oxygen
DOE	U.S. Department of Energy
EA	Environmental Assessment
EC	Engineering Circular
EFH	essential fish habitat
EH&A	Espey, Huston & Associates, Inc. (now PBS&J)
EIA	Energy Information Administration
EIS	Environmental Impact Statement
EJ	Environmental Justice
EO	Executive Order
EOP	Environmental Operating Principles
EPA	U.S. Environmental Protection Agency
ER	Engineering Regulation
ERDC	Engineer Research and Development Center
ERL	effects range low
ERM	effects range medium
ERNS	Emergency Response Notification System
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FCSA	Feasibility Cost-Sharing Agreement
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FHCIP	Freeport Harbor Channel Improvement Project
FHWA	Federal Highway Administration
FM	Farm to Market Road
FONSI	Finding of No Significant Impact
FPPA	Farmland Protection Policy Act of 1981
FR	Feasibility Report
FS	Feasibility Study
Fugro	Fugro Consultants, L.P.
FWOP	Future Without-Project
GHG	Greenhouse Gas
GIS	Geographical Information System
GIWW	Gulf Intracoastal Waterway
GLO	Texas General Land Office
GMFMC	Gulf of Mexico Fisheries Management Council

gpm	gallon-per-minute
GRBO	Gulf Regional Biological Opinion
Gulf	Gulf of Mexico
HEP	Habitat Evaluation Procedure
HGB	Houston-Galveston-Brazoria
HHS	U.S. Department of Health and Human Services
HSI	habitat suitability index
HTRW	Hazardous, Toxic, and Radioactive Waste
IOP	Innocent Owner/Operator Program
IPCC	Intergovernmental Panel on Climate Change
ISD	Independent School District
L_{dn}	Day-Night Sound Level
LEP	Limited English Proficiency
L_{eq}	equivalent sound level
LFUN	Unauthorized and Unpermitted Landfill Sites
LNG	liquefied natural gas
LOA	length overall
LPP	Locally Preferred Plan
MBTA	Migratory Bird Treaty Act
mcy	million cubic yards
mcy/year	million cubic yards per year
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MLLW	Mean Lower Low Water
MLT	mean low tide
mm/year	millimeters per year
MMB	million barrels
MOA	Memorandum of Agreement
MPN/dL	Most Probable Number/deciliter
MPRSA	Marine Protection, Research, and Sanctuaries Act
msl	mean sea level
NAAQS	National Ambient Air Quality Standards
NBIC	National Ballast Information Clearinghouse
NCDC	National Climatic Data Center
NED	National Economic Development
NEPA	National Environmental Policy Act
NFRAP	no further remedial action planned
NFWL	National Fish and Wildlife Laboratory

NGL	natural gas liquid
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NO	nitric oxide
NO_2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NO_X	nitrous oxides
NPL	National Priority List
NPS	National Park Service
NRC	National Research Council
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NWI	National Wetland Inventory
NWR	National Wildlife Refuge
O&M	operation and maintenance
O_3	ozone
ODMDS	Ocean Dredged Material Disposal Site
Oiltanking	Oiltanking Holdings Americas
OPA	Otherwise Protected Area
PA	placement area
PAg	Cultural Resource Programmatic Agreement
PAI	Prewitt and Associates, Inc.
Pb	lead
PCB	polychlorinated biphenyls
PED	Preconstruction, Engineering, and Design
PM_{10}	particulate matter with particle diameters of 10 microns or less
$PM_{2.5}$	particulate matter with diameters of 2.5 microns or less
ppm	parts per million
ppt	parts per thousand
RCRA	Resource Conservation and Recovery Act
RCRA TSD	RCRA Treatment, Storage, or Disposal List
RCRA-G	RCRA Generators and Violators List
RHA	River and Harbor Act
RIA	Regional Implementation Agreement
ROD	Record of Decision
RRC	Railroad Commission of Texas
RSLR	relative sea level rise
SAL	State Archeological Landmark

SAV	Submerged Aquatic Vegetation
SCS	Soil Conservation Service
SH	State Highway
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
SMMP	Site Monitoring and Management Plan
SO_2	sulfur dioxide
SOC	species of concern
SP	solid phase
SPP	suspended particulate phase
SPR	Strategic Petroleum Reserve
SSA	sole source aquifer
SWQM	Surface Water Quality Monitoring
TAMU	Texas A&M University
TARL	Texas Archeological Research Laboratory
TCEQ	Texas Commission on Environmental Quality
TCMP	Texas Coastal Management Program
TCWC	Texas Colonial Waterbird Census
TDSHS	Texas Department of State Health Services
TelALL	TelALL Corporation
TERP	Texas Emissions Reduction Plan
THC	Texas Historical Commission
TOPS	Texas Offshore Oil Port System
TPWD	Texas Parks and Wildlife Department
tpy	tons per year
TSS	total suspended solids
TWC	Texas Workforce Commission
TWDB	Texas Water Development Board
TWQS	Texas Surface Water Quality Standards
TXAST	Texas aboveground storage tank database
TxDOT	Texas Department of Transportation
TXLF	City/County Solid Waste Landfill Listings
TXLUST	Texas leaking underground storage tank database
TXNDD	Texas Natural Diversity Database
TXSPILL	Texas Spills Incident Information System
TXSSF	State Superfund List
TXUST	Texas underground storage tank database
TXVCP	Texas Voluntary Cleanup Program

UPRR	Union Pacific Railroad
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	volatile organic compounds
WMA	Wildlife Management Area
WQC	water quality discrete criteria
WRDA	Water Resources Development Act

1.0 NEED FOR AND OBJECTIVES OF ACTION

1.1 STUDY AUTHORITY AND PROJECT INFORMATION

1.1.1 Study Authority

The existing Freeport Harbor Project was authorized by the Rivers and Harbors Acts of May 1950 and July 1958, providing for an Entrance Channel (composed of the Outer Bar and Jetty channels) of 38-foot depth and 300-foot width from the Gulf of Mexico (Gulf) to inside the jetties, and for interior channels of 36-foot depth and 200-foot width up to and including the Upper Turning Basin. The relocation and deepening of the Jetty Channel to a 45-foot depth and 400-foot width and the Outer Bar Channel to a 47-foot depth and 400-foot width, with an extension of approximately 4.6 miles into the Gulf was authorized by Congress in 1978 with the passage of Section 101 of the Rivers and Harbors Act of 1970 (PL 91-611; House Document 289, 93rd Congress – 2nd Session, December 31, 1975) and by the president in 1974. The construction of this existing navigation project, referred to in this document as the Freeport Harbor Channel 45-Foot Project, was completed in 1993.

The Authority for proposed channel improvements to the existing navigation project is contained in Section 216 of the 1970 Flood Control Act.

1.1.2 Project Sponsors and Cooperating Agencies

The Brazos River Harbor Navigation District (now Port Freeport), the non-Federal sponsor of the existing project, requested consideration of additional channel improvements to alleviate navigation problems experienced at Port Freeport. Authority for a reconnaissance report (Section 905(b)) was included in the Water Resources Development Act of 1986 (WRDA 86), which was completed in 2002 by U.S. Army Corps of Engineers (USACE). The report documented Federal interest in a widening and deepening project with National Economic Development (NED) benefits in the form of transportation savings that could substantially exceed the cost of the project. Additionally, a general screening analysis was conducted to identify structural plans that would provide efficient navigation at the least cost while minimizing environmental impacts, and included a ship simulation study conducted at the U.S. Army Engineer Research and Development Center (ERDC) in Vicksburg, Mississippi. As a result, a feasibility study (FS) was initiated to determine whether a Federal navigation improvements project at Freeport Harbor was justified and to provide a decision document to Congress regarding authorizing construction and future maintenance of the recommended plan. On July 7, 2003, USACE and Port Freeport signed a Feasibility Cost-Sharing Agreement (FCSA) to conduct the FS, including an Environmental Impact Statement (EIS). The FS is being developed by USACE, Galveston District with the FS cost being equally shared by USACE and Port Freeport.

The USACE Galveston District Engineer is responsible for the overall management of this EIS. Port Freeport is the non-Federal sponsor for the study. The study is being coordinated with interested Federal, State, and local agencies and the public. There are no cooperating agencies for the Freeport Harbor Channel Improvement Project (FHCIP).

1.1.3 Project Location

The proposed project is located on the mid- to upper Texas coast in Brazoria County and encompasses the communities of Surfside, Quintana, Oyster Creek City, and the City of Freeport (Figure 1.1-1). Freeport Harbor Channel provides deepwater access from the Gulf of Mexico to Port Freeport. Specifically, the existing Freeport Channel system begins approximately 5.7 miles seaward of the coastal jetty tips at the 47-foot contour in the Gulf, continuing upstream through the Freeport Harbor Entrance Channel, and winding westward for approximately 5.5 miles into Freeport to the Stauffer Channel Turning Basin.

1.1.4 Project History and National Environmental Policy Act Compliance

The original project for Federal improvement at Freeport was authorized by the Rivers and Harbors Act of June 14, 1880, which provided for construction of jetties for controlling and improving the channel over the bar at the mouth of the Brazos River. The work was started in 1881 and continued until 1886 when operations were suspended for lack of funds. On April 25, 1899, in accordance with requirements of the Rivers and Harbors Act of March 3, 1899, the project was transferred to the United States. This constituted the initial authorization for the existing Freeport Channel system.

The Federal project known as Freeport Harbor, Texas, is an improvement of the original mouth of the Brazos River that provides for a deep-draft waterway from the Gulf of Mexico to the City of Freeport. A diversion dam about 7.5 miles above the original river mouth, and a diversion channel rerouting the Brazos River from the dam to an outlet in the Gulf about 6.5 miles southwest of the original mouth, now make the Freeport Channel system entirely tidal.

The Freeport Harbor waterway, as currently authorized, has an overall length of about 9.8 miles from deep water in the Gulf of Mexico to the Brazos Harbor Turning Basin. The Stauffer Channel was dredged originally by local interests to a depth of 25 feet over a bottom width of 300 feet, with a 500-foot square basin area. The Rivers and Harbors Act of 1935 incorporated the 1.4-mile-long channel and turning basin into the Federal project and authorized its deepening to 30 feet over a bottom width of 200 feet, and deepening the basin to 30 feet. Prior to deauthorization in 1974, available depths were adequate for existing traffic and the authorized 30-foot depth was not dredged. The project also provided for construction of a navigation lock in the diversion dam by local interests, when required in the interest of commerce and navigation. The lock has not been required and at present is classified as an inactive element of the project.

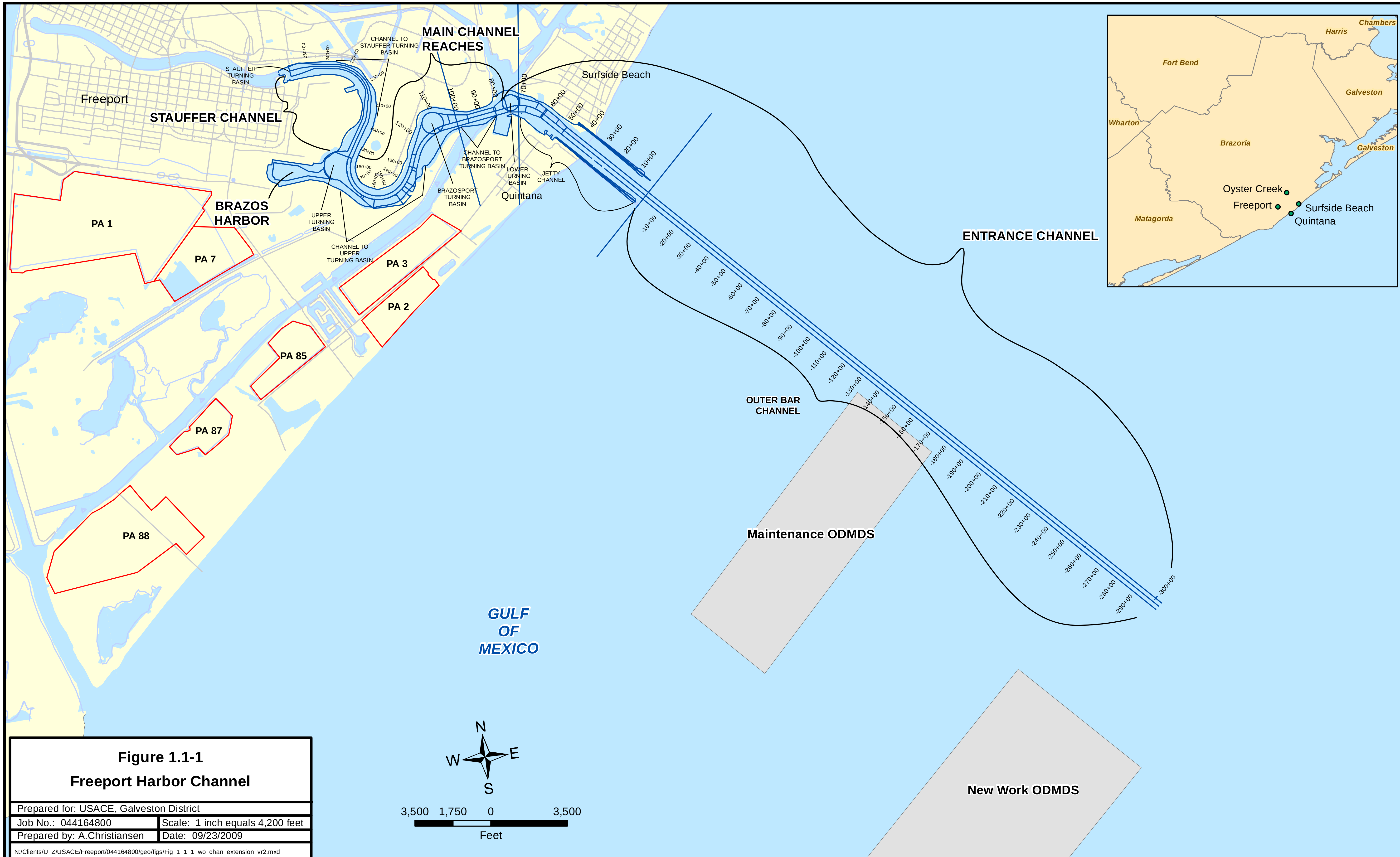


Figure 1.1-1
Freeport Harbor Channel

Prepared for: USACE, Galveston District	
Job No.: 044164800	Scale: 1 inch equals 4,200 feet
Prepared by: A.Christiansen	Date: 09/23/2009

N:/Clients/U_Z/USACE/Freeport/044164800/geo/figs/Fig_1_1_1_wo_chan_extension_vr2.mxd

(This page intentionally left blank.)

The Freeport Harbor Project was subsequently authorized by the Rivers and Harbors Acts of May 1950 and July 1958. The Acts provided for a deeper and wider Outer Bar Channel and interior channels up to the Upper Turning Basin. Greater depths, widths, and relocations of the Outer Bar and Jetty channels were authorized by Congress in 1970, and an EIS was prepared by USACE in 1978 for these actions. In 1978, Seaway Pipeline, Inc., under a Department of Army permit, widened the Outer Bar Channel to 400 feet and the Jetty Channel to 230 feet. The 45-foot channel was completed in 1993, including channel and turning basins dredging, relocation of the U.S. Coast Guard (USCG) station, construction of the 3,700-foot North Jetty, construction of public use facilities, rehabilitation of the South Jetty and addition of 500 feet to the North Jetty, and adjustments to a bend near the project's main turning basin, which was covered under a 1997 Record of Environmental Consideration.

Based on navigation problems associated with the existing 45-foot Project, USACE completed a Section 905(b) analysis (WRDA 86) reconnaissance report that confirmed the potential need for the channel improvements and documented Federal interest in a project. In July 2003, USACE and Port Freeport signed an FCSA, and efforts were initiated to prepare a Feasibility Report (FR) and EIS to identify and evaluate alternative plans, to determine whether channel improvements were justified, and to comply with the National Environmental Policy Act (NEPA).

In a separate action from the FR, Port Freeport undertook efforts to widen, but not deepen, the Outer Bar and Jetty channels at Freeport Harbor. As part of this action, Port Freeport applied to USACE for a Clean Water Act (CWA) Section 404(b)(1) permit and Rivers and Harbors Act Section 10 permit for dredge and fill and other construction activities related to widening portions of the Freeport Channel system. Permit Application No. 23752 was submitted to USACE on April 14, 2005. An EIS was coordinated and a Record of Decision (ROD) was signed by the Commander, USACE Galveston District on February 3, 2009. The Widening Project permit was issued on March 20, 2009. Construction of the Widening Project will begin once the Assistant Secretary of the Army – Civil Works (Secretary) approves Federal assumption of maintenance for the proposed improvements.

1.2 PURPOSE AND NEED

Vessel operations are currently constrained by the dimensions of the Freeport Harbor Channel. The maximum ship dimensions currently permitted by the Brazos Pilots Association (BPA) at Freeport Harbor are 825-foot length overall (LOA), 145-foot maximum beam, and 42-foot draft. The channel dimension constraints include (a) lightering and lightening, (b) LOA restrictions, (c) beam restrictions, (d) one-way traffic, and (e) daylight-only operation restrictions. These problems are discussed in more detail below.

- **Lightering and Lightening.** Since the completion of the 45-foot Project, the size of the vessels navigating the waterway has steadily increased so that many vessels currently have to be light-loaded to traverse the channel. The current channel depth requires that large crude carriers remain offshore and transfer their cargo into smaller crude tankers for navigating the channel. This lightering operation takes place in the Gulf where two ships, the mother ship and the lightering ship, come together so that a cargo transfer can occur. Lightening operations are similar except that cargo is transferred to another ship so that both ships can enter port. Although these operations have occurred frequently in the past, the possibility for a collision, oil spill, fire, or other adverse environmental consequence is always present. Current projections indicate that crude imports will increase in the near future. As these imports increase, the number of lightering vessels and product carriers will also increase, adding to shipping delays, congestion, and the potential risk of collision or spill.

- **LOA Restrictions.** The length limitation of 825 feet is enforced because crosswinds and crosscurrents force tankers to “crab” at an angle through the Entrance Channel. Ships of greater length than 825 feet are not able to clear the jetties under adverse wind and current conditions. Waivers on ship length are granted on a case-by-case basis for ships as large as 900-foot LOA and 160-foot beam to transit the Freeport Harbor Channel, provided that winds are less than 20 knots and that there is no more than a 0.5 knot crosscurrent at the mouth of the jetties. About three to four ships per month are granted these waivers. Numerous requests have been submitted for ships in the 920- to 950-foot LOA range to transit the channel, and these requests have been denied. When denied access to Freeport Harbor, these ships normally divert to Corpus Christi or New Orleans.
- **Beam Restrictions.** The maximum beam permitted under normal operations of the existing project is 145 feet. Vessels with larger beams require waivers to enter the port.
- **One-Way Traffic Restriction.** Because of the 400-foot width of the Entrance and inside channels, one-way ship traffic is always in effect in the Freeport Harbor Channel. This can result in delays when ship schedules coincide.
- **Daylight-Only Operation Restriction.** Because of channel dimensions as well as the nature of the cargo, daylight-only operation is enforced on all vessels greater than 750-foot LOA or over 107-foot beam. This can result in waiting time of up to 12 hours, if ship arrival/departure occurs at dark.

Port Freeport requested that the terminus of the Federal project extend to include the Stauffer Channel. As part of the FS, optimization of the depth for the channel extension for the Lower Stauffer Channel was determined. Depth alternatives of 30, 40, and 50 feet were initially evaluated and resulted in a more focused evaluation of a smaller range of depths. Analyses were conducted to determine any competitive advantage that Port Freeport might potentially have over competing ports. For instance, there is considerable overlap between the Houston and Freeport population centers, and a Port Freeport container terminal has the potential of capturing associated savings. In addition, Port Freeport offers an advantage over existing facilities in Houston because terminal capacity in Houston is near capacity.

The purpose of the proposed project is to improve navigation efficiency by reducing the number of lightering and lightening operations by deepening the channel, and to eliminate operational constraints by improving the channel.

The project need is to eliminate operational constraints in order to allow vessels to avoid shipping delays, thereby reducing shipping costs and logistical problems.

As previously mentioned (Section 1.1.4), Port Freeport has moved forward with the Widening Project in an effort to address some of the needs of the port. Since the Widening Project is likely to be constructed prior to authorization of the FHCIP, it is expected that constraints associated with the 400-foot channel width would be reduced or eliminated. Federal deepening of the channel would address other needs by allowing larger vessels to navigate the channel, which would result in a reduction of costly delays from lightering and lightening and may reduce vessel trips. Therefore, the alternatives evaluated by the FS would need to provide sufficient depth to allow the projected fleet of ships to efficiently navigate Port Freeport, with significantly reduced lightering and lightening requirements.

Port Freeport has one of the largest petrochemical complexes in the world. The ship channel is lined with industry. Major petrochemical industries in the harbor include ConocoPhillips, Dow Chemical, and BASF. Located adjacent to the channel is Dow Chemical Company's Texas Division plant, which produces large quantities of basic industrial chemicals. ConocoPhillips has an oil terminal and large tank farm fronting the waterway, with pipeline connections to its refinery in Sweeny about 28 miles to the northwest. ConocoPhillips operates the Seaway Pipeline, which moves crude petroleum from Sweeny to Cushing, Oklahoma. There are also product pipelines from Sweeny and the Freeport region to Pasadena, Texas, on the Houston Ship Channel. Refined products are distributed throughout the Midwest and southeastern United States through pipelines, barge, and rail car from Freeport. A natural gas liquids (NGL) processing unit and olefins plants owned and operated by Chevron Phillips Chemical Company also are located at the Sweeny complex.

According to the U.S. Department of Energy's (DOE) Energy Information Administration (EIA), nearly 80 percent of the regional crude oil and product transfers move by pipeline from the U.S. Gulf Coast. The U.S. Gulf Coast leads the Nation in refinery capacity, with 41 percent of the Nation's crude oil distillation capacity. One-half of the Gulf Coast refinery capacity is in Texas, and the remainder is in Louisiana. Freeport's refinery capacity represents approximately 6 percent of the Texas capacity. The Gulf Coast is also the Nation's leading supplier of refined products. Products such as gasoline, heating oil, and diesel and jet fuel are transported from the Gulf Coast to the East Coast and the Midwest. Port Freeport terminals provide pipeline transmittal to underground storage facilities of the DOE's Strategic Petroleum Reserve (SPR) "Bryan Mound Site," near Freeport, Texas, to crude oil distribution hubs in Texas City and Jones Creek, Texas, as well as the noted connections to Houston and the Midwest.

Deep-draft petroleum and chemical import and export volumes for 2005–2007 increased over 100 percent from 1990–1992 levels. Port Freeport has facilities for a significant increase in crude petroleum imports. As such, more vessels can be expected to call at the port and a higher throughput-to-vessel-call ratio would reduce both the amount of lightering and the number of vessels passing through the Freeport Harbor Channel. Freeport's refined product import growth mirrors trends at other U.S. and Gulf Coast ports. Petroleum product imports primarily consist of lube oil and naphtha. It was determined, based on vessel size utilization trends, that a portion of petroleum products would benefit from channel depths over 50 feet.

Port Freeport's remaining cargo throughput primarily consists of banana imports, rice exports, and outbound coastwise chemical shipments. Most of the general cargo docks are located within the Brazos Harbor Turning Basin where the project depth is 36 feet.

Large bulk carriers are used in the import of limestone and building materials. The vessels used had vessel design drafts in the 40- to 44-foot range. Loaded drafts ranged from 35 to 39 feet. Total limestone imports for 2007 were 174 thousand tons. Limestone imports represented 24 percent of the 2005–2007 total general cargo tonnage.

Although Port Freeport handles general cargo and containerized cargo, crude petroleum imports account for the majority of throughput. As the imports increase, the number of lightering and lightening vessels and product carriers will also increase, adding to shipping delays, congestion, and potential risk of collision, unless the Freeport Harbor Channel is deepened. The proposed FHCIP entails deepening the channels at Freeport Harbor, which will provide opportunities for service ships to be more fully loaded and will also allow larger lightened tankers to transit within the channel at greater drafts. The results will be potential improvements to transportation savings in the form of reduced shipping costs, stemming from improved navigation efficiency by decreasing the number of lightering and lightening operations, which ultimately translates into economic benefits to the Nation.

1.3 EXISTING PROJECT

The existing 45-foot Project provides deepwater access from the Gulf to Port Freeport. The waterway extends from deep water in the Gulf, through a rock-protected Jetty Channel to the Lower Turning Basin. The waterway then turns in a westerly direction to, and including, a turning basin at Brazosport, and then curves southwesterly then northward through the Upper Turning Basin, passing Brazos Harbor and its turning basin to the west. The waterway then continues north and westerly through the Upper Turning Basin where it terminates at the Stauffer Turning Basin (see Figure 1.1-1).

The existing authorized depth for the Freeport Harbor Channel is 45 feet mean low tide (MLT). Project widths of the channel range from 400 feet at the Brazosport Turning Basin to 200 feet for the Brazos Harbor Channel. The Brazos Harbor Channel and Turning Basin are currently 36 feet

MLT. The Stauffer Channel measures 200 feet wide with a depth of 30 feet MLT. The tidal range for Freeport Harbor is typically 2 feet. Construction of the existing 45-foot Project was completed in 1998.

The project is geographically divided into four main segments: the Entrance Channel, Main Channel, Brazos Harbor, and the Stauffer Channel. Each segment is described as follows:

- **Entrance Channel –** This segment is bound by the Gulf and the Lower Turning Basin. It comprises the Outer Bar Channel, Jetty Channel, and a portion of the Lower Turning Basin. The Outer Bar Channel extends about 5.7 miles into the Gulf. The Jetty Channel extends 1.35 miles and stabilizes the original Brazos River mouth at Freeport.

- **Main Channel –** This approximately 2-mile segment extends west from the Lower Turning Basin through the Upper Turning Basin. Various petroleum and petrochemical facilities are located along the Main Channel.

- **Brazos Harbor –** This 0.6-mile segment is located to the west of the Upper Turning Basin and includes the Brazos Harbor Turning Basin. Brazos Harbor is not included in the channel portions proposed for improvements.

- **Stauffer Channel –** This approximately 1.4-mile segment extends from the Upper Turning Basin upstream through the Stauffer Turning Basin. This channel was authorized as a 30-foot by 200-foot channel but was deauthorized in 1974 under Section 12 of the WRDA (Public Law 93-251). Various commercial fisheries, marine businesses, and recreational facilities are located along the Stauffer Channel.

A detailed description of the 45-foot Project authorized dimensions is presented in Table 1.3-1, with USACE's channel stations (see Figure 1.3-1).

The depth and width of the existing channel system remains restrictive due to the size of the current world fleet. Beam-width restrictions continue to cause delays for larger ships wishing to enter Freeport's port facilities. Increased channel depths would reduce the requirement for lightering. Access to additional facilities would also allow Port Freeport to utilize facilities for future development. A project alleviating shipping delays for industry is needed.

1.4 PROBLEMS, NEEDS, AND PUBLIC CONCERNS

The environmental concerns identified during the reconnaissance study (USACE, 2002) included the following items:

- The potential for environmental harm as a result of shipping accidents is of concern.
- Sediment quality in Freeport Harbor was an issue raised at one of the public meetings; however, studies indicate that there are no sediment contamination issues.

Table 1.3-1
Freeport Harbor Channel
Currently Authorized Dimensions for Reaches and Basins

Channel Segment	Depth (feet)	Width (feet)	Length (miles)
Entrance Channel			
Outer Bar Channel	47	400	5.68
Jetty Channel	45	400	1.35
Lower Turning Basin	45	750	0.14
Main Channel			
Channel to Brazosport Turning Basin	45	400	0.50
Brazosport Turning Basin	45	1,000	0.19
Channel to Upper Turning Basin	45	350–375	1.08
Upper Turning Basin	45	1,200	0.23
Brazos Harbor			
Channel to Brazos Harbor[a]	36	200	0.51
Brazos Harbor Turning Basin	36	750	0.13
Stauffer Channel[b]			
Channel to Stauffer Turning Basin	30	200	1.34
Stauffer Turning Basin	30	500	0.09

[a]Channel to Brazos Harbor and Brazos Harbor Turning Basin will not be improved by the FHCIP.
[b]Stauffer Channel was deauthorized in 1974.

A Public Scoping Meeting was held on January 15, 2004, at the Lake Jackson Civic Center, Lake Jackson, Texas. The purpose of the meeting was to inform stakeholders and interested parties about the proposed FHCIP, to outline the planning and feasibility study processes, to present the proposed project schedule, and to solicit public comments/input. Solicitation of public comments was a primary objective of the scoping meeting to ensure that significant issues were addressed as required by NEPA. Generally, the public provided positive comments in support of the proposed project. However, one commenter expressed concerns regarding potential cumulative environmental impacts from navigation improvement projects for the Texas Gulf Coast, and asserted that the environmental community would probably oppose deepening the channel beyond 50 feet.

No oral comments were provided by Federal or State resource agencies at the meeting, and USACE received no subsequent written comments within the allotted comment period. A summary of information from the scoping meeting is provided in Appendix A-1.

1.5 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, regulations, and executive orders (EOs). The planning objectives of this Federal navigation project include improvement in the efficiency of the deep-draft navigation system and maintenance or enhancement of the quality of the area's coastal and estuarine resources. Economic efficiency would result from the passage of ships into and out of Freeport Harbor that previously had to remain offshore and transfer cargo into smaller crude tankers for product delivery. Economic benefits could also be realized through decreased vessel delays, as the preponderance of benefits are derived from increases in transportation efficiency and lower vessel operating costs.

1.6 OTHER PLANNING CONSIDERATIONS

1.6.1 Environmental Operating Principles

As a reemphasis of the USACE's commitment to the environment and to ensure effective participation in sound environmental stewardship, a formalized set of "Environmental Operating Principles," containing seven principles, was promulgated and promoted throughout USACE to inform and guide its corporate program execution and project development decision-making process. The purpose of the USACE Environmental Operating Principles (EOP) is to illuminate the ways in which the USACE's missions are to be integrated with natural resources laws, values, and sound environmental practices, in order to focus on achieving greater synergy between environmental sustainability and implementation of the full spectrum of USACE activities, including planning, design and construction, operations and maintenance, regulatory, research and development, acquisition, real estate, and support for others (USACE, 2003). The seven EOPs are summarized as follows:

1. Strive to achieve environmental sustainability. An environment maintained in a healthy, diverse, and sustainable condition is necessary to support life.
2. Recognize the interdependence of life and the physical environment. Proactively consider environmental consequences of USACE programs and act accordingly in all appropriate circumstances.
3. Seek balance and synergy among human development activities and natural systems by designing economic and environmental solutions that support and reinforce one another.
4. Continue to accept corporate responsibility and accountability under the law for activities and decisions under our control that impact human health and welfare and the continued viability of natural systems.
5. Seek ways and means to assess and mitigate cumulative impacts to the environment; bring systems approaches to the full life cycle of our processes and work.
6. Build and share an integrated scientific, economic, and social knowledge base that supports a greater understanding of the environment and impacts of our work.

7. Respect the views of individuals and groups interested in USACE activities, listen to them actively, and learn from their perspective in the search to find innovative win-win solutions to the Nation's problems that also protect and enhance the environment.

These principles have been integrated into the earliest stages of the FHCIP's plan formulation and study development process.

1.6.2 USACE Campaign Plan

In August 2006, as a result of lessons learned from hurricanes Katrina and Rita, the USACE Chief of Engineers initiated the "Actions for Change" in an effort to transform USACE planning, design, construction, and operation and maintenance principles and decision-making processes. This program has been further developed into a Campaign Plan. USACE is moving forward with this Campaign Plan to transform the way business is done. The USACE Campaign Plan is available on the internet at http://www.usace.army.mil/about/campaignplan/Pages/Home.aspx.

The successful achievement of the goals and objectives contained in this Campaign Plan are dependent on actions implemented by the entire USACE team. The Campaign Plan includes four goals for USACE. These goals are:

Goal 1: Ready for all Contingencies – Deliver USACE support to combat, stability, and disaster operations through forward deployed and reachback capabilities.

Goal 2: Engineering Sustainable Water Resources – Deliver enduring and essential water resource solutions through collaboration with partners and stakeholders.

Goal 3: Delivering Effective, Resilient, Sustainable Solutions – Deliver innovative, resilient, sustainable solutions to the Armed Forces and the Nation.

Goal 4: Recruit and Retain Strong Teams – Build and cultivate a competent, disciplined, and resilient team equipped to deliver high-quality solutions.

Goals 1 and 4 do not apply directly to the USACE planning process and are not discussed in detail. Goals 2 and 3 pertain to water resources planning and directly to the FHCIP. These goals are described in more detail below.

1.6.2.1 Goal 2: Engineering Sustainable Water Resources

With Goal 2, USACE focuses on comprehensive, sustainable, and integrated solutions to the Nation's water resources challenges through collaboration with stakeholders. This goal refers to not only developing and delivering comprehensive and lasting solutions but also ensuring that these solutions are long lasting, integrated, and holistic to respond to today's and future challenges.

1.6.2.2 Goal 3: Delivering Effective, Resilient, Sustainable Solutions

Goal 3 emphasizes that USACE will provide innovative, resilient, and sustainable infrastructure solutions for the Nation today and in the future. USACE is the Nation's premier public service engineering and construction organization and can provide infrastructure support to serve both the military and national civilian arenas. This effort will improve resilience and lifecycle investment in critical infrastructure, deliver reliable infrastructure using a risk-informed asset management strategy, and develop and apply innovative approaches to delivering quality infrastructure.

(This page intentionally left blank.)

2.0 ALTERNATIVES

2.1 INTRODUCTION

For the development of the proposed FHCIP, several alternatives were identified in the 2002 USACE, Galveston District Section 905(b) Analysis Reconnaissance Report. Five alternatives were analyzed during this initial stage. The FR, which this EIS accompanies, includes detailed analyses of a broader range of improvements and their effectiveness at improving efficiency by allowing the use of larger, more-efficient vessels and reducing delays. Details of the Alternatives Analysis are provided in the FR. Only a brief summary is included below.

Formulation of alternative alignments and dredged material placement areas (DMPAs) included an evaluation and analysis of historical and projected shoaling rates, erosion causes and rates, and general structural and nonstructural alternatives applicable for conditions specific to the project area. Operational concerns of the BPA were also considered. Channel widths and depths were determined by ship simulations based on information from BPA and ERDC. Non-Federal sponsor requests were also evaluated.

An economic evaluation of project modifications to Freeport Harbor was conducted by calculating project benefits based on reductions in transportation costs. Various combinations of widening and deepening alternatives were initially evaluated and screened for more-detailed consideration. Following initial analysis and evaluation, more-detailed cost/benefit analyses were performed on selected alternatives.

An evaluation of jetty stability performed for the FHCIP (Fugro Consultants, L.P. [Fugro], 2005) indicated that at 60-foot depth, relocation of the inshore jetties would be required for widths 550 feet or greater. Incremental benefit-to-cost analyses of the proposed channel configurations took into consideration the cost of jetty relocation. Cross-sectional channel dimensions for Jetty Channel stability can be seen in Appendix K, Figure 2 (Freeport Harbor Jetty Channel Cross Section: Jetty Stability Analysis). Based on the results of those analyses, it was determined that 540 feet was the maximum bottom width that could be constructed between the jetties that would maintain stability and the standard 3-foot horizontal to 1-foot vertical channel side slope. Therefore, the most economical channel width at maximum 60-foot depth was 540 feet, which would allow larger ships to enter the channel without the associated costs of jetty relocation.

2.2 PRELIMINARY SCREENING

The objective of the alternatives screening process is to identify a plan that best meets the purpose and need defined for the project by analysis of a full range of alternatives, including both structural and nonstructural possibilities. Table 2.2-1 lists all project alternatives considered.

Table 2.2-1
Initial Project Alternative Plans

Initial Screening Alternative	Selected Alternative #
1-No Action	Alternative 1; FWOP-2
2a-Widening – 500 foot	
2b-Widening – 600 foot	Alternative 2; FWOP-1; Widening Project
3a-Deepen – 50 foot	Alternative 3
3b-Deepen – 55 foot	Alternative 4
3c-Deepen – 60 foot	Alternative 5
4a-Deepen/Widen – 50x500	
4b-Deepen/Widen – 50x600	
4c-Deepen/Widen – 55x500	
4d-Deepen/Widen – 55x600	
4e-Deepen/Widen – 60x500	
4f-Deepen/Widen – 60x600	
5a-Deepen Brazos Harbor Channel – 40 foot	
5b-Deepen Brazos Harbor Channel – 42 foot	
5c-Deepen Brazos Harbor Channel – 45 foot	
6a-Deepen/Widen Brazos Harbor Channel – 40x300	
6b-Deepen/Widen Brazos Harbor Channel – 42x300	
6c-Deepen/Widen Brazos Harbor Channel – 45x300	
7-Reauthorization of Stauffer Channel to 30 foot	Alternative 6
8a-Deepen Lower Stauffer Channel – 36 foot	
8b-Deepen Lower Stauffer Channel – 40 foot	
8c-Deepen Lower Stauffer Channel – 42 foot	
8d-Deepen Lower Stauffer Channel – 45 foot	
8e-Deepen Lower Stauffer Channel – 50 foot	
9-Widen Lower Stauffer Channel – 300 foot	Alternative 7
10a-Deepen/Widen Lower Stauffer Channel – 36x300	
10b-Deepen/Widen Lower Stauffer Channel – 40x300	Alternative 8
10c-Deepen/Widen Lower Stauffer Channel – 42x300	
10d-Deepen/Widen Lower Stauffer Channel – 45x300	
10e-Deepen/Widen Lower Stauffer Channel – 50x300	Alternative 9
11-Redredge Upper 3,400 feet of Stauffer Channel to 30 foot	

As required by NEPA, each alternative carried forward is traditionally compared to a No Action or Future Without-Project Alternative. Because of the port's Widening Project, however, we have two possible Future Without-Project conditions: one where the Widening Project is constructed before the Federal CIP, or one where Port Freeport's Widening Project is not built before the Federal FHCIP. Our assumption is that the Widening Project will be built, but we must consider both possible futures. If Port Freeport constructs the Widening Project, the Future Without-Project condition for the Federal project would be an existing widened Entrance Channel. This is identified as Future Without-Project 1 (FWOP-1), or Alternative 2 in Table 2.2-1. If the port does not widen the channel, the Federal construction project would then include widening the Entrance Channel as proposed by the permit, and would also deepen it. This alternative is the equivalent of the traditional No Action Alternative (Alternative 1 in Table 2.2-1), but is referred to as Future Without-Project 2, or FWOP-2. Because FWOP-1 is the most likely future, it is the alternative against which all Federal project alternatives are compared, rather than the traditional No Action, or FWOP-2, Alternative. A brief discussion of project area impacts should no construction occur, or under the traditional No Action condition, is presented in the FWOP-2 description, below.

2.2.1 No Action (FWOP-2)

The No Action, or FWOP-2, Alternative is the existing 45-foot Project. The 45-foot Project depth would be maintained throughout the Freeport Harbor Entrance Channel. The Main Channel, turning basins and Stauffer Channel dimensions would remain as described in Section 1.3 and Table 1.3-1. Maintenance material would continue to be placed in the existing Maintenance ocean dredged material disposal site (ODMDS) for the Entrance Channel, and in placement area (PA) 1 for the channels inshore of the Jetty Channel. The Widening Project would not be built.

The future condition should neither the Widening Project nor Federal CIP be built assumes that current project conditions would continue. Future development of the Freeport area would occur without these projects, but would occur faster if they were constructed (Section 4.15). Impacts from naturally occurring relative sea level rise (RSLR) would occur, but would result in minimal impacts to habitats or facilities (Appendix L). Possible takes of threatened and endangered sea turtles would continue to occur as a result of maintenance dredging of the existing project. Port development would be constrained by channel depth and width limitations.

2.2.1.1 FWOP-2, with the Proposed FHCIP

In a future where the Widening Project is not constructed but a Federal FHCIP is, the proposed Federal project would both widen (up to 600 feet) and deepen (by as much as 60 feet) the Entrance Channel, claiming project benefits for both widening and deepening, and increasing Federal project impacts as a result of Federal widening.

Under this scenario, the proposed Federal project could generate up to 15.3 million cubic yards (mcy) of new work dredged material of which 300,000 cubic yards (cy) of silty/sand material would likely be used beneficially by placing it on Quintana Beach in front of the Seaway upland PA. The remainder of the material would be placed in the existing New Work ODMDS. Maintenance of these improved reaches would generate up to 120 mcy of material over the 50-year evaluation period.

In upland areas, channel widening would remove 1.9 acres of habitat consisting of 1.65 acres of herbaceous/grassland, 0.25 acre of beach, and 1,000 square feet (0.023 acre) of shrub/scrub wetland. In the vicinity of the high-tide line, 2 acres of sand-covered, estuarine (tidal) mudflats would be removed. The flats, which are exposed at low tide, are underlain with Beaumont clay and the sand cover is ephemeral, shifting with strong currents. Because of this and wave disturbance from ships passing through the Jetty Channel and the periodic strong currents in the channel, impacts at these locations are not considered significant. All of these areas are located along the north (Surfside) side of the Jetty Channel between Surfside Jetty Park and the USCG Station. Minor and temporary effects on water quality and benthic organisms would occur.

Noise levels in the widening area would be temporarily elevated and minor short-term impacts on air quality would occur. Nitrous oxide (NO_X) emissions for the project would exceed the conformity threshold requiring a General Conformity Determination.

With respect to threatened or endangered species, sea turtle takes could occur as a result of new work and maintenance dredging associated with widening and deepening. The beach and sandy flats that would be removed from the Jetty Channel shoreline could be used for foraging by piping plover, which are known to occur in the area; however, no impact to designated piping plover critical habitat would occur. Endangered Species Act (ESA) Section 7 consultation would be required to address potential impacts to endangered species from Federal widening.

2.2.2 Port Freeport Widening Project (FWOP-1)

FWOP-1 assumes that construction of the Widening Project would occur before Federal construction of the FHCIP. Under FWOP-1, all channels and turning basins would be maintained at the currently authorized depth of 45 feet, with construction of the permitted 600-foot widening of the Entrance Channel. As the most probable project future, FWOP-1 is the condition against which all proposed project alternatives are evaluated, rather than the No Action Alternative (FWOP-2).

2.2.3 Nonstructural Alternatives

Nonstructural alternatives would include restrictions such as one-way traffic, lightering and lightening, and an alternative mode of commodity transport. One nonstructural opportunity available is the continued use of beam width restrictions within the channel. Current pilot rule restrictions prevent two ships from passing in the channel. These rules are agreed upon by the shipping industry, supported by USCG, and administered by BPA. This measure would only maintain current operations, with its increased costs and delays. Another nonstructural measure is use of lightering and lightening vessels. This is another practice already in use and would offer no additional benefits.

The proposed Texas Offshore Oil Port System (TOPS) was evaluated as an alternative mode of commodity transport. TOPS was originally proposed as a joint venture among three firms, but two of those firms announced in 2009 that they were withdrawing from the project. The remaining partner, Oiltanking Holdings Americas (Oiltanking) announced at that time that it intended to continue with the project. However, Oiltanking submitted a letter to the Maritime Administration on April 12, 2010, requesting to withdraw their application for a deepwater port license for the TOPS project (U.S. Department of Transportation, 2012).

In a general discussion with industry, a representative noted that offshore oil terminal projects surface periodically, but the cost of these alternatives keeps them from moving beyond the initial planning stage. TOPS included no plans for connections to either the Seaway or ConocoPhillips docks. It was a proposed offshore terminal project that would provide feedstock to Texas City, Houston, and Port Arthur. Freeport's Seaway dock also serves Texas City and Houston. Additionally, TOPS would not provide connections to Cushing, Oklahoma, which the Freeport refineries serve. The terminal operating on the Freeport Channel and those in Port Arthur have noted that TOPS would serve as an addition to and complement the existing method of importing crude petroleum and was not intended as a substitute for existing modes of shipment. TOPS would reduce the volume of Freeport crude oil transported by vessels by an unknown amount. Because of this, an economic sensitivity analysis was performed to determine if a structural alternative would still be the NED alternative. The result of this sensitivity analyses showed that the 60-foot channel depth continues to produce the highest net excess benefits among the array of depth alternatives.

Therefore, nonstructural alternatives were not considered feasible or did not fully address the problems.

2.2.4 Screening Process for Structural Alternatives

A general screening process was first used to determine which structural alternative plan would result in the objective of providing reliable and efficient navigation at the least cost while minimizing environmental impacts. The non-Federal sponsor initially expressed a desire for a channel 600 feet wide and 60 feet deep. Constraints to widening were identified in the Jetty Channel and in the channel reach between the Brazosport Turning Basin and the Upper Turning Basin. Multiple alternative plans were evaluated for more-detailed consideration. The initial array of alternatives is listed in Table 2.2-1. These initial screening alternative plans included:

- No Action Plan (1).

- Widening of the Outer Bar and Jetty channels only with no deepening (2).
- Deepening to 50, 55, or 60 feet from the Gulf of Mexico to the Upper Turning Basin, with and without widening, and with widening to 500 and 600 feet only through the Jetty Channel (3 and 4).
- Deepening to 40, 42, or 45 feet the Brazos Harbor Channel and Turning Basin, without widening and with widening to 300 feet (5 and 6).
- Reauthorization of Stauffer Channel to 30 feet (7)
- Deepening the lower (3,700-foot) reach of the Stauffer Channel to 36, 40, 42, 45, and 50 feet without widening and with widening to 300 feet (8–10).
- Dredging the upper (remaining 3,400 feet) reach of the Stauffer Channel to its previously authorized 30-foot depth (11).

The initial array was also screened regarding environmental considerations. To assist with screening of the initial project alternatives for potential positive or negative environmental impacts, particular emphasis was placed on the following environmental considerations:

- Protection and preservation of the existing fish and wildlife resources, estuaries, wetland habitats, and water quality, and where practicable, beneficially using dredged material to create and/or protect habitat;
- 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 impacts to these resources; and,
- Consideration of socioeconomic effects.

Based on the problems and opportunities identified by the non-Federal sponsor and the public comments received at the public scoping meeting, a variety of alternative plans was identified to address one or more of the planning objectives. Screening of alternative plans focused on whether deepening and widening would be cost effective. The following criteria were used to evaluate and screen the alternative plans:

Dredging Quantities	Minimize Environmental Impacts
Cultural Resource Concerns	Real Estate Issues
Construction Costs	Project Benefits
Sponsor’s Preferences	Safety Issues
Public Acceptance	

Preliminary benefits and costs developed for these alternative plans were used to reduce the number of alternative plans considered during more-detailed evaluation. Mitigation was considered to be the same for all alternatives during the screening of alternative plans. Cost factors such as levee construction, dredging, and pipeline relocation/removal, engineering design, and construction management were included in this cost analysis. Although no ecological benefits and mitigation costs were calculated, all alternatives were reviewed for potential effects to the environment in a nonquantitative manner. Costs for operation and maintenance for each of the alternatives were not included in the initial evaluation but were considered in the later screening process. Costs were developed for all of the alternative plans; however, benefits were determined only for traffic associated with terminals on the authorized channel. Benefits for the Stauffer Channel were not calculated for the initial screening.

The channel was divided into its basic reaches, Outer Bar, Jetty, Lower Turning Basin, Channel to Brazosport Turning Basin, Brazosport Turning Basin, Channel to Upper Turning Basin, Upper Turning Basin, Brazos Harbor Channel and Turning Basin, and Stauffer Channel. The various depth and width options were applied to these reaches. In the Channel to Upper Turning Basin reach, there was some width restriction due to docks on both sides of the channel.

Dredged material from the Outer Bar and Jetty channels reach would be placed in ODMDSs by hopper dredges. There are two existing ODMDSs associated with the existing 45-foot Project, the New Work ODMDS and the Maintenance ODMDS. Dredged material from the inshore channel reaches would be placed in confined upland PAs by hydraulic pipeline dredging. There are several existing PAs in the vicinity of the channel; however, new PAs would be needed for new work and maintenance material. Port Freeport owns large tracts of land in the area available for use as PAs.

Initial analysis of the Brazos Harbor Channel and Turning Basin, used for general cargo and not used by large, deep-draft vessels, showed that deepening and widening were not justified. No increase in ship size is projected for the users of this area. The 36-foot-deep channel intersects with the Main Channel near Station 170+00, just above ConocoPhillips's petroleum docks. Brazos Harbor Turning Basin vessel traffic primarily consists of refrigerated container vessels delivering bananas and general cargo vessels shipping rice. The configuration of the access area and turning basin limits future expansion opportunities due to the high density of docks and landside facilities. The water and landside limitations of the general cargo reaches prompted development of the adjacent Velasco property for the construction of the new container terminal. The Brazos Harbor Channel was dropped from detailed plan formulation.

2.3 SECONDARY SCREENING

Nine project alternatives including FWOP-2 were identified for further evaluation. Evaluation included performing a more-detailed economic analysis to establish the benefit-to-cost ratio and net excess benefits for each alternative identified in Section 2.3, below. Both the NED Plan and the Locally Preferred Plan (LPP) were identified as a result of this detailed economic analysis.

The NED Plan consists of deepening the channel to 60 feet at a width of 540 feet, and the LPP entails deepening the channel to 55 feet at a width of 600 feet. Both plans include widening and dredging the Lower and Upper Stauffer channels. The nine alternatives that were carried forward for detailed analysis are described below.

2.3.1 Alternatives Considered for Detailed Analysis

The final array of alternatives considered included:

Alternative 1: No Action; FWOP-2; the existing project, described above.

Main Channel

Alternative 2: FWOP-1; widen the Outer Bar and Jetty channels to 600 feet.

Alternative 3: Deepen to 50 feet from the Gulf of Mexico to the Upper Turning Basin and widen to 600 feet through the Jetty Channel.

Alternative 4: Deepen to 55 feet from the Gulf of Mexico to the Upper Turning Basin and widen to 600 feet through the Jetty Channel.

Alternative 5: Deepen to 60 feet from the Gulf of Mexico to the Upper Turning Basin and widen to 600 feet through the Jetty Channel.

Stauffer Channel

Alternative 6: Dredge Stauffer Channel to its previously authorized dimensions of 30 feet deep by 200 feet wide.

Alternative 7: Widen the lower 3,700 feet of the Stauffer Channel to 300 feet and reestablish its previously authorized depth of 30 feet, with the upper 3,400 feet of the Stauffer Channel dredged to its previously authorized dimensions of 30 feet deep and 200 feet wide.

Alternative 8: Widen the lower 3,700 feet of the Stauffer Channel to a 300-foot width and deepen it to 40 feet, with the upper 3,400 feet of the Stauffer Channel dredged to previously authorized dimensions of 30 feet deep and 200 feet wide.

Alternative 9: Widen the lower 3,700 feet of the Stauffer Channel to a 300-foot width and deepen it to 50 feet, with the upper 3,400 feet of the Stauffer Channel dredged to its previously authorized dimensions of 30 feet deep and 200 feet wide.

Detailed analyses of benefits and costs were conducted for a 50-year period of analysis for all the above alternatives, combining various channel widths and depths with the different Stauffer Channel configurations.

2.3.2 Environmental Considerations

Eight channel improvement alternatives were proposed for analysis. All were variations of deepening and/or widening of various reaches or the entire length of the authorized ship channel, as well as an extension of the existing Outer Bar Channel with deepening and widening. The proposed depths for the existing channel ranged from 47 to 60 feet plus advance maintenance and overdepth dredging. Proposed widening would increase the existing project from 400 feet up to 600 feet along most of its length. With two exceptions, none of the alternatives would impact wetlands or upland areas, and all dredging will be confined to open water. However, initial channel widening (from 400 to 600 feet) would be accomplished by the non-Federal sponsor under a permit, ahead of proposed Federal channel improvements. The permit widening would remove approximately 1.9 acres of upland area located near the Jetty Channel just east of the USCG Station on the north (Surfside Beach) side of the channel. Proposed Federal channel improvements (deepening and selective widening) would follow the permit project, producing no additional impacts in the Jetty Channel portion of the permit project area. Alternatives 3 through 9 would impact benthic organisms that would recover rapidly after construction.

During plan formulation, the Federal project considered potential beneficial uses identified by the permit Widening Project such as beach renourishment and marsh restoration using new work dredged material from inland portions of the ship channel. While soil borings indicated some sandy material, no concentrated sand lenses were identified, and the high percentage of clay could not be used for beach nourishment. Marsh restoration was also precluded because of the presence of oysters at two of the three sites considered for restoration. The third potential site was cost prohibitive because of pump distance. New work and maintenance material from the offshore reaches of the ship channel would be placed in existing New Work and Maintenance ODMDSs located along the Outer Bar Channel for all alternatives considered. The U.S. Environmental Protection Agency (EPA) has concurred in the use of the existing ODMDSs for proposed new construction and continued project maintenance.

Both new work and maintenance material removed from inland reaches of the ship channel would be placed in existing PA 1 and two proposed new upland PAs, 8 (168 acres) and 9 (250 acres) (see Figure 2.5-1). The proposed PAs are currently used as pasture for cattle grazing. Construction of the two new upland PAs would impact approximately 21 acres of riparian forest and 39 acres of ephemeral wetlands. Coordination with U.S. Fish and Wildlife Service (USFWS) and Texas Parks and Wildlife Department (TPWD) regarding these impacts has resulted in proposed mitigation that includes creation and maintenance of riparian forest habitat and wetlands.

A terrestrial cultural resource investigation of proposed PAs 8 and 9 located a possible Civil War gun emplacement that will require avoidance or further investigation if avoidance of the site is not possible. Additional cultural resource investigations will be conducted and coordinated under an executed Programmatic Agreement (PAg) pursuant to 36 Code of Federal Regulations (CFR) 800.

A Hazardous, Toxic, and Radioactive Waste (HTRW) assessment was conducted for the project area, including proposed PAs 8 and 9. While several sources of HTRW were identified at upland industries that line the banks of the Freeport Harbor Channel, no active enforcement actions were under way, and no HTRW sites were located within the project area footprint. Previous sediment quality analyses also revealed no contaminant concerns. Therefore, it is unlikely that contaminants will be encountered during construction activities.

Based on environmental screening considerations, it was determined that the initial alternatives under consideration presented no environmental constraints that would result in adverse impacts to the human or natural environment, to include fish and wildlife resources, wetlands, cultural resources, and socioeconomics. According to Table 2.3-1, impacts to benthic organisms from channel dredging and ODMDS placement activities represent the largest areal impacts regarding proposed project improvements. Additional information associated with potential environmental impacts from the alternatives is also found in this matrix.

2.3.3 Results of Detailed Analysis

Per ton transportation cost savings for channel depth alternatives of 50 to 60 feet at project widths of 500 to 600 feet were compared with the existing 45-foot channel depth costs. Some were only briefly examined and are not included here (see FR for more detail). The increased channel depths would provide improved access to the crude petroleum and petroleum product docks; thus, benefit calculations were limited to petroleum. The analysis included crude petroleum imports transportation savings, petroleum product import and export tonnage transportation savings, and total annual costs. Based on the average annual benefits over a 50-year period of analysis at a 4.0 percent discount rate, the benefit/cost ratios and average annual net excess benefits were computed for various depth increments beginning at the Outer Bar Channel up to the Upper Turning Basin, and for the Stauffer Channel. These increments were derived from the nine alternatives, above.

As detailed plan formulation began, the alternatives were reevaluated. In reevaluation of the Jetty Channel area, it was determined that in order to provide adequate stability of the rock jetties, the bottom width for a 60-foot-deep channel would have to be reduced. It was determined that 540 feet was the maximum bottom width that could be constructed between the jetties and maintain the standard 3-foot horizontal to 1-foot vertical channel side slope. Economic evaluation of the Stauffer Channel indicated that benefits were maximized at a depth of 25 feet in the Upper Channel reach. Thus, the alternative plans were modified accordingly.

After the conclusion of the preliminary screening, detailed plan formulation focused on the refinement of two alternatives determined to be the most feasible: 60-x-540-foot and 55-x-600-foot channel improvements, both of which are described in greater detail below. The FWOP-1 Alternative was also carried forward into detailed analysis to provide for comparison with proposed Federal action alternatives. All nonstructural alternatives were eliminated.

Table 2.3-1
Alternatives Screening Matrix – Potential Impacts to Evaluated Resources

ALTERNATIVES	1	2	3	4	5	6	7	8	9	NED Plan	LPP
	No Action	**Entrance & Jetty Channel 600' Width**	**Main Channel 50' Depth**	**Main Channel 55' Depth**	**Main Channel 60' Depth**	**Stauffer Ch Authorized Dimensions 30' Depth**	**Stauffer Channel Widened and 30' Depth**	**Stauffer Channel Widened and 40' Depth**	**Stauffer Channel Widened and 50' Depth**	**Alternatives 5 and 8**	**Alternatives 4 and 9**
EVALUATION CRITERIA											
Construction Dredging Volumes	None	3.1 mcy	15.8 mcy	15.7 mcy	21.8 mcy	4.7 mcy	1.0 mcy	1.4 mcy	1.6 mcy	23.2 mcy	17.3 mcy
Maintenance Dredging Volumes (50-year plan)	112 mcy	161 mcy	171.4 mcy	175.8 mcy	190.4 mcy	0.08 mcy	0.08 mcy	0.08 mcy	0.08 mcy	190.5 mcy	175.9 mcy
Construction Air Quality (NO_X emissions)	None	Approximately 430 tons, conformity determination required	Less than NED	Less than NED	Less than NED	Less than NED	Less than NED	Less than NED	Less than NED	Approximately 3,522 tons, conformity determination required	Approximately 2,620 tons, conformity determination required
Noise (dBA)	3–6 dBA over ambient	12–23 dBA over ambient during construction	Less than NED	Less than NED	Less than NED	Less than NED	Less than NED	Less than NED	Less than NED	12 to 23 dBA over ambient	Same as NED
Salinity	No change	No change	Minor increase	Minor increase	Minor increase	Minor increase	Minor increase	Minor increase	Minor increase	Minor increase	Minor increase
Essential Fish Habitat	No change	Less turbidity than NED	Less turbidity than NED	Less turbidity than NED	Less turbidity than NED	Less turbidity than NED	Less turbidity than NED	Less turbidity than NED	Less turbidity than NED	Temporary turbidity during construction	Less turbidity than NED
Benthic Habitat (acres of impact)	1,291 acres Maintenance ODMDS	1,291 acres Maintenance ODMDS 2,236 New Work ODMDS	1,291 acres Maintenance ODMDS 2,236 New Work ODMDS	1,291 acres Maintenance ODMDS 2,236 New Work ODMDS	1,291 acres Maintenance ODMDS 2,236 New Work ODMDS	None	None	None	None	1,291 acres Maintenance ODMDS 2,236 New Work ODMDS	1,291 acres Maintenance ODMDS 2,236 New Work ODMDS
Threatened and Endangered Species	Chance of turtle takes	Chance of turtle takes	Chance of turtle takes	Chance of turtle takes	Chance of turtle takes	Minimal chance of turtle takes	Minimal chance of turtle takes	Minimal chance of turtle takes	Minimal chance of turtle takes	Greater chance of turtle takes	Less chance of turtle takes
Terrestrial Wildlife Habitat (acres of impact)	None	Less than 2 acres of impact along channel	418 acres, PAs 8 and 9	418 acres, PAs 8 and 9	418 acres, PAs 8 and 9	418 acres, PAs 8 and 9	418 acres, PAs 8 and 9	418 acres, PAs 8 and 9	418 acres, PAs 8 and 9	418 acres, PAs 8 and 9	418 acres, PAs 8 and 9
Wetlands (acres and AAHUs)	None	0.48 acres; AAHUs not reported	39.5 acres 1.1 AAHUs	39.5 acres 1.1 AAHUs	39.5 acres 1.1 AAHUs	39.5 acres 1.1 AAHUs	39.5 acres 1.1 AAHUs	39.5 acres 1.1 AAHUs	39.5 acres 1.1 AAHUs	39.5 acres 1.1 AAHUs	39.5 acres 1.1 AAHUs
Riparian Forest (acres and AAHUs)	None	None	21 acres 7.46 AAHUs	21 acres 7.46 AAHUs	21 acres 7.46 AAHUs	21 acres 7.46 AAHUs	21 acres 7.46 AAHUs	21 acres 7.46 AAHUs	21 acres 7.46 AAHUs	21 acres 7.46 AAHUs	21 acres 7.46 AAHUs
Prime Farmlands (acres)	None	None	250 acres in PA 9	250 acres in PA 9	250 acres in PA 9	250 acres in PA 9	250 acres in PA 9	250 acres in PA 9	250 acres in PA 9	250 acres in PA 9	250 acres in PA 9
Socioeconomics	Potentially increased delays and economic loss as ship sizes increase	Short-term increase in construction employment; potential for economic growth	Short-term increase in construction employment; potential for economic growth	Short-term increase in construction employment; potential for economic growth	Short-term increase in construction employment; potential for economic growth	Short-term increase in construction employment; potential for economic growth	Short-term increase in construction employment; potential for economic growth	Short-term increase in construction employment; potential for economic growth	Short-term increase in construction employment; potential for economic growth	Short-term increase in construction employment; potential for economic growth	Short-term increase in construction employment; potential for economic growth

dBA = A-weighted sound level; AAHU = average annual habitat unit

(This page intentionally left blank.)

Detailed engineering analysis focused on development of hydrology and hydraulic analysis, channel layout, engineering quantities, geotechnical analysis, operations and maintenance, and cost estimating.

2.4 EVALUATION OF SCREENED ALTERNATIVES

The following subsections provide descriptions of the alternatives carried forward for further analysis and comparison. The alternatives include the FWOP-1, NED (alternatives 5 and 8, above, slightly modified to account for jetty stability and depth of the Upper Reach of the Stauffer Channel), and LPP (alternatives 4 and 9, above, slightly modified for depth of the Upper Reach of the Stauffer Channel). Detailed project dimensions for the FWOP-2 were previously displayed in Table 1.3-1.

2.4.1 FWOP-1 Alternative, Widening Project

The Widening Project would be maintained at the authorized depth of 45 feet and permitted width of up to 600 feet for the Entrance Channel. The Jetty Channel from Channel Station 63+46 would be gradually widened, at the authorized depth, from 400 feet to 550 feet up to Channel Station 43+00. From that station to Channel Station 38+00, the channel width would be between 550 feet and 600 feet. The remainder of the Jetty Channel and the entire Outer Bar Channel (to approximately Channel Station –300+00) would be approximately 600 feet wide. The remainder of the Freeport Harbor Main Channel, turning basins, and Stauffer Channel would remain as described in Section 1.3 and Table 1.3-1. Construction of the Widening Project would result in approximately 3.2 mcy of new work dredged material consisting of approximately 2.9 mcy of clay/silt material and about 300,000 cy of silty/sand material. The 2.9 mcy of clay/silt material would be placed in the existing New Work ODMDS. The 300,000 cy of silty/sand material would be placed on Quintana Beach in front of the Seaway PA.

Construction of the Widening Project is expected to impact approximately 3.9 acres along the north (Surfside) side of the Jetty Channel between Surfside Jetty Park and the USCG Station. This area would be dredged as part of the widening of the Jetty Channel. Removal of this land area would result in the loss of shrub/scrub upland vegetation, beach, and tidal mud flats.

Maintenance material would continue to be removed and placed in the existing Maintenance ODMDS currently used for the Jetty and Outer Bar channels, and in PA 1 for the channels inshore of the Jetty Channel. None of the maintenance dredged material would be used beneficially because it is not suitable for beach nourishment and there are no economically justified marsh creation sites within reasonable pumping distance of the project.

2.4.2 NED Alternative

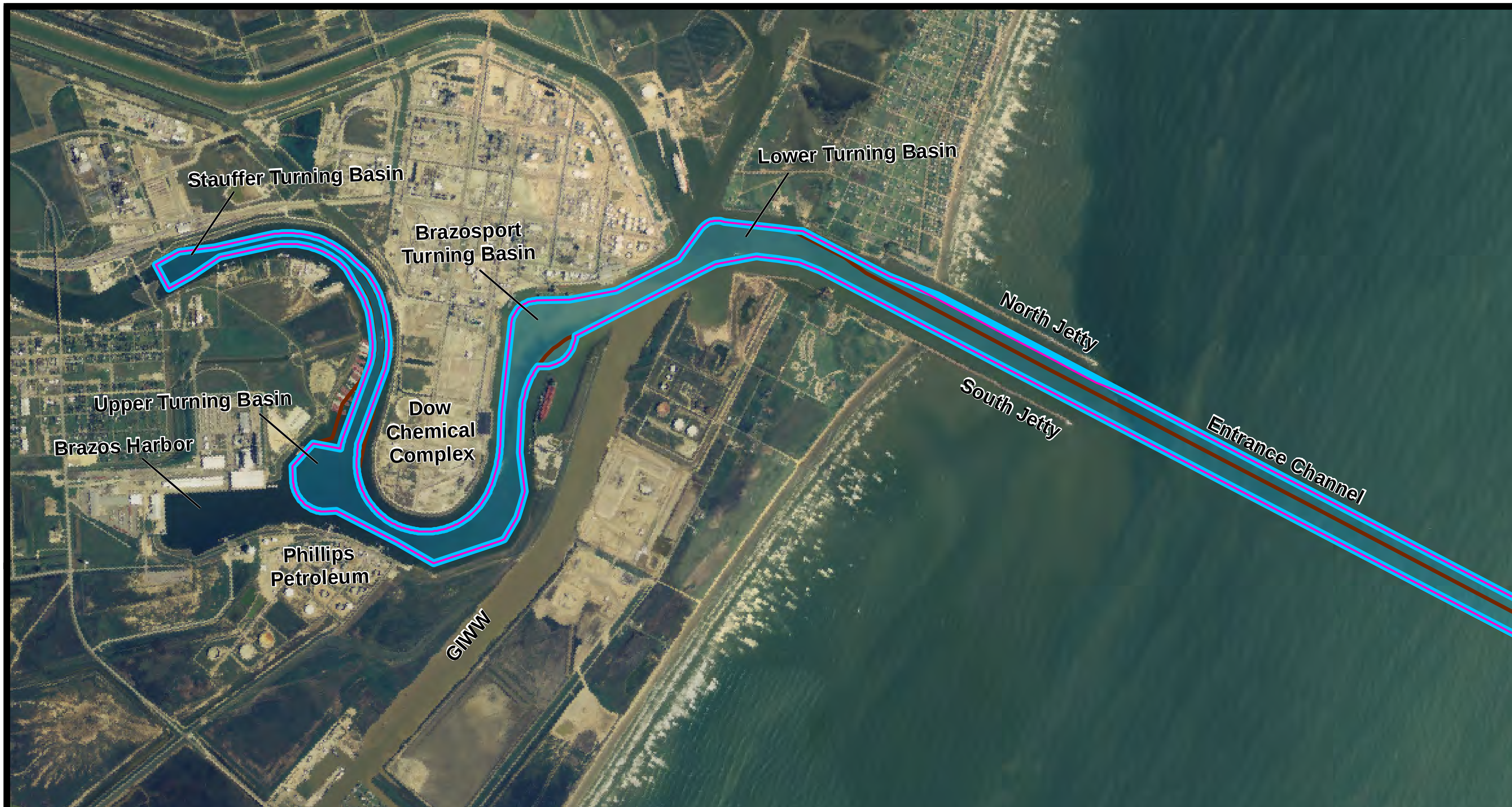
Channel configuration details of the NED Plan (NED Alternative) are summarized in Table 2.4-1. Several cross sections showing channel dimensions for the NED Alternative can be seen on Figures K1–7, located in Appendix K, and the proposed NED Alternative channel footprint, compared to the 45-foot Project (existing channel), can be seen on Figure 2.4-1.

Table 2.4-1
Freeport Harbor Channel
Proposed NED Plan Dimensions for Reaches and Basins

Channel Section	Required Depth (feet)	Width (feet)	New Work Quantity (cy)[a,b]
Future Channel Extension (Sta –300+00 to Stat –470+00)	62	600	2,670,000
Outer Bar Channel (Sta 0+00 to Sta –300+00)	62	600	11,100,000
Jetty Channel (Sta 0+00 to Sta 71+52)	60	540	4,187,000
Lower Turning Basin (Sta 71+52 to Sta 78+52)	60	750	318,000
Channel to Brazosport and New 1,200-foot Turning Basin (Sta 78+52 to Sta 115+00)	60	existing[c]	2,316,000
Channel from Brazosport Turning Basin (Sta 115+00 to Sta 132+66)	60	existing[c]	547,000
Channel to Upper Turning Basin and Upper Turning Basin (Sta 132+66 to Sta 184+20)	50	existing[c,d]	490,000
Stauffer Channel – Lower Reach (Sta 184+20 to Sta 222+00)	50	300	1,340,000
Stauffer Channel – Upper Reach and Turning Basin (Sta 222+00 to Sta 260+00)	25	200[e]	427,000

[a] Includes Advance Maintenance
[b] Includes Allowable Overdepth
[c] Channel width varies from 350 to 400 feet
[d] Upper Turning Basin is 1,200 feet
[e] Stauffer Turning Basin is 500 feet

In general, the NED Alternative is referred to as the 60- by 540-foot project because the width of the Jetty Channel would be restricted to 540 feet. This alternative proposes to extend the Outer Bar Channel 3.2 miles farther into the Gulf at a depth of 62 feet and a width of 600 feet, deepen the existing Outer Bar Channel to 62 feet and the Jetty Channel to 60 feet, deepen the Lower Turning Basin and Main Channel through Station 132+66 (just above the Brazosport Turning Basin) to 60 feet and widen the Brazosport Turning Basin to 1,200 feet, deepen the channel from Station 132+66 through the Upper Turning Basin to 50 feet, deepen and widen the Lower Stauffer Channel to 50 feet by 300 feet, and dredge the Upper Stauffer Channel to 25 feet deep by 200 feet wide in lieu of restoring its previous dimensions of 30 feet by 200 feet. The above depths are authorized depths and do not include 2 feet of advanced maintenance or allowable overdepth dredging. Material dredged from the Entrance Channel during construction



Legend

- LPP Proposed Channel*
- NED Proposed Channel*
- Existing Channel

N E W S

0 1,500 3,000 6,000 Feet

Note: *Created using plan drawings provided by USACE 03/02/2010

Figure 2.4-1
NED & LPP Proposed Channels

Freeport Harbor Channel Improvement Project

Prepared for: USACE	
Job No.: 044190100	Scale: 1 inch equals 3,000 feet
Prepared by: 15490	Date: 03/09/2010
File: N:/Clients/U_Z/USACE/Projects/Freeport/044190100/projects/Figures/2_5_2.mxd	

would be placed in the New Work ODMDS, and the remainder of the new work material would be placed in PAs 1, 8, and 9. Construction would generate approximately 20.4 mcy of new work dredged material (including advance maintenance and allowable overdepth), of which 15 mcy would be placed in the New Work ODMDS and 2.1 mcy and 3.3 mcy would be placed in PAs 8 and 9, respectively. Maintenance of the improved channel is calculated to generate a total of 190.5 mcy of material over the 50-year evaluation period. Of this, 3.5 mcy would be placed in the Maintenance ODMDS on an estimated 1-year cycle, and 0.04 mcy, 0.12 mcy, and 0.19 mcy would be placed in PAs 1, 8, and 9, respectively, on a 3-year cycle. Maintenance material dredged from the Entrance and Lower Turning Basin channels would be placed in the Maintenance ODMDS, and material from the remainder of the channels would be placed in PAs 1, 8, and 9.

2.4.3 LPP Alternative, Preferred Alternative

An analysis of channel configuration plans identified the 60-x-540-foot alternative, or NED Plan, as the plan with the most net benefits; however, the port prefers the smaller and less costly 55-x-600-foot plan, or the LPP Alternative. Although the benefits associated with this plan are slightly less, the amount of new work dredged material is smaller, and at the request of Port Freeport, USACE has selected the LPP Alternative as the Preferred Alternative for implementation. Channel dimensions for the LPP Alternative compared to the Widening Project can be seen on Figures K1–7, located in Appendix K, and the proposed LPP Alternative channel footprint, compared to the 45-foot Project (existing channel), can be seen on Figure 2.4-1.

The LPP Alternative proposes to extend the Outer Bar Channel (Channel Extension) 1.3 miles farther into the Gulf at a depth of 57 feet (–58 Mean Lower Low Water [MLLW]) and a width of 600 feet, deepen the existing Outer Bar Channel to 57 feet (–58 MLLW) and the Jetty Channel to 55 feet (–56 MLLW), deepen the Lower Turning Basin and Main Channel through Station 132+66 (just above the Brazosport Turning Basin) to 55 feet (–56 MLLW) and widen the Brazosport Turning Basin to 1,200 feet, deepen the channel from Station 132+66 through the Upper Turning Basin to 50 feet (–51 MLLW), deepen and widen the Lower Stauffer Channel to 50 feet (–51 MLLW) by 300 feet wide, and dredge the Upper Stauffer Channel to 25 feet (–26 MLLW) deep by 200 feet wide in lieu of restoring its previously authorized dimensions of 30 feet (–31 MLLW) by 200 feet. The above depths are authorized depths and do not include 2 feet of advanced maintenance or allowable overdepth dredging. Proposed channel dimensions for the Preferred Alternative can be found in Table 2.4-2. Material dredged from the Entrance Channel during construction would be placed in the New Work ODMDS, and the remainder of the new work material would be placed in PAs 1, 8, and 9. Construction of the LPP Alternative would generate approximately 17.3 mcy of new work dredged material (including advance maintenance and allowable overdepth), of which 12.7 mcy would be placed in the New Work ODMDS, and 1.9 and 2.7 mcy would be placed in PAs 8 and 9, respectively.

Table 2.4-2
Freeport Harbor Channel
Proposed Dimensions for Preferred Alternative Reaches and Basins

Channel Section	Required Depth (feet)	Width (feet)	New Work Quantity (cy)[a,b]
Future Channel Extension (Sta –300+00 to Stat -370+00)	57	600	795,000
Outer Bar Channel (Sta 0+00 to Sta –300+00)	57	600	8,290,000
Jetty Channel (Sta 0+00 to Sta 71+52.58)	55	600	3,648,000
Lower Turning Basin (Sta 71+52 to Sta 78+52)	55	750	208,000
Channel to Brazosport and New 1,200-foot Turning Basin (Sta 78+52 to Sta 115+00)	55	existing[c]	1,716,000
Channel from Brazosport Turning Basin (Sta 115+00 to Sta 132+66)	55	existing[c]	391,000
Channel to Upper Turning Basin and Upper Turning Basin (Sta 132+66 to Sta 184+20)	50	existing[c,d]	490,000
Stauffer Channel – Lower Reach (Sta 184+20 to Sta 222+00)	50	300	1,387,000
Stauffer Channel – Upper Reach and Turning Basin (Sta 222+00 to Sta 260+00)	25	200[e]	427,000

[a] Includes advanced maintenance
[b] Includes allowable overdepth
[c] Channel width varies from 350 to 400 feet
[d] Upper Turning Basin is 1,200 feet
[e] Stauffer Turning Basin is 500 feet

Material dredged from the Entrance and Lower Turning Basin channels during maintenance cycles would be placed in the Maintenance ODMDS, and material from the remainder of the channel would be placed in PAs 1, 8, and 9. Maintenance of the deepened and widened channel would generate a total of 175.9 mcy of maintenance dredged material over the 50-year evaluation period. Of this, as with the NED Alternative, 3.2 mcy would be placed in the Maintenance ODMDS on an estimated 1-year cycle, and 0.4 mcy, 0.12 mcy, and 0.19 mcy would be placed in PAs 1, 8, and 9, respectively, on a 3-year cycle.

2.5 DREDGED MATERIAL PLACEMENT ALTERNATIVES

Although not part of the initial screening, various alternatives for placement of dredged material were also considered. For the NED Alternative, a maximum of 20.4 mcy of new work material and 190.5 mcy of maintenance material over the 50-year period of economic evaluation are expected to be produced by the proposed project. Placement alternatives considered included expansion of existing upland PAs, creating new upland PAs, and use of existing ODMDSs. Tables 2.5-1 and 2.5-2 below contain summaries of new work and maintenance volumes, distribution to placement areas, and maintenance dredging cycles.

Table 2.5-1
Freeport Harbor Deepening and Widening – Summary of New Work Dredging

Alternative	Channel Reaches	Channel Reach Stationing To	Channel Reach Stationing From	Required Quantity (cy)	Overdepth Quantity (cy)	Total Quantity (cy)	Dredging Stationing & Placement Site Designation To	Dredging Stationing & Placement Site Designation From	Site	Quantity Breakdown to Placement Sites (cy)
NED	Future Channel Extension	–470+00	–300+00	2,000,000	670,000	2,670,000	–470+00	–300+00		
	Outer Bar Channel	–300+00	00+00	7,800,000	1,300,000	9,100,000	–300+00	00+00	ODMDS 1	14,957,454
	Jetty Channel	00+00	71+52	2,900,000	287,000	3,187,000	00+00	71+52		
	Lower Turn Basin	71+52	78+52	280,000	38,000	318,000	71+52	78+52	PA 8	2,087,559
	Ch to Brazosport & New 1,200-foot Brazosport TB*	78+52	115+00	2,200,000	116,000	2,316,000	78+52 106+40	106+40 115+00		
	Ch from Brazosport TB	115+00	132+66	513,000	34,000	547,000	115+00	132+66		
	Ch to Upper TB & Upper TB	132+66	184+20	380,000	110,000	490,000	132+66	184+20	PA 9	3,396,987
	Stauffer Channel, Lower Stauffer TB	184+20	222+00	1,340,000	47,000	1,113,000	184+20	222+00		
	Stauffer Channel, Upper Staffer & TB	222+00	260+00	390,000	37,000	427,000	222+00	260+00		
	Total			**17,803,000**	**2,639,000**	**20,442,000**				
LPP	Future Channel Extension	–370+00	–300+00	500,000	295,000	795,000	–470+00	–300+00		
	Outer Bar Channel	–300+00	00+00	4,990,000	1,300,000	6,290,000	–300+00	00+00	ODMDS 1	9,733,297
	Jetty Channel	00+00	71+52	2,345,000	303,000	2,648,000	00+00	71+52		
	Lower Turn Basin	71+52	78+52	170,000	38,000	208,000	71+52	78+52	PA 8	1,853,144
	Ch to Brazosport & New 1,200-foot Brazosport TB	78+52	115+00	1,600,000	116,000	1,716,000	78+52 113+50	113+50 115+00		
	Ch from Brazosport TB	115+00	132+66	357,000	34,000	391,000	115+00	132+66		
	Ch to Upper TB & Upper TB	132+66	184+20	380,000	110,000	490,000	132+66	184+20	PA 9	2,765,559
	Stauffer Channel, Lower Stauffer TB	184+20	222+00	1,340,000	47,000	1,387,000	184+20	222+00		
	Stauffer Channel, Upper Staffer & TB	222+00	260+00	390,000	37,000	427,000	222+00	260+00		
	Total			**12,072,000**	**2,280,000**	**14,352,000**				**14,352,000**

*TB = Turning Basin.

Table 2.5-2
Freeport Harbor Deepening and Widening – Summary of Maintenance Dredging and Placement Area Parameters

Alternative	Channel Reaches	Channel Reach Stationing		Annual Shoaling Rate From Channel Reaches (cy)	Dredging Stationing & Placement Site Designation			Approx. Size of Placement Site (Acres)	Approx. Existing Levee Elevation (feet in MLT)	1st Construction Levee Elev. (feet in MLT)	Shaped NW Levee Elev. (feet in MLT)	50-Year Levee Elev. (feet in MLT)	Annual Shoaling Rate to Placement Site (cy)	Years Per Cycle	Dredge Quantity Per Cycle (cy)	Total Number of Cycles	Total 50-Year Maintenance Dredging Quantity (cy)
		To	From		To	From	Site										
NED	NED Extension	–450+00	–300+00	1,044,448	–450+00	–300+00	ODMDS 1A	1,291	NA	NA	NA	NA	3,472,580	1	3,472,580	50	173,628,985
	Outer Bar Channel	–300+00	00+00	2,088,897	–300+00	00+00											
	Jetty Channel	00+00	71+52	316,289	00+00	71+52											
	Lower Turning Basin	71+52	78+52	22,946	71+52	78+52											
	Ch to Brazosport & Brazosport TB*	78+52	115+52	142,181	78+52	90+20	PA 1	320	29.0	31.5	31.5	33.5	44,883	3	134,649	16	2,154,384
					90+20	115+52	PA 8	168	NA	23.0	33.5	33.5	119,183	3	357,550	16	5,720,805
	Ch to Upper TB	115+52	132+66	57,889	115+52	122+00											
					122+00	132+66	PA 9	254	NA	23.0	33.5	33.5	177,700	3	533,101	16	8,529,620
	Ch to UP TB & UP TB	132+66	184+20	141,697	132+66	184+20											
	Lower Stauffer TB	184+20	222+00	4,826	184+20	222+00							9,826	12	117,912	4	471,648
	Upper Staffer TB	222+00	260+00	5,000	222+00	260+00											
	Total			**3,824,173**									**3,824,173**				**190,505,443**
LPP	LPP Extension	–450+00	–300+00	873,159	–450+00	–300+00	ODMDS 1A	1,291	NA	NA	NA	NA	3,188,339	1	3,188,339	50	159,416,960
	Outer Bar Channel	–300+00	00+00	1,969,531	–300+00	00+00											
	Jetty Channel	00+00	71+52	324,554	00+00	71+52											
	Lower Turning Basin	71+52	78+52	21,095	71+52	78+52											
	Ch to Brazosport & Brazosport TB	78+52	115+52	132,400	78+52	89+10	PA 1	320	29.0	31.5	31.5	33.5	37,859	3	113,577	16	1,817,240
					89+10	115+52	PA 8	168	NA	21.5	33.0	33.0	119,008	3	357,025	16	5,712,400
	Ch to Upper TB	115+52	132+66	53,220	115+52	123+40											
					123+40	132+66	PA 9	254	NA	21.5	33.0	33.0	170,450	3	511,350	16	8,181,594
	Ch to UP TB & UP TB	132+66	184+20	141,697	132+66	184+20											
	Lower Stauffer TB	184+20	222+00	11,507	184+20	222+00							16,907	12	202,884	4	811,536
	Upper Staffer TB	222+00	260+00	5,400	222+00	260+00											
	Total			**3,532,564**									**3,532,564**				**175,939,729**

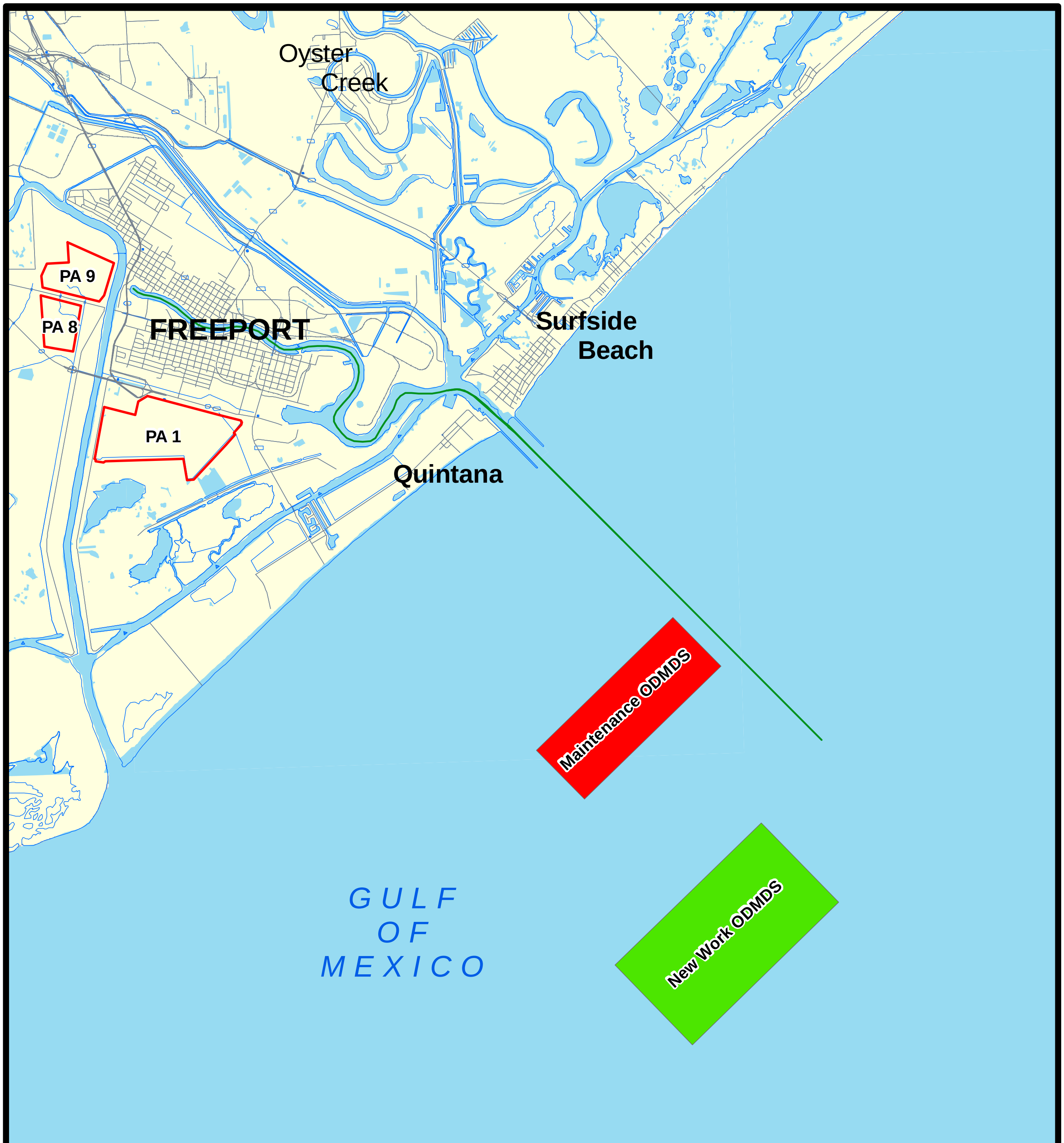
*TB = Turning Basin.

During plan formulation, the Federal project considered potential beneficial uses identified by the Widening Project such as beach nourishment and marsh restoration for new work dredged material. While soil borings in the project area indicated some sandy material, no concentrated lenses were identified, and the high percentage of clay material present would not be compatible with existing sandy beach soils in terms of nourishment efforts. The potential for marsh restoration was also precluded because sensitive resources (oysters) and recreational use existed at two of the three sites considered for proposed restoration activities; moreover, restoration activities at the remaining site considered would be cost prohibitive due to rehandling of dredging equipment, dredging time, and dredging conditions.

Each of the following dredged material disposal plans includes a different mix of possible placement alternatives.

Gulf Placement Plan – Two EPA-designated dispersive ODMDSs exist south of Freeport in the Gulf of Mexico (Figure 2.5-1). The ODMDS closest to shore was originally designated to receive maintenance dredged material and is referred to as the Maintenance ODMDS, while the ODMDS farthest from shore was originally designated to receive new work (construction) material from the 45-foot Project and is referred to as the New Work ODMDS. Coordination with EPA under Section 102 of the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972 (Ocean Dumping Act) resulted in their concurrence to utilize the existing Maintenance and New Work ODMDSs in similar capacity for the FHCIP. Surveys were conducted to establish the condition of the present ODMDS sites, and it has been determined that they are of sufficient size to accommodate placement activities for the proposed project (Appendix B). New work dredged material removed from the Entrance Channel seaward would be placed in the New Work ODMDS, while maintenance material from the Lower Turning Basin and Entrance Channel would be placed in the Maintenance ODMDS. EPA concurrence in the use of these sites precluded the need to identify and designate new ODMDS sites, which would have increased project impacts.

Upland Placement Plan – Several existing PAs are located in the proposed project area (see Figure 1.1-1). The 45-foot Project currently uses PA 1, a 330-acre site, which retains some capacity but cannot be expanded, for placement of maintenance material. It is proposed to use PA 1 for placement of maintenance material for the Main and Stauffer channels for the FHCIP. PAs 2 and 3 are designated for Gulf Intracoastal Waterway (GIWW) maintenance material placement and are not available for FHCIP use. Given estimated quantities, approximately 418 additional upland acres would be needed for placement in order to handle new work material from the Main and Stauffer channels and maintenance material from the Lower Turning Basin. Several tracts of land owned by Port Freeport were considered for upland PA development for the FHCIP. Two potential new PAs, 8 (168 acres) and 9 (250 acres), were identified on port land west of the Brazos River Diversion Channel and northwest of PA 1 (see Figure 2.5-1).



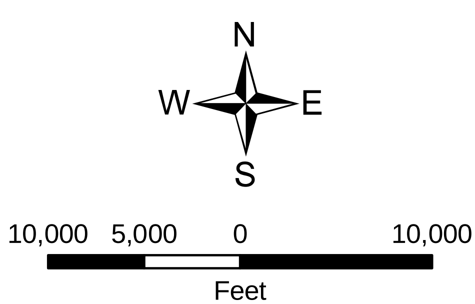


Figure 2.5-1

Freeport Harbor Channel Improvement Project

Dredged Material Placement Area Alternatives

Prepared for: USACE, Galveston District	
Job No.: 044190100	Scale: 1:120,000
Prepared by: A. Christiansen	Date: 03/24/2008
File: N:/Clients/U_Z/USACE/Projects/Freeport/044190100/projects/fig_2_4_1.mxd	

2.6 COMPARISON OF REASONABLE ALTERNATIVES

The following provides a comparison of potential impacts resulting from the two action alternatives, the NED and LPP, and FWOP-1 (Widening Project). In general, NED and LPP impacts are quite similar, with NED impacts slightly greater, as might be expected. The primary impact of FWOP-1 would be an increase in the amount of maintenance dredged material placed in the Maintenance ODMDS by approximately 1 mcy per year (USACE, 2008a). The NED Alternative would result in the placement of approximately 20.4 mcy of new work dredged material during construction, while the LPP Alternative would result in the placement of approximately 17.3 mcy. Maintenance dredged material over the 50-year project would be 190.5 and 175.9 mcy for the NED and LPP, respectively.

NO_X emissions are expected to exceed the threshold for General Conformity for both NED and LPP, but would be higher for the NED Alternative (approximately 437 tons per year [tpy] NO_X) than for the LPP Alternative (approximately 333 tpy NO_X). The anticipated increase in air emissions associated with an increase in the amount of dredged material during maintenance cycles would be the same for both alternatives. Noise impacts during dredging operations would be about 3 to 6 dBA (A-weighted sound level) higher at the nearest noise receptors than what is experienced during current maintenance dredging for both alternatives. The NED Alternative would result in average annual net excess benefits of approximately $42.6 million with a benefit cost ratio of 2.3, while the LPP Alternative would yield $22.6 million in average annual net excess benefits with a benefit cost ratio of 1.9. Under FWOP-1, if the trend to larger ships continues, more delays for commercial vessels can be expected, resulting in the potential loss of economic benefit for the region. Both action alternatives could result in potential lethal and nonlethal takes of sea turtles during construction and maintenance dredging.

Construction of two new upland confined PAs, PAs 8 and 9, required for both action alternatives, would convert approximately 418 acres of land, including 21 acres of riparian forest and 39 acres of ephemeral wetlands, to DMPAs. The impacts and the proposed mitigation would be the same for both alternatives.

Both alternatives have the potential to result in similar economic development in the study area. Essentially, there are only minor different potential impacts related to implementation of either of the action alternatives. Although long-term impacts for both projects are expected to be roughly equivalent, construction-related impacts are slightly less for the LPP Alternative, except for air emissions, which are reduced by about 27 percent. Thus, the LPP Alternative has been identified as the environmentally preferable alternative. Table 2.6-1 below provides a comparison of alternative plans for channel improvements.

