Appendix C-2

Clean Water Act 404(b)(1) Evaluation

Job No. TGL18185

APPENDIX C-2

DRAFT
SECTION 404(B)(1) EVALUATION
FOR THE
COASTAL TEXAS PROTECTION AND RESTORATION STUDY

Prepared for:

U.S. Army Corps of Engineers
and
Texas General Land Office

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Acronyms and Abbreviations

BU	beneficial use
BUDM	beneficial use of dredged material
Coastal Texas Study	Coastal Texas Protection and Restoration Study
CSRM	coastal storm risk management
DIFR-EIS	Draft Integrated Feasibility Report and Environmental Impact Statement
DMMP	dredge material management plan
DO	dissolved oxygen
ER	ecosystem restoration
GIWW	Gulf Intracoastal Waterway
Gulf	Gulf of Mexico
H_2S	hydrogen sulfide
HSC	Houston Ship Channel
mcy	million cubic yards
MSL	mean sea level
NED	National Economic Development
NER	National Ecosystem Restoration
PL	Public Law
ppt	parts per thousand
RSLR	relative sea level rise
TSP	Tentatively Selected Plan
USACE	U.S. Army Corps of Engineers
WRDA	Water Resources Development Act

1.0 PROJECT DESCRIPTION

1.1 LOCATION

The study area for the Coastal Texas Protection and Restoration Study (Coastal Texas Study) consists of the entire Texas Gulf Coast from the mouth of the Sabine River to the mouth of the Rio Grande and includes the Gulf of Mexico (Gulf) and tidal waters, barrier islands, estuaries, coastal wetlands, rivers and streams, and adjacent areas that make up the interrelated ecosystem along the coast of Texas. The study area encompasses 18 coastal counties along the Gulf coast and bayfronts (U.S. Army Corps of Engineers [USACE], 2015). This area is where potential project effects would likely occur. The Texas shoreline is characterized by seven barrier islands: Galveston, Follets, Matagorda, St. Joseph's (San José), Mustang, Padre, and Brazos. These islands serve as the backbone for the Texas Gulf coast. A key feature of the study is the Gulf Intracoastal Waterway (GIWW), which parallels the Texas coastline and can be found directly behind the seven barrier islands. The study area can be divided into three sections: Upper Texas Coast, Middle Texas Coast, and Lower Texas Coast. Additional information can be found in Section 1 (Introduction and Purpose) of the Draft Integrated Feasibility Report and Environmental Impact Statement (DIFR-EIS).

1.2 GENERAL DESCRIPTION

This DIFR-EIS examines coastal storm risk management (CSRM) and ecosystem restoration (ER) opportunities within 18 counties along the entire Texas Gulf coast. The report presents the investigation of comprehensive water resources management for the Texas Gulf coast to ensure public safety and benefit the Nation, while balancing the primary missions of navigation, flood, and hurricane storm damage reduction and environmental stewardship. This DIFR-EIS will be used to inform decisionmakers, stakeholders, and the public of the tradeoffs that should be considered in future decisions to maintain existing coastal storm risk levels and/or reduce coastal storm risk along the Texas Gulf coast. Additional information can be found in Section 1 (Introduction and Purpose) of the DIFR-EIS.

The CSRM planning goals would promote a sustainable economy by reducing the risk of storm damage to residential structures, industries, and businesses critical to the nation's economy. The CSRM measures and alternatives were formulated to achieve National Economic Development (NED) principles and objectives. CSRM features include surge gates, levees, floodwalls, environmental gates, pump stations, and, potentially, nonstructural approaches (e.g., buyouts, policy changes, etc.). Additional information can be found in Section 1 (Introduction and Purpose) of the DIFR-EIS.

The planning goals for ER would sustainably reduce coastal erosion, restore fish and wildlife habitat, such as coastal wetlands, oyster reefs, beaches and dunes, and evaluate a range of coastal restoration components to address a multitude of ecosystem problems. ER measures and alternatives were formulated to achieve National Ecosystem Restoration (NER) principles and objectives. Contributions to the NER are increases in the net quantity and/or quality of desired ecosystem resources and are measured in the study area and nationwide. ER measures and alternatives include a collection of projects aiming to restore oyster reefs, marshes, beaches, and dunes, tidal hydrology, and bird islands. Additional information can be found in Section 1 of the DIFR-EIS.