Table 2.6-1
Freeport Harbor Channel and Stauffer Modification
NED and LPP Economic Summary
Average Annual Values at 4.0% and $1,000s

	NED Plan			
	Freeport Channel 60/50 feet	**Stauffer Modification**		**Totals**
		Lower Reach 50 feet	**Upper Reach 25 feet**	
First Cost of Construction	$374,522	$12,664	$4,090	$391,276
Interest During Construction	$28,477	$149	$6	$28,632
Total Investment	$402,999	$12,813	$4,096	$419,909
Average Annual Cost	$18,760	$596	$191	$19,547
Average Annual O&M	$11,258	$1,024	$42	$12,324
Total Annual Cost	$30,018	$1,620	$233	$31,871
Average Annual Benefits	$65,270	$7,784	$1,419	$74,474
Net Excess Benefits	$35,253	$6,164	$1,186	$42,603
B/C Ratios	2.2	4.8	6.1	**2.3**
	LPP			
	Freeport Channel 55/50 feet	**Stauffer Modification**		**Totals**
		Lower Reach 50 feet	**Upper Reach 25 feet**	
First Cost of Construction	$274,988	$11,840	$3,823	$290,651
Interest During Construction	$19,156	$139	$6	$19,301
Total Investment	$294,144	$11,979	$3,829	$309,952
Average Annual Cost	$13,692	$558	$178	$14,428
Average Annual O&M	$9,569	$1,024	$42	$10,635
Total Annual Cost	$23,261	$1,581	$221	$25,063
Average Annual Benefits	$38,442	$7,784	$1,419	$47,646
Net Excess Benefits	$15,181	$6,203	$1,199	$22,583
B/C Ratios	1.7	4.9	6.4	**1.9**

2.6.1 Identification of the Preferred Alternative

The identification of the Preferred Alternative was based on economic, engineering, and environmental factors and local preferences. Costs were estimated for all the alternatives and compared to the benefits. Based on the ship simulation studies, the Brazosport Turning Basin was set at 1,200 feet. No work was proposed for the Brazos Harbor Channel and Turning Basin. Included in the costs are dredging, PA levee construction, and operation and maintenance (O&M) costs for the 50-year period of analysis. Ecosystem mitigation requirements and costs were determined. During detailed plan formulation, the non-Federal sponsor expressed their preference for a channel deepening and widening project slightly different than the plan resulting from the NED analysis.

The Preferred Alternative addresses the problems and opportunities identified during the study and satisfies the planning objectives of increasing navigation efficiency along the Freeport Harbor Channel while maintaining the coastal and estuarine resources within the project area. This Preferred Alternative is the LPP, the plan preferred by the non-Federal sponsor. The Preferred Alternative calls for a 57- to 55-foot-deep by 600-foot-wide Outer Bar and Jetty Channel (57-foot-deep Outer Bar Channel/55-foot-deep Jetty Channel) and 55-foot Main Channel. The LPP is recommended in lieu of the NED Plan. The LPP is less costly than the NED Plan for the Entrance and Main channels, and the net excess benefits are less. The Preferred Alternatives for the Lower and Upper Stauffer channels are the same as the NED Plan.

Table 2.6-1 presents the economic summaries for the NED and the LPP. Incremental analysis of the NED components showed that the highest net excess benefits are for the 60/50-foot depth alternative for all of the Freeport channels through the Lower Stauffer Channel. The maximum net excess benefits for the Upper Stauffer Channel maximized at 25 feet. The overall benefit to cost (B/C) ratio for the Preferred Alternative (LPP) is 1.9.

2.6.2 Sensitivity of Project Alternatives to Relative Sea Level Rise

Sea level rise can affect coastal communities and habitats in a variety of different ways, including submerging low-lying lands, eroding beaches, converting wetlands to open water, intensifying coastal flooding, and increasing the salinity of estuaries and freshwater aquifers. It is caused by a number of natural and human-induced factors and can vary by region. Some impacts of sea level rise can already be observed along the U.S. coast. The primary causes of global sea level rise are the expansion of ocean water due to warming and the melting of glaciers and ice sheets. Locally, sea level rise is also influenced by changes to the geology of coastal land.

RSLR consists of two components: global (eustatic) sea level rise and local subsidence. The uncertainty inherent in the rates of eustatic sea level rise is evident in the variability of the different modeled rates given for the National Research Council (NRC, 1987) projections and the Intergovernmental Panel on Climate Change (IPCC, 2007). A similar degree of uncertainty exists with the rate of local subsidence.

Recent USACE guidance (Engineering Circular [EC] 1165-2-211, July 2009) provides direction for incorporating the direct and indirect physical effects of projected future sea level change in managing, planning, engineering, designing, constructing, operating, and maintaining USACE projects and systems of projects. Recent climate research by IPCC predicts continued or accelerated global warming for the twenty-first century and possibly beyond, which will cause a continued or accelerated rise in global mean sea level (msl). Impacts to coastal and estuarine zones caused by sea level change must be considered in all phases of Civil Works programs.

In order to meet the requirements of EC 1165-2-211, the sensitivity of project alternatives to potential changes in sea level must be evaluated (Table 2.6-2). The range of RSLR was determined using both tide gage and basal peat data for the local subsidence component of RSLR. Tide gage data reflect the effects of recent historical subsidence.

Table 2.6-2
Comparison of Alternative Plans – Potential Impacts to Evaluated Resources

	No Action (FWOP-2)	Widening Project (FWOP-1)	NED Alternative	LPP Alternative (Preferred Alternative)
Construction Dredging Volumes	None	3.1 mcy	20.4 mcy	14.4 mcy
Maintenance Dredging Volumes (50-year plan)	112 mcy	161 mcy	190.5 mcy	175.9 mcy
Construction Air Quality (NO_X emissions)	None	Approximately 430 tons, conformity determination required	Approximately 3,522 tons, conformity determination required	Approximately 2,620 tons, conformity determination required
Noise (dBA)	3–6 dBA over ambient	12–23 dBA over ambient during construction	12 to 23 dBA over ambient	Same as NED
Salinity	No change	No change	Minor increase	Minor increase
Essential Fish Habitat	No change	Less turbidity than NED	Temporary turbidity during construction	Less turbidity than NED
Benthic Habitat (acres of impact)	1,291 acres Maintenance ODMDS	1,291 acres Maintenance ODMDS 2,236 New Work ODMDS	1,291 acres Maintenance ODMDS 2,236 New Work ODMDS	1,291 acres Maintenance ODMDS 2,236 New Work ODMDS
Threatened and Endangered Species	Chance of turtle takes	Chance of turtle takes	Greater chance of turtle takes	Less chance of turtle takes
Terrestrial Wildlife Habitat (acres of impact)	None	Less than 2 acres of impact along channel	418 acres, PAs 8 and 9	418 acres, PAs 8 and 9
Wetlands (acres and AAHUs)	None	0.48 acre; AAHUs not reported	39.5 acres 1.1 AAHUs	39.5 acres 1.1 AAHUs
Riparian Forest (acres and AAHUs)	None	None	21 acres 7.46 AAHUs	21 acres 7.46 AAHUs
Prime Farmlands (acres)	None	None	250 acres in PA 9	250 acres in PA 9
Socioeconomics	Potentially increased delays and economic loss as ship sizes increase	Short-term increase in construction employment; potential for economic growth	Short-term increase in construction employment; potential for economic growth	Short-term increase in construction employment; potential for economic growth

The recent historic rate of local RSLR extracted from the National Oceanic and Atmospheric Administration (NOAA) tide gage at Freeport, Texas, is 0.0143 foot/year, for the 52-year period between 1954 and 2006 (NOAA, 2006). This study assumes a historic eustatic sea level rise rate equal to the globally averaged rate given for the Modified NRC curves (= 1.7 millimeters per year [mm/year], or 0.0056 foot/year) (NRC, 1987). Subtracting the historic eustatic rate from the local historic RSLR tide gage rate yields an estimated observed subsidence rate of 2.65 mm/year (0.0087 foot/year) for the Freeport area.

To date, however, there is no scientific consensus concerning the projection of future subsidence rates in the Texas and Louisiana coastal region. The relative influence of historic anthropogenic activities in this area (e.g., oil and gas withdrawal) is difficult to quantify. If these activities contributed significantly to recent observations of subsidence, then significant reductions or cessation of these activities may result in rapid deceleration of subsidence rates, returning them to long-term average rates.

Several studies of basal peat layers have been conducted in the Texas and Louisiana coastal region to determine estimates of the long-term average rates of subsidence for the northwest Gulf Coast. These rates are generally on the order to 0.5 mm/year (0.0016 foot/year) (Törnqvist et al., 2006). This rate is significantly lower than the observed tide gage rates. Therefore, if historic anthropogenic activities are largely responsible for the accelerated rates observed in the tide records, then projected rates would be expected to decelerate rapidly over the next several decades.

Deriving RSLR estimates using both basal peat and tide gage data, possible RSLR rates were estimated for a 50-year period of analysis (the period from 2012 to 2062) to range from 0.36 to 2.40 feet. Possible low (historic), intermediate, and high RSLR rates are given for subsidence values that correspond to both the observed tide gage values (rapid subsidence), and the observed basal peat values (moderate subsidence), and are as follows:

- 0.71 foot, Low (216 mm/year), based on tide gage subsidence rates
- 0.36 foot, Low (110 mm/year), based on basal peat subsidence rates
- 1.11 feet, Intermediate (338 mm/year), based on tide gage subsidence rates
- 0.76 foot, Intermediate (232 mm/year), based on basal peat subsidence rates
- 2.40 feet, High (732 mm/year), based on tide gage subsidence rates
- 2.04 feet, High (662 mm/year), based on basal peat subsidence rates

RSLR rates for the project area are discussed in greater detail in Appendix L (Relative Sea Level Rise) of this EIS.

The most apparent potential for RSLR impacts in the Freeport Harbor project area includes impacts on wetlands and other sensitive low-lying areas due to higher water levels, impacts on vessel navigation due to changes in current velocities in the area, and impacts on surge levels. These potential impacts are examined in Section 4, Environmental Consequences.

2.6.3 Tidal Datum Conversion

USACE regulations and Headquarter (HQ) guidance on tidal datum stress the necessity of converting local datum, such as MLT to MLLW. The predominant reasons for conversion to MLLW are the need for consistency throughout the ports of the U.S., continuity of NOAA and

USCG navigation charts, and the avoidance of misconceptions within the shipping and dredging industries with regard to channel depths. USACE has an established survey control network along the Freeport Harbor Channel. To comply with the guidance on referencing tidal datums using MLLW, USACE took vertical survey measurements at tide gages and benchmarks to estimate the relative difference between MLT and MLLW datums along the Freeport Channel. The objective was to maintain an effective water depth of 55 feet while correctly referencing resulting water surface level in MLLW. At Freeport Channel, datum values for MLLW are +1 foot above MLT. However, this does not result in increased water depth, as the additional +1 foot of nominal depth is actually +1 foot above the normal surface water level. Therefore, the actual water depths are equivalent between a 55-foot MLT channel template and a 56-foot MLLW channel template. As the study and its documentation were completed using MLT, references to MLT have been maintained throughout this document. As the project moves to PED phase, tidal data references will be documented as MLLW.

(This page intentionally left blank.)

3.0 AFFECTED ENVIRONMENT

To facilitate the description of existing resources and potential impacts from the proposed FHCIP, a study area and project area have been defined. The study area encompasses a much larger area that could potentially be impacted by the proposed FHCIP, while the project area encompasses a smaller area, more immediate to the proposed project construction footprint.

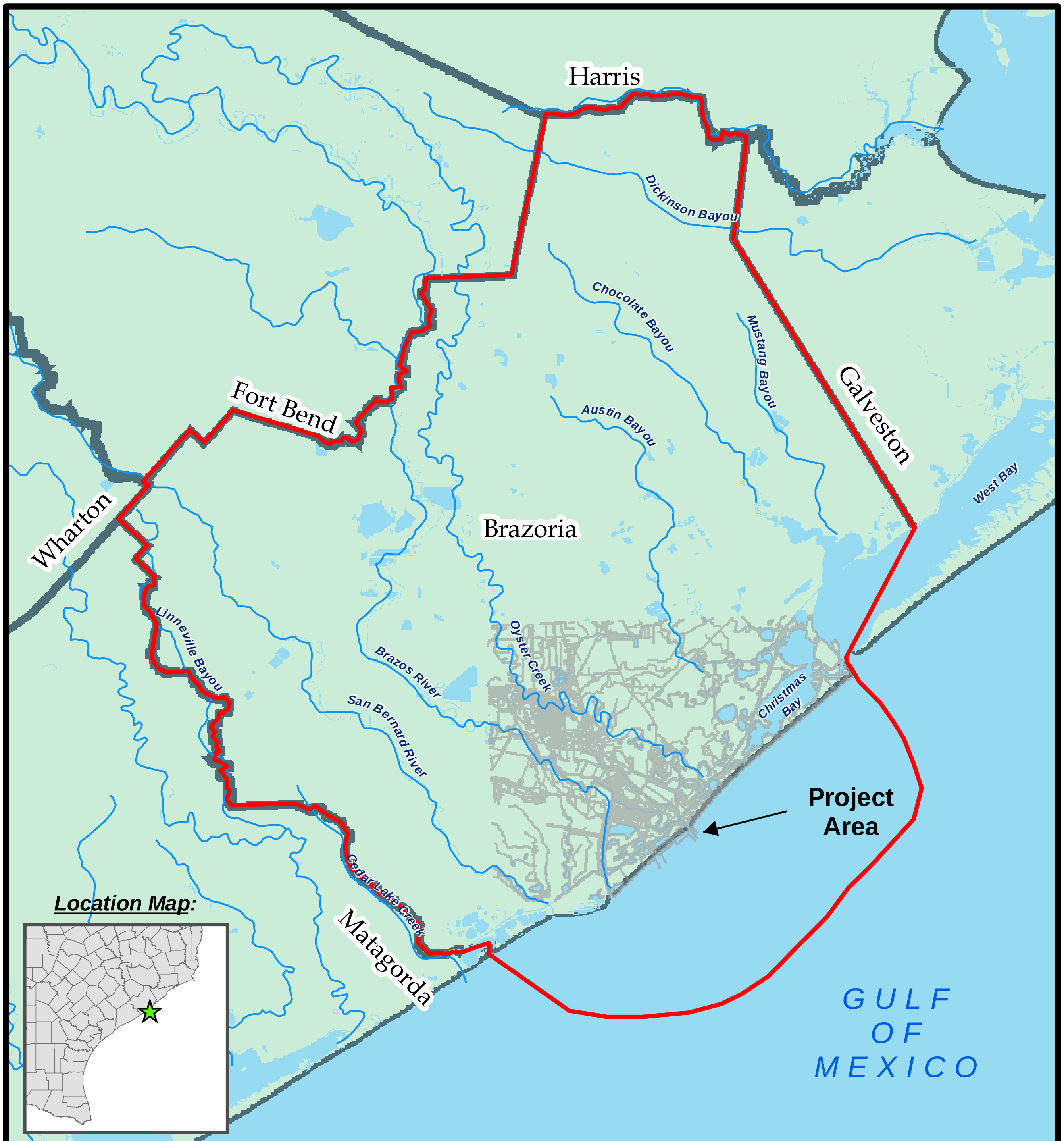
The study area and project area are part of the Texan Biotic Province (Province), an ecological region that is rich in species diversity and composition. While the study area is more similar to the larger Province, much of the project area is significantly degraded in terms of biological resources, largely due to a long history of industrial, commercial, and human settlement activities. More-detailed descriptions of the study and project areas along with the natural systems and human components are discussed below.

3.1 STUDY AREA DESCRIPTION

Because availability of information for specific resource categories varies, definition of the study area was driven by the smallest unit of available information or regulatory consideration for certain resources. Information regarding protected (threatened and endangered) species and wildlife species is available at the county level but is not available for more-specific geographic areas. For other resources, such as socioeconomics and land use, information is available in units varying from the entire United States, Texas, Brazoria County, and local communities, to transects within local communities. When discussing water quality issues, the study area may be defined as the approximate 70-square-mile Freeport Harbor Channel watershed. Thus, study area definitions tend to be resource specific. However, for general description purposes, the study area has been defined as Brazoria County plus a 10-mile radius into the Gulf to account for marine species that could occur within the project vicinity (Figure 3.1-1). For other resources, where the study area may be more specific, a description of the study area is provided at the beginning of that section.

3.2 PROJECT AREA DESCRIPTION

The project area is defined as the footprint of the construction area within the channel, the existing New Work and Maintenance ODMDSs, the three upland PAs 1, 8, and 9, plus a 1-mile buffer around these features (Figure 3.2-1). The project area takes into consideration areas of potential direct impact and areas potentially affected by immediate indirect or secondary impacts. Included in the project area are all or portions of the cities of Freeport, Surfside Beach, and Quintana.



Legend

Freeport Harbor CIP Area

Study Area

N S E W

10 5 0 10 Miles

Figure 3.1-1

Freeport Harbor Channel Improvement Project Study Area

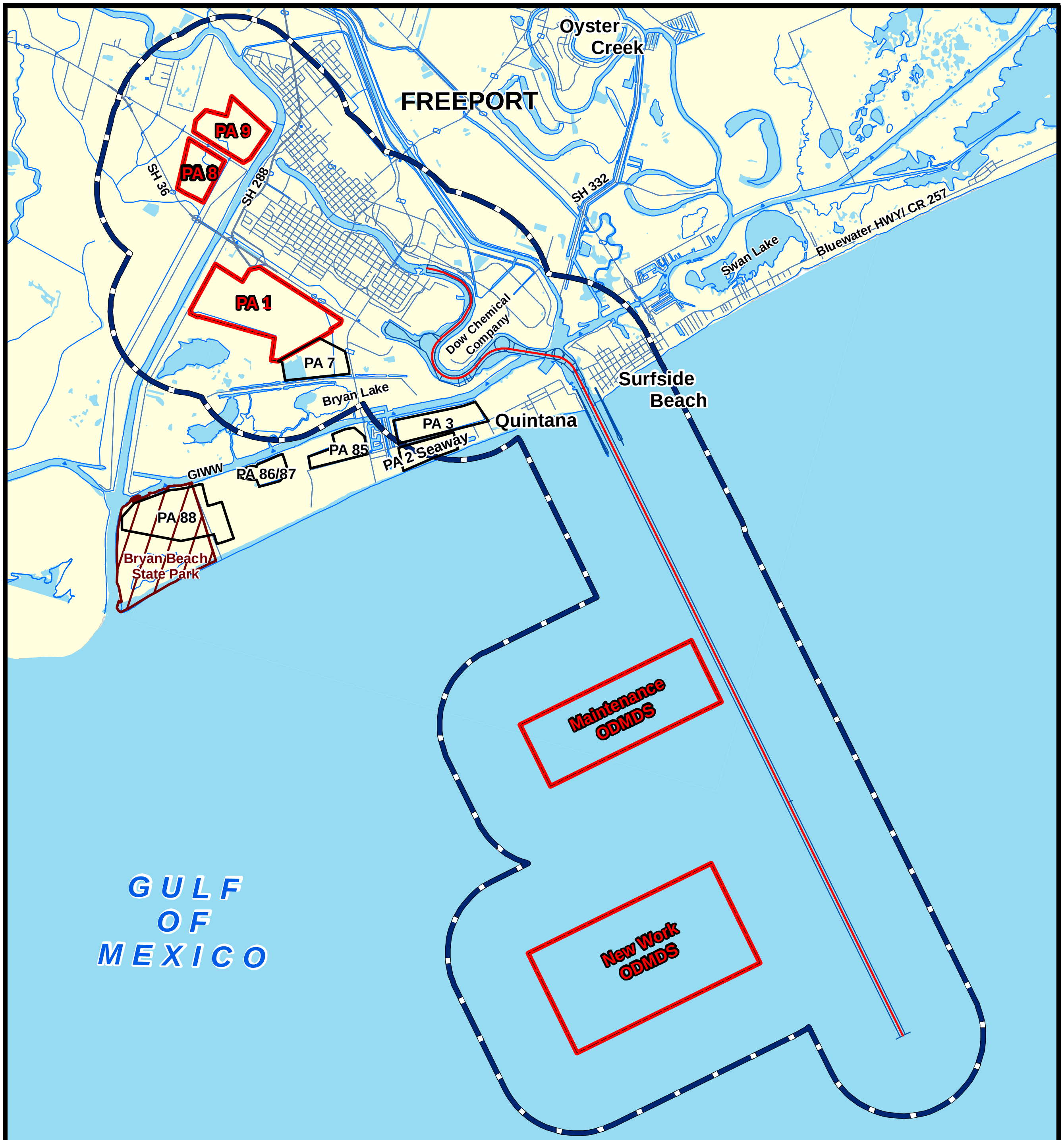
Prepared for: USACE Galveston

Job No.: 044190100

Prepared by: A.Christiansen

Date: 03/14/2008

File: N:/Clients/U_Z/USACE/Projects/Freeport/044190100/projects/Fig_3_0_2_vr2.mxd



Legend

- Channel Centerline
- Dredged Material Placement Areas
- Bryan Beach State Park
- Project Area
- Placement Areas

0 0.45 0.9 1.8

Miles

Figure 3.2-1

Freeport Harbor Channel Improvement Project Area

Prepared for: USACE Galveston	
Job No.: 044190100	
Prepared by: A.Christiansen	Date: 03/24/2008

File: N:/Clients/U_Z/USACE/Projects/Freeport/044190100/projects/Figures/Fig_3_0_1_vr2.mxd

In general, the landward portion of the project area encompasses areas dominated by industrial, commercial, and residential development with some recreation areas, as well as scattered agricultural land and some marshes, all of which are centered around the Freeport Harbor Channel. Prior to the diversion of the Brazos River, the channel was the mouth of the Brazos River. Currently, the Freeport Harbor Channel extends south into the Gulf with no associated bay or estuary, and dead-ends to the north just before reaching State Highway (SH) 288 after passing through the City of Freeport. The community of Surfside Beach is located immediately northeast of the Freeport Harbor Jetty Channel, and Quintana is located immediately to the southwest. Both communities are small beachfront residential areas along public-access beaches. Surfside Beach has been affected by erosion, with homes currently being removed from the beach in efforts to proceed with beach nourishment and shoreline stabilization projects. Quintana is located adjacent to the Seaway upland confined DMPA and the Freeport liquefied natural gas (LNG) facility. Just past that facility, the GIWW crosses Freeport Harbor Channel. From that point, industrial complexes, such as Dow Chemical Company and ConocoPhillips facilities, line the banks of the channel until the transition into the City of Freeport. Inland from the channel, areas that are not developed are generally either converted into upland DMPAs or are marshes or lakes that are used for fishing and other recreational uses, or agricultural land used for livestock or crop production. The majority of marsh habitat found in the project area does not have a direct hydrological connection to the Freeport Harbor Channel.

The natural environment within the project footprint is highly fragmented due to human disturbance and is largely devoid of natural habitats. Upland areas along the channel banks contain broadly scattered grasses, sparse stands of shrub vegetation including non-native invasive salt cedar (*Tamarisk* sp.) and big leaf sumpweed (*Iva* sp.), as well as small fringes of giant reed (*Phragmites communis*). Within the project footprint, there is no submerged aquatic vegetation (SAV), beach or dune habitat, estuarine wetlands or estuarine tidal flats, forested wetlands, or no freshwater flats. However, ephemeral wetlands (39 acres) located on overgrazed pasture and riparian forest (21 acres) can be found within the project footprint at the proposed site of upland PA 9. These resources would be converted into a DMPA, but project mitigation of wetlands and riparian forest would be provided.

Farther upland, the grasslands that may occur within the project area include pasture dominated by introduced species including bermudagrass (*Cynodon dactylon*) and bahiagrass (*Paspalum notatum*). Remnants of the original coastal prairie, with common species including little bluestem (*Schizachyrium scoparium),* brownseed paspalum (*Paspalum plicatulum*), indiangrass (*Sorghastrum nutans*), rosettegrass (*Panicum oligosanthes*), and thin paspalum (*Paspalum setaceum*) may occur within the project area as only a small percentage of the upland grassland. Most prairie remnants support a mix of non-native pasture grasses in addition to some native species.

3.3 ENVIRONMENTAL SETTING

3.3.1 Climate

The climate of the study area is predominantly marine, with periods of modified continental influence during the colder months when cold fronts from the northwest sometimes reach the coast. Because of its coastal location and relatively low latitude, cold fronts that reach the area seldom have severe temperatures.

Climate normals for Brazoria County were taken from the National Climatic Data Center (NCDC) public database. Climatology data have been recorded since 1946 at three weather stations located in Alvin, Angleton, and Freeport, Texas. Monthly normal temperatures and precipitation, as recorded at these three weather stations for the period of 1971 to 2000, are provided in Table 3.3-1.

Table 3.3-1
Monthly Normals of Temperature and Precipitation (1971–2000)
Brazoria County

	Temperature									Precipitation		
	Alvin			Angleton			Freeport			Alvin	Angleton	Freeport
	Avg Daily Max	Avg Daily Min	Avg Daily	Avg Daily Max	Avg Daily Min	Avg Daily	Avg Daily Max	Avg Daily Min	Avg Daily	Avg	Avg	Avg
Month	°F	°F	°F	°F	°F	°F	°F	°F	°F	inches	inches	inches
January	62.2	43.1	52.7	62.8	43.7	53.3	62.6	45.4	54.0	4.76	4.76	4.29
February	65.7	46.1	55.9	65.9	46.9	56.4	65.4	47.9	56.7	2.91	3.50	2.84
March	72.0	53.0	62.5	72.1	53.6	62.9	71.5	54.7	63.1	3.11	3.76	2.87
April	77.3	59.6	68.5	77.5	59.6	68.6	76.5	61.4	69.0	3.22	3.74	2.82
May	83.6	67.3	75.5	83.8	67.3	75.6	82.6	69.2	75.9	4.92	5.20	4.02
June	88.8	72.5	80.7	89.1	72.7	80.9	87.8	75.1	81.5	5.35	6.44	4.65
July	91.2	74.2	82.7	91.8	74.2	83.0	90.2	77.2	83.7	4.78	4.24	4.74
August	91.6	73.8	82.7	91.9	73.7	82.8	90.2	76.5	83.4	3.84	4.83	4.18
September	87.7	69.6	78.7	88.1	69.8	79.0	86.7	72.2	79.5	7.12	7.49	7.80
October	80.8	60.4	70.6	81.2	60.3	70.8	80.2	63.5	71.9	3.93	4.25	4.52
November	72.2	52.1	62.2	72.4	52.0	62.2	72.0	54.1	63.1	4.43	4.86	4.42
December	64.7	45.1	54.9	65.1	45.2	55.2	65.0	47.4	56.2	3.36	4.17	3.51
Annual	78.2	59.7	69.0	78.5	59.9	69.2	77.6	62.1	69.8	51.73	57.24	50.6

Source: NCDC (2006a)

Mean daily temperatures range from about 55 degrees Fahrenheit (°F) in December and January to above 80°F in the summer months. Minimum temperatures fall as low as 43°F, and maximum temperatures rise as high as 92°F.

Monthly rainfall is evenly distributed throughout the year. Average annual precipitation is about 52 inches, 57 inches, and 51 inches for Alvin, Angleton, and Freeport, respectively. Monthly precipitation averages range from about 2.82 to 7.80 inches.

Freeze occurrence data were also extracted from the NCDC database for the three monitoring stations in Brazoria County. Table 3.3-2 shows probable dates of the first freeze in fall and the last freeze in spring.

Table 3.3-2
Freeze Dates in Spring and Fall (1971–2000)
Brazoria County

Probability	Freeze Dates (Below 32°F)		
	Alvin	**Angleton**	**Freeport**
Last Freeze in Spring			
10	Mar 20	Mar 26	Mar 03
50	Feb 15	Feb 15	Jan 31
90	Jan 10	Jan 04	-
First Freeze in Fall			
10	Jan 01	Dec 29	-
50	Dec 09	Dec 05	Dec 28
90	Nov 19	Nov 13	Nov 28

Source: NCDC (2006b)

Snowfall is rare. In 95 percent of the winters, there is no measurable snowfall. In 5 percent, the snowfall, usually of short duration, is no more than 4 inches. The heaviest 1-day snowfall on record was more than 2 inches.

The average humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 90 percent. The sun shines 60 percent of the time possible in summer and in winter. The prevailing winds are from the south and southeast. Average windspeed, 10 miles per hour, is highest in March (Soil Conservation Service [SCS], 1981).

On average, Port Freeport is affected by a tropical storm or hurricane every 3.34 years and is directly hit by a hurricane (within 40 miles) every 11.42 years (Hurricanecity, 2008). An investigation of tropical storms in the Freeport area was conducted by the Texas Engineering Experiment Station at Texas A&M University (TAMU) to determine the degree of risk of flooding for the Freeport area that is protected by the levee system (Edge et al., 2006). The study was based on numerical simulations of tidal elevations and storm surges for tropical storm events that have historically impacted the area. Simulation models were used to produce multiple life-cycle simulations of tide and storm surge activity for 35 locations within the Freeport area. Based on study results, the maximum storm surge plus tide value was calculated to be 17.9 feet for the 200-year storm and 13.1 feet for the 100-year storm, both in Oyster Creek. None of the storm-surge-plus-tide values were greater than the current height of the levee system. The study also addressed runup of wind-generated waves at five locations along the levee. The highest expected value for the maximum wave elevation was calculated to be 21.7 feet above msl for a 200-year storm and 16.1 feet for a 100-year event. The maximum storm runup waves were in excess of 26.2 feet; however, those were associated with events greater than the 200-year event (Edge et al., 2006). Thus it is reasonable to expect that the existing levee system would provide protection for up to a 200-year storm event.

3.3.2 Geology

The study area is situated near the seaward margin of the west Gulf Coastal Plain Physiographic Province. Regionally, the area is characterized by a nearly continuous series of marginal marine embayments separated from the Gulf by a system of barrier islands and peninsulas (Lankford and Rehkemper, 1969). Coastline features are typically the result of several active, geologic processes including longshore drift, beach wash, wind deflation and deposition, tidal currents and waves, delta outbuilding, and river point bar and flood deposits. The coastal zone is underlain by sedimentary deposits that originated in ancient but similar coastal systems (McGowen et al., 1976).

The coastal plain near the Gulf is located within the Gulf Coast geosyncline, a major center of sediment deposition since the middle to late Jurassic Period. More than 30,000 feet of Jurassic- to Pleistocene-aged sedimentary deposits dip and thicken toward the Gulf. During part of the Mesozoic Era (late Triassic to Jurassic), the seas in the area were isolated and water inflow was restricted, resulting in the deposition of evaporate sediments dominated by salt (Wermund et al., 1989). After salt deposition, the region was overlain primarily by prograding sands and muds. Interspersed throughout these layers are salt domes that have migrated upwards through the underlying strata to within a few thousand feet of the land surface. In addition, the regional dip is bisected by belts of arcuate growth faults that are typically downthrown to the Gulf, or by faults in the proximity of salt domes.

The study area is characterized as Quaternary (Recent and Holocene) Alluvium containing thick deposits of clay, silt, sand, and gravel (Barnes, 1982, 1987), overlying the Pleistocene Beaumont Formation. These formations consist mainly of stream channel, point bar, natural levee, and backswamp deposits associated with former and current river channels and bayous. The Alluvium outcrops in a belt approximately 70 to 90 miles wide paralleling the Texas coastline. The underlying Beaumont Formation is estimated to be less than 1,000 feet thick and consists mostly of clay, silt, sand, and gravel.

Construction and maintenance of the GIWW, irrigation and drainage canals, and access channels has resulted in extensive channelization and associated disposal of dredged material in the area (McGowen et al., 1976). The project area is further characterized by recent fill and subaqueous dredged material deposits located on the landward and seaward sides of the barrier beach (Quintana and Surfside) associated with the construction of the Freeport Harbor Channel for the City of Freeport's chemical-processing complex. Material composition at these locations is dictated by the origin of the material; however, dredging and disposal typically make the material less coherent and more permeable. Typically, fill and dredged material consists of mixed mud, silt, sand, shell, and reworked dredged material. Reworked dredged material from the Jetty Channel may be sandy and moderately sorted with high to very high permeability and low water-holding capacity. Maintenance material from the remainder of the channels is fine silt.

The 1929 diversion of the Brazos River resulted in shoreline erosion in the Surfside area and the deposition of a new delta at the mouth of the relocated Brazos (McGowen et al., 1976). Sediment distributions within the new fluviatile-deltaic system consist primarily of sand, silt, and mud. Beyond the delta front is an area of prodelta muds. The sand-mud boundary lies between 2.0 to 2.9 miles offshore from the present Brazos River delta. Muddy sands also occur adjacent to DMPAs, in the shallow bay margin next to the mainland shore, and at the edge of wind tidal flats. Muddy sand distribution is not controlled by depth; rather, it is related to hurricane washovers, dredging activities, and reworking of relict sediment (McGowen and Morton, 1979).

Along the Texas coastal zone, subsurface faults are relatively common, and a number of these have been activated as a result of subsidence in the Freeport area. Most surface faults are related to long-trending coastal fault systems extending upwards from thousands of feet below surface and/or to faults associated with salt domes (Brown et al., 1974). Coastal zone faults form primarily by natural geologic processes, including deposition and differential sediment compaction, upward movement of salt deposits to form diapirs, gulfward creep of coastal landmass, and warping of landmass due to regional tectonics. There are two types of faults that occur in the region, growth and salt dome. Growth faults form by subsurface slumping, creep, and consolidation of sediments during deposition. These faults are confined to Cenozoic-aged sediments and are typically parallel to the Gulf Coast, with lengths exceeding 6 miles. Salt dome faults occur in radial and crestal graben-type patterns over and around the dome top, revealing linear surface traces that are somewhat curved with numerous intersections. These faults are typically localized (<3 miles long) and numerous.

Subsidence occurs as sudden sinking or gradual downward settling of land with little or no horizontal motion, caused by surface faults and intensified and/or accelerated by subsurface mining or the pumping of oil or groundwater. Subsidence is the major manifestation of surface faulting throughout the Texas Gulf Coast, and typically occurs on the downthrown side of the fault. In addition, the extraction of groundwater, oil and gas, and salt brine in the Freeport area (and subsequent active faulting) has caused land subsidence on the order of 1.5 to 2 feet in the area vicinity. However, subsidence has been observed to lessen and diminish altogether as groundwater, oil, and gas pumping has decreased or ceased (Holzer and Gabrysch, 1982; Verbeek and Clanton, 1981).

Several geotechnical studies have been conducted within the project area over the past 40 years that included numerous cores. However, most of these cores were taken for past projects and did not extend to potential project depths. Additionally, since these cores are of virgin sediments, change in those sediments should not be expected over a few decades. The most recent study of sediments (virgin and dredged) located in the immediate vicinity of the Freeport Harbor Channel was conducted by Fugro (2005) between January 28, 2005, and February 3, 2005, for the permit Widening Project, and has been used for preparation of this EIS. According to the Fugro report, a total of seven soil borings were drilled in the Jetty Channel. Geotechnical information from this report is discussed in Section 3.5.

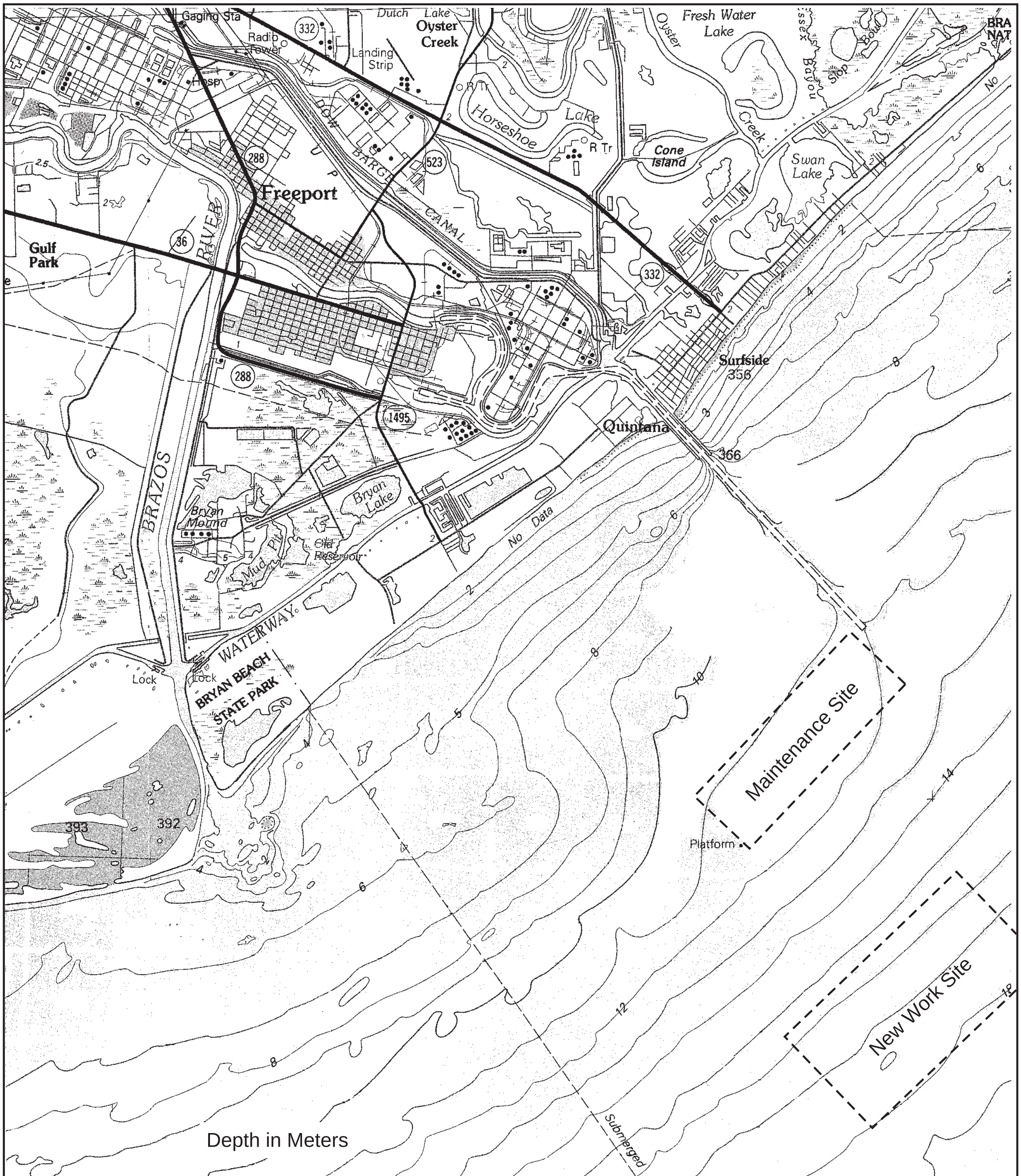
3.3.3 Physiography and Bathymetry

The primary physiographic environments of the study area include fluvial deltaic systems, barrier island strandplain systems, and aeolian (wind) systems. The Coastal Zone within the study area is underlain by sedimentary deposits that originated in ancient, but similar, physiographic environments. These ancient sediments were deposited by the same natural processes that are currently active in shaping the present coastline such as longshore drift, beach wash, wind deflation and deposition, tidal currents, wind-generated waves and currents, delta outbuilding, and river point bar and flood deposition (McGowen et al., 1976).

The study area is characterized by interconnected natural waterways, the GIWW, and other navigable channels. The surface topography of the project area is mainly flat to gently rolling and slopes to the southeast toward the Gulf. The diverted Brazos River drains areas to the west of the study area and discharges into the Gulf, forming a delta west of the project area. A few short, low-gradient streams drain directly into the GIWW, navigation channels, and scattered lakes. Most common among coastal features are beach ridges, open sand beaches, dunes, mudflats, marshes, and deltas. A topographic map for the study area is presented on Figure 3.3-1.

The Brazos River is a fine-grained meanderbelt system characterized by frequent cutoff and abandoned channel courses, relatively high mud load, and narrow to broad floodplains. Natural ponds, lakes, holding ponds, and artificial reservoirs are present on the floodplains of the Brazos River (McGowen et al., 1976). Dredged material has been placed along most of the turning basins, channels, and canals in the project area.

The portion of the Gulf within the project area is confined to the shallow Gulf shelf area and is largely devoid of significant physiographic features. The shelf slopes uniformly in the project area at a rate of approximately 5:10,000 feet, except within approximately 3,000 feet of the coastline where the slope is steeper, about 5:1,000 feet. The turning basins and GIWW are relatively low-energy environments protected on the seaward side by beach ridges and open sand



north

0 1 2 miles

Base Map: USGS 1:100,000 Quadrangle; Freeport, Texas

Figure 3.3-1

TOPOGRAPHIC MAP
OF PORT FREEPORT, TEXAS

L:\projects\hc1\USACE\Galv\441901- Freeport Federal Impacts EIS\Background - Freeport Fed\cad\figure3_1-1.ai beaches. The Freeport Harbor Channel is a moderate- to high-energy environment partially protected by two (north-south) man-made rock jetties. These jetties extend into the Gulf approximately 0.5 mile from the shoreline.

The bathymetry of the project area has been partially modified by channel dredging and subsequent formation of ODMDS. Channel depths in the Outer Bar and Jetty channels are currently maintained to –47 feet MLT. The existing channel is approximately 5.2 miles in length and has a bottom width of approximately 400 feet. The bathymetry of the project area is presented on Figure 3.3-1.

3.3.4 Water Exchange and Inflows

There are two principal types of water exchange in the Freeport Harbor system: bidirectional (tidal exchange with the Gulf) and unidirectional (flows from rainfall runoff and wastewater that enter the harbor and flow to the Gulf). Of the two, the tidal exchange is by far the greatest volume. When the Brazos River was diverted in 1929, most freshwater inflow into the Freeport Harbor Channel system was lost, with the exception of rainfall, sheet flow, and wastewater. Tidal influence in the Gulf is dominated by the 12.4-hour semidiurnal and the 24.8-hour diurnal lunar tides and the 13.6-day cycle in the magnitude of the declination of the moon (Ward, 1977). Tidal waters in Freeport Harbor have a total surface area (measured from navigation chart 11321) of approximately 2,550 acres. If the tidal range (elevation difference between low and high water) was 1.5 feet, the volume of water that would need to enter or leave the Jetty Channel would be 166.5 million cubic feet. If this took place during semidiurnal tides (6.2 hours for a flood or ebb tide), the average tidal flow would be 7,460 cubic feet per second (cfs). The cross-sectional area of the Jetty Channel is approximately 33,000 square feet, so the average tidal current velocity through the channel is about 0.2 foot/second.

Freshwater inflows from the approximately 70-square-mile watershed are much smaller than the tidal flows. There is no flow measurement in this watershed, but the nearby U.S. Geological Survey (USGS) Chocolate Bayou gage near Alvin (08078000) can provide an estimate and has a drainage area of 87.7 square miles. The average flow from 1959 to 2001 was 118 cfs. Adjusting for the watershed area gives a projected average freshwater flow at the Jetty Channel of 94 cfs, which is much smaller than the average semidiurnal tidal flow of 7,460 cfs.

Frontal passages can cause more-rapid changes in water levels and exchanges with the Gulf. As a front approaches from the north, onshore airflow increases, forcing water from the Gulf into the harbor. With frontal passage, the wind direction shifts, forcing water from the harbor into the Gulf. The effect is heightened because the front pushes water away from the coast, causing more water to flow Gulfward.

Storm surges associated with hurricanes can be severe. For example, the storm surge during Hurricane Claudette in July 2003 was observed to be around 5.8 feet above msl at the tide gage at Freeport Harbor (Edge et al., 2006), and the surge from Hurricane Carla in late September 1961 was calculated to be almost 11 feet msl.

3.3.5 Shoreline Changes in Project Area

The shorelines of both Surfside Beach and Quintana have changed substantially over the last 150 years. This area has been studied extensively, and a number of contributing causes have been identified in the literature. Most of the Texas shoreline is now in retreat because of RSLR and a reduced supply of sand from the Mississippi and Atchafalaya River systems and from Texas rivers because of the construction of reservoirs. The 1929 Brazos River diversion also removed an important sand source from area beaches. The greatest rate of shoreline change occurs with severe storms, including:

- Hurricane Carla 1961
- Hurricane Alicia 1983
- Tropical Storm Francis 1998
- Tropical Storm Allison 2001
- Hurricane Rita 2005

Other major factors are RSLR that results in shoreline regression and aeolian erosion of sand aggravated by beach vehicle traffic. Finally, there has been the interception of sand from the longshore system by the navigation channel and jetties. The navigation channel in the relatively shallow coastal waters affects the propagation of waves approaching the coast, and this has an effect on the longshore transport of sand. The jetties act as groins to block longshore sediment movement, but some material gets around the jetties and must be periodically dredged from the Outer Bar and Jetty channels.

Morton (1997) and Gibeaut et al. (2000) have summarized shoreline change information in the project area. Figure 3.3-2 presents data, extracted from Morton (1997), of shoreline positions along transect locations in the Surfside/Quintana area. Figure 3.3-3 is a plot of the shoreline positions for representative years taken from the Morton (1997) transects. All of the shoreline positions are shifted to start with the 1996 position as seen on the shoreline of an aerial photograph from that year. In 1852, the shoreline was well inland from its position today. Between 1852 and 1930, the shoreline at Freeport shows strong accretion. At that point, the shoreline was over a mile into what is now the Gulf. However, transects farther west show little change. Following the 1929 relocation of the river, the shoreline at stations 21 and 22, near the new river mouth, advanced substantially, while the area around the Freeport jetties retreated rapidly. Between 1958 and 1996, the shoreline has retreated over the entire area.

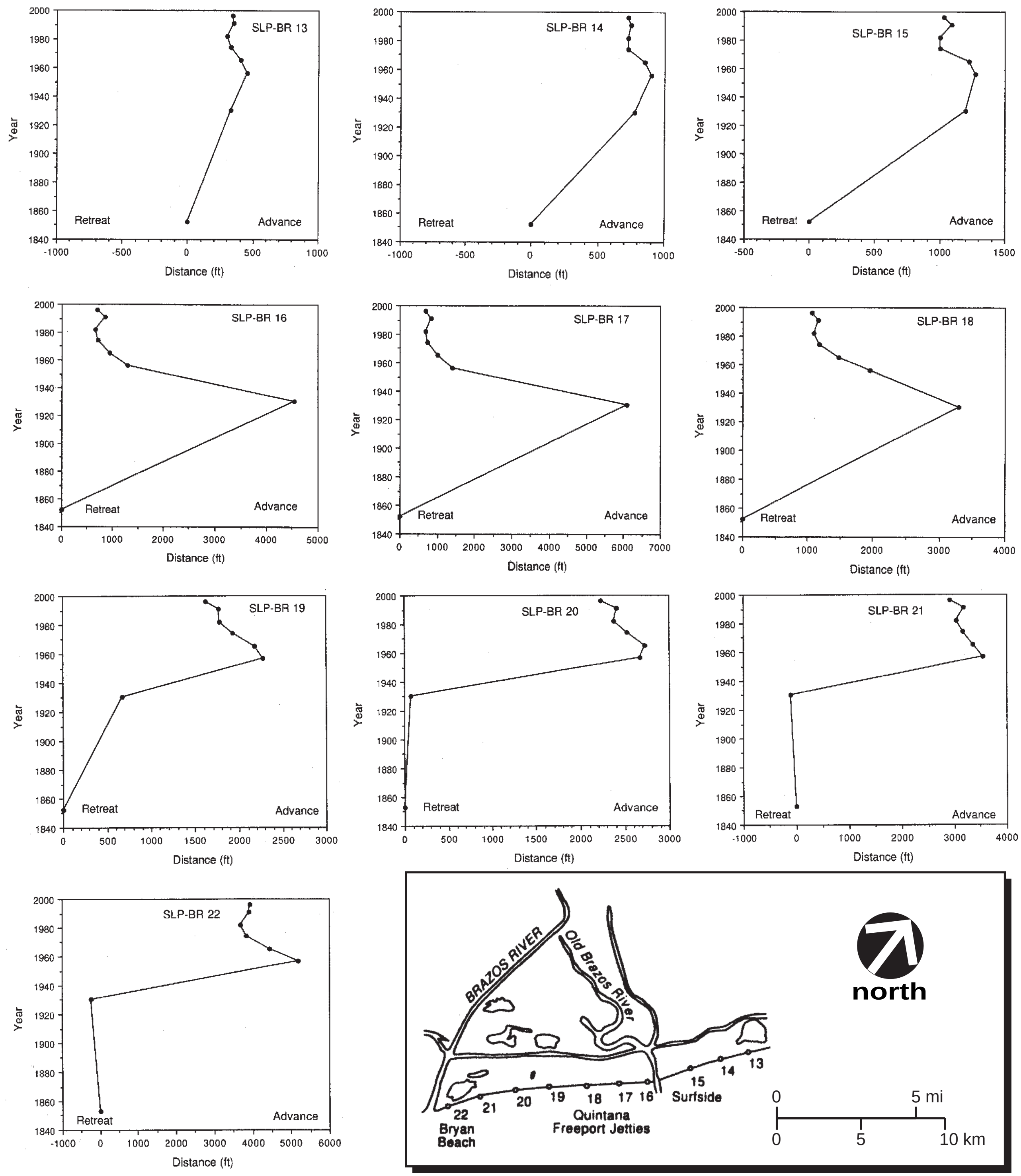


Figure 3.3-2

SHORELINE CHANGES
IN PROJECT AREA
1852-1996

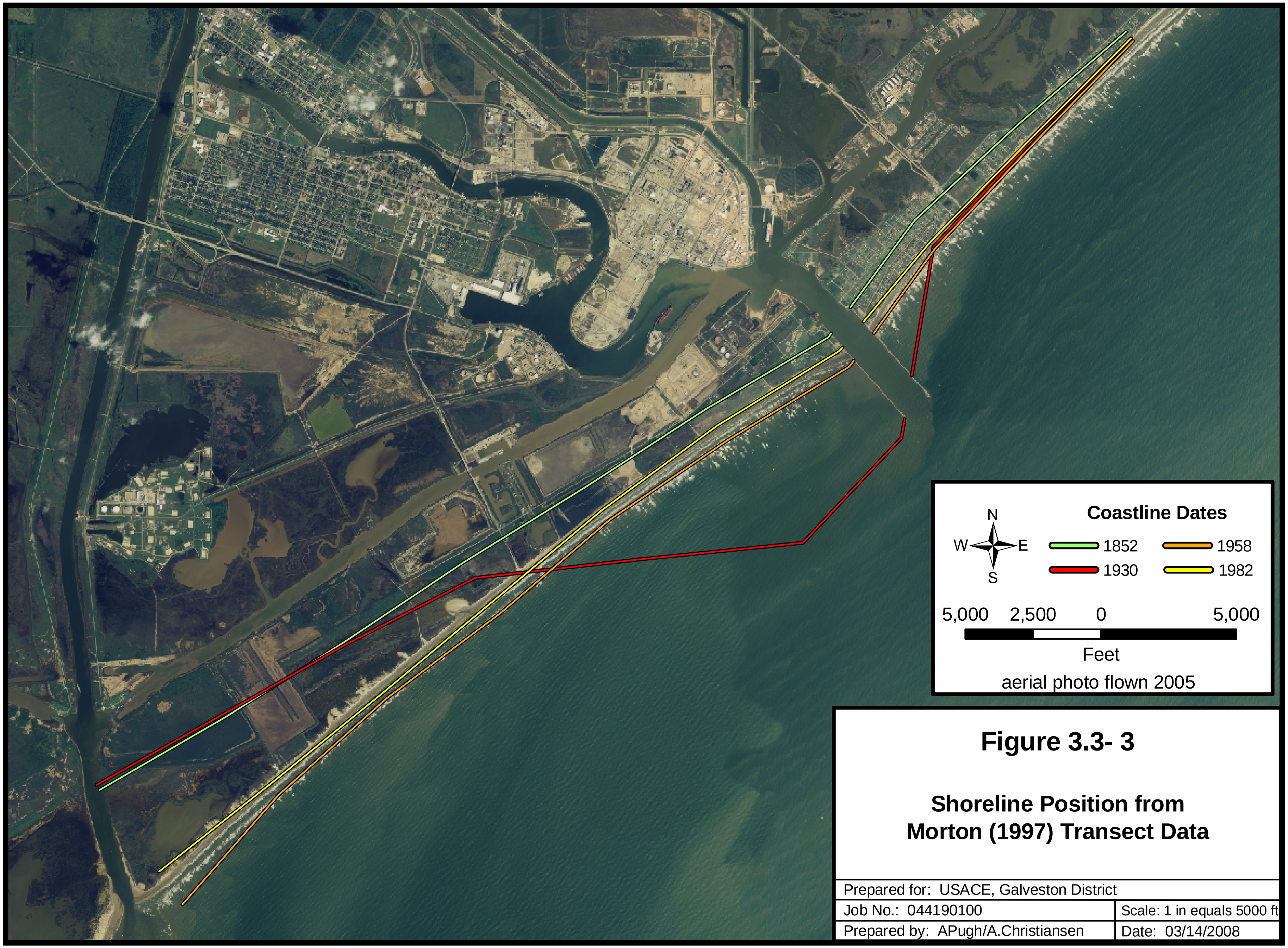


Figure 3.3- 3

Shoreline Position from Morton (1997) Transect Data

Prepared for: USACE, Galveston District	
Job No.: 044190100	Scale: 1 in equals 5000 ft
Prepared by: APugh/A.Christiansen	Date: 03/14/2008

File: N:/Clients/U_Z/USACE/Projects/Freeport/044190100/projects/fig_3_1_3_vr2.mxd

The shoreline accretion or advance near Freeport between 1852 and 1930 was due to a combination of the deposition of sand supplied by the river and the effect of the jetties (built between 1889 and 1896) (Morton and Pieper, 1975). An intermediate point in the shoreline advance can be seen on Figure 3.3-4, taken from Morton and Pieper (1975). It shows the shoreline at the Brazos River mouth advancing substantially between 1852 and 1891. Note that the jetty construction began in 1889 and probably had no effect on the shoreline by 1891.

As seen on Figure 3.3-2, since 1930 (and the 1929 river relocation) the Surfside stations (13, 14, and 15) have been relatively stable or slowly retreating and the Quintana stations (16, 17, and 18) have been retreating more rapidly. This difference appears to reflect the effect of the Freeport jetties acting as groins to block the normal longshore sediment transport towards the southwest. Near the relocated Brazos River mouth (transects 19–22), the shoreline advanced noticeably between 1930 and 1958. During this period, the Brazos River was supplying most of its full sand load. By 1958, reservoir development on the Brazos River has substantially reduced the sand supply, and since that time the shoreline has been retreating.

A major factor in coastal erosion is the amount of sand supplied to the system. The Brazos River is one of the few that still terminates in the Gulf and historically carried a substantial amount of the sand that advanced the beaches in the area. Mathewson and Minter (1976) analyzed the effect of reservoir development in the Brazos River basin and found a major reduction in the amount of beach sand supplied since reservoir development started in the 1920s. The first reservoir, Mineral Wells, started impoundment in 1920. By 1969, 29 reservoirs had been constructed on the Brazos River. The mechanisms identified and quantified in the study include trapping of sand by reservoirs (95 percent trapping efficiency for sand is employed) and reduction of peak river flow rates that perform most of the sand transport in the river. The total Brazos River watershed is 44,640 square miles, but only 35,400 square miles were contributing in 1975 (Mathewson and Minter, 1976). The watershed not affected by major reservoirs in 1975 was noted to be only 10,934 square miles, or about 30 percent of the contributing watershed. The contributing watershed is smaller today. Additional reservoirs completed since the Mathewson and Minter study include Lake Limestone, 1978; Lake Granger and Lake Georgetown, 1980; Lake Aquilla, 1983; and Lake Alan Henry, 1994.

In addition to sand trapping in over 70 percent of the watershed, reservoirs have also reduced peak flood discharges that are important in conveying sand in the river to the coast. The reduction in peak flood discharge was found to be larger in the upper basin (52 percent reduction at Waco) than in the lower basin (30 percent at Richmond). Mathewson and Minter (1976) estimated that about 76 percent of the sand that historically reached the coast was not reaching it in 1975. Their calculations indicate that prior to reservoir development the river transported 101 billion cubic feet of sand or 3.75 million cubic yards per year (mcy/year), and that the transport rate in the early 1970s was 1.14 mcy/year. This is a reduction in sand supply to the coast of about 2.6 mcy/year. This sand would have been supplied during short periods of high

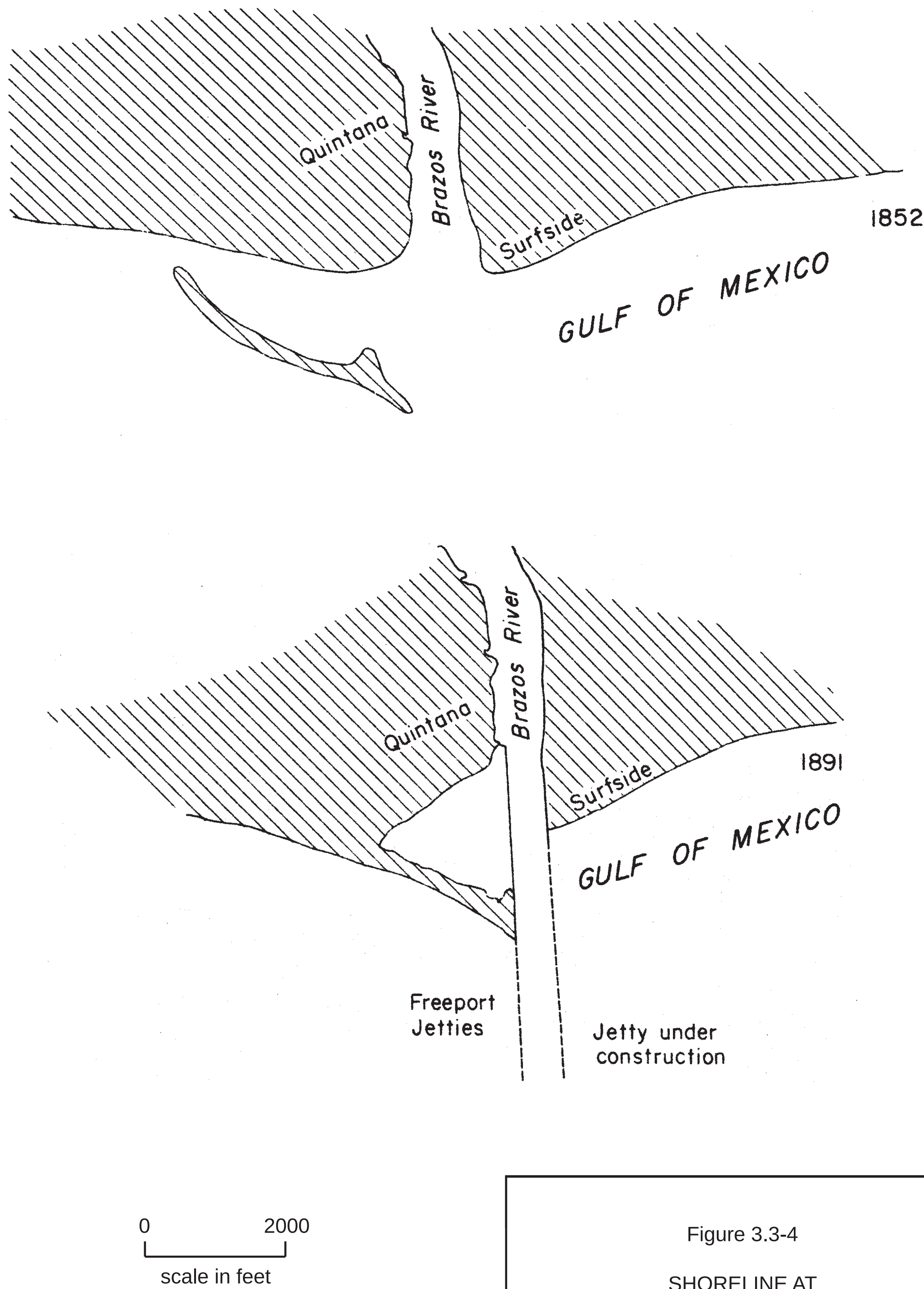


Figure 3.3-4

SHORELINE AT
FREEPORT 1852 AND 1891
(MORTON & PIEPER, 1975)

L:\projects\hc1\USACE\Galv\441901 - Freeport Federal Impacts EIS\Background - Freeport Fed\cad\figure3_1-4.ai river flow, and be distributed both east and west of the river, but predominantly to the west because of the prevailing orientation of onshore winds and longshore drift.

Efforts to offset shoreline erosion with beach nourishment have been carried out under the Texas Coastal Erosion Planning and Response Act (CEPRA). These have involved both trucking in at least 950 cy of sand in one project and bringing sand from a DMPA near Baytown by barge for dune rehabilitation (Newby, 2006). A major limitation of beach nourishment in the area is the limited availability and expense of a suitable sand supply. Nourishing the beach with sand brought by truck or barge from a substantial distance is expensive. In the early 1990s, approximately 300,000 cy of silty sand from the 45-foot Project was placed on the Surfside Beach (Rodino and Moseley, 2005). Currently, beaches on both sides of the Freeport jetties are severely eroded, with the current average rate of shoreline retreat 9 to 10 feet per year (Bureau of Economic Geology [BEG], 2007). Erosion on the Quintana Beach side is threatening the stability of the Seaway upland confined PA, and erosion of Surfside Beach is threatening beachfront homes.

3.4 WATER QUALITY

3.4.1 Salinity and Other Conventional Water Quality Parameters

The Texas Commission on Environmental Quality (TCEQ) has designated the old Brazos River Channel Tidal (Freeport Harbor) as Segment 1111. This essentially covers Freeport Harbor. The designated uses for Segment 1111 are contact recreation (swimming) and high-quality aquatic habitat.

TCEQ monitors this station quarterly. Table 3.4-1 summarizes results for the last 5 years for several key parameters. With little watershed area and freshwater inflow, the average salinity at the station is almost the same as the coastal waters. The minimum salinity is over 18 parts per thousand (ppt) and the average is over 26 ppt. Gulf salinity at Freeport ranges from 32 to 35 ppt. Dissolved oxygen (DO) concentrations average 7.2 milligrams per liter (mg/L), and all are well above the criterion for high-quality aquatic life use of 4 mg/L. *Enterococci* concentrations are all well below the criterion of 35 Most Probable Number/deciliter (MPN/dL), indicating that the waters of Freeport Harbor support the contact recreation use. There is one TCEQ station in the Gulf (Segment 2501) at the end of the South Jetty (17519), but there was only one sample at this station since 2003. The results of that sample were similar to those presented in Table 3.4-1.

During maintenance dredging operations, dredged material is discharged into an upland confined PA and the Maintenance ODMDS. Material excavated from the Entrance and Jetty channels is deposited at the Maintenance ODMDS, and these placement activities may affect DO concentrations in the water column (Brown and Clark, 1968; Hopkins, 1972; May, 1973; Pearce, 1972; Wakeman, 1974; Windom, 1972). May (1973) found that although the water column DO

Table 3.4-1
Summary of Surface Measurements at Station 11498, Old Brazos River Channel
Midway Between Mouth and Terminus

Parameter	aux	Unit	Start date	End date	Num of data	Average	Minimum	Maximum	Std Dev	Criterion
Dissolved Oxygen	00300	mg/L	3/29/2000	1/3/2006	24	7.2	4.9	10.8	1.4	4.0
Salinity	00480	ppt	3/29/2000	1/3/2006	24	26.7	18.4	33.7	4.0	
Enterococci [1]	31701	MPN/dL	3/13/2001	1/3/2006	20	7.8	<1	20	5.7	35

Source: TCEQ Surface Water Quality Monitoring (SWQM) database, http://www.tceq.state.tx.us/compliance/monitoring/crp/data/samplequery.html
[1] For data below reporting limit, half reporting limit used in calculating average and standard deviation.

did not change, there was a temporary decrease in DO at the water/sediment interface in the areas of mud flow. He also found little apparent difference in the immediate oxygen demand between recently deposited sediments from dredged material placement and other sediments. May (1973), Jones and Lee (1978), Peddicord (1979), and Lee (1976) agree that high total oxygen demand, as measured in the laboratory, does not necessarily lead to oxygen depletion upon placement since only a small part of the oxygen demand is exerted at placement and the only open-water placement at Freeport during maintenance activities would be offshore in 35 to 40 feet of water.

Maintenance dredging and placement of dredged materials during maintenance operations also increases turbidity in the water column, which has been shown to reduce primary production in laboratory studies (Sherk, 1971). Field studies, however, have shown essentially no biological impacts from turbidity (May, 1973; Odum and Wilson, 1962), probably because both coastal and estuarine animals are accustomed to large variance in turbidity from a variety of sources, e.g., storms, tidal fluctuations, currents (Clarke and Wilber, 2000).

3.4.2 Water and Elutriate Chemistry

Since EPA is hesitant about relying on data more than 5 years old, only data collected within 5 years of the beginning of the preparation of this EIS (i.e., data from 2002 to the present were analyzed to determine the water quality of the project area) (Table 3.4-2). However, Table 3.4-3 summarizes the detected constituents, by year, from the USACE database since 1987. There were no collections in 2002 and 2003, so data from 2004, 2005, 2006, and 2008 are included in Table 3.4-2. Since Table 3.4-2 only presents the constituents that were detected, Table 3.4-4 provides the complete list of contaminants of concern, for which all samples are tested. This list was compiled jointly by EPA Region VI and Galveston District and is incorporated in the Regional Implementation Agreement (RIA) (EPA/USACE, 2003). The data presented are from samples of maintenance material from the Outer Bar Channel, the Jetty Channel, the Lower Turning Basin, and the Channel to Brazosport Turning Basin. Since the material from the channel landward from the Jetty Channel is maintained less frequently, those materials are sampled less frequently, and the Brazosport Turning Basin, the Channel to Upper Turning Basin, and the Upper Turning Basin have not been sampled since 1998/1999. Also included below is a discussion of elutriate samples, which provide information on those constituents that are dissolved into the water column during hydraulic dredging and placement (see Table 3.4-2). Since the elutriate represents the dissolved concentrations that would be expected in the water column, they are compared to the Texas Surface Water Quality Standards (TWQS) provided by TCEQ (2000) for the protection of aquatic life and EPA water quality discrete criteria (WQC) (EPA, 2008). Since the values are from grab samples, not long-term composites or averages, and are from a marine environment, the acute marine TWQS and WQC are used for comparison. Sediment data are also included in Table 3.4-2 since the elutriate is a measure of the release of

Table 3.4-2

Detected Parameters
Freeport Harbor Channel

					Station:	FH-EC-04-01			FH-EC-04-02			FH-EC-04-03			FH-EC-04-03 DUP			FH-EC-04-REF		
					Date:	4/29/2004			4/29/2004			4/29/2004			4/29/2004			4/29/2004		
					Channel Station:	60+00			–45+00			–150+00			–150+00					
Parameter	**Liquid Media Unit**	**Solid Media Unit**	**WQC**	**TWQS**	**ERL**	**Water**	**Elutriate**	**Sediment**	**Water**	**Elutriate**	**Sediment**	**Water**	**Elutriate**	**Sediment**	**Water**	**Elutriate**	**Sediment**	**Water**	**Elutriate**	**Sediment**
Sand		%						7.5			10.7			1.1			0.9			12.9
Silt		%						28.0			65.5			68.0			63.6			28.2
Clay		%						64.5			23.8			30.9			35.5			58.9
D50		mm						0.00			0.01			0.01			0.01			0.00
Percent Solids		%						40.2			42.6			35.4			33.5			47.2
Antimony	µg/L	mg/kg	N/A	N/A	N/A	<3.00	<3.00	<2.5	<3.00	<3.00	<2.5	<3.00	<3.00	<2.5	<3.00	<3.00	<2.5			<2.5
Arsenic	µg/L	mg/kg	69	149	8.2	1.83	2.58	6.75	1.32	2.47	7.12	1.30	1.45	**8.63**	1.80	1.07	**9.15**			6.93
Beryllium	µg/L	mg/kg	N/A	N/A	N/A	<0.2	<0.2	<1.00	<0.2	<0.2	<1.00	<0.2	<0.2	<1.00	<0.2	<0.2	<1.00			<1.00
Cadmium	µg/L	mg/kg	40	45.4	1.20	<1.00	<1.00	<0.10	<1.00	<1.00	<0.10	<1.00	<1.00	<0.10	<1.00	<1.00	<0.10			0.13
Chromium	µg/L	mg/kg	1,100	1,090	81.0	<1.00	<1.00	18.8	<1.00	<1.00	14.9	<1.00	<1.00	19.3	<1.00	<1.00	20.5			19.6
Copper	µg/L	mg/kg	4.8	13.5	34.0	<1.00	<1.00	11.3	<1.00	<1.00	8.55	<1.00	<1.00	11.2	<1.00	<1.00	11.8			12.2
Lead	µg/L	mg/kg	210	133	46.7	<1.00	<1.00	17.9	<1.00	<1.00	17.8	<1.00	<1.00	22.5	<1.00	<1.00	23.7			17.6
Mercury	µg/L	mg/kg	1.8	2.1	0.15	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20			<0.20
Nickel	µg/L	mg/kg	74	118	20.9	<1.00	<1.00	17.3	<1.00	<1.00	14.9	<1.00	<1.00	18.6	<1.00	<1.00	19.3			18.8
Selenium	µg/L	mg/kg	290	564	N/A	<2.00	<2.00	<0.50	<2.00	<2.00	<0.50	<2.00	<2.00	<0.50	<2.00	<2.00	<0.50			<0.50
Silver	µg/L	mg/kg	1.9	2.0	1.00	<1.00	<1.00	<0.20	<1.00	<1.00	<0.20	<1.00	<1.00	<0.20	<1.00	<1.00	<0.20			<0.20
Thallium	µg/L	mg/kg	N/A	N/A	N/A	<1.00	<1.00	0.27	<1.00	<1.00	0.21	<1.00	<1.00	0.28	<1.00	<1.00	0.27			0.21
Zinc	µg/L	mg/kg	90	92.7	150	8.39	9.70	28.6	4.61	8.72	27.3	12.2	8.61	31.0	2.83	8.04	34.1			25.4
Bis(2-ethylhexyl) phthalate	µg/L	µg/kg	N/A	N/A	N/A	<3.00	<3.00	<50.0	<3.00	<3.00	<50.0	<3.00	<3.00	<50.0	<3.00	<3.00	<50.0			<50.0
TOC	mg/L	%	N/A	N/A	N/A	4.32	8.34	7800	3.07	5.33	7800	3.33	3.98	11300	3.71	3.95	11500			10300
Ammonia	mg/L	mg/kg	Var	N/A	N/A	0.05	1.17	99.9	0.03	1.25	88.6	0.03	0.55	83.5	0.03	0.72	82.8			71.0

Table 3.4-2 (Continued)

		Station:				FH-EC-05-01			FH-EC-05-02			FH-EC-05-02 DUP			FH-EC-05-03			FH-EC-05-REF		
		Date:				6/29/2005			6/29/2005			6/29/2005			6/29/2005			6/29/2005		
		Channel Station:				60+00			–45+00			–45+00			–150+00					
Parameter	**Liquid Media Unit**	**Solid Media Unit**	**WQC**	**TWQS**	**ERL**	**Water**	**Elutriate**	**Sediment**	**Water**	**Elutriate**	**Sediment**	**Water**	**Elutriate**	**Sediment**	**Water**	**Elutriate**	**Sediment**	**Water**	**Elutriate**	**Sediment**
Sand		%						4.0			16.7			14.5			1.0			7.5
Silt		%						19.1			41.5			47.8			70.2			5.7
Clay		%						76.9			41.8			37.7			28.8			86.8
D50		mm						0.00			0.01			0.01			0.01			0.00
Percent Solids		%						41.4			45.8			43.1			33.7			47.4
Antimony	µg/L	mg/kg	N/A	N/A	N/A	<3.00	<3.00	<2.5	<3.00	<3.00	<2.5	<3.00	<3.00	<2.5	<3.00	<3.00	<2.5			<2.5
Arsenic	µg/L	mg/kg	69	149	8.2	2.25	3.84	7.26	2.26	4.08	6.19	2.34	3.78	6.47	2.42	3.10	**8.61**			7.53
Beryllium	µg/L	mg/kg	N/A	N/A	N/A	<0.2	<0.2	<1.00	<0.2	<0.2	<1.00	<0.2	<0.2	<1.00	<0.2	<0.2	<1.00			<1.00
Cadmium	µg/L	mg/kg	40	45.4	1.20	<1.00	<1.00	<0.10	<1.00	<1.00	<0.10	<1.00	<1.00	<0.10	<1.00	<1.00	<0.10			0.2
Chromium	µg/L	mg/kg	1,100	1,090	81.0	<1.00	<1.00	23.5	<1.00	<1.00	18.7	<1.00	<1.00	18.7	<1.00	<1.00	23.6			23.8
Copper	µg/L	mg/kg	4.8	13.5	34.0	<1.00	<1.00	14.0	<1.00	<1.00	10.4	<1.00	<1.00	10.3	<1.00	<1.00	13.9			15.4
Lead	µg/L	mg/kg	210	133	46.7	<1.00	<1.00	18.5	<1.00	<1.00	15.2	<1.00	1.27	16.1	<1.00	1.19	21.7			16.8
Mercury	µg/L	mg/kg	1.8	2.1	0.15	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20			<0.20
Nickel	µg/L	mg/kg	74	118	20.9	<1.00	6.06	19.2	<1.00	3.89	15.8	<1.00	4.34	16.0	<1.00	4.35	19.9			20.8
Selenium	µg/L	mg/kg	290	564	N/A	2.26	<2.00	<0.50	2.24	<2.00	<0.50	2.26	<2.00	<0.50	2.21	<2.00	<0.50			<0.50
Silver	µg/L	mg/kg	1.9	2.0	1.00	<1.00	<1.00	<0.20	<1.00	<1.00	<0.20	<1.00	<1.00	<0.20	<1.00	<1.00	<0.20			<0.20
Thallium	µg/L	mg/kg	N/A	N/A	N/A	<1.00	<1.00	1.09	<1.00	<1.00	0.50	<1.00	<1.00	0.28	<1.00	<1.00	0.53			0.38
Zinc	µg/L	mg/kg	90	92.7	150	<1.00	5.03	19.6	<1.00	1.89	17.1	<1.00	2.40	17.4	<1.00	2.29	24.1			17.9
Bis(2-ethylhexyl) phthalate	µg/L	µg/kg	N/A	N/A	N/A	<3.00	<3.00	<50.0	<3.00	<3.00	<50.0	<3.00	<3.00	<50.0	<3.00	<3.00	<50.0			<50.0
TOC	mg/L	%	N/A	N/A	N/A	2.80	3.37	14800	3.25	4.29	15300	1.87	5.49	12900	2.28	4.13	18900			13300
Ammonia	mg/L	mg/kg	Var	N/A	N/A	0.15	0.87	17.2	0.11	0.74	7.7	0.19	1.07	21.2	0.16	0.98	20.6			12.2

Table 3.4-2 (Continued)

	Station: Date: Channel Station:					F-06-01B 8/22/2006 95+00			F-06-01A 8/22/2006 85+00			F-06-01 8/22/2006 75+00			FH-06-01 8/22/2006 50+00			FH-06-01 DUP 8/22/2006 50+00		
Parameter	**Liquid Media Unit**	**Solid Media Unit**	**WQC**	**TWQS**	**ERL**	**Water**	**Elutriate**	**Sediment**	**Water**	**Elutriate**	**Sediment**	**Water**	**Elutriate**	**Sediment**	**Water**	**Elutriate**	**Sediment**	**Water**	**Elutriate**	**Sediment**
Sand		%						1.8			4.2			1.8			1.8			1.8
Silt		%						40.6			35.6			40.6			40.6			40.6
Clay		%						57.6			60.2			57.6			57.6			57.6
D50		mm						0.00			0.00			0.00			0.00			0.00
Percent Solids		%						41.0			40.8			41.0			41.0			41.0
Antimony	µg/L	mg/kg	N/A	N/A	N/A	<3.00	<3.00	<2.5	<3.00	<3.00	<2.5	<3.00	<3.00	<2.5	<3.00	<3.00	<2.5	<3.00	<3.00	<2.5
Arsenic	µg/L	mg/kg	69	149	8.2	4.19	5.59	7.81	4.29	7.92	8.13	4.10	6.30	7.82	4.09	5.87	7.08	3.52	6.13	7.35
Beryllium	µg/L	mg/kg	N/A	N/A	N/A	<0.2	<0.2	<1.00	<0.2	<0.2	<1.00	<0.2	<0.2	<1.00	<0.2	<0.2	<1.00	<0.2	<0.2	<1.00
Cadmium	µg/L	mg/kg	40	45.4	1.20	0.04	0.29	<0.10	<1.00	0.47	<0.10	0.98	1.07	<0.10	0.27	0.82	<0.10	0.86	0.59	0.16
Chromium	µg/L	mg/kg	1,100	1,090	81.0	1.08	1.08	9.25	<1.00	<1.00	8.11	<1.00	1.28	8.41	<1.00	<1.00	6.84	<1.00	<1.00	6.78
Copper	µg/L	mg/kg	4.8	13.5	34.0	1.89	2.21	12.1	1.57	2.16	10.6	1.43	1.91	10.7	1.36	1.66	8.57	1.43	2.18	8.02
Lead	µg/L	mg/kg	210	133	46.7	<1.00	<1.00	15.1	<1.00	0.18	14.9	1.15	<1.00	16.0	<1.00	<1.00	14.0	0.84	<1.00	14.2
Mercury	µg/L	mg/kg	1.8	2.1	0.15	1.05	0.31	<0.20	1.19	0.26	<0.20	0.82	0.21	<0.20	1.20	0.11	<0.20	0.95	0.22	<0.20
Nickel	µg/L	mg/kg	74	118	20.9	<1.00	<1.00	4.56	<1.00	<1.00	3.97	<1.00	<1.00	4.13	<1.00	<1.00	3.67	<1.00	<1.00	3.43
Selenium	µg/L	mg/kg	290	564	N/A	1.92	1.50	0.44	1.28	2.31	0.64	1.54	3.78	0.66	1.33	5.09	0.65	1.09	5.46	0.76
Silver	µg/L	mg/kg	1.9	2.0	1.00	<1.00	<1.00	<0.20	<1.00	<1.00	<0.20	<1.00	<1.00	<0.20	<1.00	<1.00	<0.20	<1.00	<1.00	<0.20
Thallium	µg/L	mg/kg	N/A	N/A	N/A	<1.00	<1.00	0.34	<1.00	<1.00	0.34	1.68	<1.00	0.25	<1.00	<1.00	<1.00	0.71	<1.00	<1.00
Zinc	µg/L	mg/kg	90	92.7	150	<1.00	41.1	14.8	<1.00	5.82	14.1	<1.00	40.2	13.4	<1.00	13.5	12.9	<1.00	79.8	12.1
Bis(2-ethylhexyl) phthalate	µg/L	µg/kg	N/A	N/A	N/A	<3.00	<3.00	207	<3.00	<3.00	145	<3.00	<3.00	180	<3.00	<3.00	209	<3.00	<3.00	185
TOC	mg/L	%	N/A	N/A	N/A	5.60	7.05	0.98	5.16	5.02	0.91	3.14	5.52	1.06	4.11	5.25	1.15	4.31	5.55	0.90
Ammonia	mg/L	mg/kg	1.7	N/A	N/A	0.06	0.25	254	0.08	0.23	319	0.05	0.49	283	0.08	0.52	222	0.07	0.38	259

Table 3.4-2 (Continued)

	Station:					FH-06-02			FH-06-04			FH-06-06			FH-06-REF			FH-06-PA1		
	Date:					8/22/2006			8/22/2006			8/22/2006			8/22/2006			8/22/2006		
	Channel Station:					0+00			–100+00			–200+00								
Parameter	**Liquid Media Unit**	**Solid Media Unit**	**WQC**	**TWQS**	**ERL**	**Water**	**Elutriate**	**Sediment**	**Water**	**Elutriate**	**Sediment**	**Water**	**Elutriate**	**Sediment**	**Water**	**Elutriate**	**Sediment**	**Water**	**Elutriate**	**Sediment**
Sand		%						1.8			4.2			1.1			4.0			23.7
Silt		%						40.6			40.1			37.3			31.5			56.1
Clay		%						57.6			55.7			61.6			64.5			20.2
D50		mm						0.00			0.00			0.00			0.00			0.00
Percent Solids		%						41.0			44.4			39.1			46.0			68.3
Antimony	µg/L	mg/kg	N/A	N/A	N/A	<3.00	<3.00	<2.5	<3.00	<3.00	<2.5	<3.00	<3.00	<2.5	<3.00	<3.00	<2.5	<3.00	<3.00	<2.5
Arsenic	µg/L	mg/kg	69	149	8.2	3.74	7.96	**8.57**	3.49	6.03	**8.62**	3.68	4.77	**9.45**	3.65	5.51	**8.90**	3.57	3.87	4.51
Beryllium	µg/L	mg/kg	N/A	N/A	N/A	<0.2	<0.2	<1.00	<0.2	<0.2	<1.00	<0.2	<0.2	<1.00	<0.2	<0.2	<1.00	<0.2	<0.2	<1.00
Cadmium	µg/L	mg/kg	40	45.4	1.20	0.67	0.74	<0.10	0.32	0.40	<0.10	0.78	0.26	<0.10	0.49	0.42	<0.10	0.54	0.68	<0.10
Chromium	µg/L	mg/kg	1,100	1,090	81.0	<1.00	<1.00	7.69	<1.00	<1.00	6.80	<1.00	1.28	8.14	<1.00	<1.00	8.25	<1.00	<1.00	3.24
Copper	µg/L	mg/kg	4.8	13.5	34.0	1.11	0.94	8.54	1.07	1.38	7.65	1.61	1.79	10.1	1.52	1.66	10.2	1.07	1.03	3.02
Lead	µg/L	mg/kg	210	133	46.7	<1.00	<1.00	17.3	<1.00	<1.00	16.4	<1.00	<1.00	20.7	<1.00	<1.00	17.8	<1.00	<1.00	8.48
Mercury	µg/L	mg/kg	1.8	2.1	0.15	0.99	0.10	<0.20	0.66	0.32	<0.20	0.91	0.38	<0.20	0.58	0.23	<0.20	0.50	0.28	<0.20
Nickel	µg/L	mg/kg	74	118	20.9	<1.00	<1.00	3.95	<1.00	<1.00	3.08	<1.00	<1.00	3.89	<1.00	<1.00	3.73	<1.00	<1.00	1.77
Selenium	µg/L	mg/kg	290	564	N/A	1.09	4.50	0.72	1.26	6.31	0.50	0.91	7.63	0.61	1.24	6.98	0.69	0.86	8.20	0.32
Silver	µg/L	mg/kg	1.9	2.0	1.00	<1.00	<1.00	<0.20	<1.00	<1.00	<0.20	<1.00	<1.00	<0.20	<1.00	<1.00	<0.20	<1.00	<1.00	<0.20
Thallium	µg/L	mg/kg	N/A	N/A	N/A	<1.00	<1.00	<1.00	<1.00	<1.00	<0.20	0.76	<1.00	<0.20	<1.00	<1.00	<0.20	<1.00	<1.00	<0.20
Zinc	µg/L	mg/kg	90	92.7	150	<1.00	<1.00	12.9	<1.00	13.30	11.7	<1.00	<1.00	15.7	<1.00	<1.00	11.6	<1.00	<1.00	7.68
Bis(2-ethylhexyl) phthalate	µg/L	µg/kg	N/A	N/A	N/A	<3.00	<3.00	227	<3.00	<3.00	183	<3.00	<3.00	247	<3.00	<3.00	172	<3.00	<3.00	127
TOC	mg/L	%	N/A	N/A	N/A	2.48	4.96	1.04	1.62	4.25	0.81	1.86	3.82	0.87	2.17	4.84	0.61	2.38	3.54	0.50
Ammonia	mg/L	mg/kg	1.7	N/A	N/A	0.06	0.53	206	0.06	0.44	227	0.05	0.43	226	0.05	0.52	276	0.05	0.49	183

Table 3.4-2 (Concluded)

					Station:	F-08-01			F-08-02			F-08-03			F-08-04		
					Date:	6/5/2008			6/6/2008			6/6/2008			6/6/2008		
					Channel Station:	75+00			112+00			125+00			175+00		
Parameter	**Liquid Media Unit**	**Solid Media Unit**	**WQC**	**TWQS**	**ERL**	**Water**	**Elutriate**	**Sediment**	**Water**	**Elutriate**	**Sediment**	**Water**	**Elutriate**	**Sediment**	**Water**	**Elutriate**	**Sediment**
Sand		%						2.7			0.7			2.8			1.0
Silt		%						26.1			26.2			26.6			14.8
Clay		%						71.2			73.1			70.6			84.2
D50		mm						0.00			0.00			0.00			0.00
Percent Solids		%						34.9			35.5			36.6			35.9
Antimony	µg/L	mg/kg	N/A	N/A	N/A	<3.00	<3.00	<2.5	<3.00	<3.00	<2.5	<3.00	<3.00	<2.5	0.71	0.44	<2.5
Arsenic	µg/L	mg/kg	69	149	8.2	2.63	3.20	7.23	2.02	5.87	5.78	2.61	3.19	**8.35**	2.55	5.78	5.94
Beryllium	µg/L	mg/kg	N/A	N/A	N/A	<0.2	<0.2	1.23	<0.2	<0.2	0.90	<0.2	<0.2	1.20	<0.2	<0.2	1.06
Cadmium	µg/L	mg/kg	40	45.4	1.20	<1.00	<1.00	0.17	<1.00	<1.00	<0.10	<1.00	<1.00	0.19	<1.00	<1.00	<0.10
Chromium	µg/L	mg/kg	1,100	1,090	81.0	2.90	<1.00	27.8	<1.00	<1.00	22.5	0.49	<1.00	34.4	<1.00	<1.00	27.6
Copper	µg/L	mg/kg	4.8	13.5	34.0	1.08	1.28	13.2	1.14	1.05	12.7	1.60	1.88	18.5	1.08	1.03	17.5
Lead	µg/L	mg/kg	210	133	46.7	<1.00	<1.00	15.2	<1.00	<1.00	13.0	<1.00	<1.00	21.1	<1.00	<1.00	16.2
Mercury	µg/L	mg/kg	1.8	2.1	0.15	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Nickel	µg/L	mg/kg	74	118	20.9	<1.00	<1.00	12.9	<1.00	<1.00	4.62	<1.00	<1.00	6.85	<1.00	<1.00	5.64
Selenium	µg/L	mg/kg	290	564	N/A	0.69	1.90	0.14	1.04	0.76	0.14	1.60	1.40	0.14	1.03	1.50	0.17
Silver	µg/L	mg/kg	1.9	2.0	1.00	<1.00	<1.00	0.72	<1.00	<1.00	0.08	<1.00	<1.00	0.25	<1.00	<1.00	0.08
Thallium	µg/L	mg/kg	N/A	N/A	N/A	<1.00	<1.00	0.29	<1.00	<1.00	0.20	<1.00	<1.00	0.33	<1.00	<1.00	0.25
Zinc	µg/L	mg/kg	90	92.7	150	8.48	3.64	62.6	0.96	8.31	50.8	2.18	2.45	79.2	0.61	17.00	72.3
Bis(2-ethylhexyl) phthalate	µg/L	µg/kg	N/A	N/A	N/A	<3.00	<3.00	<50.0	<3.00	<3.00	<50.0	<3.00	<3.00	<50.0	<3.00	<3.00	<50.0
TOC	mg/L	%	N/A	N/A	N/A	2.68	3.15	1.03	3.23	3.76	0.90	2.82	4.06	0.71	2.85	4.08	0.95
Ammonia	mg/L	mg/kg	1.7	N/A	N/A	0.38	1.83	293	0.34	1.54	268	0.22	1.65	271	0.33	1.76	254

Chromium = CrIII and Total Cr

Var = varies based on pH, salinity, and temperatures

N/A means that no applicable value exists.

WQC = EPA Acute, Marine Water Quality Criterion; TWQS = Texas Acute, Marine Water Quality Standard; ERL = Effects Range Low.

µg/L = micrograms per liter

mg/kg = milligrams per kilogram

mm = millimeter

Table 3.4-3
Constituents Detected in Water and Elutriate Samples by Year*

Parameter	Year																									
	1987		1988		1989		1993		1995		1997		1998		1999		2000		2004		2005		2006		2008	
	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E
Antimony	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A							X	X
Arsenic												X	X	X	X	X			X	X	X	X	X	X	X	X
Barium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	X	X	X	X	X	X	X	X	X	X	N/A	N/A	N/A	N/A	NA	N/A	N/A	N/A
Cadmium			X	X					X	X	X		X	X	X		X	X					X	X		
Chromium								X			X		X	X									X	X	X	
Copper	X	X									X	X	X	X			X	X					X	X	X	X
Lead	X	X										X			X							X	X	X		
Mercury											X												X	X		
Nickel			X	X							X	X		X	X	X						X				
Selenium												X									X		X	X	X	X
Thallium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A					X			
Zinc	X	X	X	X			X	X			X	X	X	X	X	X	X	X	X	X		X		X	X	X
TOC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	X	X					X	X	X	X	X	X	X	X
Ammonia	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	X	X		X	X	X	X		X	X	X	X	X	X	X	X

* Channel Stations Only, PA and Reference samples are not included.

W = water, E = elutriate, N/A = analysis not conducted for that constituent.

Table 3.4-4

Parameters Determined by Chemical Analysis

METALS	
Antimony	Lead
Arsenic	Mercury
Beryllium	Nickel
Cadmium	Selenium
Chromium, Total	Silver
Chromium, Trivalent	Thallium
Chromium. Hexavalent	Zinc
Copper	
PESTICIDES AND PCBs	
Aldrin	Dieldrin
Alpha-BHC	Endosulfan I
Beta-BHC	Endosulfan II
Gamma-BHC (Lindane)	Endosulfan sulfate
Delta-BHC	Endrin
Chlordane	Endrin aldehyde
Alpha-Chlordane	Heptachlor
Gamma- Chlordane	Heptachlor epoxide
4,4'-DDD	Toxaphene
4,4'-DDE	Total PCBs
4,4'-DDT	
SEMIVOLATILES	
Acenaphthene	Dimethyl phthalate
Acenaphthylene	Di-n-butyl phthalate
Anthracene	2,4-Dinitrotoluene
Benzidine	2,6-Dinitrotoluene
Benzo(a)anthracene	Di-n-octyl phthalate
Benzo(a)pyrene	1,2-Diphenylhydrazine
Benzo(ghi)perylene	Fluoranthene
Benzo(b&k)fluoranthene	Fluorene
Bis(2-chloroethyloxy)methane	Hexachlorobenzene
Bis(2-chloroethyl)ether	Hexachlorobutadiene
Bis(2-chloroisoproply)ether	Hexachlorocyclopentadiene
Bis(2-ethylhexyl)phthalate	Hexachloroethane
4-Bromophenyl phenyl ether	Indeno(123-CD)pyrene
Butyl benzyl phthalate	Isophorone
4-chloro-3-methylphenol	2-Methyl-4,6-dinitrophenol
2-Chloronapthalene	Naphthalene
2-Chlorophenol	Nitrobenzene
4-Chlorophenyl phenyl ether	2-Nitrophenol
Chrysene	4-Nitrophenol
Dibenzo(ah)anthracene	N-nitrosodimethylamine
1,2-Dichlorobenzene	N-nitrosodi-n-propylamine
1,3-Dichlorobenzene	N-nitrosodiphenylamine
1,4-Dichlorobenzene	Phenanthrene
3,3'-Dichlorobenzidine	Phenol
2,4-Dichlorophenol	Pentachlorophenol
2,4-Dinitrophenol	Pryene
Diethyl phthalate	1,2,4-Trichlorobenzene
2,4-Dimethylphenol	2,4,6-Trichlorophenol
CONVENTIONAL PARAMETERS	
Ammonia	
Cyanide	Total Petroleum Hydrocarbons
Total Organic Carbon	% Solids*

* sediment only

constituents from the sediment into the water column and it may be informative to be able to compare elutriate results to sediment results. Also provided in Table 3.4-2, and other tables in this section, are the USACE channel stations, which can be compared to Figure 1.3-1 to determine station locations. Table 3.4-2 shows that, of the metals, beryllium and silver were not detected in water or elutriate samples. Of the 22 samples collected for water and elutriate testing in 2004, 2005, 2006, and 2008, antimony was found in only one water and one elutriate sample in 2008; thallium was found in only three water samples in 2006; nickel was found in four elutriate samples in 2005; chromium was found in one water and three elutriate samples in 2006 and two water samples in 2008; and lead was found in two elutriate samples in 2005 and two water samples and an elutriate sample in 2006. Copper and mercury were found in no samples in 2004 and 2005 but were found in all samples in 2006. Cadmium was not found in 2004 or 2005 but was found in all elutriates and all but one water sample in 2006. Selenium was also found in all 2006 and 2008 samples, and in all water samples in 2005. Zinc was in water samples only in 2004 and 2008 but was found in all elutriate samples in 2004, 2005, and 2008, and 6 of 10 elutriate samples in 2006. Arsenic was the only metal found in all water and elutriate samples in 2004, 2005, 2006, and 2008. Total Organic Carbon and ammonia were also found in all samples for all 4 years and bis(2-ethylhexyl)phthalate, while found in the sediments in 2006, was not detected in any water or elutriate sample. Table 3.4-3 shows the years in which the various constituents in Table 3.4-2 were detected in channel stations, and includes all years for which there are data. While PA and reference area samples are included in Table 3.4-2, they are not indicative of water quality in the project area and are not included in Table 3.4-3.

Only two definite trends are demonstrated by the data in Table 3.4-2. When detected, water concentrations of mercury are always higher than the elutriate concentrations, and ammonia is always higher in the elutriates. Selenium is generally quite a bit higher in the elutriates than in the water samples. Arsenic, copper, and zinc concentrations are generally, but not always, higher in the elutriate samples than in the water samples, but the differences are small.

None of the water or elutriate samples exceeded applicable WQC or TWQS, so there are no indications of water or elutriate problems in the Jetty and Outer Bar channels.

Additionally, water, elutriate, and sediment chemical analyses were conducted on new work samples from the Main (Inner) Channel by USACE in 1971, 1975, and 1976 (USACE, 1978), but the water and elutriate results are not reported here. Water samples were not filtered, as is required now, and water and elutriate concentrations were reported in mg/L (e.g., lead concentrations of 0.001 mg/L), indicating a high detection limit and accuracy that was insufficient for comparison to WQC and TWQS. However, after analysis of the data, including monitoring in both the channel and the Maintenance ODMDS during and after dredging and placement, the conclusion of USACE (1978), with concurrence of the other State and Federal resource agencies, was that there were no significant causes for concern relative to the construction material elutriates. Sediment data are discussed in Section 3.5.1.

Following EPA designation of the Maintenance and New Work ODMDSs (see Figure 1.3-1) in 1988 (EPA, 1989), USACE undertook extensive monitoring of the New Work ODMDS (Espey, Huston & Associates, Inc. [EH&A] now PBS&J, 1994). Testing included water, sediment, and elutriate chemistry and benthic community analyses. In general, the testing determined no significant impacts attributable to dredged material placement, either in the chemical analyses or benthic community structure and assemblages (EH&A, 1994).

3.4.3 Bioassays

One set of suspended particulate phase (SPP), or unfiltered elutriate, bioassays was conducted on samples collected from the Outer Bar and Jetty channels (PBS&J, 2004a) since 2002 (see Section 3.4.2), although before that time, numerous SPP bioassays were conducted and indicated no toxicity. The results of these tests are presented in Table 3.4-5. Results indicate that in all tests survival of organisms exposed to the SPP sediments from the Outer Bar and Jetty channels was above 90 percent. So, no 96-hour LC_{50} (that concentration of a substance that is lethal to 50 percent of test organisms after a continuous exposure time of 96 hours) could be calculated. Furthermore, there were no tests in which the survival in the Dilution Water Control was greater than survival in the channel treatments. Thus, pursuant to the RIA, no statistical analyses are required and the Limiting Permissible Concentration for the SPP is met. Therefore, these data indicate that no acute toxicity to water column organisms could be expected from dredging the Outer Bar and Jetty channels or placement of channel sediments.

3.4.4 Ballast Water

Ballast water is loaded on empty ships to provide weight and stability while traveling from one port to the next. There are thousands of marine species that can be carried from port to port in ballast water, which may ultimately result in the introduction of non-native or invasive aquatic species from foreign ports (Global Ballast Water Management Programme, 2006). Ballast water is the largest single vector for nonindigenous species transfer in the U.S. (EPA, 2001). EPA has compiled a list of invasive species that have been unintentionally introduced in Texas, although not necessarily through ballast water alone (EPA, 2001). TPWD has identified the invasive species that pose the greatest threat in Texas (Table 3.4-6). Over half of these are considered current management priorities by TPWD.

USCG, under the provisions of the National Invasive Species Act of 1996, has implemented mandatory ballast water management (BWM) protocols. All vessels, foreign and domestic, equipped with ballast water tanks that operate within U.S. waters are required to comply with the 33 CFR Part 151 management protocol. This includes conducting ballast water exchange at a minimum of 200 miles offshore and submitting a ballast water exchange report to the National Ballast Information Clearinghouse (NBIC) to ensure compliance with the management requirements (USCG, 2006).

Table 3.4-5
The Number and Percentages of Surviving Organisms
Suspended Particulate Phase Bioassays
100% Test Solution
May 2004

		Number of Survivors							
	Replicate	**Dilution Control**	**Reference Control**	**Dilution Control**	**FH-EC-01 60+00**	**Dilution Control**	**FH-EC-02 –45+00**	**Dilution Control**	**FH-EC-03 –150+00**
A. bahia	1	10	10	10	10	10	10	10	10
juveniles	2	10	10	10	10	10	10	10	10
10/replicate	3	10	10	10	10	10	10	9	10
	4	10	10	10	10	10	10	10	10
	5	10	10	10	10	10	10	10	10
	Average	10.0	10.0	10.0	10.0	10.0	10.0	9.8	10.0
	(%)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	98.0%	100.0%
A. bahia	1	10	10	10	10	10	10	10	10
adults	2	10	9	10	10	10	10	10	10
10/replicate	3	10	10	10	10	10	9	10	10
	4	10	10	10	10	10	10	10	10
	5	10	9	10	10	10	10	10	10
	Average	10.0	9.6	10.0	10.0	10.0	9.8	10.0	10.0
	(%)	100.0%	96.0%	100.0%	100.0%	100.0%	98.0%	100.0%	100.0%
M. beryllina	1	10	10	10	10	10	10	10	10
10/replicate	2	6	10	6	10	6	9	6	10
	3	10	10	10	10	10	10	10	10
	4	10	10	10	10	10	9	10	10
	5	10	10	10	9	10	10	10	9
	Average	9.2	10.0	9.2	9.8	9.2	9.6	9.2	9.8
	(%)	92.0%	100.0%	92.0%	98.0%	92.0%	96.0%	92.0%	98.0%

Table 3.4-6
Current and Potential Management Priorities of Invasive Aquatic Species in Texas

Scientific Name		Common Name	Texas
Shrimp Viruses			
	Taura Syndrome Virus	shrimp virus	ü
	White Spot Syndrome Virus	shrimp virus	ü
Coelenterates			
	Phyllorhiza punctata	spotted jellyfish	P
Roundworms (phylum Nematoda)			
	Anguillicola crassus	eel parasite	P
Mollusks			
	Corbicula fluminea	Asian clam	P
	Crassostrea gigas	Japanese (or Pacific giant) oyster	ü
	Dreissena polymorpha	zebra mussel	P
	Perna perna	brown mussel	P
	Pomacea canalicula	channeled applesnail	ü
Crustaceans			
	Carcinus maenas	green crab	P
	Charybdis helleri	marine swimming crab	P
	Eriocheri sinensis	Chinese mittencrab	P
Fishes			
	Cichlasoma cyanoguttatum	Rio Grande cichlid	ü
	Ctenopharyngodon idella	grass carp	ü
	Hypophthalmichthys molitrix	silver carp	P
	Hypophthalmichthys nobilis	bighead carp	P
	Mylopharyngodon piceus	black carp	P
	Oreochromis aureus	blue tilapia	ü
	Oreochromis mossambicua	Mozambique tilapia	ü
Mammals			
	Myocastor coypus	nutria	ü
Algae			
	Aureoumbra lagunensis	brown tide algae	ü*
Vascular Plants			
	Alternanthera philoxeroides	alligatorweed	ü
	Eichhornia crassipes	water hyacinth	ü
	Hydrilla verticillata	hydrilla	ü
	Ipomoea aquatica	waterspinach	P
	Lythrum salicaria	purple loosestrife	P
	Panicum repens	torpedograss	ü
	Pistia stratiotes	waterlettuce	ü
	Salvinia minima	common salvinia	ü
	Salvinia molesta	giant salvinia	ü
Semi-Aquatic Vascular Plants			
	Pueraria montana	kudzu	P
	Sapium sebiferum	Chinese tallow tree	ü

P = Potential TPWD management priority for Texas.
ü = Current TPWD management priority for Texas.
[*]Cryptogenic (a species whose status as indigenous or nonindigenous remains unresolved)

Source: EPA (2001).

According to the NBIC (2006) ballast water reporting database, between 2004 and 2006, 217 ballast water exchange reports were submitted for Freeport Harbor. Of these, 14 represented treated and 8 represented untreated discharges that occurred at Freeport. Treated discharges consisted of either flow-through (pumping seawater in to displace the tank contents) or empty/refill of ballast tanks.

3.5 SEDIMENT QUALITY

3.5.1 Surficial Sediments

There has been only one recent study that evaluated construction material, as part of the jetty stability analysis, which is pertinent to the project (PBS&J, 2005a). Soil samples were collected by Fugro (2005) to determine whether the soils presented a contamination “cause for concern.” Contaminants of concern are presented in Table 3.4-4. There are no sediment or soil quality criteria with which to compare concentrations in soils; however, several different guidelines are used to look for a cause for concern in sediment samples. One of these guidelines is the effects range low (ERL), which has been used in the past to examine both soils and sediments destined for beneficial use (BU) or ocean disposal in the Gulf.

It should be noted that while ERLs are used for comparative purposes, they were developed by assembling a large group of sediment data sets, comprising samples for which there was both bulk sediment chemistry and exhibition of toxicity. For each chemical in the data set, the concentrations were ranked in ascending order, and the ERL was calculated as the lower 10th percentile of the concentrations. However, this approach demonstrates no cause and effect from the chemicals in the data set, since the fact that a chemical was detected does not demonstrate that it was responsible for any of the toxicity exhibited by the sediment. Not surprisingly, when ERLs derived from sets of data from different areas are compared, the results are inconsistent (USACE, 1998). For example, when the ERLs of a number of chemicals were compared using a northern California data set versus a southern California data set, the ERLs differed by a range from only a factor of three for total polychlorinated biphenyls (PCBs) to a factor of 2,689 for p,p'dichlorodiphenyldichloroethylene, a breakdown product of the pesticide DDT (DDE). Since the ERLs are not based on cause and effect data, they exhibit low predictive ability and give a high number of false positives (USACE, 1998). Also used, on occasion, are the Effects Range Medium (ERM), similar to the ERLs but representing the median range of concentrations, and thus, higher concentrations. The ERLs (and the one ERM) used here are those presented in the NOAA 1999 Screening Quick Reference Tables (Buchman, 1999).

Data for detected compounds are presented in Table 3.5-1: a total of 10 samples taken from six borings (Figure 3.5-1). While seven borings were taken, as indicated on Figure 3.5-1, only six of these were submitted for chemical analysis. Arsenic, beryllium, total chromium, copper, lead, manganese, nickel, and zinc were detected in all samples. Thallium was detected in 6 of 10 samples, mercury in 2 samples.

Organic compound analyses were conducted including organic halides, volatile organic compounds (VOCs), semivolatile organic compounds, pesticides, and PCBs. Of these, fluoranthene was detected in only one sample.

There were six exceedances of ERLs, all by nickel, ranging from 23.8 milligrams per kilogram (mg/kg) (114 percent of the ERL) to 35.3 mg/kg (170 percent of the ERL). To determine whether these nickel levels are of concern, recent (since 2002) sediment zinc concentration and percent survival in solid phase (SP) bioassays of Entrance Channel sediment samples along the Texas coast were examined. This yielded 26 data points from six bioassays (PBS&J, 2004a, 2004b, 2004c, 2005b, 2007, 2008). Both average percent survival and lowest percent survival (indicating the most sensitive species) were compared to the nickel concentration in the bioassayed sediments. Correlation was poor. Using a linear equation, the Pearson r-value was 0.151 (R^2 = 0.023) for the average percent survival and 0.342 (R^2 = 0.117) for the lowest percent survival. The r-value was positive in both cases, indicating higher survival with increasing nickel concentration within the range of nickel concentrations found in the sediments. However, higher R^2 values were obtained for polynomial equations, with second- to fourth-order equations yielding R^2 values of 0.154 to 0.156 for nickel concentrations versus lowest percent survival and 0.050 to 0.052 for average percent survival. All polynomial equations indicated that, for the data available and ignoring all other potential contributing factors, an hormetic effect was demonstrated with an optimum nickel concentration of around 15 mg/kg, with percent survival declining at higher and lower nickel concentrations. Using a second-order polynomial equation, the concentration of nickel required to reduce survival to 50 percent is 41 mg/kg for the lowest percent survival curve and 76 mg/kg for the average percent survival curve. While these data demonstrate no more cause and effect relation than the ERL, they do indicate that the range of nickel concentrations determined for the soils is unlikely to cause significant toxicity to sensitive benthic organisms during bioassays conducted according to procedures provided in EPA/USACE (1991).

There would appear to be no significant cause for concern relative to placing these soils in the Gulf or using them beneficially because of the following reasons.

1. As noted above, there is no cause and effect built into the development of an ERL, so there is no way to determine whether nickel was the causative factor in the data that led to the nickel ERL;
2. toxicity data predict that nickel concentrations in the same range as the ERL did not cause toxicity;
3. the concentrations are less than a factor of two of the ERL;
4. the concentrations are below the ERM concentration (51.6 mg/kg) and well below the Apparent Effects Threshold values, of which 110.0 mg/kg (for echinoderm larvae) is the lowest value (Buchman, 1999);

Table 3.5-1
Concentrations of Detected Constituents in Soils (dry weight)
Freeport Harbor Channel Improvement Project

Date Sampled: February 2005

Parameter	**Units**	**NOAA ERL***	**B-1,E,26' 0211038**	**B-2,E-1,24' 0211039**	**B-2,E-2,46' 0211040**	**B-3,E-1,26' 0211041**	**B-3,E-2,35' 0211042**	**B-4,E-1,35' 0211043**	**B-4,E-2,40' 0211044**	**B-5,E-1,34' 0211045**	**B-5,E-2,59' 0211046**	**B-6,E-2,32-34' 0211047**
Arsenic	mg/kg	8.2	2.7	2.4	1.4	0.700	8.2	2.0	4.1	0.600	2.0	1.6
Beryllium	mg/kg	N/A	1.15	1.18	1.46	0.274	1.46	0.743	1.16	0.142	0.983	0.433
Chromium, Total	mg/kg	81.0	28.1	46.0	59.9	7.8	46.8	15.3	23.2	4.1	20.2	9.9
Copper	mg/kg	34.0	25.8	19.1	19.9	3.6	26.1	10.1	19.5	1.6	12.2	4.6
Lead	mg/kg	46.7	14.9	27.6	29.9	5.1	39.9	7.0	15.6	2.8	10.7	6.8
Manganese	mg/kg	N/A	257.7	184.7	214.1	130.2	723.2	157.2	489.6	85.2	290.1	311.9
Mercury	mg/kg	0.150	< 0.00794	< 0.00664	< 0.00663	< 0.00613	< 0.00647	< 0.00597	< 0.00647	< 0.00602	0.0111	0.0129
Nickel	mg/kg	20.9	**30.2**	**26.8**	**33.3**	6.0	**35.3**	17.6	**29.8**	3.3	**23.8**	10.6
Thallium	mg/kg	N/A	0.294	0.284	0.340	< 0.190	0.324	< 0.195	0.285	< 0.176	0.214	< 0.193
Zinc	mg/kg	150	61.7	63.1	73.5	38.0	64.5	34.8	58.9	10.5	50.4	40.6
Fluoranthene	ug/kg	600	< 635	< 531	< 265	534	< 259	< 239	< 259	< 241	< 237	< 259
Percent Solids	%	N/A	63.0	75.3	75.4	81.5	77.3	83.8	77.3	83.0	84.5	77.1

ERL = Effects Range Low for Marine Sediments. There are no ERLs for soils.
Bold indicates exceedance of an ERL.

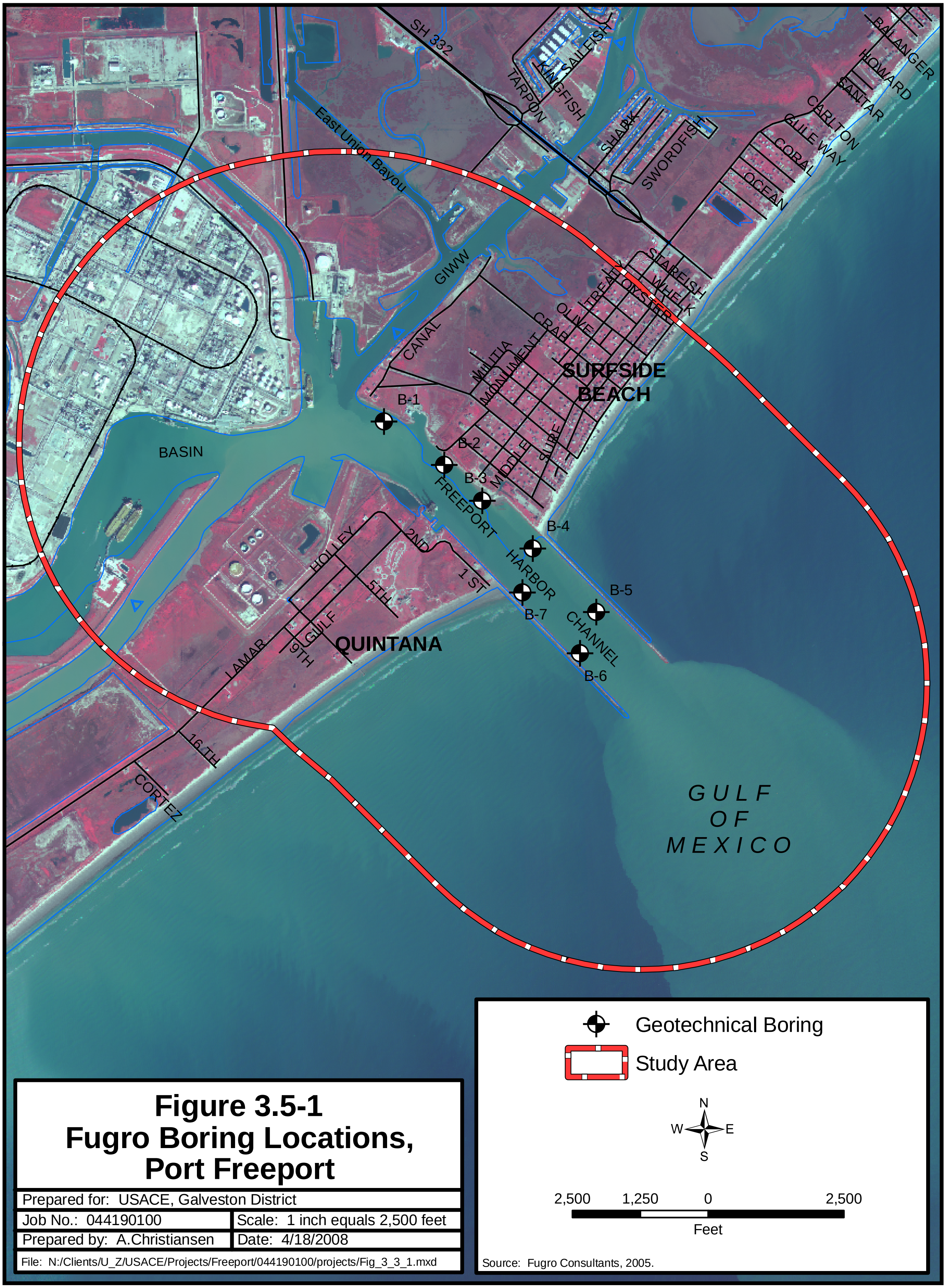


Figure 3.5-1
Fugro Boring Locations,
Port Freeport

Prepared for: USACE, Galveston District	
Job No.: 044190100	Scale: 1 inch equals 2,500 feet
Prepared by: A.Christiansen	Date: 4/18/2008
File: N:/Clients/U_Z/USACE/Projects/Freeport/044190100/projects/Fig_3_3_1.mxd	

5. there are no Action Levels established by the Food and Drug Administration for poisonous or deleterious substances in human food and animal feed (which includes fish and shellfish) for nickel; and
6. no other ERLs were exceeded.

Data for construction material taken by USACE in 1975 and 1976 for core samples collected from the downstream edge of the Stauffer Channel (Station C2), the Channel to Upper Turning Basin (Station C3), the Channel to Brazosport Turning Basin (Station C4), and the upstream end of Jetty Channel (Station C9) are presented in Table 3.5-2 and compared to the ERLs. It should be noted that techniques and detection limits were not as stringent in the 1970s as they are today and that collection devices and techniques were not as "clean" as they are at present. However, these data are presently the only data available for the construction material from the Main (Inner) Channel.

As an examination of Table 3.5-2 will show, the ERL for arsenic was slightly exceeded in 1976, but not in 1975 at Station C3. The cadmium ERL was exceeded in 1975 at stations C2 and C9. However, 1976 values were a fraction of the 1975 values, and none exceeded the cadmium ERL. Additionally, Station C9 is very near Fugro boring Station B-2 (Fugro, 2005; PBS&J, 2005a), and cadmium was not detected in the samples from Station B-2. The nickel ERL was exceeded at Station C3 in 1975 and 1976 and at Station C4 in 1976. However, the discussion above concerning the nickel ERL applies to these data as well. Therefore, these data provide a preliminary assurance that no cause for concern is indicated for the construction material from the inner portions of the Freeport Ship Channel, including the Stauffer Channel. However, during the Preconstruction, Engineering, and Design (PED) phase of the project, USACE plans additional sampling of construction material from both the Stauffer Channel and from the extension of the Outer Bar Channel.

USACE conducted monitoring of the ocean placement of construction material from dredging of the Outer Bar and Jetty channels for the 45-foot Project (USACE, 1978). No water column, sediment, or benthos problems were noted.

3.5.2 Maintenance Material

3.5.2.1 Chemistry

Only data since 2002 are presented and analyzed for this EIS (see Section 3.4.2) to determine the sediment quality of the project area. The data presented here are from bulk sediment analyses, which tend to show considerable variation, even within duplicates. The data from reference and PA sites are not included in this analysis because those sediments will not be part of the maintenance material from the improved channel. Like the construction material discussed above, the sediment data are compared to ERLs.

Table 3.5-2
Concentrations of Detected Constituents in Soils (dry weight)
Freeport Harbor Channel Improvement Project

Parameter	**Units**	**NOAA ERL***	**C2 3/10/75 ~190+00**	**C3 3/12/75 ~130+00**	**C4 4/3/75 ~100+00**	**C9 3/5/75 ~60+00**	**C2 5/21/76 ~190+00**	**C3 5/21/76 ~130+00**	**C4 5/21/76 ~100+00**	**C9 6/15/76 ~60+00**
Arsenic	mg/kg	8.2	5.8	< 1.0	4.2	2.9	2.3	**9.1**	7.7	3.9
Cadmium	mg/kg	1.2	**3.0**	< 1.0	< 1.0	**4.0**	0.31	0.79	0.49	0.69
Chromium, Total	mg/kg	81.0	N/A	N/A	N/A	N/A	14	16	23	10
Copper	mg/kg	34.0	12	3.0	7.0	8.0	5.6	13	9.3	8.6
Lead	mg/kg	46.7	27	10	18	34	12	20	19	12
Mercury	mg/kg	0.150	< 0.2	< 0.2	< 0.2	< 0.2	< 0.1	< 0.1	< 0.1	< 0.1
Nickel	mg/kg	20.9	20	**50**	14	17	11	**25**	**22**	15
Selenium	mg/kg	N/A	N/A	N/A	N/A	N/A	0.23	0.23	< 0.10	< 0.10
Zinc	mg/kg	150	56	22	40	38	18	40	51	26
Percent Solids	%	N/A	81.4	79.2	75.7	83.4	80	74	73	75

ERL = Effects Range Low for Marine Sediments.
Bold indicates exceedance of an ERL.

The sediment chemistry data are presented in Table 3.4-2 for the same time period and the same stations as for the water and elutriate samples. PA stations and Reference station data are included in Table 3.4-2 for comparison purposes. Exceedances of ERLs are bolded in Table 3.4-2. Table 3.5-3 shows the years in which the various constituents in Table 3.4-4 were detected, but only in channel station sediments.

In 2004, the ERL for arsenic was slightly exceeded (8.63 and 9.15 mg/kg versus the ERL of 8.2 mg/kg) at one Entrance Channel station and its duplicate. There was one exceedance of the arsenic ERL in 2005 (8.61 mg/kg versus 8.2 mg/kg) at an Entrance Channel station. The arsenic ERL was exceeded in 2006 at three stations in the Entrance Channel (8.57 mg/kg–9.45 mg/kg) and also at the Reference Station (8.90 mg/kg) versus an ERL of 8.2 mg/kg. In 2008, there was one exceedance at a station in the Main Channel (8.35 mg/kg). Because of the lack of cause and effect in the generation of the ERL, this is not necessarily indicative of a cause for concern. As noted in Section 3.4.3, water column bioassays prepared with these sediments indicated no toxicity. The following sections deal with benthic bioassays and bioaccumulation studies with these sediments.

3.5.2.2 Bioassays

Table 3.5-4 presents the data for SP, or whole mud, bioassays with Outer Bar and Jetty Channel sediments conducted for the EPA or USACE from 2003, 2004, and 2005 (Battelle, 2004; PBS&J, 2004a, 2005b). These bioassays were conducted according to protocols in EPA/USACE (1991) and the RIA. Only data since 2002 are presented here (see Section 3.4.2), but numerous SP bioassays were conducted prior to 2002 with no exhibition of toxicity.

Survival in the SP bioassays conducted with the amphipod *Leptocheirus plumulosus* on samples collected in April 2004 was acceptable, and survival in the Reference Control was not at least 10 percent greater than survival in the treatments. However, survival of the opossum shrimp, *Americamysis bahia*, was poor, especially in the Reference Control. While the tests theoretically passed the requirements of the RIA, the results were not typical, and the SP bioassays with *A. bahia* were repeated in 2005. As can be seen from Table 3.5-4, survival was good for all test groups. Survival was also nearly equal in all tests, confirming the conclusions drawn from the SP bioassay with the April 2004 samples that there is no indication of a cause for concern from the ocean placement of the maintenance material from Outer Bar and Jetty channels.

Solid phase bioassays using the amphipod *Ampelisca abdita* were also conducted for EPA in 2003 (Battelle, 2004). The data reported in Battelle (2004) are also included in Table 3.5-4. These bioassays were on composite sediment samples from the four quadrants of the Maintenance ODMDS, from a reference area roughly 2 miles up-current from the Maintenance ODMDS, from an area roughly 750 feet down-current of the down-current edge of the Maintenance ODMDS, and two laboratory controls. Survival ranged from 77 to 89 percent.

Table 3.5-3
Constituents Detected in Sediment Samples by Year*

Parameter	1987	1988	1989	1993	1995	Jan-97	Sep-97	Mar-98	Jul-98	1999	2000	2004	2005	2006	2008
Arsenic	X	X					X	X	X	X	X	X	X	X	X
Barium	N/A	N/A	N/A	N/A	X	X	X	X	X	X	X	N/A	N/A	N/A	N/A
Beryllium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				X
Cadmium				X	X			X						X	X
Chromium	X	X	X	X	X	X		X	X	X	X	X	X	X	X
Copper	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Lead	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Mercury					X		X		X	X	X				
Nickel	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Selenium					X						X			X	X
Silver	N/A	N/A	N/A	N/A				X			X				
Thallium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	X	X	X	X
Zinc	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bis(2-ethylhexyl) phthalate	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A			X	
TOC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	X	X	X	X	X	X	X	X
Total PCB					X										
Ammonia	N/A	N/A	N/A	N/A	N/A	X	X	N/A	X	X	X	X	X	X	X

* Channel Stations Only, PA and Reference samples are not included.

Table 3.5-4
The Number and Percentages of Surviving Organisms
10-Day Solid Phase Bioassays
Freeport Harbor Jetty and Entrance Channels

2004

		Number of Survivors				
	Replicate (n=5)	**True Control**	**Reference Control**	**FH-EC-01 60+00**	**FH-EC-02 –45+00**	**FH-EC-03 –150+00**
10-DAY	1	20	19	19	20	20
L. plumulosis	2	20	15	18	12	19
20/replicate	3	20	19	19	20	20
	4	20	19	18	9	18
	5	20	15	15	16	8
	Average	20.0	17.4	17.8	15.4	17.0
	(%)	100.0%	87.0%	89.0%	77.0%	85.0%
A. bahia	1	20	6	19	18	20
20/replicate	2	20	16	20	15	17
	3	18	3	19	19	10
	4	19	0	18	7	17
	5	18	12	15	8	15
	Average	19.0	7.4	18.2	13.4	15.8
	(%)	95.0%	37.0%	91.0%	67.0%	79.0%
Total Organisms	1	40	25	38	38	40
30/replicate	2	40	31	38	27	36
	3	38	22	38	39	30
	4	39	19	36	16	35
	5	38	27	30	24	23
	Average	39.0	24.8	36.0	28.8	32.8
	(%)	97.5%	62.0%	90.0%	72.0%	82.0%

2005

		Number of Survivors				
	Replicate (n=5)	**True Control**	**Reference Control**	**FH-EC-05-01 60+00**	**FH-EC-05-02 –45+00**	**FH-EC-05-03 –150+00**
10-DAY	1	19	15	17	18	17
A. bahia	2	19	18	17	13	20
20/replicate	3	19	18	15	17	17
	4	20	20	17	20	20
	5	19	18	20	18	19
	Average	19.2	17.8	17.2	17.2	18.6
	(%)	96.0%	89.0%	86.0%	86.0%	93.0%

Table 3.5-4 (Concluded)
Freeport ODMDS

2003

	Replicate (n=5)	Number of Survivors True Control	Reference	Q1 NW Quadrant	Q2 NE Quadrant
10-DAY	A	15	17	15	17
A. abdita	B	19	17	18	13
20/replicate	C	17	18	13	18
	D	17	18	17	19
	E	18	17	14	18
	Average	17.2	17.4	15.4	17.0
	(%)	86.0%	87.0%	77.0%	85.0%

	Replicate (n=5)	Number of Survivors Q3 SE Quadrant	Q4 SW Quadrant	Down Current	LA-5 Control
10-DAY	A	17	18	16	16
A. abdita	B	16	18	17	16
20/replicate	C	17	16	20	13
	D	19	18	18	18
	E	16	19	18	18
	Average	17.0	17.8	17.8	16.2
	(%)	85.0%	89.0%	89.0%	81.0%

There were no tests in which survival in the Reference Control was greater than survival in the treatments and the difference exceeded 10 percent, requiring statistical analysis.

3.5.2.3 Bioaccumulation Studies

Bioaccumulation studies were also conducted on samples of the maintenance material for USACE (PBS&J, 2004a) and from the Battelle (2004) stations previously noted for the SP bioassays (Table 3.5-5).

Although these data are the only ones included in this EIS (see Section 3.4.3), bioaccumulation studies were conducted numerous times prior to 2002 with similar results. In 2004, the organic chemical bis(2-ethylhexyl)phthalate was found above detection limits in test organism tissues. Of the metals, arsenic, chromium, copper, lead, nickel, selenium, and zinc were found in tissue samples above detection limits. Concentrations of none of the constituents in tissues of *N. virens* or *M. mercenaria* exposed to test sediments were significantly higher than the respective concentrations in Reference Control organisms (PBS&J, 2004a).

The Battelle bioaccumulation studies, using *M. nasuta*, were on the composite sediment samples from the four quadrants of the Maintenance ODMDS, the reference area, the down-current station, and three laboratory controls. Samples were also taken from clams that were not tested (archive samples). In general, all of the values were approximately the same for individual constituents, although the archive tissue tended to have the highest numerical values. “There were no environmentally noteworthy elevations of” metals or organic compounds “in tissues exposed to sediments from the active discharge quadrants (Q1 and Q2), the inactive quadrants (Q3 and Q4), the Down Current site, or the Reference site” (Battelle, 2004).

3.6 AIR QUALITY

The following sections discuss the applicable regulatory framework and existing ambient air quality within the study area. Due to the regional nature of air quality, although the project occurs only in Brazoria County, the air quality study area analysis consists of the Houston-Galveston-Brazoria (HGB) Consolidated Metropolitan Statistical Area. The air quality analysis study area consists of this larger area because it is the unit at which EPA evaluates air quality.

3.6.1 Regulatory Context

3.6.1.1 National Ambient Air Quality Standards

The Clean Air Act (CAA), which was last amended in 1990, regulates air emissions from area, stationary, and mobile sources. The CAA requires EPA to establish National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment. The CAA establishes two types of national air quality standards. Primary standards

Table 3.5-5
Average Concentrations of Detected Compounds
in Tissue Samples of
Freeport Harbor Entrance Channel

***N. virens* 2004**

	STATION				
Parameter	**True Control**	**Reference Control**	**FH-EC-01 60+00**	**FH-EC-02 -45+00**	**FH-EC-03 -150+00**
Metals (mg/kg)					
Arsenic	3.41	2.39	2.39	2.38	2.50
Chromium	0.13	0.08	0.10	0.10	0.10
Copper	1.28	1.23	1.36	1.25	1.30
Lead	0.11	0.11	0.12	0.11	0.13
Mercury	0.03	0.03	0.03	0.03	0.02
Nickel	0.32	0.28	0.27	0.24	0.26
Selenium	0.26	0.25	0.25	0.23	0.24
Zinc	12.80	9.13	10.40	13.00	8.90
Bis (2-ethylhexyl) phthalate	67.50	73.00	76.60	85.10	100.00

***M. mercenaria* 2004**

	STATION				
Parameter	**True Control**	**Reference Control**	**FH-EC-01 60+00**	**FH-EC-02 -45+00**	**FH-EC-03 -150+00**
Metals (mg/kg)					
Arsenic	1.99	1.98	1.51	2.03	1.89
Chromium	0.12	0.09	0.09	0.05	0.08
Copper	1.09	0.98	1.00	1.14	1.20
Nickel	0.39	0.41	0.32	0.37	0.42
Selenium	0.18	0.20	0.15	0.18	0.15
Silver	0.08	0.07	0.07	0.08	0.08
Thallium	0.09	0.10	0.10	0.10	0.10
Zinc	9.19	9.05	8.51	9.27	8.79
Bis (2-ethylhexyl) phthalate	61.60	65.70	58.70	76.10	74.00

Table 3.5-5 (Concluded)

***M. nasuta* 2003**

Parameter	STATION				
	Control A	**Control B**	**Control C**	**Reference**	**Archive**
Metals (mg/kg)					
Arsenic	1.83	2.15	2.20	1.77	1.73
Cadmium	0.02	0.03	0.03	0.02	0.03
Chromium	0.17	0.43	0.41	0.20	0.08
Copper	0.90	1.25	1.22	0.95	1.65
Lead	0.11	0.13	0.16	0.18	0.12
Nickel	0.32	0.49	0.64	0.39	0.32
Selenium	0.15	0.12	0.17	nd	0.17
Silver	0.02	0.02	0.03	0.02	0.03
Zinc	6.07	6.95	9.02	6.73	9.60
Low Molecular Wt PAH	0.94	1.34	1.34	0.62	2.84
High Molecular Wt PAH	1.49	1.50	2.41	1.00	6.59
Total PAH	2.43	2.84	3.75	1.62	9.43
Total DDT	0.08	0.12	0.22	0.06	0.09

Parameter	STATION				
	Q1 NW Quadrant	**Q2 NE Quadrant**	**Q3 SE Quadrant**	**Q4 SW Quadrant**	**Down Current**
Metals (mg/kg)					
Arsenic	1.94	1.87	2.19	2.03	2.13
Cadmium	0.02	0.02	0.02	0.02	0.04
Chromium	0.18	0.25	0.30	0.24	0.23
Copper	1.19	1.22	1.09	1.14	1.24
Lead	0.20	0.20	0.28	0.19	0.22
Nickel	0.30	0.36	0.46	0.38	0.40
Selenium	0.17	0.24	0.14	0.17	0.14
Silver	0.03	0.02	0.03	0.02	0.03
Zinc	6.90	7.10	8.62	7.33	8.41
Low Molecular Wt PAH	2.27	0.99	0.87	0.70	0.72
High Molecular Wt PAH	2.35	1.53	1.57	1.52	1.64
Total PAH	4.62	2.52	2.44	2.22	2.36
Total DDT	0.10	0.11	0.09	0.10	0.11

define the maximum levels of air quality that EPA judges necessary, with an adequate margin of safety, to protect public health, including the health of “sensitive” populations such as asthmatics, children, and the elderly. Secondary standards define the maximum levels of air quality that EPA judges necessary to protect public welfare, including protection against decreased visibility, and damage to animals, crops, vegetation, and buildings. Air quality is generally considered acceptable if pollutant levels are less than or equal to these established standards on a continuing basis.

EPA has set NAAQS for seven principal pollutants, called “criteria” pollutants. They are carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), lead (Pb), inhalable particulate matter with an aerodynamic diameter less than or equal to a nominal 10 microns (PM_{10}), fine particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 microns ($PM_{2.5}$), and sulfur dioxide (SO_2). The NAAQS are further defined in 40 CFR Part 50.

CO is a colorless and practically odorless gas primarily formed when carbon in fuels is not burned completely. Transportation activities, indoor heating, industrial processes, and open burning are among the anthropogenic (man-made) sources of CO.

NO_2, nitric oxide (NO), and other oxides of nitrogen are collectively called nitrous oxides (NO_X). These species are interrelated, often changing from one form to another in chemical reactions. NO_2 is the species commonly measured in ambient air monitors. NO_X are generally emitted in the form of NO, which is oxidized to NO_2. The principal anthropogenic sources of NO_X are fuel combustion in motor vehicles and stationary sources such as boilers and power plants. Reactions of NO_X with other atmospheric chemicals can lead to the formation of O_3.

Ground-level O_3 is a secondary pollutant, formed from daytime reactions of NO_X and VOCs rather than being directly emitted by natural and anthropogenic sources. VOCs, which have no NAAQS, are released in industrial processes and from evaporation of organic liquids such as gasoline and solvents. O_3 contributes to the formation of photochemical smog.

Pb is a heavy metal that may be present as dust or as a fume. Dominant industrial sources of Pb emissions include waste oil and solid waste incineration, iron and steel production, lead smelting, and battery and lead alkyl manufacturing. The lead content of motor vehicle emissions, which was the major source of lead in the past, has significantly declined with the widespread use of unleaded fuel.

The NAAQS for particulate matter are based on two different particle-diameter sizes: PM_{10} and $PM_{2.5}$. PM_{10} are small particles that are likely to reach the lower regions of the respiratory tract by inhalation. $PM_{2.5}$ is considered to be in the respirable range, meaning these particles can reach the alveolar region of the lungs and penetrate deeper than PM_{10}. There are many sources of particulate matter, both natural and anthropogenic, including dust from natural wind erosion of soil, construction activities, industrial activities, and combustion of fuels.

SO_2 is a colorless gas with a sharp, pungent odor. SO_2 is emitted in natural processes, such as volcanic activity, and by anthropogenic sources such as combustion of fuels containing sulfur and the manufacture of sulfuric acid.

The CAA also requires the results of the ambient air quality monitoring data be used by EPA to assign a designation to each area of the U.S. regarding compliance with the NAAQS. EPA categorizes the level of compliance or noncompliance with each criteria pollutant as follows:

- Attainment – area currently meets the NAAQS
- Maintenance – area currently meets the NAAQS, but has previously been out of compliance
- Nonattainment – area currently does not meet the NAAQS

Ozone nonattainment areas are further classified as extreme, severe, serious, moderate, or marginal depending on the severity of nonattainment.

Under the CAA, individual states were required to develop a State Implementation Plan (SIP) to define the strategies for assessing and maintaining the NAAQS. TCEQ has the responsibility for developing the SIP with approval by EPA. For areas that are in nonattainment with the NAAQS, the SIP describes how the area will reach attainment of the air quality standards. The SIP sets emissions budgets for point sources such as power plants and manufacturers, areawide sources such as dry cleaners and paint shops, off-road mobile sources such as boats and lawn mowers, and on-road sources such as cars, trucks, and motorcycles.

The project area is in the HGB Intrastate Air Quality Control Region (EPA, 2007a). The HGB is in attainment or unclassified with the NAAQS for all criteria pollutants except ozone. It is classified as a "severe" nonattainment area with respect to the 1-hour and the 8-hour NAAQS for ozone. Under the "severe" attainment designation, the HGB has a deadline of June 15, 2019, for attainment of the 8-hour ozone standard. The 1-hour attainment reclassification is still pending (*Federal Register* Vol. 73, No. 191).

The topography and meteorology of the study area should not seriously restrict dispersion of airborne pollutants. However, ground-level ozone is typically formed during periods of high solar radiation, low wind speeds, and elevated temperatures. There is a significant amount of variability year to year in regional ozone levels. This year-to-year variability is generally considered to be the result of the important role that weather conditions play in ozone formation.

In the HGB area, as in many other coastal communities, a "sea breeze-land breeze" effect is caused by temperature differences between the land and the Gulf. This effect moves air from the land out over the Gulf during the night, and moves it back in as temperatures rise the following day, i.e., recirculating polluted air. During the years when there are high numbers of sunny days combined with either stagnant wind conditions or winds that blow out into the Gulf in the morning and then back onto land in the afternoon, the eight-county area sees higher ozone levels. Varying wind patterns and time required for ozone to form can also result in high concentrations of ozone at locations remote from pollution sources.

3.6.1.2 Conformity of Federal Actions

As required by the CAA, EPA has also promulgated rules to ensure that Federal actions conform to the appropriate SIP. Two rules were promulgated: (1) the Transportation Conformity Rule (40 CFR Part 93); and (2) the General Conformity Rule (40 CFR 51, Subpart W). The Transportation Conformity Rule applies to Federal Highway Administration (FHWA)/Federal Transit Authority projects within maintenance or nonattainment areas. The General Conformity Rule applies to Federal actions, except FHWA and Transit Authority actions, within maintenance or nonattainment areas.

The CAA prohibits Federal agencies from funding, permitting, constructing, or licensing any project that does not conform to an applicable SIP. The purpose of this General Conformity requirement is to guarantee that Federal agencies consult with State and local air quality districts to assure these regulatory entities know about the expected impacts of the Federal action and can include expected emissions in their SIP emissions budget.

Because the project is located in the HGB severe nonattainment area for ozone, if the total emissions from the project are equal to or greater than 25 tpy of VOC or 25 tpy of NO_X, then USACE must issue a General Conformity Determination stating how the project conforms or will conform with the SIP for that pollutant, prior to approval for the project. However, even if the emissions of NO_X or VOCs are below these levels, a conformity determination may also be required if the increase in emissions due to the project would equal or exceed 10 percent of the total emissions of those pollutants for the entire nonattainment area (i.e., the project is considered a regionally significant action).

Because project emissions are expected to exceed 25 tpy for $NO_{X,}$ a draft General Conformity Determination was prepared by USACE (Appendix C). The determination takes into account estimated project emissions and whether or not those emissions conform to the SIP. The General Conformity Determination was submitted to EPA and TCEQ for review concurrent with the Draft Environmental Impact Statement (DEIS) in December 2010. The results of this coordination are reported in EIS Section 4.4.

3.6.1.3 Greenhouse Gas Emissions and Climate Change

Air emissions from the project will result from the operation of dredges, tugboats, and land-side construction equipment powered by internal combustion engines that produce exhaust emissions. Emissions from this equipment will result in an increase in Greenhouse Gas (GHG) emissions that could contribute to global climate change. To date, specific thresholds to evaluate adverse impacts pertaining to GHG emissions have not been established by local decision-making agencies, the State, or the Federal government. The Council on Environmental Quality (CEQ) has published “Draft NEPA Guidance on Consideration of the Effects of Climate Change and Greenhouse Gas Emissions,” February 10, 2010. The Draft Guidance suggests that the impacts of projects directly emitting GHGs in excess of 25,000 metric tons or more of carbon dioxide (CO_2)-equivalent (CO_2e) GHG emissions on an annual basis be considered in a qualitative and quantitative manner. However, the guidance stresses that, given the nature of GHGs and their persistence in the atmosphere, climate change impacts should be considered on a cumulative level. Appendix N presents a project-level analysis of GHG emissions.

3.6.2 Air Quality Baseline Condition

Ambient air quality in the project area is directly related to emissions from man-made sources such as from stationary sources (stacks, vents, etc.); emissions from mobile sources such as vehicles, ships, trains, etc.; chemical reactions in the atmosphere such as the formation of ozone; and natural sources such as trees, fires, and wind-blown dust. Since all of these sources must be considered in an assessment of air quality, EPA has identified air emissions inventories and ambient air monitoring as key methods for assessing air quality.

3.6.2.1 Existing Air Emissions Inventory

Baseline emissions were determined using data from EPA’s emissions inventory database (EPA, 2009). Table 3.6-1 is a summary of emissions for Brazoria County for 2002, the most recent data available from EPA’s database. For comparison, the total emissions inventory for the HGB air quality region is also provided. The emissions information for each pollutant is broken out by category: area source, point source, highway, and off-highway emissions. These data provide a base from which to compare the proposed project emissions.

3.6.2.2 Existing Air-monitoring Data

Air pollutants within and near the project area are measured by numerous air-monitoring stations. Most of the stations in the region measure the concentrations of criteria air pollutants, as well as temperature, wind velocity, wind direction, and other meteorological parameters. The monitors operate continuously and are routinely calibrated and maintained to assure quality data. Current monitoring data are available for CO, NO_2, O_3, SO_2, $PM_{2.5}$, PM_{10}, and Pb. Monitoring for other criteria pollutants has either been discontinued or data are not available.

Review of available monitoring data for the HGB for the years 1997–2007 (EPA, 2007c) shows a decreasing trend over the years for CO, $PM_{2.5}$, and SO_2. Monitored values for ozone also appear to be declining, probably as a result of increased regulations to meet the NAAQS for ozone. Concentrations of PM_{10} appear to have increased over the years. Monitored values for NO_2 and Pb show little variability over the past few years.

Table 3.6-1
Summary of 2002 Air Emissions Inventory for Brazoria County Compared to the HGB by Source Category (tpy)

Source Category	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC
Brazoria County						
Area	7,355	2,114	38,241	4,581	1,441	4,655
Point	5,974	20,851	898	826	4,705	6,111
Highway Vehicle	29,211	4,183	115	80	137	2,349
Off-Highway Vehicles	17,277	16,980	1,109	1,028	4,911	2,727
Total	59,817	44,128	40,363	6,515	11,194	15,842
HGB						
Area	57,739	20,587	301,949	38,726	22,219	82,371
Point	54,451	111,280	12,635	11,008	106,166	47,441
Highway Vehicle	615,263	96,492	2,647	1,830	3,143	49,826
Off-Highway Vehicles	374,240	128,993	8,123	7,591	20,490	34,490
Total	1,101,693	357,353	325,353	59,155	152,017	214,128
Brazoria County as a Percent of HGB Emission Source Categories, %						
Area	12.7	10.3	12.7	11.8	6.5	5.7
Point	11.0	18.7	7.1	7.5	4.4	12.9
Highway Vehicle	4.7	4.3	4.3	4.4	4.4	4.7
Off-Highway Vehicles	4.6	13.2	13.7	13.5	24.0	7.9
Total	5.4	12.3	12.4	11.0	7.4	7.4

Source: EPA (2009)

A “design value” is used by EPA to determine the correct designation of an ozone nonattainment area. Air quality data are collected at each monitoring site in the HGB nonattainment area and used to calculate the design value. For compliance with the ozone 1-hour and 8-hour standards, NAAQS will be met (i.e., the site is said to be in attainment) when the design value is less than or equal to 0.12 parts per million (ppm) and 0.08 ppm, respectively. Both the 1-hour and 8-hour ozone monitored values have decreased over the past 18 years. The 2009 1-hour ozone design value was 0.127 ppm, representing a 42 percent decrease from the value for 1991 of 0.220 ppm. The 2009 8-hour ozone design value was 0.084 ppm, a 29 percent decrease from the 1991 value of 0.119 ppm (TCEQ, 2010a).

As previously noted, a General Conformity Determination has been prepared by USACE (see Appendix C). Coordination with EPA and TCEQ was conducted to ensure the project is compliant with the SIP.

3.7 NOISE

3.7.1 Fundamentals and Terminology

The magnitude of noise is usually described by its sound pressure. Since the range of sound pressure varies greatly, a logarithmic scale is used to relate sound pressures to some common reference level, usually in decibels (dB). Sound pressures described in decibels are called sound pressure levels and are often defined in terms of frequency-weighted scales (A, B, C, or D).

The A-weighted scale is used almost exclusively in environmental noise measurements because it places most emphasis on the frequency range detected by the human ear (1,000–6,000 hertz). Sound levels measured using A-weighting are often expressed as dBA. Throughout this section, references are made to dBA, which means an A-weighted decibel level. Common sound/noise levels that an individual may encounter daily are listed in Table 3.7-1. Noise levels associated with the dredging equipment that may be used for this project are also included in this table for reference.

In accordance with standard practice, noise levels in this document are discussed in terms of the equivalent sound level (L_{eq}) and the day-night sound level (L_{dn}). Typical noise environments consist of numerous noise sources that vary and fluctuate over time. L_{eq} provides a way to describe the average sound level, in decibels, for any given time period under consideration. L_{dn} is the 24-hour average sound level obtained after the addition of a 10 dB penalty for sound levels that occur during nighttime hours (10:00 P.M. to 7:00 A.M.) in order to account for heightened sensitivity to noise during that period. Federal agencies, including EPA, Department of Defense, and Department of Housing and Urban Development, have adopted this descriptor in assessing environmental impacts. Regulatory agencies generally recognize an L_{dn} of 55 dBA as a goal for the outdoor noise environment in residential areas. Studies have found that outdoor noise environments across the United States range from approximately 40 L_{dn} in rural residential areas, to nearly 60 L_{dn} in older urban residential areas, to as much as 90 L_{dn} in congested urban settings (EPA, 1974).

Sound pressure levels of two separate sources are not directly additive. Therefore, as shown in Table 3.7-2, if a sound of 60 dBA is added to another sound of 60 dBA, the resulting noise level is 63 dBA, not 120 dBA. For example, if the noise level of a hopper dredge is measured at 85 dBA at 50 feet, and the noise level of a tug boat is measured at 82 dBA at 50 feet, the combined noise level of both would be approximately 87 dBA at 50 feet.

Table 3.7-1
Hearing: Sounds that Bombard Us Daily

Decibels		
140 130	Shotgun blast, jet 100 feet away at takeoff Motor test chamber	Pain Human ear pain threshold
120 110	Firecrackers Severe thunder, pneumatic jackhammer Hockey crowd Amplified rock music	Uncomfortably loud
100 90	Textile loom Subway train, elevated train, farm tractor Power lawn mower, newspaper press Heavy city traffic, noisy factory	Loud
80 70	**Large tug boat at 50 feet**[1] **Hopper Dredge at 160 feet away**[2] **Bulldozer at 50 feet away**[3] Diesel truck 40 mph 50 feet away Crowded restaurant, garbage disposal **Small tug boat at 50 feet away**[4] Average factory, vacuum cleaner Passenger car 50 mph 50 feet away	Moderately loud
60 50	Quiet typewriter Singing birds, window air conditioner Quiet automobile Normal conversation, average office	Quiet
40	Household refrigerator Quiet office	Very quiet
30 20 10	Average home Dripping faucet Whisper 5 feet away Light rainfall, rustle of leaves Whisper	Average person's threshold of hearing Just audible
0		Threshold for acute hearing

Source: Olishifski and Harford (1975)
[1]Geier & Geier Consulting (1997)
[2]Assumed same as large tug
[3]FHWA (2006)
[4]Epsilon Associates (2006)

Table 3.7-2
Decibel Addition

Difference Between Two Sources	For Example	Add To Higher Level	Resultant Sound Level
0 dB	60 and 60 dB	3 dB	63 dB
1 dB	60 and 61 dB		64 dB
2 dB	60 and 62 dB	2 dB	64 dB
3 dB	60 and 63 dB		65 dB
4–9 dB	60 and 65 dB	1 dB	66 dB
10 dB or more	60 and 70 dB	0 dB	70 dB

Source: Texas Department of Transportation (TxDOT, 1996)

3.7.2 Affected Environment for Noise

Noise-sensitive receivers are facilities or areas where excessive noise may disrupt normal activity, cause annoyance, or cause loss of business. Land uses such as residential, religious, educational, recreational, and medical facilities are more sensitive to increased noise levels than are commercial and industrial land uses. Although the vast majority of land use along the ship channel is dominated by commercial and industrial uses, noise-sensitive receivers are concentrated in the communities of Quintana, Surfside Beach, and Freeport. Although portions of the Freeport Harbor Channel are dominated by industrial development, single-family residences, RV parks, and recreational areas also occur on both sides of the channel.

The existing noise environment of these communities is affected by a number of sources, most of which are transportation related (i.e., barges, railway, roadway, etc.). Waterborne transportation includes barges, commercial vessels, sport and recreation boats, and current maintenance dredging of the ship channel. Heavy industrial facilities such as the Dow Chemical plant also contribute to the existing noise environment within these communities. Hourly L_{eq} noise levels measured at noise-sensitive receivers within Quintana were found to range from approximately 49 dBA L_{eq} to approximately 61 dBA L_{eq}. The calculated L_{dn} for the same receivers ranged from a high of 65.1 dBA to a low of 60.9 dBA (HFP Acoustical Consultants, Inc., 2002). Although the measurements were taken approximately 0.5 mile from the channel, they provide a point of reference for the existing noise levels within the area. It is assumed that noise levels adjacent to the channel could be slightly higher due to the waterborne traffic. For evaluation purposes, existing noise levels were assumed to be 55 dBA L_{eq} (the average of ambient levels recorded within Quintana). This level is more appropriate due to the increased activity in the channel's vicinity, and is also the goal for the outdoor noise environment in residential areas as set by numerous agencies.

The majority of mechanical dredging equipment on a hopper dredge is housed below the vessel's deck; therefore, noise levels associated with the equipment are comparable to tug boats. Table 3.7-3 summarizes dredging-related noise levels produced by equipment type.

Table 3.7-3
Typical Noise Levels of Dredge and Construction Equipment

Equipment	Noise Level (dBA)
Cutterhead dredge (at 160 feet)	79[1]
Hopper dredge (at 50 feet)	87[2]
Large tug boat (at 50 feet)	87[3]
Small tug boat	72[3]
Bulldozer (at 50 feet)	82[4]
Bucket crane (at 50 feet)	82[4]

[1] Geier & Geier Consulting (1997)
[2] Assumed same as large tug
[3] Epsilon Associates (2006)
[4] FHWA (2006)

Maintenance dredging currently occurs on the Freeport Harbor Channel approximately every 10 months and generally includes use of a hopper dredge and tending boats. The nearest noise-sensitive receivers affected by existing channel maintenance activities are located within Surfside Beach. The Surfside Beach Jetty Park is located approximately 220 feet from the channel centerline, and the nearest residences at Surfside Beach are located approximately 880 feet from the channel centerline. Worst-case noise levels related to maintenance dredging operations were calculated to be approximately 75 dBA at the Surfside Beach Jetty Park and 63 dBA at Surfside Beach's nearest residences. Maintenance dredging, therefore, may temporarily increase noise levels by approximately 20 dBA at the Surfside Beach Jetty Park and 8 dBA at the nearest Surfside Beach residences.

3.8 ENERGY AND MINERAL RESOURCES

Abundant natural resources, including oil and gas, sulfur, salt, shell, clay, sand, magnesium, and bromine occur within the study area; the most important being oil and gas (McGowen et al., 1976). The presence and historical exploitation of these natural resources in the Freeport area have contributed to the maritime industry. Oil, natural gas, and NGLs are major contributors to the current area economy. Major nonagricultural land use of the Freeport area is either directly or indirectly related to oil and gas production.

Sulfur is not commonly used by individual consumers but rather in the manufacture of a variety of products including sulfuric acid. Salt domes are numerous in the region and provide an abundant supply of high-grade sodium chloride. The bulk of Texas salt production comes from the Texas coastal zone. The nearest brine-production site is located at the Bryan Mound facility, which is the former site of a sulfur mine that produced 5 million tons of sulfur between 1918 and 1935.

Associated with the massive salt domes is the underground storage of crude oil. The oil is stored in the cavities created in the salt domes, and the liquid hydrocarbons stored in the Texas coast in this manner account for a significant portion of the total liquid hydrocarbon storage in the U.S. The nearest commercial storage facility is also located at the Bryan Mound facility located adjacent to PA 1.

Within the study area, shell naturally occurs as discrete reefs and banks mixed with bottom sand and mud in the shallow bays. The physical and chemical properties of shell make it suitable for use as aggregate and road base and for the production of lime, cement, and chemicals. Historical shell production has depleted oyster reefs within the bays in the general region, and oyster shell is no longer commercially mined.

Sand deposits in the area have the potential for industry or specialty uses such as foundry sands, glass sands, and chemical silica. Common clays are used in the manufacture of brick and tile. Gypsum, used mainly as a construction raw material, occurs in the caprock deposits of the region but, unlike salt and sulfur, is not easily mined and significant production is unlikely. Magnesium compounds and magnesium metal are produced from magnesium chloride, which is extracted from sea water in the Freeport-Velasco area. Historically the area has been the largest producer of magnesium metal in the U.S. Similarly, bromine is extracted from sea water in the Freeport area (McGowen et al., 1976).

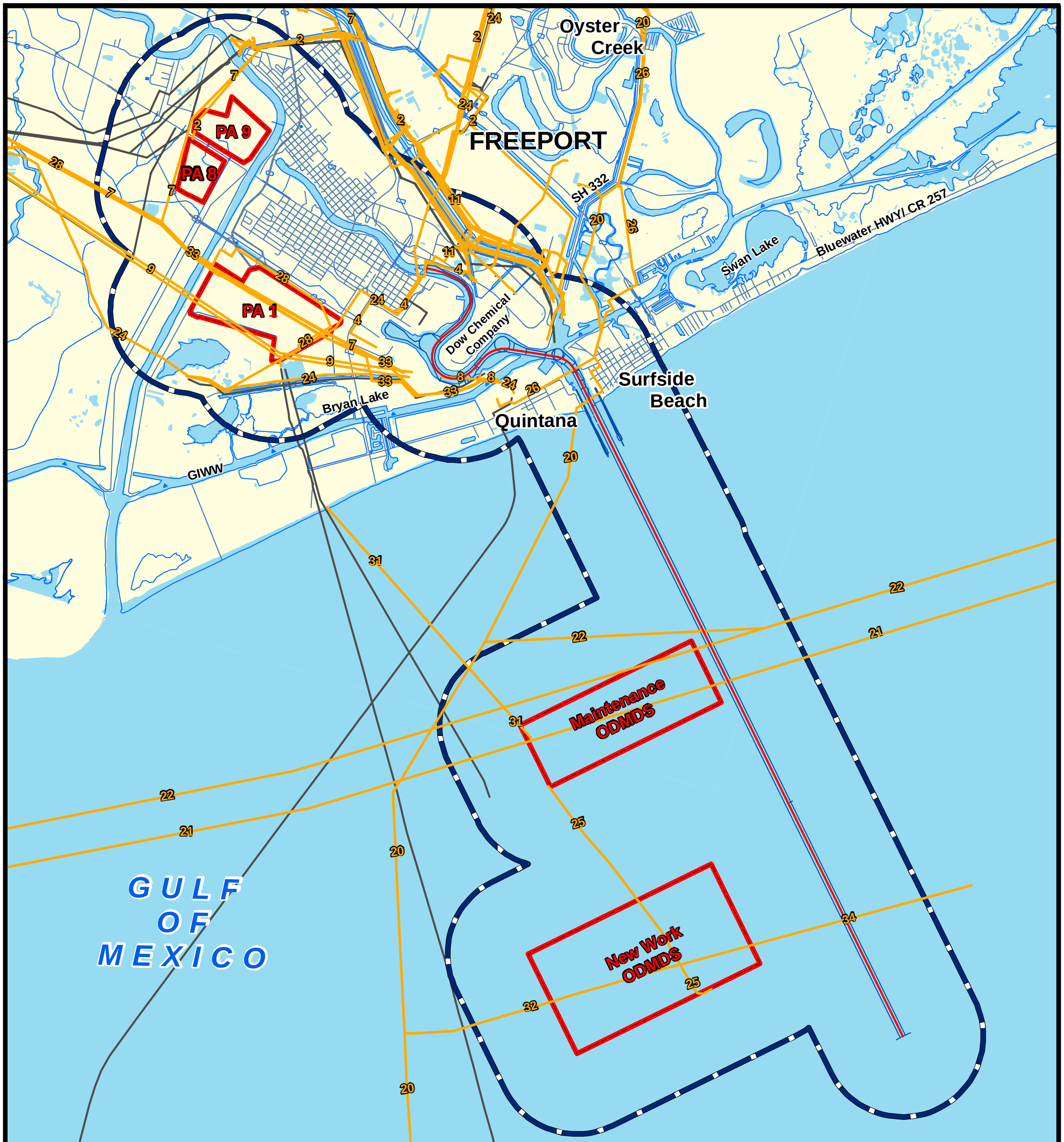
Atkins obtained and reviewed the oil/gas well-bore and pipeline electronic database maintained by the Railroad Commission of Texas (RRC). The results of the oil/gas well review indicate that there are a total of three permitted well sites located within the project area. These well sites include one permitted drilling location and two dry holes (Table 3.8-1).

Table 3.8-1
Summary of Oil and Gas Wells within a 1-mile Radius of the Project

API No.	Longitude	Latitude	Status
42-039-31442-00	–95.32816	28.93214	Dry Hole
42-039-32574-00	–95.34556	28.94892	Permitted Location
42-039-32395-00	–95.38498	28.96022	Dry Hole

Given the highly developed nature of the project area, further exploration for oil and gas is unlikely. However, private enterprise and government facilities in the project area will continue to play a major role in the petroleum industry.

Numerous pipelines were identified within the project area (Figure 3.8-1). According to the RRC pipeline database, a total of eight active pipelines cross the Freeport Ship Channel (Table 3.8-2), six cross PAs 1, 8, and 9 (Table 3.8-3), and five lay beneath the ODMDSs (Table 3.8-4). While the RRC pipeline database is the most comprehensive account of pipelines in the State of Texas, this database may not include every existing pipeline.



Legend

- Pipelines which intersect Project Components
- Pipelines which do not intersect Project Components
- Channel Centerline
- Project Area
- Dredged Material Placement Areas

N W E S

0 0.5 1 2
Miles

Figure 3.8-1

Freeport Harbor Channel Improvement Project Area Petroleum Pipelines

Prepared for: USACE Galveston	
Job No.: 044190100	
Prepared by: A.Christiansen	Date: 03/11/2008

File: N:/Clients/U_Z/USACE/Projects/Freeport/044190100/projects/Figures/Fig_3_6_1.mxd

Table 3.8-2
Summary of Petroleum Pipelines Crossing Freeport Harbor Channel

Operator	System Name	Diameter (inches)	Commodity	T4 Permit No.	Map Id No.
Enbridge Offshore PLS	Galveston Island Gathering System	16	Natural gas	04099	20
Freeport LNG	Freeport LNG	42	Natural gas	07100	26
Dow Chemical Co.	SPO Liquid	4.5	Product	07040	11
ExxonMobil Pipeline Co	Diana Hoover Onshore Crude	24	Crude oil	06461	24
ConocoPhillips Co.	Freeport to Freeport 2 Terminal	30	Crude oil	04057	8
BASF Corporation	Brazoria County	4.5	Anhydrous ammonia	04969	4
Enterprise Products	Seagull	24	Natural gas	02878	21, 22
Tri-C Resources	Tract 306L	6.6	Natural gas	06846	34

Table 3.8-3
Summary of Petroleum Pipelines Crossing PA 1, PA 8, and PA 9

Operator	System Name	Diameter (inches)	Commodity	T4 Permit No.	Map Id No.
Air Liquide	Oxy Choc-Freeport-Phillips	12.75	Hydrogen gas	05467	2
ConocoPhillips Co.	Sweeney-Freeport 1 Terminal	8.63	Benzene	04052	7
ConocoPhillips Co.	Sweeney-Freeport 1 Terminal	24	Crude oil	04057	9
ExxonMobil Pipeline Co	Diana Hoover Onshore Crude	40	Crude oil	06461	24
Houston Pipeline Co.	1089-000	10.75	Natural gas	00749	28
TEPPCO Crude Pipeline	Seaway	42	Crude oil	05161	33

Table 3.8-4
Summary of Petroleum Pipelines Crossing ODMDSs

Operator	System Name	Diameter (inches)	Commodity	T4 Permit No.	Map Id No.
Enterprise Products	Seagull Pipeline	24	Natural gas	02878	21, 22
Flash Gas & Oil SW	Galveston 310-L to Brazos 386	3.5	Natural gas (inactive)	02698	25
Mobil Oil Corp.	Brazos Block 386 Field	8.63	Natural gas (inactive)	00896	31
Seneca Resources Corp	Galveston 310-L	6.63	Natural gas	05251	32
Tri-C Resources, Inc.	Tract 360L	6.63	Natural gas	06846	34

3.9 SOILS

Mapping by the SCS (1981) shows a total of six soil series located at existing PA 1 and proposed PAs 8 and 9.

PA 1 is underlain by Surfside clay (west and southeast) and Velasco clay (northeast). The Surfside clay is a nearly level saline soil that occurs in marshes. The surface layer is mildly alkaline, saline, very dark gray clay about 14 inches thick. The next layer, to a depth of 32 inches, is mildly alkaline, saline, dark gray clay. This soil is poorly drained and rarely flooded. Surface runoff and permeability are very slow. The water table is above a depth of about 2 feet during the winter. The potential for urban use is low. The primary restrictive features are wetness, clayey texture, high shrink-swell potential, salinity, and susceptibility to flooding (SCS, 1981). Velasco clay is a nearly level saline soil that occurs in marshes. This soil is a moderately alkaline, saline clay to a depth of about 65 inches. From the surface to about 8 inches it is dark reddish brown, from 8 to 30 inches it is dark brown, and from 30 to 65 inches it is mottled with reds, browns, and grays. This soil is very poorly drained and frequently flooded. Surface runoff and permeability are very slow. The water table is within 20 inches of the surface throughout most of the year. The soil is used as rangeland and wildlife habitat. The main restrictive features are wetness, salinity, clayey texture, and susceptibility to flooding (SCS, 1981).

The PA 8 area consists primarily of Velasco clay with very minor amounts of Surfside clay in the extreme south. These soils are described above.

The PA 9 area is composed primarily of Brazoria clay, with lesser amounts of Clemville silty clay loam (northeast), Norwood silt loam (east), and Pledger clay (south).

Brazoria clay (0–1 percent slopes) is a nearly level nonsaline soil. It is dark reddish brown, calcareous, moderately alkaline clay to a depth of more than 60 inches. This soil is poorly drained and rarely flooded. Surface runoff is slow and permeability very slow. The water table is at a depth of 1 to 3 feet during winter. This soil is used mainly as pastureland and in some areas as cropland. The restrictive features are the wetness, high shrink-swell potential, and susceptibility to flooding (SCS, 1981).

Clemville silty clay loam is a nearly level nonsaline soil. This soil is moderately alkaline, calcareous silty clay loam to a depth of 30 inches. To a depth of 60 inches, it is reddish brown calcareous, moderately alkaline silty clay that grades to clay in the lower part. This soil is well drained and rarely flooded. Surface runoff and permeability are slow. This soil is used mainly for cropland. The potential for urban use is medium because of the hazard of flooding (SCS, 1981).

Norwood silt loam (0–1 percent slopes) is a nearly level nonsaline soil that occurs on levees situated along bayous and rivers. This soil is reddish brown silt loam to a depth of about 48 inches. From 48 to 54 inches it is yellowish red very fine sandy loam, and from 54 to

64 inches it is reddish brown silt loam. The soil is well drained and rarely flooded. Surface runoff is slow and permeability is moderate. This soil is used mainly as cropland and pastureland. Potential urban use is low due to possibility of flooding (SCS, 1981).

Pledger clay is a nearly level nonsaline soil that has a surface layer of mildly alkaline black clay about 26 inches thick. The subsoil to a depth of 50 inches is moderately alkaline, calcareous, reddish brown silty clay. This soil is poorly drained and rarely flooded. Surface runoff is slow and permeability is very slow. This soil is used mainly as pastureland and in some areas as cropland. It has a perched water table above a depth of 2 feet in winter. The main restrictive features are wetness, clayey texture, high shrink-swell potential, and susceptibility to flooding (SCS, 1981).

Additionally, the soil map indicates the general area surrounding the Freeport area consists of the Surfside-Velasco association (SCS, 1981). This soil association unit is about 60 percent Surfside soils, 11 percent Velasco soils, and 29 percent soils of minor extent.

The Surfside soils are nearly level, poorly drained, saline, clayey soils. The surface layer is very dark to dark gray clay from 14 to 32 inches thick. Below, to a depth of 72 inches, is dark reddish brown saline clay. The Velasco soils are on broad, nearly level flats that are at elevations lower than the Surfside soils. The surface layer is a dark reddish brown to dark brown saline clay from 8 to 30 inches thick. The underlying layer to a depth of 65 inches is gray, mottled, saline clay. Of minor extent in the Surfside-Velasco association are Asa, Ijam, Harris, Pledger, and Veston soils. The soils of this association are used as rangeland and wildlife habitat. Wetness and salinity preclude their use for pastureland and cropland. The potential for urban use is low, the most restrictive features being wetness, clayey texture, high shrink-swell potential, and the susceptibility to flooding (SCS, 1981).

3.9.1 Prime and Unique Farmland

Prime farmland soils are defined by the Secretary of Agriculture in 7 CFR Part 657 (*Federal Register* Vol. 43, No. 21) as those soils that have the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops. The soil quality, growing season, and moisture supply are available to economically produce sustained high yield of crops when treated and managed, including water management, according to acceptable farming methods. Some soils are considered prime farmland in their native state, and others are considered prime farmland only if they are drained or watered well enough to grow the main crops in the area. There are no designated “unique farmlands” in the State of Texas (Brown, 2002).

Soil Survey Geographic Database information acquired from the Natural Resources Conservation Service (NRCS) indicates that the soils located in PA 9 are considered prime farmlands (NRCS, 2007). The total estimated acreage of prime farmland located within PA 9 is approximately 250 acres. Figure 3.9-1 presents prime farmland soils located within PA 9. No prime farmland soils are located within PA 8. NRCS has been notified of impacts to prime farmland from construction of PA 9 and mitigation areas. Coordination with NRCS has been completed for prime farmland soils (Appendix A-4).

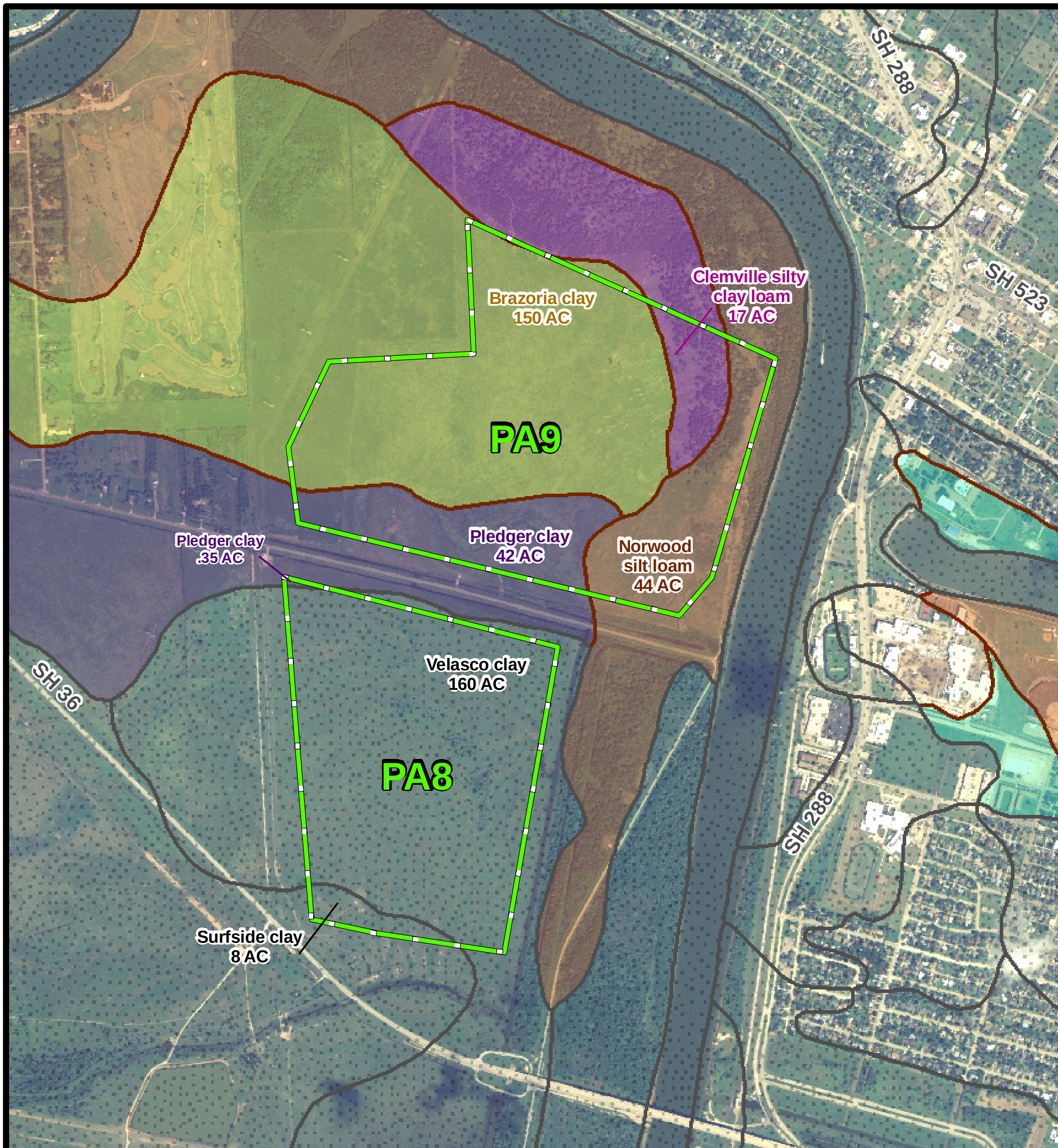
3.10 GROUNDWATER HYDROLOGY

In the study area, the Gulf Coast Aquifer system is the principal source of groundwater for public, agricultural, and industrial needs. Within the aquifer system, the Chicot Aquifer is the uppermost aquifer, and all public and private water-supply wells in the area are supplied by this aquifer (Texas Water Development Board [TWDB], 2007). The Evangeline Aquifer underlies the Chicot Aquifer. The Evangeline Aquifer is noted for its abundance of good-quality groundwater and is considered one of the most prolific aquifers in the Texas Coastal Plain (Baker, 1979) but is not used in the Freeport area. The Chicot and Evangeline aquifers are commonly used hydrogeologic-unit designations for subdivisions of the upper, mostly sandy part of the deposits; and the lower permeable zones make up the Jasper Aquifer.

The lithology of the Gulf Coast aquifer system consists of sand, silt, and clay, reflecting three depositional environments: continental (alluvial plain), transitional (delta, lagoon, and beach), and marine (continental shelf). These deposits thicken as they dip toward the Gulf, resulting in a wedge-shaped configuration of the hydrologic units. Numerous retreats and advances of ancient shorelines have resulted in a complex, overlapping mixture of sand, silt, and clay. These complex deposits have been divided into seven units (five permeable zones and two confining units) based on permeability differences, water depths, and vertical differences in hydraulic head.

As noted above, the Chicot Aquifer is the uppermost water-bearing unit in the Gulf Coast Aquifer system. The Chicot-Evangeline boundary runs approximately parallel to the coast, and forms an outcrop about 90 miles inland from Freeport (Baker, 1979). All public, industrial, and private water supply wells in the Freeport area draw from the Chicot Aquifer. According to 1999 estimated water-use data for Brazoria County, approximately 203 million gallons of groundwater and surface water were withdrawn per day for municipal, manufacturing, irrigation, mining, and livestock uses (TWDB, 2007).

Groundwater recharge into the aquifers occurs primarily by precipitation onto outcropped areas and downward leakage from overlying saturated (perched) layers and/or aquifers. Regional groundwater flow in the aquifers is generally in a southeastward direction from outcrop areas towards areas of natural discharge (Wesselman, 1971). Superimposed upon this natural discharge regime is artificial discharge from groundwater pumping.



NRCS Soil Types within Placement Areas:

Prime Farmland Areas:

- Brazoria clay, 0 to 1% slopes
- Clemville silty clay loam
- Norwood silt loam, 0 to 1% slopes
- Pledger clay
- Asa silt loam

- Placement Areas
- Non-Prime Farmland Areas

N W E S

0 500 1,000 1,500 2,000

Feet

Figure 3.9-1
Prime Farmland Areas
Freeport Harbor
Channel Improvement Project

Prepared for: USACE Galveston	
Job No.: 441901.00	Scale: 1inch equals 1,500 feet
Prepared by: A.Christiansen	Date: 03/14/2008

File: N:/Clients/U_Z/USACE/Projects/Freeport/044190100/projects/fig_3-7-1_vr3.mxd

Significant changes in groundwater elevation have occurred in the Freeport area over the last 60 years. Water levels dropped nearly 100 feet during the 1940s and 1950s, but began to recover as the rate of groundwater pumping in the area leveled off (Texas Water Commission, 1963). Depth to groundwater in USGS- and TWDB-monitored wells remained greater than 70 feet throughout most of the Freeport area through the 1980s (TWDB, 2007; USGS, 2007).

Current water levels in the Chicot Aquifer in most of southern Brazoria County have remained relatively constant since the late 1970s, with water-level elevations of 30 to 50 feet below msl (Coplin and Lanning-Rush, 2002). However, none of the wells monitored for these surveys are located in the Freeport area, which had typically seen the most dramatic fluctuations in water level in southern Brazoria County (Texas Water Commission, 1963).

A sole source aquifer (SSA) is an aquifer that has been designated by EPA as the sole or principal source of drinking water for an area. As such, a designated SSA receives special protection. The program for protecting SSAs was established by the Safe Drinking Water Act of 1974. EPA designates an aquifer as a sole source based upon a petition from an individual, company, association, or government entity. EPA has not designated any SSAs within the study area (EPA, 2007b).

Records from the TWDB indicate there are approximately 17 water wells located within 0.5 mile of the Freeport Harbor Channel. Figure 3.10-1 presents the approximate water well locations within 0.5 mile from the Freeport Harbor Channel according to the TWDB database (TWDB, 2007). (Note: data is not guaranteed by TWDB to be 100 percent accurate). Typically, all nearby water wells are screened in the Chicot Aquifer and range from 241 to 1,130 feet in total depth (Table 3.10-1).

Two active public supply wells are located within 0.30 mile of the ship channel. The town of Surfside has a public supply well located approximately 0.30 mile northeast of the ship channel, and the City of Freeport has a public supply well located approximately 0.15 mile south of the Stauffer Turning Basin. The depth of these wells is 249 and 300 feet (see Table 3.10-1). A third (unused) public supply well for Quintana is located less than 0.10 mile due southwest of the ship channel (8106522). This well was reportedly drilled in 1895 and is 650 feet deep. A private water well is located approximately 0.2 mile west of the Jetty Channel and is 250 feet deep.

There are approximately 10 industrial wells owned by Dow Chemical within 0.25 mile east of the Freeport Harbor Channel between the Brazosport and Upper turning basins. These wells range in depth from 241 to 1,130 feet.

Table 3.10-1
Summary of Water Wells within 0.5 mile of Freeport Harbor Channel

State Well Number/Map Id No.	Owner	Water Use	Well Depth (feet)
8106405	City of Freeport	Public	249
8106423	B.H. Gardner Constructors	Industrial	248
8106501	Dow Chemical	Industrial	273
8106504	Ortloff Corporation	Industrial	266
8106506	Dow Chemical	Industrial	254
8106507	Dow Chemical	Industrial	241
8106508	Dow Chemical	Industrial	265
8106509	Dow Chemical	Industrial	273
8106510	Dow Chemical	Industrial	252
8106512	City of Surfside	Public	300
8106513	C.L. Ray	Private	250
8106514	Dow Chemical	Industrial	1,130
8106516	Dow Chemical	Industrial	269
8106517	Dow Chemical	Industrial	1,130
8106519	Dow Chemical	Industrial	263
8106521	U.S. Army	Industrial/unused	258
8106522	City of Quintana	Public/unused	650

3.11 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

The following provides a summary of an HTRW data review for the project area. This HTRW assessment was conducted in general accordance with procedures described in the Department of the Army, USACE document Engineering Regulation (ER) 1165-2-132, Water Resource Policies and Authorities–Hazardous, Toxic, and Radioactive Waste (HTRW) Guidance for Civil Works Projects. The objective of this preliminary assessment is to identify “the existence of, and potential for, HTRW contamination on lands in the project area, or external contamination which could impact, or be impacted by a project.” The findings and recommendations presented in this HTRW assessment are based on information derived from a review of historic aerial photographs, interviews with persons knowledgeable of the area, a review of regulatory agency databases, and a site visit. More-detailed information regarding this HTRW assessment can be found in Appendix D-1.

Groundwater wells

Project Area

N
W E
S

0 1,150 2,300

Feet

Figure 3.10-1

Freeport Harbor Channel Improvement Project Water Well Locations

Prepared for: USACE	
Job No.: 044190100	Scale: 1 inch equals 2,300 feet
Prepared by: A.Christiansen	Date: 3/19/2008

File: N:/Clients/U_Z/USACE/Projects/Freeport/044190100/projects/Figures/Fig_3_8_1.mxd

3.11.1 Aerial Photographic Review

Aerial photographs of the project area were obtained to examine the historic usage of the current Freeport Harbor Channel system including Port Freeport and the former Brazos River Channel. The photographs depict the project area as it appeared in 1944, 1965, 1975, 1987, 1995, and 2004 (Appendix D-2). The aerial photographs were obtained from the USGS, the Agricultural Stabilization Conservation Service, and TxDOT.

The earliest aerial photography available of the area was taken in 1944. These aerial photographs indicate that development immediately adjacent to the project area is limited to a large industrial facility located on the east bank of a narrow bend of the Brazos River. This facility is identified as the first process areas of the Dow Chemical facility. Along the west bank of the waterway, a small area containing several large, open-top aboveground storage tanks is visible (Phillips). The remaining areas adjacent to the waterway are mostly undeveloped, with some unimproved roads providing limited access. Large tracts of land adjacent to the GIWW appear to be used as PAs for dredged material. The tracts of land proposed for proposed PAs 8 and 9 are undeveloped marshland, possibly used for agriculture.

The 1965 and 1975 photographs depict the continued growth of the Dow facility, the dredging of the Brazos Harbor Turning Basin and construction of new warehouses, the installation of additional storage tanks at the Phillips tank farm along the west shore of the waterway, and a new bridge crossing the Old Brazos River at Farm to Market Road (FM) 1495. The 1987 photograph indicates the addition of facilities and land-use changes in the project area. The most notable changes occurred along the shoreline of the waterway, including the construction of a facility at Quintana consisting of a small tank farm and a berthing dock, the construction of a berthing facility on the peninsula between the GIWW and the Old Brazos River, the construction of additional process and storage facilities adjacent to Dow east of the channel, additional storage capacity at the Phillips tank farm, and new docking facilities along the west bank of the Old Brazos River west of Dow. The 1995 photograph indicates that the project area, adjacent properties, and surrounding properties remain basically unchanged from the 1987 photograph. The drilling platform known as Zeus is visible at its mooring in the Entrance Channel. The tract of land identified as PA 1 was converted to an upland PA.

The most recent aerial photograph was taken in 2004, and the project area and surrounding properties are basically unchanged from the previous photograph. Portions of the original Dow facility appear to have been dismantled and are vacant. A canal is visible across the length of PA 1, while the tracts of proposed PAs 8 and 9 remain undeveloped agricultural land. No other visible changes are detectable in the photograph.

3.11.2 Interviews

PBS&J conducted interviews with staff of the TCEQ Region 12 office in May 2006 regarding potential sources of contamination to the project area (Appendix D-3). PBS&J contacted Aron Athavaley, site investigator, regarding his knowledge of HTRW contamination on lands in the project area, or external contamination that could impact the project. Mr. Athavaley informed PBS&J that, while there are facilities with ongoing corrective action activities in upland areas along the banks of the waterway, there are no active enforcement actions under way. When PBS&J inquired of any direct sources of contamination to the project, he noted the potential for off-site migration of impacted groundwater to discharge into the waterway. These impacts have been documented by groundwater monitor wells along the Dow facility.

3.11.3 Regulatory Agency Database Review

PBS&J retained the services of TelALL Corporation (TelALL) to conduct the regulatory agency database information search. The scope of the regulatory information search included the following databases: the National Priority List (NPL); the State Superfund List (TXSSF); Comprehensive Environmental Response, Compensation and Liability Information System Database (CERCLIS) including the No Further Remedial Action Planned (NFRAP) database; Resource Conservation and Recovery Act (RCRA) Generators and Violators List (RCRA-G); RCRA Corrective Actions List (CORRACT); RCRA Treatment, Storage, or Disposal List (RCRA TSD); Texas Underground and Aboveground Storage Tank Database (TXUST and TXAST); Leaking Underground Storage Tank Listings (TXLUST); Texas Voluntary Cleanup Program (TXVCP); Innocent Owner/Operator Program (IOP); City/County Solid Waste Landfill listings (TXLF); Unauthorized and Unpermitted Landfill Sites (LFUN); Emergency Response Notification System (ERNS) database; and Texas Spills Incident Information System (TXSPILL) database.

PBS&J performed a review and evaluation of the available public information relating to the site. The review consisted of summarizing the regulatory agency database information acquired by TelALL. A site reconnaissance was conducted in March 2008 to verify the location of sites referenced in the regulatory database search and to locate any additional unreported hazardous materials sites. The site locations were provided by TelALL and are approximate, since they are based on street address information included in the databases. A map illustrating the locations of these registered sites is included in Appendix D-2.

3.11.4 Regulatory Agency Database Results

During the various database searches, a total of 1,066 listings were identified along upland areas of the Freeport Channel system. These listings were located primarily at the heavily concentrated industrial and petrochemical facility complexes that line the banks and upland areas of the waterway. No known sites or sources of contamination were identified within the project area footprint. Several of these listings were associated with the same facility or property (e.g., a facility/property that contains multiple petroleum storage tanks and is the site of several reported spills or emergency response actions). The 1,066 database listings were associated with a total of 201 facilities or properties within the project area. On the basis of the results of the regulatory database searches, the following sites were identified:

- Three CERCLIS sites;
- Six NFRAP sites;
- Five CORRACT sites;
- Nine RCRA generators sites;
- One RCRA treatment, storage, and disposal site;
- One hundred twenty-six petroleum storage tanks at 30 sites;
- Nineteen leaking underground storage tank sites;
- Five hundred forty-five reported emergency response actions; and
- Four hundred five reported spills.

No NPL, State Superfund, Voluntary Cleanup, or City/County solid waste landfill sites were located within the project area. The regulatory agency databases searched include sites that are onshore and are not typically available for the offshore portion of the project. A summary description of regulated sites and spill incidents is included in Appendix D-1, and TelALL Summary Reports are included in Appendix D-4.

3.11.5 Site Reconnaissance

A visual inspection of the project area was conducted by PBS&J personnel on March 18–19, 2008, by boat and automobile. Port Freeport provided an escorted tour of the project area using Port Security personnel and a Port Security boat. The remaining component of the site reconnaissance was conducted by accessing the project area by public roadways. The site inspection was intended to identify indicators of areas of potential hazardous waste and confirm mapped locations of sites identified through the various regulatory agency reviews. Photography of the project area was restricted; however, photographs allowed during the site reconnaissance have been included in Appendix D-5.

The site reconnaissance conducted by boat began at the Stauffer Turning Basin, which defines the northern extent of the project area (Site Photograph No. 1, Appendix D-5). A sign indicating the presence of underground gas or petroleum pipelines was observed within the turning basin (Site Photograph No. 2, Appendix D-5). The properties along the western shore of this northern segment of the Old Brazos River include small private businesses, which provide boat maintenance including wet and dry docks and refueling. One of these businesses operates several registered aboveground storage tanks used apparently for retail fuel sales. These tanks were reported in the regulatory agency database report. The tanks appeared to be located within secondary containment. The property along the entire eastern shore from the water lock to the GIWW is owned and operated by Dow. This facility has the greatest number of records reported in the regulatory agency database report for releases of regulated substances. Land use adjacent to the shore includes a railroad spur, a surface impoundment, a freshwater canal, and existing and former process areas. An earthen levee constructed along the shore separates the waterway from the adjacent railroad spur and process areas at the Dow facility.

Adjacent to Port Freeport, along the western shore, is a facility that stores anhydrous ammonia. The facility has a ship dock and a large pressurized storage vessel. ConocoPhillips operates the adjacent facility, which is a tank farm containing over 19 registered aboveground storage tanks. The tanks appear to be within secondary containment. Another feature encountered during the site reconnaissance was the abandoned drilling platform known as Zeus, which was a potential source of contaminants to the project area. However, the platform has since been removed from the project area, following the site visit. A pipeline marker was observed near the USCG Station indicating one or more underground pipelines crossing the Freeport ship channel (Site Photograph No. 6). Another pipeline marker was observed near the mouth of the Entrance Channel. The site reconnaissance conducted by boat concluded at the mouth of the jetty.

The areas designated as PAs are characterized as undeveloped land. PA 1 has been used as a PA and as a result remains undeveloped with several large unvegetated areas containing dredged material. Proposed PAs 8 and 9 are accessible by county roadway and appear to be primarily overgrazed grasslands with some wooded areas.

The results of the site reconnaissance confirmed mapped locations of upland facilities with hazardous materials, along the banks of the waterway, as identified through the various regulatory agency reviews. No new sites were identified.

3.12 VEGETATION INCLUDING WETLANDS

The study area is located within the Upper Coast division (Hatch et al., 1999) of the Gulf Coast Prairies and Marshes Vegetational Region (Gould, 1975). This region is a nearly level plain less than 250 feet in elevation, covering approximately 10 million acres (Hatch et al., 1990). The Gulf Prairies include the coastal plain that extends approximately 30 to 80 miles inland. The Gulf Marshes are located in a narrow strip of lowlands that are adjacent to the coast and barrier islands (Hatch et al., 1999). Unlike most of the major river systems in Texas, there is no bay or estuary associated with the Freeport project area. McGowen et al. (1976) present a detailed history of the geological development of the area that caused this condition. Additionally, there is no active delta or direct inflow from the river into the Freeport Harbor Channel area because the Brazos River was diverted in 1929, relocating the mouth of the river approximately 6 miles to the southwest.

The vegetation communities of the Freeport area, with particular attention to the wetlands, have been mapped and described in several studies (Bezanson, 2001; Houston-Galveston Area Council, 2002; McGowen et al., 1976; TPWD, 1999; USFWS, 1992a; White et al., 1988, 2004, 2005). However, the Freeport Harbor Channel is commonly the eastern or western boundary of these studies, which focus either on the Galveston Bay System to the northeast or the Matagorda Bay System to the southwest, so that in these reports, the acreage values and trends for plant community types in the Freeport area tend to be overshadowed by the values and trends in the other estuaries.

An important ecosystem that occurs within the study area is the Columbia Bottomlands, which is located in the floodplains of the Brazos, San Bernard, and Colorado rivers (Figure 3.12-1). The Columbia Bottomlands area supports uplands and wetlands including marshes, forested wetlands, small scattered prairies, and bottomland hardwood forests (The Nature Conservancy, 2002, 2004). Once contiguous along the rivers and bayou corridors, remaining bottomland hardwood forests compose only one-quarter of their historic cover due to fragmentation by human activities (The Nature Conservancy, 2004). The forests of the Columbia Bottomlands primarily occur north of the Freeport Harbor Channel, outside of the likely influence of project activities.