This 404(b)(1) Evaluation is applied to the Tentatively Selected Plan (TSP), which consists of 1) the Coastal Barrier CSRM measure, 2) a collection of nine ER measures, and 3) the South Padre Island CSRM measure. Additional information can be found in Section 4 (Formulation and Evaluation of Alternative Plans) of the DIFR-EIS.

1.3 AUTHORITY AND PURPOSE

From USACE (2015), the study is authorized under Section 4091, Water Resources Development Act (WRDA) of 2007 Public Law (PL) 110-114 which states:

> *"Sec. 4091. Coastal Texas Ecosystem Protection and Restoration, Texas.*
>
> *(a) In General. — The Secretary shall develop a comprehensive plan to determine the feasibility of carrying out projects for flood damage reduction, hurricane and storm damage reduction, and ecosystem restoration in the coastal areas of the State of Texas.*
>
> *(b) Scope. — The comprehensive plan shall provide for the protection, conservation, and restoration of wetlands, barrier islands, shorelines, and related lands and features that protect critical resources, habitat, and infrastructure from the impacts of coastal storms, hurricanes, erosion, and subsidence.*
>
> *(c) Definition. — For purposes of this section, the term ''coastal areas in the State of Texas'' means the coastal areas of the State of Texas from the Sabine River on the east to the Rio Grande on the west and includes tidal waters, barrier islands, marshes, coastal wetlands, rivers and streams, and adjacent areas."*

Along the Texas coast, vital resources critical to the economic and environmental welfare of the Nation are at risk from coastal storm damage. Forty percent of the nation's petrochemical industry, 25 percent of national petroleum-refining capacity, eight deep-draft ports, 750 miles of shallow-draft channels (including 400 miles of the GIWW), and critical transportation infrastructure will continue to be at risk without a comprehensive plan to protect, restore, and maintain a robust coastal ecosystem and reduce the risk of storm damage to industries and businesses critical to the Nation's economy and protect the health and safety of Texas coastal communities. The study area also includes critical coastal ecosystems in need of restoration, including wetlands, seagrass beds, sea turtle nesting habitat, piping plover critical habitat, and whooping crane critical habitat, as well as numerous State and Federal wildlife refuges (USACE, 2015). Additional information can be found in Section 1 (Introduction and Purpose) of the DIFR-EIS.

The feasibility study will identify critical data needs and recommend a comprehensive strategy for reducing coastal storm flood risk through structural and nonstructural measures that take advantage of natural features like barrier islands and storm surge storage in wetlands. Structural alternatives to be considered include improvements to existing systems (such as existing hurricane protection projects at Texas City, Freeport, and Lynchburg and seawalls at Galveston and South Padre Island), and the creation of new structural plans for CSRM. ER alternatives to be considered include estuarine marsh restoration, beach and dune restoration, rookery island restoration, oyster reef restoration, and seagrass bed restoration (USACE, 2015). As noted in Engineer Regulation 1105-2-100, CSRM and ER are two of the USACE high-priority authorized missions. Additional information can be found in Section 1 (Introduction and Purpose) of the DIFR-EIS.

1.4 GENERAL DESCRIPTION OF DREDGED OR FILL MATERIAL

1.4.1 General Characteristics of Material

Although a dredge material management plan (DMMP) has not been developed for the proposed CSRM and ER measures, it is assumed that finer substrates (muds and silts) would be used for marsh restoration efforts. Coarser substrates would be used for beach and dune nourishments, and bird island creation or improvements could use a range of fine and coarser materials, depending on location and restoration goals. Oyster restoration efforts would include a discharge of cultch (e.g., oyster shell, limestone, rock, gravel, etc.) or reef balls. Fill discharges would occur where rock breakwaters are proposed.

1.4.2 Quantity of Material

Although quantity estimates are still in progress, approximate volume (million cubic yards [mcy]) estimates for proposed CSRM and ER measures, including those estimated for out-year nourishments and maintenance, are displayed in Table 1. Additional information can be found in Appendix D (Engineering Design, Cost Estimates, and Cost Risk Analysis) of the DIFR-EIS.