A vegetation map (Figure 3.12-2) was produced with Geographical Information System (GIS) data from NOAA's Coastal Change Analysis Program (C-CAP), specifically for the Freeport Harbor Channel project area. C-CAP is a nationally standardized database of land cover and land change information for the coastal regions of the U.S. Figure 3.12-2 is based on 2005 satellite (Landsat Thematic Mapper and/or Landsat Enhanced Thematic Mapper) imagery. The acreage values (calculated from the C-CAP data) for vegetation categories within the FHCIP project area appear in Table 3.12-1. More information, including the Gulf Coast GIS data file (NOAA, 2006) that was used to produce Figure 3.12-2, is available online (www.csc.noaa.gov/crs/lca/ccap.html). The C-CAP dataset was used to provide baseline vegetation information because it provided more information on upland and wetland communities, unlike the National Wetland Inventory (NWI) (USFWS, 1992a) which mapped all uplands as a single category. As a reminder, it should be noted that with regard to acres of vegetation provided in Section 3.12, the project area includes the footprint of the construction area within the channel, the existing New Work and Maintenance ODMDSs, the three upland PAs (PA 1, PA 8, and PA 9), plus a 1-mile buffer area around these features. The project area and footprint occurring offshore contain no vegetation due to tidal and wave disturbances and water depths that preclude SAV establishment. Vegetation occurring within the project footprint was categorized using a combination of field verifications, C-CAP, and review of 2004 infrared aerial imagery and 2005 and 2008 true color aerial imagery. These combined resources were used for project footprint vegetation assessments due to inaccuracies of C-CAP data at finer spatial scales. C-CAP data are more accurate at larger spatial scales and coarser-grained spatial analysis and may overestimate vegetation types at the project area and footprint spatial scale.

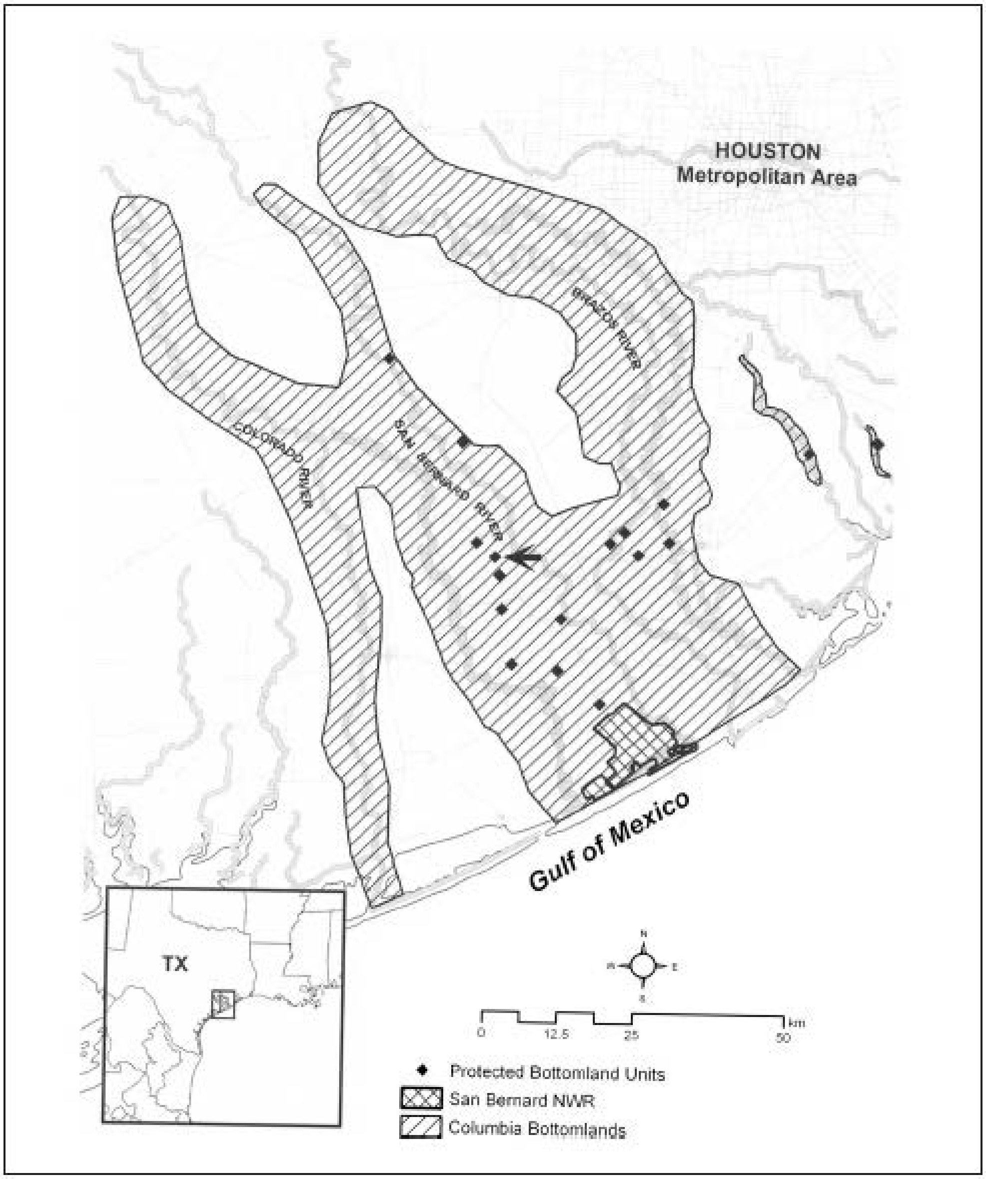
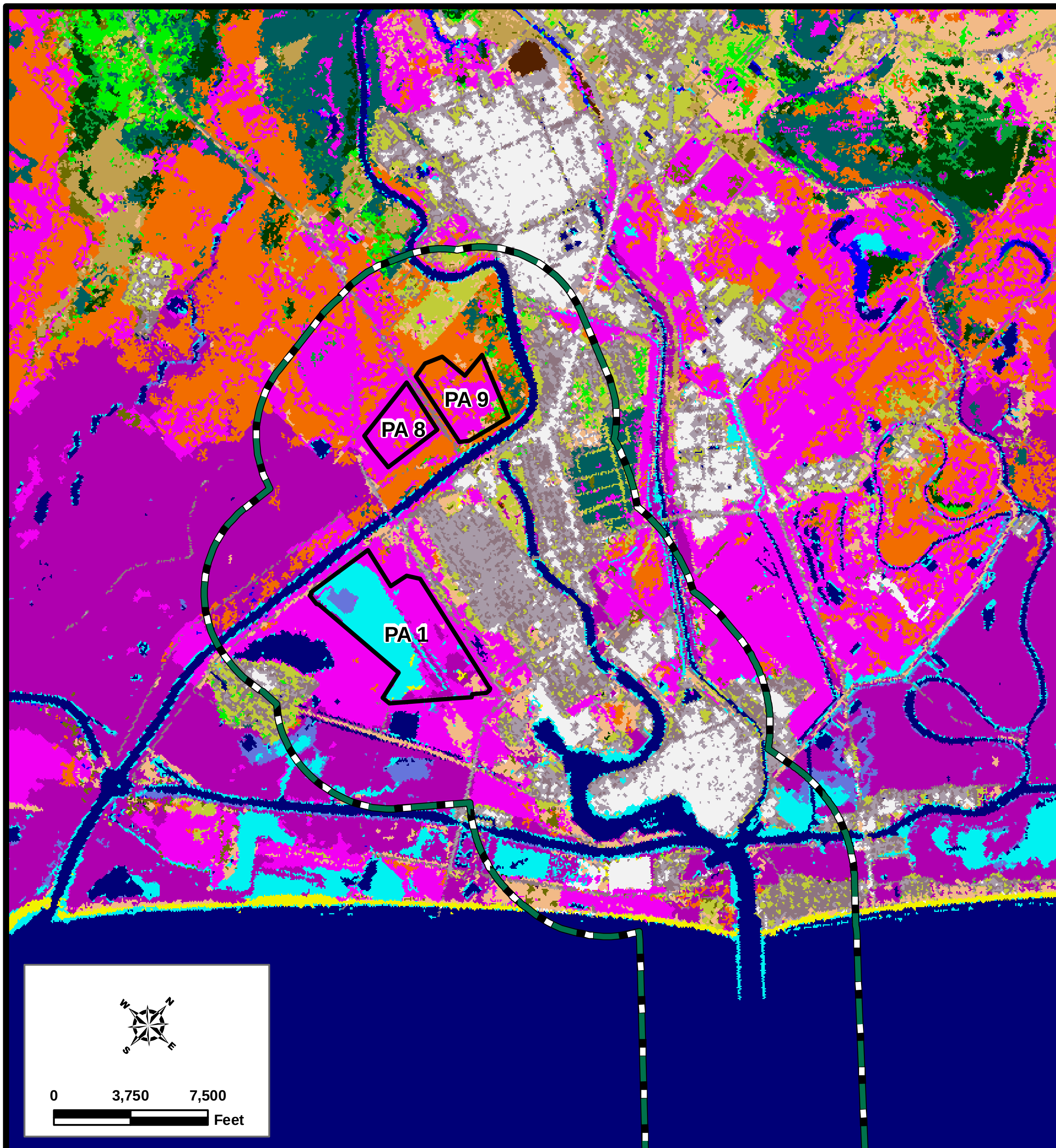


Figure 3.12-1
Approximate Historic Extent of the Columbia Bottomlands Ecosystem (Rosen et al. 2008)



Vegetation Including Wetlands of Project Area*:

High Intensity Developed
Medium Intensity Developed
Low Intensity Developed
Cultivated
Pasture/Hay
Grassland
Deciduous Forest
Evergreen Forest
Unconsolidated Shore
Bare Land
Mixed Forest
Scrub/Shrub
Palustrine Forested Wetland
Palustrine Scrub/Shrub Wetland**
Palustrine Emergent Wetland**
Estuarine Forested Wetland
Developed Open Space
Estuarine Scrub/Shrub Wetland
Estuarine Emergent Wetland
Water
Palustrine Aquatic Bed
Estuarine Aquatic Bed

Project Features:

Placement Areas
Project Area

*Source: NOAA C-CAP 2006, **Note: Features not consistent with NWI (FWS, 1992) map.

Figure 3.12-2
Freeport Harbor Channel Improvement Project Area

Vegetation Including Wetlands Based on 2005 NOAA Imagery

Prepared for: USACE Galveston
Job No.: 044190100 | Scale: 1 inch equals 7,500 feet
Prepared by: A.Christiansen | Date: 03/14/2008
File:N:/Clients/U_Z/USACE/Projects/Freeport/044190100/projects/Figures/3_10_1.mxd

3.12.1 Uplands

The mouth of the Freeport Harbor Channel is in a relatively upland area of the Texas coast line. Wetlands are more extensive 10 miles to the southwest (Brazos River Delta and the San Bernard National Wildlife Refuge [NWR]) and 5 miles to the northeast (Christmas Bay, Drum Bay, and part of the Brazoria NWR). Uplands include developed areas, dunes and relict beach ridges, grasslands, and woodlands. There are approximately 4,792 acres of developed land, 89 acres of beaches and dunes, 80 acres of upland forest, 98 acres of upland shrub/scrub, and 725 acres of upland grassland/pastures in the project area according to C-CAP data (Table 3.12-1; NOAA, 2006).

Sand dunes help absorb the impacts of storm surges and high waves and also serve to slow the intrusion of water inland. In addition, dunes store sand that helps deter shoreline erosion and replenishes eroded beaches after storms. Within the project area, these habitats are impacted by development and shoreline erosion. In the vicinity of Freeport Harbor Channel, the shoreline is eroding at a rate of 9 to 10 feet/year (BEG, 2007; ERDC, 2007). Typical plant species of the primary dunes in the broader study area include sea oats (*Uniola paniculata*), bitter Panicum (*Panicum amarum*), Gulf croton (*Croton punctatus*), beach morning glory (*Ipomea pes-caprae*), and fiddleleaf morning glory (*Ipomea stolonifera*). Secondary dune species include marshhay cordgrass (*Spartina patens*), seashore dropseed (*Sporobolus virginicus*), seacoast bluestem (*Schizachyrium littorale*), seashore saltgrass (*Distichlis spicata*), pennywort (*Hydrocotyle bonariensis*), and partridge pea (*Chamaecrista fasciculata*). The secondary dune community, which is located in the hummocky area leeward of the higher and drier primary dunes, is often a wetland community or considered a transitional community between upland and wetland. There are approximately 89 acres of beach in the project area according to C-CAP data (see Table 3.12-1; NOAA, 2006). No beach or dune habitat occurs within the project footprint.

Diamond and Smeins (1987) describe forest and woodlands that occur in the Upper Coastal Prairie, including Coastal Live Oak/Post Oak (*Quercus virginiana/Q. stellata*) Forest, Water Oak (*Quercus nigra*)/Coastal Live Oaks Forest, and Mesquite-Huisache (*Prosopis glandulosa-Acacia farnesiana*) Shrublands. The typical forest and shrub/scrub vegetation within the project area could include a diverse range of native and non-native tree and brush species such as sugar hackberry (*Celtis laevigata*), cedar elm (*Ulmus crassifolia*), Chinese tallow (*Sapium sabiferum*), toothache tree (*Zanthoxylum fracineum*), pecan trees (*Carya illinoinensis*), red mulberry (*Morus rubra* L.), honey locust (*Gleditsia aquatica*), gum bumelia (*Sideroxylon lanuginosum*), Jerusalem tree (*Parkinsonia aculeata*), chinaberry (*Melia azedarach*), yaupon holly (*Ilex vomitoria*), palmetto (*Serenoa repens*), green briar (*Smilax* sp.), McCartney's rose (*Rosa bracteata*), peppervine (*Ampelopsis brevipedunculata*), trumpet creeper (*Campsis radicans*), poison ivy (*Toxicodendron radicans*), dewberry (*Rubus eubatus*), blackberry (*Rubus* sp.), native chili peppers (*Capsicum annum L.*), sumpweed (*Iva* sp.), *Baccharis* spp., turk's cap (*Malvaviscus arboreus*), and frogfruit (*Phyla lour*).

Table 3.12-1
Vegetation/Land Cover within Project Area[a] and Project Footprint

NOAA C-CAP Land Cover Categories	Project Area (Acres) (C-CAP Data)	Project Footprint (Acres) (Field-Verified Data)	Location of Footprint Impacts
Vegetation – Uplands			
Deciduous Forest	66	21	PA 9
Evergreen Forest	7	0	
Mixed Forest	7	0	
Shrub/Scrub	98	0	
Grassland	725	358	PAs 8 and 9
	963	***379***	
Bare Land (Gulf shore – beach/dune)	***89***	***0***	
Vegetation – Wetlands			
Estuarine[b]			
Estuarine Aquatic Bed	174	0	
Estuarine Emergent Wetland	1,957	0	
Estuarine Forested Wetland	0	0	
	2,131	***0***	
Palustrine[b]			
Palustrine Aquatic Bed	3	0	
Palustrine Emergent Wetland	3,020	39	PAs 8 and 9
Palustrine Forested Wetland	248	0	
Palustrine Shrub/Scrub Wetland	1,106	0	
	4,377	***39***	
Unconsolidated Shore (includes sand/mud flats)	***946***	***0***	
Developed Lands			
High Intensity Developed	1,106	0	
Low Intensity Developed	1,449	0	
Medium Intensity Developed	1,437	0	
Developed Open Space	800	0	
	4,792	***0***	
Water			
Marine Water (Gulf of Mexico)	24,193	0	
non-Marine Water (channels and other interior waters)	1,395	0	
	25,587	***0***	
Agricultural/Cultivated (not including pasture/hay)	***1***	***0***	
TOTAL – Project Area and Footprint	**38,826**	**418**	

[a]Project Area includes project footprint, exclusive of mitigation areas, with a 1-mile buffer; although part of the project footprint, the mitigation areas are not included in the calculations for the above table.
[b]Overestimate of wetland acreages are likely since C-CAP data are produced on spatial scales much greater than the project area. Field verifications have confirmed overestimation of wetlands by C-CAP data at some LPP project impact locations.

The upland grasslands that may occur within the project area include pasture lands, dominated by introduced species including bermudagrass (*Cynodon dactylon*) and bahaigrass (*Paspalum notatum*). Remnants of the original coastal prairie, with common species including little bluestem (*Schizachyrium scoparium)*, brownseed paspalum (*Paspalum plicatulum*), indiangrass (*Sorghastrum nutans*), rosettegrass (*Panicum oligosanthes*), and thin paspalum (*Paspalum setaceum*) are likely to occur within the project area as only a small percentage of the upland grassland. Most are likely to support a mix of introduced pasture grasses in addition to some native species.

According to field verification results, within the project footprint, upland vegetation includes 21 acres of deciduous upland forest and 365 acres of grassland (includes 358 acres of grazed coastal grassland). Some of the 21 acres of upland deciduous forest include riparian forested areas adjacent to the Brazos River, which is the location proposed for construction of PA 9. Within PA 9's footprint, the forest consists of second-growth woods and is contiguous with a larger woodland to the north. It is a mixed-species woodlot, approximately 40 years in age, somewhat open with a grazed understory. The forest consists of a range of native and non-native tree and brush species similar to that described above.

3.12.2 Wetlands

The following provides a description of the wetland vegetation types found within the project area based on C-CAP data. The vegetation described within the project footprint, and immediately adjacent areas, is based on a combination of some field verifications, review of aerial imagery, and C-CAP data.

3.12.2.1 Estuarine Habitats

Coastal wetlands (saline to freshwater) are distinct areas between terrestrial and aquatic systems where the water table is at or near the surface, or the land is covered by shallow water with emergent vegetation. They are important natural resources that provide essential habitat for fish, shellfish, and other wildlife. Coastal wetlands also serve to filter and process agricultural and urban runoff and buffer coastal areas against storm and wave damage.

According to White et al. (2005), the condition and distribution of wetland types can be affected by changes in depth and frequency of inundation as well as salinity. RSLR is also of concern to coastal wetlands. ERDC (2009) reports that the historic rate of local RSLR (i.e., a combination of eustatic or worldwide sea level rise and local subsidence) in the Freeport area was 0.0143 foot/year for the 52-year period between 1954 and 2006. According to ERDC, the observed subsidence rate is 0.0087 foot/year for the Freeport area. This apparent change in RSLR could have been associated with man-made or anthropogenic activities such as oil extraction and groundwater withdrawal, which may have increased subsidence, exacerbating local sea levels. Descriptions of the wetland plant communities (including aquatic vegetation) that occur in the project area appear in the following paragraphs. There are no estuarine wetland habitats in the project footprint, and none will be impacted by the proposed project.

*3.12.2.1.1 Estuarine Submerged Aquatic Vegetation (***Estuarine Aquatic Bed***)*

Seagrasses, which are SAV, are considered to be critical coastal nursery habitat for estuarine fisheries and wildlife. They also serve as a food source for fish, waterfowl, and turtles. They contribute organic matter to the nutrient cycle and stabilize coastal sedimentation and erosion processes (TPWD, 1999). The estuarine SAV species may include shoalgrass (*Halodule wrightii*) and widgeongrass (*Ruppia maritima*).

According to C-CAP, there are approximately 174 acres of SAV (equivalent to C-CAP's category, Estuarine Aquatic Bed) in the project area (see Table 3.12-1; NOAA, 2006); however, these are primarily located in estuarine marshes that are indirectly connected to the Freeport Harbor Channel via the GIWW, or, in some cases, within leveed areas. C-CAP maps some narrow patchy areas of SAV along the channel shoreline. However, based on some field verifications and review aerial interpretation, there is no SAV in the project footprint and immediately adjacent areas, and none will be impacted by the proposed project.

*3.12.2.1.2 Estuarine Marshes – Salt/Brackish (***Estuarine Emergent Wetlands***)*

The dominant species in the frequently inundated low salt marshes is smooth cordgrass (*Spartina alterniflora*) and, secondarily, seashore saltgrass. These are often interspersed with low brackish marshes dominated by saltmarsh bulrush (*Bolboschoenus robustus*) and glasswort (*Salicornia virginicus*). Commonly, the low salt marsh is adjacent to open-water areas, with the low brackish marsh adjacent to the low salt marsh. At slightly higher elevations (and less frequently inundated) are the high salt/brackish marshes. Common species in the high marshes include sea ox-eye daisy (*Borrichia frutescens*), saltwort (*Batis maritima*), and shoregrass (*Monanthochloe littoralis*). According to C-CAP data, there are approximately 1,957 acres of estuarine emergent wetlands in the project area (see Table 3.12-1; NOAA, 2006). There are no saltwater or brackish estuarine wetland habitats in the project footprint, and none will be impacted by the proposed project.

3.12.2.1.3 Estuarine Shrub/Scrub Wetlands – Salt/Brackish

The estuarine intertidal shrub/scrub category describes coastal wetlands dominated by woody vegetation and periodically flooded by tidal waters. Examples of estuarine intertidal shrub/scrub species in the study area include big leaf sumpweed (*Iva frutescens*), the exotic invasive tamarisk (*Tamarix* spp.), and bushy sea-ox-eye. C-CAP does not map any estuarine shrub/scrub wetlands within the project area (see Table 3.12-1; NOAA, 2006); however, some areas were observed during field visits in the surrounding marshes (not adjacent to the Freeport Harbor Channel). So the actual cover by estuarine shrub/scrub may be underestimated by C-CAP. There are no saltwater or brackish estuarine shrub/scrub wetland habitats in, or immediately adjacent to, the project footprint, and none will be impacted by the proposed project.

3.12.2.1.4 Estuarine Tidal Flats (Unconsolidated Shore)

This community type includes coastal wetlands periodically flooded by tidal waters and with less than 30 percent areal coverage by vegetation. This category includes sandbars, mud flats, and other nonvegetated or sparsely vegetated habitats called salt flats. Sparse vegetation of salt flats may include glasswort, saltwort, and shoregrass. These tidal flats serve as valuable feeding grounds for coastal shorebirds, including the threatened piping plover, fish, and invertebrates. Although C-CAP data (NOAA, 2006) maps 946 acres of tidal flats within the project area, C-CAP data do not differentiate between estuarine and palustrine 'unconsolidated shore' (including flats). Also, although there are small flats displayed (see Figure 3.12-2) on the shoreline of the channel that would be considered estuarine, based on field verifications and review of aerial imagery, these areas are considered overestimates and errors of C-CAP data. As previously mentioned, C-CAP data are more accurate at larger spatial scales and coarser-grained spatial analysis, and may overestimate vegetation or habitat types at the project footprint spatial scale. Because the C-CAP acreage for 'unconsolidated shore' includes both estuarine and palustrine areas, including areas within levees, overall acreages within the project area are likely greatly overestimated. Within the project footprint, no estuarine tidal flats occur.

3.12.2.2 Freshwater Habitats

3.12.2.2.1 Freshwater Aquatic Vegetation – Submerged and Floating (Palustrine Aquatic Bed)

Common submerged and floating freshwater aquatic species may include the invasive exotic species water hyacinth (*Eichornia crassipes*) and water lettuce (*Pistia stratiotes*), or the native frogbit (*Linobium spongia*). Other species may include widgeongrass, as well as other strictly fresh-intermediate species like Sago pondweed (*Potamogeton pectinatus*), cabomba (*Cabomba caroliniana*), and mermaid weed (*Proserpinica palustris*). Only 3 acres of palustrine aquatic beds are mapped by C-CAP (see Table 3.12-1; NOAA, 2006) within the project area. No submerged or floating freshwater aquatic vegetation occurs within the project footprint and none will be impacted by the project.

3.12.2.2.2 Freshwater Marshes (Palustrine Emergent Wetland)

The estuarine system extends landward to the point where salinity is less than 0.5 ppt (during average annual low flow) (Cowardin et al., 1979). Most of the freshwater marshes are located more inland than the estuarine marshes; however, some do occur in swales near the Gulf shoreline. Common species include spikerush (*Eleocharis* sp.), flat-sedge (*Cyperus* spp.), rushes (*Juncus* spp.), smartweed (*Polygonum* sp.), coastal water-hyssop (*Bacopa monnieri*), seashore paspalum (*Paspalum vaginatum*), California bulrush (*Schoenoplectus californicus*), coastal cattails (*Typha domingensis*), jointed flatsedge, and American bulrush (*Schoenoplectus pungens*). According to C-CAP, there are approximately 3,020 acres of palustrine emergent wetlands in the project area. As previously mentioned, C-CAP data are more accurate at larger spatial scales and coarser-grained spatial analysis, and may overestimate vegetation or habitat types at the project footprint spatial scale. Field verifications within PAs 8 and 9 revealed some overestimates of this vegetation type. Within the project footprint, PA 8 (which contains two small stock ponds) contains common arrowhead (*Sagittaria* sp.), Walteri millet (*Echinochloa walterii*), rattle bush (*Sesbania drummondii*), seacoast sumpweed (*Iva annua*), frogfruit, St. Augustine grass (*Stenoptaphrum secundatum*), Chinese tallow (*Sapium sebiferum*), marshhay cordgrass, gulf cordgrass (*Spartina spartinae*), sea-ox eye daisy, and smooth cordgrasss. PA 8 is adjacent to a prominent wetland swale, which has been excluded from project impacts through avoidance measures. Ephemeral wetland swales on PAs 8 and 9 generally consist of a semipermanent water regime, with water depths potentially approaching 3–5 inches during winter months. Within the project footprint at PAs 8 and 9, there are 39 acres of ephemeral freshwater marsh that will be impacted by the project (see Table 3.12-1).

3.12.2.2.3 Freshwater Shrub/Scrub Wetlands

Freshwater shrub/scrub wetlands in the coastal zone may include woody species such as buttonbush (*Cephalanthus occidentalis*), baccharis shrub (*Baccharis* sp.), big leaf sumpweed, and tamarisk. According to C-CAP, there are approximately 1,106 acres of palustrine shrub/scrub wetlands in the project area. Within the project footprint, there are no freshwater shrub/scrub wetlands (see Table 3.12-1).

3.12.2.2.4 Freshwater Forested Wetlands

Forested wetlands, typical of the Columbia Bottomlands, are located farther inland than the project area, and are upstream along the Brazos River, creeks, and sloughs, as described earlier. The plant communities may include Ash Flats (dominated by green ash and including water hickory, eastern swamp privet, and swamp panic grass) and Water Oak Flats. Bald cypress (*Taxodium distichum*) also occurs along some of the waterways. There are some forested wetlands, mapped by C-CAP, within leveed (impounded) areas. It is assumed that these are not the more mature communities described above but are more likely to be dominated by black willow (*Salix nigra*), Chinese tallow, or similar pioneer-type species. None of these wetlands have direct hydrologic connections to the Freeport Harbor Channel. C-CAP data identify 248 acres of freshwater forested wetlands within the project area. No freshwater forested wetlands occur within the project footprint.

***3.12.2.2.5 Freshwater Flats* (Unconsolidated Shore)**

Freshwater flats are unvegetated to sparsely vegetated areas with sand or mud substrate. Common species are the same as freshwater marshes. Although C-CAP data (NOAA, 2006) map

946 acres of ‘unconsolidated shore’ (which includes flats) within the project area, C-CAP data do not differentiate between estuarine and palustrine ‘unconsolidated shore’ (including flats). Figure 3.12-2 does not map the freshwater flats as a unique feature. However, the relative location to estuarine waters as shown on Figure 3.12-2 indicates whether flats would likely be estuarine or palustrine. As previously mentioned, C-CAP data are more accurate at larger spatial scales and coarser-grained spatial analysis, and may overestimate vegetation or habitat types at the project footprint spatial scale. No freshwater flats occur within the Freeport Harbor Channel or within the project footprint.

3.13 TERRESTRIAL WILDLIFE

The study area is within the Texan Biotic Province, as described by Blair (1950). The climate of the region is moist subhumid, with some excess rainfall. The vertebrate fauna of the province includes considerable elements of Austroriparian as well as grassland species. Wildlife habitats within the study area include beach, shell ramp-barrier flats, dredged material, saltwater marsh, brackish to freshwater marsh, fresh to brackish waterbodies (i.e., ponds and lakes), inland freshwater marsh, grassland, and riparian forest (McGowen et al., 1976).

The Texan Biotic Province supports a diverse fauna composed of a mixture of species common to neighboring provinces. Austroriparian species from the east are generally restricted to forests, bogs, and marshes. Grassland species, entering the area from the west, are generally restricted to the prairies. No vertebrate species are endemic to the Texan Biotic Province (Blair, 1950).

At least 49 mammal species occur or have occurred in the Texan Biotic Province (Blair, 1950). Although terrestrial habitat is of limited extent in the study area, common terrestrial mammals of potential occurrence include Virginia opossum (*Didelphis virginiana*), least shrew (*Cryptotis parva*), nine-banded armadillo (*Dasypus novemcinctus*), swamp rabbit (*Sylvilagus aquaticus*), eastern cottontail (*Sylvilagus floridanus*), black-tailed jackrabbit (*Lepus californicus*), eastern fox squirrel (*Sciurus niger*), American beaver (*Castor canadensis*), marsh rice rat (*Oryzomys palustris*), fulvous harvest mouse (*Reithrodontomys fulvescens*), white-footed mouse (*Peromyscus leucopus*), northern pygmy mouse (*Baiomys taylori*), hispid cotton rat (*Sigmodon hispidus*), eastern woodrat (*Neotoma floridana*), nutria (*Myocastor coypus*), coyote (*Canis latrans*), common gray fox (*Urocyon cinereoargenteus*), northern raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), bobcat (*Lynx rufus*), and white-tailed deer (*Odocoileus virginianus*) (Schmidly, 2004).

At least 16 species of lizards and 39 species of snakes occur or have occurred in the Texan Biotic Province (Blair, 1950). In addition, at least 5 urodeles (newts and salamanders) and 18 anurans (frogs and toads) have occurred in the Texan Biotic Province (Blair, 1950). Terrestrial amphibian and reptile species of potential occurrence in the study area include Blanchard’s cricket frog (*Acris crepitans blanchardi*), Gulf Coast toad (*Bufo nebulifer*), Cope’s gray treefrog (*Hyla* *chrysoscelis*), green treefrog (*Hyla cinerea*), squirrel treefrog (*Hyla squirella*), gray treefrog (*Hyla versicolor*), American bullfrog (*Rana catesbeiana*), southern leopard frog (*Rana sphenocephala*), small-mouthed salamander (*Ambystoma texanum*), green anole (*Anolis carolinensis*), eastern six-lined racerunner (*Aspidoscelis sexlineata sexlineata*), Mediterranean house gecko (*Hemidactylus turcicus*), little brown skink (*Scincella lateralis*), southern copperhead (*Agkistrodon contortrix contortrix*), western cottonmouth (*Agkistrodon piscivorus leucostoma*), eastern yellow-bellied racer (*Coluber constrictor flaviventris*), western diamond-backed rattlesnake (*Crotalus atrox*), Texas ratsnake (*Elaphe obsoleta*), western coachwhip (*Masticophis flagellum testaceus*), several species of watersnake (*Nerodia* spp.), Gulf saltmarsh snake (*Nerodia clarkii clarkii*), Gulf Coast ribbonsnake (*Thamnophis proximus orarius*), and three-toed box turtle (*Terrapene carolina triunguis*) (Dixon, 2000).

The immediate study area and vicinity support an abundant and diverse avifauna. Tidal flats, bay margins, and beaches provide excellent habitat for numerous species of herons and egrets, shorebirds, wading birds, gulls, and terns. According to the USFWS Texas Colonial Waterbird Census (TCWC) (USFWS, 2010), several rookeries occur within the study area (Figure 3.13-1). Table 3.13-1 provides information on nesting activities at these rookeries. Common species of potential occurrence in the study area include great blue heron (*Ardea herodias*), great egret (*Ardea alba*), snowy egret (*Egretta thula*), little blue heron (*Egretta caerulea*), white ibis (*Eudocimus albus*), roseate spoonbill (*Platalea ajaja*), clapper rail (*Rallus longirostris*), common moorhen (*Gallinula chloropus*), killdeer (*Charadrius vociferus*), black-necked stilt (*Himantopus mexicanus*), yellowlegs (*Tringa* spp.), willet (*Catoptrophorus semipalmatus*), long-billed curlew (*Numenius americanus*), sanderling (*Calidris alba*), least sandpiper (*Calidris minutilla*), dunlin (*Calidris alpina*), dowitchers (*Limnodromus* spp.), Wilson's snipe (*Gallinago delicata*), laughing gull (*Larus atricilla*), ring-billed gull (*Larus delawarensis*), herring gull (*Larus argentatus*), Forster's tern (*Sterna forsteri*), and least tern (*Sternula antillarum*) (Richardson et al., 1998). In addition, prairies and marshes provide habitat for numerous waterfowl, several species of raptors, and a variety of songbirds. Texas is one of the most significant waterfowl wintering regions in North America with 3 to 5 million waterfowl annually wintering in the state (Texas Coastal Management Program [TCMP], 1996). In addition, the mainland and barrier islands of the Texas Gulf Coast provide critical stopover habitat for numerous species of neotropical songbirds during migration.

3.14 AQUATIC ECOLOGY

3.14.1 Aquatic Communities

Many aquatic communities are present in the study area that serve to support ecological diversity and abundance. These include commercial and recreational species, oyster reef habitat, and offshore sands, as discussed in the following sections. In general, fish species found mainly in

Rookery

N W E S

0 6,250 12,500

Feet

Figure 3.13-1
Rookeries
in and near the Project Area

Prepared for: USACE Galveston

Job No.: 044190100	Scale: 1 inch equals 6,250 feet
Prepared by: A.Christiansen	Date: 03/14/2008

File: N:/Clients/U_Z/USACE/Projects/Freeport/044190100/projects/Figures/Fig_3_11_1.mxd

Table 3.13-1
Number of Nests of Colonial Waterbirds at Selected Rookeries in the Study Area

Rookery/ ID	Common Name	Scientific Name	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000
Freeport Dow/ 610-100	Black skimmer	*Rynchops niger*	–	–	–	–	320	380	–	1,600	725	500
	Gull-billed tern	*Sterna* (now *Gelochelidon*) *nilotica*	–	–	–	–	–	25	–	60	72	60
	Least tern	*Sterna* (now *Sternula*) *antillarum*	–	–	–	–	40	30	–	40	50	17
Bryan Beach State Park/ 610-101	Black skimmer	*Rynchops niger*	–	–	–	–	–	–	–	–	–	–
	Least tern	*Sterna (*now *Sternula) antillarum*										
Bryan Beach Spoil/ 610-102	Tricolored heron	*Egretta tricolor*	–	–	–	–	–	–	–	–	–	–
	Little blue heron	*Egretta caerulea*	–	–	–	–	–	–	–	–	–	–
	Least tern	*Sterna* (now *Sternula*) *antillarum*	–	–	–	–	–	–	–	–	–	–
	Great egret	*Ardea alba*	–	–	–	–	–	–	–	–	–	–
	Great blue heron	*Ardea herodias*	–	–	–	–	–	–	–	–	–	–
	Cattle egret	*Bubulcus ibis*	–	–	–	–	–	–	–	–	–	–
	Black skimmer	*Rynchops niger*	–	–	–	–	–	–	–	–	–	–
Bryan Mound/ 610-103	Roseate spoonbill	*Ajaia ajaja*	–	–	–	–	–	–	–	–	8	30
	Neotropic cormorant	*Phalacrocorax brasilianus*	–	–	–	–	–	–	–	–	20	60
	Least tern	*Sterna* (now *Sternula*) *antillarum*	–	–	–	–	–	–	–	–	5	15
	Gull-billed tern	*Sterna* (now *Gelochelidon*) *nilotica*	–	–	–	–	–	–	–	–	–	–
	Great egret	*Ardea alba*	–	–	–	–	–	–	–	–	5	4
	Great blue heron	*Ardea herodias*	–	–	–	–	–	–	–	–	4	3
	Cattle egret	*Bubulcus ibis*	–	–	–	–	–	–	–	–	–	200

Table 3.13-1 (Cont'd)

Rookery/ ID	Common Name	Scientific Name	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000
	White ibis	*Eudocimus albus*	–	–	–	–	–	–	–	–	–	–
	White-faced ibis	*Plegadis chihi*	–	–	–	–	–	–	–	–	–	–
	Tricolored heron	*Egretta tricolor*	–	–	–	–	–	–	–	–	–	–
	Snowy egret	*Egretta thula*	–	–	–	–	–	–	–	–	1	–
	Black-crowned night-heron	*Nycticorax nycticorax*	–	–	–	–	–	–	–	–	–	2
Dow Gate A-40/ 610-104	Least tern	*Sterna* (now *Sternula*) *antillarum*	24	–	–	–	–	–	–	–	6	2
	Gull-billed tern	*Sterna* (now *Gelochelidon*) *nilotica*	50	–	–	–	–	–	–	–	–	–
	Black skimmer	*Rynchops niger*	500	–	–	–	–	–	–	–	–	–
Dow Tern/ 610- 105	Least tern	*Sterna* (now *Sternula*) *antillarum*	–	–	–	–	–	–	–	–	–	–
Bryan Beach Diked Spoil/ 610-106	N/A		–	–	–	–	–	–	–	–	–	–

Source: TCWC Database (USFWS, 2010)

shallow areas include Gulf killifish (*Fundulus grandis*), sheepshead minnow (*Cyprinodon variegates*), and silversides (*Menidia* sp.) (Pattillo et al., 1997). Inhabitants of marsh areas include the pinfish (*Lagodon rhomboids*), silver perch (*Bairdiella chrysoura*), and gizzard shad (*Dorosoma cepedianum*) (Pattillo et al., 1997). Species often found in deeper areas include the Atlantic croaker (*Micropogonias undulatus*), Gulf menhaden (*Brevoortia patronus*), and hardhead catfish (*Arius felis*), while a number of fish occur in abundance in both marsh and deeper areas, including bay anchovy (*Anchoa mitchilli*), spot (*Leiostomus xanthurus*), and striped mullet (*Mugil cephalus*) (Pattillo et al., 1997). These species are ubiquitous along the Texas coast with seasonal differences in abundance. Newly spawned fish and shellfish begin migrating into the estuary in winter and early spring, with the maximum biomass observed during the summer months (Parker, 1965). A list of fish species found in the study area is presented in Table 3.14-1. Marine mammals of potential occurrence in the study area include the bottlenose dolphin (*Tursiops truncatus*).

The entire food chain is dependent on the microscopic plankton that utilize nutrients and provide an abundant food source. The plankton community consists of small plants (phytoplankton) and animals (zooplankton) that are suspended in the water column. Diverse and abundant plankton communities exist throughout the study area. The dominant phytoplankton assemblages include diatoms, green algae, and blue-green algae, while the dominant zooplankton include the barnacle nauplii, the copepod *Acartia tonsa*, and the dinoflagellate *Noctiluca scintillans* (Armstrong et al., 1987).

The open-water bottom includes all areas of the study area not covered with oyster reefs (Lester and Gonzales, 2001). Benthic organisms are divided into two groups: epifauna, such as crabs and smaller crustaceans, which live on the surface of the bottom substrate, and infauna, such as mollusks and polychaetes, which burrow into the bottom substrate (Green et al., 1992). Mollusks and some other infaunal organisms are filter feeders that strain suspended particles from the water column. Others, such as polychaetes, feed by ingesting sediments and extracting nutrients. Many of the epifauna and infauna feed on plankton, and are then fed upon by numerous fish and birds (Armstrong et al., 1987; Lester and Gonzales, 2001). The open-water bottom includes flat areas consisting of mud and sand that contribute large quantities of nutrients and food, making them one of the most important components of this habitat type. The distribution of the benthic macroinvertebrates is primarily influenced by bathymetry and sediment type (Calnan et al., 1988). Benthic macroinvertebrates found in the sediments of the Freeport area are primarily polychaetes, bivalves, gastropods, and crustaceans (Calnan et al., 1988). The dominant bivalves include the dwarf surf clam (*Mulinia lateralis*) and the concentric nut clam (*Nuculana concentrica*); the dominant gastropods are the Eastern white slipper shell (*Crepidula plana*) and the vitrinella (*Vitrinella floridana*); the dominant polychaetes are *Mediomastus californiensis* and *Paraprionospio pinnata*; and the dominant crustaceans are *Ampelisca abdita* and *Ampelisca agassizi*.

Table 3.14-1
Representative Fish Species Found within the Study Area

Common Name	Scientific Name	Relative Abundance
Bay squid	*Lolliguncula brevis*	common
Brown shrimp	*Farfantepenaeus aztecus*	abundant
Pink shrimp	*Farfantepenaeus duorarum*	common
White shrimp	*Litopenaeus setiferus*	abundant
Grass shrimp	*Palaemonetes pugio*	highly abundant
Blue crab	*Callinectes sapidus*	common
Gulf menhaden	*Brevoortia patronus*	abundant
Gizzard shad	*Dorosoma cepedianum*	common
Bay anchovy	*Anchoa mitchilli*	highly abundant
Hardhead catfish	*Arius felis*	common
Sheepshead minnow	*Cyprinodon variegatus*	abundant
Gulf killifish	*Fundulus grandis*	abundant
Silversides	*Menidia* sp.	abundant
Bluefish	*Pomatomus saltatrix*	common
Crevalle jack	*Caranx hippos*	common
Gray snapper	*Lutjanus griseus*	common
Pinfish	*Lagodon rhomboides*	abundant
Silver perch	*Bairdiella chrysoura*	common
Sand trout	*Cynoscion arenarius*	common
Spotted trout	*Cynoscion nebulosus*	common
Spot	*Leiostomus xanthurus*	abundant
Atlantic croaker	*Micropogonias undulatus*	highly abundant
Black drum	*Pogonias cromis*	common
Red drum	*Sciaenops ocellatus*	common
Striped mullet	*Mugil cephalus*	common
Spanish mackerel	*Scomberomorous maculatus*	rare
Southern flounder	*Paralichthys lethostigma*	common
Gag grouper	*Mycteroperca microlepis*	occurrence
Scamp	*Mycteroperca phenax*	occurrence
Red snapper	*Lutjanus campechanus*	common
Lane snapper	*Lutjanus synagris*	common
Greater amberjack	*Seriola dumerilli*	common
King mackerel	*Scomberomorus cavalla*	common
Cobia	*Rachycentron canadum*	common

Source: Pattillo et al. (1997); Gulf of Mexico Fisheries Management Council (GMFMC, 2004).

Aquatic reptiles of potential occurrence in the study area include American alligator (*Alligator mississippiensis*), snapping turtle (*Chelydra serpentina*), Mississippi mud turtle (*Kinosternon subrubrum hippocrepis*), stinkpot (*Sternothorus odoratus*), red-eared slider (*Trachemys scripta elegans*), and Texas diamond-backed terrapin (*Malaclemys terrapin littoralis*).

The project area includes a small portion of the Old Brazos River Channel, and the Gulf nearshore waters at the Freeport Harbor Channel. Within the project area, environmental fluctuations are extreme and the inhabitant biota reflect and are adapted to this lack of stability in the environment (Warshaw, 1975). Large changes in habitat can occur on a daily basis with respect to wind, tidal action, salinity regimes, and freshwater inflow. These ongoing natural processes are coupled with other natural events such as freezes, droughts, hurricanes, and anthropogenic pressures (i.e., management practices and coastal projects) in the study area. Nevertheless, the biological community present in the project area remains diverse and abundant. The Gulf nearshore community includes many species found in both estuarine and offshore oceanic habitats (Tunnell et al., 1996). Most of the species in the Gulf nearshore waters are temperate in biogeographic distribution with a few tropical species (Tunnell et al., 1996).

3.14.1.1 Commercial and Recreational Species

Over the years, many commercially important fish have been subject to overfishing and subsequent decline in the Gulf. In recent years, however, certain fish stocks in the Gulf are no longer overfished and are beginning to show signs of rebuilding (NOAA, 2004). TPWD does not collect commercial or recreational fishery statistics for the Brazos River estuary. The most important commercially harvestable species that utilize the Brazos River estuary include brown shrimp (*Farfantepenaeus aztecus*), white shrimp (*Litopenaeus setiferus*), pink shrimp (*Farfantepenaeus duorarum*), blue crab (*Callinectes sapidus*), and southern flounder (*Paralichthys lethostigma*). Important recreational species include red drum (*Sciaenops ocellatus*), red snapper (*Lutjanus campechanus*), speckled trout (*Cynoscion nebulosus*), black drum (*Pogonias cromis*), southern flounder, greater amberjack (*Seriola dumerili*), Spanish mackerel (*Scomberomorus maculatus*), and king mackerel (*Scomberomorus cavalla*). No oysters are commercially harvested within the project area.

3.14.1.2 Oyster Reef Habitat

Many organisms, including mollusks, barnacles, crabs, gastropods, amphipods, polychaetes, and isopods, can be found living on oyster reefs, forming a very diverse community (Sheridan et al., 1989). Oyster reef communities are dependent upon food resources from the open bay and marshes. Many organisms feed on oysters including fish, such as black drum, crabs (*Callinectes* spp.), and gastropods such as the oyster drill (*Thais haemastoma*) (Lester and Gonzales, 2001; Sheridan et al., 1989). When oyster reefs are exposed during low tides, shore birds will use the reef areas as resting places (Armstrong et al., 1987).

Scattered reefs of eastern oyster (*Crassostrea virginica*) are present in areas surrounding Oyster Creek, and scattered oysters are found in many of the nearby open-water areas (Swan Lake, Bryan Lake); however, no oysters are found within the immediate project area. Oysters are not commercially harvested from the project area. The Freeport area has been classified as restricted by the Texas Department of State Health Services (TDSHS, formerly the Texas Department of Health) and is closed to the harvesting of molluscan shellfish from this system (TDSHS, 2007). In addition, TDSHS does not have any bay water sampling stations for monitoring oysters within the project area (Heideman, 2006).

3.14.1.3 Offshore Sands

Few seagrasses or attached algae are found in the offshore sands within the project area due to the strong currents and unstable sediments. Most of the bottom surface is populated with macroinfauna, with the exception of an occasional hermit crab, portunid crab, or ray. Even though there is little life on the sand surface itself, the overlying waters are highly productive. Phytoplankton are abundant, including microscopic diatoms, dinoflagellates, and other algae (Britton and Morton, 1989).

Much of the faunal diversity lies buried in the sand and relies on the phytoplankton for food. Bivalves found in offshore sands include the blood ark (*Anadara ovalis*), incongruous ark (*Anadara brasiliana*), southern quahog (*Mercenaria campechiensis*), giant cockle (*Dinocardium robustum*), disk dosinia (*Dosinia discus*), pen shells (*Atrina serrata*), common egg cockle (*Laevicardium laevigatum*), cross-barred venus (*Chione cancellata*), tellins (*Tellina* spp.), and the tusk shell (*Dentalium texasianum*). One of the most common species occurring in the shallow offshore sands is the sand dollar (*Mellita quinquiesperforata*) as well as several species of brittle stars (*Hemipholis elongata*, *Ophiolepis elegans*, and *Ophiothrix angulata*). Many gastropods are common, including the moon snail (*Polinices duplicatus*), ear snail (*Sinum perspectivum*), Texas olive (*Oliva sayana*), Atlantic auger (*Terebra dislocata*), Salle's auger (*Terebra salleano*), scotch bonnet (*Phalium granulatum*), distorted triton (*Distorsio clathrata*), wentletraps (*Epitonium* spp.), and whelks (*Busycon* spp.). Crustaceans inhabiting these waters include white and brown shrimp (both commercially caught species), rock shrimp (*Sicyonia brevirostris*), blue crabs, mole crabs (*Albunea* spp.), speckled crab (*Arenaeus cribrarius*), box crab (*Calappa sulcata*), calico crab (*Hepatus epheliticus*), and pea crab (*Pinotheres maculatus*). The most abundant infaunal organism, with respect to the number of individuals, are the polychaetes (Capitellidae, Orbiniidae, Magelonidae, and Paraonidae) (Britton and Morton, 1989).

3.14.2 Essential Fish Habitat

Congress enacted amendments to the Magnuson-Stevens Fishery Conservation and Management Act (PL 94-265) in 1996 that established procedures for identifying essential fish habitat (EFH) and required interagency coordination to further the conservation of federally managed fisheries.

Rules published by National Marine Fisheries Service (NMFS) (50 CFR Sections 600.805–600.930) specify that any Federal agency that authorizes, funds, or undertakes, or proposes to authorize, fund, or undertake an activity that could adversely affect EFH is subject to the consultation provisions of the above-mentioned act. The rules also identify consultation requirements. The DEIS initiated EFH consultation under the Magnuson-Stevens Fishery Conservation and Management Act.

EFH is defined as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity” (16 U.S. Code 1802(10)). EFH is separated into estuarine and marine components. The estuarine component is defined as “all estuarine waters and substrates (mud, sand, shell, rock, and associated biological communities); sub-tidal vegetation (seagrasses and algae); and adjacent inter-tidal vegetation (marshes and mangroves).” The marine component is defined as “all marine waters and substrates (mud, sand, shell, rock, and associated biological communities) from the shoreline to the seaward limit of the Exclusive Economic Zone” (Gulf of Mexico Fisheries Management Council [GMFMC], 2004).

The GMFMC has identified the project area as EFH for adult and juvenile brown, white, and pink shrimp, red drum, gag grouper (*Mycteroperca microlepis*), scamp (*Mycteroperca phenax*), red snapper, gray snapper (*Lutjanus griseus*), lane snapper (*Lutjanus synagris*), greater amberjack, king mackerel, Spanish mackerel, cobia (*Rachycentron canadum*), Atlantic bluefin tuna (*Thunnus thynnus*), bonnethead shark (*Sphyrna tiburo*), blacktip shark (*Carcharhinus leucas*), bull shark (*C. leucas*), and Atlantic sharpnose shark (*Rhizoprionodon terraenovae*) (Appendix A-4). The categories of EFH that occur within the project area include estuarine water column, estuarine mud and sand bottoms (unvegetated estuarine benthic habitats), estuarine emergent wetlands, marine water column, and marine nonvegetated bottoms. EFH that occurs within the project footprint includes marine water column and marine nonvegetated bottoms. Although there are a few areas of quality EFH within the project area, the habitat within the project footprint in the Freeport Harbor Channel and areas immediately adjacent to the project footprint is dominated by industrial, commercial, and residential development, which does not represent high-quality EFH. Additionally, marine water column and marine nonvegetated bottoms occur in abundance within the study area and are, therefore, not unique to the area.

The following describes the preferred habitat, life history stages, and relative abundance of each federally managed species based on information provided by GMFMC (2004). Table 3.14-2 describes EFH for each of these species.

Brown Shrimp: Brown shrimp eggs are demersal (bottom-dwelling) and are deposited offshore. The larvae begin to migrate through passes with flood tides into estuaries as postlarvae. Migrating occurs at night mainly from February to April, with a minor peak in the fall. Brown shrimp postlarvae and juveniles are associated with shallow vegetated habitats in estuaries, but

Table 3.14-2
Essential Fish Habitat – Adult and Juvenile Presence
in Port Freeport Study Area

<table>
<tr><th rowspan="2">Common Name/
Scientific Name</th><th colspan="2">ESTUARINE</th><th colspan="2">MARINE</th></tr>
<tr><th>Adults</th><th>Juvenile</th><th>Adults</th><th>Juvenile</th></tr>
<tr><td rowspan="2">Brown shrimp
(Farfantepenaeus aztecus)</td><td rowspan="2">not present</td><td rowspan="2">abundant
year-round</td><td>major adult area
spring, summer, fall</td><td>spawning area</td></tr>
<tr><td colspan="2">spawn year-round at
depths greater than 13 m</td></tr>
<tr><td>White shrimp
(Litopenaeus setiferus)</td><td>common
April–June</td><td>abundant
November–June

highly abundant
July–October</td><td>adult area year-round</td><td>not present in
study area</td></tr>
<tr><td>Pink shrimp
(Farfantepenaeus duroarum)</td><td>not present</td><td>common
November–March</td><td>adult area year-round
summer spawning</td><td>not present in
study area</td></tr>
<tr><td>Red drum
(Sciaenops ocellatus)</td><td>no data</td><td>common
year-round</td><td>adult area year-round</td><td>spawning area
fall and winter – spawn in
shallow coastal waters</td></tr>
<tr><td>Gag grouper
(Mycteroperca microlepis)</td><td>not present</td><td>not present</td><td>adult occurrence</td><td>not present
in study area</td></tr>
<tr><td>Scamp
(Mycteroperca phenax)</td><td>not present</td><td>not present</td><td>adult occurrence</td><td>not present in
study area</td></tr>
<tr><td>Red snapper
(Lutjanus campechanus)</td><td>not present</td><td>not present</td><td>not present in
project area</td><td>nursery area year-round</td></tr>
<tr><td>Gray snapper
(Lutjanus griseus)</td><td>not present</td><td>not present</td><td>major adult area
year-round
spawn June to August</td><td>nursery area</td></tr>
<tr><td>Lane snapper
(Lutjanus synagris)</td><td>not present</td><td>not present</td><td>not present in
project area</td><td>nursery area</td></tr>
<tr><td>Greater amberjack
(Seriola dumerilli)</td><td>not present</td><td>not present</td><td>adult area year-round
year-round spawning</td><td>nursery area year-round</td></tr>
<tr><td rowspan="2">King mackerel
(Scomberomorus cavalla)</td><td rowspan="2">not present</td><td rowspan="2">not present</td><td>adult area year-round</td><td>nursery area year-round</td></tr>
<tr><td colspan="2">spawn May to November</td></tr>
<tr><td>Spanish mackerel
(Scomberomorus maculatus)</td><td>common
April–October

rare
November–March</td><td>rare
July–October</td><td>adult area year-round</td><td>spawning area
summer and fall

nursery area
year-round</td></tr>
<tr><td rowspan="2">Cobia
(Rachycentron canadum)</td><td rowspan="2">not present</td><td rowspan="2">not present</td><td>adult area summer</td><td>nursery area year-round</td></tr>
<tr><td colspan="2">spawn in spring and summer</td></tr>
<tr><td>Atlantic bluefin tuna
(Thunnus thynnus)</td><td>not present</td><td>not present</td><td>potential occurrence</td><td>potential occurrence</td></tr>
<tr><td>Bonnethead shark
(Sphyrna tiburo)</td><td>potential
occurrence</td><td>potential
occurrence</td><td>potential occurrence</td><td>potential occurrence</td></tr>
<tr><td>Blacktip shark
(Carcharhinus limbatus)</td><td>not present</td><td>potential
occurrence</td><td>potential occurrence</td><td>potential occurrence</td></tr>
<tr><td>Bull shark
(Carcharhinus leucas)</td><td>potential
occurrence</td><td>potential
occurrence</td><td>potential occurrence</td><td>potential occurrence</td></tr>
<tr><td>Atlantic sharpnose shark
(Rhizoprionodon terraenovae)</td><td>potential
occurrence</td><td>potential
occurrence</td><td>potential occurrence</td><td>potential occurrence</td></tr>
</table>

are also found over silty sand and nonvegetated mud bottoms. Postlarvae and juveniles occur in salinity ranging from zero to 70 ppt. The density of late postlarvae and juvenile brown shrimp is highest in marsh-edge habitat and submerged vegetation, followed by tidal creeks, inner marsh, shallow, open water, and oyster reefs. Muddy substrates seem to be preferred in unvegetated areas. Juvenile and subadult brown shrimp can be found from secondary estuarine channels out to the continental shelf, but prefer shallow estuarine habitats, such as soft, muddy areas associated with plant-water interfaces. Subadult brown shrimp migrate from estuaries, at night, on ebb tides during new and full moon phases in the Gulf. Their abundance offshore correlates positively with turbidity and negatively with hypoxia (low levels of oxygen in the water). Adult brown shrimp inhabit neritic Gulf waters (marine waters extending from MLT to the edge of the continental shelf) and are associated with silt, muddy sand, and sandy substrates (GMFMC, 2004). Juvenile brown shrimp are common within the study area estuaries year-round.

Larval brown shrimp feed on phytoplankton and zooplankton. Postlarvae brown shrimp feed on phytoplankton, epiphytes, and detritus. Juvenile and adult brown shrimp prey on amphipods, polychaetes, and chironomid larvae, but graze on algae and detritus (Pattillo et al., 1997).

White Shrimp: White shrimp inhabit Gulf and estuarine waters and are pelagic or demersal, depending on their life stage. Their eggs are demersal and larval stages are planktonic, and both occur in nearshore Gulf waters. Postlarvae migrate into estuaries through passes from May to November, with most migration occurring in June and September. Migration is in the upper 6.5 feet of the water column at night and at mid-depths during the day. Postlarval white shrimp become benthic once they reach the estuary. Here they seek shallow water with mud or sand bottoms high in organic detritus or rich marsh where they develop into juvenile white shrimp. Postlarvae and juveniles prefer mud or peat bottoms with large quantities of decaying organic matter or SAV. Densities are usually highest along marsh edge and in SAV, followed by marsh ponds and channels, inner marsh, and oyster reefs. White shrimp juveniles prefer salinities of less than 10 ppt and occur in tidal rivers and tributaries. As white shrimp juveniles mature, they migrate to coastal areas where they mature and spawn. Adult white shrimp are demersal and inhabit soft mud or silt bottoms (GMFMC, 2004).

Adult and juvenile white shrimp are common to highly abundant in the estuary throughout the year. Adult white shrimp also occur throughout the Gulf to depths of about 131 feet. White shrimp larvae feed on phytoplankton and zooplankton. White shrimp postlarvae feed on phytoplankton, epiphytes, and detritus. Juvenile and adult white shrimp prey on amphipods, polychaetes, and chironomid larvae, but also graze on algae and detritus (Pattillo et al., 1997).

Pink Shrimp: Pink shrimp inhabit Gulf and estuarine waters and are pelagic or demersal, depending on their life stage. After spawning offshore, postlarval pink shrimp recruitment into the estuaries occurs in the spring and fall through passes. Juveniles can be found in SAV meadows where they burrow into the substrate; however, postlarvae, juvenile, and adults may prefer a mixture of coarse sand/shell/mud. Densities of pink shrimp are lowest or absent in marshes, low in mangroves, and greatest near or in SAV. Adults occur offshore in depths of 30 to 145 feet and prefer substrates of coarse sand and shell (GMFMC, 2004). Juvenile pink shrimp are common from November through March in the study area estuaries.

Pink shrimp feed on phytoplankton and zooplankton. Postlarvae feed on phytoplankton, epiphytes, and detritus. Juveniles and adults prey on amphipods, polychaetes, and chironomid larvae but also on algae and detritus (Pattillo et al., 1997). The habitat of these prey is essentially the same as that required by shrimp, estuarine and marine.

Red Drum: Red drum occupy a variety of habitats, ranging from offshore depths of 131 feet to very shallow estuarine waters. Spawning occurs in the Gulf near the mouths of bays and inlets during the fall and early winter. Eggs usually hatch in the Gulf, and larvae are transported with tidal currents into the estuaries where they mature. Adult red drum use estuaries, but tend to migrate offshore where they spend most of their adult life. Red drum occur over a variety of substrates including sand, mud, and oyster reefs and can tolerate a wide range of salinities (GMFMC, 2004).

Estuaries are especially important to larval, juvenile, and subadult red drum. Juvenile red drum are most abundant around marshes, preferring quiet, shallow, protected waters over mud substrate or among SAV. Subadult and adult red drum prefer shallow bay bottoms and oyster reefs (GMFMC, 2004). Adult red drum that migrate into the Gulf are pelagic.

Estuaries are also important for the prey of larval, juvenile, and subadult red drum. Red drum larvae feed primarily on shrimp, mysids, and amphipods, while juvenile red drum prefer fish and crabs. Adult red drum feed primarily on shrimp, blue crab, striped mullet, and pinfish (GMFMC, 2004). Juvenile red drum are common year-round within the estuary.

Gag Grouper: Gag grouper are demersal and are most common in the eastern Gulf. Eggs are pelagic and are spawned from December through April. Larvae are pelagic and most abundant in the early spring. Postlarvae and pelagic juveniles move through inlets into high-salinity estuaries from April through May, where they become benthic and settle into grass flats and oyster beds. Older juveniles move offshore in the fall to shallow reef habitat in depths of 3 to 165 feet. Adults prefer depths of 33 to 328 feet and utilize hard bottoms, oil platforms, and artificial reefs. Spawning occurs on the west Florida shelf from December through April (GMFMC, 2004).

Gag grouper feed on estuarine-dependent organisms such as shrimp, small fish, and crabs during their juvenile stages. As they mature and move offshore, they become opportunistic predators, feeding on a variety of fish and crustaceans (GMFMC, 2004). Adult gag grouper occur in Gulf waters within the study area.

Scamp: Scamp are demersal and widely distributed on shelf areas of the Gulf. Scamp eggs and larvae are pelagic and are spawned offshore in the spring. Juvenile scamp occur on shallow, nearshore hard bottoms and reefs in depths of 40 to 620 feet. Scamp spawn in aggregations from late February to early June.

Juvenile scamp feed on estuarine-dependent organisms such as shrimp, small fish, and crabs. As they mature and move offshore, they become opportunistic predators, feeding on a variety of fish and crustaceans (GMFMC, 2004). Adult scamp occur in Gulf waters within the study area.

Red Snapper: Red snapper are demersal and found over sand and rock substrates around reefs, and underwater objects to depths of 656 feet. However, adult red snapper prefer depths ranging from 131 to 360 feet (GMFMC, 2004). Spawning occurs in the Gulf from May to October, at depths of 60 to 122 feet over fine sand substrate. Larvae, postlarvae, and early juveniles occur from July through November in shelf waters. Early and late juveniles are often associated with underwater structures or small burrows, but are also abundant over barren sand and mud bottoms.

Juvenile red snapper feed on shrimp, but after age one, prey primarily on fish and squid. Of the vertebrates consumed, most are not obligate reef dwellers, indicating that red snapper feed away from reefs (GMFMC, 2004). Juvenile red snapper occur in the Gulf waters within the study area.

Gray Snapper: Gray snapper can be demersal, structure, or mid-water dwellers inhabiting marine, estuarine, and riverine habitats. They inhabit depths to about 550 feet in the Gulf. Juvenile gray snapper are common in shallow water around SAV, while adult gray snapper tend to congregate in deeper Gulf waters around natural and artificial reefs. Spawning occurs in the Gulf from June to August around structures and shoals. Their eggs are pelagic and the larvae are planktonic, both occurring in Gulf shelf waters and near coral reefs. Postlarvae migrate into the estuaries and are most abundant over *Halodule* and *Syringodium* grassbeds. Juveniles seem to prefer *Thalassia* grassbeds, seagrass meadows, marl bottoms, and mangrove roots, and are found in estuaries, bayous, channels, grassbeds, marshes, mangrove swamps, ponds, and freshwater creeks (GMFMC, 2004).

Juvenile gray snapper feed on estuarine-dependent organisms such as shrimp, small fish, and crabs. Gray snapper are classified as opportunistic carnivores at all life stages (Pattillo et al., 1997). In estuaries, juvenile gray snapper feed on shrimp, larval fish, amphipods, and copepods. Adult gray snapper feed primarily on fish, but smaller individuals will prey on crustaceans (GMFMC, 2004). Adult and juvenile gray snapper are found in the Gulf waters of the study area.

Lane Snapper: Lane snapper are demersal, occurring over all substrate types, but are most commonly found near coral reefs and sandy bottoms. Spawning occurs in Gulf waters from March through September. Nursery areas include mangrove and grassy estuarine habitats in southern Texas and Florida and shallow waters with sand and mud bottoms along all Gulf states.

Juvenile lane snapper appear to favor grass flats, reefs, and soft bottoms to depths of 66 feet. Adult lane snapper occur offshore in depths ranging from 13 to 433 feet near sand bottoms, natural channels, banks, and artificial and natural structures (GMFMC, 2004).

Juvenile lane snapper feed on estuarine-dependent organisms such as shrimp, small fish, and crabs. Lane snapper are considered to be unspecialized, opportunistic predators, feeding on a variety of crustaceans and fish. However, adult lane snapper tend to prefer fish (GMFMC, 2004). Juvenile lane snapper are found in estuaries and Gulf waters within the study area.

Greater Amberjack: Greater amberjack occur throughout the Gulf to depths of 1,300 feet. Adults are pelagic and epibenthic, occurring near reefs and artificial structures. Spawning occurs offshore, and juvenile greater amberjack are associated with floating sargassum and debris (GMFMC, 2004). Greater amberjack feed on small fish, crabs, squid, and a variety of crustaceans and invertebrates (GMFMC, 2004). Adult and juvenile greater amberjack are found in the Gulf within the study area.

King Mackerel: King mackerel are pelagic and found in Gulf waters from nearshore to 655 feet. Spawning occurs in the Gulf from May to October. Eggs are pelagic, occurring over depths of 98 to 590 feet. Nursery areas are located in marine waters with juveniles only occasionally entering estuaries (GMFMC, 2004).

While estuaries are important for most king mackerel prey, they feed on a variety of fishes, extensively utilizing herrings. Squid, shrimp, and other crustaceans are also prey for king mackerel. Adult and juvenile king mackerel are found in the Gulf within the study area.

Spanish Mackerel: Spanish mackerel are pelagic, inhabiting depths to 245 feet throughout the Gulf coastal zone. Adult Spanish mackerel are usually found from nearshore to the edge of the continental shelf. However, they may also migrate seasonally into estuaries with high salinity, but this migration is infrequent and rare. Spawning occurs in the Gulf from May through October. Larvae typically occur in the Gulf in depths ranging from 30 to 275 feet. Juveniles inhabit the Gulf surf and sometimes estuarine habitats. However, juvenile Spanish mackerel prefer marine salinities and are not considered estuarine-dependent. Adult and juvenile Spanish mackerel are found in the Gulf year-round within the study area. Juvenile Spanish mackerel prefer clean sand bottoms, but the substrate preferences of the other life stages are unknown (GMFMC, 2004).

While Spanish mackerel rarely use estuarine environments, estuaries are important for most of their prey. They feed on a variety of fishes, extensively herrings. Squid, shrimp, and other crustaceans are also fed upon by Spanish mackerel.

Cobia: Cobia are large pelagic fish, occurring from nearshore to depths of 131 feet near artificial and natural structures, including floating objects. In the study area, cobia occur only in the Gulf and do not use estuarine waters (GMFMC, 2004).

However, estuaries are important for most cobia prey. They feed on a variety of fishes, extensively herrings. Squid, shrimp, and other crustaceans are also prey for cobia (GMFMC, 2004).

3.14.2.1 Highly Migratory Species

Atlantic Bluefin Tuna: Atlantic bluefin tuna are a pelagic species found in brackish to marine waters at depths from 0 to 9,840 feet. Spawning occurs from April to June in the Gulf, but individuals may spawn more than once a year. Larvae are found around the 1,000 fathom curve in the northern Gulf, with intermittent collections off Texas. Juveniles can be found over the continental shelf in the summer and farther offshore in the winter. Adult Atlantic bluefin tuna prey on schooling fish, benthic invertebrates, and cephalopods (NMFS, 2006a). Eggs, larvae, and spawning adults occur in the Gulf portion of the study area.

***Bonnethead Shark*:** Bonnethead sharks can be found on sand or mud bottoms in shallow coastal waters. The bonnethead shark is viviparous, reaching sexual maturity at about 30 inches. The pups are born in late summer and early fall, measuring 12 to 13 inches (Froese and Pauly, 2007). Both juveniles and adults inhabit shallow coastal waters up to 82 feet deep, inlets, and estuaries over sand and mud bottoms (Froese and Pauly, 2007; NMFS, 2006a). They feed mainly on small fish, bivalves, crustaceans, and octopi (Froese and Pauly, 2007). Juveniles and adults occur year-round in the Gulf and estuarine portion of the study area.

***Blacktip Shark*:** Blacktips are fast-moving sharks, occurring in shallow waters and offshore surface waters of the continental shelf. Blacktips are viviparous, and young are born in bay systems in late May and early June after a year-long gestation period. The reproductive cycle occurs every 2 years. Juveniles are found in all Texas bay systems in a variety of habitats and shallow coastal waters from the shore to the 82-foot isobath (NMFS, 2006a). They feed mainly on pelagic and benthic fishes, cephalopods and crustaceans, and small rays and sharks (Froese and Pauly, 2007). Juvenile blacktip sharks occur in the Gulf and estuarine portions of the study area and adults in the Gulf portions of the study area.

***Bull Shark*:** Bull sharks are coastal and freshwater sharks that inhabit shallow waters, especially in bays, estuaries, rivers, and lakes. They frequently move between fresh and brackish water and are capable of covering great distances. Adults are often found near estuaries and freshwater inflows to the sea (Froese and Pauly, 2007). Bull sharks are viviparous, have a gestation period of a little less than 1 year, and it is assumed the reproductive cycle occurs every 2 years. Juveniles are found in waters less than 82 feet deep in shallow coastal waters, inlets, and estuaries (NMFS, 2006a). They feed on bony fishes, sharks, rays, shrimp, crabs, squid, sea urchins, and sea turtles (Froese and Pauly, 2007). Juvenile bull sharks occur in the Gulf and estuarine portions of the study area.

***Atlantic Sharpnose Shark*:** Atlantic sharpnose shark inhabits intertidal to deeper waters, often in the surf zone off sandy beaches, bays, estuaries, and river mouths (Froese and Pauly, 2007). They are viviparous, and mating occurs in June, with a gestation period of about a year (NMFS, 2006a). They feed on fish, shrimp, crab, mollusks, and segmented worms (Froese and Pauly, 2007). Juvenile Atlantic sharpnose shark occur in the Gulf and estuarine portions of the study area.

3.15 THREATENED AND ENDANGERED SPECIES

Congress enacted the ESA [16 USC 1531 et seq.] of 1973, as amended, to provide a program for the preservation of threatened and endangered species and to provide protection for the ecosystems upon which these species depend for their survival. All Federal agencies are required to implement protection programs for these designated species and to use their authorities to further the purposes of the act. An endangered species is one that is in danger of extinction throughout all or a significant portion of its range in the U.S. A threatened species is one likely to become endangered within the foreseeable future throughout all or a significant portion of its range. USFWS and NMFS are the primary agencies responsible for implementing the ESA. USFWS is responsible for terrestrial and freshwater species, while NMFS is responsible for marine and anadromous species.

The State of Texas also has regulations to protect endangered species (chapters 67, 68, and 88 of the TPWD Code and sections 65.171–65.184 and 69.01–69.14 of Title 31 of the Texas Administrative Code). These regulations, administered by TPWD, prohibit commerce of threatened and endangered plants and wildlife and the collection of listed plant species from public land without a permit. This assessment addresses State-listed threatened and endangered species; however, the ESA does not protect these species.

Only those species that USFWS or NMFS lists as threatened or endangered have complete Federal protection under the ESA. Inclusion on the following lists does not imply that a species occurs in the study area, but only acknowledges the potential for occurrence. USFWS (2007), NMFS (2007a), and TPWD (2007) provided county-level lists of endangered and threatened species of potential occurrence in the study area (see Appendix A-2). In addition, TPWD's Texas Natural Diversity Database (TXNDD, 2007) provided digital map data presenting specific locations of listed species within the study area.

3.15.1 Plants

TPWD's official State list of threatened and endangered species includes the same species that USFWS lists as threatened or endangered as well as species that carry a global conservation status indicating a species is critically imperiled, very rare, vulnerable to extirpation, or uncommon. USFWS (2007) currently identifies 30 plant species as threatened or endangered in Texas; however, USFWS indicates no Federal or State-listed plant species of potential occurrence in Brazoria County (USFWS, 2007; TPWD, 2007). TPWD (2007) indicates five plant species as rare species (Table 3.15-1); however, these species have no regulatory listing status. These plant species of potential occurrence in Brazoria County include coastal gay-feather (*Liatris bracteata*), giant sharpstem umbrella-sedge (*Cyperus cephalanthus*), Texas meadow-rue (*Thalictrum texanum*), Texas windmill grass (*Chloris texensis*), and threeflower broomweed (*Thurovia triflora*). Of these, only the Texas meadow-rue is not found throughout coastal habitat types. This plant is most commonly found in upland woodland habitat types and is therefore unlikely to occur within the project area.

The coastal gay-feather is endemic to the Gulf Coastal Plain of Texas in Brazoria County and others, and is found in coastal prairie grasslands of various types, from salty prairie on low-lying somewhat saline clay loams to upland prairie on nonsaline clayey to sandy loams (Poole et al., 2007). This plant is likely to occur in grasslands encompassed by the project area.

The only known extant population of giant sharpstem umbrella-sedge in Texas occurs in Brazoria County. Poole et al. (2007) does not specify the exact location of this population in Brazoria County; however, this population is described as occurring in saturated fine sandy loam soils along nearly level fringes of deep prairie depressions, and frequently occurs with other *Cyperus* species. This species is likely to occur where conditions similar to these are found throughout grassland areas encompassed by the project area.

Texas windmill grass is also endemic to the Gulf Coastal Plain of Texas in Brazoria County. This species is likely to occur in the project area where sandy to sandy loam soils in relatively bare areas in coastal grassland remnants exist, and on roadsides where regular mowing may mimic natural prairie fire regimes (Poole et al., 2007).

Threeflower broomweed is another Gulf Coastal Plain endemic from Brazoria County and is also likely to occur in the project area where preferred conditions are present. Near the coast, this species is most commonly encountered in sparse, low vegetation on a veneer of light-colored silt or fine sand over saline clay along drier upper margins of ecotone between salty prairies and tidal flats (Poole et al., 2007).

3.15.2 Wildlife

According to USFWS (2007), NMFS (2007a), and TPWD (2007), 32 federally and/or State-listed threatened or endangered wildlife species, 9 NMFS-designated wildlife species of concern (SOC), and 15 rare wildlife species are of potential occurrence in Brazoria County, Texas (see Table 3.15-1). As noted above, inclusion on the following list does not imply that a species occurs in the study area, but only acknowledges the potential for occurrence.

Table 3.15-1
Threatened, Endangered, and Rare Species and Species of Concern of Possible Occurrence in Brazoria County, Texas[a]

Common Name[b]	Scientific Name[b]	Status[c]			Likelihood of Occurrence
		USFWS	NMFS	TPWD	
PLANTS					
Coastal gay-feather	*Liatris bracteata*			R	Likely
Giant sharpstem umbrella-sedge	*Cyperus cephalanthus*			R	Likely
Texas meadow-rue	*Thalictrum texanum*			R	Unlikely
Texas windmill grass	*Chloris texensis*			R	Likely
Threeflower broomweed	*Thurovia triflora*			R	Likely
INVERTEBRATES					
False spike mussel	*Quincuncina mitchelli*			R	Unlikely
Ivory bush coral	*Oculina varicosa*		SOC		Unlikely
Pistolgrip	*Tritogonia verrucosa*			R	Unlikely
Rock pocketbook	*Arcidens confragosus*			R	Unlikely
Smooth pimpleback	*Quadrula houstonensis*			R	Unlikely
Texas fawnsfoot	*Truncilla macrodon*			R	Unlikely
FISHES					
American eel	*Anguilla rostrata*			R	Unlikely
Dusky shark	*Carcharhinus obscurus*		SOC		Likely
Largetooth sawfish	*Pristis pristis*		SOC		Unlikely
Night shark	*Carcharhinus signatus*		SOC		Unlikely
Saltmarsh topminnow	*Fundulus jenkinsi*		SOC		Unlikely
Sand tiger shark	*Carcharias taurus*		SOC		Unlikely
Sharpnose shiner	*Notropis oxyrhynchus*			R	Unlikely
Smalltooth sawfish	*Pristis pectinata*		E		Unlikely
Speckled hind	*Epinephelus drummondhayi*		SOC		Unlikely
Warsaw grouper	*Epinephelus nigritus*		SOC		Unlikely
White marlin	*Tetrapturus albidus*		SOC		Unlikely
TERRESTRIAL REPTILES					
Texas horned lizard	*Phrynosoma cornutum*			T	Unlikely
Timber rattlesnake	*Crotalus horridus*			T	Unlikely
AQUATIC REPTILES					
Alligator snapping turtle	*Macrochelys temminckii*			T	Unlikely
Green sea turtle	*Chelonia mydas*	T	T	T	Likely
Gulf saltmarsh snake	*Nerodia clarkii*			R	Likely
Hawksbill sea turtle	*Eretmochelys imbricata*	E	E	E	Likely
Kemp's ridley sea turtle	*Lepidochelys kempii*	E	E	E	Likely
Leatherback sea turtle	*Dermochelys coriacea*	E	E	E	Unlikely
Loggerhead sea turtle	*Caretta caretta*	T	T	T	Likely
Texas diamondback terrapin	*Malaclemys terrapin littoralis*			R	Likely
BIRDS					
Bald eagle	*Haliaeetus leucocephalus*	DL[d]		T	Likely

Table 3.15-1 (Cont'd)

Common Name[b]	Scientific Name[b]	Status[c]			Likelihood of Occurrence
		USFWS	NMFS	TPWD	
Black rail	*Laterallus jamaicensis*			R	Likely
Eskimo curlew	*Numenius borealis*	E		E	Unlikely
Henslow's sparrow	*Ammodramus henslowii*			R	Unlikely
Piping plover	*Charadrius melodus*	T w/CH		T	Likely
Peregrine falcon	*Falco peregrinus*			E/T	Unlikely
Peregrine falcon (American subspecies)	*Falco peregrinus anatum*			E	Unlikely
Peregrine falcon (Arctic subspecies)	*Falco peregrinus tundrius*			T	Unlikely
Reddish egret	*Egretta rufescens*			T	Likely
Snowy plover	*Charadrius alexandrinus*			R	Likely
Snowy plover (southeastern subspecies)	*Charadrius alexandrinus tenuirostris*			R	Likely
Snowy plover (western subspecies)	*Charadrius alexandrinus nivosus*			R	Likely
Sooty tern	*Onychoprion fuscatus* (formerly *Sterna fuscata*)			T	Unlikely
White-faced ibis	*Plegadis chihi*			T	Likely
White-tailed hawk	*Buteo albicaudatus*			T	Likely
Whooping crane	*Grus americana*	E, EXPN		E	Unlikely
Wood stork	*Mycteria americana*			T	Likely
MAMMALS					
Jaguarundi	*Herpailurus yaguarondi*			E	Unlikely
Louisiana black bear	*Ursus americanus luteolus*			T	Unlikely
Ocelot	*Leopardus pardalis*			E	Unlikely
Plains spotted skunk	*Spilogale putorius interrupta*			R	Unlikely
Red wolf	*Canis rufus*			E	Unlikely
MARINE MAMMALS					Unlikely
Blue whale	*Balaenoptera musculus*		E/D		Unlikely
Fin (finback) whale	*Balaenoptera physalus*		E/D		Unlikely
Humpback whale	*Megaptera novaeangliae*		E/D		Unlikely
Sei whale	*Balaenoptera borealis*		E/D		Unlikely
Sperm whale	*Physeter macrocephalus*		E/D		Unlikely
West Indian manatee	*Trichechus manatus*			E	Unlikely

[a]According to USFWS (2007), NMFS (2007a), and TPWD (2007).

[b]Nomenclature follows American Ornithologists' Union (AOU, 1998, 2000, 2002, 2003, 2004, 2005, 2006, 2007), Crother et al. (2000, 2001, 2003), Baker et al. (2003), Brant and Jones (2005), USFWS (2007), NMFS (2007a), and TPWD (2007).

[c]E – Endangered; T – Threatened; T w/CH – Threatened with Federal designated Critical Habitat; DL – Federally delisted; EXPN – Experimental Population; D – Depleted as defined by the Marine Mammal Protection Act; SOC – Species of Concern (NMFS only); R – Rare but with no regulatory listing status (TPWD only).

[4]On July 9, 2007, USFWS published the final rule to remove the species from the list of Federal endangered and threatened species (72 *Federal Register* 37345–37372); the rule became official on August 8, 2007.

Thirteen of the 56 wildlife species of possible occurrence listed in Table 3.15-1 are identified by USFWS and/or NMFS as federally threatened or endangered in Brazoria County. These include the smalltooth sawfish (*Pristis pectinata*), green sea turtle (*Chelonia mydas*), hawksbill sea turtle (*Eretmochelys imbricata*), Kemp's ridley sea turtle (*Lepidochelys kempii*), leatherback sea turtle (*Dermochelys coriacea*), loggerhead sea turtle (*Caretta caretta*), piping plover (*Charadrius melodus*), whooping crane (*Grus americana*), blue whale (*Balaenoptera musculus*), fin (or finback) whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), Sei whale (*Balaenoptera borealis*), and the sperm whale (*Physeter macrocephalus*).

Nine of the 56 wildlife species listed in Table 3.15-1 are identified by NMFS as SOC: ivory bush coral (*Oculina varicosa*), dusky shark (*Carcharhinus obscurus*), largetooth sawfish (*Pristis pristis*), night shark (*Carcharhinus signatus*), saltmarsh topminnow (*Fundulus jenkinsi*), sand tiger shark (*Carcharias taurus*), speckled hind (*Epinephelus drummondhayi*), Warsaw grouper (*Epinephelus nigritus*), and the white marlin (*Tetrapturus albidus*). These species, while listed by NMFS as SOC, do not receive Federal protection under the ESA.

TPWD (2007) includes the federally listed endangered Eskimo curlew (*Numenius borealis*), endangered jaguarundi (*Herpailurus yaguarondi*), threatened Louisiana black bear (*Ursus americanus luteolus*), endangered ocelot (*Leopardus pardalis*), endangered red wolf (*Canis rufus*), and endangered West Indian manatee (*Trichechus manatus*) on their Brazoria County annotated list of rare species. USFWS (2007), however, does not include these species on their county-by-county list for Brazoria County. In addition to these, 12 species are identified by TPWD as solely State-listed threatened or endangered species in Brazoria County. These include the Texas horned lizard (*Phrynosoma cornutum*), timber rattlesnake (*Crotalus horridus*), alligator snapping turtle (*Macrochelys temminckii*), American peregrine falcon (*Falco peregrinus anatum*), Arctic peregrine falcon (*Falco peregrinus tundrius*), bald eagle (*Haliaeetus leucocephalus*), peregrine falcon (*Falco peregrinus*), reddish egret (*Egretta rufescens*), sooty tern (*Onychoprion fuscatus*), white-faced ibis (*Plegadis chihi*), white-tailed hawk (*Buteo albicaudatus*), and wood stork (*Mycteria americana*). These species do not receive Federal protection under the ESA, but may receive protection under other Federal and/or State laws, such as the Migratory Bird Treaty Act (MBTA), Bald Eagle Protection Act (BEPA), chapters 67, 68, and 88 of the TPWD Code, and sections 65.171–65.184 and 69.01–69.14 of Title 31 of the Texas Administrative Code.

Fifteen wildlife species listed in Table 3.15-1 are identified as rare species by TPWD (2007). Just as with the rare plants discussed in Section 3.15.1, these wildlife species also have no regulatory status. These species include the false spike mussel (*Quincuncina mitchelli*), pistolgrip (*Tritogonia verrucosa*), rock pocketbook (*Arcidens confragosus*), smooth pimpleback (*Quadrula houstonensis*), Texas fawnsfoot (*Truncilla macrodon*), American eel (*Anguilla rostrata*), sharpnose shiner (*Notropis oxyrhynchus*), gulf saltmarsh snake (*Nerodia clarkii*), Texas diamondback terrapin (*Malaclemys terrapin littoralis*), black rail (*Laterallus jamaicensis*), Henslow's sparrow (*Ammodramus henslowii*), snowy plover (*Charadrius alexandrinus*), southeastern snowy plover (*Charadrius alexandrinus tenuirostris*), western snowy plover (*Charadrius alexandrinus rivosus*), and the plains spotted skunk (*Spilogale putorius interrupta*).

The following discusses those species listed in Table 3.15-1 that are either federally listed threatened, endangered, or SOC. Species are considered "likely to occur" in the project area if the presence of at least one individual not only has potential for occurrence, but is probable to occur. Species are considered to have "potential" for occurrence if presence of a preferred habitat type exists that has potential to sustain the species. Rarity typically refers to frequency or commonness of occurrence in a general area and does not necessarily indicate the likelihood of occurrence in the project area.

3.15.2.1 Invertebrates

Colonies of ivory bush coral (NMFS-SOC) are found to depths of 152 meters on substrates of limestone rubble, low-relief limestone outcrops, and high-relief, steeply sloping prominences (NMFS, 2007b). The project area is not located within the historical range for this species, and potential habitat is absent, and therefore this species is unlikely to occur in the project area.

3.15.2.2 Fishes

The dusky shark (NMFS-SOC) is a large shark with a wide-ranging distribution in warm-temperate and tropical continental waters. In the western Atlantic, it occurs from Massachusetts to Florida, the Caribbean, the northern Gulf, and south to northern South America (McEachran and Fechhelm, 1998; NMFS, 2007c). It is coastal and pelagic in its distribution, where it occurs from the surf zone to well offshore (McEachran and Fechhelm, 1998; NMFS, 2007c). Habits of this shark are not well known, although a number have been taken over the middle shelf (Hoese and Moore, 1998). Potential habitat is present for this species in the study area, and this species is known to occur in the northern Gulf; therefore, this species is likely to occur within the project area.

The largetooth sawfish (NMFS-SOC) is a sluggish demersal fish inhabiting near-shore marine, coastal, estuarine, and tidal freshwater habitats (NMFS, 2007d). In the U.S., historic records of largetooth sawfish exist from the northern Gulf; however, the species is considered extirpated in U.S. waters and is not likely to occur in the study area (NMFS, 2007d).

The night shark (NMFS-SOC) is a deep-water shark reported in waters from Delaware south to Brazil, including the Gulf (McEachran and Fechhelm, 1998). This shark is usually found at depths greater than 150–200 fathoms during the day and 100 fathoms at night (NMFS, 2007e). Potential habitat for this shark does not exist in the project area, and therefore this species is not likely to occur.

The saltmarsh topminnow (NMFS-SOC) is endemic to the north-central coast of the Gulf from Galveston Bay eastward to western Florida (McEachran and Fechhelm, 1998; NMFS, 2007f). They tend to live in salt marshes and brackish water. This species requires shallow flooded marsh surfaces for breeding and feeding (NMFS, 2007f). In Texas, the saltmarsh topminnow is known only from Dickinson Bayou near Galveston Bay and is not likely to occur in the project area (Hubbs et al., 1991).

The sand tiger shark (NMFS-SOC) has a broad distribution, occurring in the eastern and western Atlantic, southwestern Indian, and western Pacific oceans (McEachran and Fechhelm, 1998). In the western Atlantic, this shark occurs from the Gulf of Maine to South America, the Gulf, the Bahamas, and east to Bermuda (McEachran and Fechhelm, 1998). The species typically occurs in coastal waters, generally from the surf zone out to depths of 75 feet, although they may occur in waters with depths to 600 feet (McEachran and Fechhelm, 1998; NMFS, 2007g). They also frequent shallow bays. Hoese and Moore (1998) indicate that the sand tiger is uncommon in the Gulf, and is not likely to occur in the project area.

The smalltooth sawfish (NMFS-endangered) is a circumtropical species that typically occurs in shallow coastal waters with muddy and sandy bottoms, but also occurs in sheltered bays, on shallow banks, and in estuaries or river mouths (NMFS, 2007h). In the western Atlantic, the smalltooth sawfish historically ranged from Brazil through the Caribbean and Central America, the Gulf, and along the Atlantic coast of the United States (NMFS, 2006b). Smalltooth sawfish were historically common in the Gulf; however, since 1971, only three documented capture records of smalltooth sawfish exist from the region, all of which are from Texas (NMFS, 2006b). The current range of this species has contracted to peninsular Florida, and smalltooth sawfish are relatively common only in the Everglades region at the southern tip of the state (NMFS, 2007h). This species is extremely rare to Texas and is not likely to occur in the project area.

The speckled hind (NMFS-SOC) inhabits warm, moderately deep waters from North Carolina to Cuba, including Bermuda, the Bahamas, and the Gulf (McEachran and Fechhelm, 1998; NMFS, 2007i). The preferred habitat is hard-bottom reefs in depths ranging from 150 to 300 feet (NMFS, 2007i). This species is rare in the northwestern Gulf (Hoese and Moore, 1998) and is not likely to occur in the project area.

The Warsaw grouper (NMFS-SOC) is a very large fish found in the deep-water reefs of the southeastern U.S. This fish ranges from North Carolina to the Florida Keys and throughout much of the Caribbean and Gulf to the northern coast of South America (McEachran and Fechhelm, 1998; NMFS, 2007j). This species inhabits deep-water reefs on the continental shelf break in waters 350 to 650 feet deep (NMFS, 2007j). The Warsaw grouper is known to occur near jetties and offshore oil platforms (Hoese and Moore, 1998); however, the nearest offshore oil platform is at least 5 miles away from the project area. Although the Warsaw grouper could occur in the project area, their occurrence is not likely.

The white marlin (NMFS-SOC) is found in offshore waters throughout the tropical and temperate Atlantic Ocean and adjacent seas (McEachran and Fechhelm, 1998; NMFS, 2007k). They prefer deep blue water over 100 m deep (NMFS, 2007k). Preferred habitat for this species does not exist in the project area; therefore, this species is not likely to occur.

3.15.2.3 Reptiles

The green sea turtle (USFWS and NMFS threatened) is a circumglobal species in tropical and subtropical waters. In U.S. Atlantic waters, it occurs around the U.S. Virgin Islands, Puerto Rico, and continental U.S. from Massachusetts to Texas. Major nesting activity occurs on Ascension Island, Aves Island (Venezuela), Costa Rica, and in Surinam. Relatively small numbers nest in Florida, with even smaller numbers in Georgia, North Carolina, and Texas (Hirth, 1997; NMFS and USFWS, 1991). The green turtle in Texas inhabits shallow bays and estuaries where its principal foods, the various marine grasses, grow (Bartlett and Bartlett, 1999). While green turtles prefer to inhabit bays with seagrass meadows, they may also be found in bays that are devoid of seagrasses. The green turtles in these Texas bays are mainly small juveniles. Adults, juveniles, and even hatchlings are occasionally caught on trotlines or by offshore shrimpers or are washed ashore in a moribund condition. Green turtle nests are rare in Texas. Five nests were recorded at the Padre Island National Seashore in 1998, none in 1999, and one in 2000 (Shaver, 2000). For the last 7 years, up to five nests per year have been recorded from the Texas coast, including three in 2007 (National Park Service [NPS], 2006, 2007; Shaver, 2006). Since long migrations of green turtles from their nesting beaches to distant feedings grounds are well documented (Green, 1984; Meylan, 1982), the adult green turtles occurring in Texas may be either at their feeding grounds or in the process of migrating to or from their nesting beaches. The juveniles frequenting the seagrass meadows of the bay areas may remain there until they move to other feeding grounds or, perhaps, once having attained sexual maturity, return to their natal beaches outside of Texas to nest. The USACE Sea Turtle Data Warehouse (USACE, 2008b) maintains records of documented incidental takes of sea turtles as a result of hopper dredging activities throughout southeastern coastal waters. Incidences involving impacts to two green sea turtle individuals within Freeport Harbor Channel were recorded in 2006. One incident regarding impact to an individual green sea turtle within the Outer Bar and Jetty channels was documented in 2007. These documented events provide clear indication of the likelihood of these turtles occurring within the project area.

The hawksbill sea turtle (USFWS and NMFS endangered) is circumtropical, occurring in tropical and subtropical seas of the Atlantic, Pacific, and Indian oceans (Witzell, 1983). This species is probably the most tropical of all marine turtles, although it does occur in many temperate regions. The hawksbill sea turtle is widely distributed in the Caribbean Sea and western Atlantic Ocean, with representatives of at least some life history stages regularly occurring in southern Florida and the northern Gulf (especially Texas), south to Brazil (NMFS, 2006c). The hawksbill generally inhabits coastal reefs, bays, rocky areas, passes, estuaries, and lagoons, where it occurs at depths of less than 70 feet. Like some other sea turtle species, hatchlings are sometimes found floating in masses of marine plants (e.g., sargassum rafts) in the open ocean (National Fish and Wildlife Laboratory [NFWL], 1980). In the continental U.S., the hawksbill largely occurs in Florida where it is sporadic at best. In 1998 the first hawksbill nest recorded on the Texas coast was found at Padre Island National Seashore. This nest remains the only documented hawksbill nest on the Texas coast (NPS, 2007). Elsewhere in the western Atlantic, hawksbills nest in small numbers along the Gulf Coast of Mexico, the West Indies, and along the Caribbean coasts of Central and South America (Musick, 1979). Texas is the only state outside of Florida where hawksbills are encountered with any regularity. Most of these sightings involve posthatchlings and juveniles and are primarily associated with stone jetties. These small turtles are believed to originate from nesting beaches in Mexico (NMFS, 2006c). This species is likely to occur in the study area. The USACE Sea Turtle Data Warehouse (USACE, 2008b) has yet to document any incidental takes of this species in the Galveston District.

Kemp's ridley sea turtle (USFWS and NMFS endangered) inhabits shallow coastal and estuarine waters, usually over sand or mud bottoms. Adults are primarily restricted to the Gulf, although juveniles may range throughout the Atlantic Ocean since they have been observed as far north as Nova Scotia (Musick, 1979) and in coastal waters of Europe (Brongersma, 1972). Almost the entire population of Kemp's ridley nests on an 11-mile stretch of coastline near Rancho Nuevo, Tamaulipas, Mexico, approximately 190 miles south of the Rio Grande. Sporadic nesting has been reported from Mustang Island, Texas, southward to Isla Aquada, Campeche. Kemp's ridley occurs in Texas in small numbers and in many cases may well be in transit between crustacean-rich feeding areas in the northern Gulf and breeding grounds in Mexico. It has nested sporadically in Texas in the last 50 years. The number of nestings in Texas, however, has increased over the last 12 years from 4 nests in 1995 to 51 nests in 2005, to a record 128 nests in 2007, 73 of which were from the Padre Island National Seashore (NPS, 2006, 2007; Shaver, 2006). Several of the ridley nests were from headstarted individuals. Such nestings, together with the proximity of the Rancho Nuevo rookery, probably account for the occurrence of hatchlings and subadults in Texas. Kemp's ridley has been recorded from the study area. In 1994, an angler accidentally caught a headstarted Kemp's ridley on a rod and reel in the GIWW and later released the turtle alive (TXNDD, 2007). This species has also nested in the study area. One nest was found on Quintana Beach in 2002, and another was found near Surfside Beach in 2003 (Yeargan, 2006). In 2006, one nest was found on Surfside Beach (Echols, 2006), while two nests were found on Surfside Beach and one on Bryan Beach in 2007 (NPS, 2007). The USACE Sea Turtle Data Warehouse (USACE, 2008b) documents the taking of two Kemp's ridley turtles within the Outer Bar and Jetty channels in 2007. Thus, this species is likely to occur in the project area.

The leatherback sea turtle (USFWS and NMFS endangered) is probably the most wide-ranging of all sea turtle species. It occurs in the Atlantic, Pacific, and Indian oceans; as far north as British Columbia, Newfoundland, Great Britain, and Norway; as far south as Australia, Cape of

Good Hope, and Argentina; and in other water bodies such as the Mediterranean Sea (NFWL, 1980). The leatherback is mainly pelagic, inhabiting the open ocean, and seldom approaches land except for nesting (Eckert, 1992) or when following concentrations of jellyfish (TPWD, 2006), when it can be found in inshore waters, bays, and estuaries. It dives almost continuously, often to great depths. Leatherbacks nest primarily in tropical regions and only sporadically in some of the Atlantic and Gulf states of the continental U.S., with one nesting reported as far north as North Carolina (Schwartz, 1976). In the Atlantic and Caribbean, the largest nesting assemblages occur in the U.S. Virgin Islands, Puerto Rico, and Florida (NMFS, 2006c). No nests of this species have been recorded in Texas for at least 70 years (NPS, 2007); the last two, one from the late 1920s and one from the mid-1930s, were both from Padre Island (Hildebrand, 1982, 1986). Apart from occasional feeding aggregations such as the large one of 100 animals reported by Leary (1957) off Port Aransas in December 1956, or possible concentrations in the Brownsville Eddy in winter (Hildebrand, 1983), leatherbacks are rare along the Texas coast, tending to keep to deeper offshore waters where their primary food source, jellyfish, occurs (NMFS and USFWS, 1992). Although this species is unlikely to occur along the Texas coast, a leatherback was caught by a relocation trawler in a shipping channel approximately 1.5 miles north of Aransas Pass in 2003 (NMFS and NOAA, 2003). The USACE Sea Turtle Data Warehouse (USACE, 2008b) has yet to report any documented incidental takes of this species in the Galveston District.

The loggerhead sea turtle (USFWS and NMFS threatened) is widely distributed in tropical and subtropical seas, being found in the Atlantic Ocean from Nova Scotia to Argentina, the Gulf, the Indian and Pacific oceans (although it is rare in the eastern and central Pacific), and the Mediterranean Sea (Iverson, 1986; Rebel, 1974; Ross, 1982). In the continental U.S., loggerheads nest along the Atlantic coast from Florida to as far north as New Jersey (Musick, 1979) and sporadically along the Gulf coast, including Texas. Like the worldwide population, the population of loggerheads in Texas has declined. The loggerhead is the most abundant turtle in Texas marine waters, preferring shallow inner continental shelf waters and occurring only very infrequently in the bays. It is often seen around offshore oil rig platforms, reefs, and jetties. Loggerheads are probably present year-round but are most noticeable in the spring when one of their food items, the Portuguese man-o-war, is abundant. Loggerheads constitute a major portion of the dead or moribund turtles washed ashore (stranded) on the Texas coast each year. A large proportion of these deaths are the result of accidental capture by shrimp trawlers, where caught turtles drown and their bodies are thrown overboard. In 1999, two loggerhead nests were confirmed in Texas, while in 2000, five loggerhead nests were confirmed (Shaver, 2000). Between 2001 and 2005, up to five loggerhead nests per year were recorded from the Texas coast (Shaver, 2006); in 2007, six loggerhead nests were recorded (NPS, 2007). Between 1995 and 2000, eight loggerheads were caught in Freeport Harbor, and during Freeport Harbor maintenance dredging (July 13 to September 24, 2002), a relocation trawler captured one loggerhead (NMFS and NOAA, 2003). More recently, an additional loggerhead was incidentally taken in the Outer Bar and Jetty channels in 2007 USACE (2008b) as a result of dredging activities. Since the species has been recorded from the study area, it is therefore likely to occur within the project area.

3.15.2.4 Birds

The bald eagle is present year-round in Texas, including breeding, wintering, and migrating birds. In Texas, bald eagles breed along the Gulf Coast and on major inland lakes and reservoirs in the eastern two-thirds of the state (Lockwood and Freeman, 2004). Additional numbers of bald eagles winter in these habitats, as far west as the Trans-Pecos (Lockwood and Freeman, 2004). Bald eagles prefer large bodies of water surrounded by tall trees or cliffs, which they use as nesting sites (Buehler, 2000). On July 9, 2007, the USFWS published its final ruling to remove the bald eagle from the list of endangered and threatened wildlife (72 *Federal Register* 37345–37372), and the change of listing status became official on August 8, 2007. The bald eagle will still receive protection at the State level and under provisions of the BEPA and the MBTA. Ortego (2002, 2005) identified 160 nesting territories statewide, of which at least 4 currently exist in Brazoria County. Ortego (2005) does not disclose the locations of bald eagle nests; therefore, the exact locations of the nests are unknown. TXNDD (2007) indicates an active bald eagle territory north of Freeport, between Clute and Oyster Creek (TPWD nest #020-8A). The species is likely present in Brazoria County at some time during the year; however, no suitable nesting habitat is present in the project area.

The piping plover (USFWS threatened) is a small shorebird that inhabits coastal beaches and tidal flats. Approximately 35 percent of the known global population of piping plovers winters along the Texas Gulf Coast, where they spend 60 to 70 percent of the year (Campbell, 1995; Haig and Elliott-Smith, 2004). The piping plover population that winters in Texas breeds on the northern Great Plains and around the Great Lakes. The species is a common migrant and rare to uncommon winter resident on the upper Texas coast (Lockwood and Freeman, 2004; Richardson et al., 1998). The USFWS has designated critical habitat for the species in its nesting and wintering range (65 *Federal Register* 41781–41812). Designation of critical habitat became final on July 10, 2001 (66 *Federal Register* 36038–36143), and was modified on May 19, 2009 (74 *Federal Register* 23475-23600). Critical Habitat Unit TX-33 encompasses approximately 211 acres between the mouth of the Brazos River and FM 1495 and includes Bryan Beach and adjacent beach habitat (74 *Federal Register* 23475-23600), which occurs in the study area. Although TXNDD (2007) maps show no documented records within the project area, this species is likely to occur.

The whooping crane (USFWS endangered) is a large wading bird that in the last 50 years has returned from the brink of extinction. Currently, only two wild populations of whooping cranes exist, the largest of which is the self-sustaining Aransas/Wood Buffalo population, which breeds in Wood Buffalo National Park in northern Canada and migrates annually to Aransas NWR and adjacent areas of the central Texas coast in Aransas, Calhoun, and Refugio counties where it winters (Lewis, 1995; USFWS, 1995). A second, smaller experimental nonessential population was reintroduced in 1993 in Florida (Lewis, 1995). In Texas, the whooping crane's wintering habitat includes estuarine marshes, shallow bays, and tidal flats, and occasionally nearby rangelands or farmlands. During migration, whooping cranes stop over at wetlands and pastures to roost and feed. According to the USFWS (1995), Brazoria County is within the species' migration corridor; however, the species is unlikely to occur in the study area because of the absence of suitable wintering habitat. TXNDD (2007) indicates documented records of whooping cranes from marshes west of the Brazos River; however, these likely represent vagrant birds, and no wintering populations are known from the study area, and thus this species is not likely to occur in the project area.

3.15.2.5 Mammals

The blue whale (NMFS endangered) is the largest of all whales and ranges worldwide, where it occurs in both coastal and pelagic environments. The blue whale is considered only an occasional visitor in the U.S. Atlantic waters (NMFS, 2007l). This may represent the southern limit of the western North Atlantic blue whale's feeding range, although the actual southern limit of its range is unknown (NMFS, 2007l). Blue whales are accidental visitors to the Gulf, and only two documented records exist from Gulf waters (Schmidly, 2004). The only documented Texas record is of a stranded individual between Freeport and San Luis Pass in 1940 (Schmidly, 2004). The blue whale is not expected to occur in the project area.

The fin whale (NMFS endangered) is a nomadic offshore species that occurs worldwide. Fin whales occur in high latitudes during the summer and spring, while in the fall these whales migrate several thousand miles to equatorial waters to mate and calve (NMFS, 2007m). While the fin whale has been recorded year-round in the Gulf, only one documented record exists from Texas, a stranded individual found at Gilchrist, Chambers County, in 1951 (Schmidly, 2004). The fin whale is not expected to occur in the project area.

The humpback whale (NMFS endangered) is a highly migratory species with worldwide distribution. During the winter breeding season, humpbacks occur in temperate and tropical waters of both hemispheres, while in the summer feeding season, most humpbacks occur in higher-latitude waters with high biological productivity (NMFS, 2007n). There are currently four recognized stocks (based on geographically distinct winter ranges) of humpback whales in the U.S.: Gulf of Maine, the eastern North Pacific, the central North Pacific, and the western North Pacific stocks (NMFS, 2007n). In the Gulf, humpbacks have occurred around the Florida Keys, the west coast of Florida, Alabama, and Cuba (Schmidly, 2004; Tove, 2000). Only one documented humpback has occurred in Texas waters, an immature individual observed in 1992 at Bolivar Jetty near Galveston (Schmidly, 2004). The species is very rare in the Gulf and is unlikely to occur in the project area.

The sei whale (NMFS endangered) is a migratory species that occurs in both hemispheres, but is generally restricted to mid-latitude oceans. During the winter breeding season, sei whales occur in subtropical and tropical waters of both hemispheres, while in the summer, they move to high-latitude feeding grounds (NMFS, 2007o). In the western North Atlantic, sei whales occur offshore from the Gulf and Caribbean Sea north to Nova Scotia and Newfoundland (Schmidly, 2004; Tove, 2000). Stranding records exist from Louisiana and Florida; however, no Texas records exist (Schmidly, 2004). The sei whale is not expected to occur in the project area.

The sperm whale (NMFS endangered) is a migratory species with worldwide distribution. Sperm whales inhabit deep waters (1,970 feet or more, and less commonly in waters less than 985 feet deep) (NMFS, 2007p). Their distribution is dependent on their food source and suitable conditions for breeding, and varies with the sex and age composition of the group. Sperm whale migrations are not as predictable or well understood. In some mid-latitudes, there seems to be a general trend to migrate north and south depending on the seasons (whales move poleward in the summer). However, in tropical and temperate areas, there appears to be no obvious seasonal migration (NMFS, 2007p). The sperm whale is the most common large whale in the Gulf, and aerial and shipboard sightings off the Texas Coast are common (Schmidly, 2004). Stranding and sighting records have occurred in every month, suggesting a stock unique to the Gulf, although this remains unsubstantiated (Schmidly, 2004). Although the sperm whale is known to occur in the Gulf, they typically inhabit the deepest offshore waters and are not likely to occur in the project area.

3.16 CULTURAL RESOURCES

The project area is located in Brazoria County, Texas, which is part of the Southeast Texas Archeological Region of the Eastern Planning Region of Texas (Kenmotsu and Perttula, 1993). The cultural history of the study area has been assigned to four primary developmental periods: Paleoindian, Archaic, Late Prehistoric, and Historic. These divisions generally are believed to reflect changes in subsistence as reflected by the material remains and settlement patterns of the people occupying this portion of Texas in prehistoric and early historic times.

The earliest generally accepted culture of the Americas, the Paleoindian (10,000–6500 B.C.), appears to have extended over most if not all of North America by the end of the Pleistocene epoch. It has been hypothesized that in Texas the Pleistocene coastline extended as much as 25 miles into the present Gulf, and that rivers cut deep canyons into sediments deposited during previous periods of glaciation (Aten, 1983). With the close of the Pleistocene came a period of climatic warming and a consequent rise in sea level as surface water was released from glaciers and polar ice. Paleoindian cultural developments in the Gulf Coastal Plain region, as in most areas of North America, appear to have been intimately related to these gradual but vast changes in the world climate and local environmental conditions.

Occupation of the Texas Gulf Coast during the terminal Pleistocene is evidenced by the recovery of several types of well-made, lanceolate, parallel-flaked projectile points such as Scottsbluff, Clovis, Plainview, Angostura, and possibly San Patrice types. The presence of these distinctive projectile point types along the coastal plain appears to reflect activities that would typically have occurred in areas farther inland where the environment is characterized by a mixture of deciduous and pine woodlands (Aten, 1983). According to Aten (1983), this type of habitat typically supports low-density human populations. Archeological evidence synthesized by Story et al. (1990) from numerous counties composing the greater Gulf Coastal Plain in Texas, Louisiana, Arkansas, and Oklahoma supports the suggestion that the Paleoindian groups probably existed in small nuclear families or bands that migrated widely in pursuit of seasonal subsistence resources.

Cultural developments appear to have progressed somewhat beyond those of the Paleoindian period with the onset of the Holocene epoch. Changes in the world climate caused sea levels to rise, inland prairies to expand, and regional weather patterns to become more variable (Aten, 1983). Generally termed the Archaic (7000 B.C.–A.D. 700), this next period of cultural development in the New World has been further subdivided into Early, Middle, and Late subperiods based on changes observed in the archeological record, which appear to coincide with episodic shifts in the Holocene climate and environment. It is commonly thought that human lifestyles and subsistence strategies maintained patterns developed during the previous Paleoindian period, but with some notable differences.

Aten (1983) suggests that Early Archaic groups, like their Paleoindian predecessors, probably continued to migrate seasonally in small bands and relied on a generalized projectile point technology to facilitate their hunting and gathering of a variety of faunal and vegetal foodstuffs. Despite a paucity of intact Archaic components at sites in the upper Texas Gulf Coast region, it has been observed that Archaic lithic technologies appear to show an increased diversity of functional types and styles over those associated with the Paleoindian period. However, the level of craftsmanship and the use of fine exotic materials appear to have declined. In addition, the greater array of Archaic projectile point styles appears to reflect a greater degree of regional cultures. Story et al. (1990) surmise that Archaic period human populations may have become more dense, with individual bands covering less overall territory on their seasonal rounds.

Differentiation between Early, Middle, and Late Archaic culture sites in the upper Texas Gulf Coastal region, without the benefit of sufficient associated cultural features and artifacts from which strong chronological dates and sequences can be derived, has been based largely on observation and comparison of projectile point styles associated with more-intact archeological contexts elsewhere in Texas and North America. The assumption has been that similar point styles are probably related chronologically despite sometimes vast geographical distances. According to these lines of reasoning, Early Archaic point types are usually considered to include Baird, Bell, Andice, and Wells, whereas Bulverde, Carrollton, and Trinity points are usually attributed to the Middle Archaic. Based on a relatively greater database for defining the Late Archaic, point types considered diagnostic of this cultural stage typically include Gary, Kent, Yarbrough, Ellis, Palmillas, and Refugio (Patterson, 1979).

The Late Preceramic, which coincides in part with the Late Archaic elsewhere in Texas, extends from the approximate period in which sea level attained its present state until the advent of ceramic service and storage vessels, ca. A.D. 100 (Aten, 1983). During this period, population increased significantly, marked by an increase in the number of sites as well as intrasite artifact frequencies (Aten, 1983). Hall (1981) has also noted an increase in traumatic death and the development of trade relations with Woodland cultures to the east during the Late Archaic. A settlement system that may have included a seasonal round with group dispersal in coastal areas during the summer and consolidation in inland areas during the winter months may have begun during the Late Archaic (Aten, 1983). However, the occurrence of shell middens at Late Archaic sites is not as common as at later sites (Patterson, 1979).

The Late Prehistoric, or Ceramic period (700–1519 A.D.), cultures experienced a relatively static environment. This period lasted from the time when ceramics were adopted until European interaction with the aboriginal populations became firmly established.

The addition of Perdiz and Scallorn arrow points to the inventory marks the beginning of the Late Ceramic period. Ceramics of the earlier period may include Goose Creek Plain variety Anahuac, O’Neal Plain variety Conway, Mandeville Plain, Tchefuncte Plain, Goose Creek variety unspecified, and Tchefuncte Stamped. In the Late Ceramic period, the ceramic inventory may include San Jacinto Incised and Baytown Plain varieties Phoenix Lake and San Jacinto (Aten, 1983). It should be noted, however, that several varieties of Goose Creek Plain, as well as Goose Creek Incised (and Red-Filmed), and the occurrence of bone tempering, span much of the Ceramic period.

Population during the Late Prehistoric tended to increase until European-introduced disease helped to decimate the aboriginal inhabitants. Patterson (1979) observed an increase in numbers of Late Prehistoric sites, while individual sites exhibit fewer cultural remains. He interprets this as evidence of a more mobile lifestyle.

3.16.1 Native Inhabitants

When Europeans arrived on the northern Texas coast, they encountered two major native groups, the Atakapa and the Karankawa Indians, who occupied separate territories divided approximately at the western shore of Galveston Bay. The Atakapa, speaking a language of the Tunican family, displayed traits closely related to the natives of southwestern Louisiana. The Karankawan groups spoke a language of the Coahuiltecan family and were more closely related to the Indians farther south in Texas and Mexico.

In spite of differences in language and apparent cultural derivation, the Atakapa and Karankawa maintained similar cultural patterns (Ricklis, 1996). Both groups were nomadic, although the Atakapa maintained semipermanent winter villages in the interior. The Atakapa subsisted on shellfish, fish, birds' eggs, wild plants, deer, and bear, while the Karankawa ate shellfish, turtles, marine and land plants, alligator, deer, bison, bear, and peccary. Conical huts and skin tents served as shelter for the Atakapa, while the Karankawa lived in portable windbreak-style huts. Atakapan technology included pottery, bows and arrows, dugout canoes, basketry, traps, manos and metates, drums and flutes, wooden bowls and utensils, and grass-fiber textiles. The Karankawa also used pottery, the bow and arrow, dugout canoes propelled by poles, basketry, cane weirs, milling stones, drums and whistles, tambourines, lances, clubs, axes, and bone tools. Both groups buried their dead in burial mounds and left refuse middens, primarily shell. Both wore breechcloths and skirts and decorated themselves with tattoos. Both groups were equally unprepared to defend themselves and their cultural traditions from the newly arrived Europeans. By the late eighteenth century, both the Atakapa and Karankawa peoples were in serious decline (Ricklis, 1996).

3.16.2 European Exploration and Colonization

European exploration of the Texas coast began, albeit by accident, in November 1528. Álvar Núñez Cabeza de Vaca was a member of the Narváez expedition that was destined for Pánuco (Tampico), Mexico. Cabeza de Vaca and his men were plagued with misfortune when the expedition departed from Florida in April (Creighton, 1975). While adrift and seeking fresh water, Cabeza de Vaca's group discovered the mouth of the Brazos River, naming it Los Brazos de Dios, the Arms of God.

French exploration of Texas in the seventeenth century was focused primarily in the Matagorda Bay area. René Robert Cavelier, Sieur de La Salle traversed the Brazos River in 1686, though his journey did not take him to the river's mouth. An unfortunate malady that occurred at this time inspired La Salle to name the river the Rivière Maligne. While crossing the river on a raft, La Salle's servant Dumesnil was pulled into the water by an alligator and killed (Weddle, 1991).

The Spanish conducted preliminary exploration and mapping of the Freeport area in the early eighteenth century. In 1724, Brigadier Pedro de Rivera y Villalón began a 3-year-long inspection tour of the 23 military outposts in northern New Spain (Chipman 1992; Weddle 1991). A series of six maps of northern New Spain created by Francisco Alvarez Barriero during the expedition is considered the first attempt at a systematic mapping of Texas (Weddle, 1991). Following this study, the Texas governor was required to conduct an annual surveillance of the coast from Matagorda Bay to the Sabine River (Weddle, 1991).

Captain Carlos Luis Cazorla conducted a survey in 1772 to identify the level of trade between the local tribes and newly established English trading posts. On his return trip he traveled down the Brazos to its entry into the Gulf, near present-day Freeport. He discovered that the stream divided into two channels with a maze of lagoons. This was the first exploration of the mouth of the Brazos (Weddle, 1992). Ineffectual organization and motivation prevented additional substantial exploration of the Texas coast east of Matagorda Bay. It would not be until the early nineteenth century that successful immigration to the Brazos would be realized.

3.16.3 Early Settlements (1800–1835)

In 1821 the governor of Texas, Antonio Martínez, granted permission to Moses Austin for the creation of Mexican colonies in Texas. After Moses's death later that year his son, Stephen F. Austin, selected the lands for colonization. Austin organized a group of 18 immigrants that landed at the mouth of the Brazos River in late December 1821 (Bugbee, 1899). Though they mistakenly landed at the Brazos River instead of the intended destination of the Colorado River, the group labored for several weeks exploring the immediate area and building seven boats for carrying their supplies upriver. In February, the party journeyed up the Brazos until the first "high land" was sighted. At this site (Velasco), a large log house was erected and preparations were made for planting a corn crop (Bugbee, 1899). Asa Mitchell arrived at the mouth of the Brazos in January 1822 and opened a salt-manufacturing business (Creighton, 1975). He received the title to this land in 1824 and lived in the Velasco area until moving to Washington-on-the-Brazos in 1835, thus becoming possibly the first colonist to settle permanently at the site (Earls et al., 1996).

The advantageous location of Mitchell's land grant, at the juncture of the Brazos River and the Gulf, persuaded Austin in 1823 to propose the location as a port. Austin acknowledged, in December of 1835, that Velasco was without a natural harbor and also had a treacherous sand bar at the mouth of the river (Earls et al., 1996). Despite these drawbacks, entrepreneurs encouraged steamboat navigation on the Brazos to cater to the cotton plantations along the river. The establishment of a trading post at Bell's Landing (now East Columbia) by John Richardson Harris in the 1820s encouraged the use of the river for the trade and transportation of commodities. Harris's small schooner, *The Rights of Man*, may have been the first vessel specially designated for trade between the Brazos River, Galveston Bay, and New Orleans (Earls et al., 1996). The popularity of Velasco as a commercial trade center was superceded by Brazoria, 15 miles upriver, which had been established about 5 years earlier. In 1833, Mitchell formed a land association with his neighbors William H. Wharton and Branch T. Archer. This collaboration would develop Mitchell's property into a thriving river and seaport (Earls et al., 1996).

Increased immigration into Texas in the 1820s possibly encouraged Mexico to create several military outposts, one of which was established at Velasco in 1831 (Rowe, 1903). Asa Mitchell was commissioned to serve as a boarding officer at Velasco by the fall of that year (Earls et al., 1996). With the establishment of the fort and customhouse at Velasco, the Mexican government attempted to forcibly regulate Brazos River traffic and exert tax and customs control. The conflicts created by these new restrictions culminated at Velasco in 1832. In response to friction between Mexican authority and the colonists, 150 men gathered to attack General Ugartechea at Velasco. The Mexican force commanded by Ugartechea was composed of 91 men. On June 26, three divisions of colonists attacked the fort until sunrise the following morning (Rowe, 1903). The fort's cannon fired upon the town's structures, destroying all but the customhouse and a small office (Smith, 1910). Surrender was negotiated on June 29, in which Ugartechea's troops were ordered to withdraw (Rowe, 1903).

Following the battle, Mitchell began to sell portions of his property, possibly to facilitate town rebuilding. In addition to the public sale of lots, the Velasco Association also announced construction of a major hotel to accommodate its many anticipated visitors. A nationwide cholera epidemic finally touched Velasco in the spring of 1833; only 12 of the 20 townspeople survived. This tragedy, and a diversion of town resources towards Texas's quest for independence, would quell the building initiative envisioned by the Velasco Association. Their grand designs would not again be revisited until after the conclusion of the Texas Revolution in 1836 (Earls et al., 1996).

3.16.4 Texas War for Independence (1835–1836)

Though Velasco was not a location of direct military engagements after 1832, it was used as a training post for Texas militia. John Sowers Brooks began drilling 250 men in late December 1835 (Roller, 1906). Anticipating a military conflict with Mexico, the abandoned fort at Velasco was refortified with a long 18-pound cannon and several smaller artillery pieces (Earls et al., 1996). Though humble in appearance, the fort was described as the best coastal defense work in Texas in May of 1836 (Pierce, 1969).

Velasco itself did not witness growth during the years of conflict (Earls et al., 1996); however, its location at the mouth of the Brazos River was strategically important to the movement of troops and supplies throughout Texas. The region experienced a marked increase in maritime activity during the Texas Revolution. Quintana, Velasco's competitor on the river's east bank, was also the location for the mercantile house of Thomas McKinney and Samuel Williams. This commercial house is accredited with establishing the first regular steam commerce on the Brazos and served plantation owners such as William Wharton (Puryear and Winfield, 1976). It was also instrumental in providing funds and military supplies for the Texas cause (Miller, 2004). Military supplies for the Texas volunteers were stored in warehouses in Velasco and Quintana (Miller, 2004). Vessels transported supplies and volunteers from New York and New Orleans to both Quintana and Velasco (Brinkley, 1937). These materials were then transshipped to locations such as Galveston, Matagorda, Columbia, and Copano Bay (Brinkley, 1936).

Velasco was homeport to the vessels *Invincible*, *Yellow Stone*, and *Independence*. The schooners *Invincible* and *Independence* were both purchased as vessels of the "privateer" Texas navy organized in 1836 (Barker, 1927; General Council, 1839). The steamboat *Yellow Stone* was used by Sam Houston to transport troops and supplies across the Brazos River in April 1836 (Hardin, 1992).

The surrender of the Mexican army at San Jacinto was negotiated in the Treaty of Velasco, signed at Velasco on May 14, 1836, by Antonio López de Santa Anna and David G. Burnet, ad interim president of Texas. Santa Anna was forced to stay on the schooner *Invincible* when Texas troops under Thomas Jefferson Green refused to allow his departure to Veracruz. Santa Anna spent the next several months as a prisoner at Velasco until he was moved to Columbia towards the end of the year (Miller, 2004).

3.16.5 Texas Republic (1836–1845) and Early Statehood (1845–1862)

Following the battle of San Jacinto, ad interim President David G. Burnet selected Velasco as the location for his government offices (Winkler, 1906). Velasco was never able to earn the distinction of being Texas's "first capital," as the seat of government was transferred to Columbia in October 1836 (Pierce, 1969). Brazoria County was subsequently created on December 20, 1836. Velasco, Columbia, and Brazoria were incorporated in June 1837. These first few years of the Texas Republic, from 1836 to 1840, were the greatest period of development for Velasco (Earls et al., 1996).

At the close of the war, and with the resumption of port and customs activities, Velasco received renewed commercial interest. The Velasco Association reorganized and expanded its membership to include such key individuals as Jeremiah Brown and Isaac Hoskins. The year 1837 was both the height of land sales/building activity in Velasco and the beginning of a boom in port activity. An average of 425 persons arrived annually at Velasco in 1837, 1838, and 1839. Velasco additionally had an average of 36 vessels visiting its port annually during the Republic years. The largest number of vessels to anchor at Velasco was 85 in 1838 (Earls et al., 1996).

Velasco's growth and importance as a commercial entity declined with the emergence of Galveston as one of Texas's principal ports. An analysis of commercial activity in 1839 demonstrated that even with Galveston's more-abundant maritime traffic, its export value was nearly matched by Velasco. Additionally, delayed effects of an economic depression in 1837 would impact the value of property lots, causing them to crash near the end of 1839 (Earls et al., 1996). The economic crash and the effects of reoccurring storms would quash Velasco's continued growth and development as a commercial center.

In an attempt to sustain Velasco's role in trade, a steam vessel, *Lafitte*, was built in 1840 to run on the Brazos between Velasco, Galveston, and the Sabine River (Earls et al., 1996). The use of the *Lafitte* for Brazos River shipping was fleeting. In 1842, with renewed hostilities with

Mexico, the *Lafitte* was pressed into Texas government service as she lay at anchor in Galveston Bay (Haviland, 1852). In this same year, Sam Houston spent $9,000–10,000 fortifying the 370-mile Texas coastline at three places: Galveston, Velasco, and Matagorda (Wells, 1960). The effort to reinforce and protect Texas's coast, however, did not prevent the economic demise of Velasco.

The decline in shipping at Velasco, combined with the associated hazards of its riverine access, initiated the overland transportation of goods in this area. In the waning years of the Republic period, Velasco continued to depreciate in both real estate and shipping. A major tropical storm in 1842 dropped Velasco's sea trade to only five vessels in that year. By the mid-1840s Velasco had digressed from its reputation as "coming city of the Gulf" to a seaside resort and mail stop (Earls et al., 1996).

In spite of the difficulties at Velasco, the Brazos area prospered in cotton and sugar. Planters transported their goods overland and shipped them from Galveston. In the 1850s a proposed intracoastal waterway between Velasco and Galveston promised to bring more commercial activity to the mouth of the Brazos. With completion of the canal in 1856, sternwheel steamers transported cargoes from Galveston up the Brazos River. Rather than revitalize maritime commerce in this area, the waterway circumvented trade from Velasco to Galveston (Dorchester, 1936). Planters continued to ship goods down the waterway to Galveston, which as a consequence bolstered the city's now undeniable reputation as a maritime trade center.

3.16.6 American Civil War (1861–1865)

In antebellum Texas, in the region of Houston and Galveston, the farming of cotton and sugarcane was highly profitable. Planters along the Brazos River were increasingly dependent on slave labor. In 1860, 18 of the state's 44 slaveholders resided in Brazoria, Wharton, and Fort Bend counties. Many of the planters who lived in this region were very wealthy; one-fifth of all Texans with estates valued at over $100,000 were from these three counties. These slaveholders collectively owned more than 100 slaves. The dependence on slave labor created unyielding support for secession, and an overwhelming majority of residents voted in favor of withdrawal from the Union on February 23, 1861 (Buenger, 1984).

Texas itself became important as a source of military supplies for the Trans-Mississippi region of the Confederacy (Barr, 1961). Federal gunboats patrolled the Texas coastline in an effort to blockade strategic waterways such as Galveston Bay and the Sabine River. Forts were erected at Quintana and Velasco (Looscan, 1898). At the outbreak of the Civil War there were only four Federal blockaders operating off the Texas coast. In January 1862, the ships *Midnight*, *Arthur*, and *Rachel Seaman* shelled the coastal fortifications at both Aransas Pass and Velasco (Barr, 1961). The fort at Velasco fired upon the vessels with such accuracy that the captain of the

Midnight thought the fort was defended by heavy (possibly rifled) guns. The fort had only a single piece of artillery, an 18-pounder (Creighton, 1975).

Following Confederate victories at Galveston and Sabine Pass in 1863 and with Union possession of the southern half of Texas's coast, Confederate forces concentrated on holding Sabine Pass, Galveston, and Velasco at all costs. Velasco itself was so heavily reinforced, with a battery of six 32-pounders, that Federal blockaders never engaged the fort for any great length of time. By late 1864 the number of cannons at Velasco had increased to 8, with Galveston having a total of 41 cannons. Blockade-running in Texas had grown to such an extent that by 1865 the blockade squadron off the Texas coast had no fewer than 20 ships (Barr, 1961).

3.16.7 Post–Civil War and Early Industrial Revolution (1865–1910)

With the close of the Civil War and the abolition of slavery, the commercial viability of Velasco and Quintana became greatly depressed. At the end of the nineteenth century Velasco had only a general store and boat-builder's shop. Only 2 of the 20 plantations in Brazoria County were still held by their prewar owners, the rest having been sold or lost to taxes (Earls et al., 1996).

Storms in the late 1860s and early 1870s forced many families to move inland or leave the area altogether. The remaining Velasco lands were sold in 1872 and transferred to the Texas Land Company. With the acquisition of these properties, Velasco ceased to be a municipal entity. The great storm of 1886 and the hurricane that followed in 1887 destroyed any remaining town structures (Earls et al., 1996).

At the urging of W.M.D. Lee, Velasco was redeveloped in order to facilitate the building of a deepwater port at the mouth of the Brazos River. Lee was a Texas cattle baron and oilman. He believed a deepwater port at the mouth of the Brazos was the best way to move his cattle to market (Earls et al., 1996). In February 1888, Lee filed his charter for the Brazos River Channel and Dock Company. When construction began in April 1889, the influx of workers increased the population of Velasco from 50 residents to 700 by the end of the year (Earls et al., 1996). A new location for Velasco was surveyed and laid out in 1891, with the old site becoming the town of Surfside. Surfside was platted as a resort town, and a large beachfront hotel was built to help raise funds for the construction project (Earls et al., 1996). The Galveston hurricane of 1900 destroyed much of the Brazoria County coastline, including the hotel. A second hotel, built on its original site, was destroyed by fire in 1904 (Earls et al., 1996). These successive events destroyed any remaining impetus for the development of commercial enterprise at this location until the founding of Freeport in 1912.

The City of Freeport, Texas, was founded on November 20, 1912, on the west bank of the Brazos River and adjacent to the historic site of Velasco (Freeport Townsite Company, 1912). The Brazos River itself was strategically important for the transportation of needed goods and supplies inland. The importance of this riverine passage to mercantile trade preempted the founding of Freeport, as well as Velasco and historic Quintana.

3.16.8 File and Literature Review

A site file and records review was conducted for the Freeport Channel Widening Project in Brazoria County. The files at the Texas Archeological Research Laboratory (TARL) at The University of Texas at Austin and at the Texas Historical Commission (THC) were both examined for the location of recorded terrestrial archeological sites, listed National Register of Historic Places (NRHP) properties, State Archeological Landmark (SAL) sites, and Texas Historic Markers. The shipwreck files at the THC's State Marine Archeologist's Office were also examined for the location of plotted shipwrecks. The results of the file and literature review are presented in the following section.

3.16.9 Previous Investigations

Several terrestrial and marine archeological investigations have been conducted in the project area surrounding Freeport, Texas. The previous projects relevant to this project consist of terrestrial surveys and data recovery projects, marine surveys and diver investigations, and archival research. These projects are summarized below.

In 1975 the USACE contracted with the Texas A&M Research Foundation to conduct an intensive archeological survey of an area between the Brazos River Diversion Channel and the Freeport Harbor navigation channel (Ippolito and Baxter, 1976). One prehistoric site (41BO117) and three historic sites (41BO116, 41BO123, and 41BO125) were recorded as a result of this effort. Site 41BO117 was recorded as a prehistoric shell midden. However, subsequent research determined this site was not cultural in origin, and the location is no longer considered an archeological site. Site 41BO116 consists of two earthen mounds used as gun batteries during World War II. Site 41BO123 is the cemetery for the old city of Quintana. Site 41BO125 was originally recorded as the location of Fort Velasco. However, subsequent investigations identified this site as part of the community of Quintana (Fox et al., 1981).

In 1977, the USACE contracted with Odom Offshore Surveys, Inc. (Odom) to conduct a marine magnetometer survey for the Freeport Harbor, Texas 45-foot Project (Odom, 1978). The survey covered portions of the ship channel, an area north of the North Jetty, and an offshore PA. The survey resulted in the identification of seven magnetic anomalies that required additional research.

In 1978, the USACE contracted with Fairfield Industries to conduct additional marine magnetometer survey of the anomalies identified during the survey by Odom (Lawrence and Hole, 1979). This survey resulted in the reidentification of the anomalies identified during the previous survey conducted by Odom and the identification of numerous additional anomalies.

Based on additional research, 18 magnetic anomalies were recommended for additional investigations.

In 1979, the USACE requested the NPS conduct diver investigations on a cluster of magnetic anomalies identified during the Fairfield investigations (Murphy and Lenihan, 1980). As a result of this investigation, the cluster of magnetic anomalies was identified as portions of a modern shipwreck.

In 1980, the USACE contracted with the Cultural Resources Laboratory of TAMU to conduct diver investigations on six of the magnetic anomalies identified during the Fairfield Survey (Bond, 1980). All six of the anomalies were identified as either not being cultural or historic in origin.

In 1980, the USACE contracted with the Center for Archaeological Research, University of Texas at San Antonio to conduct extensive testing at the communities of Quintana (41BO125) and Velasco (41BO135) (Fox et al., 1981). Based on this fieldwork, it was determined that very little of either community survived. The lack of structural remains at both locations is attributed to severe and numerous hurricanes, modern street building, drainage, and large surface modifications.

In 1981, the USACE contracted with the Archaeology Program of the Institute of Applied Sciences, North Texas State University, and TAMU’s Department of Nautical Archaeology to conduct additional diver investigations on five of the anomalies identified during the Fairfield survey (Hays, 1981). This work identified three of the anomalies as modern, and no source could be identified for the remaining two anomalies. All five of the anomalies were recommended as not being of historic interest.

In 1988 the USACE contracted with Coastal Environments, Inc. to conduct emergency investigations on a shipwreck discovered during the construction of the North Jetty (Pearson, 1989). The shipwreck was identified as the *General C.B. Comstock* (41BO171), a USACE self-propelled hopper dredge that burned and sank in 1913. The USACE contracted with CEI to perform data recovery on the *General C.B. Comstock* since construction on the North Jetty would totally destroy the ship (James et al., 1991).

Prewitt and Associates, Inc. (PAI) in late 1992 and early 1993 conducted site testing and data recovery at the old Velasco townsite (41BO125) for the USACE. Erosion of the northeast bank of the channel, dredged as part of the 45-foot Project, had exposed cultural materials from the Velasco townsite. A 200-x-400-feet (61.0-x-121.9-meter) area centered over the exposed culture material was selected for archeological assessment. Over 475 features, including 311 postholes, were recorded. The majority of the large artifact assemblage recovered from the site supports an 1830–1840s habitation date. Planned improvements to the channel included construction of a new jetty inland of the PAI project area. Portions of the Velasco townsite were later destroyed to accommodate creation of the new jetty (Earls et al., 1996).

Following the excavations conducted by PAI at Velasco townsite in 1992 and 1993, the USACE funded production of two catalogs illustrating the transfer-print ceramics collected by the Brazosport Archaeological Society at Velasco and Quintana (Blake and Freeman, 1998; Pollen et al., 1995). The 1995 catalog of Velasco transfer-printed ceramics features only the artifacts recovered by Brazosport Archaeological Society though many examples are portions of vessels collected during the 1992–1993 excavation. Over 400 ceramic vessels are represented in this study. The ceramic artifacts were collected in the general vicinity of the former 1917 lighthouse and related parking lot.

In the summer and fall of 1994, PAI conducted archival research as an aid in determining property ownership boundaries related to Civil War fortifications and bombardment sites (Freeman, 1995). Research was focused in the area of the Brazos River mouth at Quintana and Velasco, and at Virginia Point in Galveston, Texas.

Between 1996 and 1997, PBS&J conducted reconnaissance-level archival research along the GIWW in preparation for proposed channel modifications (Hoyt et al., 1999). The study area encompassed the full length of the GIWW between High Island and the Brazos River Floodgate. Over 200 cartographic sources were reviewed for the study; 194 properties of unknown significance were identified, 50 of which are within the vicinity of the current project area. These properties ranged from graveyards to historic buildings, forts, bridges, and shipwrecks.

In 1999, PBS&J evaluated historical sites, both terrestrial and nautical, in relation to proposed channel modifications along the GIWW (Hoyt et al., 1999). Thirteen shipwrecks were identified in the report, lying between Oyster Creek and the Brazos River. Eight of these shipwrecks are located in or near the survey area. The locations for all the shipwrecks in this study were drawn from historical and archival sources.

In 2005, Shiner Mosley and Associates contracted with PBS&J to conduct marine surveys for the Freeport Harbor Ship Channel widening project (Borgens et al., 2005). This survey resulted in the identification of 11 magnetic anomalies and two sonar targets that had the potential to be significant cultural resources. Subsequently, in 2006, the Brazos River Harbor Navigation District contracted with PBS&J to conduct additional close-order surveys on the identified magnetic anomalies and sonar targets (Borgens et al., 2007a). Based on the additional close-order surveys, only three of the anomalies required diver investigations. The diver investigations determined that none of the anomalies were significant cultural resources.

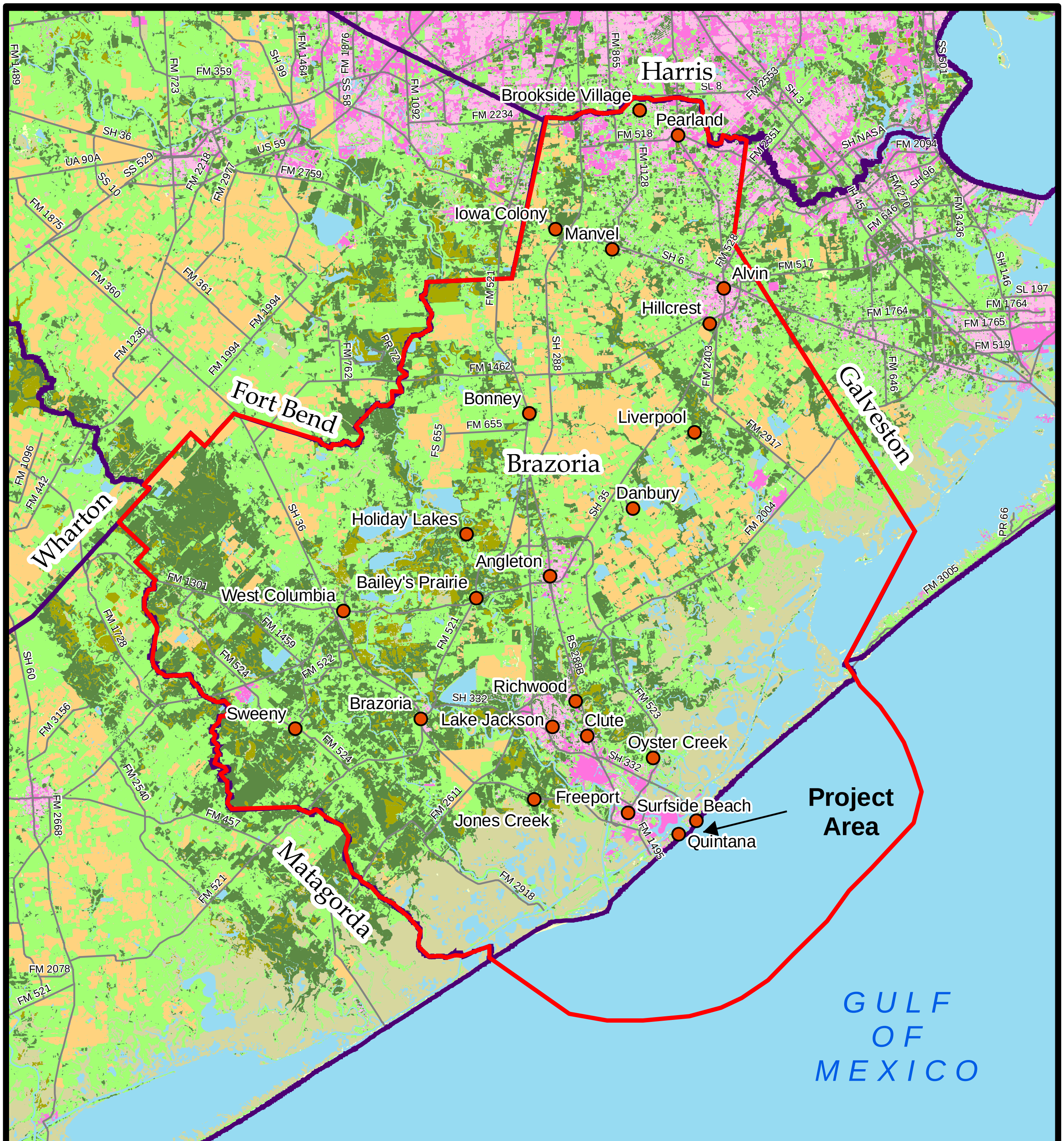
In 2006, the USACE contracted with PBS&J to conduct marine magnetometer and side-scan sonar surveys of areas proposed for modification for the Freeport Harbor Improvement Project (Borgens et al., 2007b). The survey resulted in the identification of three sonar targets with potential to be significant cultural resources. Additional analysis and research has determined that none of the targets are cultural in origin (see Appendix E).

In 2007, the USACE contracted with PAI to conduct geoarcheological and historical research for the Freeport Harbor Improvement Project. PAI determined that PA 8 and PA 9 had the potential to contain Historic Properties (PAI, 2007). Based on this recommendation, the USACE had PAI conduct field investigations in both areas. As a result of these investigations, two historic sites were identified, 41BO226 and 41BO227. Both of these sites are located on PA 9; no cultural resources were identified in PA 8 (PAI, 2008). Site 41BO226 consists of three mounds. These mounds (A, B, and C) each measure approximately 10 to 15 meters in diameter and rise 80 to 100 centimeters (cm) above the surrounding terrain. Test excavations in Mound A produced an array of historic artifacts, including hand-made bricks, a small-gauge railroad rail section, and other unidentifiable metal objects. In addition, a brass survey marker with raised letters identifying it as a “UNITED STATES ENGINEER DEPARMENT” marker with the notation “US ENGINEER OFFICE GALVESTON TEXAS” was also discovered at Mound A. A survey using a metal detector did not identify artifacts in mounds B or C, possibly because they would be buried too deeply (PAI, 2008). Based on the existing evidence, 41BO226 is most likely the remains of a Confederate gun battery. Site 41BO227 consists of four livestock watering troughs (PAI, 2008). This site is not recommended as eligible for inclusion in the NRHP, and no further work is recommended. Additional investigations on 41BO226 are under way to determine the significance and extent of the site.

In 2008, the USACE, the Texas State Historic Preservation Officer (SHPO), and Port Freeport signed a PAg regarding compliance with Section 106 of the National Historic Preservation Act (NHPA) for the construction and maintenance of the Federal Freeport Harbor Navigation Channel Improvement Project. The PAg addresses the identification of historic properties, the evaluation of significance, the assessment of effects, the resolution of adverse effects, and unanticipated discoveries for the construction and maintenance of the Federal project (see Appendix E).

3.17 SOCIOECONOMIC RESOURCES

This section presents a brief summary of economic and demographic characteristics of the study area within Brazoria County. The study area includes Brazoria County as well as the following towns/cities: Alvin, Angleton, Bailey’s Prairie, Bonney, Brazoria, Brookside Village, Clute, Danbury, Freeport, Hillcrest, Holiday Lakes, Iowa Colony, Jones Creek, Lake Jackson, Liverpool, Manvel, Oyster Creek City, Pearland, Quintana, Richwood, Surfside Beach, Sweeny, and West Columbia. Data were collected for Brazoria County and for the towns and cities that are within the study area (Figure 3.17-1), as described in the sections below. Population, employment, the area economy, a historical perspective of economic development, and



●	Incorporated towns/cities		Grassland
	Study Area		High Intensity Developed
	On-System Roads 2003		Low Intensity Developed
←	Freeport Harbor CIP Area		Non-Woody Wetland
Cover Types			Open Water
	Agricultural		Woody Land
	Bare or Transitional		Woody Wetland

10 5 0 10 Miles

Figure 3.17-1

Freeport Harbor Channel Improvement Study Area and Land Use Categories

Prepared for: USACE Galveston

Job No.: 044190100

Prepared by: A.Christiansen | Date: 03/14/2008

File: N:/Clients/U_Z/USACE/Projects/Freeport/044190100/projects/AppG_Fig3_15_1_vr2.mxd

Environmental Justice (EJ) are key areas of discussion. Additional information is provided in Appendix F.

3.17.1 Population

The proposed FHCIP is located in Brazoria County with a 2009 population of 304,844 persons. Brazoria County maintained steady growth, increasing by 13 percent between 1980 and 1990, by 26 percent between 1990 and 2000, and 26 percent between 2000 and 2009. Populations given for the study area towns/cities represent 2009 population estimates (Texas State Data Center, 2010). The City of Freeport, population 13,677, is located south of Oyster Creek (population 1,429), which is located northwest of the proposed FHCIP, while Quintana (population 37) and Surfside Beach (population 922) make up the southern portion of the study area.

Population projections provided by the TWDB 2006 Regional Water Plan indicate that growth in Brazoria County is expected to occur at a similar rate to the state through 2040. Brazoria County is projected to grow 37 percent from 2009 to 2040 while the State of Texas is projected to grow 50 percent during the same time (see Appendix F). In addition, towns/cities within the study area are also expected to grow between 2007 and 2040. Cities that are expected to have the greatest growth include Freeport (82 percent increase), Oyster Creek (48 percent increase), and Brookside Village (47 percent increase).

Due to the expected growth within the study area, a likely concern is the amount of available housing, so a multiple listing service was reviewed to determine the amount of housing within the study area. The data (provided in Appendix F) indicate that adequate housing is available within the study area to meet the demands of a growing population.

The U.S. Census Bureau’s 2000 census data were used to identify general population characteristics (Tables 3 through 7 are provided in Appendix F). Whenever possible, the most up-to-date information has been provided to characterize the study area general population. The 2000 data are the most consistent for all parameters at the city/town level.

The study area general population can be characterized as comprising family households with an average family size of 3.16 persons that own their own home. The largest age cohort was persons between 35 and 49 years of age (25.6 percent), followed by persons 50 to 64 years of age (13.9 percent), and persons 5 to 14 years of age (16.0 percent).

The study area median household income was $44,311, and the total percentage of persons living below the poverty level was 10.2 percent. The majority of the population attained a high school diploma and attended college. However, on average, only 7 percent received an Associates Degree, 9.5 percent received a Bachelors Degree, and 4.5 percent received a Graduate or Professional degree.

3.17.2 Community Services

Brazoria County has a well-developed infrastructure to provide health, police, fire, emergency, and social services within the study area. A wide range of public services and facilities are offered at different locations for the local communities of Surfside Beach, the City of Freeport, Quintana, and the Lake Jackson/Clute area. A brief summary is provided in the following paragraphs. Additional discussion is provided in Appendix F.

Fire protection within the vicinity of the study area is provided by the various fire departments of the study area cities. The project area is served by the Freeport Fire Department. The Freeport Fire & Emergency Medical Service Department currently provides service to the City of Freeport and Quintana. Surfside Beach provides emergency services through the Surfside Beach Police Department (*The Alliance*, 2006a). Law enforcement within the vicinity of the study area is served by both state and local departments. The Texas Highway Patrol maintains an office in Angleton. The Brazoria County Sheriff's office and the Texas Highway Patrol serve the highways in unincorporated areas of Brazoria County. Within the incorporated area of Brazoria County, the cities of Alvin, Angleton, Brazoria, Brookside Village, Clute, Danbury, Hillcrest, Freeport, Jones Creek, Lake Jackson, Manvel, Oyster Creek, Pearland, Quintana, Richwood, Surfside Beach, Sweeny, and West Columbia all provide police protection.

Brazoria County is served by eight school districts: Alvin Independent School District (ISD), Angleton ISD, Brazosport ISD, Columbia-Brazoria ISD, Damon ISD, Danbury ISD, Pearland ISD, and Sweeny ISD. Higher education is offered at Alvin Community College and through the Brazosport College campus located in Lake Jackson. Within Brazoria County, a variety of entities provide electric utility, natural gas, water, wastewater, and solid waste disposal services. These services are summarized in Table 8 of Appendix F.

3.17.3 Employment

According to the Texas Workforce Commission (TWC), the largest percentages of jobs in Brazoria County are within education and health services, trade, transportation and utilities, and government service sectors. Third-quarter employment in 2007 had a total of 84,819 persons employed in Brazoria County, of which 19 percent were employed in trade, transportation, and utilities, 19 percent in education and health services, and 18 percent in the government sector. The workforce decreased 3.2 percent from 2007 to 2009, with a total of 82,063 persons employed in Brazoria County for the third quarter of 2009. The top three employment sectors for the third quarter of 2009 were trade, transportation and utilities (21 percent), the government sector (20 percent), and education and health care services (20 percent). Between 2007 and 2009, unemployment rates increased from 4.8 to 7.5 (TWC, 2010).

According to the U.S. Census Bureau 2000 data, the class of workers within the study area is similar to the State of Texas when looking at the percentage of government workers and unpaid family workers and has a slightly lower percentage of self-employed workers and a slightly higher percentage of private wage and salary workers (Table 9 in Appendix F).

Approximately 55,192 Texas jobs are related to the activity within Port Freeport. The port is responsible for 11,696 direct local jobs, which creates $1.11 billion in personal income, with Brazoria County residents holding 75 percent of those jobs (Port Freeport, 2009). Top employers within the Brazosport area are primarily oil industry/port-related enterprises, healthcare, government, and retail industries (Table 10 in Appendix F).

The number of workers who work outside their place of residence but still within the state and county in which they reside are much higher when compared to the State of Texas. The study area has a similar percentage of persons working inside their state of residence (99.1 percent) when compared to the state, with 99.0 percent; the percentage of workers that work inside their county of residence (59.7 percent) is much lower than the state (78.6 percent); and outside their place of residence (75.6 percent) is higher than the State of Texas (44.6 percent) (Table 11 in Appendix F).

3.17.4 Economics

The economy of Brazoria County and the Port Freeport area is broadly based in manufacturing, agriculture, and fishing. The primary economic bases of the county include chemical manufacturing, petroleum processing, offshore production maintenance services, biochemical and electronic industries, commercial fishing, and agriculture. The deepwater channel and port facilities, sports fishing services, and tourism are major components of the county's economic base (Brazos River Harbor Navigation District [BRHND], 2004).

Port Freeport handles large volumes of commodities, including petroleum products, agricultural products, and general cargo such as animal feed, synthetic rubber, and automobiles (BRHND, 2004). The port is ranked 16th in U.S. foreign tonnage and 27th in the U.S. in total tonnage. Port Freeport totaled over $28.6 million in revenue in 2009. As a result of local and regional purchases by the 11,696 employees, an additional 43,496 induced jobs are estimated to be supported in the regional economy resulting in $4.6 billion in personal income, $10.2 billion in total economic activity in Texas, and $1.3 billion of investment in the local economy over the past 5 years (Port Freeport, 2009).

Several new or expanded businesses are in progress or anticipated in the near future including the following efforts for BASF Corporation, Freeport LNG, Dow Texas Operations, a new Velasco Terminal, and Air Liquide.

These new efforts will increase the industrial activity at Port Freeport, generate thousands of jobs in the area, and add docking area to the port (*The Alliance*, 2005a, 2006b; Evans, 2007; Hagerty, 2007; Tompkins, 2006).

3.17.4.1 Tourism and Recreation

Tourism is a major contributor to the study area economy. The natural resources of the Gulf provide extensive recreational opportunities. Outdoor recreation in the area includes fishing, bird watching, windsurfing, boating, jet skiing, swimming, shelling, and beachcombing (among others). Brazoria County was chosen as the location for the 2006 Texian Rally, sponsored by The Texas Independence Trail Region, because of its association with the Texas Independence Trail as well as being the original burial place of Stephen F. Austin (*The Alliance*, 2006c).

Freeport ranks as one of the top areas in the Nation for diversity of species and number of species encountered (*Texas Explorer*, 2006). There are several marinas located within the Freeport area that support recreational as well as commercial fishing. There are numerous parks located within the area that provide beach access and are used for swimming, picnicking, and fishing. Quintana Beach Park includes such amenities as restrooms, showers, concession stand, boardwalks, picnic areas, and shaded pavilions for group rentals. On the property is the Coveney House, which has a beach ecology laboratory featuring hands-on displays. One of the newest parks is the Surfside Jetty Park, which has a visitor's center, shuffleboard, picnic tables, public showers, convenience store, restrooms, playground, horseshoe pits, lighted volleyball courts, and a sidewalk from the park to the jetty and beach. The Surfside Pedestrian Beach is located on the west side of Surfside Beach (City of Freeport, 2006). The City of Freeport and TPWD have signed an agreement for enhancements to Bryan Beach Park (*The Alliance*, 2006d). Additionally, a marina is proposed on the Old Brazos River that could become the catalyst for downtown revitalization with restaurants, hotels, and gift shops. An agreement has been reached for Surfside Beach to lease ½ acre, adjacent to city hall, for a nature trail and home for Surfside Beach's Save Our Beach Association (*The Alliance*, 2005b).

3.17.4.2 Community Values

Overall, the communities in the study area support development at Port Freeport. Future growth at the port includes new construction and expansion of existing facilities for companies such as Freeport LNG, BASF Corporation, Dow Chemical, and ConocoPhillips. New jobs in the Brazosport community are a direct result of the expansion of Port Freeport. However, the Gulf-front beaches also promote a relaxed, beachfront community atmosphere.

3.17.4.3 Commercial Fisheries

There is little commercial fishing in the Freeport area. Commercial fishing within the Galveston Bay system is a relatively moderate contributor to the Freeport area economy compared to other industry sectors.

3.17.4.4 Tax Base

In Texas, the state sales tax is 6.25 percent, with local sales/use tax not to exceed an additional 2 percent. Property is appraised and property tax is collected by local (county) tax offices or appraisal districts (Texas Comptroller of Public Accounts, 2010). The predominant property tax jurisdictions within the study area include ISDs, municipalities, and municipal utility districts (Table 12 in Appendix F).

Activity at Port Freeport terminals generates $163.6 million in state and local taxes. Also, the Federal government receives $6.3 million of customs revenue from cargo activity at the public and private facilities (Port Freeport, 2004).

3.17.5 Environmental Justice

In compliance with EO 12898 – Federal Action to Address Environmental Justice (EJ) in Minority Populations and Low-Income Populations—an analysis has been performed to determine whether the proposed action would have a disproportionately adverse impact on minority or low-income population groups within the study area. The EO requires that minority and low-income populations do not receive disproportionately high adverse human health and environmental impacts and requires that representatives of minority or low-income populations, who could be affected by the project, be involved in the community participation and public involvement process.

The data used in this study to determine the potential for disproportionate impacts to low-income and/or minority populations within the project study area and within the region and the state are presented in Tables 13 and 14 in Appendix F. The information is based on 2000 U.S. Census Bureau state, county, and block group level data for ethnicity and income.

In terms of ethnicity, the population living within the study area census tracts (CT) (with a total minority population of 37.6 percent) is less ethnically diverse than Brazoria County and the State of Texas. The percentage of white persons within the study area is 65.3 percent with the largest percentage of minority persons being Hispanic or Latino, with 22.8 percent of the total population. Within the study area, Freeport has the largest minority population (67.0 percent), which is predominantly composed of Hispanic (51.6 percent) and African American (13.2 percent) persons. Freeport also has the highest percent of persons living below poverty in the study area. The percentage of persons living below poverty within the study area is 10.2 percent. The poverty rates of the study area cities range from 3.0 percent (Bonney and Manvel) to 22.9 percent (Freeport).

To better understand the affected human environment for minority and low-come populations, an evaluation of the social make-up and economic baseline of the study area communities was conducted. Those communities that were determined to have substantial minority and/or low-income populations (total minority and/or low-income population exceeds 50 percent of the community) were then further evaluated. Within the study area, three communities were identified for further study—Clute, Holiday Lakes, and Freeport. Because Holiday Lakes is located more than 20 miles from the project area and is less likely to be impacted by the proposed project, it was removed from further analysis. Clute and Freeport are proximate to the project area and more susceptible to any potential impacts associated with the proposed action and are therefore subject to further analysis. All information discussed in the following can be found in Tables 1–18 of Appendix F.

According to the 2000 census, Freeport has a population of 12,717 people of which 67.0 percent are considered minority. The majority of the population identifies as Hispanic or Latino (51.6 percent). The median household income in Freeport for 2000 was $30,245, which though significantly lower than the median household income for Brazoria County ($48,632), is still higher than the 2011 U.S. Department of Health and Human Services (HHS) poverty guideline for a family of four ($22,350) (HHS, 2011). However, the percentage of those living below the poverty level in Freeport (22.9 percent) is more than double the percentage for Brazoria County (10.2 percent). Freeport could therefore be considered a minority population and potentially a low-income population.

Clute has a population of 10,424 people according to the 2000 census, 57.6 percent of which are considered minority, and 48.1 percent of Clute's population identifies as Hispanic or Latino. Clute's median household income in 2000 was $32,622, which is only slightly lower than Brazoria County, and well above the HHS 2011 poverty guideline (HHS, 2011). The percentage of those living below the poverty level in Clute is 18.2 percent, which is higher than Brazoria County (10.2 percent). Considering these factors, Clute would be considered a minority population but not low income.

Clute and Freeport also have higher populations of persons 5 years of age and older with limited English proficiency. According to 2000 U.S. Census data, 10.9 percent of Clute's population and 14.0 percent of Freeport's population speak English either "not well" or "not at all," compared to 4.2 percent of the population of Brazoria County (U.S. Census Bureau, 2000).

In terms of housing, Clute and Freeport have high percentages of housing units occupied by renters rather than owners. In Clute, 56 percent of housing units are renter-occupied, and 43 percent of housing units in Freeport are occupied by renters rather than owners (U.S. Census Bureau, 2000). The majority of households in these communities are composed of families (70 percent for Clute and 74 percent for Freeport), compared to 77 percent for Brazoria County. The average family sizes for these communities (3.35 for Clute and 3.59 for Freeport) are slightly higher than that of Brazoria County (3.23) (U.S. Census Bureau, 2000).

Clute and Freeport are also somewhat less educated than Brazoria County. For the population 25 and older for Brazoria County, only 20.4 percent of the population did not receive a high school diploma, some college, an associate's degree, bachelor's degree, or graduate or professional degree. By comparison, 35.3 percent of Clute's population and 44.9 percent of Freeport's population have either less than a 9th grade education or completed 9th–12th grade and received no diploma (U.S. Census Bureau, 2000).

EO 13166, "Improving Access to Services for Persons with Limited English Proficiency (LEP)," signed by President Bill Clinton on August 11, 2000, calls for all agencies to ensure that their federally conducted programs and activities are meaningfully accessible to LEP individuals. Table 14 in Appendix F contains the percent LEP population for the study area, which ranges between 0.0 (Bonney, Manvel, and Quintana) and 9.4 percent (Holiday Lakes).

A small percentage of persons in the study area do not speak English or have difficulty speaking English. Data for "Ability to Speak English" for the population 5 years old and over indicates that 3 percent of the population in the study area speak English "not well," while 1.2 percent of the population speak English "not at all" (see Table 14 in Appendix F).

Census tracts within the project area that contain and surround the project area components are CTs 6639, 6641, 6642, 6643, 6644, and 6645. The population living within these census tracts is predominantly white, with the exception of CT 6644, whose minority population is 61.8 percent of the total population. One of the PAs (PA 1) is located in CT 6644; PAs 8 and 9 are both located in CT 6645. The highest percentage of Hispanic or Latino persons within the project area components was found in CT 6643 (58.0 percent) and CT 6644 (48.4 percent). The largest percentage of other minority persons (Black or African American, American Indian/Alaskan Native, Asian, and Native Hawaiian or other Pacific Islander) was also found in CT 6643 (16.2 percent) and CT 6644 (13.5 percent).

Median household incomes for persons living in the project area components range from $23,415 in CT 6643 to $40,271 in CT 6641. Overall, median household incomes for the project area components are lower than Brazoria County ($48,632) or the State of Texas ($39,927); however, they are still above the HHS 2008 poverty guideline of $22,200 for a family of four (see Table 13 in Appendix F).

Within the project area components, the percentage of persons living below poverty is generally higher than Brazoria County. The population in CT 6643 has the largest percentage of persons living below poverty with 27.3 percent, followed by the City of Freeport (22.9 percent), CT 6644 (19.5 percent), and CT 6642 (16.6 percent). These percentages are higher than Brazoria County (10.2 percent) and the State of Texas (15.4 percent); therefore, the project area components do have some areas that have high percentages of persons living below poverty.

3.17.6 Protection of Children from Environmental Health Risks and Safety Risks

In compliance with EO 13045—Protection of Children from Environmental Health Risks and Safety Risks—an analysis was performed to determine the potential of the proposed action to have disproportionate impacts to child populations within the project area. The EO requires that Federal agencies "(a) shall make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children, and (b) shall ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks and safety risks."

Detailed information regarding age characteristics of the study area are provided in Table 5 of Appendix F. The percentage of the population aged 19 and under for communities within the study area varies from 13.2 percent (Quintana) to 39.2 percent (Holiday Lakes). In Freeport, 39.1 percent of the population is aged 19 and under, with 30.1 percent aged 14 and under. While Freeport's population had one of the highest percentages of population aged 19 and under (second only to Holiday Lakes), it is not significantly greater than the average for Brazoria County (31.4 percent) (U.S. Census Bureau, 2000).

The following Brazosport ISD schools are located in Freeport in the vicinity of the proposed action. The proximity to the project area and 2009–2010 enrollments (Texas Education Agency, 2011) for these schools are as follows:

- Jane Long Elementary – 526 students (approximately 1.3 miles from the project area boundary)
- O.A. Fleming Elementary School – 330 students (approximately 0.5 mile from project area boundary)
- Velasco Elementary School – 597 students (approximately 1.6 miles from the project area boundary)
- R.O. Lanier Middle School – 423 students (approximately 1.6 miles from the project area boundary)
- Freeport Intermediate School – 558 students (approximately 1.8 miles from the project area boundary)
- Brazosport High School – 1,104 students (approximately 1.9 miles from the study area boundary)

Several child care facilities are also located within the vicinity of the proposed project. These are Luna Daycare, Precious Jewels Preschool, and Memorial Child Care Center.

3.18 LAND USE/AESTHETICS

3.18.1 Land Use

The Freeport Channel system is located in Brazoria County within the Coastal Bend region, on the mid to upper Texas coast, about 40 miles southwest of Galveston, Texas. Land use within the study area consists of agricultural land, industrial land, urban-residential and urban-commercial land, recreational land and facilities, and marshlands. Water use includes mineral production, commercial and sport fishing, recreation, and transportation.

In Brazoria County, agriculture has historically been and continues to be an important part of the economy. Approximately 61 percent of the land is used for agriculture, with 41 percent used for range and pastureland and the remaining 20 percent cultivated (NRCS, 2000). Within Brazoria County, only about 14 percent of land use is considered urban. According to the U.S. Department of Agriculture (USDA) 2002 Census of Agriculture, Brazoria County had 2,455 farms in 2002, up 8 percent from 1997, and had approximately 614,000 acres of land in farms. In 2002, the market value of production for Brazoria County was $47,422,000, with crop sales accounting for 52 percent and livestock sales accounting for the remaining 48 percent (USDA, 2002).

For the purposes of this analysis, the study area includes the following towns/cities: Alvin, Angleton, Bailey's Prairie, Bonney, Brazoria, Brookside Village, Clute, Danbury, Freeport, Hillcrest, Holiday Lakes, Iowa Colony, Jones Creek, Lake Jackson, Liverpool, Manvel, Oyster Creek City, Pearland, Quintana, Richwood, Surfside Beach, Sweeny, and West Columbia (see Figure 3.17-1).

The study area is approximately 1,110,643 acres in size. It is primarily comprised of open water (245,336 acres) and undeveloped land. The undeveloped land consists of grassland (335,531 acres), woody (forested) land (208,508 acres), agricultural (118,698 acres), nonwoody wetland (113,517 acres), and bare or transitional (3,418 acres). Developed land (28,833 acres high intensity, 19,919 acres low intensity) is primarily concentrated in the northeastern portion of the study area around Pearland and Alvin as well as the southern portion of the study area in communities near Port Freeport and along major roadways.

Port Freeport currently comprises 186 acres of developed land and 7,723 acres of undeveloped land (Port Freeport, 2006). Facilities along the west side of the Jetty Channel include the Exxon Quintana Station and LNG Quintana Terminal, as well as the USCG Boat Basin and access channel located on the east side of the channel. Continuing northward along the Brazos River Channel, ConocoPhillips facilities and the BASF Corporation Terminal are to the west and Dow Chemical is to the east of the channel. The northernmost facilities in the project area include Chiquita, American Rice Inc., and Vulcan Materials Bulk Aggregate Facility, located just south of the Stauffer Turning Basin. All parcels are accessible by water, highway, and rail.

Golf courses and county parks are located within the study area, including those that provide beach access (Figure 3.18-1). In addition to public and private parks, there are state and Federal areas located in the study area. These include Nannie M. Stringfellow Wildlife Management Area (WMA) located in the southwestern portion of the study area as well as the Peach Point WMA, Brazoria NWR, San Bernard NWR, and Christmas Bay State Park located along the coastline.

3.18.2 Transportation

Projects listed on the 2008–2011 Statewide Transportation Improvement Program are planned to be constructed. These projects include the construction of a four-lane County Road (CR) 220 from FM 521 to SH 288, widening of existing CR 220 from SH 288 to FM 523, construction of a six-lane toll highway (SH 99) from the Harris County line to FM 1093, the reconstruction of FM 2351 (CR 129) to a four-lane divided highway from SH 35 to the Galveston County line, widening of FM 523 from FM 2004 to SH 332, and the replacement of the CR 160 bridge at the Gulf Coast Water Canal (TxDOT, 2007). Enhancements to rail capabilities will include replacement of a rail bridge over the Old Brazos River Channel in downtown Freeport to serve increasing cargo volumes from Port Freeport (*The Alliance*, 2006e). Future transportation projects specific to the port include reconstructing the intersection of Fifth Street and Terminal Street to include an entrance road with two 16-foot lanes with 8-foot shoulders, and widening of a truck-queuing area along Navigation Boulevard.

Major roadways within the study area include FM 523, which provides access from Angleton to Oyster Creek; SH 288, the primary land route connecting the Freeport area with the Houston metropolitan area; SH 36, which provides north-south connection from Rosenberg to Freeport; and SH 332, which provides a direct route from Lake Jackson to Surfside Beach. There is direct access to the GIWW and Freeport Harbor utilizing FM 523, SH 36, SH 288, and SH 332, with rail service provided by the Union Pacific Railroad (UPRR).

Rail transportation is integral to the operations of Port Freeport and numerous industrial sites located along the Freeport Jetty Channel, GIWW, Brazos River Channel, Brazos Harbor, Brazosport Turning Basin, and the Stauffer Turning Basin. The UPRR provides direct service to these facilities (Port Freeport, 2006).

Regarding air travel, Brazoria County Airport is the only airport serving the project area vicinity. Brazoria County Airport is located 13.25 miles northeast of Freeport, in the city of Angleton, Texas.

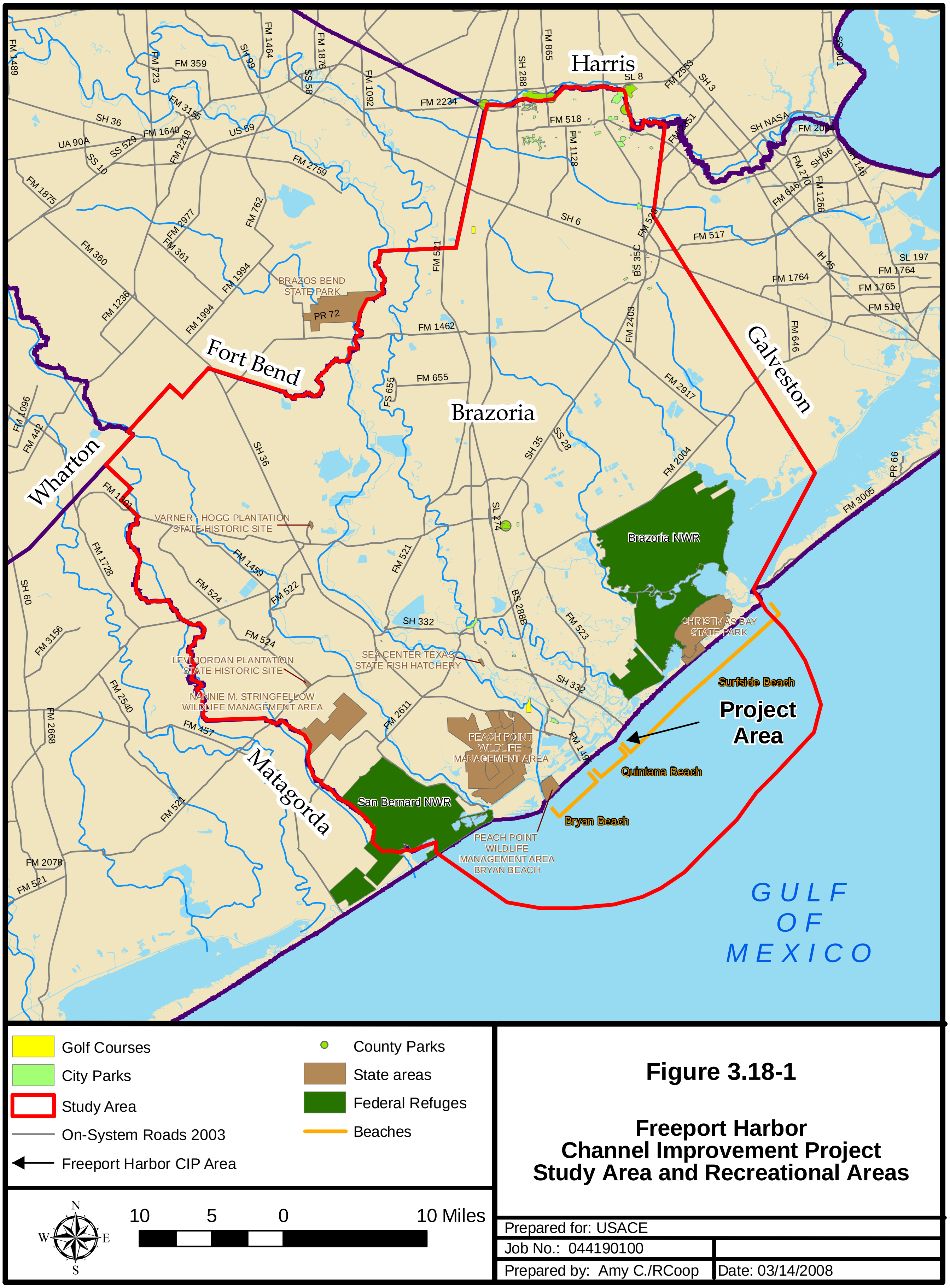


Figure 3.18-1

Freeport Harbor Channel Improvement Project Study Area and Recreational Areas

Prepared for: USACE
Job No.: 044190100
Prepared by: Amy C./RCoop
Date: 03/14/2008

File: N:/Clients/U_Z/USACE/Projects/Freeport/044190100/projects/Figures/AppG_Fig3_16_1_vr3.mxd

3.18.3 Aesthetics

The term aesthetics deals with the subjective perception of natural beauty in a landscape by attempting to define and measure an area's scenic qualities. Consideration of the visual environment includes a determination of aesthetic values (where the major potential effect of a project on the resource is considered visual) and recreational values (where the location of a proposed project could potentially affect the scenic enjoyment of the area). Aesthetic values considered in this study, which combine to give an area its aesthetic identity, include:

- topographical variation (hills, valleys, etc.);
- prominence of water in the landscape (rivers, lakes, etc.);
- vegetation variety (woodlands, meadows, etc.);
- diversity of scenic elements;
- degree of human development or alteration; and
- overall uniqueness of the scenic environment compared to the larger region.

The study area (see Figure 3.1-1) consists of a variety of terrain characterized by varying levels of aesthetic quality. The topography of the area is mostly flat to gently rolling. Generally, the study area consists mostly of undeveloped areas. Within the southern portion of the study area, landscapes with water as a major element are generally considered visually pleasing, and this is the case for recreational land adjacent to these water features. The southern portion of the study area includes a variety of land uses, including residential development, commercial development, public and private marinas, parkland, relatively undisturbed natural areas, fishing and tourism-related businesses, civic uses, transportation systems (highways and railways), port facilities, and heavy industry areas. Generally, the study area is considered to be visually pleasing, with the exception of industrial and port facilities located in the southern portion along the Freeport Harbor Channel. However, the area is distinguished in aesthetic quality from other adjacent areas within the region that lack the vast waterbodies and many of the outdoor recreational amenities. The landscape exhibits a generally moderate to high level of impact from human activities. No designated scenic views or scenic roadways were identified from the literature review.

3.18.4 Future Development

Throughout Brazoria County, future projects include expansion of highways, new schools, new businesses, and improvements to water and sewer projects in communities such as Surfside Beach. Big industrial employers, including Freeport LNG, BASF, Dow Chemical, and ConocoPhillips, plan to expand with major projects.

There are numerous developments planned or in progress including the following:

- Freeport will become BASF Corporation's manufacturing base for nylon intermediates and polymers in North America, with a new plant to be constructed on-site (*The Alliance*, 2005a).
- Food companies such as GrupoSOS began construction of the first phase of their $200 million expansion (*The Alliance*, 2006f).
- Freeport is discussing the possible annexation of 122 acres along the GIWW adjoining the Bridge Harbor subdivision. If approved, the mile-long parcel would likely be used for residential/commercial development (*The Alliance*, 2007a). Subsequently, Freeport has plans for a marina to be built on the Old Brazos River, which would potentially attract restaurants and hotels around the site (*The Alliance*, 2006g).
- In 2007, the Velasco Drainage District gave Freeport permission to make cuts in the Old Brazos River levee for the dry-stack boat storage facility (*The Alliance*, 2007b).
- Future development in Surfside Beach includes a proposed 9-acre, 260-slip, dry dock marina that would be located off the SH 322 Intracoastal Bridge (*The Alliance*, 2007c).
- A joint venture among Surfside Beach, Brazoria County, and TPWD is planned to construct a four-bay boat ramp between Village Hall and the USCG Station (*The Alliance*, 2007d).
- Industrial construction and/or expansion projects include the construction of Shintech's new 500-acre site near current industrial plants in the Chocolate Bayou area (*The Alliance*, 2007e).
- AirLiquide plans to construct an air separation unit adjacent to its current Oyster Creek plant (*The Alliance*, 2007f).
- Future expansion of Port Freeport includes an LNG facility (under construction) including the construction of new berths and a transit shed. The project is expected to be completed in 2011. There are approximately 8,000 acres of land adjacent to the Gulf available for future development in Port Freeport.
- New construction within Port Freeport would include the construction of a new Velasco Terminal that will add 2,400 feet of docking area to the port (*The Alliance*, 2006h).
- Future development of property located south of SH 36 (Parcel 14) would provide a multi-modal facility with on-site warehousing and rail facilities (Port Freeport, 2009).
- Future development of property located adjacent to Navigation Boulevard and the Channel to Brazos Harbor (Parcel No. 25) would expand Port Freeport's warehousing and rail facilities (Port Freeport, 2006). With the increasing warehousing capabilities of the port, companies like Reliance Bulk Carriers of Houston will be able to utilize the storage facilities (*The Alliance*, 2007g).

Transportation improvement projects include:

- Construction of a four-lane CR 220 from FM 521 to SH 288;
- Widening of existing CR 220 from SH 288 to FM 523;
- Construction of a six-lane toll highway (SH 99) from the Harris County line to FM 1093;
- Reconstruction of FM 2351 (CR 129) to a four-lane divided highway from SH 35 to the Galveston County line;
- Widening of FM 523 from FM 2004 to SH 332; and
- Replacement of the CR 160 bridge at the Gulf Coast Water Canal (TxDOT, 2007).

Enhancements to highway capabilities in the area will also include widening SH 36 from two lanes to four lanes to facilitate hurricane evacuations and passenger and freight movement. There will also be improvements made to SH 288, the main direct north-south route between Freeport and Houston.

Enhancements to rail capabilities will include replacement of a rail bridge over the old Brazos River Channel in downtown Freeport to serve increasing cargo volumes from Port Freeport (*The Alliance*, 2006e). In addition, UPRR plans to construct a new rail line through Angleton (*The Alliance*, 2006i).

(This page intentionally left blank.)

4.0 ENVIRONMENTAL CONSEQUENCES

4.1 ENVIRONMENTAL SETTING

Due to the timing of the 600-foot Widening Project for the Freeport Channel system Outer Bar and Jetty channels (Widening Project), the FWOP-1 Alternative description has been written to assume the Widening Project would occur with placement of 300,000 cy of silty/sand new work material at Quintana, and that the NED and LPP are compared to the FWOP-1 Alternative regarding impacts (see Section 2.2).

4.1.1 Physiography and Geology

4.1.1.1 FWOP-1 Alternative

The FWOP-1 Alternative would cause no significant change to physiography or geology. The Widening Project is expected to result in approximately 3.2 mcy of new work dredged material. Approximately 2.9 mcy would be placed in the previously designated New Work ODMDS and 300,000 cy of silty/sand material would be placed on Quintana Beach in front of the Seaway PA. Maintenance dredging of existing ship channels and placement of that dredged material at PAs would continue as it is currently. The amount of material dredged from the Outer Bar and Jetty channels during maintenance cycles is expected to be about 3.3 mcy per year, an increase of about 1 mcy over existing conditions. This material would continue to be placed in the Maintenance ODMDS. The amount of material dredged from the remainder of the channels would remain unchanged from current conditions.

4.1.1.2 NED Alternative

Under this alternative, channel improvements would have minimal impacts on the physiography of the project area. The proposed channel improvements would impact approximately 13.8 linear miles of the existing Freeport Harbor Channel from the Stauffer Turning Basin (Station 260+00) to offshore Channel Station –470+00. In addition, the proposed upland PAs 8 and 9 ranging in size from approximately 160 to 250 acres, respectively, would be constructed. The existing PA 1 would continue to be used for placement of dredged material.

The NED Alternative construction would generate approximately 20.4 mcy of new work dredged material. Of this, approximately 6.6 mcy of material would be placed in PAs 8 and 9, and approximately 15.0 mcy of material would be placed in the New Work ODMDS.

While local changes would occur to bathymetry and topography with construction of this alternative, these alterations would be expected to have negligible impacts on the overall physiography and geology of the submerged and subaerial portions of the project area. Equipment staging areas and dredge pipelines would not result in any detrimental effects to physiography and geology of the project area. Upland PAs would be accessed through existing waterways, road or highway rights-of-way, or disturbed areas.

4.1.1.3 LPP Alternative

The potential effects of the LPP Alternative are similar to those of the NED Alternative; however, less dredged material would be generated (17.3 mcy) and placed into the New Work ODMDS and PAs. Approximately 4.6 mcy of material would be placed in PAs 8 and 9, and approximately 12.7 mcy of material would be placed in the New Work ODMDS.

While local changes would occur to bathymetry and topography during construction of the LPP Alternative, these alterations would be expected to have negligible impacts on the regional physiography, topography, and bathymetry of the submerged and subaerial portions of the project area. Last, equipment staging areas and dredge pipelines would not result in any detrimental effects to physiography and geology of the project area. Upland PAs would be accessed through existing waterways, road or highway rights-of-way, or disturbed areas.

4.1.2 Water Exchange and Inflows

4.1.2.1 Projected Relative Sea Level Rise Impacts for the Project Area

The potential for RSLR impacts in the FHCIP area includes impacts on low-lying, tidal wetlands due to higher water levels, impacts on vessel traffic due to changes in current velocities in the area, and impacts on surge levels.

In general, the functioning of the navigation features associated with all alternatives (channel depths of 55 through 60 feet, turning basins, PAs, and ODMDSs) would be insignificantly affected by the full range of potential sea level change. Upland confined PAs and mitigation features are located at elevations higher than the full range of potential RSLR calculated by ERDC. The following discussion describes possible ways that RSLR might affect the project alternatives.

Hydrodynamic modeling performed for the proposed project shows that implementation of the NED or LPP would result in changes in current velocities in the harbor, tidal timing and range within the harbor, and a small change in the height of tidal surge. The depth-averaged velocities in the harbor for both plans show a decrease in peak ebb and flood velocities of from 0.0 to 0.18 foot/second (5.4 centimeters per second [cm/sec]), the decrease becoming less moving upstream into the harbor. The LPP and NED alternatives produce tidal results that are essentially identical. Tidal differences include advancement of the flood and ebb tides by approximately 30 minutes in this diurnal system, and an increase in the mean tide range of about 0.3 percent, or 0.01 foot (0.2 cm). The surge values for alternatives 4 and 5 are about 0.16 foot (5 cm) higher with the proposed changes than without them. These differences in tidal velocities, tidal timing and tide range, and surge height are the result of physical changes to the system that would result from the LPP and NED alternatives, primarily associated with deepening and widening of the channels.

Both types of changes tend to increase the coupling of the harbor to the Gulf. The excavation of portions of the southwest peninsula would increase the tidal prism of the harbor by about 0.05 percent. This increased tidal prism would result in more water moving into and out of the system during each tidal cycle. Since more water is entering and leaving the system during each tidal cycle, peak velocities would be expected to increase as a result. Deepening and widening of the Jetty Channel and the Lower Turning Basin also would result in a stronger coupling between the Gulf and the harbor. This deepening and widening of the harbor would result in increases in the volume of the harbor of from 5.8 percent (NED) to 6.4 percent (LPP). The increased cross-sectional area for the water to flow into the system would result in decreased peak velocities. Hydrodynamic modeling shows that the net effect of these competing processes would be to lower the peak velocities, up to 0.18 foot/second (5.4 cm/sec), in the harbor, as one would expect from the relative size of the effects. With the projected RSLR the system is, in effect, deepened from 0.36 foot (11.0 cm) to 2.4 feet (73.2 cm) further, depending on the sea level rise and subsidence scenario. This additional “deepening” would result in further, though slight, decreases in peak velocities by further increasing the cross section of the channel.

The increased coupling would also affect the tide. The advancement of the timing of the tide means that, with the deeper and wider channel, the tide could move into and out of the harbor more easily and, thus, the timing of the tide would change. Deepening of this type generally also causes an increase in the tide range inside a waterway; the range of the driving Gulf tide is diminished less as it experiences relatively less friction, due to the deeper water, as it travels up into the system. In this case, however, the system in its existing condition is already well coupled to the Gulf, as evidenced by the similarity of the tides in the jetties to those in the harbor. Given the lack of resonant behavior in the short channel (about 3 miles [5 kilometers] from jetties to the end of the deepened portion of the channel), only small increases in the tide range, predicted to be about 0.3 percent, or 0.01 foot (0.2 cm), for a mean tide of 1.64 feet (50 cm), would be expected with further deepening and widening. Again, with the projected RSLR for this system, no additional increase in tidal range would be expected since the incremental change, due to RSLR, decreases the relative differences between the existing condition and LPP or NED Plan conditions.

The increased coupling due to the project would also affect the surge, increasing surge levels by about 0.16 foot (5 cm) locally. The percent differences of water level in the system between the with-project and without-project cases for RSLR of 0.36 foot (11.0 cm) to 2.4 feet (73.2 cm) would be smaller than without RSLR. The differences in surge height would thus be expected to be less, as well. Additionally, the effects of increased surge due to the project would be local and, given the general inundation of the greater Freeport area during a significant surge, the additional water elevation due to the project, with or without RSLR, would be expected to be small.

Given the above discussion, impacts on wetlands in the Freeport Harbor project area are thus expected to be negligible for two reasons. First, there are no low-lying, tidal wetlands in the footprint of the channel system. Second, changes in tidal range are expected to be small and difficult to measure, residing in the millimeter range. Since Freeport Harbor is a highly developed industrial area with no tidal wetlands, water level changes due to RSLR would have an effect on the harbor similar to that of a deepening. As seen in the modeling and an examination of the tide data, the harbor is already closely coupled to the Gulf so that any further increases in depth would result in very small increases in tide range. Thus, RSLR is expected to result in an insignificant difference between the existing channel conditions and the LPP or NED Plan.

Impacts on navigation would also be negligible, with currents likely decreasing with RSLR, even further from the decreases expected with the project. RSLR, serving in this case as essentially a deepening, means that an even larger effective cross-sectional area would be available for the flooding and ebbing tides, and that the peak velocities would decrease further. Hence, RSLR would be expected to cause an insignificant difference between the existing channel and the LPP or NED Plan.

Finally, impact differences on the surge levels due to the project, with and without RSLR, would be expected to be very small and local.

4.1.2.2 FWOP-1 Alternative

Conditions during potential high-inflow events such as tropical storms and hurricanes would not change significantly from what is currently experienced. There would also be essentially no changes in storm surge moving in from the Gulf. The widening is expected to slightly increase the amount of water that would move through the channel system during high-inflow events such as hurricanes. However, that should have very little effect on the surge elevations inside the jetties because the area affected by surge behind the jetties is small. With a small area and volume of water, the channel cross-sectional area has little effect on the amount of water entering or leaving with a surge.

4.1.2.3 NED Alternative

The proposed FHCIP would cause a small increase in the amount of water entering or leaving the channel. Thus, it is still reasonable to expect that the current levee system would provide adequate protection following the proposed channel improvements. Last, equipment staging areas and dredge pipelines would not result in any detrimental effects to water exchange and flows of the project area. Hydraulic-pipelines would not affect water exchange or block flows.

4.1.2.4 LPP Alternative

As noted for the NED Alternative, the proposed LPP channel improvements are expected to result in a small increase in storm-surge elevations inside the jetties. Likewise, the proposed channel improvements are not expected to have a substantial effect on the level of protection offered by the current levee system. Thus, impacts would be the same as described for the NED Alternative.

4.1.3 Shoreline Change

4.1.3.1 FWOP-1 Alternative

The existing patterns of shoreline erosion on both the Surfside and Quintana beaches are expected to continue. The current average rate of shoreline retreat is between approximately 9 and 10 feet/year (BEG, 2007).

A study was conducted by ERDC to determine potential impacts to longshore sediment transport rates on adjacent shorelines for four proposed options to deepen and widen the Outer Bar and Jetty channels (ERDC, 2007). The four channel alternatives considered were 50 feet deep by 600 feet wide, 55 feet deep by 600 feet wide, 58 feet deep by 540 feet wide, and 60 feet deep by 540 feet wide. The first alternative is closest to the FWOP-1 Alternative. Analysis included consideration of Texas shoreline change rates calculated by BEG. The study used the GENESIS model to predict long-term shoreline change and the STWAVE model to incorporate wave effects on longshore sediment transport. Results of the ERDC study indicate that although sediment transport impacts on adjacent shorelines would increase with depth of the offshore channel, the impacts would be minor and so slight they would not be noticeable, and would be dwarfed by the annual shoreline retreat of 9 to 10 feet, as noted above. Thus, the FWOP-1 Alternative is not expected to significantly affect shoreline erosion rates at either Surfside or Quintana beaches.

Additionally, 300,000 cy of silty/sand material would be placed on Quintana Beach in front of the Seaway PA. Although this material is expected to remain in this location for only about a year, it would act as a sand source for downdrift shorelines, potentially providing material for those beaches.

4.1.3.2 NED Alternative

The ERDC modeling described above for the FWOP-1 Alternative evaluated how changes in wave-refraction due to the proposed deepening and extension of the Freeport Entrance Channel could affect the Gulf shoreline in the study area (ERDC, 2007). The study concluded that the wave-induced impacts on the adjacent shorelines would be slight and limited to within a few miles of the jetties. Although there is a general erosion trend along much of the study area, the pattern is not straightforward. Individual shorelines do not maintain a fixed relationship to each other and the year-to-year change of a shoreline position is on the order of a few feet to a few tens of feet per year.

The ERDC modeling determined that within about 0.25 mile of each jetty, the shoreline change rate for the NED Alternative could increase by up to 1.5 feet/year. However, the background change rate is approximately 6 times greater than the wave-induced impacts attributable to the proposed project, and thus is much higher than the potential change due to the project. In addition, not all of the potential changes would result in an increase in shoreline erosion. A much larger length of shoreline could experience a slight reduction in the erosion rate. In areas from 0.5 to about 3 miles from the jetties, the modeling indicated that the shoreline erosion rate could decrease by up to 0.6 foot/year. Thus, the primary conclusion from this analysis is that impacts from construction of the NED Alternative would be so slight that they would not be noticeable against the background changes in shoreline position.