Table 1
Quantity of Material Estimated for the Preferred Alternative

Measure Name	Measure Type	Waterbody (Location)	Quantity (Approximate mcy)
Coastal Barrier	CSRM	Galveston Bay	10.2
G-5	ER	Galveston Bay	70.5
G-28	ER	Galveston Bay	16.4
B-2	ER	Galveston Bay	20.4
B-12	ER	Galveston Bay	29.5
M-8	ER	Matagorda Bay	102.3
CA-5	ER	Matagorda Bay	0.9
CA-6	ER	Matagorda Bay	0.4
SP-1	ER	Redfish Bay	6.7
W-3	ER	Laguna Madre	not available
South Padre	CSRM	Gulf of Mexico	3.8
Total			277.9

1.5 DESCRIPTION OF THE PROPOSED DISCHARGE

1.5.1 Location

CSRM measures would be constructed along Galveston Island and Bolivar Peninsula (Coastal Barrier). An additional CSRM measure would be constructed on the southern portion of South Padre Island.

Nine ER measures are proposed along the entire Texas coast, with most of the ER measures within the upper Texas coast. Four ER measures occur within the Galveston Bay system, four ER measures occur within the Matagorda Bay system, and one is located within the lower Laguna Madre. Additional information can be found in Section 4 (Formulation and Evaluation of Alternative Plans), Appendix A (Plan Formulation), and Appendix D (Engineering Design, Cost Estimates, and Cost Risk Analysis) of the DIFR-EIS.

Sediment sources for the Coastal Barrier CSRM measure are currently planned to come from inland commercial borrow sites. Specific locations of sediment sources for ER measures would likely come from offshore sources (e.g., Sabine and Heald banks, shoreface sediments) and maintenance materials (Table 2). Additional information can be found in Appendix D (Engineering Design, Cost Estimates, and Cost Risk Analysis) of the DIFR-EIS.

Table 2
Potential Sediment Source Locations for the Preferred Alternative

Measure	Potential Sediment Source Location
Coastal Barrier CSRM Measure	Inland commercial sites
G-5 – Bolivar Peninsula/Galveston Island Gulf Beach and Dune Restoration	Sabine and Heald Banks, shoreface sediments
G-28 – Bolivar Peninsula and West Bay GIWW Shoreline and Island Protection	GIWW beneficial use of dredged material (BUDM), Houston Ship Channel (HSC) Bypass, Big Reef, GIWW Bolivar Flare Sediment Trap, HSC BUDM, Sabine and Trinity River paleo channels
B-2 – Follets Island Gulf Beach and Dune Restoration	Sabine and Heald Banks, shoreface sediments
B-12 – West Bay and Brazoria GIWW Shoreline Protection	Freeport Channel, GIWW, Chocolate Bayou, and San Bernard BUDM
CA-5 – Keller Bay Restoration	Matagorda Ship Channel BUDM
CA-6 – Powderhorn Shoreline Protection and Wetland Restoration	Matagorda Ship Channel BUDM
M-8 – East Matagorda Bay Shoreline Protection	Colorado River Diversion Delta, GIWW BUDM, Colorado and Brazos River paleo channels
SP-1 – Redfish Bay Protection and Enhancement	Corpus Christi Ship Channel BUDM, La Quinta Channel BUDM
W-3 – Port Mansfield Channel, Island Rookery, and Hydrologic Restoration	Port Mansfield Channel
South Padre Island CSRM Measure	Brazos Island Harbor BUDM, shoreface or offshore sediments

1.5.2 Size

For CSRM measures, the Coastal Barrier measure would occupy 4,525 acres (3,004.3 acres are within waters). ER measures would cover approximately 14,878.7 acres (12,532.7 acres are within waters).

Projections of relative sea level rise (RSLR) in 2065 indicate a need for out-year nourishments for marsh areas predicted to degrade into open waters. These out-year nourishments would occur over an area of approximately 28,000 acres, with approximately 1,975 acres occurring on uplands or developed land, and 26,117 acres within waters. Additional information can be found in Section 4 (Formulation and Evaluation of Alternative Plans), Appendix A (Plan Formulation), and Appendix D (Engineering Design, Cost Estimates, and Cost Risk Analysis) of the DIFR-EIS.

1.5.3 Type of Site and Habitat

For portions of ER and CSRM measures within waters, the types of habitat that could be directly impacted include:

- Palustrine emergent wetlands
- Estuarine emergent wetlands
- Submerged Aquatic Vegetation (seagrass)
- Oyster reef
- Islands/bird rookeries
- Dunes
- Supratidal beach zones
- Intertidal beach zones
- Uplands/developed lands

Additional information can be found in Appendix C-8 (Habitat Evaluation Procedures and Ecological Modeling Report) of the DIFR-EIS.

1.5.4 Time and Duration of Discharge

Construction is expected to occur from 2025 until 2035; out-year marsh nourishments would occur in or before 2065 where necessary to address RSLR impacts.

1.5.5 Description of Disposal Method

It is anticipated that materials would be used beneficially for restoration or for construction of CSRM features (i.e., levees, etc.). For ER measures consisting of marsh restoration actions, fill discharges may consist of thin-layer placement or confined placement, depending on the target restoration elevations. Direct placement is anticipated for larger restoration actions including beach and dune restoration and bird island creation and restoration. Levee construction for CSRM features may be performed with heavy equipment such as bulldozers and will likely require barge access for portions of the structure within the bay. Rock breakwaters may be constructed with a barge and excavator or similar method and equipment. Additional information can be found in Appendix D (Engineering Design, Cost Estimates, and Cost Risk Analysis) of the DIFR-EIS. More information would be obtained during future planning and design phases.

2.0 FACTUAL DETERMINATIONS

2.1 PHYSICAL SUBSTRATE DETERMINATIONS

2.1.1 Substrate Elevation and Slope

Marsh and oyster restoration actions would result in elevations ranging from below mean sea level (MSL) to about +1.5 feet MSL; slopes would be generally flat. For beach and dune nourishment, dune elevations would range from +4 to +12 feet (top of dune), with a slope of 1:3; beach portions of the action would range from –4 to +4 feet, and slopes would range from 1:50 for subaerial portions and 1:25 for intertidal portions. Bird islands would range in elevations like the dune profile (i.e., 10 to 14 feet high), with similar sloping. Rock breakwaters would have a crest height of 10 feet and would have 2:1 slopes. Additional information can be found in Appendix D (Engineering Design, Cost Estimates, and Cost Risk Analysis) of the DIFR-EIS.

2.1.2 Sediment Type

Finer substrates (muds and silts) would be used for marsh restoration efforts, sands would be used for beach and dune nourishments, and a range of sediment types may be used for bird island creation. Oyster restoration efforts would include a discharge of cultch (e.g., oyster shell, limestone, rock, gravel, etc.) or reef balls. Rock discharges would occur where breakwaters are proposed. It is assumed that any borrow sites for beneficial use (BU) materials (both offshore sources and within the bay) would be tested and would comply with State and Federal regulations. More information would be obtained during future planning and design phases.

2.2 DREDGED/FILL MATERIAL MOVEMENT

In most instances, project actions would use a containment structure to hold materials in situ; in other instances, thin layer placement would be performed where some material movement throughout the marsh is intended. Last, any beach and dune nourishments would result in erosion into the surf zone over time. For structural CSRM features, no material is intended to move once in place.

2.3 PHYSICAL EFFECTS ON BENTHOS

There would be direct impacts to benthic organisms, which would be buried or removed during construction of the TSP. Excavation of sediments removes and buries benthic organisms, whereas placement of dredged material and structures smothers or buries benthic communities. Dredging and placement activities may cause ecological damage to benthic organisms due to physical disturbance, mobilization of sediment contaminants, and increasing concentrations of suspended sediments (Montagna et al., 1998).

Recolonization of areas impacted by dredging and dredged material placement occurs through vertical migration of buried organisms through the dredged material, immigration of organisms from the surrounding area, recruitment from the water column, and/or sediments slumping from the side of the dredged area (Bolam and Rees, 2003; Newell et al., 1998). The response and recovery of the benthic community from dredged material placement is affected by many factors, including environmental (e.g., water quality, water stratification), sediment type and frequency, and timing of disposal. Communities in these dynamic ecosystems are dominated by opportunistic species tolerant of a wide range of conditions (Bolam et al., 2010; Bolam and Rees; 2003, Newell et al., 2004; Newell et al., 1998). Although changes in community structure, species composition, and guild function may occur, these impacts would be temporary in some dredging and disposal areas (Bolam and Rees, 2003). Shallower, higher energy estuarine habitats can recover as fast as 1 to 10 months from perturbation, while deeper, more-stable habitats can take up to 8 years to recover (Bolam et al., 2010; Bolam and Rees, 2003; Newell et al., 1998; Sheridan, 1999, 2004; Wilber et al., 2006; VanDerWal et al., 2011).