4.1.3.3 LPP Alternative

Shoreline impacts from the LPP Alternative would be less than the NED alternative. Within about 0.25 mile of each jetty, the shoreline change rate could increase by up to 1.0 feet/year. However, the background change rate is approximately 10 times greater than the wave-induced impacts attributable to the proposed project, and thus is dramatically higher than the potential change due to the project. In addition, not all of the potential changes would result in an increase in shoreline erosion. A much larger length of shoreline could experience a slight reduction in the erosion rate. In areas from 0.5 to about 3 miles from the jetties, the modeling indicated that the shoreline erosion rate could decrease by up to 0.5 foot/year. Thus, the primary conclusion from this analysis is that impacts from construction of the LPP Alternative would be so slight that they would not be noticeable against the background changes in shoreline position.

4.2 WATER QUALITY

The proposed project has been reviewed for compliance with Section 404(b)(1) guidelines of the CWA. Results are presented in Appendix G. CEQ has concurred that there is reasonable certainty that the proposed project would not violate water quality standards and has provided water quality certification for the Preferred Alternative.

4.2.1 Salinity and Other Water Quality Parameters

4.2.1.1 FWOP-1 Alternative

Under the FWOP-1 Alternative, there would also be no changes in the water inflows and no change in wastewater or stormwater runoff sources. Because the FWOP-1 Alternative assumes a wider channel would be in place, there would be minor changes in the pattern of maintenance dredging and a very slight increase in tidal exchange. Water quality conditions, including salinity, dissolved oxygen, indicator bacteria, and other chemical constituents, should not change in a detectable fashion relative to the current baseline conditions.

4.2.1.2 NED Alternative

Under the NED Alternative there would be no changes in wastewater or stormwater runoff sources or water inflows, but there would be a slight increase in tidal water exchange due to the larger channel cross section. Hypoxic conditions are not expected to occur with respect to increased channel depth because conditions are not favorable for stratification and projected vessel traffic would continue to promote vertical mixing and aeration within the water column. Because there would be no significant changes in inflows and only a slight increase in tidal exchange, there should be no detectable changes in water quality conditions, including salinity, dissolved oxygen, indicator bacteria, and other chemical constituents, relative to the FWOP-1 Alternative. There would be changes associated with dredging activities that would be similar to those under the FWOP-1 Alternative. Last, equipment staging areas and dredge pipelines would not result in any detrimental effects to water quality of the project area and appropriate Best Management Practices (BMPs) would be implemented where necessary.

4.2.1.3 LPP Alternative

Effects under this alternative are similar to those described for the NED and FWOP-1 alternatives. There should be no significant effects on salinity, dissolved oxygen, indicator bacteria, or other chemical constituents relative to current baseline conditions. Last, equipment staging areas and dredge pipelines would not result in any detrimental effects to water quality of the project area and appropriate BMPs would be implemented where necessary.

4.2.2 Water and Elutriate Chemistry

4.2.2.1 FWOP-1 Alternative

Under the FWOP-1 Alternative, there would be construction dredging associated with the Widening Project. This construction material has been tested for contaminants (USACE, 2008a), and no causes for concern were found. There should be no water quality impacts from beach nourishment, aside from short-term increased turbidity. The impacts from ocean placement of 2.8 mcy of new work material were found to be acceptable (USACE, 2008a), in that only increases in turbidity would be expected from ocean placement. There would be less new work material under the FWOP-1 Alternative than under the NED or LPP alternatives and therefore less turbidity.

Under the FWOP-1 Alternative, the long-term water quality in the project area would be essentially as it is described in Section 4.2.1.1. There would be short-term increases in turbidity.

4.2.2.2 NED Alternative

As noted in Section 2.4.2, all construction material and all future maintenance material is destined for ocean placement or upland confined placement. Therefore, there are three impacts of interest: impacts from dredging, impacts from ocean placement, and impacts from the effluent coming from the PA spillways.

All of the impacts noted above for maintenance dredging with the FWOP-1 Alternative would also be expected with the construction dredging associated with the NED Alternative. However, the construction material from the Outer Bar and Jetty channels has been tested for contaminants, and there was monitoring of the water column before, during, and after dredging and placement in the New Work ODMDS in the early 1990s (see Section 3.4.2; EH&A, 1994). No causes for concern for the water column were found upon placement of this material in the New Work ODMDS. While the construction material for the NED Alternative has not been subjected to water quality analyses, it is virgin bottom material. Sediment quality analyses of construction material from the portion of the Jetty Channel from the Widening Project (USACE, 2008a) have been conducted (see Section 3.5.1). Samples were collected to the depth of the NED Alternative, and no causes for concern were determined. Therefore, there should be no unacceptable water quality impacts from dredging or open-ocean placement. However, as noted in Section 3.5.1, during the PED phase of the project, the USACE plans additional sampling of construction material from the extension of the Outer Bar Channel. Additional effects of ocean placement can be found in Appendix B.

As noted in Section 3.4.2, elutriate chemistry was performed on the material from the inner portions of the Freeport Harbor Channel, and monitoring was conducted on the effluent from a PA where sediments from the Inner Channel were placed. No unacceptable water quality impacts were found (USACE, 1978), and, therefore, none should be expected with the NED Alternative. USACE anticipates additional testing of the Inner Channel. Last, equipment staging areas and dredge pipelines would not result in any detrimental effects to water quality of the project area and appropriate BMPs would be implemented where necessary.

4.2.2.3 LPP Alternative

Water quality impacts from this alternative would be the same as those described for the NED Alternative, except that there would be less construction and maintenance material. However, the sources of the material would be the same, so water quality impacts would be essentially the same as those described for the NED Alternative, but with a slightly shorter duration for construction and maintenance activities. Last, equipment staging areas and dredge pipelines would not result in any detrimental effects to water quality of the project area and appropriate BMPs would be implemented where necessary.

4.2.3 Ballast Water

Ballast water has the potential to include potentially invasive species from a remote location. Recognizing this danger, the U.S. has adopted a BWM program described in Section 3.4.4. It includes a number of management measures, including having ballast water exchange a minimum of 200 miles offshore, substantially reducing the risk of introducing invasive species in discharged ballast water in port. It should be noted that vessels loading cargo for export are a small percentage of the vessel traffic at Port Freeport.

4.2.3.1 FWOP-1 Alternative

The number of ballast water exchange reports that were submitted for Freeport Harbor between 2004 and 2006 was 217 (NBIC, 2006). This existing rate of activity is expected to continue under the FWOP-1 Alternative. However, the risk of introducing invasive species through ballast water releases may increase slightly with the projected increase in tonnage handled and number of port calls per year with the widened Outer Bar and Jetty channels.

4.2.3.2 NED Alternative

Under the NED Alternative, there would be a slight increase in risk of potential impacts from ballast water releases. The improved channel would allow the use of larger vessels that would need fewer port calls to carry cargo. This could act to reduce the risk. However, the larger channel may create the opportunity for new development at Port Freeport, thus resulting in additional ship traffic, potentially from ports not currently calling at Port Freeport. This could increase the risk relative to the FWOP-1 Alternative. However, current compliance with USCG BWM protocols, as described in Section 3.4.4, would continue. Thus, ballast water exchange would continue to occur a minimum of 200 miles offshore, reducing the risk of introducing invasive species. The risk of introduction, despite these management protocols, correlates with the number of ships calling at the port.

4.2.3.3 LPP Alternative

Potential impacts from ballast water releases would be slightly less than under the NED Alternative. However, the risk is greatly reduced through compliance with USCG BWM protocols.

4.3 SEDIMENT QUALITY

4.3.1 Surficial Sediments (New Work Material)

4.3.1.1 FWOP-1 Alternative

Some of the material excavated from the channel would nourish the beach at Quintana, and the remainder would be placed in the New Work ODMDS. Sediment quality is discussed in Section 3.5.1, which indicates no cause for concern with this sediment. The 300,000 cy of silty sand that would be excavated was determined to be of sufficient quality to be used for beach placement (PBS&J, 2005b) at Quintana Beach. Fine material would be placed offshore (USACE, 2008a). Thus, no impacts from disposal of new work material are expected.

4.3.1.2 NED Alternative

As noted above, the quality of sediment from the Jetty Channel is discussed in Section 3.5.1. While the extension of the Outer Bar Channel has not been tested, it is virgin Gulf bottom far removed from sources of contamination. The NED Alternative would generate approximately 20.4 mcy of sediment. Of this, roughly 15.0 mcy would be placed offshore in the New Work ODMDS. Modeling of the placement of the projected amount of construction material was performed (Appendix B, Section 5.0), and it was determined that maximum mound height would be 12 feet, although since the site is dispersive, the material would not stay in the New Work ODMDS long term. The modeling indicates that a very small amount of dredged material placed in the New Work ODMDS during construction will slough outside the boundaries of the site (see Appendix B, Attachment A). Almost all benthos inside the New Work ODMDS would be buried. However, monitoring of the New Work ODMDS after construction of the 45-foot Project showed no significant impacts outside the ODMDS attributed to the placement of sediment at the site. In addition, the majority of benthos at the site were opportunistic species that would be able to rapidly repopulate the area. There is no reason to believe that more impacts will occur for the NED Alternative than for the 45-foot Project, and monitoring would be conducted to ensure that there is no excessive mounding and that there is no short-term transport of sediment outside the New Work ODMDS (Appendix B, Attachment B). There would also be monitoring for contamination at and near the New Work ODMDS before construction begins, at the end of construction, and 6 months and 1 year after cessation of dredging (see Appendix B, Attachment B). Appendix B provides more details on the potential impacts of the sediment that is projected to be placed offshore. All other sediment would be placed in upland PAs.

4.3.1.3 LPP Alternative

The LPP Alternative would generate less (17.3 mcy) sediment than the NED Alternative, of which 12.7 mcy would be destined for offshore placement. Thus, the New Work ODMDS would still be needed and benthos would be buried. Long-term impacts are not expected, as the opportunistic species in the area (EH&A, 1994) would be expected to repopulate in a relatively short period of time. Mounding of material placed in the New Work ODMDS for the LPP Alternative was not modeled, since the NED Alternative was used as a worst-case scenario. However, it is reasonable to expect mounding would be less with the LPP Alternative than with the NED Alternative because the dredged material quantities are smaller. However, the thickness would still be sufficient to prevent significant migration of benthic organisms. The same monitoring noted above for the NED Alternative would also be conducted under the LPP Alternative.

4.3.2 Maintenance Material

4.3.2.1 FWOP-1 Alternative

The existing maintenance material is described in Section 3.5.2. The quality of this material would not be expected to change with the FWOP-1 Alternative. Currently 2.23 mcy/year of maintenance material is dredged from the 45-foot Project, which would increase to approximately 3.3 mcy/year, with the FWOP-1 Alternative. Over the next 50 years, approximately 161.5 mcy of maintenance material is expected to be dredged from the permitted channel, an increase of about 49 mcy over 50 years.

4.3.2.2 NED Alternative

The quantity of this material is expected to increase significantly from the FWOP-1 Alternative. Over the 50-year life of the proposed project, approximately 190.5 mcy of maintenance material would be dredged from the FHCIP. This is an increase of approximately 29.0 mcy over 50 years, relative to the FWOP-1 Alternative. However, the quality is not expected to change, since the source of the maintenance material and the method of placement will not change. USACE also routinely tests the maintenance material according to RIA, Green Book, and Inland Testing Manual protocols before dredging to ensure that there are no causes for concern. As noted in Section 3.5.2, past testing of maintenance material with chemical analyses, whole mud bioassays, and bioaccumulation studies has indicated no cause for concern. Thus, impacts associated with maintenance dredging and material placement would not be expected to change from the FWOP-1 Alternative except that the quantity of material would be larger.

4.3.2.3 LPP Alternative

The LPP Alternative is similar to the NED Alternative relative to maintenance material. Over the 50-year proposed period of analysis, approximately 175.9 mcy of maintenance material would be dredged from the FHCIP. This is approximately 14.4 mcy more than would be dredged for the FWOP-1 Alternative over the same 50-year time period, but the quality should not change.

4.4 AIR QUALITY

This section provides a discussion of the air quality impacts associated with the No Action, FWOP, and potential alternatives. It addresses both direct and indirect effects and discusses their impacts relative to the inventory of air emissions for the HGB nonattainment area. As discussed in Section 3.6, for air quality monitoring and planning purposes, the EPA relies on the designation of nonattainment areas for air pollutants within the boundaries of geographical planning units. For consistency with the EPA's designations, the HGB nonattainment area was considered to determine the potential air quality impacts of the proposed alternatives.

The evaluation of impacts to air quality associated with the alternatives was based on the identification of air contaminants and estimated emission rates. The air contaminants considered are those covered by the NAAQS (except for lead [Pb], which is not relevant to project emissions) including CO, O_3, NO_X, PM_{10}, $PM_{2.5}$, and SO_X. Air emissions were considered for channel improvement activities and placement of dredged material as well as emissions from vehicular traffic associated with the project employees' commute. Project emissions were estimated based on preliminary assumptions regarding construction timing and equipment developed for this project. It is not within the scope of this analysis to perform the refined dispersion modeling necessary to predict concentrations for each contaminant and alternative. Rather, the impact of emissions was analyzed relative to the existing inventory and monitored data for air contaminant emissions in the HGB nonattainment area.

The estimated air contaminant emissions, except O_3 and its precursors, were compared to the 2002 emissions inventory for the HGB nonattainment area. Assuming an increase in air emissions would result in a corresponding increase in the ambient air concentration for that air contaminant, the ratio of the estimated emissions to the existing 2002 emissions for that contaminant provided a relative indication of the potential increase in ambient concentrations for the air contaminant. Because air emissions are generally dispersed with distance and time, a relatively small increase in emissions may be assumed to cause a correspondingly small increase in ambient air quality concentrations for that air contaminant, and it may be expected that the increase in emissions would not cause an exceedance of the NAAQS. Because authorization for the project is considered a Federal action, emissions were also considered in terms of the General Conformity Rules.

4.4.1 No Action Alternative

No construction or new operating GHG emission sources are associated with the No Action Alternative. However, it is expected that air contaminant emissions will increase due to continued operational constraints on the existing system and projected increased ship traffic resulting both from growth of existing business and from new business at the Port. Without project implementation, air quality within the area will continue at current trends. Port Freeport is within a nonattainment area for ozone. Although mobile emission sources are expected to increase in the area, EPA standards for cleaner-burning engines and fuel sources are expected to reduce emissions. Over the past 15 years, ozone monitored values have decreased, despite a 36 percent increase in area population from 1991 to 2005 (TCEQ, 2010a). It is anticipated that there would be a continued reduction in ozone due to controls imposed by the Texas SIP requirements. By 2019, the area is expected to achieve and maintain attainment with the NAAQS for ozone. The planning and implementation of these SIP requirements incorporate the effects of population and industrial growth, technology changes, and national or statewide control measures.

4.4.2 FWOP-1 Alternative

The Widening Project is expected to result in between 231 and 214 tpy of NO_X emissions in the first year of construction and between 82 and 76 tpy of NO_X emissions in the second year of construction, not to exceed 100 tpy in the second year of construction (USACE, 2008a). The exact amount of emissions is dependent on the type of equipment used for widening the Jetty Channel. The final estimate of projected emissions will be communicated to the TCEQ for seeking concurrence that these updated emissions are conformant with the SIP. Under the FWOP Alternative, it is expected that, after construction, air contaminant emissions will continue at roughly current trends.

GHG emissions produced under the FHCIP FWOP Alternative would likely be similar to emissions generated under existing conditions but may be slightly higher or lower depending on any changes in shipping patterns or volume. Any increase in GHG emissions under the FWOP alternative would most likely be minor and would not cause an individually discernible impact on global climate change.

4.4.3 NED Alternative

The evaluation of air quality impacts associated with the NED Alternative was based on the identification of air contaminants and estimated emission rates for this project alternative. Air contaminant emissions were estimated for project-related activities based on the schedule, equipment use, capacity, and other related assumptions developed for this alternative. Detailed emissions estimates are contained in the reference document in Appendix C.

The emission sources for this alternative would consist of marine vessel and land-based mobile sources that would be used during the channel improvement activities, as follows:

- Marine Vessels – dredges (cutterhead and hopper) and support equipment (tugboats and survey boats), and shrimp trawlers; and
- Land-based – off-road (bulldozers) and on-road (employee vehicles).

Air contaminant emissions associated with the channel improvement would be primarily combustion products from fuel burned in equipment used for project dredging, support vessels, and dredged material placement equipment. Activities at dredged material placement sites would involve the use of earth-moving equipment. The marine vessel emission sources would be primarily diesel-powered engines. The off-road equipment was assumed to be a mix of gasoline- and diesel-powered and the on-road vehicles all gasoline-powered vehicles.

Regarding the use of low-emission diesel and newer equipment (with lower NO_X), USACE would (1) encourage construction contractors to apply for Texas Emission Reduction Plan grants, the EPA's Voluntary Diesel Retrofit Program, or the EPA's Diesel Emission Reduction Plan offering the opportunity to apply for resources for upgrading or replacing older equipment to reduce NO_X emissions, (2) encourage contractors to use cleaner, newer equipment with lower NO_X emissions, (3) direct contractors and operators that will use non-road diesel equipment to use clean, low-sulfur fuels, (4) direct contractors that will use tugboats during construction to use clean, low-sulfur fuels, (5) direct operators of the assist tugboats used in maneuvering dredge vessels to use clean, low-sulfur fuels, and (6) direct operators of the dredging vessels to use clean, low-sulfur fuels. A more detailed discussion of methods used for estimation of air contaminant emissions can be found in Appendix C.

4.4.3.1 Air Quality Analysis Results – NED Alternative

Emissions from the activities associated with the NED Alternative would include VOC, NO_X, CO, SO_X, PM_{10}, and $PM_{2.5}$. As $PM_{2.5}$ is a subset of PM_{10} particles, when the estimation model used did not specifically provide a $PM_{2.5}$ emission rate, the estimated $PM_{2.5}$ emission rate was conservatively assumed to be equivalent to that of PM_{10}. These construction activities would be considered one-time activities, i.e., the channel improvement activities would not continue past the date of completion. Because of the high moisture content of the dredged material, it is expected that there would be no particulate matter emissions from the placement of dredged material in upland placement areas. Further, the non-Federal sponsor has no plans to move the dredged material after placement. Thus no future release of particulate matter associated with the movement of dry material is anticipated.

A summary of the total estimated emissions in tons resulting from the use of dredging equipment, nonroad equipment, and on-road equipment for the project NED Alternative is presented in Table 4.4-1. A detailed summary of emissions can be found in the reference document (see Appendix C).

Table 4.4-1
NED Alternative – Total Estimated Project Emissions by Source*

Air Contaminant	Dredging Equipment Emissions (tons)	Nonroad Vehicle Emissions (tons)	On-road Vehicle Emissions (tons)
CO	397	14.7	162
NO_X	3,522	32.9	11.8
$PM_{2.5}$	80	2.4	0.26
PM_{10}	84	2.4	0.57
SO_2	541	5.1	0.18
VOC	41	2.4	15.5

*Project construction is expected to be completed over a period of about 5 years.

For a discussion of air quality impacts, the total air contaminant emissions from the NED Alternative were compared to the 2002 emissions inventory for Brazoria County as described in Section 3.6.2. The comparison is presented in Table 4.4-2.

Table 4.4-2
NED Alternative – Peak Annual Estimated Project Emissions
Compared with Brazoria County and HGB Emissions (2002)

Air Contaminant	Peak Estimated Project Emissions (tpy)	Project Emissions % of Brazoria County Emissions	Project Emissions % of HGB Emissions
CO	144	0.2	0.01
NO_X	945	2.1	0.26
$PM_{2.5}$	22	0.3	0.04
PM_{10}	23	0.06	0.01
SO_X	156	1.4	0.1
VOC	15	0.1	0.01

As shown in Table 4.4-2, air contaminant emissions from the NED Alternative would result in a relatively small increase in emissions above those from existing sources in the county and the HGB nonattainment area. As a result, it is expected that air contaminant emissions from the combustion of fuel in equipment used for dredging and placement activities would also result in correspondingly minor short-term impacts on air quality in the immediate vicinity of the project area and even less as emissions are dispersed over the HGB nonattainment area. Due to the anticipated short-term duration of the channel improvement activities, there would be no long-term impacts, and therefore emissions from these activities are not expected to adversely impact the long-term air quality in the area.

The estimated annual GHG emissions as CO_2e for the NED Plan Alternative are summarized in Table 4.4-3 for each year of the anticipated construction activities. Appendix N presents a project-level analysis of GHG emissions.

Table 4.4-3
NED Plan Alternative – Summary of GHG Emissions
(metric tons per year as CO_2 Equivalent)

Activity	2011	2012	2013	2014	2015	2016
Dredging Activities	6,175	51,832	57,073	48,099	33,716	18,504
Land-side Dredged Material Placement	0	698	9	865	731	122
Employee Commuter Vehicles	58	1,252	931	1,248	663	244
Totals	**6,233**	**53,782**	**58,013**	**50,212**	**35,111**	**18,870**

4.4.3.2 General Conformity Applicability – NED Alternative

For comparison with the thresholds defined in the General Conformity Rule, the estimated emissions of NO_X and VOC for the NED Alternative are summarized in Tables 4.4-4 and 4.4-5 for each year during which the project activities are anticipated to occur. Emissions of CO, SO_2, and particulate matter are not considered in the General Conformity evaluation, as the HGB Air Quality Control Region is in attainment with the NAAQS for those pollutants.

As shown in Table 4.4-4, emissions of VOC for project-related activities are exempt from a General Conformity Determination because they are below the 25 tpy threshold.

Table 4.4-4
NED Alternative – Summary of VOC Emissions (tpy)

Activity	2011	2012	2013	2014	2015	2016
Dredging Activities	1.16	9.61	10.78	9.08	6.41	3.48
Land-side Dredged Material Placement	--	0.48	0.65	0.62	0.58	0.10
Employee Commuter Vehicles	0.2	4.41	3.28	4.40	2.34	0.86
Totals	**1.36**	**14.51**	**14.71**	**14.11**	**9.33**	**4.43**

As shown in Table 4.4-5, NO_X emissions for project construction activities show the project would exceed the conformity threshold, i.e., greater than 25 tpy, for all years of projected construction activity. Therefore, a General Conformity Determination for NO_X emissions would be required for these years.

Table 4.4-5
NED Alternative – Summary of NO_X Emissions (tpy)

Activity	2011	2012	2013	2014	2015	2016
Dredging Activities	100.96	847.8	933.1	786.4	551.1	302.6
Land-side Dredged Material Placement	--	6.75	9.0	8.48	7.44	1.24
Employee Commuter Vehicles	0.16	3.36	2.50	3.35	1.78	0.65
Totals	**101.1**	**857.9**	**944.6**	**798.2**	**560.4**	**304.5**

As noted in Section 4.4.4.3, a General Conformity Determination has been prepared by the USACE (see Appendix C). This document was noticed for public review concurrent with the

DEIS in December 2010. Subsequent coordination with the EPA and TCEQ will ensure the project is compliant with the SIP.

4.4.4 LPP Alternative

The evaluation of air quality impacts associated with the LPP Alternative was based on the identification of air contaminants and estimated emission rates for this project alternative. Emissions inventories were estimated for project-related activities based on the schedule, equipment use, capacity, and other related assumptions developed for this alternative. Detailed emissions estimates are contained in the reference document in Appendix C.

The emission sources corresponding to the LPP Alternative are consistent with those described for the NED Alternative and include both marine vessels and land-based equipment. However, dredged material quantities would be smaller for the LPP Alternative, and this is taken into account in emissions estimates.

4.4.4.1 Air Quality Analysis Results – LPP Alternative

Emissions from the activities associated with the LPP Alternative would be considered one-time activities, i.e., the channel improvement activities would not continue past the date of completion. Because of the high moisture content of the dredged material, it is expected that there would be no particulate matter emissions from the placement of dredged material in upland placement areas. Further, the non-Federal sponsor has no plans to move the dredged material after placement. Thus no future release of particulate matter associated with the movement of dry material is anticipated.

A summary of the total estimated emissions in tons resulting from the use of dredging equipment, nonroad equipment, and on-road equipment from the LPP Alternative is presented in Table 4.4-6. A detailed summary of emissions can be found in the reference document (see Appendix C).

Table 4.4-6
LPP Alternative – Total Estimated Project Emissions by Source*

Air Contaminant	Dredging Equipment Emissions (tons)	Nonroad Vehicle Emissions (tons)	On-road Vehicle Emissions (tons)
CO	296	25.7	164.8
NO_X	2620	59.5	12.0
$PM_{2.5}$	59	4.19	0.27
PM_{10}	63	4.32	0.58
SO_2	434	9.33	0.18
VOC	30	4.33	15.8

*Project construction is expected to be completed over a period of about 4 years.

For a discussion of air quality impacts, the total air contaminant emissions from the LPP Alternative were compared to the 2002 emissions inventory for Brazoria County and the HGB Air Quality Control Region as described in Section 3.6.2. The comparison is presented in Table 4.4-7.

Table 4.4-7
LPP Alternative – Peak Annual Estimated Project Emissions Compared with Brazoria County and HGB Emissions (2002)

Air Contaminant	Peak Estimated Project Emissions (tpy)	Project Emissions % of Brazoria County Emissions	Project Emissions % of HGB Air Quality Control Region Emissions
CO	169	0.3	0.02
NO_X	883	2.0	0.25
$PM_{2.5}$	21	0.3	0.04
PM_{10}	22	0.06	0.01
SO_X	146	1.3	0.10
VOC	17	0.1	0.01

As shown in Table 4.4-7, air contaminant emissions from the LPP Alternative would result in a relatively small increase in emissions above those from existing sources in the county and the HGB Air Quality Control Region. As a result, it is expected that air contaminant emissions from the combustion of fuel in equipment used for dredging and placement activities would also result in correspondingly minor short-term impacts on air quality in the immediate vicinity of the project area and even less as emissions are dispersed over the HGB Air Quality Control Region. Due to the anticipated short-term duration of the channel improvement activities, there would be no long-term impacts, and therefore emissions from these activities are not expected to adversely impact the long-term air quality in the area

The estimated annual GHG emissions for the LPP Plan Alternative are summarized in Table 4.4-8 for each year of the anticipated construction activities. Appendix N presents a project-level analysis of GHG emissions.

Table 4.4-8
LPP Alternative – Summary of GHG Emissions
(metric tons per year as CO_2 Equivalent)

Activity	2011	2012	2013	2014	2015
Dredging Activities	5,833	45,694	52,306	43,051	13,355
Land-side Dredged Material Placement	0	2,008	2,677	1,421	7
Employee Commuter Vehicles	41	2,104	906	1,081	0
Totals	**5,875**	**49,805**	**55,890**	**45,554**	**13,362**

4.4.4.2 General Conformity Applicability – LPP Alternative

For comparison with the thresholds defined in the General Conformity Rule, the estimated emissions of NO_X and VOC for the LPP Alternative are summarized in Tables 4.4-9 and 4.4-10 for each year during which the project activities are anticipated to occur. Emissions of CO, SO_2, and particulate matter are not considered in the General Conformity evaluation, as this area is in attainment with the NAAQS for each of those pollutants.

As shown in Table 4.4-9, emissions of VOC for project-related activities are exempt from a General Conformity Determination because they are below the 25 tpy threshold.

Table 4.4-9
LPP Alternative – Summary of VOC Emissions (tpy)

Activity	2011	2012	2013	2014	2015
Dredging Activities	1.09	8.52	9.86	8.18	2.55
Land-side Dredged Material Placement	--	1.39	1.86	1.08	--
Employee Commuter Vehicles	0.15	7.42	3.19	3.81	1.18
Totals	1.24	17.33	14.91	13.08	3.73

Table 4.4-10
LPP Alternative – Summary of NO_X Emissions (tpy)

Activity	2011	2012	2013	2014	2015
Dredging Activities	95.4	747.3	855.2	703.7	218.3
Land-side Dredged Material Placement	--	19.41	25.88	14.23	--
Employee Commuter Vehicles	0.11	5.65	2.43	2.90	0.90
Totals	95.5	772.4	883.5	720.9	219.2

As shown in Table 4.4-10, NO_X emissions for project construction activities show the project would exceed the conformity threshold, i.e., greater than 25 tpy, for all years of projected construction activity. Therefore, a General Conformity Determination for NO_X emissions would be required for these years.

4.4.4.3 General Conformity Determination

As part of the General Conformity process, the USACE has prepared a Draft General Conformity Determination to discuss whether emissions that would result from the proposed FHCIP are in conformity with the Texas SIP for the HGB nonattainment area. This document (included as Appendix C) was noticed for public comment concurrent with the DEIS in December 2010 and was submitted to TCEQ, EPA, and the Brazoria County Health Department, the local air pollution control program. Following coordination with TCEQ and the EPA regarding conformity with the SIP, a Final General Conformity Determination that provides the

USACE final determination with regard to the conformity of this project with the SIP will be prepared.

In response to the issuance of the Draft General Conformity Determination in December 2010, TCEQ provided a General Conformity Concurrence letter dated March 1, 2011. A copy of this letter is provided in Appendix C.

In its letter, the TCEQ provided its General Conformity concurrence for the proposed FHCIP and a determination that emissions from the project would not exceed the emissions budgets in the most recent SIP approved by the EPA. The most recently approved SIP revision, the “HGB Reasonable Further Progress SIP BPA Rate-of-Progress,” adopted by the TCEQ on May 23, 2007, was approved by the EPA on March 29, 2010. In addition, the TCEQ suggested that the USACE adopt pollution prevention and/or reduction measures in conjunction with this and future projects including the following:

- Encourage construction contractors to apply for Texas Emission Reduction Plan grants;
- Establish bidding conditions that give preference to clean contractors;
- Direct construction contractors to exercise air quality BMPs;
- Direct contractors that will use tugboats during construction to use clean fuels;
- Direct operators of the assist tugboats used in maneuvering dredge vessels to use clean fuels;
- Select assist tugs based on lowest NO_X emissions instead of lowest price; or
- Purchase and permanently retire surplus NO_X offsets prior to commencement of operations.

The EPA also provided comments with regard to the Draft General Conformity Determination by letter dated February 11, 2011, as follows:

> “The DEIS and appendices do not indicate plans for this project to use cleaner, newer equipment with lower NO_X emissions. EPA encourages the use of clean, lower-emissions equipment and technologies to reduce pollution. Further, EPA’s final Highway Diesel and Nonroad Diesel Rules mandate the use of lower-sulfur fuels in nonroad and marine diesel engines beginning in 2007. Please indicate a discussion of additional measures the project will incorporate to reduce emissions and the anticipated reductions in emissions. Initiatives such as the EPA Voluntary Diesel Retrofit Program, the EPA Diesel Emission Reduction Program (DERA), and the Texas Emissions Reduction Plan (TERP) on the State level offer the opportunity to apply for resources for upgrading and replacing older equipment to reduce NO_X emissions.”

In response to these suggestions USACE will:

1. Encourage construction contractors to apply for Texas Emission Reduction Plan grants, the EPA's Voluntary Diesel Retrofit Program, or the EPA's Diesel Emission Reduction Plan offering the opportunity to apply for resources for upgrading or replacing older equipment to reduce NO_X emissions;
2. Encourage contractors to use cleaner, newer equipment with lower NO_X emissions;
3. Direct contractors and operators that will use non-road diesel equipment to use clean, low-sulfur fuels;
4. Direct contractors that will use tugboats during construction to use clean, low-sulfur fuels;
5. Direct operators of the assist tugboats used in maneuvering dredge vessels to use clean, low-sulfur fuels; and
6. Direct operators of the dredging vessels to use clean, low-sulfur fuels.

Based on the General Conformity Concurrence letter provided by TCEQ, USACE has prepared a Final General Conformity Determination (see Appendix C) to document that emissions that would result from the proposed FHCIP are in conformity with the Texas SIP for the HGB nonattainment area. A Notice of Availability of this document was published in the newspaper of general circulation in Brazoria County concurrent with the EIS and was submitted to TCEQ, EPA, and the Brazoria County Health Department, the local air pollution control program.

TCEQ and USACE’s determination of conformity is based on the emissions information and project schedule proposed at the time. Once a final project schedule is completed, USACE will provide an update of the General Conformity documentation to TCEQ and EPA for review and concurrence that the updated emissions and schedule will still be conformant with the currently approved Houston-Galveston area SIP.

4.4.5 Additional Maintenance Dredging

After the improvements to the channel are completed, maintenance dredging of the channel will be required. Maintenance dredging is conducted within the channel by USACE on a cyclical basis with a current maintenance volume of 1.88 mcy per every 10.1 months (equivalent to 2.23 mcy per year), with material taken to an approved disposal site. Under the FWOP Alternative, maintenance dredging volumes would be approximately 3.23 mcy per year. The forecasted total maintenance volume after the channel deepening and widening (NED Alternative) has been accomplished is 3.81 mcy per year; an increase in 1.58 mcy per year over the No Action Alternative and 0.58 mcy per year over the FWOP Alternative. Similarly, the forecasted total maintenance volume after the channel deepening and widening (LPP Alternative) has been accomplished is 3.51 mcy per year; an increase in 1.28 mcy per year over the No Action Alternative and 0.28 mcy per year over the FWOP Alternative.

A summary of the estimated emissions in tons resulting from the additional maintenance dredging equipment is shown in Tables 4.4-11 and 4.4-12, for the NED and LPP Alternatives, respectively.

Table 4.4-11
NED Alternative – Additional Maintenance Dredging – Total Estimated Emissions

Air Contaminant	Dredging Equipment Emissions (tons/year)
CO	8.09
NO_X	69.90
$PM_{2.5}$	1.59
PM_{10}	1.67
SO_2	11.06
VOC	0.85

Table 4.4-12
LPP Alternative – Additional Maintenance Dredging – Total Estimated Emissions

Air Contaminant	Dredging Equipment Emissions (tons/year)
CO	6.55
NO_X	56.63
$PM_{2.5}$	1.28
PM_{10}	1.36
SO_2	9.40
VOC	0.69

Although included as part of the project impact evaluation, the General Conformity rules specifically exclude maintenance dredging and debris disposal. Therefore, the General Conformity Determination for this project does not include emissions from the additional maintenance dredging activities.

4.5 NOISE

Project-related noise impacts were evaluated by calculating the worst-case noise levels related to the proposed dredge and placement operations at noise-sensitive receivers. Worst-case conditions would be considered to occur when all dredging or placement equipment is operating in one specific location simultaneously. However, noise levels related to these operations would be based upon the actual number/type of equipment operating in one location at a specific time, and would also fluctuate as equipment is maneuvered throughout the channel. Worst-case impacts were assessed by comparing the noise levels of typical dredge and construction equipment with the ambient noise levels in the vicinity of the project area. Project-related noise levels at receivers were calculated based on numerous properties of noise attenuation and industry accepted standards (see Table 3.7-2).

Noise attenuation between dredge activities and sensitive receivers was calculated based on the assumption that noise attenuates 6 dBA per doubling distance from its source. For example, if dredging activities are measured at 87 dBA at 50 feet, the noise levels would decrease 6 dBA to 81 dBA at 100 feet, decrease an additional 6 dBA to 75 dBA at 200 feet, and decrease to 69 dBA at 400 feet, etc.

4.5.1 FWOP-1 Alternative

Construction of the Widening Project would result in increased noise levels at area receptors. Increases would range from between 12 and 23 dBA over ambient conditions. However, this is only a slight increase (3 to 6 dBA at Surfside Beach Jetty Park and 4 dBA at Surfside Beach residences) over noise impacts currently experienced during maintenance dredging.

The existing regime of maintenance dredging would continue as normal. However, the Widening Project would result in maintenance dredging activities being closer to noise receptors at Surfside. Thus, noise levels associated with maintenance dredging under the FWOP-1 Alternative are expected to increase noise levels during maintenance dredging activities by approximately 3 to 6 dBA at Surfside Jetty Park and approximately 4 dBA at the nearest residences. These noise increases will be barely perceptible to the human ear.

As noted in Section 2.6, there is potential for growth to occur at Port Freeport under the FWOP-1 Alternative. If this were to occur, it is likely ship traffic would increase, resulting in slightly higher noise levels along the Freeport Harbor Channel.

4.5.2 NED Alternative

The NED Alternative is not expected to result in long-term noise impacts. No permanent noise sources would be installed as part of this project. The NED Alternative would, however, create short-term noise level increases at noise-sensitive receivers. Equipment and duration for the proposed action varies by contract or channel reach. Worst-case conditions under the NED Alternative would occur in the vicinity of the Jetty Channel and the Stauffer Turning Basin. Like maintenance dredging, the NED Alternative’s dredging operations would utilize a hopper dredge and tending boats in the Jetty Channel. Therefore, noise level increases in this portion of the project would be nearly identical to the increases during maintenance dredging (approximately 79 dBA at the Surfside Beach Jetty Park and 67 dBA at Surfside Beach’s nearest residences). This is equivalent to a 12 to 23 dBA increase over ambient conditions, which is the same as described for the FWOP-1 Alternative. Dredging operations in the Stauffer Turning Basin would utilize a 30-inch cutterhead dredge and tending boats. Under the NED Alternative, worst-case noise levels at the nearest receivers in the vicinity of the Stauffer Turning Basin were calculated at 68 dBA. This could contribute to slightly increased noise levels in the vicinity.

The proposed NED Alternative would also include activities at PAs 1, 8, and 9. The construction and placement activities could cause temporary noise level increases at nearby sensitive receivers. Initially, levees would be raised around the perimeter of the sites to provide the capacity for future maintenance material. Construction equipment would be operated on an as-needed basis at the PA. Material would be delivered to the site through a pipeline and moved by various earth-moving equipment. As shown in Table 3.7-1, the typical noise level of a bulldozer operating at 50 feet is approximately 82 dBA. Noise emissions would be reduced to 76 dBA at 100 feet, 70 dBA at 200 feet, and diminish quickly as the distance from the noise source increases. Proposed PAs 8 and 9 are located along SH 217, southwest of Freeport. Noise-sensitive receivers in this area include residential structures, a church, and the Freeport Municipal Golf Course. The greatest sound level increases related to placement would occur at the golf course, located approximately 600 feet west of PA 9. Noise levels from construction and placement activities could temporarily reach approximately 60 dBA at this distance. Existing noise conditions at the golf course are influenced by vehicle traffic on SH 217, as well as mowers and maintenance equipment operated throughout the course. The proposed action would not be expected to substantially increase noise levels above current conditions.

Although the NED Alternative is not expected to directly result in increased ship traffic, it could allow for larger ships to enter Port Freeport, and allow the opportunity for additional development at the port, resulting in an increased number of calls to the port and increased ship traffic in the channel. This could contribute to increased noise levels in the vicinity. However, these indirect impacts would be similar to potential increases under the FWOP-1 Alternative.

4.5.3 LPP Alternative

The LPP Alternative is not expected to result in long-term noise impacts. No permanent noise sources would be installed as part of this project. The proposed action, however, would create short-term noise levels at noise-sensitive receivers. Equipment for this alternative would be identical to that described for the NED Alternative, but the duration would vary. Worst-case conditions under the LPP Alternative would also occur in the vicinity of the Jetty Channel and the Stauffer Turning Basin. Noise level increases would be almost identical to the NED Alternative; however, the duration of operations would be expected to last about 2 months longer in the Stauffer Turning Basin, and almost 6 months less in the Jetty Channel than for the NED Alternative. Noise levels during the maintenance dredging would be essentially the same as described for the FWOP-1 Alternative for the Outer Bar and Jetty channels.

The proposed LPP Alternative would also include activities at PAs 1, 8, and 9. Expected noise level increases would be identical to those described for the NED Alternative.

Although the LPP Alternative is not expected to directly result in increased ship traffic, it could allow for larger ships to enter Port Freeport, and allow the opportunity for additional development at the port, resulting in an increased number of calls to the port and increased ship traffic in the channel. This could contribute to increased noise levels in the vicinity. These potential indirect impacts are expected to be the same as the NED Alternative and similar to the FWOP-1 Alternative.

4.6 ENERGY AND MINERAL RESOURCES

4.6.1 FWOP-1 Alternative

The Widening Project would not require relocation of any wells or pipelines.

4.6.2 NED and LPP Alternatives

There are no reported oil or gas wells located within the project area that would be directly or indirectly impacted by the proposed dredging or dredged material placement for any of the alternatives. However, there are 14 reported pipelines that cross the ship channel or its PAs (see Tables 3.8-2 and 3.8-3). Five of the pipelines cross under the two ODMDSs (see Table 3.8-4; RRC, 2006). For the NED and LPP alternatives, the required depth for pipelines up to the Stauffer Channel would be 80 feet. At this time, USACE has determined that all pipelines are at least 80 feet below msl, thus no pipeline relocations are needed.

4.7 SOILS INCLUDING PRIME AND UNIQUE FARMLANDS

4.7.1 FWOP-1 Alternative

Under the FWOP-1 Alternative, no new impacts to surface soils and prime and/or unique farmlands would occur from construction of the Widening Project. However, impacts to surface soils and prime farmland could occur primarily from commercial and/or residential development, which would continue according to expected trends, with potential for accelerated development from the Widening Project.

4.7.2 NED and LPP Alternatives

For both the NED and LPP Alternatives, soils within the project area would be impacted by construction of new upland PAs 8 and 9. These areas would be converted from pasture to areas used for placement of dredged material. However, the conversion would be consistent with current practices in the area.

Prime farmland soils located within the project area would be impacted by the NED Alternative. Construction of PA 9 would convert approximately 250 acres of prime farmland to a dredged material PA, thus making the area unavailable for future agricultural use. Additionally, preservation of about 132 acres as part of the mitigation for impacts to PAs 8 and 9 would preclude the use of this area from future farming. Coordination with NRCS has been completed using Form AD-1006 (Farmland Conversion Impact Rating). According to NRCS, PA 9 and the mitigation area do contain soils classified as Important Farmland and are subject to the Farmland Protection Policy Act (FPPA). NRCS (2011) calculated the Farm Conversion Impact Rating to be a total of 161. However, this EIS presents detailed alternatives analyses that identified no other practicable alternatives for the placement of dredged material from this project.

4.8 GROUNDWATER HYDROLOGY

4.8.1 FWOP-1 Alternative

The FWOP-1 Alternative would not impact groundwater hydrology within the project area. Any groundwater quality impacts are contingent upon the amount and type of development that may take place within the study area.

4.8.2 NED and LPP Alternatives

Construction and operation activities associated with the NED and LPP Alternatives are not expected to result in impacts to groundwater hydrology, quantity, or quality. In addition, no groundwater withdrawals are anticipated for the project. No apparent private, public, or industrial water wells registered with TWDB (2006a) would be destroyed and/or affected based on their proximal distances and completed depths below surface grade.

Possible impacts to shallow groundwater along the axis of the channel may result from a greater channel depth allowing Gulf salinity to exist at a greater depth. However, this will not negatively affect water supply wells in the area. As noted in Section 3.10, all nearby wells are from the Chicot Aquifer and are screened at depths ranging from 250 to 1,330 feet, well below the proposed channel depths.

4.9 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

4.9.1 FWOP-1 Alternative

Under the FWOP-1 Alternative, the chance of encountering hazardous material during construction of the Widening Project is considered negligible, as no known sites exist within the proposed widening footprint.

4.9.2 NED and LPP Alternatives

Proposed improvements for either alternative would remove new work material consisting primarily of 80–90 percent clays, which are highly impermeable to contaminant migration, located beneath existing maintenance overburden. Based on this and the findings of the HTRW survey that reported no known sites in the project footprint, contaminants at concentrations of concern are not likely to be encountered during proposed channel construction.

4.10 VEGETATION

4.10.1 Uplands

The vegetation communities are described and mapped in Section 3.12. The following describes potential nonwetland vegetation impacts associated with each of the alternatives. The potential impacts to wetlands are described in Section 4.10.2.

4.10.1.1 FWOP-1 Alternative

Upland habitats in the majority of the project area would be expected to remain as described in Section 3.12; however, development unrelated to the proposed Widening Project may convert upland habitat to developed areas. Additionally, if current subsidence, shoreline erosion, and sea level rise rates continue as described in Section 3.12, some habitats nearest the coastline could be converted to marshes or open-water habitat.

The Widening Project would remove approximately 1.65 acres of herbaceous/grassland and 0.25 acre of beach located along the north (Surfside) side of the Jetty Channel between Surfside Jetty Park and the USCG Station (Figure 4.10-1).

4.10.1.2 NED and LPP Alternatives

The impacts to upland vegetation would be the same for both the NED and LPP alternatives. Impacts to 21 acres of riparian forest, 358 acres of grassland, and 39 acres of ephemeral freshwater wetlands would result from the construction of PAs 8 and 9 (Table 4.10-1; Figure 4.10-2), which would occur under both alternatives. Section 5.0 and Appendix H provide detailed information on these habitats and their mitigation, which is the same for both alternatives. Last, equipment staging areas and dredge pipelines may result in temporary minor effects to uplands within the project area. Appropriate BMPs would be implemented where necessary to avoid and minimize potential effects. Upland PAs would be accessed through existing waterways, road or highway rights-of-way, and disturbed areas to minimize impacts.

Table 4.10-1
Vegetation Impacts from Construction of PAs 8 and 9

Placement Area	Forest	Grasslands	Ephemeral Freshwater Wetlands
PA 8	0 acre	145 acres	23 acres
PA 9	21 acres	213 acres	16 acres
Totals	**21 acres**	**358 acres**	**39 acres**

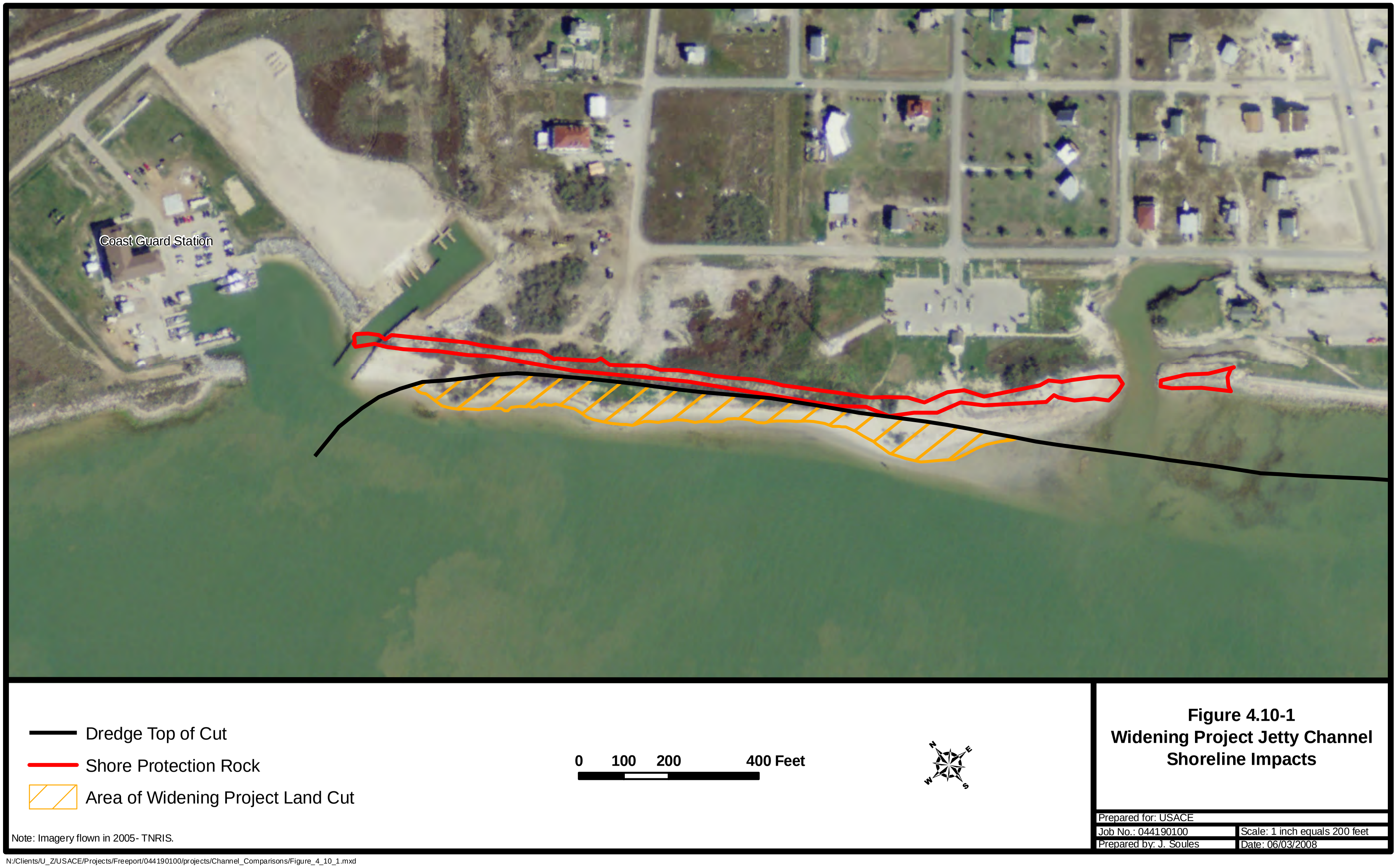


Figure 4.10-1
Widening Project Jetty Channel Shoreline Impacts

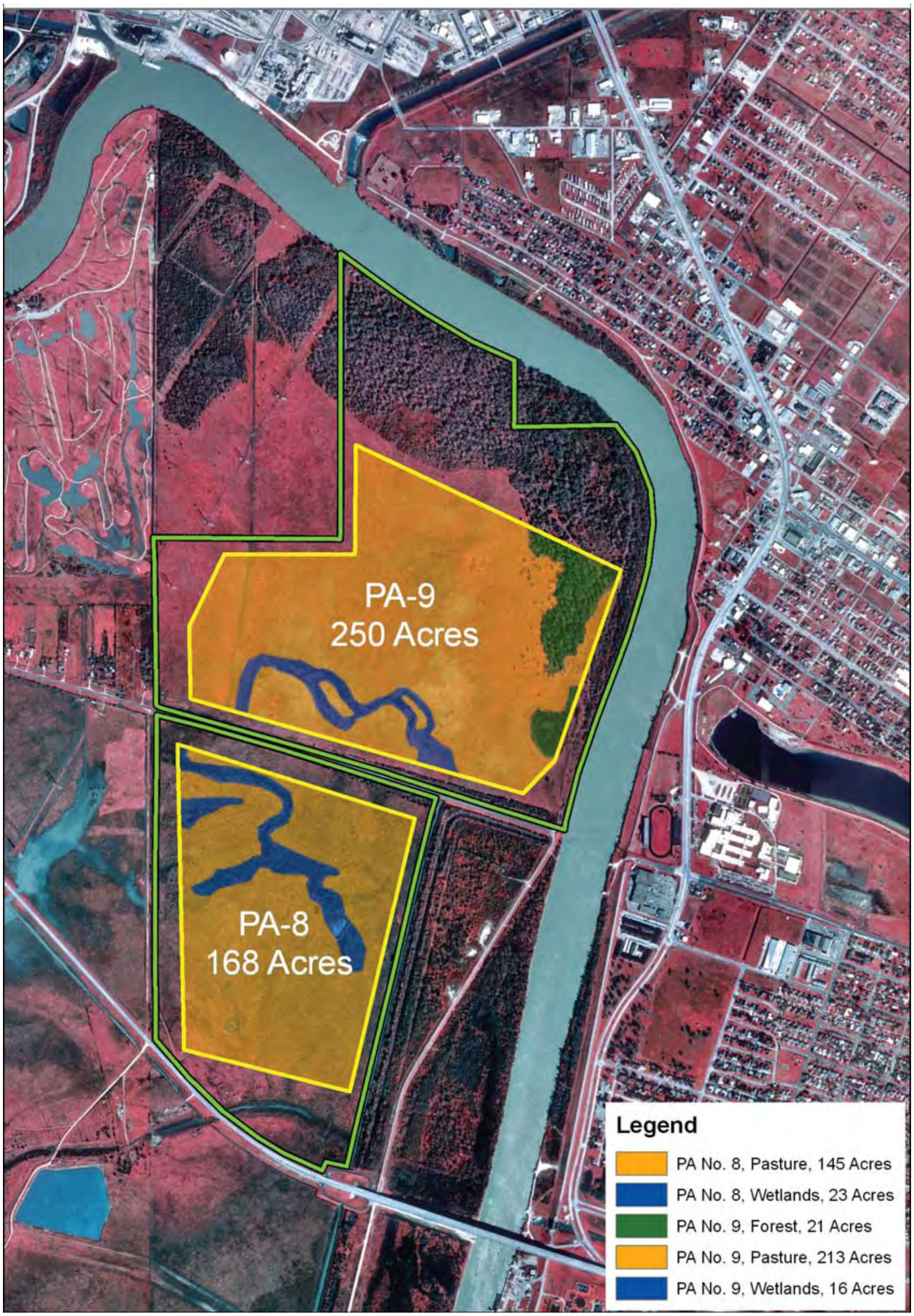


Figure 4.10-2

VEGETATION IMPACTS
FROM PAS 8 AND 9

File: I:\projects\hc1\usace\galv\441901\pdeis document\pdeis 3\pdeis 3 figures\use these\figure4_10-3.ai

4.10.2 Wetlands and Aquatic Vegetation Communities

4.10.2.1 FWOP-1 Alternative

The following describes potential changes in each of the wetland and aquatic vegetation communities considered in the project area when the proposed Widening Project is implemented.

4.10.2.1.1 Estuarine Habitats

Beach nourishment that would occur with construction of the Widening Project would provide limited protection to inter-ridge swales of the Brazos River delta as sediments placed on Quintana Beach eroded and were carried down drift. Limited estuarine habitat found along the Jetty Channel includes some shallow-water habitat and intertidal mud flats, amounting to less than 0.1 acre. Approximately 2 acres of sandy, tidal mudflats would be removed along the north (Surfside) side of the Jetty Channel between Surfside Jetty Park and the USCG Station.

4.10.2.1.2 Freshwater Habitats

Although the Widening Project is not expected to directly impact the wetland area located in the Jetty Channel on the north (Surfside) shoreline, indirect impacts to this area are expected to result in loss of habitat. These impacts are likely to result from equipment staging, site access, and upland and waterside construction activities, including the potential relocation of some of the old jetty rocks.

4.10.2.2 NED and LPP Alternatives

4.10.2.2.1 Estuarine Habitats

Some shallow-water habitat and intertidal mud flats along the Jetty Channel would be destroyed by the Widening Project. While there are estuarine marshes outside of the NED and LPP project footprints that are hydrologically connected to the project area by the GIWW, there will be no direct or indirect project impacts from either alternative. Because of the lack of changes to the salinity regime (see Section 4.2.1), no indirect salinity-related impacts to any of these habitats would be expected.

4.10.2.2.2 Freshwater Habitats

A wetland located on the north (Surfside) side of the Jetty Channel east of the USCG Station would be impacted by the Widening Project prior to construction of either the NED or LPP alternatives. There would be no impacts to freshwater habitat for either the NED or LPP alternatives resulting from channel construction or salinity-related impacts.

The NED and LPP alternatives would both impact freshwater wetlands as a result of PA construction, as described in Section 4.10.1.2, above. Construction of PAs 8 and 9 would impact

23 acres and 16 acres of wetlands, respectively. The Habitat Evaluation Procedure (HEP) Analysis in Appendix H-1 presents an extensive discussion of impacts to this resource, which would be mitigated. Last, appropriate BMPs would be implemented to avoid and minimize the potential for equipment staging areas and dredge pipelines to result in temporary direct and indirect impacts to wetlands and vegetation adjacent to PAs 8 and 9 along the Brazos River. Upland PAs would be accessed through existing waterways, road or highway rights-of-way, and disturbed areas to minimize impacts.

4.11 TERRESTRIAL WILDLIFE

4.11.1 FWOP-1 Alternative

Construction of the Widening Project would result in removal of approximately 1.9 acres of shoreline near the Jetty Channel along the north (Surfside) side of the channel. This area includes some upland grass and shrub/scrub vegetation, and some portions of sandy beach. Removal of this habitat is not expected to have negative effects on local wildlife because of the small size of the area being removed and the presence of similar habitat types within the project area. Dredging activities from the Widening Project may have some indirect temporary effects to shorebirds, wading birds, and waterfowl in the immediate vicinity by potentially reducing the availability of the food supply through increased turbidity. Temporary impacts to aquatic communities and habitat from increased sedimentation and turbidity would be expected from placement of dredged material at the ODMDSs. This in turn may affect birds in the area by potentially reducing the availability of their local food supply temporarily. However, due to the large area of Gulf waters surrounding the project, it is doubtful that construction and dredged material placement operations would have any meaningful impact on the local food supply for birds in the area. Impacts would be short term and would be only slightly higher than those that occur during current maintenance and dredging activities for the existing channel, which occur approximately every 10 months. Due to the distance of known rookeries in relation to the ODMDSs, rookeries would not be impacted by the placement of dredged material at these sites.

The noise of equipment and increased human activity during dredging activities may disturb some local wildlife, particularly birds, especially during the breeding season. Such impacts, however, should be temporary and without significant long-term implications. Furthermore, noise and artificial lighting impacts related to proposed activities would have minimal additive effects, given the current environment is affected by a number of transportation-related (i.e., barges, railway, roadway, etc.) and heavy industrial activities. Salinity effects are unlikely and are not expected to affect infaunal organisms in the area. Beach placement under FWOP-1 would potentially impact piping plovers and sea turtles. These potential impacts to endangered species are addressed in Section 4.13, below.

4.11.2 NED and LPP Alternatives

NED and LPP Alternatives impacts would be similar for this resource. Although there will be less material dredged under the LPP Alternative, the footprint of the projects is the same. Dredging activities may have a minimal impact on terrestrial wildlife species as a result of increased turbidity and altered hydrology, which in turn may indirectly affect shorebirds, wading birds, and waterfowl in the immediate vicinity of the dredge by potentially reducing the availability of the food supply. These impacts are local and temporary and are not likely to be significant considering the overall availability of similar habitats in the general area, the mobility of birds, and the frequent occurrence of similar impacts due to maintenance activities.

Additional impacts from noise and increased human activity would be the same as those described for the FWOP-1 Alternative, except that they would occur farther up the channel to the Stauffer Turning Basin.

According to the USFWS TCWC (USFWS, 2010), several rookeries occur within the study area. Table 3.13-1 provides information on nesting activities at these rookeries. Dredging activities for the FHCIP would occur immediately adjacent to rookeries 610-101 and 610-102 (USFWS, 2010). Rookery 610-101 (Bryan Beach State Park), which is located near the intersection of the Freeport Harbor Channel system and the GIWW, historically supported nesting populations of black skimmer (*Rynchops niger*) and least tern; however, the black skimmer has not nested at the site since 1991 and least terns have been absent since 1982 (USFWS, 2010). Rookery 610-102 (Bryan Beach Spoil) is on the south side of the Freeport Harbor Channel system, situated on the southwest portion of the TEPPCO Peninsula. This rookery historically supported several species of herons and egrets, least terns, and black skimmers, but is currently inactive (USFWS, 2010). A field survey conducted on June 18, 2010 (USACE, 2010), confirmed that rookeries 610-101 and 102 are presently inactive, based on the absence of nests and nesting birds. Therefore, dredging activities at present would not affect these rookeries. Other rookeries in the study area include 610-100 (Freeport Dow), 610-103 (Bryan Mound), 610-104 (Dow Gate A-40), 610-105 (Dow Tern), and 610-106 (Bryan Beach Diked Spoil). Dredging activities would not result in impacts to these rookeries. Last, equipment staging areas and dredge pipelines may result in temporary direct and indirect minor impacts to wildlife and habitats during construction only. Upland PAs would be accessed through existing waterways, road or highway rights-of-way, and disturbed areas to minimize impacts.

4.12 AQUATIC ECOLOGY

4.12.1 Aquatic Communities

4.12.1.1 FWOP-1 Alternative

Aquatic communities would be temporarily affected by construction of the Widening Project. Aquatic organisms in the area would be impacted by short-term increases in turbidity, excavation of bay bottom, and dredged material placement. Benthic organisms would be impacted by construction and placement, although they would be expected to recover quickly. Benthic community structure and abundance would eventually return to preplacement levels at the New Work ODMDS site. In contrast, repeated placement of dredged material at the Maintenance ODMDS may result in the benthic community not fully recovering to preplacement populations between maintenance cycles. The Maintenance ODMDS is currently used for placement of dredged material from maintenance cycles, and therefore continued placement of maintenance material at the site would not be expected to change current conditions. No long-term effects would be expected.

4.12.1.2 NED and LPP Alternatives

Construction of the FHCIP and future maintenance activities would bury benthic organisms and generate suspended solids and turbidity, as described for the FWOP-1 Alternative, above. Repeated dredging in one place may prevent benthic organisms from fully developing (Dankers and Zuidema, 1995). Excavation destroys the community that previously existed but creates new habitat for colonization (Montagna et al., 1998). Excavation can actually maintain high rates of macrobenthos productivity (Rhoades et al., 1978). By repeatedly creating new habitat via disturbance, new recruits continually settle and grow. However, these new recruits are always small, surface-dwelling organisms with high growth rates. Large, deep-dwelling organisms that grow slower and live longer are lost to the areas of repeated excavation. In this way, excavation may not cause a decrease in production, but rather a shift in community structure (Montagna et al., 1998).

Although water column turbidity would increase during project construction and maintenance dredging, such effects are usually temporary and local. Elevated turbidities during construction and maintenance dredging may affect some aquatic organisms near the dredging activity; however, turbidities can be expected to return to near ambient conditions within a few hours after dredging ceases or moves out of a given area. Shideler (1984) reports similar total suspended solids (TSS) levels from dredging and storm events. Overall, motile organisms are mobile enough to avoid highly turbid areas (Hirsch et al., 1978). Under most conditions, fish and other motile organisms are only exposed to localized suspended-sediment plumes for short durations (minutes to hours) (Clarke and Wilber, 2000). These impacts would be the same as those described for the FWOP-1 Alternative. Notwithstanding the potential harm to some individual organisms, compared with the existing condition, no significant impacts to finfish or shellfish populations are anticipated from project construction or maintenance dredging activities for either alternative.

No salinity changes are anticipated with channel improvements. Additionally, no sensitive estuarine or marsh environments occur within the Freeport Channel system, and therefore no adverse effects are expected to occur to finfish or shellfish populations due to changes in salinity. Last, equipment staging areas and dredge pipelines would not result in any detrimental effects to the aquatic ecological resources, and appropriate BMPs would be implemented. Upland PAs would be accessed through existing waterways, road or highway rights-of-way, and disturbed areas to minimize impacts.

4.12.2 Essential Fish Habitat

4.12.2.1 FWOP-1 Alternative

EFH is not expected to be significantly affected by construction of the Widening Project. Impacts from maintenance dredging would include short-term increases in water column turbidity and benthic impacts, although no long-term effects would be expected. NMFS concurred with this determination per letter dated December 5, 2006 (Appendix A-4).

4.12.2.2 NED Alternative

EFH for adult and juvenile brown, white, and pink shrimp, red drum, gag grouper, scamp, red snapper, gray snapper, lane snapper, greater amberjack, king mackerel, Spanish mackerel, cobia, Atlantic bluefin tuna, bonnethead shark, blacktip shark, bull shark, and Atlantic sharpnose shark occur in the study area and include estuarine emergent wetlands, estuarine mud and sand bottoms, estuarine water column, marine water column, and marine nonvegetated bottoms. EFH that occur within the direct project footprint and immediately adjacent areas include marine water column and marine nonvegetated bottoms. Estuarine emergent wetlands, estuarine mud and sand substrates, and estuarine water column that exist within the project area boundary would not be directly impacted by the proposed project and are not likely to be indirectly impacted as well.

Benthic organisms would be impacted by construction and ODMDS disposal, but are expected to quickly recover. Turbidity could impact EFH during construction and maintenance dredging, but these impacts are not considered significant.

4.12.2.3 LPP Alternative

Under the LPP Alternative, impacts to EFH would be the same as those described for the NED Alternative (see Section 4.12.2.2). The shorter construction duration for the LPP Alternative would shorten the potential impact duration in comparison to the NED Alternative.

4.13 THREATENED AND ENDANGERED SPECIES

A Biological Assessment (BA) for this project has been prepared to fulfill the USACE requirements as outlined under Section 7(c) of the ESA, as amended, and is included in Appendix I. The BA has been provided to NMFS and USFWS for review and serves to initiate consultation with these agencies.

4.13.1 FWOP-1 Alternative

Placement of 300,000 cy of silty/sand material on Quintana Beach may affect, but is not likely to adversely affect, piping plovers. Hopper dredging activities during construction may affect sea turtles. According to the Biological Opinion (BO) published by NMFS dated August 21, 2007, the construction of the Widening Project is likely to adversely affect, but is not likely to jeopardize the continued existence of, Kemp’s ridley, loggerhead, leatherback, green, and hawksbill sea turtles. The BO specifies that incidental take by injury or mortality would consist of 2 sea turtles and 32 noninjurious takes by relocation trawling. The USFWS and NMFS have not indicated the potential for additional threats to threatened or endangered species as a result of existing maintenance activities. Hopper dredging would continue to directly affect sea turtles. These potential impacts are addressed in the November 19, 2003, Gulf Regional Biological Opinion (GRBO) to USACE on Hopper Dredging of Navigation Channels and Borrow Areas in the U.S. Gulf of Mexico, and Revision 2 to the GRBO, issued January 9, 2007, for USACE dredging projects on the Gulf Coast.

Since no federally protected fish or whale species occur in the project area (see sections 3.15.2.2 and 3.15.2.5), the FWOP-1 Alternative would have no impacts on any threatened and endangered fish or whales, and fish SOC and candidate species would remain as described in Section 3.15.2.2.

4.13.2 NED Alternative

4.13.2.1 Dredging/Construction Activities

No federally listed plant species are of potential occurrence in Brazoria County (USFWS, 2007). Thus, the proposed project would not result in impacts to any threatened and endangered plant species.

The NED Alternative is unlikely to affect any threatened and endangered terrestrial animal species. Many are inland species that are not likely to occur in the affected areas, while others are migrants that pass through the region seasonally. Listed species of potential occurrence in the study area during some portion of the year include the whooping crane and piping plover, and sea turtles. The whooping crane, while of potential occurrence in the study area, would only occur as a transient within the project area and, therefore, is unlikely to be affected by the proposed project. Thus, there is likely to be no effect to these species. Further, equipment staging areas and dredge pipelines would not result in any direct and indirect impacts to threatened and endangered species. Upland PAs would be accessed through existing waterways, road or highway rights-of-way, and disturbed areas to minimize impacts.

Wintering piping plovers are of potential occurrence on Gulf beaches and mudflats along the bay margins of the project area. No construction or placement of dredged material would impact designated piping plover critical habitat, which occurs near the project area. The project area is not likely to be an important feeding or resting area for piping plovers due to year-round human recreational use. Piping plovers have been observed using upland PAs for resting and loafing between placement activities. PA 1 is currently used every 10 months for maintenance, and no change in that placement schedule is anticipated. The NED Alternative will have no effect on piping plovers.

Green, loggerhead, Kemp's ridley, and hawksbill sea turtles may occur in the project area. Of the five species of sea turtle known to potentially occur in Texas waters, the leatherback is the least likely to occur in the project area due to its pelagic nature. The proposed project calls for the use of both pipeline and hopper dredges. It has been well documented that hopper dredging activities occasionally result in sea turtle entrainment and death, even with seasonal dredging windows, V-shaped turtle-deflector dragheads, and concurrent relocation trawling (NMFS and NOAA, 2003). Between 1995 and 2008, a total of 73 turtles were taken as a result of Gulf-wide hopper dredging, including loggerheads (29), greens (29), and Kemp's ridleys (15). Hawksbills and leatherbacks are not known to have been caught in hopper dredges since monitoring began (USACE, 2008b). Sea turtles easily avoid pipeline dredges due to the slow movement of the dredge. Restriction of hopper dredging activities to between December 1 and March 31, whenever possible, would reduce the likelihood of mortality. Any dredging activities outside of this window should be with hydraulic dredges, if possible, to reduce mortality. Hopper dredging impacts to sea turtles can also be reduced by having a trawler precede the dredges to capture turtles and relocate them away from the project. An increase in marine traffic could result in a higher incidence of collisions with sea turtles. Other potential impacts of the project include disorientation because of lighting on vessels and increased accumulation of plastic detritus. If sea turtles are present at ODMDSs, they may be affected by sedimentation and turbidity. Nevertheless, no significant adverse impacts are expected to sea turtles from material placement activities.

Green sea turtles have been recorded in the project area. The USACE Sea Turtle Data Warehouse (USACE, 2008b) maintains records of incidental takes from hopper dredging activities. Two green sea turtle takes occurred in Freeport Harbor in 2006, and one green sea turtle take occurred in the Entrance Channel in 2007.

Kemp's ridley has also been recorded in the study area, and two takes are documented in the Entrance Channel in 2007 (USACE, 2008b). If dredging were to occur during the nesting season (March 15–October 31), Kemp's ridley hatchlings, if present, could be adversely affected by disorientation from bright lights generated by hopper dredges. Typically, hatchlings take the shortest route to water; however, bright lights can cause hatchlings to move toward the lights rather than the water, resulting in disorientation and increased danger from predators. Although nesting is uncommon in the study area, project impacts could occur. The loggerhead sea turtle has been recorded in the study area. Between 1995 and 2000, eight loggerheads were caught in Freeport Harbor Channel, and during maintenance dredging (July 13 to September 24, 2002), a relocation trawler captured one loggerhead (NMFS and NOAA, 2003). In 2007 a loggerhead was taken in the Entrance Channel by dredging (USACE, 2008b).

Four sea turtle species (green, hawksbill, Kemp's ridley, and loggerhead) could be negatively impacted by hopper dredging activities. Relocation trawlers working ahead of the hopper dredges would help to reduce these impacts. Because of the history of turtle takes by dredging along the Texas coast, the NED Alternative is likely to adversely affect these four sea turtle species. However, these impacts are not likely to jeopardize the continued existence or recovery of these species. Placement of dredged material associated with the proposed project may affect, but is not likely to adversely affect, these four sea turtles species.

Of the five species of sea turtles occurring in Texas waters, the leatherback is the species least likely to be affected by the proposed project because of its rare occurrence and pelagic nature. It is unlikely to occur in the project area and has not been caught in hopper dredges. Although no impact to this species is anticipated to result from the proposed project, because the leatherback does occur within Texas waters, the proposed project may affect, but is not likely to adversely affect, this species.

Following consultation with NMFS regarding potential impacts to sea turtles during hopper dredging activities, Terms and Conditions described in the November 19, 2003, GRBO, in Revision 2 to the GRBO issued January 9, 2007, and in their anticipated project-specific BO for new work dredging would be implemented to minimize impacts and the incidental take of sea turtles during construction of the proposed project. The following measures are proposed:

1. Hopper dredging activities shall be completed, whenever possible, between December 1 and March 31, when sea turtle abundance is lowest throughout Gulf coastal waters.

2. Because they are not known to take turtles, pipeline or hydraulic dredges must be used whenever possible between April 1 and November 30.

3. NMFS-approved protected species observers will be aboard the hopper dredges for sea turtle monitoring. Observer coverage sufficient for 100 percent monitoring (i.e., two observers) of hopper dredging operations is required aboard the hopper dredges between April 1 and November 30, and whenever surface water temperatures are 11 °Celsius or greater.

4. During periods in which hopper dredges are operating and NMFS-approved protected observers are NOT required, additional instruction and notification to NMFS must be enacted.

5. When sea turtle observers are required on hopper dredges, 100 percent inflow screening of dredged material is required and 100 percent overflow screening is recommended. If conditions prevent 100 percent inflow screening, inflow screening may be reduced gradually, but 100 percent overflow screening is then required.

6. Standard operating procedure shall be that dredging pumps shall be disengaged by the operator when the dragheads are not firmly on the bottom to prevent impingement or entrainment of sea turtles within the water column. This precaution is especially important during the cleanup phase of dredging operations.

7. A state-of-the-art rigid deflector draghead must be used on all hopper dredges at all times.

8. Observer reports of incidental take by hopper dredges must be submitted appropriately by onboard NMFS-approved protected species observers, the dredging company, or the Galveston District USACE within 24 hours of any sea turtle or other listed species take observed. A final report summarizing the results of the hopper dredging and any documented sea turtle or other listed species takes must be submitted to NMFS within 30 working days of completion of the dredging project.

9. The Sea Turtle Stranding and Salvage Network state representative shall be notified of the start-up and completion of hopper dredging operations and bed-leveler dredging operations, as well as any sea turtle strandings in the project areas that may be a result of the project construction. Written reports shall be submitted within 30 days of project completion if any strandings are identified.

10. NMFS's southeast regional office shall receive a report detailing incidents, with photographs when available, of stranded sea turtles that bear indications of draghead impingement or entrainment.

11. An end-of-project report shall be provided to NMFS within 30 days of completion of any relocation trawling.

12. Handling of sea turtles captured during relocation trawling in association with the dredging project shall be conducted by NMFS-approved protected species observers. Relocation trawling shall be undertaken after the take of one sea turtle during the project.

13. Relocation trawling for the project is subject to trawl time, handling during trawling, captured sea turtle holding, scientific measurement, take and release time during trawling, injury, flipper tagging, PIT-Tag scanning, and other sampling procedure conditions. There are also PIT-Tag scanning and data submission requirements and handling fibropapillomatose turtle guidelines that must be followed.

14. NMFS-approved protected species observers aboard a relocation trawler or hopper dredge is authorized for tissue sampling of live or dead sea turtles without the need for an ESA permit.
15. All contracted personnel involved in operating hopper dredges must receive thorough training on measures of dredge operation that will minimize sea turtle takes.
16. From May 1 through October 31, sea turtle nesting and emergence season, all lighting aboard hopper dredges and hopper dredge pumpout barges operating within 3 nautical miles of sea turtle nesting beaches shall be limited to the minimal lighting necessary to comply with USCG and/or Occupational Safety and Health Administration requirements. Nonessential lighting shall be minimized through reduction, shielding, lowering, and appropriate placement.

4.13.3 LPP Alternative

Impacts to threatened and endangered species resulting from dredging, construction, and operational activities associated with the LPP Alternative would be similar to those associated with the NED Alternative, which are discussed in Section 4.13.2, above. The LPP Alternative would result in the placement of less dredged material than the NED Alternative; however, footprints of the projects would be the same. A summary of effect determinations for threatened and endangered species listed by USFWS and NMFS within the project area is provided in Table 4.13-1.

4.14 CULTURAL RESOURCES

Pursuant to Section 106 of the NHPA, a Federal agency shall take into consideration the effects a project will have on any district, site, building, structure, or object that is included in or eligible for inclusion in the NRHP (Historic Property). An adverse effect is defined as occurring when an undertaking alters any of the characteristics of a historic property that qualify it for inclusion in the NRHP in a manner that would diminish the property's eligibility (36 CFR 800.5).

The following sections discuss potential adverse effects to Historic Properties for each of the alternatives.

4.14.1 FWOP-1 Alternative

The Widening Project is not expected to have adverse impacts on terrestrial or nautical cultural resource sites. As growth naturally occurs within the project area, impacts could occur to known resources (and there is potential for unknown resources to be identified as well). Port Freeport has plans to develop portions of Tract Eight, the site of the proposed PA 8, for the two action alternatives (Appendix H-1). Where this development occurs, there is potential to impact cultural resources that may be present on that tract of land. Under this alternative, the Programmatic

Table 4.13-1
Effect Determinations Summary for the Proposed LPP

Common Name[1]	Scientific Name[1]	Dredging Activity	Placement of Dredged Materials
FISHES			
Smalltooth sawfish	*Pristis pectinata*	No effect	No effect
REPTILES			
Green sea turtle	*Chelonia mydas*	Likely to adversely affect*	May affect, but not likely to adversely affect
Hawksbill sea turtle	*Eretmochelys imbricata*	Likely to adversely affect*	May affect, but not likely to adversely affect
Kemp's ridley sea turtle	*Lepidochelys kempii*	Likely to adversely affect*	May affect, but not likely to adversely affect
Leatherback sea turtle	*Dermochelys coriacea*	May affect, but not likely to adversely affect	May affect, but not likely to adversely affect
Loggerhead sea turtle	*Caretta caretta*	Likely to adversely affect*	May affect, but not likely to adversely affect
BIRDS			
Piping plover**	*Charadrius melodus*	No effect	No effect
Whooping crane	*Grus americana*	No effect	No effect
MAMMALS			
Blue whale	*Balaenoptera musculus*	No effect	No effect
Finback whale	*B. physalus*	No effect	No effect
Humpback whale	*Megaptera novaengliae*	No effect	No effect
Sei whale	*B. borealis*	No effect	No effect
Sperm whale	*Physeter macrocephalus*	No effect	No effect

*The likelihood of adverse effects (incidental take) of sea turtles due to dredging activities is greatly reduced by implementation and adherence to the conservation measures. Adverse effects are not expected to jeopardize the continued survival or recovery of the species.

**No effect to piping plover critical habitat is expected.

[1]Nomenclature follows AOU (1998, 2000, 2002, 2003, 2004, 2005, 2006, 2007), Crother et al. (2000, 2001, 2003), TPWD (2007), and USFWS (2007).

Agreement would not apply to the above-mentioned activity since there would be no Federal involvement.

4.14.2 NED Alternative

Under the NED Alternative, two new upland confined PAs (PAs 8 and 9) would be constructed. PAI (2007) conducted prefield geoarcheological and historical research on PAs 8 and 9. No cultural resources sites were identified in PA 8, but two historic archeological sites were identified on PA 9: 41BO226 and 41BO227. Additional research and coordination for these two sites is being handled under the PAg. The marine portion of the project area has been fully surveyed, and no historic properties were identified. Last, equipment staging areas and dredge pipelines are not expected to result in any direct and indirect impacts to cultural resources, as these areas can be adjusted to avoid potential impacts, if necessary. If unidentified cultural resources are encountered during construction of the project, the identification, evaluation of significance, assessment of adverse effect, and resolution of adverse effect will be handled pursuant to the PAg.

4.14.3 LPP Alternative

Under the LPP Alternative, two new upland confined PAs (PAs 8 and 9) would be constructed. PAI (2007) conducted prefield geoarcheological and historical research on PAs 8 and 9. No cultural resources sites were identified in PA 8, but two historic archeological sites were identified on PA 9: 41BO226 and 41BO227. Additional research and coordination for these two sites is being handled under the PAg. The marine portion of the project area has been fully surveyed and no historic properties were identified. Last, equipment staging areas and dredge pipelines are not expected to result in any direct and indirect impacts to cultural resources, as these areas can be adjusted to avoid potential impacts, if necessary. If unidentified cultural resources are encountered during construction of the project, the identification, evaluation of significance, assessment of adverse effect, and resolution of adverse effect will be handled pursuant to the PAg.

4.15 SOCIOECONOMICS

4.15.1 Population and Demographics

4.15.1.1 FWOP-1 Alternative

Based on the current population projections, any increase in population associated with the Widening Project would likely have negligible effects on overall population growth within the study area. This alternative would not result in potentially significant impacts.

4.15.1.2 NED Alternative

The NED Alternative would not require business or residential relocations. The proposed action would likely have a negligible effect on population growth trends within Brazoria County. Population in this county is projected to grow at a rapid rate of 78 percent between 2000 and 2040, regardless of the proposed project. As a result of the NED Alternative, demand for community facilities, services, and housing would be expected to increase at a rate that is consistent with the projected population growth and similar to what is expected for the FWOP-1 Alternative. The location of these resources would generally follow development and land use plans currently identified. Most of the construction workers are likely to come from labor forces outside of Brazoria County, which would lead to temporary increases in population and an increased demand for temporary housing. These increases would be temporary, as workers are not likely to permanently relocate. As indicated in Section 3.17.1, there is adequate housing available within the study area for the anticipated population growth.

The NED Alternative would allow for larger vessels to enter the channel and increase business, which in turn could lead to increased employment opportunities and increased population. However, as the population of the county is already expected to experience significant growth regardless of the project, this increase would likely have a negligible effect on population growth in the study area. This alternative would not result in potentially significant impacts.

4.15.1.3 LPP Alternative

The LPP Alternative would not require business or residential relocations. Impacts to population would be similar to those of the NED Alternative. However, as the LPP Alternative represents a smaller increase in channel depth, benefits could be slightly decreased, which could have negligible affects on changes in employment in the study area. Infrastructure, including health, police, fire, emergency, and social services within the study area is well developed and will continue to expand as demand increases; therefore, no adverse impacts to current or future infrastructure are anticipated.

4.15.2 Employment

4.15.2.1 FWOP-1 Alternative

The FWOP-1 Alternative would have a negligible effect on local employment within the study area and within Brazoria County. Following completion of the construction of the Widening Project, increases in employment may be observed and residual effect may still be present. It would not change industry trends. Employment would increase in response to projected population growth.

4.15.2.2 NED Alternative

Full-time dredge workers would be needed throughout the duration of the construction period. Minor indirect and induced employment would occur within Brazoria County as dredge workers spend some of their disposable income locally and as operation of the dredges would necessitate expenditures on fuel, which would be purchased from local vendors.

When the proposed project is completed, it is likely that new industrial development would occur within Freeport Harbor. The widened and deepened ship channel would provide an additional benefit to industry, which would likely attract new companies to locate within the Freeport area. With the improved channel in place, it would be more likely that new petrochemical plants, bulk grain facilities, and petroleum and natural gas refineries would be built within the area. The impact of these new industries on employment within Brazoria County is unknown. This increase in employment may augment the already projected 78 percent rate of immigration and the demand for housing, schools, and other services within Brazoria County between 2000 and 2040. As a result of the increased rate of immigration, it is likely that an increase in single-family homes would occur in Brazoria County where vacant land is available for such development and is located near such available industrial sites. This increase in new residents within Brazoria County would also increase the demand for commercial development, schools, roads, and other services.

During the proposed project construction, Brazoria County would experience a temporary increase in employment and local purchases of construction materials. As construction dollars are spent locally, there would be a beneficial effect on local employment in the area.

4.15.2.3 LPP Alternative

Impacts associated with the LPP Alternative would be similar to those of the NED Alternative. The channel widening could lead to the establishment of additional businesses in the study area, which in turn could lead to an increase in employment opportunities.

4.15.3 Economics

4.15.3.1 FWOP-1 Alternative

The FWOP-1 Alternative would have a negligible effect on the local economy within the study area. Following completion of the Widening Project, two-way traffic would be allowed in the channel, which would reduce delay times for all vessels and barges transiting the Freeport Harbor Channel. As a result, the total annual national economic benefits due to time saving are estimated to be over $41.2 million (Martin Associates, 2006; TransSystem Corp., 2006). However, without further improvements to channel dimensions, there will continue to be some, although reduced, vessel delays and economic impact.

Tourism and recreation, both large contributors to the economy, would be somewhat impacted during construction dredging activities. Turbidity associated with dredging activities is likely to result in short-term impacts to recreational opportunities such as fishing in the project area. No long-term effects are expected.

4.15.3.2 NED Alternative

Within Brazoria County, the economic effects accruing from the proposed project would simply contribute to the current development trends that have historically affected the regional economy. During project construction, Brazoria County would have an increase in construction employment and local purchases of construction materials. As construction dollars are spent locally, there would be a beneficial effect on local economic output, income, and employment in the area.

The increase in jobs, economic output, and the tax base would be fairly moderate and consistent with historical growth trends. Port Freeport and its associated industries and international commerce currently serve an important role for the Freeport area economy. These industries provide jobs, income, and a tax base for the area, and the effects reverberate within other industries such as housing, retail services, and wholesale trade. The proposed project may provide a boost to the development of industrial sites along the Freeport Harbor Channel and in Brazoria County. Larger ships would be able to navigate the channel, providing cost savings for commercial vessels. In short, Port Freeport would become a more attractive location for companies involved in industry and international commerce to conduct their business. This goal would be consistent with a steady historical trend towards increased reliance on these industries and these types of development within the region.

According to the Freeport FS, average annual benefits for the NED Alternative (60-foot depth alternative) would result in average annual benefits of approximately $65.3 million in transportation savings for crude petroleum imports, petroleum product and chemicals import and export. Total average annual net excess benefits are expected to be $42.6 million.

As previously discussed, the primary economic bases of the county include chemical manufacturing, petroleum processing, offshore production maintenance services, biochemical and electronic industries, commercial fishing, and agriculture. As a result of the proposed project, the positive economic effects to the Brazoria County economy would be moderate at the least and substantial at best.

Tourism and recreation, both large contributors to the economy, would be somewhat impacted during construction dredging activities. Turbidity associated with dredging activities is likely to result in short-term impacts to recreational opportunities such as fishing in the project area. No long-term effects are expected. These impacts would be similar to impacts expected for the FWOP-1 Alternative. However, turbidity associated with construction of the FHCIP would occur farther up the Freeport Harbor Channel and would be in addition to what would occur under the FWOP-1 Alternative.

4.15.3.3 LPP Alternative

The economic effects of the LPP Alternative are similar to those of the NED Alternative, but may be slightly less substantial. According to the Freeport FS, average annual benefits for the LPP Alternative (55-foot depth alternative) would result in annual benefits of approximately $38.4 million in transportation savings for crude petroleum imports, petroleum product and chemical import and export. This is about half the annual benefits of the NED Alternative (60-foot depth). Total average annual net excess benefits are expected to be $22.6 million, and $20 million less than the NED Alternative. The LPP Alternative would have a beneficial effect to the local economy, as it would allow for more-efficient movement of large vessels in the channel and would have similar benefits as the NED Alternative.

Tourism and recreation, both large contributors to the economy, would be somewhat impacted during construction dredging activities. Turbidity associated with dredging activities is likely to result in short-term impacts to recreational opportunities such as fishing in the project area. No long-term effects are expected. These impacts would be similar to impacts expected for the FWOP-1 Alternative. However, turbidity associated with construction of the FHCIP would occur farther up the Freeport Harbor Channel and would be in addition to what would occur under the FWOP-1 Alternative.

4.15.4 Environmental Justice

4.15.4.1 FWOP-1 Alternative

Under the FWOP-1 Alternative, the Widening Project is not expected to result in adverse changes that would affect minority or low-income populations. Increased spending in the area may boost the local economy, resulting in a benefit to these populations. The trends of disproportionately higher minority and/or low-income populations in Clute and Freeport will continue unaffected.

In the event of an oil spill within the Freeport Harbor Channel, Freeport would likely face minimal impacts as such an event would be confined to Gulf waters and potentially to immediately adjacent beaches. There is little commercial fishing and recreation associated with Freeport, thus impacts to fishing in the area would not be substantial. A hazardous material spill poses a higher risk, depending on the type of hazardous material involved. The City of Clute is farther removed from the Freeport Harbor Channel and would have no impact from any spill event.

In the event of an oil spill or other incident, the Brazosport Industrial Community Awareness and Emergency Response (CAER) plan would be initiated. CAER is a program that provides information to the community in the event of an emergency in the industrial area surrounding the port. CAER has developed an emergency siren system that places 14 sirens in the industrial port area. The sirens only sound in the community it affects. A telephone notification is activated in the community to inform area residences and businesses of the potential issue as well as any actions that should be taken. The emergency notification system would also be activated. These measures would be provided to all persons regardless of their minority or low-income status.

Additionally, USCG has Incident Action Plans specific to Freeport in place in the event of hazardous material spills, LNG incidents, and oil spills (USCG, 2008). The City of Freeport is involved in the USCG and CAER plans. Additionally, the City of Freeport has an Emergency Management Office that takes control of the city during times of emergency and provides a crisis hotline for residents to call (City of Freeport, 2011).

In the event of an accident that causes a hazardous material spills, LNG incidents, and oil spills, local communities would be the first place most citizens would turn to for information and assistance. The plans and initiatives being undertaken by CAER and the USCG are designed to assist and even relieve the local communities of some responsibility for handling emergency situations should they occur. These initiatives are designed to provide safety and assurance to area communities and would be implemented without regard to minority or low-income status. As a result, long-term impacts to local and regional populations, including Freeport, would be minimized.

4.15.4.2 NED Alternative

The minority and low-income populations living within the project area would experience no adverse changes to the demographic, economic, or community cohesion characteristics within their neighborhoods as a result of the proposed project. Generally speaking, the population living within these census tracts could benefit from the proposed project. These benefits would be manifested mainly in a slight increase in economic output, jobs, and tax base within these communities. New development expands the tax base, benefiting existing taxpayers by alleviating their overall tax burden. Therefore, the proposed project would not result in disproportionately high and adverse impacts on minority and low-income persons living within the project area components.

Freeport, a minority population, would likely be most affected by the NED Alternative, as it is the city most proximate to the proposed project. Under the NED Alternative, it is anticipated that the same types of commodities would continue to be imported and exported as under the FWOP-1 Alternative. The deeper channel would allow more-efficient utilization of the channel, as vessels can be loaded more fully, and the number of vessels required to transport crude oil would actually be reduced over FWOP-1 conditions. Therefore, potential impacts of an oil or hazardous material spill would be similar to those described for the FWOP-1 Alternative.

4.15.4.3 LPP Alternative

As with the NED Alternative, the minority and low-income populations living within the project area for the LPP Alternative would experience no adverse changes to the demographic, economic, or community cohesion characteristics within their neighborhoods as a result of the proposed project. Generally speaking, the population living within these census tracts could benefit from the proposed project. These benefits would be manifested mainly in a slight increase in economic output, jobs, and tax base within these communities. Therefore, the proposed project would not result in disproportionately high and adverse impacts on minority and low-income persons living within the project area components.

Similar to the NED Alternative, Freeport would likely be most affected as it is the city most proximate to the proposed project. Under the LPP Alternative, it is anticipated that the same types of commodities would continue to be imported and exported as under the FWOP-1 Alternative. The deeper channel would allow more-efficient vessel utilization of the channel, as vessels can be loaded more fully. The number of vessels required to transport crude oil would actually be reduced over FWOP-1 conditions but slightly higher than the NED Alternative. Therefore, potential impacts of an oil or hazardous material spill would be similar to those described for the FWOP-1 Alternative.

4.15.5 Protection of Children from Environmental Health Risks and Safety Risks

According to EPA, children are more susceptible to environmental health hazards because “their bodily systems are still developing; they eat more, drink more, and breathe more in proportion to their body size; and their behavior can expose them more to chemicals and organisms” (EPA, 2011a). The following sections are consistent with EO 13045, which requires that Federal agencies assess and evaluate potential disproportionate impacts to children.

4.15.5.1 FWOP-1 Alternative

Under the FWOP-1 Alternative, the Widening Project could potentially present environmental health hazards to child populations within the vicinity of the proposed action. Current projections indicate that crude imports will increase in the near future. As these imports increase, the number of lightering vessels and product carriers will also increase, adding to shipping delays, congestion, and the potential risk of collision or spill. In the event of a collision or spill, children would be more sensitive to any contaminants. In Freeport, 10.0 percent of the population is under age 5 (approximately 127 persons), and 20.1 percent is between the ages of 5 and 14 (approximately 2,542 persons).

In the event of such a catastrophe, emergency plans are in place that would enable the population (including children) to avoid contact with any contaminants. While there is a potential risk for oil spills, these would likely be confined to the water and beaches. As there is little recreational swimming and fishing within the study area, this would likely have little effect on children. In the event of hazardous material spills, LNG incidents, or collisions of vessels in the harbor carrying potentially flammable or toxic substances, populations of children within the study area would be affected.

In the event of an emergency, the City of Freeport has an Emergency Management Office that takes control of the city during times of emergency, and provides a crisis hotline for residents to call (City of Freeport, 2011). The Brazosport Industrial CAER plan encompasses all of Brazoria County, and includes information regarding emergency levels, and instructions for events when the CAER sirens are sounded. In addition to these plans, Brazosport ISD has Crisis Response Guidelines, which outlines crisis procedures for action during chemical spills and gas release, and instructions for any evacuations (Brazosport ISD, 2011).

4.15.5.2 NED Alternative

The NED Alternative does not have the potential to increase risks to children's health and safety. The same types of commodities would continue to be imported and exported as under the FWOP-1 Alternative. The deeper channel would allow more-efficient utilization of the channel, as vessels can be loaded more fully, and the number of vessels required to transport crude oil would actually be reduced over FWOP-1 conditions. Therefore, potential impacts of an oil or hazardous material spill would be similar to those described for the FWOP-1 condition. In the event of an emergency, the Brazosport CAER emergency notification system would be utilized. This system would be used to notify schools, day care centers, and residences of the emergency and recommended actions.