The release of nutrients during dredging may also enhance species diversity and population densities of benthic organisms outside the immediate dredge placement area as long as the dredged material is not contaminated (Newell et al., 1998).

During construction of the TSP, temporary disturbances and impacts to benthic organisms would occur. For example, there would be additional bay bottom habitat impacts from dredging the bypass channel. More information can be found in Section 5.4.2 (Aquatic Communities, Appendix C-1) of the DIFR-EIS.

2.3.1 Other Effects

Construction activities, particularly beach and dune restoration and offshore sediment source dredging, may affect, but are unlikely to adversely affect, Federally listed sea turtles. Beach and dune restoration actions are anticipated to benefit sea turtles by increasing available nesting habitat. Beach and dune restoration activities may also have temporary and localized disturbances to the Federally listed piping plover (*Charadrius melodus*) and rufa red knot (*Calidris canutus rufa*); however, long-term benefits to these species are anticipated due to habitat creation and maintenance (both species forage and loaf on beach habitats). Additional information can be found in Section 5.4.4.2 (Threatened and Endangered Species, Appendix C-1) of the DIFR-EIS, or Appendix C-3 (Endangered Species Act – Biological Assessment) of the DIFR-EIS.

2.3.2 Actions Taken to Minimize Impacts

This project was fully coordinated with State and Federal resource agencies during development of the DIFR-EIS. In addition, responses to their comments will be incorporated into the development of the Final IFR-EIS. ER measures are intended to be restorative actions and should be beneficial. CSRM measures are also intended to reduce damages and impacts from storm events. Any unavoidable losses or unintended effects will be mitigated as best as practical.

2.4 WATER CIRCULATION, FLUCTUATION, AND SALINITY DETERMINATIONS

2.4.1 Water

2.4.1.1 Salinity

Construction of the preferred alternative could slightly decrease bay salinities on average 2 parts per thousand (ppt), based on the estuarine modeling conducted by the USACE (McAlpin et al., 2018). During normal flow conditions, average salinities range from less than 10 ppt in upper Trinity Bay to 30 ppt at Bolivar Roads (Lester and Gonzalez, 2011).

2.4.1.2 Water Chemistry

Dredging and placement actions would result in short-term and localized impacts and would not be expected to degrade the long-term water quality within the project area. These patterns would return to their previous condition following completion of dredging. Temporary changes to dissolved oxygen (DO), nutrients, turbidity, and contaminant levels may occur due to sediment disturbance and mixing during construction. Temporary DO decreases may also happen from aerobic decomposition from short-term increases in organic matter suspended within the water column.

The Coastal Barrier is expected to impact water and sediment quality throughout the Galveston Bay system, because it would reduce flushing and mixing of point and nonpoint source pollutants entering the bay. Gulf water contains fewer pollutants than the bay and tidal exchange dilutes pollutants entering the bay (Brock et al., 1996). Seventy-five percent of the tidal flow into and out of Galveston Bay occurs at Bolivar Roads (Matsumoto et al., 2005), and the barrier is estimated to reduce the volume of tidal flow (McAlpin et al., 2018); modeling results suggest that the average tidal prism and average tidal amplitudes at various locations did vary between with- and without-project over the simulation year. The tidal prism change with the project alternative in place is a 13.5 percent and 16.5 percent reduction for the present and future conditions, respectively. The tidal amplitudes are also reduced at all bayside locations — between 9 and 22 percent. These indicate that the proposed structures have potential to restrict the flow and limit the volume of water moving in and out of the bay at Bolivar Roads. Hydraulic modeling indicates the Coastal Barrier along with smaller gates at Clear Lake, Dickinson Bay, and Offatts Bayou may increase retention time upstream of each barrier.

Reducing tidal flushing by construction of barriers may alter nutrient balance by reducing phosphorus input into the bay and nitrogen transport out of the bay. Changes in ratios of nitrogen and phosphorus may change plankton communities in the bay.

ER measures that include marsh nourishment or restoration may experience periods of turbidity and depressed oxygen levels associated with construction and dredged material placement. Additional information can be found in Section 5.3.4 (Water and Sediment Quality, Appendix C-1) of the DIFR-EIS.