4.15.5.3 LPP Alternative

The LPP Alternative does not have the potential to increase risks to children's health and safety. The same types of commodities would continue to be imported and exported as under the FWOP-1 Alternative. The deeper channel would allow more-efficient utilization of the channel, as vessels can be loaded more fully. The number of vessels required to transport crude oil would actually be reduced over FWOP-1 conditions but would be slightly higher than the NED Alternative. Therefore, potential impacts of an oil or hazardous material spill would be similar to those described for the FWOP-1 condition. In the event of an emergency, the Brazosport CAER emergency notification system would be utilized. This system would be used to notify schools, day care centers, and residences of the emergency and recommended actions.

4.16 LAND USE/AESTHETICS

4.16.1 FWOP-1 Alternative

Under the FWOP-1 Alternative, the project area and surrounding areas, including Brazoria County, would continue on its present course of moderate population growth and of fairly rapid commercial, residential, and industrial land development with the potential for slight increases following the Widening Project. Port Freeport would continue to function as an important port for its industrial facilities and international commerce. Port Freeport would also continue to develop its industrial properties, but at a slower rate than it would with the proposed action.

Future conditions include an increase in crude petroleum imports, refined petroleum and chemicals, and LNG with or without the Widening Project. The amount and types of future imports depend greatly on the channel dimensions at Port Freeport. Three significant developments known to the port include the construction of a $750 million facility to receive and store LNG, which converts the LNG back to a gas and transports it to commercial and industrial users via pipeline. The project is expected to generate increased funding for the port and provide facilities for the local petrochemical industry. The Freeport LNG facility began receiving LNG in spring 2008. The port also plans to construct three 1,200-foot berths, which began with the construction of 800 feet in October 2006. Proposed Berth No. 7 will include an 800-foot-long berth along with 20 acres of stabilized backlands to handle new cargo activity and future development for Parcel No. 25. Berth No. 5 property is expected to facilitate the port’s warehousing and rail facilities (BRHND, 2004). In addition, the port has begun engineering design for Transit Shed 6 adjacent to Dock 5. The 125,000-square-foot facility would include rail service and is likely to attract new business to the port (Port Freeport, 2006). Without the channel deepening and widening, lightering and lightening operations would continue.

There would be no changes in the visual quality within the project area; therefore, no impact to aesthetic quality is anticipated. It should be noted that following completion of the Widening Project, the visual quality of the Quintana Beach portion of the study area would be temporarily affected by placement of material for beach nourishment.

4.16.2 NED and LPP Alternatives

Under both alternatives, the channel would be deepened following the current channel alignment beginning offshore near the 60-foot contour and terminating at the Stauffer Channel Turning Basin. Both would provide two new upland confined PAs (PAs 8 and 9), which would be located adjacent to the Brazos River along SH 36 (see Figure 2.5-1). The proposed PAs will be leveed and contain spillways for discharge of effluent. The surface areas of PAs 8 and 9 are approximately 168 and 250 acres, respectively.

Land-use impacts are also related to PAs, which would change current land use at PAs 8 and 9 from agricultural to dredged material storage, and indirect future land development that may occur as a result of the proposed action. Dredged material removed from the Lower Turning Basin, upstream through the Channel to Stauffer Turning Basin is to be placed at PAs 8 and 9.

Port Freeport currently owns large tracts of land along the Freeport Channel system, of which a large portion is marsh. Therefore, it is likely that only a small percentage of this land would be available for development of commercial or industrial sites. When completed, however, the project would have a wider and deeper ship channel that could provide incentive for new development at all of the port properties, based on navigation cost savings. Future industrial development could include oil and gas refineries, petrochemical plants, and bulk grain facilities. The long-term land use effects of these industrial facilities are largely unknown; however, they would likely lead to an increase in demand for new housing development, new roads, commercial services, schools, and other services within Brazoria County.

The alternatives would have a minimal effect on the overall visual quality within the project area. New PAs 8 and 9 may be visible from the channel and industrial sites at Port Freeport, as well as the Peach Point WMA, Quintana Beach, and Bryan Beach. The Freeport Municipal Golf Course is located northwest of PA 9 and is anticipated to have potential visual impacts arising from the approximately 50-foot berm. However, PA 9 would not be inconsistent with land uses within the project area (i.e., placement area currently located across Freeport Harbor Channel to the north).

In conclusion, under both the NED and LPP Alternatives there would be two new upland confined PAs (PAs 8 and 9) located along SH 36. The new PAs would have relatively minor land use impacts. However, the new PAs could have a visual impact in the immediate area. The greatest long-term land use consequence of the alternatives would likely be an increase in the rate of industrial development that may occur in response to the proposed channel improvements. These future developments are not considered part of the proposed action but would be far less likely to occur without it.

4.16.3 Transportation

4.16.3.1 FWOP-1 Alternative

Under the FWOP-1 alternative, there would be no change to projected transportation improvements in the project area, and no increased potential for an aircraft wildlife-strike in the project vicinity.

4.16.3.2 NED and LPP Alternatives

Under the NED and LPP alternatives, the existing transportation system within the project area could be temporarily affected by the influx of construction workers and the delivery of construction equipment and materials to the project area. The addition of employees accessing the project area on a daily basis would not result in a significant increase in volume adversely affecting traffic on area roadways. As stated in the Houston-Galveston Area Council 2025 Regional Transportation Plan, the port will sponsor various transportation projects to accommodate future port services. Future transportation projects specific to the port include reconstructing the intersection of Fifth Street and Terminal Street to include an entrance road with two 16-foot lanes with 8-foot shoulders and reconstruct a portion of Port Road, with a total cost of $803,000. Along Navigation Boulevard, from FM 518 to Pete Schaff Boulevard, a truck-queuing area will be widened to provide a left-turn lane at the entrance to Port Freeport. In addition, an additional queuing space will be constructed to alleviate truck congestion, with a total cost of $480,000. Without the proposed action, these future transportation projects may be cancelled or delayed.

Regarding potential impacts to area airports, the alternatives, like the FWOP-1, are not expected to increase the potential for an aircraft wildlife-strike near airports, and no further coordination is required.

4.16.4 Future Development

Future expansion of Port Freeport includes construction of new berths and the building of a transit shed.

4.16.4.1 FWOP-1 Alternative

Under the FWOP-1 Alternative, future expansion of Port Freeport and increases in cargo volumes would be consistent with long-range plans developed by the port and communities, depending on the economic vitality of the port.

4.16.4.2 NED and LPP Alternatives

The NED and LPP alternatives are compatible with existing and proposed land uses in the project area. Improvements would support current local land-use objectives for property adjacent to the project area and are consistent with long-range plans to increase cargo capacity into the port. The alternatives would not require changes in local agency zoning codes or site-specific zoning. These alternatives would not require the conversion of land use types and the displacement of general land uses or structures within the project area would be negligible; therefore, no impact to future development or zoning is anticipated.

(This page intentionally left blank.)

5.0 MITIGATION

Mitigation refers to the avoidance, minimization, and rectification, reduction, or compensation of impacts resulting from implementation of an action. For the proposed FHCIP, the majority of potential project-related impacts were avoided. Thus, mitigation in the form of minimization or rectification, reduction, or compensation was initiated for only potential impacts to freshwater wetlands and riparian forest.

To mitigate for the loss of wetland and riparian forest from construction of PAs 8 and 9, USACE worked in conjunction with resource agency personnel from USFWS and TPWD to develop a mitigation plan (Appendix H-2). Approximately 418 acres of upland habitats would be impacted from construction of PAs 8 and 9, including 21 acres of riparian forest and 39 acres of ephemeral wetlands. In accordance with USACE guidance ER 1105-2-100, impacts to significant resources were avoided or minimized to the extent practicable and a HEP analysis was used to determine the amount of mitigation needed to appropriately compensate for project impacts. The mitigation plan was also developed to satisfy requirements for cost effectiveness and incremental cost analysis requirements.

The focus of the Mitigation Plan is the compensatory replacement of impacted riparian forest and ephemeral wetland habitats with forest or wetland of equivalent value. HEP analysis was used to quantify the impacts, incorporating the area and quality (functional value) of specific habitats into a standardized value. The HEP Analysis report is included as Appendix H-1, which should be consulted for a detailed description of the methods used and results of this analysis. Approximately 21 acres of riparian forest, 358 acres of grassland, and 39 acres of ephemeral freshwater wetlands (described as swales with a semipermanent water regime that supports 3- to 5-inch water depths in winter) would be destroyed by the construction of PAs 8 and 9. Although grassland impacts were quantified, no mitigation is provided for impacts to grasslands as the existing affected grasslands are neither scarce nor unique.

Mitigation for riparian forest and wetland impacts from PAs 8 and 9 is proposed to be located within the larger real estate tracts Eight and Nine (see Appendix H-2). Forest areas lying north and east of PA 9 and east of PA 8, all of which are situated within the confines of tracts Eight and Nine, are available for mitigation purposes. The proposed mitigation forests north and east of PA 9 are a continuation of the impacted forest on PA 9. These forest areas could be used for mitigating project losses to forest on PA 9, and also potentially be used for the creation of wetlands to offset wetland project losses incurred on PAs 8 and 9. Additionally, nonproject lands, including port-owned lands adjacent to Peach Point WMA, were considered as mitigation sites.

Ultimately, it was determined that project impacts would be compensated for by preserving approximately 131 acres of riparian forest north of PA 9 and enhancing its habitat value by clearing approximately 11 acres of tallow trees and establishing approximately 11 acres of woodlands (7.7 average annual habitat units (AAHUs) to compensate for 7.41 AAHUs of impact). The non-Federal sponsor has agreed to grant a conservation easement for the 131 acres used for mitigation to TPWD or a recognized nature conservancy (see Port Freeport letter dated December 21, 2009 in Appendix A-6). Additionally, about 3 acres of wetlands (1.5 AAHUs to compensate for 1.1 AAHUs of impact) would be established between the forest and the northern boundary of PA 9. An additional acre of trees would be created around the wetland, resulting in a total of 12 acres of tree plantings. The mitigation sites are within Tract Nine, adjacent to PA 9. Forest mitigation consists of planting about 150 seedling trees per acre, spaced as forest openings will allow. Wetland mitigation includes construction of one 3-acre pond planted with a variety of aquatic plant plugs on 5-foot to 6-foot centers. Approximately 3 years after the seedling tree plantings, mitigation forest areas would be cleared of tallows. Additionally, 30 percent of seedling trees will be replanted to offset expected mortality (see Appendix H-2).

5.1 ECOLOGICAL RISK AND UNCERTAINTY

Uncertainty is present in all ecological modeling and risk assessments, and is complicated by variation in characteristics of the environment and within species themselves. For example, significant variability in survivability and growth rates can occur within the same species under different environmental conditions, as well as under similar conditions. Therefore, it is necessary to identify risk and uncertainty to avoid the impression that modeling fully captures variability in nature, with respect to survivability and establishment of the proposed mitigation measures in the project area. Moreover, risk to survivability potentially induced by causes not related to ecology must also be considered.

Professional judgment is often used to determine uncertainty associated with information taken from the literature, and for any extrapolations used in developing expected outcomes. The following is an overview of potential risk and uncertainty associated with habitat modeling for developing the proposed mitigation measures.

5.1.1 Habitat Modeling

As a species-habitat approach for assessing environmental impacts, HEP is used to document the quality and quantity of available habitat for selected wildlife species. Habitat value is assessed through use of a habitat suitability index (HSI), whose value is derived from an evaluation of the ability of key habitat components to supply life requisites of selected species of fish and wildlife. HSI values are obtained for individual species through use of documented habitat suitability models employing measurable key habitat variables. However, the ability to document data and ultimately compare alternatives presents inherent limitations. One of the challenges is documenting the differences in quality (HSI) and quantity (area) between existing habitat conditions (baseline) and various projected future sets of conditions for selected evaluation species. This is because HEP does not currently provide guidance for performing future projections. Therefore, projected impacts are no better than the user's ability to predict future conditions. However, potential uncertainty in assessing future ecological conditions for modeling and mitigation efforts within proposed FHCIP habitats is offset by the combined professional judgment of resource agency and USACE personnel. The use of professional judgment, while still subjective, alleviates a measure of uncertainty concerning future conditions and the success of mitigation measures.

Also, identification of differing types and magnitudes of impacts is dependent on the validity and sensitivity of the HSI models used to generate data for HEP. As with other approaches, the results of an impact assessment employing HEP are no better than the reliability of resource data used. Similarly, because HEP is a species-habitat approach to impact assessment, it conceptually addresses only the issues of species populations and habitat. However, the degree to which these indicators are addressed is again dictated by the HSI models. Improved HSI models could more completely examine the remaining issues of biological integrity and environmental values. Nonetheless, with regard to the proposed project, the species models used are likely the most appropriate and technically complete models available for the project area, with respect to establishing acceptable mitigation schemes.

5.1.2 Mitigation Monitoring and Contingency Plans

Monitoring and contingency plans for the mitigation measures are presented in Appendix H-2 (Mitigation Monitoring and Contingency Plans).

The monitoring and contingency plans for mitigation measures have been developed in accordance with recent implementing guidance for Section 2036 (a) of WRDA 07. The monitoring plans identify specific ecological success criteria to be used in determining if the mitigation measures have been successful. Details of the monitoring plan for project mitigation sites including monitoring parameters, periodicity, costs, and responsible parties are presented in Appendix H-2.

Periodic monitoring to determine the success of mitigation measures would continue until the District Engineer determines that the ecological success criteria established for the mitigation features have been met. This determination would be based upon monitoring results and reports provided to the District Engineer, from a USACE-led monitoring team consisting of USACE personnel, the resource agencies, and the non-Federal sponsor, whose responsibility is long-term preservation of the mitigation measures. The team would be consulted annually to determine progress in the planning, construction, and postconstruction evaluation of the ecological success of the measures.

Contingency plans (adaptive management measures) were also developed to address unforeseen natural events such as drought and flooding, or anthropogenic activities that could disrupt or impede successful establishment of mitigation features, and achievement of defined success criteria. Adaptive management measures and costs are also presented in Appendix H-2.

6.0 CUMULATIVE IMPACTS

The CEQ defines cumulative impacts as those impacts "on the environment which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or persons undertake such actions." Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Impacts include both direct effects (caused by the action and occurring at the same time and place as the action), and indirect effects (caused by the action but removed in distance and later in time, and reasonably foreseeable).

Cumulative effects can result from a wide range of activities including the addition of materials to the affected environment, repeated removal of materials or organisms from the affected environment, and repeated environmental changes over large areas and long periods. Complex cumulative effects can occur when different types combine to produce a single effect or suite of effects. Cumulative impacts may also occur when individual disturbances are clustered, creating conditions where effects of one episode have not dissipated before the next occurs (timing) or are so close that their effects overlap (distance).

In assessing cumulative impact, consideration is given to the following:

- the degree to which the proposed action affects public health or safety;
- unique characteristics (physical, biological, and socioeconomic factors) of the geographic area;
- the degree to which the effects on the quality of the human environment are likely to be highly controversial;
- the degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks; and,
- whether the action is related to other actions with individually insignificant, but cumulatively significant, impacts on the environment.

The methodology is consistent with similar Federal projects.

6.1 ASSESSMENT METHOD

The FHCIP EIS follows a traditional cumulative impact assessment method, addressing impacts for a finite set of criteria, comparing projects within the study area to the LPP Alternative. Thirteen cumulative impact criteria were identified to evaluate projects relevant to the future condition of the study area (project area and surrounding Brazoria County). Fifteen projects were considered.

6.1.1 Evaluation Criteria

Criteria include ecological, physical, chemical, socioeconomic, and cultural attributes, listed in Table 6.1-1. These parameters were identified as key resources discussed in NEPA documents and project reports, and they form a basis for comparison of other projects in the area with the LPP Alternative.

Table 6.1-1
Cumulative Impacts Criteria

Ecological Environment	Physical/Chemical Environment	Socioeconomic Environment
Wetlands	Air Quality	Environmental Justice
Benthos	Noise Impacts	Cultural Resources
Essential Fish Habitat	Water Quality	Commercial Fisheries
Threatened/Endangered Species	Sediment Quality	Recreational Fisheries
	Shoreline/Bank Erosion	

6.1.2 Individual Project Evaluation

Twenty-two past, present, and reasonably foreseeable projects/activities within the study area were determined relevant for this cumulative impacts analysis (in no particular order). These projects are listed in Table 6.1-2 and are compared to the LPP Alternative presented in this EIS.

Table 6.1-2
Past, Present, and Reasonably Foreseeable Actions within the Study Area

Past or Present Projects/Activities	Reasonably Foreseeable Future Projects/Activities
Freeport Harbor Channel 45-foot Project	BP Exploration Gulf of Mexico Fiber Optic Network
Freeport Harbor Jetties	Freeport LNG Phase II
Brazos River Diversion Channel	Port Freeport modifications
GIWW maintenance	TEPPCO Seaway Crude Pipeline Company facility modification(s)
Freeport Hurricane Flood Protection Levees	Surfside Beach Shoreline Protection
Bryan Mound Strategic Petroleum Reserve	Freeport Desalinization Plant
CenterPoint Energy 69-kV electric transmission line	Gulf Coast Regional Spaceport
Petrocom Fiber Optic Network	Park Upgrades and Marinas
Freeport Area Industrial Complex(es)	Freeport Marine
Freeport Harbor Channel Outer Bar and Jetty Channels Widening (Widening Project)	Parcel 14 Developments
Freeport LNG Phase I	Various Roadway Improvement Projects
Surfside Marina	
Velasco Terminal	

Individual project documents were reviewed for impacts to selected habitats based on the evaluation criteria described above. No attempts were made to verify or update published documents, nor were the disposal practices proposed in reviewed documents verified for current ongoing projects. In addition, no field data were collected to verify project impacts described in reviewed documents. Mitigation outlined in individual project documents may be in place or proposed. This analysis recognizes that some of the projects assessed are undergoing revisions that may alter their environmental impact. This analysis relied only on existing published documents. Project descriptions follow in sections 6.2 (Past or Present Projects) and 6.3 (Reasonably Foreseeable Future Actions).

6.1.3 Resource Impact Evaluation

Biological/ecological, physical/chemical, and cultural/socioeconomic resource impacts were evaluated based on individual project reviews. Acreages and rankings for the past, present, and reasonably foreseeable projects, compared to the quantifiable impacts of the LPP Alternative, are presented in Table 6.1-3. Impacts and mitigating factors of the LPP Alternative considered in this cumulative analysis are presented in sections 4.0 and 5.0 and summarized in this analysis table. Direct impacts to specific habitats that could be quantified (acreage) from existing project documents were considered. Where relevant information is not quantifiable, impacts are given a ranking: Benefit or Net Benefit, No Long-term Impact, Not Available. Cumulative impact conclusions follow the project descriptions and summary table. Although 24 projects are discussed in the following sections, only 10 are included in Table 6.1-3. Five projects were not included in the table for various reasons, as specifically described for each project below.

6.2 PAST OR PRESENT ACTIONS

6.2.1 Freeport Harbor Channel 45-Foot Project (Past and Current Condition)

The existing 45-foot Project was constructed in 1978. The Freeport Harbor Channel Jetty and Outer Bar channels are currently maintained by USACE to a depth of –47 feet MLT at a width of 400 feet. These existing channels are approximately 6.3 miles long. Ongoing routine maintenance requires the removal of an average (since 1992) of 1.90 mcy of material per maintenance cycle for placement in the Maintenance ODMDS at a roughly 10-month interval. Maintenance impacts are included in Table 6.1-3.

6.2.2 Freeport Harbor Jetties

The original project for Federal improvement at Freeport was authorized by the River and Harbor Act (RHA) of June 14, 1880, which provided for construction of jetties for controlling and improving the channel over the bar at the mouth of the Brazos River (Alperin, 1977). The work was started in 1881 and continued to 1886 when operations were suspended due to lack of funds. USACE repaired and strengthened the jetties in 1908. Currently, the jetties extend approximately 7,700 feet and 8,640 feet on the north and south sides of the channel, respectively. The North Jetty was relocated north of its original location as part of 45-foot project improvements; approximately 3,500 feet were added onshore to protect against flanking, and it was lengthened seaward by 500 feet. The South Jetty was also rehabilitated concurrent with the North Jetty improvements. It is generally believed that construction of the jetties blocks sand transport in either direction across the harbor entrance (Watson, 2003). In addition, sand moving southwest along the beach at Surfside is carried out along the North Jetty and deposited in the channel, where it is regularly removed by hopper dredge and deposited in the Maintenance ODMDS. No quantifiable environmental impacts from this project could be located for inclusion in Table 6.1-3 as it was constructed in the distant past.

6.2.3 Brazos River Diversion Channel

Due to excessive siltation problems at Freeport, the Brazos River was diverted in 1929 (Alperin, 1977). A diversion dam about 7.0 miles above the original river mouth and a diversion channel rerouted the Brazos River from the dam to an outlet in the Gulf about 6.5 miles southwest of the original mouth. This project was authorized by Congress on March 3, 1925, and the project was completed in 1929. This diversion of the river downdrift of the predominant littoral current has starved the Surfside and Quintana beaches of river sand (Watson, 2003). The old Brazos delta has completely eroded away and no longer serves as a nearshore source for sand that waves can bring onshore to nourish the beach, and a new delta has formed at the mouth of the diversion channel. No quantifiable environmental impacts from this project could be located for inclusion in Table 6.1-3 as it was constructed in the distant past.

6.2.4 GIWW Maintenance Activities

The GIWW is a coastal canal from Brownsville, Texas, to the Okeechobee Waterway at Fort Myers, Florida. The Texas portion of the canal system extends 426 miles, from Sabine Pass to the mouth of the Brownsville Ship Channel at Port Isabel (Leatherwood, 2002). The GIWW crosses the existing Freeport Harbor Channel project near mile 1.5. A Galveston District 1975 EIS addressed maintenance dredging potential impacts, based on the best available information at that time. The current authorized maintenance dimensions of the GIWW are 12 feet by 125 feet, maintained using a hydraulic pipeline dredge. The GIWW from Chocolate Bayou to Freeport Harbor is dredged at approximately 36- to 48-month intervals, and the estimated annual maintenance material according to recent Dredging Conference Reports (USACE, 2005) is 1.5 to 2 mcy. The GIWW from Freeport Harbor to Cedar Lakes is maintained every 24 months with an estimated annual maintenance material of 1 mcy. Dredged material from the GIWW in the vicinity of the project area is placed in PAs designated for GIWW maintenance dredging (USACE, 1975). In Table 6.1-3, potential impacts for the GIWW segment(s) within the Freeport

LPP Alternative study area have been generally estimated from the 1975 EIS, although the maintenance segments are not exactly correlated to study area boundaries.

6.2.5 Freeport Hurricane Flood Protection Levees

Galveston District studies in 1958 led to legislation in 1962 providing for hurricane-flood protection projects at Freeport and Port Arthur (USACE, 1977, 2002). Both areas had local levee systems at the time, challenged by Hurricane Carla; the newer Federal projects were designed to improve and augment existing protection. At Freeport, approximately 42 square miles (including areas of Freeport, Velasco, Lake Jackson, Clute, Lake Barbara, and Oyster Creek) were protected by approximately 56 miles of levees, wave barriers, floodwalls, drainage structures, pumping plants, and a vertical-lift tide gate with a navigation opening 61 feet high and 75 feet wide (USACE, 1977). In 1982, approximately 43 miles of the existing levee system and 2 miles of new levee were constructed, with two pumping stations (USACE, 2002). According to a 2006 report (Edge et al.), the Freeport Harbor levee system is projected to be able to protect the city and port from a 200-year hurricane; therefore, it is not likely that any additional construction would be required for the levee system. No documentation could be located about the construction impacts of the Freeport Hurricane Flood Protection Levee system, either from the 1970s or 1980s. Because this information is not available and no new construction is anticipated, the Freeport Hurricane Flood Protection Levees are not included Table 6.1-3.

6.2.6 Bryan Mound Strategic Petroleum Reserve

The Bryan SPR storage facility occupies 500 acres, close to port and terminal facilities at Freeport and the ConocoPhillips tank farm. The site has a total DOE-authorized storage capacity of approximately 232 million barrels (MMB) as part of the United States's emergency oil supply (DOE, 2004). The Bryan Mound site was proposed as an SPR storage facility in various Congressional reports, workshops, and EISs from 1977 through 1979; the site was operational by 1979 (DOE, 2004). The facility was expanded under two supplemental NEPA documents: Seaway Group EIS (DOE EIS 0021) and Seaway EIS (DOE EIS 0075) (DOE, 2004). A Finding of No Significant Impact (FONSI) was issued in 1993 on a brine pipeline replacement (DOE, 1993a). A new commercial potable water line was permitted by USACE, and the installation was completed in 1985.

Bryan Mound SPR operations have contributed to three of the documented four large brine spills in the SPR system: two spills totaled 606,000 barrels at Bryan Mound and West Hackberry in 1985; one 825,000-barrel spill at Bryan Mound in 1989; and one 74,000-barrel spill at Bryan Mound in 1990 (DOE, 1993a). The 1989 brine spill caused devegetation of a limited area and subacute toxicity over a wider area; eventual recovery was achieved over time in some areas through natural flushing and succession, but revegetation and/or drainage enhancement was required to restore completely any poorly drained areas (DOE, 1993a). According to monitoring well data, the Bryan Mound brine pond concrete basin was suspected to leak, contaminating shallow and deep aquifers (DOE, 1993b); however, upon final structural inspection in 1998 toward decommissioning in 1999, no structural compromise was detected (DOE, 2000). To date, two principal crude oil pipelines extend from Bryan Mound: a 4-mile, 30-inch-diameter line to the ConocoPhillips terminal and docks; and a 46-inch line to the ARCO Pipeline Company terminal in Texas City, Texas.

In 2005, the Energy Policy Act directed the DOE to select sites necessary to expand the entire SPR system to the authorized capacity of one billion barrels of oil (DOE, 2005). The existing Bryan Mound SPR storage facility was not considered for expansion because the salt dome has no capacity available for additional storage caverns (DOE, 2006). Construction and operational impacts from Bryan Mound are included to the extent available in Table 6.1-3.

6.2.7 CenterPoint Energy, Inc.

Construction and operation of the Freeport LNG Project required that new, dedicated electrical service be brought to the LNG Terminal site (Federal Energy Regulatory Commission [FERC], 2004b). Freeport LNG requested CenterPoint Energy to provide a new 69-kV electric transmission line from an existing CenterPoint Energy substation (FERC, 2004a) to the Freeport LNG substation, located near the storage and vaporization facility on Quintana Island. CenterPoint Energy submitted an Environmental Assessment (EA) in January 2005 (Burns & McDonnell Engineering Company, 2005), and the Public Utility Commission of Texas took the project on the docket in 2006 (No. 30617); the final order was signed in March 2006. Construction on the facility ended in June 2007. Impacts from this transmission line are included in Table 6.1-3, based on the Preferred Route (Route 4) presented in the EA.

6.2.8 Petrocom Fiber Optic Network

Petrocom, a Gulf cellular and microwave communications provider, created a fiber optic ring in a rough oval, starting in Texas from Freeport north to Houston, crossing into Louisiana to New Orleans and south to Fourchon, then offshore south and westward to return to Freeport. Cable installation began in June 1999 (Smith, 1999). The oval network allows bidirectional signal transmission, increasing reliability in case of a break in the cable. This advanced technology provides offshore oil production platforms with the infrastructure for high-volume, high-speed voice, data, and video capabilities (Payne and Miller, 1999). No environmental impacts from this project could be located for inclusion in Table 6.1-3.

6.2.9 Freeport Area Industrial Complex(es)

The Freeport area and surrounding communities within the study area support a wide variety of private industrial uses. Operations, materials storage and transport, and discharges are generally

Table 6.1-3
Freeport Federal Cumulative Impacts Section

	Past or Present Actions						Reasonably Foreseeable Actions				
Resources	**Existing FH-45**	**GIWW**	**Bryan Mound SPR**	**CenterPoint Energy Transmission Line (Route 4)**	**Freeport LNG Phase I**	**Freeport Channel Widening**	**BP Fiber Optic Network**	**Freeport LNG Phase II**	**Port Freeport Modifications (Berth 7)**	**Surfside Beach Shoreline Protection**	**Preferred Alternative**
Wetlands Impacted acres (ac)	NA1 "some water filled low areas and ponds"	dredge: NO disposal: 4,464 ac	20 ac (brackish marsh and creek/river)	8 ac	68 ac	NO	NO	NI	2 ac	NA	39 ac
Wetlands Mitigation (ac)	400 ac acquired by local sponsor	NA2	NA2	NA2	58 ac	NO	NA2	31 ac	16 ac	NA	3 ac with plantings to compensate AAHUs; ~12 ac protected/ enhanced forest
Benthos	NA1	dredge: 3,550 to 3,600 ac disposal: NA1	20 ac potential	NA2	NI	NA1	NO	NA1	NA2	NA	
Threatened or Endangered Species	NA2	NO	NO	NO	NO	may affect, not likely to adversely affect, piping plover, 2 injury or mortality sea turtle takes, 32 noninjurious sea turtle takes allowed per NMFS BO	NO	NO	NA2	NI	likely to affect sea turtles during dredging; may affect, not likely to adversely affect piping plover
EFH	NA2	NA2	NA2	NA2	NI	NA1	NO	NI	NA2	NA	NO
Air Quality	odors	dredge: NO disposal: NI	hydrocarbon emissions periodically exceed stds: NA1	NA2	NO	NO_X exceedances; coordinating regarding compliance with SIP is ongoing	NO	NO	NA2	NI	NO_x exceedances
Noise	NA2	dredge: NO disposal: NO	NO	NA2	NO	NO	NA2	NO	NA2	NI	NO
Water Quality	NO	dredge turbidity: NO disposal turbidity: NO dredge pollutants: NA1 disposal pollutants: NO	possible toxic releases and increase in groundwater salinity: NA1	NO	groundwater: NI surface water: NO	groundwater: NO surface water: NO	NO	groundwater: NI surface water: NO	NA2	NI	groundwater: NO surface water: NO
Sediment Quality	NO	NI	NA2	NA2	NI	NO	NA2	NI	NA2	NA	NO
Shoreline/Bank Erosion	NA2	NI	NA2	NA2	NI: 14 ac planted to prevent erosion	9-ac benefit (Quintana)	NO	NA2	NA2	Net Benefit	NO
Environmental Justice	NA2	NA2	NA2	NA2	NA2	NO	NA2	NA2	NA2	NA2	NO
Cultural Resources	historic USCG building relocation	dredge: NO disposal: NA1	NA2	NO	NO	NO	NI: 3 anomalies, buffered to avoid	NO	NA2	NI	NI: 3 anomalies will require diving, and additional investigation of site 41BO226 in PA 9 will be needed

(This page intentionally left blank.)

Table 6.1-3 (concluded)

	Past or Present Actions						Reasonably Foreseeable Actions				
Resources	**Existing FH-45**	**GIWW**	**Bryan Mound SPR**	**CenterPoint Energy Transmission Line (Route 4)**	**Freeport LNG Phase I**	**Freeport Channel Widening**	**BP Fiber Optic Network**	**Freeport LNG Phase II**	**Port Freeport Modifications (Berth 7)**	**Surfside Beach Shoreline Protection**	**Preferred Alternative**
Commercial Fisheries	benefit to shrimping; NO for other fisheries	Benefit	NA2	NA2	NA2	NO	NO	NA2	NA2	NA	NO
Recreational Fisheries	benefit	Benefit	NA2	NA2	NA2	NO	NO	NA2	NA2	NA	NO

Impacts in this table are derived from publicly available project impact documents. These impacts are presented as they were in the documents, at the time of the document production.

Note: Acreage has been rounded to nearest whole number.

Benefit Results that have an overall positive effect, when compared to the FWOP condition of the resource; not quantified, but stated as a benefit in project document(s).

NO No adverse effect from project; limited in duration or extent such that the resource is not adversely affected, according to project document(s).

NI Impact mitigated by compensatory or protective measures, as stated in project document(s).

NA1 Impact may occur or is expected to occur; however, quantified impact information not available in project document(s).

NA2 No impact information is available for the resource in project document.

(This page intentionally left blank.)

regulated under EPA and TCEQ guidelines and requirements. According to the EPA EnviroFacts database and mapper, the EPA tracks approximately 528 facilities within Brazoria County. None of the regulated industrial facilities and uses within the study area (Brazoria County) can be classified as Superfund, toxic release, water discharge, hazardous waste, or air emission sites (EPA, 2007d). As construction and operational impact information is not uniformly available on all of these sites, impacts from industrial facilities within the project area are not included in Table 6.1-3.

6.2.10 Freeport Harbor Channel Widening Project (Widening Project)

The BRHND of Brazoria County, Texas (Port Freeport) applied to USACE, Galveston District, for a CWA Clean Air Act Section 404 permit and Rivers and Harbors Act Section 10 permit for dredge and fill activities related to the widening of portions of the Freeport Harbor Channel on April 14, 2005. Activities subject to the jurisdiction of USACE would include dredging in navigable waters to widen portions of the Jetty Channel and all of the Outer Bar Channel, and placement of fill in waters of the U.S. Based on the Section 10/404 permit application submitted by Port Freeport to USACE in April 2005, USACE determined that the permitting action for the proposed dredge and fill activities constitutes a major Federal action.

The proposed project site is located along the northern edge of the Freeport Harbor Jetty and Outer Bar channels, between Surfside and Quintana, in Brazoria County, Texas. The Freeport Harbor Jetty and Outer Bar channels are currently maintained by the USACE to a depth of –47 feet MLT at a width of 400 feet. These existing channels are approximately 6.3 miles in length and approximately 400 feet in width. Port Freeport proposes to widen, but not deepen, the Jetty Channel and all of the Outer Bar Channel. Beginning at Channel Station 63+46, which is just about even with the center of the USCG Station access channel, the Jetty Channel will be gradually widened, at the authorized depth, up to an additional 150 feet to Channel Station 43+00. From that point to Channel Station 38+00, the widening will be less gradual and will go from the additional 150 feet to an additional 200 feet. From Channel Station 38+00 through the rest of the Jetty Channel and to the end of the Outer Bar Channel at Channel Station –260+00, the channel will be widened an additional 200 feet. The length of channel that is proposed for widening is 32,335 feet, or 6.1 miles, of which 5.7 miles will be widened by 200 feet.

Approximately 300,000 cy of silty/sand construction material will be used beneficially to nourish Quintana Beach. The rest of the construction material (2.9 mcy) is Beaumont clay for which there is no viable BU and is proposed for offshore placement. Impacts to resources are included in Table 6.1-3.

Because this Widening Project is further along in the process for implementation than the proposed FHCIP, it is reasonable to assume that the channel widening would have been completed prior to completion of the authorization process for the FHCIP. Therefore, the

Widening Project is included in the "Past or Present Actions" category rather than the "Reasonably Foreseeable Future Actions" category. The project is included in Table 6.1-3.

6.2.11 Freeport LNG Phase I

Freeport LNG Development, LP was permitted to construct the new Freeport LNG Import Terminal Project (Freeport LNG Project) on Quintana Island, Brazoria County, Texas, providing infrastructure to shippers at the Stratton Ridge Meter Station (FERC, 2004a). The 2004 Final Environmental Impact Statement (FEIS) lists the following components for the Freeport LNG Project:

- LNG ship docking and unloading facilities with a protected single berth equipped with mooring and breasting dolphins, three liquid unloading arms, and one vapor return arm;
- reconfiguration of a storm protection levee and a permanent access road;
- two 26-inch-diameter (32-inch outside diameter) LNG transfer lines, one 16-inch-diameter vapor return line, and service lines (instrument air, nitrogen, potable water, and firewater);
- two double-walled LNG storage tanks, each with a usable volume of 1,006,000 barrels (3.5 billion cubic feet of gas equivalent);
- six 3,240-gallon-per-minute (gpm) in-tank pumps;
- seven 2.315-gpm high-pressure LNG booster pumps;
- three boil-off gas compressors and a condensing system;
- six high-pressure LNG vaporizers using a primary closed-circuit water/glycol solution heated with 12 water/glycol boilers during cold weather, and a set of intermediate heat exchangers using a secondary circulating water system heated by an air tower during warm weather, and circulation pumps for both systems;
- two natural gas superheaters and two fuel gas heaters;
- ancillary utilities, buildings, and service facilities at the LNG terminal; and
- 9.6 miles of 36-inch-diameter natural gas pipeline extending from the LNG import terminal to a proposed Stratton Ridge Meter Station (FERC, 2004b).

This first phase of the Freeport LNG Project was completed in April 2008 and is currently operational. Potential impacts associated with this first phase are included in Table 6.1-3. A description of Phase II of the project is presented in Section 6.3.2.

6.2.12 Surfside Marina

Located on the GIWW at the SH 332 bridge, this marina includes 260 dry stack slips and 38 water slips. The 9-acre facility is a full service dock, with 24-hour fuel, ice, and bait and also offers mechanical services (Surfside Marina, 2010). No environmental impacts from this project could be located for inclusion in Table 6.1-3.

6.2.13 Velasco Terminal

The Velasco Terminal is one of the larger port improvements in the last 40 years. Although it is planned to total 2,400 linear feet of berth, Phase I has completed 800 feet of berth thus far (Port Freeport, 2009). The terminal would handle containerized and break-bulk cargo, with 90 acres of developable land with rail (20 acres are currently under contract). No environmental impacts from this project could be located for inclusion in Table 6.1-3.

6.3 REASONABLY FORESEEABLE FUTURE ACTIONS

6.3.1 BP Fiber Optic Cable Network

BP Exploration and Production, Inc. has proposed installation of a 725-mile fiber optic cable network extending across the Gulf from Pascagoula, Mississippi, to Freeport, Texas. The proposed network will provide offshore oil and gas facilities in the Gulf with updated telecommunications service. Onshore construction in Freeport has been designed to avoid all wetland impacts. Construction would begin at the proposed beach manhole located near the northwest corner of a levee that surrounds the old Phillips Petroleum drilling material deposition site, now owned by the Texas General Land Office (GLO). This location is on Quintana Beach between the Seaway PA and PA 85, adjacent to the Quintana beach PA proposed for the Widening Project (see Section 6.2.8). The proposed fiber optic beach manhole would be a subterranean vaultlike structure that houses the splice linking the terrestrial cable with the submarine cable. From this manhole, the fiber optic cable would continue seaward via a horizontal directionally drilled bore pipe conduit approximately 30 feet below the existing ground elevation and seafloor surface for about 4,920 feet. At this point the cable would exit and lie on the Gulf floor, except at two fairway crossings (within the Galveston District), where it would be buried 10 feet below the seafloor. Construction would include building a 150-x-100-foot concrete pad for equipment associated with the horizontal directional drilling and a 20-x-20-foot access road from CR 723 to the existing levee.

Following a preliminary review of the Section 404/10 permit application, the Galveston District made a preliminary determination that an EIS is not required for the project (USACE, 2007). The proposed fiber optic cable network project is subject to Section 404(b)(1) evaluation, Texas Coastal Zone consistency certification, and Section 401 water quality certification from TCEQ. To avoid potential impacts to three previously identified potential cultural resource sites (anomalies), construction will not occur within a 164-foot radius avoidance zone around each anomaly. Preliminary indications are that no known threatened or endangered species or their critical habitat will be affected by the proposed project, and no substantial adverse impacts to EFH or federally managed Gulf fisheries are anticipated. An EA and Statement of Findings was issued August 16, 2007 (Permit Application – SWG-2007-884). This project is included in Table 6.1-3.

6.3.2 Freeport LNG Phase II

In July 2005, Freeport LNG Development, LP submitted environmental documentation to FERC to increase the diameter of the previously authorized 9.6-mile send-out pipeline from 36 inches to 42 inches (amendment to FERC Docket No. CP03-75) (FERC, 2005). As a result, the LNG terminal would also require expansion. The environmental effects for the LNG terminal expansion are presented in FERC Docket No. CP05-361 and the Phase II EA (FERC, 2006). Phase II of the Freeport LNG project includes the following items:

- an additional LNG ship berth and unloading facilities;
- additional vaporizers and associated systems, including an air tower;
- a third LNG storage tank;
- additional utility systems; and
- the Stratton Ridge LNG underground storage facility.

Freeport LNG Development, LP staff concluded that this second phase, with appropriate mitigating measures, would not constitute a major Federal action significantly affecting the quality of the human environment. In 2005, the RRC issued Freeport LNG Development, LP a permit to create, operate, and maintain an underground hydrocarbon storage facility at Stratton Ridge (RRC, 2005, amended 2007). A separate EA was prepared for this nonjurisdictional portion of the Freeport LNG Phase II project. Potential impacts from these underground facilities were also documented in the Freeport LNG Phase II Project EA Appendix A, Nonjurisdictional Facility Analysis (FERC, 2006). This facility for Freeport LNG would provide natural gas storage capacity for the vaporized LNG processed at the Freeport LNG terminal. The major components would include surface and subsurface facilities:

- salt dome natural gas storage caverns and well pads;
- gas-handling facility and solution-mining plant;
- one 20-inch natural gas wellhead pipeline (0.46 mile);
- one 42-inch (or smaller) natural gas pipeline (1.05 miles);
- two 6-inch water supply pipelines (1.46 miles and 0.46 mile);
- two 16-inch brine disposal pipelines (1.46 miles and 0.46 mile); and
- one 3.5-inch diesel pipeline (0.46 mile).

Impacts associated with Phase II for the Freeport LNG development are presented in Table 6.1-3.

The Stratton Ridge storage facility proposed for the Freeport LNG project is not related to the Stratton Ridge SPR expansion alternative considered and eliminated by DOE (DOE, 2007). In December 2006, the DOE released an EIS for the Nation's underground SPR expansion, including Stratton Ridge as a potential new facility approximately 5 miles northwest of Freeport. In February 2007, the DOE released its decision to not select Stratton Ridge as a new SPR storage facility because of its location within the Seaway crude oil distribution complex and potential impacts to existing commercial operations (including Dow Chemical) (DOE, 2007).

6.3.3 Port Freeport Modifications

Several projects were identified by Port Freeport as reasonably foreseeable projects in the Freeport area. Based on available information, brief descriptions of the proposed modifications are presented below. Because many of these projects are still in the conceptual planning stages, there is very little information available regarding their potential impacts; since potential impact information was not available for review at the time this document was prepared, impacts are not included in Table 6.1-3, unless otherwise noted.

6.3.3.1 Dock 5 Expansion

Development of Parcel No. 25/Berth 5 is proposed to further augment the port's warehousing and rail facilities. Transit Shed 6 adjacent to Dock 5 is proposed as a 125,000-square-foot facility with rail access (BRHND, 2004). Potential impacts associated with the Dock 5 expansion will include minimal to no wetland impacts for the initial phase and dredging activities with placement of dredged material in the port's PAs (pers. comm., Port Freeport Environmental Coordinator, 2006).

6.3.3.2 Cool Storage Facility

A 38,000- to 40,000-square-foot new waterfront cold storage facility is proposed to serve needs of fruit importers (Dole Fresh Fruit Company and Chiquita Brands, Inc.) The facility will handle palletized fruit and other temperature-sensitive commodities (BRHND, 2004). Construction of the facility involves conversion of a transit shed and does not involve construction of undeveloped land. It will contain four cubicles for fresh fruit storage that can be off-loaded as break-bulk cargo for ships or trucks.

6.3.3.3 Construction of Berth 7

This would be a new 800-foot-long berth with 20 acres of stabilized backlands for new containerized and/or break-bulk cargo activity. The facility will ultimately be 1,200 feet long and is designed to handle new-generation gantry cranes and vessels up to 48-foot draft (BRHND, 2004). According to Port Freeport's Environmental Coordinator, the project is expected to impact approximately 2.08 acres of jurisdictional waters of the U.S. The port is mitigating for that loss with the creation/enhancement of 15.7 acres of wetlands. Specifically, 8.5 acres of new wetland would be created, and 7.2 acres of existing wetlands in the Peach Point WMA would be enhanced (pers. comm., Port Freeport Environmental Coordinator, 2006). These impacts have been included in Table 6.1-3.

6.3.3.4 BASF Polycaprolactam Facility

A polycaprolactam plant is currently under construction at the BASF facilities in Port Freeport (Real Estate Center, 2006). The plant will build on the existing nylon polymer operations and will produce nylon polymers for engineering plastics used in automotive parts, electronics, and sporting goods, as well as other products (*The Alliance*, 2005a). Projected air emissions for the project have been permitted, and process wastewater will be treated on-site under their existing Texas Pollutant Discharge Elimination System wastewater discharge permit, and no increased water emissions are anticipated with the project (pers. comm., BASF Texas Hub Environmental Team Leader, 2006).

6.3.3.5 American Rice, Inc.

American Rice, Inc. has expansion plans for its on-port facilities:

- a 151,165-square-foot, fully automated warehouse on 4.3 acres for storage of finished goods;
- eight steel storage bins encompassing 45,225 square feet on 1.3 acres for holding rice brought by barge and truck;
- A 36,206-square-foot instant rice plant on 1 acre for producing instant and microwavable products;
- A 116,736-square-foot olive oil–bottling plant on 3.4 acres; and
- A cookie-baking facility.

This expansion is expected to employ approximately 335 people in the Freeport area. In addition, American Rice, Inc. plans to relocate their North American operation headquarters to Freeport (*The Alliance*, 2006j).

6.3.4 TEPPCO Seaway Crude Pipeline

TEPPCO operates the Seaway Crude Pipeline and provides marine terminal and storage services for Texas Gulf Coast area refineries. Three large-diameter lines carry crude oil from Freeport to the Jones Creek Tank Farm, which has six storage tanks capable of handling approximately 3.3 MMB of crude. The Freeport marine terminal is the origin for the 30-inch-diameter crude pipeline, which stretches approximately 500 miles to Cushing, Oklahoma, with a capacity of 350,000 barrels per day (TEPPCO, 2007). Information regarding the impacts of construction was not available at the time this report was prepared. Potential impacts from the TEPPCO Seaway facility are not included in Table 6.1-3.

6.3.5 Surfside Beach Shoreline Protection

The Federal Emergency Management Agency (FEMA) is considering funding the construction of a revetment structure along the seaward side of Beach Drive in the Village of Surfside Beach, Brazoria County, Texas, to provide protection to the transportation facility and the public infrastructure landward of Beach Drive (FEMA, 2007). The structure would be approximately 3,500 feet long. This proposed revetment is part of a larger, phased (not necessarily sequential) project including the following elements:

- concrete debris removal and demolition;
- relocation and/or removal of homes located on the beach;
- a GLO Shoreline Feasibility Study to develop additional erosion prevention alternatives; and
- evaluation and implementation of additional feasible alternatives.

The village will proceed with application(s) for CEPRA and Coastal Impact Assistance Program funding for beach nourishment, dune reconstruction, and beach stabilization. CEPRA Cycle 5 funding has been approved for house demolition and reimbursement (GLO, 2007). At the time of this document’s preparation, the only project for which environmental impact information is currently available is the revetment; therefore, impacts for the revetment are summarized in Table 6.1-3.

6.3.6 Freeport Desalination Plant

In 2004, the Brazos River Authority initiated the preparation of the Freeport Seawater Desalination Project Summary Report. According to this report, extensive analysis concluded that the project would be an integral component to meeting future water demands in Brazoria and Fort Bend counties, Texas (Brazos River Authority, 2004). In December 2006, TWDB produced recommendations and rationale for future desalination pilot projects in the Biennial Report on Seawater Desalination. The Freeport desalination project was not recommended to pursue at this time; however, this project will be considered as a possible candidate for future funding, especially if it can be integrated into broader interregional activities (TWDB, 2006b). Because the project is on hold at this time and environmental documentation has not been fully produced, potential impacts for this project are not included in Table 6.1-3.

6.3.7 Gulf Coast Regional Spaceport

In March 2000, Brazos County Commissioners voted to create the Gulf Coast Regional Spaceport Development Corporation to pursue a Federal Aviation Administration (FAA) license and develop a site to stage suborbital and orbital rocket launches by private enterprises (Brazoria County, 2000). An approximately 800- to 900-acre site was chosen off FM 2004 near Demi-John Island on a rural tract owned by Dow Chemical, close to the Brazoria NWR. The spaceport received state appropriations, and in 2006, the FAA-initiated public scoping/NEPA processes for licensing the site (FAA, 2006). On February 27, 2007, the Gulf Coast Regional Spaceport Development Corporation was dissolved; therefore, the spaceport is not currently being pursued (Brazoria County, 2007), but could be at some future date by another entity.

6.3.8 Park Upgrades and Marinas

Improvements are anticipated for Freeport’s Memorial Park and Bryan Beach Park. Improvements at Memorial Park include electrical upgrades and repairs (in-ground halogen light fixtures, accent flood lights, and sound system) (*The Alliance*, 2006i). At Bryan Beach Park, a new parking lot and a 2.9-mile crushed oyster shell trail are planned; restroom facilities may also be constructed (*The Alliance*, 2006d). The port has proposed a marina on the Old Brazos River that would market to large high-end boats. Additionally, a marina is being planned in Surfside with a 400-slip dry-dock facility, a restaurant, retail shops, showers, and a laundry facility. Off of the Highway 332 bridge, it would cater to sporting craft (*The Alliance*, 2006g).

6.3.9 Freeport Marina

Along the Old Brazos River, City of Freeport has submitted an application with USACE to build a marina with seven floating docks, dry stack storage, fuel, and marina facilities. The action would include dredging a 1,450-foot-long by 15-foot-wide area to a depth of –4 feet MLT, and bulkhead would be installed. Currently, the Old Brazos River is littered with debris and garbage; the proposed action would remove and improve the river bottom. There were no significant environmental effects identified from the proposed work (USACE, 2008c) and thus this project is not included in Table 6.1-3.

6.3.10 Parcel 14 Developments (Warehouse and Rail Multimodal Facility)

Parcel 14 is an environmentally mitigated tract immediately south of SH 36. The location would be developed as a multimodal facility with on-site warehousing and rail access. With a grade separation at FM 1495 and SH 36, connectivity with other port parcels is contiguous, with nonport traffic separated from port traffic (Port Freeport, 2009). No environmental impacts from this project could be located for inclusion in Table 6.1-3.

6.3.11 Various Roadway Improvement Projects

Several roadway improvement projects are planned for the area (TXDOT, 2010) and include two projects for improvements to CR 220, expansion of FM 2351 (to four lanes from SH 35 to Galveston County), widening of FM 523 (from FM 2004 to SH 332), bridge replacement of

CR 160 at the Gulf Coast Water Canal, and Segment B of the Grand Parkway. Because many of these projects are still in the planning stages, minimal information is available regarding their potential impacts; since no environmental impacts for these projects could be located, they are not included in Table 6.1-3.

6.4 CUMULATIVE IMPACTS DISCUSSION

6.4.1 Ecological and Biological Resources

6.4.1.1 Wetlands

The LPP Alternative would impact 39 acres of ephemeral wetlands, mitigated by one 3-acre pond planted with appropriate vegetation to fully compensate for lost AAHUs. Additional wetland habitat impacts over time are related to the Bryan Mound SPR, CenterPoint Energy electric transmission line, 45-foot Project, Freeport LNG, and Port Freeport modifications. From the 1950s to 2002, the Brazos Delta and surrounding area has shown a significant estuarine marsh loss trend (White et al., 2004). Losses can be attributed to erosion at the mouth of the diverted Brazos River, conversion to uplands due to early placement of dredged materials (e.g., the GIWW), agricultural land conversion, and residential and industrial development. Freeport Harbor and channel improvements are consistent with a steady trend toward increased reliance on area industry and continuing development. It is difficult to estimate cumulative functional impacts to area wetlands as many mitigation documents, if available, only discuss acreage lost and replacement acreage, if required. In recent years, compensatory and mitigation strategies have evolved to more fully replace wetland functionality, in addition to lost acreage. Measures taken by this proposed channel improvement project aim to accomplish that; therefore, this project’s measures should not be considered to add cumulatively to the area’s past adverse impacts to wetlands.

6.4.1.2 Benthos

Organisms present on open-bay bottom would be temporarily affected by the project excavation and placement of dredged materials. Other past, present, and potential projects in the study area have identified similar benthic community impacts through dredging for construction and maintenance. As noted in Section 4.12.1, excavation of open-water bottom buries and removes organisms; Sheridan (1999) found that benthic communities can take anywhere from 18 months to over 3 years to recover for certain parameters. Open-water disposal of dredged material in the ODMDSs smothers or buries existing benthic communities. Benthic community structure and abundance may eventually return to preplacement levels at the New Work ODMDS; however, repeated dredging and placement of dredged material at the Maintenance ODMDS site may result in less than full recovery of the benthic community between maintenance cycles, if those activities occur with frequencies more often than 18 months to 3 years. Cumulative benthic impacts may occur without adequate temporal spacing for benthic community recovery to preplacement populations at the New Work ODMDS because of placement for the Widening Project followed by placement from the FHCIP. However, it is likely that the benthic community would eventually recover, just over a longer period of time.

6.4.1.3 Essential Fish Habitat

In general, placement of dredged material into open-water areas may affect food sources, increase turbidity, and release contaminants in EFH. Several projects compared in this analysis use ODMDSs in construction and/or maintenance, potentially affecting EFH, albeit temporarily. Recovery of some benthic organisms would likely occur relatively quickly, although the assemblage in the dredged material might differ from the assemblage that existed at the PA prior to construction. Impacts to EFH from turbidity associated with ocean placement are not significant. If the material to be dredged is not contaminated, there would be no contamination issues with respect to EFH. Placement of dredged material associated with the projects included in this analysis would occur over time and would be subject to USACE and EPA permitting; therefore, it is reasonable to expect that dredged material placed into open-water sites would not contain contaminants. However, placement of material at the New Work ODMDS for the Widening Project and FHCIP may result in temporary cumulative impacts to the benthic community. Although these impacts may have slight effects on EFH-associated species, this impact is not expected to result in loss of EFH.

6.4.1.4 Threatened and Endangered Species

None of the proposed projects included in this analysis are expected to impact federally protected species, although dredging activities associated with some of the projects may affect Gulf marine turtles. Projects requiring dredging activities necessitate coordination with NMFS to avoid or minimize potential impacts to sea turtles during dredging operations; specific protective measures are engaged to prevent adverse impacts to the extent practicable. Any unavoidable impacts will be to individuals, within thresholds established by NMFS; therefore, the overall potential cumulative impacts are not expected to adversely impact sustainable populations.

6.4.2 Physical and Chemical Resources

6.4.2.1 Air Quality

Objectionable odors (e.g., hydrogen sulfide) may result from the dredging of maintenance sediments containing high concentrations of organic matter in those reviewed projects requiring dredging or digging into aquatic sediments. Current maintenance dredging activities (GIWW and Freeport Harbor Channel) and proposed projects that include dredging activities for construction (Widening Project, proposed FHCIP, Freeport LNG Project, and Port Freeport Modifications) would emit NO_X, CO, particulates, sulfur dioxides, and hydrocarbons. The project area occurs within the HGB, which is a nonattainment area for O_3 (see Section 3.6); therefore, all projects in the study area with the potential to affect air quality must coordinate with TCEQ in regards to the SIP. This coordination should ensure compliance with the SIP, and thus the NAAQS, resulting in no significant cumulative impact to air quality.

According to the 2011 U.S. Greenhouse Gas Inventory Report (EPA, 2011b), in 2009, total U.S. greenhouse gas emissions were estimated to be 6,633,200,000 metric tons as CO_2 equivalents. Based on the GHG estimates presented in Tables 4.4-3 and 4.4-8, the proposed NED Plan and LPP alternatives would result in a very small increase in GHGs compared to the national inventory. While GHG emissions from the FHCIP alternatives may be negligible relative to the total national emissions inventory, small contributions of GHGs could accumulate in the atmosphere. However, the estimated GHG emissions for the FHCIP alternatives combined with those from the projects indentified above are also expected to result in a small, short-term contribution compared to the national or global inventory of GHG emissions.

The cause of global climate change is generally accepted to be the increased production of GHG emissions worldwide. Unlike criteria pollutant impacts, which are local and regional, climate change impacts occur at a global level. In addition, the relatively long lifespan and persistence of GHGs require that climate change be considered a cumulative and global impact. It is unlikely that an increase in global temperature or sea level could be directly attributed to the emissions resulting from a single project or combination of a few local projects. Rather, it is more appropriate to conclude that the GHG emissions associated with the FHCIP alternatives would combine with emissions across the United States and the globe to cumulatively contribute to global climate change.

6.4.2.2 Noise

Noise impacts included in those projects associated with dredging will include operation and maintenance noise. This impact will be temporary, will move up and down the project area depending on the section being dredged, and is not expected to differ from current maintenance dredging for many of the projects. Additionally, it is unlikely dredging would occur for more than one of the reviewed projects at one time.

6.4.2.3 Water Quality

For those projects that include dredging activities, dredging and placement operations are expected to temporarily degrade water quality in the project vicinity through increased turbidity and the release of nutrients from the sediment. No projects reviewed cited concerns with sediment contamination or nutrients, including the LPP Alternative. Dredging and placement at proposed open-water and upland PAs may increase suspended solids, release contaminants and bound nutrients, and deplete oxygen. This impact is temporary and, except for turbidity, insignificant. If temporary degradation occurs, the study area should rapidly return to ambient conditions upon completion of dredging.

Although ship traffic in the study area may increase, this increase is expected to be offset by efficiency increases derived from the proposed Widening Project and the FHCIP.

Groundwater impacts may occur in two of the projects considered in this analysis; however, no groundwater impacts are foreseeable or expected from implementation of the LPP Alternative. With implementation of BMPs and other permitting requirements, no surface water quality impacts are expected related to this and other projects in the cumulative impacts analysis.

6.4.2.4 Sediment Quality

None of the projects reviewed are known to impact sediment quality or disturb contaminated sediment. Although ship traffic in the study area may increase, with a potential increase in the risk of a toxic spill that could eventually contaminate sediments, that risk is offset by various Freeport Channel system improvement projects and operational measures associated with the LNG transport. No cumulative impacts to sediment quality are expected.

6.4.2.5 Shoreline Erosion

The shoreline in the study area has been fluctuating since 1852, and none of the projects reviewed are expected to alter the ongoing pattern. Shoreline changes have been attributed to RSLR, a reduced sand supply, the Brazos River relocation in 1929, reservoir development in the Brazos River basin, tropical storm and hurricane effects, beach traffic, sand interception from navigation channels and jetties, and wave action caused by large ship traffic. Mathewson and Minter (1976) estimated that about 76 percent of the sand that historically reached the coast was not reaching it in 1975. Efforts to offset shoreline erosion with beach nourishment have been carried out under the Texas CEPRA. These have involved both trucking in at least 950 cy of sand in one project and bringing sand from a DMPA near Baytown by barge for dune rehabilitation (Newby, 2006). A major limitation of beach nourishment in the area is the limited availability and expense of a suitable sand supply. Currently, beaches on both sides of the Freeport jetties are severely eroded. Erosion on the Quintana Beach side is threatening the stability of the Seaway PA, and erosion of Surfside Beach is threatening beachfront homes. Several projects reviewed for the cumulative impacts analysis would enhance shoreline conditions: Quintana beach nourishment (Freeport Harbor Channel Widening Project); 14 acres of planted shoreline stabilizing grasses (Freeport LNG); and additional beach nourishment (Surfside Beach Shoreline Protection). It is not known whether channel traffic frequency will increase with the channel improvements, although the size of vessels is expected to increase. The LPP Alternative is not expected to cumulatively affect shoreline erosion rates in the study area, including Surfside and Quintana beaches.

6.4.3 Cultural and Socioeconomic Resources

6.4.3.1 Environmental Justice

The EO on EJ was instituted in 1994; therefore, several of the projects presented for evaluation in the cumulative impacts analysis did not include this as a criterion. This was not an impact in this project; therefore, the current project would not add to any cumulative impacts in the area.

6.4.3.2 Cultural Resources

Activities associated with any of the reviewed projects have the potential to adversely impact unknown cultural resources by altering the integrity of location, design, setting, materials, construction, or association that contributes to a resource's significance in accordance with the NRHP criteria. Possible cultural resources that could be impacted by the reviewed projects were identified for the Freeport LNG facility and the Widening Project. Both projects are considered a Federal action and are required to coordinate with the SHPO for Section 106 compliance; therefore, any potential impacts to cultural resources associated with these projects would be avoided or mitigated. The LPP Alternative is not expected to contribute to cumulative impacts to cultural resources.

6.4.3.3 Commercial and Recreational Fisheries

Most projects do not mention impacts to fisheries; however, for all projects that do mention impacts to fisheries, no long-term impacts are detailed. Temporary and minor impacts to recreational and commercial fisheries include decreased water quality, increased turbidity during dredging and placement activities, and a removal of productive fish habitat, which could interfere with fishing activities. Fish likely leave dredge and placement areas for more-favorable, less-turbid locations; however, once construction and placement are complete, water and foraging conditions would improve, and fish would return to the area. No long-term cumulative impacts are expected from the FHCIP combined with area projects.

6.5 CONCLUSIONS

Cumulative impacts due to past, existing, and reasonably foreseeable future projects, along with the proposed FHCIP, are not expected to have significant adverse effects in the study area. Many of the projects occurring in the vicinity of the Freeport Harbor Channel, including the FHCIP impacts, are part of the continuing urbanization and industrialization of the predominantly agricultural Brazoria County.

Most of the resources considered in this analysis are not affected by any or are affected by very few of the projects, in minor (small areas, mitigated) and/or temporary (short-term, recoverable with conditions) ways: benthic organisms, threatened or endangered species, shallow Gulf bottom, EFH, water quality, sediment quality, environmental justice focal areas, and commercial and recreational fisheries. As long as conditions continue to be favorable for recovery between periods of impact, these resources should not be affected by the projects discussed in this assessment in any permanent or cumulative way.

Some resources may experience permanent effects that have been and will be moderated by additional project actions, counteracting the potential for cumulative effects: wetlands (acreage and mitigation), shoreline (nourishment and restoration), and cultural resources (relocation, buffers, surveys for avoidance areas). Impacts associated with the Preferred Alternative for the FHCIP would be fully offset by compensatory mitigation measures.

7.0 COMPLIANCE WITH TEXAS COASTAL MANAGEMENT PROGRAM

The project will be reviewed by the Coastal Coordination Council (CCC) for consistency with the program. A review of potential BU of dredged material for the proposed FHCIP did not identify any cost-effective BUs in the project area. This was based on the characteristics of the dredged material, cost to transport the material, impacts associated with placement and manipulation of the material, and impacts to existing resources. Thus, no BU is proposed for the FHCIP. The LPP Alternative is consistent with the TCMP. All project planning has made efforts to avoid and otherwise minimize the cumulative adverse effects to coastal natural resource areas relating to the LPP Alternative. Dredged material will be placed in three upland confined PAs and two ODMDSs. Use of the ODMDSs would result in placement of dredged material within submerged lands, but these offshore placement areas are dispersive by nature, have been previously used, and will likely revert to the in situ topography prior to the next dredged material disposal. With the exception of submerged lands, which would be temporarily impacted, all Coastal Natural Resource Areas are avoided. Details regarding the LPP Alternative and compliance with the TCMP are documented in Appendix J.

(This page intentionally left blank.)

8.0 CONSISTENCY WITH OTHER STATE AND FEDERAL REGULATIONS

This EIS has been prepared to satisfy the requirements of all applicable environmental laws and regulations and has been prepared using the CEQ NEPA regulations (40 Code of Federal Regulations Part 1500–1508) and the USACE's regulation ER 200-2-2 (*Environmental Quality: Policy and Procedures for Implementing NEPA*, 33 CFR 230). USACE will follow provisions of all applicable laws, regulations, and policies related to the proposed actions, including those for which applicability, review, and enforcement are their responsibility. Additionally, the non-Federal sponsor may be required to secure local municipal permits as a "Land, Easements, Rights-of-Way, Relocation and Disposal Areas" requirement. The following sections present brief summaries of Federal environmental laws, regulations, and coordination requirements applicable to this EIS.

8.1 CLEAN AIR ACT

As required by the CAA, EPA has promulgated the General Conformity Rule as codified in 40 CFR Part 51, Subpart W, "Determining Conformity of Federal Actions to State or Federal Implementation Plans." TCEQ has promulgated its own corresponding regulations in 30 TAC §101.30, "Conformity of General Federal Actions to State Implementation Plans." Pursuant to these regulations, a Federal agency must make a General Conformity Determination for all Federal actions in nonattainment or maintenance areas where the total of direct and indirect emissions of a nonattainment pollutant or its precursors exceeds de minimis levels established by the regulations. The General Conformity Rule establishes conformity in coordination with and as part of the NEPA process. The rule takes into account air pollution emissions associated with actions that are federally funded, licensed, permitted, or approved, to ensure emissions do not contribute to air quality degradation, thus preventing the achievement of State and Federal air quality goals. The purpose of this General Conformity Rule is to assure that Federal agencies consult with State and local air quality districts, and to assure these regulatory entities know about the expected impacts of the Federal action and include expected emissions in their SIP emissions budget.

NO_X emissions for activities subject to USACE responsibility show the project would exceed the conformity threshold, i.e., greater than 25 tpy, for the 4-year construction period. Therefore, a Draft General Conformity Document for NO_X emissions was prepared and submitted to TCEQ and EPA for review. As part of the General Conformity process, USACE made this document available to the public for review and comments for a period of 30 days. The availability of the Draft General Conformity Document was published in the *Federal Register* on November 12, 2010, and in *The Facts* and *The Sentinel*, both local Freeport-area newspapers.

Based on the General Conformity Concurrence letter provided by TCEQ, a Final General Conformity Determination (see Appendix C) was prepared by USACE. A Notice of Availability of this document was published in the newspaper of general circulation in Brazoria County concurrent with the EIS and was submitted to TCEQ, EPA, and the Brazoria County Health Department, the local air pollution control program.

TCEQ and USACE's determination of conformity is based on the emissions information and project schedule proposed at the time. Once a final project schedule is completed, USACE will provide an update of the General Conformity documentation to TCEQ and EPA for review and concurrence that the updated emissions and schedule will still be conformant with the currently approved Houston-Galveston area SIP.

8.2 CLEAN WATER ACT

USACE has received Section 401 State Water Quality Certification for the Preferred Alternative. TCEQ has determined that the requirements for water quality certification have been met and has concluded that the placement of fill material will not violate water quality standards. The Preferred Alternative is the least environmentally damaging practicable alternative. A CWA Section 404(b)(1) evaluation is presented in Appendix G. New work sediments are suitable for use in the proposed upland confined PAs (1, 8, and 9) and for placement in the New Work ODMDS.

8.3 MARINE PROTECTION, RESEARCH, AND SANCTUARIES ACT

This Act requires a determination that dredged material placement in the ocean will not reasonably degrade or endanger human health, welfare, or amenities or the marine environment, ecological systems, or economic potential (shellfish beds, fisheries, or recreational areas). EPA is charged with developing ocean-dumping criteria to be used in evaluating permit applications under Section 102(a) of MPRSA. Section 102 of MPRSA authorizes USACE to place dredged material within an ODMDS, subject to EPA concurrence and use of EPA's dumping criteria. Modeling indicates the existing Maintenance ODMDS is large enough to accommodate maintenance material from the improved channel (see Appendix B). Additionally, future maintenance material is expected to have the same properties as existing maintenance material (see Appendix B). Thus, USACE would continue to use the Maintenance ODMDS, pending EPA concurrence that the criteria continue to be met and that analysis meets EPA guidelines.

The New Work ODMDS was a one-time use site for placement of new work material for the existing 45-foot Project. The site would be authorized by EPA under Section 102 for one-time placement of new work material associated with the proposed channel deepening and widening. Concurrence for using both ODMDSs was gained from EPA during August 2008.

An MPRSA Section 102/103 evaluation report for the proposed placement of new work dredged material within the ODMDS is provided in Appendix B of this EIS. Use of the ODMDSs will be in accordance with a Site Monitoring and Management Plan (SMMP) (see Appendix B). EPA has concurred that the dredged material is suitable for disposal in the ODMDSs and that the SMMP is acceptable (see Appendix A-7).

8.4 SECTION 7 OF THE ENDANGERED SPECIES ACT

Interagency consultation procedures under Section 7 of the ESA have been undertaken. A draft BA was prepared describing the study area, federally listed threatened and endangered species of potential occurrence in the study area (as provided by NMFS and USFWS), and potential impacts on these listed species (attached as Appendix I). This Draft BA was submitted to NMFS and USFWS for review with the DEIS (Appendix A-2). USACE has determined that the proposed project may adversely affect but is not likely to jeopardize the continued existence of several sea turtle species. Protective measures and documentation standards have been accepted by NMFS and USACE regarding the take of sea turtles with hopper dredges during maintenance dredging in a 2003 BO issued by NMFS (NMFS and NOAA, 2003, 2005, 2007a, 2007b). Interagency consultation under Section 7 of the ESA has been initiated with NMFS. A new BO from NMFS is anticipated for the project, to institute reasonable and prudent measures to avoid sea turtle impacts and establish new incidental take limits for construction.

8.5 MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

The Magnuson-Stevens Fishery Conservation and Management Act (PL 94-265), as amended, establishes procedures for identifying EFH and required interagency coordination to further the conservation of federally managed fisheries. Rules published by the NMFS (50 CFR sections 600.805–600.930) specify that any Federal agency that authorizes, funds, or undertakes, or proposes to authorize, fund, or undertake, an activity that could adversely affect EFH is subject to the consultation provisions of the Act and identifies consultation requirements. EFH consists of those habitats necessary for spawning, breeding, feeding, or growth to maturity of species managed by Regional Fishery Management Councils in a series of Fishery Management Plans. Submittal of the DEIS to NMFS initiated EFH consultation. USACE anticipates minor and temporary impacts to benthic organisms and turbidity during construction.

8.6 SECTION 106 OF THE NATIONAL HISTORIC PRESERVATION ACT

Compliance with the NHPA of 1966, as amended, requires identification of all NRHP-listed or NRHP-eligible properties/resources in the project area and development of mitigation measures for those adversely affected in coordination with the SHPO and the Advisory Council on Historic Preservation. As indicated in Section 4.14, a thorough file review did not identify any NRHP-listed or NRHP-eligible sites or SALs within the project footprint. Historical research and investigations identified a potential Civil War–period site near PA 9. Further investigation of the Civil War site will be addressed under the conditions of the PAg executed for this project (Appendix E). Compliance with the PAg places the project in compliance with NHPA.

8.7 COASTAL ZONE MANAGEMENT ACT

In an effort to encourage states to better manage coastal areas, Congress enacted the Coastal Zone Management Act in 1972, which created the Coastal Zone Management Program. Texas has developed and continues to implement federally approved coastal zone management programs (TCMP). States with approved plans have the right to review Federal activities to determine whether they are consistent with the policies of the state's coastal zone management program. USACE has evaluated the Preferred Alternative for consistency with the TCMP, and has concluded that it is fully consistent to the maximum extent practicable with the enforceable policies of the Texas program. By letter dated December 15, 2010 (Appendix A-4), USACE requested a review of the Consistency Determination, but to date has received no response.

8.8 NATIONAL ENVIRONMENTAL POLICY ACT

This EIS has been prepared in accordance with CEQ regulations in compliance with NEPA provisions. Impacts to the human environment, including those to terrestrial and aquatic resources and socioeconomic factors, have been identified, evaluated, and disclosed in this document.

8.9 FISH AND WILDLIFE COORDINATION ACT

The Fish and Wildlife Coordination Act provides for consultation with the USFWS and, in Texas, with TPWD whenever the waters or channel of a body of water are modified by a department or agency of the U.S. Under this Act, the Federal department or agency shall consult with the USFWS and the State agency with a view to the conservation of wildlife resources. The Act's purposes are to recognize the vital contribution of our wildlife resources to the Nation, and their increasing public interest and significance, and to provide that wildlife conservation receive equal consideration and be coordinated with other features of water-resource development programs through planning, development, maintenance, and coordination of wildlife conservation and rehabilitation. A Coordination Act Report (CAR) was prepared by USFWS and is included in Appendix A-5.

The Fish and Wildlife CAR provides USFWS's analysis of impacts and mitigation for important fish and wildlife resources related to the proposed land disposal plan. Coordination was implemented throughout the planning process to evaluate the affected environment, assess environmental impacts of the proposed activities, and to develop avoidance, minimization, and mitigation strategies for these impacts, as presented within respective sections of the document, to ensure equal consideration was given to fish and wildlife resources and that measures to conserve these resources will be taken. Per guidance provided in the CAR, riparian areas within the mitigation site will be planted with native, drought-tolerant vegetation.

8.10 MARINE MAMMAL PROTECTION ACT OF 1972

The Marine Mammal Protection Act was passed in 1972 and amended through 1997. It is intended to conserve and protect marine mammals and establish the Marine Mammal Commission, the International Dolphin Conservation Program, and a Marine Mammal Health and Stranding Response Program. The Preferred Alternative is in compliance with this Act. Proposed project improvements are not expected to impact any marine mammals as they are unlikely to occur in Brazoria County, or in the project area.

8.11 FEDERAL WATER PROJECT RECREATION ACT

This 1995 Act requires consideration of opportunities for outdoor recreation and fish and wildlife enhancement in planning water-resource projects. The proposed FHCIP is not expected to have any long-term affect on outdoor recreation opportunities in the area. This is discussed in Section 4.15.3.

8.12 COASTAL BARRIER IMPROVEMENT ACT OF 1990

This Act is intended to protect fish and wildlife resources and habitat, prevent loss of human life, and preclude the expenditure of Federal funds that may induce development on coastal barrier islands and adjacent nearshore areas. There are two Coastal Barrier Resources Act–designated areas near the project area (Coastal Barrier Resources System, 2010): Follets Island Unit T04 and Brazos River Complex T05/T05P. Unit T04 begins roughly 3.9 miles northeast of the North Jetty and continues roughly 10 miles up the coast, with a few exempted areas. There are no Otherwise Protected Areas (OPAs – undeveloped coastal barriers within the boundaries of lands reserved as wildlife refuges, parks, or for other conservation purposes) in T04 along the coastline. Unit T05 begins roughly 0.75 mile to the southwest of the South Jetty and, with one 0.4-mile break, extends to roughly 5.0 miles southwest of the South Jetty. Unit T05P, an OPA, begins roughly 5.0 miles southwest of the South Jetty and extends to, and beyond, the Brazos River mouth. Exceptions to the Federal expenditure restrictions include maintenance of constructed improvement(s) to existing Federal navigation channels and related structures (e.g., jetties), including the disposal of dredged material related to maintenance and construction. Thus, the Preferred Alternative is exempt from the prohibitions identified in this act.

8.13 FARMLAND PROTECTION POLICY ACT OF 1981 AND THE CEQ MEMORANDUM PRIME AND UNIQUE FARMLANDS

In 1980, CEQ issued an Environmental Statement Memorandum "Prime and Unique Agricultural Lands" as a supplement to the NEPA procedures. Additionally, the FPPA was passed in 1981, requiring consideration of those soils which USDA defines as best suited for food, forage, fiber, and oilseed production, with the highest yield relative to the lowest expenditure of energy and economic resources. Construction of PA 9 will impact approximately 250 acres of prime farmland. NRCS (2011; Appendix A-4) calculated the Farm Conversion Impact Rating to be a total of 161. The Farmland Conversion Impact Rating of 161 makes the tract for PA 9 subject to the FPPA. However, this EIS evaluated detailed alternatives that identified no other practicable alternatives for the placement of dredged material from this project. Accordingly, in compliance with NEPA and pursuant to the FPPA, the FHCIP has properly considered a wide range of possible alternatives.

8.14 EXECUTIVE ORDER 11988, FLOODPLAIN MANAGEMENT

This EO directs Federal agencies to evaluate the potential effects of proposed actions on floodplains. Such actions should not be undertaken that directly or indirectly induce growth in the floodplain unless there is no practicable alternative. The Preferred Alternative includes the development of two new PAs within the Brazos River floodplain. Alternatives to avoid the adverse effects of developing these PAs in the floodplain were evaluated, and it has been determined that this is the only practicable alternative.

8.15 EXECUTIVE ORDER 11990, PROTECTION OF WETLANDS

This EO directs Federal agencies to avoid undertaking or assisting in new construction located in wetlands, unless no practicable alternative is available. Construction of the two new PAs (PAs 8 and 9) would impact approximately 39 acres of ephemeral wetland habitat. These impacts are unavoidable and will be mitigated for as described in Section 5.0.

8.16 EXECUTIVE ORDER 12898, ENVIRONMENTAL JUSTICE

This EO directs Federal agencies to determine whether the Preferred Alternative will have a disproportionately adverse impact on minority or low-income population groups within the project area. An evaluation of potential EJ impacts was completed and is presented in Section 4.15.4. The Preferred Alternative is not expected to significantly affect any low-income or minority populations.

8.17 EXECUTIVE ORDER 13186, RESPONSIBILITIES OF FEDERAL AGENCIES TO PROTECT MIGRATORY BIRDS AND THE MIGRATORY BIRD TREATY ACT

The MBTA of 1918 (as amended) extends Federal protection to migratory bird species. Among other activities, nonregulated "take" of migratory birds is prohibited under this Act in a manner similar to the ESA prohibition of "take" of threatened and endangered species. Additionally, EO 13186 "Responsibilities of Federal Agencies to Protect Migratory Birds" requires Federal activities to assess and consider potential effects of their actions on migratory birds (including, but not limited to, cranes, ducks, geese, shorebirds, hawks, and songbirds). The effect of the LPP Alternative on migratory bird species has been assessed in this EIS, and no impacts are expected to migratory birds or their habitat in the study area. Construction contracts will include instructions to avoid impacts to migratory birds and their nests from construction-related activities. The Migratory Bird Conservation Act (16 USC 715–715d, 715e, 715f–715r; 45 Stat. 1222) establishes a Migratory Bird Conservation Commission to approve areas of land or water for acquisition as reservations for migratory birds and is not applicable to the project.

8.18 MEMORANDUM OF AGREEMENT BETWEEN THE FEDERAL AVIATION ADMINISTRATION—AIRCRAFT-WILDLIFE STRIKES

This Memorandum of Agreement (MOA) was executed among FAA, the U.S. Air Force, the U.S. Army, EPA, USFWS, and USDA. Through this MOA, the agencies establish procedures necessary to coordinate their missions to more-effectively address existing and future environmental conditions contributing to aircraft-wildlife strikes throughout the United States. These efforts are intended to minimize wildlife risks to aviation and human safety, while protecting the Nation's valuable environmental resources. A search was made to determine the proximity of airports to the project site. There are no airports located within 5 miles of the proposed Federal FHCIP. Therefore, the proposed project is in compliance with this MOA, and no further coordination is required.

(This page intentionally left blank.)

9.0 ANY ADVERSE ENVIRONMENTAL IMPACTS THAT CANNOT BE AVOIDED SHOULD THE PREFERRED ALTERNATIVE BE IMPLEMENTED

The Preferred Alternative would result in minor adverse impacts to benthos and fish from dredging and placement of dredged material, but these impacts will be temporary. Construction of the proposed channel deepening and widening would result in the loss of Gulf bottom. However, as noted in Section 4.12.1, areas impacted by excavation rapidly recover. Construction of PAs 8 and 9 would impact 21 acres of riparian forest, 39 acres of ephemeral freshwater wetlands, and 358 acres of pasture. This includes approximately 250 acres of prime farmland that would no longer be available for agricultural use. No other long-term environmental impacts are expected to occur as a result of the Preferred Alternative.

(This page intentionally left blank.)

10.0 ANY IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES INVOLVED IN THE IMPLEMENTATION OF THE PREFERRED ALTERNATIVE

The labor, capital, and material resources expended in the planning and construction of this project are irreversible and irretrievable commitments of human, economic, and natural resources. Deep-water bottom would be lost within the Gulf from proposed improvements for as long as the channel is maintained. Another resource that would be irretrievably committed to construct the proposed project is the approximate 250 acres of prime farmland that would no longer be available for agricultural use following construction and use of PA 9 for placement of dredged material and preservation of mitigation areas.

(This page intentionally left blank.)

11.0 RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The construction of the Preferred Alternative would result in the loss of deep-water bottom from deepening and widening the Freeport Harbor Channel. However, as noted in Section 4.12.1, the benthic community quickly recovers in excavated areas. Thus, although productivity in excavated areas would be reduced for a short period, those areas would quickly recover to preconstruction productivity levels. The conversion of prime farmland to a dredged material PA (PA 9) would remove those 250 acres from future use as agricultural land. However, allowing placement of new work and maintenance dredged material from the channel improvements will provide an economic boost to the community by reducing shipping constraints and delays at Port Freeport. Preserving approximately 132 acres of forested area for mitigation purposes would remove the area, which is categorized as prime farmland, from potential future agricultural use. However, it is unlikely that the area would be used for agriculture. Additionally, preservation of the forested area will contribute to the ecological and aesthetic value of the area.

(This page intentionally left blank.)

12.0 ENERGY AND NATURAL OR DEPLETABLE RESOURCE REQUIREMENTS AND CONSERVATION POTENTIAL OF VARIOUS ALTERNATIVES AND MITIGATION MEASURES

NEPA regulations in 40 CFR 1502.16 (e) and (f) require a discussion of project energy requirements and natural or depletable resource requirements, along with conservation potential of alternatives and mitigation measures in an EIS. The following presents discussion to meet that requirement.

Under the FWOP-1 Alternative, the energy requirements for maintaining the Freeport Harbor Channel would be slightly increased relative to the FWOP-2 Alternative. However, although channel improvements from the Widening Project would increase efficiency for current port users, thus decreasing energy requirements at Port Freeport, the navigation requirements for energy (fuel) to transport commercial products is likely to increase in the future as commerce increases and more traffic increases congestion and navigation time into and out of regional ports. Air quality impacts are likely to increase with an increase in navigation traffic congestion caused by delays and constraints currently in place for the Freeport Harbor Channel.

The Preferred Alternative is expected to reduce energy (fuel) requirements for the transport of products on a ton/mile basis by deepening and widening the channel and turning basins. These channel improvements will allow for:

- Ships to be more heavily loaded with cargo (reduced lightering to enter the channel);
- Larger ships to enter the channel during normal conditions (reduced delays); and
- Two-way traffic in the channel during normal conditions (reduced delays, congestion, and travel time).

Energy (fuel) will be required to deepen and selectively widen the channel, but this is a short-term impact. Energy to maintain the deeper and wider channel, as well as the reauthorized Stauffer Channel, is expected to increase with increased shoaling that is expected for the larger channel. This increase in fuel requirement is expected to be offset by fuel savings from more-efficient use of the channel by ships and reduced air quality impacts. Increased efficiency in moving petroleum and other petroleum-based commodities to the local refineries is expected to help conserve natural or depletable resources in the future. The reduced energy requirements of the more efficient channel should result in lower (or at least smaller increases in) transportation costs in the future, when compared to the FWOP-2 Alternative.

(This page intentionally left blank.)

13.0 PUBLIC INVOLVEMENT, REVIEW, AND CONSULTATION

13.1 PUBLIC INVOLVEMENT PROGRAM

13.1.1 Public Scoping Meeting

In accordance with NEPA guidelines, a Public Scoping Meeting was held on January 15, 2004, at the Lake Jackson Civic Center, Lake Jackson, Texas (see Appendix A-1). The meeting was advertised and promoted in conjunction with the non-Federal sponsor, the BRHND (Port Freeport). Advertising and promotion activities were initiated at least 3 weeks in advance of the scoping meeting in two local community newspapers. The meeting was also aired by a local community radio station through public service announcements. In addition, public notices were mailed to recipients that were identified utilizing USACE public and environmental database information and mailing lists maintained by Port Freeport.

The purpose of the meeting was to inform stakeholders and interested parties about the proposed FHCIP, outline the planning and feasibility study processes, present the proposed project schedule, and solicit public comments/input. Solicitation of public comments was a primary objective of the scoping meeting to ensure that significant issues were addressed, as required by NEPA. As such, meeting participants were specifically asked to identify environmental concerns, constraints, opportunities, and recommendations associated with proposed channel improvements. Meeting attendants included an elected official's representative, maritime industry representatives, including Port Freeport representatives, a local environmentalist from the Freeport area, and the general public.

13.2 PUBLIC VIEWS AND RESPONSES

Public views and concerns expressed during this study have been and will be considered during the preparation of the EIS. The views and concerns were used to develop planning objectives, identify significant resources, evaluate impacts of various alternatives, and identify a plan that is socially and environmentally acceptable.

13.2.1 Public Scoping Meeting

The Galveston District solicited both oral and written comments at the public scoping meeting. A court reporter provided by the non-Federal sponsor documented oral comments. Generally, the attending public provided positive comments in support of the proposed project. However, the local environmentalist expressed concerns regarding potential negative impacts associated with proposed channel improvements. The assertion was that the environmental community would probably oppose deepening beyond 50 feet, in an effort to avert similar plans and desires from competing Gulf ports, which if implemented could result in negative cumulative environmental impacts for the Gulf Coast region.

No oral comments were provided by Federal, State, or local resource agencies at the meeting, and the Galveston District received no subsequent written comments within the allotted comment period. Two additional public information meetings have been held. One was held in February 2006 and the other in February 2008.

13.2.2 DEIS Public Hearing

The notice for the public meeting and availability for the DEIS was published in local papers on December 19, 2010 (*The Facts*, 2010) and in the *Federal Register* on December 23, 2010. The public meeting was held on January 13, 2011, at the Freeport Community House. A website address for the DEIS was included in the notice, and both physical and email addresses were provided for submission of comments, with a comment submission deadline of February 5, 2011. Comments were received during the comment period via email (21), letters (17), comment forms (3), or verbally (3). Within these emails, letters, and written and verbal communications, there were approximately 68 comments. Comments were received from local, State and Federal agencies (e.g., Department of the Interior, EPA, NRCS, NMFS, Brazoria County, TPWD, GLO, and TCEQ), business and economic development entities (Dow Chemical, Chenier Energy, Brazosport Area Chamber of Commerce, BASF, and the Economic Alliance for Brazoria County), and residents from the Village of Surfside.

The various State and Federal agencies provided comments on the DEIS and business and economic development entities expressed support for the project. Comments included issues such as alternatives, air quality, water quality, mitigation, socioeconomic conditions and EJ, cumulative impacts, greenhouse gas emissions and climate change, prime farmland, impacts associated with proposed PAs 8 and 9, and potential impacts from placement of staging areas and the dredged material pipeline. The residents of Surfside expressed concern regarding the effect of the proposed project on erosion within the study area. Many of the residents submitted a petition opposing the project. Verbal comments addressed environmental concerns related to the project. One commenter expressed concern with the types of equipment and assumptions used in the air analyses, specifically in regards to reduction of NO_X emissions. Additionally, it was suggested that USACE require contractors to require low-emission technologies during requests for contractor bids. Another verbal commenter expressed concern that contaminated sediments would be encountered during dredging operations, and the need to properly handle and place the material in an appropriate manner. Last, a comment was made asking for an analysis of the potential negative economic effects of LNG tanker noise and vibration on Quintana residents and park visitors, and how these effects may increase with a deeper channel and changes in ship traffic. All of these comments, as well as others received, are addressed in Appendix A-7, and text has been inserted or revised in the EIS as appropriate.

13.3 REQUIRED COORDINATION

The Draft Feasibility Report and DEIS were circulated to all known applicable Federal, State, and local agencies. Interested organizations and individuals were sent the Notice of Availability with instructions to access the documents online or request electronic or paper copies. Copies were also made available for public review at local libraries or other available repositories in the community. The same will be done for the EIS.