2.4.1.3 Clarity

There would be some temporary increase in local turbidity during dredging and placement operations. Water clarity is expected to return to normal background levels shortly after operations are completed, as discussed further in the DIFR-EIS. Additional information can be found in Section 5.3.4 (Water and Sediment Quality, Appendix C-1) of the DIFR-EIS.

2.4.1.4 Color

Water immediately surrounding the construction area would become discolored temporarily due to disturbance of the sediment during dredging and placement actions but would be expected to return to normal after operations cease. Additional information can be found in Section 5.3.4 (Water and Sediment Quality, Appendix C-1) of the DIFR-EIS.

2.4.1.5 Odor

Negligible amounts of hydrogen sulfide may be expected during excavation and placement activities, which would be temporary and localized.

2.4.1.6 Taste

It is anticipated that no drinking water sources would be impacted by the TSP; no effects to taste are anticipated.

2.4.1.7 Dissolved Gas Levels

Negligible amounts of hydrogen sulfide (H_2S) may be expected. H_2S and other gases like methane are associated with high amounts of decaying organic matter, which are not expected to be present in excavated and placed materials. Offshore sediments may be very low in total organic carbon, an indicator of organic content. Dissolved gases have not been identified as a problem with maintenance material of the current channels, which may also be a source of BU sediments. Temporary DO decreases associated with extended periods of construction and dredged material placement may also happen from aerobic decomposition from short-term increases in organic matter suspended within the water column. Additional information can be found in Section 5.3.4 (Water and Sediment Quality, Appendix C-1) of the DIFR-EIS.

2.4.1.8 Nutrients

Reducing tidal flushing by construction of barriers may alter nutrient balance by reducing phosphorus input into the bay and nitrogen transport out of the bay. Changes in ratios of nitrogen and phosphorus may change plankton communities in the bay, particularly in areas with oysters that rely on plankton as their primary food source. Additional information can be found in Section 5.3.4 (Water and Sediment Quality, Appendix C-1) of the DIFR-EIS.

2.4.1.9 Eutrophication

Nutrients are not expected to reach levels high enough for periods long enough to lead to eutrophication of the surrounding waters.

2.4.1.10 Others as Appropriate

No other potential impacts to water quality have been identified; additional information can be found in Section 5.3.4 (Water and Sediment Quality, Appendix C-1) of the DIFR-EIS.

2.4.2 Current Patterns and Circulation

2.4.2.1 Current Patterns and Flow

Estuarine modeling was only conducted for the Coastal Barrier CSRM measure and has shown that once the navigation/environmental gate structures are constructed there would be reduced flow into and out of the bay. Modeling results suggest that the average tidal prism and average tidal amplitudes at various locations did vary between with and without project over the simulation year. The tidal prism change with the project alternative in place is a 13.5 percent and 16.5 percent reduction for the present and future conditions, respectively. The tidal amplitudes are also reduced at all bayside locations — between 9 and 22 percent. These indicate that the proposed structures have potential to restrict the flow and limit the volume of water moving in and out of the bay at Bolivar Roads.

2.4.2.2 Velocity

The velocity magnitudes vary little between with- and without-project conditions. The mean surface and bottom velocity magnitude generally drops when the project is in place, but this change is 0.16 feet per second or less. The change from the without-project condition is greatest in areas at and immediately around where the structures are located. Eddies are also expected on the backside of the gate structures. There are changes to the magnitude of the velocity extending into the bay, but they are much smaller than the effects at the locations of the modifications. The models suggest that in certain situations the velocity differences between the with-project condition and the without-project condition could be as high as 6.6 feet per second. For example, a scenario that presented a combination of a high tide and strong winds could lead to such an increase in velocity. Future project refinements may minimize differences currently seen between with- and without-project velocities (McAlpin et al., 2018).

2.4.2.3 Stratification

Relatively minor amounts of vertical salinity stratification may result from the TSP; however, minor amounts of vertical salinity stratification are present under the existing conditions (McAplin et al., 2018).

2.4.2.4 Hydrologic Regime

Regarding the Coastal Barrier CSRM measure, the modeling predicts a 16.5 percent reduction in the average tidal prism at Bolivar Roads and a tidal amplitude reduction up to 0.23 foot in areas of the bay (McAlpin et al., 2018).

2.4.3 Normal Water Level Fluctuations

Regarding the Coastal Barrier CSRM measure, freshwater retention times would increase, and tidal amplitude is reduced by up to 0.23 foot (McAlpin et al., 2018).

2.4.4 Salinity Gradients

Construction of the preferred alternative could slightly decrease bay salinities on average 2 ppt, based on the estuarine modeling conducted by the USACE (McAlpin et al., 2018). During normal flow conditions, average salinities range from less than 10 ppt in upper Trinity Bay to 30 ppt at Bolivar Roads (Lester and Gonzalez, 2011).

2.4.5 Actions that Will Be Taken to Minimize Impacts

This project was fully coordinated with State and Federal resource agencies during development of the DIFR-EIS. In addition, responses to their comments will be incorporated into the development of the Final IFR-EIS. ER measures are intended to be restorative actions and should be beneficial. CSRM measures are also intended to reduce damages and impacts from storm events. Any unavoidable losses or unintended effects will be mitigated as best as practical.

2.5 SUSPENDED PARTICULATE/TURBIDITY DETERMINATION

2.5.1 Expected Changes in Suspended Particulates and Turbidity Levels in Vicinity of Disposal Site

There will be some temporary increase in local turbidity during dredging and placement operations. Water clarity is expected to return to normal background levels shortly after operations are completed, as discussed further in the DIFR-EIS. Additional information can be found in Section 5.3.4 (Water and Sediment Quality, Appendix C-1) of the DIFR-EIS.

2.5.2 Effects on Chemical and Physical Properties of the Water Column

2.5.2.1 Light Penetration

The temporary and localized turbidity increases during dredging and placement actions would also have temporary and localized impacts to light penetration. Conditions are anticipated to return to normal levels of light penetration following construction.

2.5.2.2 Dissolved Oxygen

Temporary DO decreases associated with extended periods of construction and dredged material placement may happen from aerobic decomposition from short-term increases in organic matter suspended within the water column. Additional information can be found in Section 5.3.4 (Water and Sediment Quality, Appendix C-1) of the DIFR-EIS.

2.5.2.3 Toxic Metals and Organics

Sediments are not expected to contain toxic metals and organics. The Coastal Barrier CSRM measure would use material from inland commercial borrow sites that are assumed to be free of toxic metals and organics. Offshore and shoreface sediments are expected to also be free of toxic metals and organics. For actions that may use maintenance materials, it is assumed that only clean materials free of toxics and constituents would be used. More information would be obtained during future planning and design phases.

2.5.2.4 Pathogens

Sediments are not expected to contain or influence pathogens.

2.5.2.5 Aesthetics

ER measures would improve aesthetics. CSRM measures would be designed to not degrade aesthetics of the regions.

2.5.2.6 Others as Appropriate

No other potential impacts to water quality have been identified; additional information can be found in Section 5.3.4 (Water and Sediment Quality, Appendix C-1) of the DIFR-EIS.

2.5.3 Effects on Biota

Long-term effects to biota are expected to be beneficial due to restoration actions; negative effects to biota are expected to be temporary and localized.

2.5.4 Actions Taken to Minimize Impacts

This project was fully coordinated with State and Federal resource agencies during development of the DIFR-EIS. In addition, responses to their comments will be incorporated into the development of the Final IFR-EIS. ER measures are intended to be restorative actions and should be beneficial. CSRM measures are also intended to reduce damages and impacts from storm events. Any unavoidable losses or unintended effects will be mitigated as best as practical.

2.6 CONTAMINANT DETERMINATIONS

No sediment testing has been performed, but the Coastal Barrier CSRM measure would use material from commercial inland sources that are assumed to be in regulatory compliance regarding contaminants. Offshore and shoreface sediments are anticipated to be devoid of contaminants due to location. Last, maintenance materials may be used for some ER measures, and records from previous testing should be available; ER measures would only be constructed using materials free of contaminants. More information would be obtained in future planning and design phases of the study.

2.7 AQUATIC ECOSYSTEM AND ORGANISM DETERMINATIONS

2.7.1 Effects on Plankton

Turbidity from total suspended solids tends to reduce light penetration and thus reduce photosynthetic activity by phytoplankton (Wilber and Clarke, 2001). Such reductions in primary productivity would be localized around the immediate area of the dredging and placement operations. This reduced productivity may be offset by an increase in nutrients released into the water column during dredging activities that can increase productivity in the area surrounding the dredging activities (Newell et al., 1998; Wilber and Clarke, 2001). In past studies of impacts of dredged material placement from turbidity and nutrient release, the effects are both localized and temporary (May, 1973). Due to the capacity and natural variation in phytoplankton populations, the impacts to phytoplankton from project construction, dredging within the project area, and dredged material placement of material would be temporary.