13.4 STATEMENT RECIPIENTS

FEDERAL REPRESENTATIVES

Congressman Ron Paul
U.S. Representative
122 West Way, Ste. 301
Lake Jackson, TX 77566

Senator Kay Bailey-Hutchison
U.S. Senate
961 Federal Building
300 East 8th Street
Austin, TX 78701

Senator John Cornyn
U.S. Senate
5300 Memorial Drive, Ste. 980
Houston, TX 77007

FEDERAL AGENCIES

Aja Bonner
Center for Disease Control & Prevention Current Rotation
4770 Buford Hwy, Bldg 106
Atlanta, GA 30341

Director Office of ENV Policy & Compliance
Department of the Interior
Main Interior Bldg., MS 2342
1849 C Street, NW
Washington, DC 20240

Dr. Roy E. Crabtree, Ph.D.
Regional Administrator
National Marine Fisheries Service
263 13th Avenue South
St. Petersburg, FL 33701-5511

Yvonne L. Haberer
Headquarters USACE
Southwestern Division (EMP-SWD) Regional Integration Team
441 G Street, NW, Office 3T42
Washington, DC 20314-1000

Miles Croom, Assistant Regional Administrator
National Marine Fisheries Service
Habitat Conservation Division
263 13th Avenue South
St. Petersburg, FL 33701-5511

Rusty Swafford
National Marine Fisheries Service
Habitat Conservation Division
4700 Avenue U
Galveston, TX 77551-5997

David Bernhart
National Marine Fisheries Service, Southeast
ARA, Protected Resources Division
263 13th Ave South
St. Petersburg, FL 33701-5511

David Keyes
NEPA Coordinator
NOAA Fisheries
NMFS-SERO
263 13th Ave South
St. Petersburg, FL 33701-5511

Jennifer Sanchez
Project Leader
Texas Mid-Coast NWR Complex
2547 CR 316
Brazoria, TX 77422

Cody Dingee
Refuge Manager
Brazoria National Wildlife Refuge
24907 FM 2004
Angleton, TX 77515

Shane Kasson
Refuge Manager
San Bernard and Big Boggy National Wildlife Refuges
6801 CR 306
Brazoria, TX 77422

Don Gohmert
Natural Resources Conservation Service
101 S. Main
Temple, TX 76501

Janelle Stokes
USACE, Galveston District
2000 Fort Point Road
Galveston, TX 77550

Yvonne L. Habere
SWD-RIT Planner
Headquarters USACE Southwestern Division (CEMP-SWD) Regional Integration Team, 441 G Street, NW, Office 3T42
Washington, DC 20314-1000

Lisa Taylor
U.S. Coast Guard
823 Coast Guard Drive
Freeport, TX 77541-9451

Miles Aguinaga
U.S. DOE - Bryan Mound
PO Box 2276
Freeport, TX 77542-2276

Jim Salinas
U.S. DOE - Bryan Mound
PO Box 2276
Freeport, TX 77542-2276

Stephen Spencer
Regional Environmental Officer
U.S. DOI, Office of Environmental Policy and Compliance
1001 Indian School Road NW, Suite 348
Albuquerque, NM 87104

Thomas Diggs
Chief Air Planning Section
U.S. Environmental Protection Agency, Region 6
1445 Ross Ave., Suite 1200
Dallas, TX 75202

Michael Jansky
Office of Planning and Coordination
U.S. Environmental Protection Agency
Region 6
1445 Ross Avenue, Suite 1200, Mail Code 6 ENXP
Dallas, TX 75202-2733

Jeff Riley
U.S. Environmental Protection Agency
Region 6
1445 Ross Avenue, Suite 1200, Mail Code 6PD
Dallas, TX 75202-2733

U.S. Environmental Protection Agency
Office of Federal Activities – Room 7241
EIS Filing – Mail Code 2252A
Ariel Rios Building, South Oval Lobby
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Karen McCormick
Ocean Dumping Coordinator
U.S. Environmental Protection Agency
Region 6
1445 Ross Ave., Suite 1200
Dallas, TX 75202-2733

Robert Lawrence
U.S. Environmental Protection Agency
Region 6
1445 Ross Ave., Suite 1200
Dallas, TX 75202-2733

Barbara Keeler
U.S. Environmental Protection Agency
Region 6
1445 Ross Ave., Suite 1200
Dallas, TX 75202-2733

U.S. Environmental Protection Agency
Office of Federal Activities – Room 7241
EIS Filing – Mail Code 2252A
Ariel Rios Building, South Oval Lobby
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Edith Erfling
Field Supervisor, Clear Lake ES Field Office
U.S. Fish and Wildlife Service
Division of Ecological Services
17629 El Camino Real, Suite 211
Houston, TX 77058-3051

Donna Anderson
U.S. Fish and Wildlife Service
Division of Ecological Services
17629 El Camino Real
Suite 211
Houston, TX 77058-3051

Dr. Robert Stickney, Director
Texas Sea Grant College Program
2700 Earl Rudder Freeway South, Suite 1800
College Station, TX 77845

TRIBAL GOVERNMENTS

Bryant Celestine
Alabama-Coushatta Tribe of Texas
571 State Park Road 56
Livingston, TX 77351

Kyle Williams
Alabama-Coushatta Tribe of Texas
571 State Park Road 56
Livingston, TX 77351

Robert Cast
Tribal Historic Preservation Officer
Caddo Indian Tribe of Oklahoma
P.O. Box 487
Binger, OK 73009

Jimmy Arterberry
Tribal Historic Preservation Officer
Comanche Indian Tribe
P.O. Box 908
Lawton, OK 73502

Tamara Francis
Historic Preservation Coordinator
Delaware Tribe of Western Oklahoma
P.O. Box 825
Anadarko, OK 73005

Holly Houghten, Jr.
Tribal Historic Preservation Officer
Mescalero Apache Tribe
P.O. Box 227
Mescalero, NM 88340

Anthony Street
Tonkawa Tribe of Indians of Oklahoma
1 Rush Buffalo Road
Tonkawa, OK 74653-4449

Leslie Standing
President
Wichita and Affiliated Tribes
P.O. Box 729
Anadarko, OK 73005

STATE REPRESENTATIVES

Representative Dennis Bonnen
House District 25
122 E. Myrtle
Angleton, TX 77515

Representative Randy Webber
House District 29
2225 CR 90, Ste. 107
Pearland, TX 77584

Senator Joan Huffman
Senate District 17
129 Circle Way, Ste. 101
Lake Jackson, TX 77566

Senator Mike Jackson
Senate District 11
2225 CR 90, Ste. 107
Pearland, TX 77584

STATE AGENCIES

Office of the Governor of Texas
P.O. Box 12428
Austin, TX 78711-2428

Mark R. Vickery, P.G.
Executive Director
Texas Commission on Environmental Quality
P.O. Box 13087, Mail Code 109
Austin, TX 78711-3087

Susana M. Hildebrande, P.E.
Chief Engineers Office, Chief Engineer/Deputy Director MC168
Texas Commission on Environmental Quality
P.O. Box 13087
Austin, TX 78711-3087

Linda K. Vasse, P.G.
Regional Director
Texas Commission on Environmental Quality
5425 Polk Avenue, Suite H
Houston, TX 77023-1452

Charles Maguire
Director, Water Quality
Texas Commission on Environmental Quality
12100 Park 35 Circle, MC-150
Austin, TX 78753

Raul Cantu
Texas Department of Transportation
125 E. 11th Street
Austin, TX 78701-2483

Kate Zultner
Coastal Management Division
Texas General Land Office
P.O. Box 12873
Austin, TX 78701-2873

Tammy Brooks
Coastal Management Division
Texas General Land Office
P.O. Box 12873
Austin, TX 78701-2873

Amy Borgens
State Marine Archeologist
Texas Historical Commission
1511 Colorado
Austin, TX 78711-2276

Mark Wolfe
Texas State Historic Preservation Officer
Texas Historical Commission
1511 Colorado
Austin, TX 78711-2276

Mary Lee Stotler
Texas Historical Commission Steward
200 W. 2nd Street
Freeport, TX 77541-5773

Rebecca Hensley
Habitat Regional Director
Texas Parks and Wildlife Department
1502 FM 517 E
Dickinson, TX 77539-8687

Robert Spain
Manager
Texas Parks and Wildlife Department
Habitat Resources
4200 Smith School Road
Austin, TX 78744-3291

Carla Guthrie
Hydrologic and Environmental Monitoring Division
Texas Water Development Board
1700 N. Congress Avenue
Austin, TX 78701-1496

SPONSOR

James Brown, Jr.
Port Freeport Commissioner
221 Dewberry
Lake Jackson, TX 77566

Mike Lowrey
Port Freeport Commissioner
206 Teakwood
Lake Jackson, TX 77566

Tom Perryman
Port Freeport Commissioner
15074 Hwy. 288B
Angleton, TX 77515

Ravi Singhania
Port Freeport Commissioner
323 Timbercreek Dr.
Lake Jackson, TX 77566

Bill Terry
Port Freeport Commissioner
618 East 2nd Street
Freeport, TX 77541

Paul Kresta
Port Freeport Commissioner
2944 CR. 417
Brazoria, TX 77422

David M. Knuckey
Port Freeport
200 West Second Street, Third Floor
Freeport, TX 77541

A.J. “Pete” Reixach, Jr.
Port Freeport
200 West Second Street, Third Floor
Freeport, TX 77541

LOCAL GOVERNMENT

The Honorable E.J. "Joe" King
Brazoria County Judge
111 E. Locust Street
Angleton, TX 77515-4678

Commissioner Donald Payne
Brazoria County
111 E. Locust
County Courthouse Precinct 1
Angleton, TX 77515-4678

Commissioner Stacy L. Adams
Brazoria County Pct. 3
111 E. Locust
Angleton, TX 77515-4678

Ms. Karen Carroll
Director of Environmental Health
Brazoria County Health Department
Environmental Health Department
111 E. Locust Bldg A-29, Suite 270
Angleton, TX 77515

Gary Beverly
City Manager
City of Clute
108 East Main St.
Clute, TX 77531

Mayor Larry McDonald
City of Freeport
200 W. 2nd Street
Freeport, TX 77841

Mayor Clifford Louis Guidry
City of Oyster Creek
3210 FM 523
Oyster Creek, TX 77541

Mayor J. Patrick Henry
City of Angleton
121 S. Velasco
Angleton, TX 77515

Mayor Randy Taylor
City of Bailey's Prairie
P.O. Box 71
Angleton, TX 77516-0071

Jeff Pynes
CEO-City Manager
City of Freeport
200 West 2nd St., 2nd Floor
Freeport, TX 77541

Mayor Larry Davison
Village of Surfside Beach
1304 Monument Drive
Surfside Beach, TX 77541

Ms. Sandra Miller
City Secretary
Village of Surfside Beach
1304 Monument Drive
Surfside Beach, TX 77541

Commissioner Matt Sebesta
Brazoria County
Commissioner - Pct. 2
21017 CR 171
Angleton, TX 77515

Commissioner Mary Ruth Rhodenbaugh
Brazoria County
Commissioner - Pct. 4
PO Box 368
Brazoria, TX 77422

Ms. Kelly Hamby
Flood Plain Administrator
Brazoria County Flood Plain Administration
111 E. Locust - Bldg. A-29; Suite 210
Angleton, TX 77515

Mayor Gary Appelt
City of Alvin
216 W. Sealy
Alvin, TX 77511

Mayor Ken Corley
City of Brazoria
201 S. Main St.
Brazoria, TX 77422

Mayor Bill Turnipseed
City of Danbury
5200 5th St.
Danbury, TX 77534

Mayor Michael Hobbs
City of Jones Creek
7207 Stephen F. Austin Rd.
Jones Creek, TX 77541

Mayor Bob Sipple
City of Lake Jackson
25 Oak Dr.
Lake Jackson, TX 77566

Mayor Bill Strickland
City of Liverpool
P.O. Box 68
Liverpool, TX 77577

Mayor Michael Johnson
City of Richwood
215 Halbert
Richwood, TX 77531

Mayor Kenneth Lott
City of Sweeny
PO Box 248
Sweeny, TX 77480

Mayor Laurie Kincannon
City of West Columbia
PO Box 487
West Columbia, TX 77486

Mayor Norman Schroeder
Town of Holiday Lakes
Rt. 4 Box 747
Holiday Lakes, TX 77515

Amber Helbert
Town of Quintana
814 Lamar
Quintana, TX 77541

Stephen Alongis
Town of Quintana
814 N. Lamar
Quintana, TX 77541

Debbie Alongis
Town of Quintana
Parks and Recreation
814 N. Lamar
Quintana, TX 77541

Tonya McCaghren
Town of Quintana
814 N. Lamar
Quintana, TX 77541

Chris Gallion
Operations Superintendent
Velasco Drainage District
P. O. Box 7
Clute, TX 77531

Mel McKey
Superintendent
Velasco Drainage District
P. O. Box 7
Clute, TX 77531-0007

ORGANIZATIONS

Alvin Sun & Advertiser
570 Dula St.
Alvin, TX 77511

Keith Gray
American Rice, Inc.
PO Box 2490
Freeport, TX 77542

Beth Journeay
Angleton Chamber of Commerce
445 E. Mulberry
Angleton, TX 77515

Winnie Burkett
Houston Audubon Society
919 Layfair Place
Friendswood, TX 77546

Andy Cason
BASF
602 Copper Road
Freeport, TX 77541

Randy Harang
Brazoria Chamber of Commerce
908 S. Brooks
Brazoria, TX 77422-0992

Sandra Shaw
Brazosport Chamber of Commerce
300 Abner Jackson Pkwy.
Lake Jackson, TX 77566

Millicent Valek
Brazosport College
500 College Dr.
Lake Jackson, TX 77566

John Gunning
Brazos Pilots Association
2502 Deep Sea Dr.
Freeport, TX 77541

Tammy Moss
Brazos Pilots Association
P.O. Box 2246
Freeport, TX 77541

The Bulletin of Brazoria County
P.O. Box 2426
Angleton, TX 77516

Catherine Eisele
Carriage Services
3040 Post Oak Boulevard, Suite 300
Houston, TX 77056

Charles Beckman
Chiquita Brands International, Inc.
PO Box 3146
Freeport, TX 77542

Coastal Conservation Association-Texas Chapter
6919 Portwest, Suite 100
Houston, TX 77024

Joy Hall
Senior Project Advisor
ConocoPhillipsCompany
600 North Dairy Ashford PR-1078
Houston, TX 77079-1175

Cradle of TX Conservancy
121 Hickory St.
Lake Jackson, TX 77566-5643

Bob Smith
Dole Fresh Fruit Company
PO Box 2676
Freeport, TX 77542

Donnie Belote
Dow Chemical
2301 N. Brazosport Blvd., BM-54
Freeport, TX 77541

Lucy McGregor
Dow Chemical
2301 Brazosport Blvd., A2813 Building
Freeport, TX 77541

James Prazak
Dow Chemical
2301 N. Brazosport Blvd., B-122
Freeport, TX 77541

Julie Woodward
Dow Chemical
2301 N. Brazosport Blvd., B-122
Freeport, TX 77541

Steve Hazelwood
Dow Chemical
2301 N. Brazosport Blvd., Building APB-2019
Freeport, TX 77541

John Hoss
Freeport Launch Service
1200 East Brazos
Freeport, TX 77541

Keith Little
Freeport LNG
333 Clay Street, Ste. 5050
Houston, TX 77002-4173

Sharron Stewart
Galveston Bay Foundation
17324-A Highway 3
Webster, Texas 77598

Jay Jaffe
Gulf Chemical &
Metallurgical Corp.
PO Box 2290
Freeport, TX 77542-2290

Jim Stark
Gulf Intracoastal Canal
Association
P.O. Box 6846
New Orleans, LA 70174

Cynthia Goldberg
Gulf Restoration Network
P.O. Box 2245
New Orleans, LA 70176

Pat Younger
Honorary Consulate of
Trinidad and Tobago
2400 Augusta Dr., Ste 550
Houston, TX 77057

Alan C. Clark
Director of Transportation
Planning
Houston-Galveston Area
Council
P.O. Box 22777
Houston, TX 77227-2777

Scott Glick
J & S Marine
P. O. Box 4003
Brazoria, TX 77422

Kevin Parrish
Kirby Inland Marine
18350 Market Street
Channelview, TX 77530

Gerald Anderson
Krewe of Port Freeport
2106 Blue Water Highway
Surfside, TX 77541

Serena Andrews
Krewe of Port Freeport
61 S. Calla Lilly Ct.
Lake Jackson, TX 77566

Lisa Bailey
Krewe of Port Freeport
805 Seashell Drive
Surfside, TX 77541

Scott Barber
Krewe of Port Freeport
PO Box 866
Sweeny, TX 77480

Kevin Burns
Krewe of Port Freeport
506 E. Broad
Freeport, TX 77541

Rick Castello
Krewe of Port Freeport
346 Timbercreeek Drive
Lake Jackson, TX 77566

Terry Casey
Krewe of Port Freeport
442 Amherst
West Columbia, TX 77486

Steven Coleman
Krewe of Port Freeport
129 CR 51
Rosharon, TX 77583

Lauri Dupaquier
Krewe of Port Freeport
1604 Old Angleton Rd.
Clute, TX 77531

Bob Durham
Krewe of Port Freeport
1431 West Broad
Freeport, TX 77541

Matt Edquist
Krewe of Port Freeport
120 West Myrtle
Angleton, TX 77515

Roy Edwards
Krewe of Port Freeport
162 Fisherman's Isle
Churchill, TX 77422

Stuart Farmer
Krewe of Port Freeport
58 North Bachelor Button
Lake Jackson, TX 77566

Garvin Germany
Krewe of Port Freeport
614 McBride
Angleton, TX 77515

Charles Hawkins
Krewe of Port Freeport
404 S. Ave. G
Freeport, TX 77541

Jack Hays
Krewe of Port Freeport
P. O. Box 638
West Columbia, TX 77486

Rob Heckendorn
Krewe of Port Freeport
414 Forest Drive
Lake Jackson, TX 77566

Raymond Jess
Krewe of Port Freeport
130 Redbud
Lake Jackson, TX 77541

Lonnie Key
Krewe of Port Freeport
200 N. Brazosport Blvd.
Clute, TX 77531

Lila Loyd
Krewe of Port Freeport
1620 N. Ave. T
Freeport, TX 77541

Jay Luce
Krewe of Port Freeport
313 Timbercreek Drive
Lake Jackson, TX 77566

Scott McKay
Krewe of Port Freeport
200 Willow Drive
Lake Jackson, TX 77566

Curt Mowery
Krewe of Port Freeport
297 CT 42
Sandy Point, TX 77583

John Phillips
Krewe of Port Freeport
PO Box 724
West Columbia, TX 77486

Shane Pirtle
Krewe of Port Freeport
133 Arrowwood
Lake Jackson, TX 77566

Darrell Powell
Krewe of Port Freeport
5431 HNR Subdivision Rd.
Brazoria, TX 77422

Doug Roesler
Krewe of Port Freeport
303 E. Locust St.
Angleton, TX 77515

Frank Seidule
Krewe of Port Freeport
1314 6th Street
Angleton, TX 77515

Chris Seymour
Krewe of Port Freeport
135 Indian Warrior
Lake Jackson, TX 77566

Lon Siddall
Krewe of Port Freeport
1747 West 11th
Freeport, TX 77541

Naomi Smith
Krewe of Port Freeport
32901 FM 1301
West Columbia, TX 77486

John Smith, III
Krewe of Port Freeport
1415 N. Ave. G
Freeport, TX 77541

K.C. Strate
Krewe of Port Freeport
160 Houston Ave.
Angleton, TX 77515

Pat Webb
Krewe of Port Freeport
2607 C.R. 496
Brazoria, TX 77422

Donald Williams
Krewe of Port Freeport
201 South Main
Brazoria, TX 77422

Joyce Miley
LNG Stakeholder Relations
600 N. Dairy Ashford
Houston, TX 77079

George Wommack, Jr.
Oaks, Hartline, & Daly, LLP
PO Box 420
Lake Jackson, TX 77566

Jon Volkmer
Pearland Chamber of
Commerce
6117 Broadway St.
Pearland, TX 77581-7803

Robert Eastman
Save our Beach Association
1304 Monument Drive
Surfside, TX 77541

Jim Williams
Sierra Club-Houston Group
P.O. Box 3021
Houston, TX 77253-3021

Dr. Brandt Mannchen
Sierra Club-Lone Star
Chapter
5431 Carew
Houston, TX 77096

Ronald E. Smith
S&S Holdings, LLC
P.O. Box 1106
Sapulpa, OK 74067

Spring Branch Wildlife
Preserve
8810 Carousel Lane
Houston, TX 77080-6001

Ellis Pickett
Surfrider Foundation Texas
Chapter
P.O. Box 563
Liberty, TX 77575

Bill Bender
Sweeny Chamber of
Commerce
PO Box 84
Sweeny, TX 77480

Martha Zamora
Sweeny Chamber of
Commerce
112 Main St.
Sweeny, TX 77480

James Nealy
Texas Eastern Petroleum
Pipeline Company (TEPPCO)
P.O. Box 2486
Freeport, TX 77542-2486

Lisa F. Regan
Texas Energy Coalition
6207 Inwood Drive
Houston, TX 77057

Patrick Nugent
Executive Director
Texas Pipeline Association
604 West 14th Street
Austin, TX 78701

Pat Studdert
Texas Waterway Operators Association
c/o Buffalo Marine Service
P.O. Box 5006
Houston, TX 77262

Bridie Gensee
The Facts
720 S. Main Street
Clute, TX 77531

Val Horvath
The Facts
720 S. Main Street
Clute, TX 77531

David Bezanson
The Nature Conservancy
816 Congress, #920
Austin, TX 78701

The Source Weekly
223 Parking Way
Lake Jackson, TX 77566

Carlos Agudelo
Turbana Corporation
550 Biltmore Way, Ste. 730
Coral Gables, FL 33134

Juan Alarcon
Turbana Corporation
550 Biltmore Way, Ste. 730
Coral Gables, FL 33134

David Terry
V.I.T., Inc.
618 East Second Street
Freeport, TX 77541

Clay Upchurch
Vulcan Material
12603 Southwest Frwy, Ste 300
Stafford, TX 77477

Rita Terrell
West Columbia Chamber of Commerce
PO Box 837
West Columbia, TX 77486

JamieWalker
West Columbia Chamber of Commerce
PO Box 837
West Columbia, TX 77486

Wright Gore, Jr.
Western Seafood
308 Timbercreek Dr.
Lake Jackson, TX 77566

Dane Anderson
Westlake Picayune
3103 Bee Cave Road, #102
Austin, TX 78746

LIBRARIES

Catherine H. Threadgill
County Librarian
Brazoria County Library System
451 N. Velasco
Angleton, TX 77515

Jerry Measells
Librarian
Brazoria Library
620 South Brooks
Brazoria, TX 77422

Caroline Weatherly
Clute Branch Library
215 N. Shanks St.
Clute, TX 77531

Marge Janke
Librarian
Freeport Library
410 Brazosport Blvd
Freeport, TX 77541

Nancy Hackney
Lake Jackson Library
250 Circle Way
Lake Jackson, TX 77566

Dana Wilson
Librarian
Alvin Branch Library
105 South Gordon
Alvin, TX 77511

Kandy Taylor-Hille
Librarian
Danbury Branch Library
1702 North Main
Danbury, TX 77531

Katherine Klentzman
Librarian
Manuel Branch Library
20514B Hwy 6
Manuel, TX 77578

Leslie Smith
Librarian
Sweeney Branch Library
205 W. Ashley Wilson Rd.
Sweeney, TX 77480

Melissa Fichera
Librarian
West Columbia Branch Library
518 East Brazos
West Columbia, TX 77486

CONSULTANTS

Herbie Maurer
Maurer Advisory &
Consulting Services, Inc.
1215 Eagle Lakes Dr.
Friendswood, TX 77546

Prasad Menon
RBC Projects, LLC
363 N. Sam Houston Pkwy.
E., Ste. 1100
Houston, TX 77060

Joe Moake
HDR|Shiner Moseley
555 North Carancahua Street,
Suite 1650
Corpus Christi, TX 78478-
0010

Ann Profilet
Ecologic
4901 Welford
Bellaire, TX 77401

Bory Steinberg
Steinberg & Assoc.
1432 Lady Bird Drive
McLean, VA 22101

Pat Younger
Younger & Associates
2400 Augusta Dr., Ste. 250
Houston, TX 77057

GENERAL PUBLIC

Bob & Liz Allison
Woody T. & Leta W.
Barksdale
William Bender
Blinn S. Bolcar
Joanne Breeland
B.H. Carlton III
JP & Cassie Perry
Russell Clinton
James Cooley
Theresa Cornelison
John Damon
Tobey Davenport
Greg Flaniken
Lisa Fuka
James C. & Wanda L.
Graham
Thomas Ledkins
Peggy Llewellyn
Lila S. Lloyd
Jerry Masters
Joyce Miley
W.J. Morrison
Jimmy Nealy
William Nikolis
Melanie Oldham
Catherine & Larry F. Ostera
Murray
Daniel C. Parsons
Tom Perryman
Victor Polah
Brooks W. Porter
T.B. Ramey Jr.
Phyllis Saathoff
Jeffery M. Reynolds
John Richers
Drew Ryder
Jack Stanley
Frank W. Stevens
Elizabeth & Guy Stevens
Sharron Stewart
Mary Stotler
Jim Saccomanno
Neal Van Dussen
Christie Walne Taylor
John K. Ward

14.0 LIST OF PREPARERS

The USACE Project Manager for the CIP EIS is Sharon Tirpak. USACE and Atkins key personnel responsible for preparation of the document are listed below:

Name	Project Role
U.S. Army Corps of Engineers, Galveston District	
Sharon Tirpak	Project Manager
Cindy Burke	Project Manager
Robert VanHook	Planning Lead
George Dabney	Environmental Lead
Janelle Stokes	Environmental Lead
Terry Roberts	Technical Support (HEP Analysis)
Rob Hauch and Carolyn Murphy	QA/QC

Topic/Area of Responsibility	Name/Title	Experience
Atkins		
Project Manager Water and Sediment Quality Document Review, ODMDS Appendix	Martin Arhelger Vice President, Project Director	30 years, Environmental Assessment and Impact Analysis
Project Manager, Document Review, Cumulative Impact Analysis	Angela Bulger Project Manager	9 years, NEPA Document Preparation Management and Impact Analysis
QA/QC Manager	Tony Risko Senior Project Manager	17 years, Dredging and Dredged Material Placement
Wildlife and Habitat; Threatened and Endangered Wildlife Species	Erik Huebner Senior Scientist	7 years, Wildlife and Protected Species Specialist
Wildlife and Habitat; Threatened and Endangered Wildlife Species	Gary McClanahan Staff Ecologist	5 years, Ecologist
Sea Turtle Analysis	Derek Green Biologist, Wildlife Specialist	23 years, Environmental Assessment and Impact Analysis
Historical/Cultural Resources – Marine	Bob Gearhart Archeologist; Magnetometer and Side-Scan Sonar Specialist	21 years, Marine Archeology
	Amy Borgens Archeologist; Nautical Resources Specialist	8 years, Marine Archeology
Air Quality	Ruben Velasquez, P.E. Senior Engineer, Air Quality Specialist	22 years, Air Quality Analysis
Vegetation; Threatened and Endangered Plant Species, TCMP	Kathy Calnan Ecologist, Botanist	16 years, Vegetation Analysis and Impacts
Hazardous Materials	Steve McVey Geologist, HAZMAT Specialist	12 years, Environmental Geology

Topic/Area of Responsibility	Name/Title	Experience
Historical/Cultural Resources – Terrestrial	Meg Cruse Archeologist	17 years, Archeology
Land Use, Environmental Justice, Socioeconomics	Tricia LaRue Environmental Planner II	3 years, Urban and Environmental Planning
Geology, Bathymetry, Topography	James Killian Senior Scientist	22 years, Geologic Sciences
Noise	Thomas Ademski Senior Environmental Planner	8 years, Environmental Planning and Noise Analysis
Aquatic Ecology and Essential Fish Habitats, TCMP	Lisa Vitale Senior Scientist	15 years, Marine/Aquatic Biology
Shoreline Erosion and Navigation	Paul Jensen Principal Technical Professional	40 years, Commercial Navigation, Environmental Engineering
Shoreline Erosion and Navigation MDFATE Modeling	Ka-Leung Lee Senior Water Resources Engineer	10 years, Water Quality, Hydrologic, and Hydraulic Analyses and Modeling
Cumulative Impact Analysis	Wendy Connally Senior Scientist	19 years, Ecology, Threatened and Endangered Species, Cumulative Impacts
Technical Support	Thomas Dixon Environmental Scientist II	5 years, Wildlife Ecology BA Preparation
Technical Support	Amy Christiansen GIS Analyst II	2 years, GIS
Technical Support	David Kimmerling CAD/Graphics Specialist	21 years, Graphics
Technical Support	Bob Bryant Word Processor	17 years, Word Processing
Technical Support	Chris Vidrick Word Processor	30 years, Word Processing
Technical Editing	Linda Nance	36 years, Technical Editor

15.0 REFERENCES

Alliance, The. 2005a. “Freeport site gets nylon facility”; published March 24, 2005; <http://www.eda-bc.com/news/archives/release.asp?id+250> (accessed March 1, 2006).

———. 2005b. “Surfside approves lease for project”; published December 15, 2005; <http://wwweda-bc.com/news/archives/release.asp?id+370> (accessed March 1, 2006).

———. 2006a. “Look ahead: south county – year has hope for Freeport marina,” published January 1, 2006; <http://www.eda-bc.com/news/archives/release.asp?id=356> (accessed March 1, 2006).

———. 2006b. “Look ahead: Brazoria County – Spaceport tops county issues;” published January 1, 2006; <http://www.eda-bc.com/news/archives/release.asp?id+361> (accessed March 1, 2006).

———. 2006c. “Tour promotes history as draw for tourism”; published January 31, 2006; http://www.eda-bc.com/news/archives/release.asp?id+425 (accessed March 1, 2006).

———. 2006d. “Beach trail made of oyster shell coming to Freeport”; published January 30, 2006; <http://www.eda-bc.com/news/archives/release.asp?id+420> (accessed March 1, 2006).

———. 2006e. “Port Freeport officials look to advance enhancements following meetings with TxDOT Commissioner Houghton”; published January 26, 2006; <http://www.eda-bc. com/ news/archives/release.asp?id+423> (accessed March 1, 2006).

———. 2006f. “Look ahead: industry – future holds industry expansion;” published January 1, 2006; <http://www.eda-bc.com/news/archives/release.asp?id+360> (accessed March 1, 2006).

———. 2006g. “Developers planning Surfside marina”; published February 23, 2006; <http://www.eda-bc.com/news/archives/release.asp?id+446> (accessed March 1, 2006).

———. 2006h. “LNG Terminal to benefit Quintana, surrounding area”; published February 12, 2006; <http://www.eda-bc.com/news/archives/release.asp?id+432> (accessed March 1, 2006).

———. 2006i. “Freeport Mulling Park upgrades – city officials working to bring light, sound to Memorial Park;” published February 28, 2006; http://www.eda-bc.com/news/archives/ release. asp?id=448; (accessed August 24, 2006).

———. 2006j. “Port Freeport to be site of American Rice Inc.’s $110 million expansion”; published March 20, 2006; http://www.eda-bc.com/news/archives/release.asp?id=463; (accessed August 24, 2006).

———. 2007a. “Freeport considers annexing 122 acres” published April 19, 2007 <http://www.eda-bc.com/news/archives/release.asp?id=717> (accessed July 5, 2007).

———. 2007b. “Freeport marina progressing” published May 14, 2007 <http://www.eda-bc.com/news/archives/release.asp?id=738 (accessed July 5, 2007).

———. 2007c. “Surfside council approves marina” published April 6, 2007 <http://www.eda-bc.com/news/archives/release.asp?id=704> (accessed 2007).

———. 2007d. “Surfside to get 4-bay boat ramp” published April 16, 2007 <http://www.eda-bc.com/news/archives/release.asp?id=715> (accessed July 5, 2007).

———. 2007e. “Shintech Planning Expansion” published June 1, 2007 <http://www.eda-bc.com/news/archives/release.asp?id=748> (accessed July 5, 2007).

———. 2007f. “Air Liquide plant project gets break” published February 3, 2007 <http://www.eda-bc.com/news/archives/release.asp?id=672> (accessed July 5, 2007).

———. 2007g. “Port board approves windmill storage site” published April 30, 2007 <http://www.eda-bc.com/news/archives/release.asp?id=728> (accessed July 5, 2007).

Alperin, L.M. 1977. Custodians of the Coast, A History of the United States Army Engineers at Galveston. Published by the Galveston District, United States Army Corps of Engineers, Galveston, Texas.

American Ornithologists’ Union (AOU). 1998. Check-list of North American birds. 7th edition. Allen Press, Inc. Lawrence, Kansas.

———. 2000. 42nd supplement to the check-list of North American birds. Auk 117:847–858.

———. 2002. 43rd supplement to the check-list of North American birds. Auk 119:897–906.

———. 2003. 44th supplement to the check-list of North American birds. Auk 120:923–931.

———. 2004. 45th supplement to the check-list of North American birds. Auk 121:985–995.

———. 2005. 46th supplement to the check-list of North American birds. Auk 122:1026–1031.

———. 2006. 47th supplement to the check-list of North American birds. Auk 123: 926–936.

———. 2007. 48th supplement to the check-list of North American birds. Auk 124: 1109–1115.

Armstrong, N.E., M. Brody, and N. Funicelli. 1987. The ecology of open-bay bottoms of Texas: a community profile. U.S. Department of the Interior Fish and Wildlife Service. Biological Report 85(7.12). 104 pp.

Aten, L.E. 1983. Indians of the Upper Texas Coast. Academic Press, New York.

Baker, E.T. 1979. Stratigraphic and hydrogeologic framework of part of the coastal plain of Texas. Texas Department of Water Resources Report No. 236, Austin, Texas.

Baker, R.J., L.C. Bradley, R.D. Bradley, J.W. Dragoo, M.D. Engstrom, R.S. Hoffmann, C.A. Jones, F. Reid, D.W. Rice, and C. Jones. 2003. Revised checklist of North American mammals north of Mexico, 2003. Museum of Texas Tech University, Lubbock. Occasional Papers, Number 229. 1 December 2003.

Barker, E.C. 1927. The Austin Papers October 1834 – January 1837. Center for American History, The University of Texas at Austin.

Barnes, V.E. 1982. Geologic Atlas of Texas, Houston Sheet. (1968; revised 1982) The University of Texas at Austin, Bureau of Economic Geology, Austin.

———. 1987. Geologic Atlas of Texas, Beeville-Bay City Sheet. (1975; revised 1987) The University of Texas at Austin, Bureau of Economic Geology.

Barr, A. 1961. Texas Coastal Defense, 1861–1865. Southwestern Historical Quarterly 65(1):1–31.

Bartlett, R.D., and P.P Bartlett. 1999. A field guide to Texas reptiles and amphibians. Gulf Publishing Company, Houston, Texas.

BASF Texas Hub Environmental Team Leader (pers. comm.). 2006. Personal communication with Michael Baxter, July 17, 2006.

Battelle. 2004. Characterization of ocean dredged material disposal site at Freeport, Texas. Final Report, Volume 1. EPA Contract No. 68-C-03-041, Work Assignment No. 0-05, Amendment No. 1, Revision No. 1. February 23.

Bezanson, D. 2001. Natural vegetation types of Texas and their representation in conservation areas. The Nature Conservancy of Texas, San Antonio. http://tconr.home.texas.net/Vegetation/

Blair, W.F. 1950. The biotic provinces of Texas. Texas Journal of Science 2:93–117.

Blake, M.E., and M.D. Freeman. 1998. Nineteenth-century transfer-printed ceramics from the Texas Coast: The Quintana Collection. Prewitt and Associates, Inc., Austin.

Bond, C.L. 1980. A cultural resources assessment of selected magnetic anomalies, Freeport Harbor, Texas, 45-Foot Project. Report submitted to Corps of Engineers, Galveston District. Texas A&M University Cultural Resources Laboratory, College Station.

Borgens, A., R.L. Gearhart II, and S. Hoskins. 2007a. Marine remote-sensing survey and diving for the Freeport Ship Channel Widening, Brazoria County, Texas. Prepared for the Brazos River Harbor Navigation District. Document No. 060097. PBS&J, Austin

Borgens, A., S. Hoskins, J. Enright, and R.L. Gearhart II. 2007b. Remote-sensing survey of proposed channel modifications for historic properties, Freeport Harbor Navigation Channel Improvement Project, Freeport Harbor, Brazoria County, Texas. Prepared for the U.S. Army Corps of Engineers, Galveston District. Document No. 060218. PBS&J, Austin.

Borgens, A., D. Jones, R.L. Gearhart II, S. Hoskins, and J. Enright. 2005. Phase I cultural resources nautical archaeological survey for the proposed widening of the Freeport Ship Channel Brazoria County, Texas. Report prepared for Shiner Moseley and Associates, Inc. Document No. 050118. PBS&J, Austin, Texas.

Brant, J.G., and C. Jones. 2005. Annotated checklist of marine mammals of Texas. Museum of Texas Tech University, Lubbock. Occasional Papers, Number 244. September 28, 2005.

Brazoria County. 2000. Brazoria County Commissioners' Court: Special Session Minutes, March 29, 2000. Order No. 4 Re: Order Approving and Authorizing the Creation of the Gulf Coast Regional Spaceport Development Corporation. http://www.brazoria-county.com/comcourt/minutes/minutes 00-03-29.doc (accessed July 20, 2007). Brazoria County, Texas.

———. 2007. Brazoria County Commissioners' Court: Special Session Agenda and Minutes, February 27, 2007. Discussion Agenda Item B.1. and Order No. 31 Re: Order Approving Termination and Dissolution of the Gulf Coast Regional Spaceport Development Corporation. http://www.minutes.landata.com/TX-Brazoria/2007/2007-02-27-Special/Min-2007-02-27-Special.pdf (accessed July 20, 2007). Brazoria County, Texas.

Brazos River Authority. 2004. Freeport seawater desalination project: Brazos River Authority summary report (TWDB Contract No. 2004-483-514). http://www.twdb.state.tx.us/Desalination/The%20Future%20of%20Desalination%20in%20Texas%20-%20Volume%202/documents/B6.pdf (accessed July 17, 2007).

Brazos River Harbor Navigation District (BRHND). 2004. "Port Freeport comprehensive annual financial report for the fiscal year ended September 30, 2004."

Brazosport Independent School District. 2011. BISD Crisis Response Guidelines. http://www.brazosportisd.net/index.php?page=crisis-management (retrieved April 20, 2011).

Brinkley, W.C. (editor). 1936. Official Correspondences of the Republic of Texas 1835–1836, Vol. I. Appleton-Century Co. Inc., New York.

———. 1937. Official correspondences of the Texan Revolution, 1835–1836, Vol. II. Appleton-Century Company, New York.

Britton, J.C., and B. Morton. 1989. Shore ecology of the Gulf of Mexico. University of Texas Press, Austin. 387 pp.

Brongersma, L.D. 1972. European Atlantic turtles. Zool. Verhl. 121. 318 pp.

Brown, C.L., and R. Clark. 1968. Observations on dredging and dissolved oxygen in a tidal waterway. Water Resour. Res. 4(6):1381–1384.

Brown, L.F., Jr., R.A. Morton, J.H. McGowen, C.W. Kreitler, and W.L. Fisher. 1974. Natural Hazards of the Texas Coastal Zone. Bureau of Economic Geology, The University of Texas at Austin.

Brown, S. 2002. Soil scientist, soil survey program, Natural Resources Conservation Service (NRCS).

Buchman, M. 1999. National Oceanic and Atmospheric Administration (NOAA) Screening Quick Reference Tables. HAZMAT Report 99-1.

Buehler, D.A. 2000. Bald eagle (*Haliaeetus leucocephalus*). In: The birds of North America, No. 506 (A. Poole and F. Gill, editors). The Birds of North America, Inc., Philadelphia, Pennsylvania.

Buenger, W.L. 1984. Secession and the Union in Texas. University of Texas Press, Austin.

Bugbee, L.G. 1899. What became of the Lively? Texas Historical Association Quarterly 3(1):141–148.

Bureau of Economic Geology (BEG). 2007. The Texas shoreline change project. www.beg.utexas.edu/ coastal/intro.htm (accessed Feb. 6, 2007)

Burns & McDonnell Engineering Company, Inc. 2005. Routing study and environmental assessment for 69-kV service to Freeport LNG's Quintana (QNTANA) Substation. Prepared for CenterPoint Houston Electric, LLC (January 2005).

Calnan, T.R., R.S. Kimble, and T.G. Littleton. 1988. Benthic macroinvertebrates, pp. 39–60 in: W.A. White et al. 1988. Submerged lands of Texas, Bay City-Freeport area: sediments, geochemistry, benthic macroinvertebrates, and associated wetlands. Bureau of Economic Geology, The University of Texas at Austin. 130 pp. +maps.

Campbell, L. 1995. Endangered and threatened animals of Texas: Their life history and management. Endangered Resource Branch, Texas Parks and Wildlife Department, Austin.

Chipman, D.E. 1992. Spanish Texas 1519–1821. University of Texas Press, Austin.

City of Freeport. 2006. Official City of Freeport website. Parks and Recreation; http://www. freeport.tx.us/boatramp2.htm (accessed 10 February 2006).

———. 2011. Emergency management. http://www.freeport.tx.us/default.aspx?name= emergency_management (retrieved April 20, 2011).

Clarke, D.G., and D.H. Wilber. 2000. Assessment of potential impacts of dredging operations due to sediment resuspension. DOER Technical Notes Collection. ERDCTN-DOER-E9. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

Clean Air Act Reclassification of the Houston/Galveston/Brazoria Ozone Nonattainment Area; Texas; Final Rule. Federal Register 73:191 (October 1, 2008) / Rules and Regulations; Environmental Protection Agency 40 CFR Part 81[EPA–R06–OAR–2007–0554; Frl—8721–8]

Coastal Barrier Resources System. 2010. John H. Chafee Coastal Barrier Resources System: Official Coastal Barrier Resources System Maps. http://projects.dewberry.com/FWS/ CBRS%20Maps/Forms/AllItems1.aspx.

Coplin, L.S., and J. Lanning-Rush. 2002. Water level altitudes 2002 and water level changes in the Chicot, Evangeline, and Jasper Aquifers and Compaction 1973–2001 in the Chicot and Evangeline Aquifers, Houston-Galveston Region, Texas. U.S. Geological Survey Open File Report 02-134.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. United States Department of Interior, Fish and Wildlife Service, Washington, D.C. 131 p.

Creighton, J.A. 1975. A narrative history of Brazoria County. Texian Press, Waco, Texas.

Crother, B.I., J. Boundy, J.A. Campbell, K. De Quieroz, D.R. Frost, D.M Green, R. Highton, J.B. Iverson, R.W. McDiarmid, P.A. Meylan, T.W. Reeder, M.E. Seidel, J.W. Sites, Jr., S.G. Tilley, and D.B. Wake. 2003. Scientific and standard English names of amphibians and reptiles of North America north of Mexico: update. Herpetological Review 34(3):196–203.

Crother, B.I., J. Boundy, J.A. Campbell, K. De Quieroz, D.R. Frost, R. Highton, J.B. Iverson, P.A. Meylan, T.W. Reeder, M.E. Seidel, J.W. Sites, Jr., T.W. Taggart, S.G. Tilley, and D.B. Wake. 2000. Scientific and standard English names of amphibians and reptiles of North America north of Mexico, with comments regarding confidence in our understanding. Society for the Study of Amphibians and Reptiles, Herpetological Circular No. 29. November 2000.

Crother, B.I., J. Boundy, K. De Quieroz, and D. Frost. 2001. Scientific and standard English names of amphibians and reptiles of North America north of Mexico: errata. Herpetological Review 32(3):152–153.

Dankers, N., and D.R. Zuidema. 1995. The role of the mussel (*Mytilus edulis L.*) and mussel culture in the Dutch Waden Sea. Estuaries 18:71–80.

Department of the Army. 2009. Water Resource Policies and Authorities Incorporating Sea-Level Change Considerations in Civil Works Programs. Engineering Circular No. 1165-2-211. July 1, 2009.

Diamond, D.D., and F.E. Smeins. 1987. A framework for plant community classifications and conservation in Texas. The Texas Journal of Science 39(3):203–221.

Dixon, J.R. 2000. Amphibians and reptiles of Texas. Texas A&M University Press, College Station.

Dorchester, E.D. 1936. A historical sketch of the Old Town of Old Velasco. In Velasco in Texas History. Brazoria County Centennial Club, Angleton, Texas.

Earls, A.C., T.L. Myers, B.S. Shaffer, K.W. Kibler, K.M. Gardner, L.S. Zimmerman, E.R. Prewitt, and S.L. Hannum. 1996. Testing and Data Recovery at the Townsite of Old Velasco (41BO125), Brazoria County, Texas. Austin. Reports of Investigation No. 94. Prewitt and Associates, Inc., Austin.

Echols, D. 2006. Data in email sent to C. Murphy, U.S. Army Corps of Engineers. June 2, 2006.

Eckert, S.A. 1992. Bound for deepwater. Natural History, March. pp. 28–35.

Edge, B.L., M. Aggarwal, O. Cruz-Castro, R. Randall, and P. Lynett. 2006. Risk assessment for exposure to hurricane conditions at Freeport, Texas (March 28, 2006). Texas Engineering

Experiment Station, Department of Civil Engineering, Ocean Engineering Program, Texas A&M University.

Engineer Research and Development Center (ERDC). 2007. Shoreline changes due to proposed deepening of the Freeport, Texas Entrance Channel. Prepared for U.S. Army Engineer District, Galveston by Coastal and Hydraulics Laboratory, U.S. Army Engineer Research and Development Center, ERDC/CHL, Vicksburg, Mississippi.

———. 2009. Relative sea level rise for Freeport Harbor Channel System, Texas: addressing the most recent U.S. Corps of Engineers Guidance. Prepared for US Army Engineering District, Galveston (SWG).

Environmental Protection Agency (EPA). 1971. Noise from construction equipment and operations, building equipment, and home appliances. Washington, D.C. 20460. December 31, 1971.

———. 1974. Information on levels of environmental noise requisite to protect public health and welfare with an adequate margin of safety. EPA 550/9-74-004. March. NNA19870406.0098.

———. 1989. Draft environmental impact statement, Freeport Harbor (45-Foot Project), Ocean Dredged Material Disposal Site designation. EPA 906/01-89-003. U.S. EPA, Region VI, Dallas, Texas.

———. 2001. An initial survey of aquatic invasive species issues in the Gulf of Mexico Region, Version 4. Prepared by Battelle for the Gulf of Mexico Program U.S. Environmental Protection Agency. EPA/OCPD Contract No. 68-C-00-121. Work Assignment 1-07.

———. 2007a. Code of Federal Regulations, Title 40, Chapter I, Subpart C, Part 81, "Designation of Areas for Air Quality Planning Purposes."

———. 2007b. Sole source aquifer protection program. www.epa.gov/safewater/swp/ssa/reg6.html.

———. 2007c. "AirData." http://www.epa.gov/air/data/geosel.html.

———. 2007d. Enviromapper for Envirofacts, s.v. "Freeport area." http://134.67.99.122/enviro/emef.asp (accessed July 19, 2007).

———. 2008. Current National/Recommended Water Quality Criteria. http://www.epa.gov/waterscience/criteria/wqcriteria.html. Last updated on Thursday, January 10, 2008.

———. 2009. AirData: Access to Air Pollution Data. http://www.epa.gov/air/data/index.html.

———. 2011a. Children's environmental health protection. http://www.epa.gov/earth1r6/6pd/pd-t-kid/index.htm (retrieved April 19, 2011).

———. 2011b. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2009. U.S. Environmental Protection Agency, April 15, 2011

Environmental Protection Agency/U.S. Army Corps of Engineers (EPA/USACE). 1991. Evaluation of dredged material proposed for ocean disposal, Testing Manual. EPA-503/8-91/001. 205 pp + Appendices.

———. 2003. Regional implementation agreement for testing and reporting requirements for ocean disposal of dredged material off the Louisiana and Texas coasts under Section 103 of The Marine Protection, Research and Sanctuaries Act. U.S. Environmental Protection Agency, Region 6 and U.S. Army Corps of Engineers, Galveston and New Orleans Districts.

Epsilon Associates Inc. 2006. Hudson River PCBs Superfund Site. Phase 1 final design report (Attachment J-Noise Impact Assessment).

Espey, Huston & Associates, Inc. (EH&A). 1994. Final monitoring survey of the Freeport Harbor, virgin material ocean dredged material disposal site. Document No. 940127. Espey, Huston & Associates, Inc., Austin, Texas.

Evans, D. 2007. Dow breaks ground on production plant. *The Facts*. March 31, 2007.

Facts, The. 2010. "Notice of Public Meeting and Availability of Draft Environmental Impact Assessment – Freeport Harbor Channel Improvements Project and Draft General Uniformity Determination"; published December 19, 2010.

Federal Aviation Administration (FAA). 2006. Commercial space transportation: environmental review process for the proposed Gulf coast regional spaceport (public information meeting presentation, July 11, 2006). http://www.faa.gov/about/office_org/headquarters_offices/ast/environmental_impact/gulf_coast/media/7_11_2006_Gulf_Coast_Information_Meeting_Slides.pdf (accessed July 20, 2007).

Federal Emergency Management Agency (FEMA). 2007. Draft Environmental Assessment: Surfside Beach shoreline protection project, Brazoria County, Texas. Prepared by TCB/AECOM for FEMA Region VI Environmental Planning, Denton, Texas.

Federal Energy Regulatory Commission (FERC). 2004a. Order Granting authorization under Section 3 of the Natural Gas Act: Freeport LNG Development, L.P. FERC Docket No. CP03-75-000 (20040621-3003 Issued by FERC OSEC 06/18/2004).

———. 2004b. Final Environmental Impact Statement: Freeport LNG Project (FERC/EIS – 0164). FERC Docket No. CP03-75-000 (20040618-0151 Issued by FERC OSEC 05/28/2004).

———. 2005. Environmental Assessment for the amended Freeport LNG (Pipeline) Project. Freeport LNG Development, Inc. Docket No. CP03-75-002 (July 19, 2005).

———. 2006. Freeport LNG Phase II Project, Environmental Assessment. FERC Docket No. CP05-361-000 (June 21, 2006).

Federal Highway Administration (FHWA). 2006. U.S. Department of Transportation. Roadway construction noise model user's guide. FHWA-HEP-05-054. January 2008.

Fox, A.A., J.E. Ivey, and J.C. Markey. 1981. Cultural resource survey, Freeport Harbor, Texas (45-Foot) navigation improvement project, Brazoria County, Texas. Archaeological Survey Report No. 107. The Center for Archaeological Research, The University of Texas at San Antonio.

Freeman, M.D. 1995. A history of Civil War Activities at Velasco and Quintana, Brazoria County, & Virginia Point, Galveston, County, Texas. Reports of Investigations No. 103. Prewitt & Associates, Austin, Texas.

Freeport Townsite Company. 1912. Concerning Freeport, Texas, its progressive policy and purpose. Freeport, Texas.

Froese, R., and D. Pauly. Editors. 2007. FishBase. World Wide Web electronic publication. www.fishbase.org, version (August 2007).

Fugro Consultants L.P. 2005. Geotechnical study, jetty stability and channel widening project, Freeport Ship Channel, Port of Freeport, Freeport, Texas.

Geier & Geier Consulting. 1997. Noise measurements taken on September 23, 1997 to support the Oakland Harbor Navigation Improvement Project EIS.

General Council. 1839. Journal of the Proceedings of the General Council of the Republic of Texas. National Intelligencer Office, Houston.

General Land Office (GLO). 2007. CEPRA Cycle 5 Project Descriptions. http://www.glo.state.tx.us/coastal/erosion/cycle05/ProjectDescriptions.pdf (accessed March 17, 2008).

Gibeaut, J.C., W.A. White, T. Hepner, R. Gutierrez, T.A. Tremblay, R. Smyth, and J. Andrews. 2000. Texas shoreline change project—Gulf of Mexico shoreline change from the Brazos River to Pass Cavallo. Bureau of Economic Geology report for NOAA grant NA870Z0251.

Global Ballast Water Management Programme. 2006. The problem. <http://globallast.imo.org/index.asp?page=problem.htm&menu=true>

Gould, F.W. 1975. The grasses of Texas. Texas A&M University Press, College Station.

Green. A., M. Osborn, P. Chai, J. Lin, C. Loeffler, A. Morgan, P. Rubec, S. Spanyers, A. Walton, R.D. Slack, D. Gawlik, D. Harpole, J. Thomas, E. Buskey, K. Schmidt, R. Zimmerman, D. Harper, D. Hinkley, T. Sager, and A. Walton. 1992. Status and trends of selected living resources in the Galveston Bay system. Galveston Bay National Estuary Program Publication GBNEP-19. Webster, Texas.

Green, D. 1984. Long-distance movements of Galapagos green turtles. Journal of Herpetology 18:121–130.

Gulf of Mexico Fisheries Management Council (GMFMC). 2004. Draft Final Environmental Impact Statement for the generic essential fish habitat amendment to the following fishery management plans of the Gulf of Mexico (GOM): Shrimp Fishery of the Gulf of Mexico; Red Drum Fishery of the Gulf of Mexico; Reef Fish Fishery of the Gulf of Mexico; Stone

Crab Fishery of the Gulf of Mexico; Coral and Coral Reef Fishery of the Gulf of Mexico; Spiny Lobster Fishery of the Gulf of Mexico and South Atlantic; Coastal Migratory Pelagic Resources of the Gulf of Mexico and South Atlantic. Gulf of Mexico Fishery Management Council, Tampa, Florida.

Hagerty, T. 2007. Air Liquide plant project gets break. *The Facts*. February 3, 2007.

Haig, S.M., and E. Elliott-Smith. 2004. Piping plover. The birds of North America Online. (A. Poole, Editor) Ithaca: Cornell Laboratory of Ornithology; Retrieved from The Birds of North American Online database: http://bna.birds.cornell.edu/BNA/account/Piping_Plover/.

Hall, G.D. 1981. Allens Creek: A study in the cultural prehistory of the Lower Brazos River Valley, Texas, TAS Research Report 61, The University of Texas at Austin.

Hardin, S.L. 1992. Texian Iliad: A military history of the Texas Revolution. Reprint 2004. University of Texas Press, Austin.

Hatch, S.L., K.N. Ghandi, and L.E. Brown. 1990. Checklist of the vascular plants of Texas. MP-1655. The Texas Agricultural Experiment Station, The Texas A&M University System, College Station.

Hatch, S.L., J.L. Schuster, and D.L. Drawe. 1999. Grasses of the Texas Gulf prairies and marshes. Texas A&M University Press, College Station.

Haviland, J.E. 1852. Texas Republic claim no. 355, (July 26, 1852), Texas Comptroller’s Office. Archives and Information Services Division, Texas State Library and Archives Commission.

Hays, T.R. 1981. Underwater cultural resource investigations, Freeport Harbor, Texas (45-Foot Project). Draft Report to U.S. Army Corps of Engineers, Galveston District. North Texas State University, Denton.

Heideman, G. 2006. Texas Department of Health. Seafood Safety Division. Austin, Texas. Personal communication with Lisa Vitale, PBS&J. February 2, 2006.

HFP Acoustical Consultants, Inc. 2002. Environmental Noise Survey. Cheniere Energy, Inc. Freeport LNG Terminal in Quintana Beach, Texas. October 2002.

Hildebrand, H. 1982. A historical review of the status of sea turtle populations in the western Gulf of Mexico. In: K. Bjorndal (editor), Biology and Conservation of Sea Turtles. Pp. 447–453. Smithsonian Institution Press, Washington, D.C. 583 pp.

———. 1983. Random notes on sea turtles in the western Gulf of Mexico. In: D. Owens et al. (editors) Proc. Western Gulf of Mexico Sea Turtle Workshop, Texas A&M University, College Station. Pp. 34–40. TAMU-SG-84-105. 74 pp.

———. 1986. Personal communication to Derek Green, PBS&J, January 16, 1986. Corpus Christi, Texas.

Hirsch, N.D., L.H. DiSalvo, and R. Peddicord. 1978. Effects of dredging and disposal on aquatic organisms. U.S. Army Corps of Engineers, Waterways Experimentation Station Technical Report DS-78-5.

Hirth, H.F. 1997. Synopsis of the biological data on the green turtle *Chelonia mydas* (Linnaeus 1758). Biological Report 97 (1). U.S. Fish and Wildlife Service, Washington, D.C. 120 pp.

Hoese H.D., and R.H. Moore. 1998. The fishes of the Gulf of Mexico, Texas, Louisiana, and Adjacent Waters. Texas A&M University Press, College Station. 422 pp.

Holzer, T.L., and R.K. Gabrysch. 1982. Historical surface faulting in part of the Houston-Galveston, Texas subsidence bowl arrested by partial water-level recoveries: Geological Society of America Abstracts with Programs. Vol. 14, No. 7. pg. 517.

Hopkins, T.S. 1972. The effects of physical alteration on water quality in Mulatto Bayou, Excambia Bay. Quarterly Journal Florida Academy of Sciences 35(1):2 (Abstr.).

Houston-Galveston Area Council. 2002. Regional land cover data. GIS Data. H-GAC, Houston, Texas. (metadata and GIS data available online : http://gdc.h-gac.com/).

Hoyt, S.D., E. Foster, V. Galan, and J.S. Schmidt. 1999. Reconnaissance-level study of historic period resources, selected areas along the GIWW, High Island to Brazos River Floodgate, Brazoria, Chambers, and Galveston Counties, Texas. Document No. 970729. Espey, Huston & Associates, Inc., Austin, Texas.

Hubbs, C., R.J. Edwards, and G.P. Garrett. 1991. An annotated checklist of the freshwater fishes of Texas, with keys to identification of species. The Texas Journal of Science 43(4):56.

Hurricanecity. 2008. http://hurricanecity.com/city/freeport.htm (accessed March 19, 2008).

Intergovernmental Panel on Climate Change (IPCC) 2007 Climate Change 2007: Synthesis Report, Contribution of Working Groups I, II, and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team R.K. Pachauri and A. Reisinger (editors)]. IPCC, Geneva, Switzerland, 104 p.

Ippolito, J.E., and E.P. Baxter. 1976. An archaeological survey of the Freeport Harbor 45-Foot Navigation Project, Brazoria County, Texas. Report No. 21. Anthropology Laboratory, Texas A&M University, College Station.

Iverson, J.B. 1986. A checklist with distribution maps of the turtles of the world. Paust Printing, Richmond, Indiana. 284 pp.

James, S.R., Jr., C.E. Pearson, K. Hudson, and J. Hudson. 1991. Archaeological and historical investigations of the wreck of the Gen. C.B. Comstock, Brazoria County, Texas. Coastal Environments, Inc. Submitted to the Galveston District, U.S. Army Corps of Engineers.

Jones, R.A., and G.F. Lee. 1978. Evaluation of the elutriate test as a method of predicting contaminant release during open-water disposal of dredged sediments and environmental impact of open-water dredged material disposal. Technical Report D-78-45, U.S. Army Waterways Experiment Station, Vicksburg, Mississippi. 217 pp.

Kenmotsu, N.A., and T.K. Perttula. 1993. Archeology in the Eastern Planning Region, Texas: A planning document. Department of Antiquities Protection, Cultural Resource Management Report 3, Texas Historical Commission, Austin.

Lankford, R.R., and L.J. Rehkemper. 1969. The Galveston Bay complex, a summary of characteristics. In: R.R. Lankford and J.J.W. Rodgers, editors. Holocene Geology of Galveston Bay area.

Lawrence, M., and F. Hole. 1979 Freeport Harbor, Texas, 45-foot project, cultural resources assessment, August–October. Fairfield Industries.

Leary, T. 1957. A schooling of leatherback turtles, *Dermochelys coriacea coriacea*, on the Texas coast. Copeia 3:232.

Leatherwood, A. 2002. Handbook of Texas Online, s.v. “Gulf Intracoastal Waterway.” http://www.tsha.utexas.edu/handbook/online/articles/GG/rrg4.html (accessed July 18, 2007).

Lee, G.F. 1976. Dredged material research problems and progress. Environmental Science & Technology 10:334.

Lester, J., and L. Gonzales (editors). 2001. Ebb & flow: Galveston Bay characterization highlights. State of the Bay Symposium V, January 31–February 2, 2001. Galveston Bay Estuary Program.

Lewis, J.C. 1995. Whooping crane (*Grus americana*). In: The birds of North America, No. 153 (A. Poole and F. Gill, editors). The Academy of Natural Sciences, Philadelphia, and the American Ornithologist’s Union, Washington, D.C.

Lockwood, M.W., and B. Freeman. 2004. The TOS handbook of Texas birds. Texas A&M University Press, College Station.

Looscan, A.B. 1898. The Old Mexican Fort at Velasco. Quarterly of the Texas State Historical Association 1(4):282–284.

Martin Associates. 2006. The economic benefits of widening and deepening the Federal Port Freeport, Texas, Shipping Channel. May 1.

Mathewson, C.C., and L.L. Minter, 1976. Impact of water resource development on coastal erosion, Brazos River, Texas. Texas Water Resource Institute, TAMU, TR-77.

May, E.B. 1973. Environmental effects of hydraulic dredging in estuaries. Alabama Marine Resources Bulletin 9:1-85.

McEachran, J.D., and J.D. Fechhelm. 1998. Fishes of the Gulf of Mexico, volumes 1 and 2. University of Texas Press, Austin.

McGowen, J.H., L.F. Brown, Jr., T.J. Evans, W.L. Fisher, and C.G. Groat. 1976. Environmental Geologic Atlas of the Texas Coastal Zone – Bay City-Freeport Area. Bureau of Economic Geology, The University of Texas at Austin.

McGowen, J.H., and R.A. Morton. 1979. Sediment distribution, bathymetry, faults, and salt diapirs, submerged lands of Texas. Bureau of Economic Geology, The University of Texas at Austin.

Meylan, A. 1982. Sea turtle migration – evidence from tag returns. In: K. Bjorndal (editor), Biology and Conservation of Sea Turtles. Pp. 91–100. Smithsonian Institution Press, Washington, D.C. 583 pp.

Miller, E.L. 2004. New Orleans and the Texas Revolution. Texas A&M University Press, College Station.

Montagna, P.A., S.A. Holt, and K.H. Dunton. 1998. Characterization of anthropogenic and natural disturbance on vegetated and unvegetated Bay Bottom Habitats in the Corpus Christi Bay National Estuary Program Study Area. Final Project Report, Corpus Christi Bay National Estuary Program, Corpus Christi, Texas.

Morton, R.A. 1977. Nearshore Changes at Jettied Inlets, Texas Coast. Coastal Sediments.

———. 1997. Gulf shoreline movement between Sabine Pass and the Brazos River, Texas, 1974 to 1996. Bureau of Economic Geology Circular 97-3.

Morton, R.A., and M.J. Pieper. 1975. Shoreline changes in the vicinity of the Brazos River delta (San Luis Pass to Brown Cedar Cut) – An analysis of historical shoreline changes on the Texas Gulf Shoreline. Bureau of Economic Geology Circular 75-4.

Murphy, L., and D. Lenihan. 1980. Report on a two-day submerged cultural resources assessment survey, Freeport Harbor, Texas 45-Foot Project. Report submitted to the Corps of Engineers, Galveston District. Southwest Region, National Park Service, Santa Fe, New Mexico.

Musick, J. 1979. The marine turtles of Virginia with notes on identification and natural history. Educational Series No. 24. Sea Grant Program, Virginia Institute of Marine Science, Gloucester Point, Virginia. 18 pp.

National Ballast Information Clearinghouse (NBIC). 2006. NBIC Online Database. Electronic publication, Smithsonian Environmental Research Center & United States Coast Guard. http:// invasions.si.edu/nbic/search.html (accessed March 27, 2006).

National Climatic Data Center (NCDC)/NESDIS/NOAA. 2006a. Climatology of the United States No. 81 – Monthly Normals of Temperature, Precipitation, and Heating and Cooling Degree Days 1971–2000 – Texas. http://www5.ncdc.noaa.gov/climatenormals/clim81/TXnorm.pdf.

———. 2006b. Texas Freeze/Frost Occurrence Data 1971–2000. http://www5.ncdc.noaa.gov/climatenormals/clim20supp1/states/TX.pdf.

National Fish and Wildlife Laboratory (NFWL). 1980. Selected vertebrate endangered species of the seacoast of the United States. U.S. Fish and Wildlife Service, Biological Services Program, Washington, D.C. FWS/OBS-80/01.

National Marine Fisheries Service (NMFS). 2006a. Highly Consolidated Atlantic Highly Migratory Species Fishery Management Plan. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Sustainable Fisheries, Highly Migratory Species Management Division. Silver Spring, Maryland.

———. 2006b. Recovery plan for smalltooth sawfish (*Pristis pectinata*). Prepared by the Smalltooth Sawfish Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland.

———. 2006c. Information on sea turtles. http://www.nmfs.noaa.gov/pr/species/turtles.html.

———. 2007a. Endangered and threatened species and critical habitats under the jurisdiction of the NOAA Fisheries Service in Texas. Received on October 2.

———. 2007b. Species of concern, ivory bush coral (*Oculina varicosa*). http://www.nmfs.noaa.gov/pr/pdfs/species/ivorybushcoral_detailed.pdf (revised March 27).

———. 2007c. Species of concern, dusky shark (*Carcharhinus obscurus*). http://www.nmfs.noaa.gov/pr/pdfs/species/duskyshark_detailed.pdf (revised May 17).

———. 2007d. Species of concern, largetooth sawfish (*Pristis pristis*). http://www.nmfs.noaa.gov/pr/pdfs/species/largetoothsawfish_detailed.pdf (revised May 17).

———. 2007e. Species of concern, night shark (*Carcharhinus signatus*). http://www.nmfs.noaa.gov/pr/pdfs/species/nightshark_detailed.pdf (revised May 17).

———. 2007f. Species of concern, saltmarsh topminnow (*Fundulus jenkinsi*). http://www.nmfs.noaa.gov/pr/pdfs/species/saltmarshtopminnow_detailed.pdf (revised May 17).

———. 2007g. Species of concern, sand tiger shark (*Carcharias taurus*). http://www.nmfs.noaa.gov/pr/ pdfs/species/sandtigershark_detailed.pdf (revised May 17).

———. 2007h. Smalltooth sawfish (*Pristis pectinata*). http://www.nmfs.noaa.gov/pr/species/fish/smalltoothsawfish.htm (accessed October 31).

———. 2007i. Species of concern, speckled hind (*Epinephelus drummondhayi*). http://www.nmfs.noaa.gov/pr/pdfs/species/speckledhind_detailed.pdf (revised May 17).

———. 2007j. Species of concern, Warsaw grouper (*Epinephelus nigritus*). http://www.nmfs.noaa.gov/pr/pdfs/species/warsawgrouper_detailed.pdf (revised May 17).

———. 2007k. Species of concern, Atlantic white marlin (*Tetrapturus albidus*). http://www.nmfs.noaa.gov/pr/pdfs/species/whitemarlin_detailed.pdf (revised March 27).

———. 2007l. Blue whale (*Balaenoptera musculus*). http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/bluewhale.htm (accessed October 30).

———. 2007m. Fin whale (*Balaenoptera physalis*). http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/finwhale.htm (accessed October 30).

———. 2007n. Humpback whale (*Megaptera novaeangliae*). http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/humpbackwhale.htm (accessed October 30).

———. 2007o. Sei whale (*Megaptera borealis*). http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/seiwhale.htm (accessed October 30).

———. 2007p. Sperm whale (*Physeter macrocephalus*). http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/spermwhale.htm (accessed October 30).

National Marine Fisheries Service and U.S. Fish and Wildlife Service (NMFS and USFWS). 1991. Recovery plan for U.S. population of Atlantic green turtle. National Marine Fisheries Service, Washington, D.C. 52 pp.

———. 1992. Recovery plan for leatherback turtles in the U.S. Caribbean, Atlantic, and Gulf of Mexico. National Marine Fisheries Service, Washington, D.C. 65 pp.

National Marine Fisheries Service and National Oceanic and Atmospheric Administration (NMSFS and NOAA). 2003. Gulf of Mexico Regional Biological Opinion for dredging of Gulf of Mexico navigation channels and sand mining ("borrow") areas using hopper dredges by U.S. Army Corps of Engineers Galveston, New Orleans, Mobile, and Jacksonville districts. Consultation No. F/SER/2000/01287. November 19, 2003. 121 pp.

———. 2005. Revision No. 1 to Nov. 19, 2003, Gulf of Mexico Regional Biological Opinion on Hopper Dredging of Navigation Channels and Borrow Areas in the U.S. Gulf of Mexico (Issued January 9, 2007).

———. 2007a. Gulf of Mexico Biological Opinion for the Freeport Harbor Ship Channel Federal Permit Widening Project. Consultation No. F/SER/2006/07001. August 21, 2007. 68 pp.

———. 2007b. Revision No. 2 to Nov. 19, 2003, Gulf of Mexico Regional Biological Opinion on Hopper Dredging of Navigation Channels and Borrow Areas in the U.S. Gulf of Mexico (Issued January 9, 2007).

National Oceanic and Atmospheric Administration (NOAA). 1990. National Ocean Service Coast Survey, San Luis Pass to East Matagorda Bay. U.S. Department of Commerce.

———. 2004. 2004 Status of U.S. Fisheries. http://www.nmfs.noaa.gov/sfa/domes_fish/StatusoFisheries/StatusReport2004.pdf. 20 pp.

———. 2006. Coastal Change Analysis Program (C-CAP) including Gulf of Mexico C-CAP land cover products for 1996, 2001, and 2005. 2006 C-CAP data products are available online: www.csc.noaa.gov/crs/lca/ccap.html. The Gulf of Mexico data product including the 2005 Land Cover data product for Texas is available online : www.csc.noaa.gov/crs/lca/gulfcoast.html. Texas 2005 data was downloaded from this site March 2008 by PBS&J.

National Park Service (NPS). 2006. Information on sea turtles. http://www.nps.gov/pais/myweb2a/.

———. 2007. Information on sea turtles. http//www.nps.gov/pais/naturescience/ (accessed October 30).

National Research Council (NRC) 1987. Responding to changes in sea level: engineering implications. Commission of Engineering and Technical Systems, National Research Council, National Academy Press, Washington, DC

Natural Resources Conservation Service (NRCS). 2000. Land Use Estimates by County for Texas. 1997 Natural Resources Inventory. U.S. Department of Agriculture. Washington, D.C. <http://www. nrcs.usda.gov/technical/NRI/1997/summary_report/> (revised December 2000).

———. 2007. Soil Data Mart. Web Site: www:soildatamart.nrcs.usda.gov.

______. 2011. Letter to USACE with comments on the FHCIP DEIS, dated 18 January 2011.

Nature Conservancy, The. 2002. The Gulf Coast prairies and marshes ecoregional conservation plan. Gulf Coast Prairies and Marshes Ecoregional Planning Team, The Nature Conservancy, San Antonio, Texas.

———. 2004. Strategic Conservation Plan for the Columbia Bottomlands. The Nature Conservancy of Texas, San Antonio (http://conserveonline.org/docs/2004/04/CAP_ Columbia_Bottomlands.doc).

Newby, E.R. 2006. Personal communication on status of GLO Coastal Erosion Planning and Response Act (CEPRA) Projects.

Odum, H.T., and R.F. Wilson. 1962. Further studies on reaeration and metabolism of Texas bays, 1958–1960. Publ. Inst. Mar. Sci., Univ. of Tex. (8):23–25.

Odom Offshore Surveys, Inc. (Odum). 1978. Report of survey cultural resources reconnaissance, Freeport (Texas) Harbor 45-foot project. Survey for a U.S. Army Engineer District, Contract DACW64-77-C-0076. Galveston District.

Olishifski, P.E., and E.R. Harford. 1975. Industrial Noise and Hearing Conservation. National Safety Council, Chicago.

Ortego, B. 2002. Bald eagle nest survey and management. Performance Report, Federal Aid Grant No. W-125-R-13, Project No. 10. Texas Parks and Wildlife Department, Austin. 30 September.

———. 2005. Wildlife research and surveys, project no. 10: bald eagle nest survey and management. Performance Report, Federal Aid Project No. W-125-R-16. Texas Parks and Wildlife Department, Austin. September 30.

Parker, J.C. 1965. Ecology of western gulf estuaries. Pages 63–67 in Fish. Res. Rep Contrib. No. 207. Bur. Comm. Fish. Biol. Lab., Galveston, Texas.

Patterson, L.W. 1979. A review of the prehistory of the upper Texas Coast. Bulletin of the Texas Archeological Society 50:103–123.

Pattillo, M.E., T.E. Czapla, D.M. Nelson, and M.E. Monaco. 1997. Distribution and abundance of fishes and invertebrates in Gulf of Mexico estuaries. Vol. II: Species life history summaries. ELMR Rep. No. 11. NOAA/NOS Strategic Environmental Assessment Div. Silver Spring, Maryland. 377 pp.

Payne, J.W., and D.J. Miller. 1999. First fiber optic cable system in the Gulf of Mexico. Sea Technology 40(9):59–65.

PBS&J. 2004a. Freeport Harbor Entrance Channel contaminant assessment. Document No. 040278. PBS&J, Austin, Texas.

———. 2004b. Sabine-Neches Waterway contaminant assessment. Document No. 040338. PBS&J, Austin, Texas.

———. 2004c. SNWW Entrance Channel extension, baseline study and assessment. Document No. 040274. PBS&J, Austin, Texas.

———. 2005a. Analysis of chemistry data of potential dredged material. Letter report to Doug Hearn, Shiner, Moseley and Associates. March 2005.

———. 2005b. Freeport Harbor Entrance Channel contaminant assessment. Document No. 050194. PBS&J, Austin, Texas.

———. 2007. Galveston Harbor and channel contaminant assessment, Galveston County, Texas. Document No. 070067. PBS&J, Austin, Texas.

———. 2008. Houston Ship Channel Entrance Channel contaminant assessment. Document No. 080050. PBS&J, Austin, Texas.

Pearce, J.B. 1972. Biological survey of submerged refuse. Mar. Pollution Bulletin 3(10):157–158.

Pearson, C.E. 1989. Phase 2 of Emergency Investigation of Submerged Historic Property, Freeport Harbor 45-Foot Project, Brazoria County, Texas. Coastal Environments, Inc., Baton Rouge.

Peddicord, R.K. 1979. Impacts of open-water dredged material. In: Proceedings of Eleventh Dredging Seminar. Pp. 24–48. College Station, Texas/Texas A&M University Center for Dredging Studies, TAMU_SG-80-103.

Pierce, G.S. 1969. Texas under arms: the camps, posts, forts, & military towns of the Republic of Texas 1836–1846. The Encino Press, Austin.

Pollen, S.D., W.S. Gross, A.C. Earls, J.T. Pollan Jr., and J.L. Smith. 1995. Nineteenth-century transfer-printed ceramics from the townsite of Old Velasco (41BO125), Brazoria County, Texas: An illustrated catalog. Prewitt and Associates, Inc., Austin.

Poole, J., W. Carr, D. Price, and J. Singhurst. 2007. Rare Plants of Texas. Texas A and M University Press. 640 pp.

Port Freeport. 2004. Dockside Magazine Winter 2004 issue; "Port Freeport generates employment, revenues." http://www.portfreeport.com/pdf/DOCKSIDEfall04.pdf (accessed February 21, 2006).

———. 2006. Port Freeport website; Impact Statistics/Charts; <http://www.portfreeport.com/stats.htm> (accessed February 21, 2006).

———. 2009. Port Freeport website; Impact Statistics/Charts; <http://www.portfreeport.com/stats.htm> (accessed February 19, 2010).

Port Freeport Environmental Coordinator (pers. comm.). 2006. Personal communication with Lisa McMichael, August 23, 2006, regarding add subject matter.

Prewitt and Associates, Inc. (PAI). 2007. Field investigation plan for cultural resources survey of two proposed dredged material placement areas along the Brazos River, Freeport Harbor, Brazoria County, Texas. Project No. 207001. Austin.

———. 2008. Summary of field work for the geoarcheological survey of proposed dredged material placement areas at Freeport, Brazoria County, Texas. Austin.

Puryear, P.A., and N. Winfield, Jr. 1976. Sandbars and sternwheelers: steam navigation on the Brazos. Texas A&M University Press, College Station.

Railroad Commission of Texas (RRC). 2005 (amended 2007). New Drill Permit: Freeport LNG Development LP at Stratton Ridge (Permit Nos. 605591, 605592, and 605593). http://webapps.rrc. state.tx.us/DP/publicQuerySearchAction.do s.v. “Brazoria County” and operator = “Freeport” (accessed July 25, 2007).

———. 2006. Oil and Gas Well Database and Pipeline Database System.

Real Estate Center. 2006. Houston-Sugar Land-Baytown: infrastructure & Transportation Market News. Growth in Freeport – 1/1/2006. http://recenter.tamu.edu/mnews/mnsearch.asp?pg=2&AID=10 &TID=9 (accessed August 24, 2006).

Rebel, T.P. 1974. Sea turtles and the turtle industry of the West Indies, Florida, and the Gulf of Mexico. Rev. Ed. Univ. Miami Press, Coral Gables, Florida. 250 pp.

Rhoades, D.C., P.L. McCall, and J.Y. Yingst. 1978. Disturbance and production on the estuarine seafloor. American Scientist 66:577–586.

Richardson, D., E. Rozenburg, and D. Sarkozi. 1998. A birder’s checklist of the upper Texas coast: Brazoria, Chambers, Fort Bend, Galveston, Harris, and Jefferson counties. Houston Outdoor Nature Club, Ornithology Group, Houston, Texas.

Ricklis, R.A. 1996. The Karankawa Indians an ecological study of cultural tradition and change. The University of Texas Press, Austin.

Rodino, T.B., and J.C. Moseley. 2005. Permit application to widen portions of Freeport Harbor Jetty and Entrance Channel using non-Federal funds. Letter to Dolan Dunn. April 14, 2005.

Roller, General J. E. (editor). 1906. Captain John Sowers Brooks. Quarterly of the Texas State Historical Association 6(3):157–209.

Rosen, D.J., D.D. Steven, and M.L. Lange. 2008. Conservation strategies and vegetation characterization in the Columbia Bottomlands, an under-recognized southern floodplain forest formation. Natural Areas Journal 28: 74-82.

Ross, J.P. 1982. Historical decline of loggerhead, ridley, and leatherback sea turtles. In: K. Bjorndal (editor), Biology and Conservation of Sea Turtles. Pp. 189–195. Smithsonian Institution Press, Washington, D.C. 583 pp.

Rowe, E. 1903. The Disturbances at Anahuac in 1832. Quarterly of the Texas State Historical Association 6(4):265–299.

Schmidly, D.J. 2004. The mammals of Texas, revised edition. University of Texas Press, Austin.

Schwartz, F. 1976. Status of sea turtles, Cheloniidae and Dermochelidae, in North Carolina. Abstr. in Proceedings and abstracts from the 73rd meeting of the North Carolina Academy of Science, Inc., April 2–3, 1976, at the University of North Carolina, Wilmington. J. Elisha Mitchell Sci. Soc. 92(2):76–77.

Shaver, D. 2000. Padre Island National Seashore, field station leader. Personal communication to Derek Green, PBS&J, 20 November 2000.

———. 2006. Padre Island National Seashore, field station leader. Personal communication to Derek Green, PBS&J, 3 April 2006.

Sheridan, P.F. 1999. Temporal and spatial effects of open-water dredged material disposal on habitat utilization by fishery and forage organisms in the Laguna Madre, Texas. Final report to the Laguna Madre Interagency Coordination Team, March, 1999.

Sheridan, P.F., R.D. Slack, S.M. Ray, L.W. McKinney, E.F. Klima, and T.R. Calnan. 1989. Biological components of Galveston Bay. Pp. 23–51 in Galveston Bay: Issues, Resources, Status and Management. National Oceanic and Atmospheric Administration Estuary-of-the-Month Seminar Series No. 13. Washington, D.C.

Sherk, J.A., Jr. 1971. The effects of suspended and deposited sediments on estuarine organisms. Natural Resources Institute of the University of Maryland. Chesapeake Biological Lab. February 1971

Shideler, G.L. 1984. Suspended sediment responses in a wind-dominated estuary of the Texas Gulf coast. Journal of Sedimentary Petrology. Vol. 54. p. 731–745.

Smith, H. 1910. Reminiscences of Henry Smith. Quarterly of the Texas State Historical Association 14(1):24–73.

Smith, J. 1999. Fiber-optic loop to connect U.S. Gulf platforms, onshore. *Offshore* 59(6): June 1999. http://www.offshore-mag.com/articles/print_screen.cfm?ARTICLE_ID=35989 (accessed November 19, 2007).

Soil Conservation Service (SCS). 1981. Soil survey of Brazoria County, Texas. U.S. Department of Agriculture.

Story, D.A., J.A. Guy, B.A. Burnett, M.D. Freeman, J.C. Rose, D.G. Steele, B.W. Olive, and K.J. Reinhard. 1990. The archeology and bioarcheology of the Gulf Coastal Plain. Research Series No. 38, Arkansas Archeological Survey, Arkansas Archeological Survey, Fayetteville.

Surfside Marina. 2010. Surfside Marina website. http://www.surfside-marina.com/ Accessed 22 February 2011.

TEPPCO. 2007. Seaway Crude Pipeline. http://www.teppco.com/our_business/upstream/seaway.asp (accessed July 19, 2007).

Texas Coastal Management Program (TCMP). 1996. Texas Coastal Management Program, Final Environmental Impact Statement, August 1996. Texas General Land Office, Austin.

Texas Commission on Environmental Quality (TCEQ). 2000. Texas Surface Water Quality Standards. Texas Administrative Code (TAC), Title 30, Chapter 307. Effective August 17, 2000. http://info.sos.state.tx.us/pls/pub/readtac$ext.ViewTAC?tac_view=4&ti=30&pt=1&ch=307&rl=Y.

———. 2010a. Ozone Design Values for the HGB Area. http://www.tceq.state.tx.us/comm_exec/forms_pubs/pubs/pd/020/10-02/hgb-alt-text.

———. 2010b. TCEQ Permit Number 82045/PSD-TX-1094/N68/HAP9. https://webmail.tceq.state.tx.us/ Accessed 22 February 2011.

Texas Comptroller of Public Accounts. 2010. Texas Comptroller of Public Accounts website; “Local sales and use tax.” <http://www.window.state.tx.us/taxinfo/local/> (accessed February 19, 2010).

Texas Department of State Health Services (TDSHS). 2007. http://www.dshs.state.tx.us/seafood/certification.shtm (accessed July 12, 2007).

Texas Department of Transportation (TxDOT). 1996. Guidelines for analysis and abatement of highway traffic noise. June 1996.

———. 2007. Statewide Transportation Improvement Program (STIP) FY 2008-2011. Houston District FY 2008-2011 STIP.

———. 2010. Statewide Transportation Improvement Program, Houston District, 2011-2014. ftp://ftp.dot.state.tx.us/pub/txdot-info/tpp/stip/rev/fy_11_14/highway/houston_hwy_072510.pdf (accessed 22 February 2011).

Texas Education Agency. 2011. School enrollment for Brazosport ISD. http://wgisprd.tea.state.tx.us/SDL/ (retrieved April 19, 2011).

Texas Explorer. 2006. The Texas Explorer Magazine website. The ultimate guide to Freeport. http://www.texasexplorer.net/Freeport.htm (accessed February 10, 2006).

Texas Natural Diversity Database (TXNDD). 2007. Special species and natural community data files and TXNDD data on USGS topographic maps. Accessed October 30.

Texas Parks and Wildlife Department (TPWD). 1999. Seagrass conservation plan for Texas. Texas Parks and Wildlife Department, Austin. http://www.tpwd.state.tx.us/publications/pwdpubs/media/pwd_bk_r0400_0041.pdf.

———. 2006. Information on the leatherback sea turtle. http://www.tpwd.state.tx.us/huntwild/wild/species/endang/animals/reptiles_amphibians/leathback.html.

———. 2007. Annotated county lists of rare species, Brazoria County. http://gis2.tpwd.state.tx.us/ReportServer$gis_epasde_sql?%2fReport+Project2%2fReport5&rs:Command=Render&county=Brazoria (accessed October 30). Last revision August 14.

Texas State Data Center. 2010. Estimates of the total population of counties and places in Texas for July 1, 2008 and January 1, 2009. University of Texas at San Antonio. January 2010.

Texas Water Commission. 1963. Bulletin 6305: Reconnaissance investigation of the groundwater resources of the Gulf Coastal Region, Texas. Texas Water Commission, Austin.

Texas Water Development Board (TWDB). 2006a. Groundwater database reports, Brazoria County. Web Site: www.twdb.state. tx.us.

———. 2006b. The future of desalination in Texas. Biennial Report on Seawater Desalination. Austin, Texas.

———. 2007. Groundwater database reports, Brazoria County. Web Site: www.twdb.state.tx.us.

Texas Workforce Commission (TWC). 2010. "Quarterly employment and wages;" http://www.tracer2.com/cgi/dataAnalysis/IndustryReport.asp (accessed February 19, 2010).

Tompkins, John. 2006. Port Freeport breaks ground for terminal. *The Facts*. October 28, 2006.

Törnqvist, T.E., S.J. Bick, K. van der Borg, and A.F.M. de Jong. 2006. How stable is the Mississippi Delta?: Geology, v. 34, p. 697–700, doi: 10.1130/G22624.1.

Tove, M.H. 2000. Guide to the offshore wildlife of the Northern Atlantic. University of Texas Press, Austin.

TransSystem Corporation. 2006. Freeport Harbor improvement project vessel transit time delay analysis. Prepared for Port Freeport, Brazos River Harbor Navigation District.

Tunnell J.W. Jr., Q.R. Dokken, E.H. Smith, and K. Withers. 1996. Current status and historical trends of the estuarine living resources within the Corpus Christi Bay National Estuary Program Study Area B Vol. 1 of 4. Texas Natural Resource Conservation Commission, Austin. CCBNEP-06A. 543 pp.

U.S. Army Corps of Engineers (USACE). 1975 (reprinted 1984). Final Environmental Impact Statement: Maintenance Dredging Gulf Intracoastal Waterway Texas Section, Main Channel and Tributary Channels. Volumes 1, 2, and 3. Galveston, Texas.

———. 1977. Custodians of the coast: history of the United States Army Engineers at Galveston (Chapter 8: The inanimate enemy and the Corps). http://www.usace.army.mil/publications/misc/un23/c-8.pdf (accessed July 19, 2007).

———. 1978. Final Environmental Statement, Freeport Harbor, Texas (45-foot Project). U.S. Army Engineer District, Galveston, Texas. July

———. 1998. Use of Sediment Quality Guidelines (SQGs) in Dredged Material Management. Dredging Research Technical Note EEDP-04-29.

———. 2002. U.S. Army Corps of Engineers Civil Works Program Congressional Submission, Fiscal Year 2002. Southwestern Division. http://www.usace.army.mil/cw/cecwb/just_states/just_2002/ swd.pdf (accessed July 19, 2007).

———. 2003. Policy for Implementation and Integrated Application of the U.S. Army Corps of Engineers (USACE) Environmental Operating Principles (EOP) and Doctrine, ER 200-1-5, 30 October 2003, Department of the Army, U.S. Army Corps of Engineers, Washington, D.C.

———. 2005. Galveston District 2005 Dredging Conference (table and project summary sheets). http://www.swg.usace.army.mil/OD/2005DC/Book20%Printing%20for%202005%20Dredging%20Conf.pdf (accessed July 24, 2007).

———. 2007. Galveston District Project Update 2007. http://www.swg.usace.army.mil/items/2007%20Project%20Update%20Book.pdf (accessed July 24, 2007).

———. 2008a. Proposed Port Freeport Channel Widening, Brazoria County, Texas, Final Environmental Impact Statement. USACE, Galveston District, Texas.

———. 2008b. USACE Sea Turtle Data Warehouse http://www.el.erdc.usace.army.mil/seaturtles/species.cfm? (updated March 6, 2008).

——— 2008c. Environmental Assessment and Statement of Findings: Permit Application SWG-2006-02079.

———. 2010. USACE Field Survey for the Presence of Nesting Colonial Waterbirds in the Freeport Harbor Channel Improvement Project area. Survey conducted June 18, 2010.

U.S. Census Bureau. 2000. Census 2000. Summary File 3 (SF3). Generated by Tricia LaRue, using American Factfinder http://factfinder.census.gov (accessed January 23, 2006).

U.S. Coast Guard (USCG). 2006. http://www.uscg.mil/hq/g-m/mso/mso4/bwmcourse.pdf#search.

———. 2008. Pre-event Incident Action Plans (IAPs). from http://homeport.uscg.mil/mycg/portal/ep/contentView.do?channelId=-17389&contentId=150824&programId=12626&programPage=%2Fep%2Fprogram%2Feditorial.jsp&pageTypeId=16440&contentType=EDITORIAL&BV_SessionID=@@@@1023880315.1303406923@@@@&BV_EngineID=cccdadfdgfekhdicfjgcfgfdffhdghj.0 (retrieved April 20, 2011).

U.S. Department of Agriculture (USDA). 2002. 2002 Census of Agriculture County Profile; Brazoria County. <http://www.nass.usda.gov/census/census02/profiles/tx/cp48039.PDF> (accessed February 21, 2006).

U.S. Department of Energy (DOE). 1993a. Finding of No Significant Impact and Floodplain Statement of Findings on the Brine Pipeline Replacement for the Strategic Petroleum Reserve Bryan Mound Facility, Brazoria County, Texas (May 1993). DOE/EA-0804. http://www.ifremer.fr/avano/notices/00079/224.htm and http://www.osti.gov/energycitations/servlets/purl/10185690-nDBxTv/ native/10185690.PDF (accessed July 18 and July 25, 2007).

———. 1993b. Supplement to the Draft Environmental Impact Statement (DOE/EIS-0165, October 1992): Evaluation of Two Underground Brine Injection Fields. http://www.fossil.energy.gov/programs/reserves/publications/Pubs-SPR/Expansion_DEIS_1993_Supplement.pdf (accessed July 18, 2007). Washington, D.C.

———. 2000. Strategic Petroleum Reserve Site Environmental Report for Calendar Year 2000. Document No. ASE5400.60A0 (under Contract No. DE-AC96-93PO18000). Strategic Petroleum Reserve Project Management Office, New Orleans, Louisiana.

———. 2004. Supplement Analysis of Site-Specific and Programmatic Environmental Impact Statements: Operational and Engineering Modifications, Regulatory Review, and Socioeconomic Variation (March 2004, DOE/SPR/EIS-0075-SA01). http://www.spr.doe.gov/esh/Docs/2004_NEPA_Supplement_Analysis.pdf (accessed July 18, 2007). Strategic Petroleum Reserve Office, New Orleans, Louisiana.

———. 2005. Site Selection for Strategic Petroleum Reserve Expansion: Proposed Action Information (December 2005 newsletter). http://www.fossil.energy.gov/programs/reserves/spr/20051205_fact_sheet.pdf (accessed July 18, 2007). Office of Strategic Petroleum Reserve (FE-47), Washington, D.C.

———. 2006. Final Environmental Impact Statement Site Selection for the Expansion of the Strategic Petroleum Reserve. Volume 1: Summary and Chapters 1-8 (December 2006, DOE/EIS-0385). http://www.fossil.energy.gov/programs/reserves/spr/publications/2006_SPR_EIS/3_Sum.pdf (accessed July 18, 2007). Office of Petroleum Reserves (FE-47), Washington, D.C.

———. 2007. Record of Decision and Floodplain Statement of Findings: Site Selection for the Expansion of the Strategic Petroleum Reserve. 72 FR 35:7964–7972. http://www.epa.gov/fedrgstr/EPA-IMPACT/2007/February/Day-22/i3022.htm (accessed July 19, 2007).

U.S. Department of Health and Human Services (HHS). 2011. The 2011 HHS Poverty Guidelines. http://aspe.hhs.gov/poverty/11poverty.shtml (retrieved April 21, 2011).

U.S. Department of Transportation. 2012. Deepwater Port Licensing Program, Withdrawn Applications, Denied Applications and Surrendered Licenses. http://www.marad.dot.gov/ports_landing_page/deepwater_port_licensing/dwp_planned_ports/dwp_planned_ports.htm (accessed March 19, 2012). Maritime Administration, Washington, D.C.

U.S. Fish and Wildlife Service (USFWS), U.S. Department of the Interior. 1992a. National Wetland Inventory (NWI) maps: Freeport, Jones Creek, Lake Jackson, Oyster Creek and Christmas Point, 7.5-minute Quads. U.S. Dept. of the Interior, U.S. Fish and Wildlife Service, Office of Biological Services, Washington, D.C. (http://www.nwi.fws.gov).

———. 1992b. Threatened status of the Louisiana black bear and related rules. Federal Register. Vol. 57, No. 4.

———. 1995. Threatened and endangered species of Texas. U.S. Fish and Wildlife Service, Austin, Texas. Revised June 1995.

———. 2007. Endangered species list: list of species by county for Texas. http://www.fws.gov/ifw2es/EndangeredSpecies/lists/ListSpecies.cfm (accessed October 30).

———. 2010. Texas colonial waterbird census. http://www.fws.gov/texascoastalprogram/tcwc.htm (accessed September 14).

———. n.d. Birds of Brazoria/San Bernard/Big Boggy National Wildlife Refuges. U.S. Fish and Wildlife Service, Northern Prairie Wildlife Research Center, Jamestown, North Dakota. http://www.npwrc.usgs.gov/resource/othrdata/chekbird/r2/brazoria.htm (accessed February 22).

U.S. Geological Survey (USGS). 2007. National Water Information System. NWIS Web Site: http://waterdata.usgs.gov/nwis/gwlevels.

Verbeek, E.R., and U.S. Clanton. 1981. Historically active faults in the Houston Metropolitan Area, Texas. In: Houston Area Environmental Geology: Surface Faulting, ground subsidence, hazard liability. E.M. Etter, Editor. Houston Geological Society.

Wakeman, T.H. 1974. Release of trace constituents form sediments resuspended during dredging operations. In: American Chemical Society Conference, Atlantic City, New Jersey/COE San Francisco.

Ward, G.H. 1977. Climatology of Texas. In: Environmental assessment of the Texas Water Plan. Espey, Huston & Associates, Inc., Document No. 7703. Draft final report. MMS, Gulf of Mexico Regional OCS Office, Metairie, Louisiana.

Warshaw, S. 1975. Water quality segment report for Segment No. 2491, Laguna Madre. Report No. WQS-14. Texas Water Quality Board, Surveillance Section, Field Operations Division, Austin, Texas.

Watson, R.L. 2003. Severe Beach Erosion at Surfside, Texas Caused by Engineering Modifications to the Coast and Rivers. Port Aransas, Texas.

Weddle, R.S. 1991. The French thorn: rival explorers in the Spanish Sea 1682–1762. Texas A&M University Press, College Station.

———. 1992. Spanish exploration of the Texas Coast 1519–1800. Bulletin of the Texas Archeological Society 63:99–122.

Wells, T.H. 1960. Commodore Moore and the Texas Navy. Reprint, 1988. University of Texas Press, Austin.

Wermund, E.G., R.A. Morton, and G. Powell. 1989. Geology, climate and water circulation of the Galveston Bay System. NOAA Estuary of the Month Series No. 13, U.S. EPA and U.S. NOAA Estuarine Program Offices, Washington D.C.

Wesselman, J.B. 1971. Ground-water resources of Chambers and Jefferson counties, Texas Water Development Board Report No. 133, Austin, Texas.

White, W.A., T.R. Calnan, R.A. Morton, R.S. Kimble, T.G. Littleton, J.H. McGowen, and H.S. Nance. 1988. Submerged lands of Texas, Bay City-Freeport area: sediments, geochemistry, benthic macroinvertebrates, and associated wetlands. The University of Texas at Austin, Bureau of Economic Geology Special Publication, 130 pp.

White, W.A., T.A. Tremblay, R.L. Waldinger, and T.R. Calnan. 2004. Status and trends of wetland and aquatic habitats on Barrier Islands, Upper Texas Coast, Galveston and Christmas Bays. Final Report. Prepared for the Texas General Land Office and National Oceanic and Atmospheric Administration (GLO Contract No. 03-057). Bureau of Economic Geology, The University of Texas at Austin (http://www.glo.state.tx.us/coastal/statustrends/galveston-christmas/index.html).

White, W.A., T.A. Tremblay, R.L. Waldinger, T.L. Hepner, and T.R. Calnan. 2005. Status and trends of wetland and aquatic habitats on Barrier Islands, Freeport to East Matagorda Bay, and South Padre Island. Final Report. Prepared for the Texas General Land Office and National Oceanic and Atmospheric Administration (GLO Contract No. 04-044 and 045). Bureau of Economic Geology, The University of Texas at Austin (http://www.glo.state.tx.us/coastal/statustrends/freeport-spi/index.html).

Windom, H.L. 1972. Environmental aspects of dredging in estuaries. J. Water. Har. and Coas. Eng. Div. ASCE, 98(WW4):475–487.

Winkler, E.W. 1906. The Seat of Government in Texas. Quarterly of the Texas State Historical Association 10(2):140–171.

Witzell, W.N. 1983. Synopsis of biological data on the hawksbill turtle Eretmochelys imbricata (Linnaeus, 1766). FAO Fisheries Synopsis No. 137. FIR/S137, SAST – Hawksbill Turtle – 5.31 (07) 017.01. Food and Agriculture Organization (FAO) of the United Nations, Rome, Italy. 78 pp.

Yeargan, C. 2006. U.S. Fish and Wildlife Service, Clear Lake Office. Personal communication to Derek Green, PBS&J, 6 April 2006.

(This page intentionally left blank.)

16.0 INDEX