2.7.2 Effects on Benthos

Impacts to benthos would be localized and temporary; however, benthic organisms are expected to quickly rebound following construction activities. There would be direct impacts to benthic organisms, which would be buried or removed during construction of the Coastal Barrier. Excavation of sediments removes and buries benthic organisms, whereas placement of dredged material and structures smothers or buries benthic communities. Dredging and placement activities may cause ecological damage to benthic organisms due to ecosystem physical disturbance, mobilization of sediment contaminants making them more bio-available, and increasing concentrations of suspended sediments (Montagna et al., 1998). More information can be found in Section 5.4.2 (Aquatic Communities, Appendix C-1) of the DIFR-EIS and is previously discussed in Section 2.3 above (Factual Determinations).

2.7.3 Effects on Nekton

Although there may be temporary and localized effects to nekton due to dredging and placement operations, long-term benefits are anticipated due to restoration actions.

2.7.4 Effects on Aquatic Food Web

The effects on benthic biota (such as infauna) and nekton (e.g., plankton) that form the base of the aquatic food web would be localized, temporary, and not result in substantial adverse impacts to populations. Long-term benefits to ecological functions, including trophic dynamics, are expected due to restoration actions that benefit biota.

2.7.5 Effects on Special Aquatic Sites

Direct impacts to Special Aquatic Sites are anticipated, but the overall action is intended to restore Special Aquatic Sites.

2.8 PROPOSED DISPOSAL SITE DETERMINATIONS

2.8.1 Mixing Zone Determination

It is assumed that there would be no discharge quality concerns and that no mixing zones would be required.

2.8.2 Determination of Compliance with Applicable Water Quality Standards

Project actions would be performed in compliance with State and Federal regulations and would adhere to applicable water quality standards.

2.8.3 Potential Effects on Human Use Characteristics

2.8.3.1 Municipal and Private Water Supply

There are municipal and private water supplies located within the footprint of the TSP, but water quality of water supplies and drinking water would not be impacted. More information would be obtained during future planning and design phases of the study.

2.8.3.2 Recreational and Commercial Fisheries

Although the Coastal Barrier CSRM measure is anticipated to affect hydrosalinity gradients, tidal amplitude, tidal velocities, freshwater retention time, and tidal prism (all of which may result in effects to recreational and commercial fisheries), the ER measures are anticipated to improve and provide additional habitats for recreational and commercial fisheries.

2.8.3.3 Water-related Recreation

ER measures would contribute to improving water-related recreation; however, the Coastal Barrier CSRM measure is likely to create more hazards to boat traffic and movement patterns over existing conditions.

2.8.3.4 Aesthetics

ER measures would improve aesthetics. CSRM measures would be designed to not degrade aesthetics of the regions.

2.8.3.5 Parks, National and Historic Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves

The TSP ER measures would result in benefits to several national wildlife refuges and Padre Island National Seashore through implementation of restoration actions. Additionally, ER measures may prevent erosion of several parks and preserves or ameliorate RSLR.

2.9 DETERMINATION OF CUMULATIVE EFFECTS ON THE AQUATIC ECOSYSTEM

Positive environmental impacts would result from the TSP ER measures, which include beach and dune restoration, marsh restoration, shoreline protection, bird island restoration, and oyster reef creation. Many past, present, and reasonably foreseeable projects address restoration of coastal resources (which have the capacity to alter geomorphology and coastal processes). Some of these projects reduce erosion, provide habitat, function as storm buffers, promote recreational and commercial fisheries, and improve water quality, for example; the TSP ER measures would result in the same benefits.. ER measure construction is anticipated to temporarily increase turbidity, DO, and contaminants in the water column that would occur during dredging activities and placement of rock breakwater and sediments. Long-term direct and indirect impacts of the ER measures on wetlands and marshes in the region will be positive and will mitigate marsh loss from shoreline erosion and sea level rise. Revetments and breakwaters will diffuse erosional forces approaching the shoreline and protect sediments from disturbances. Marsh nourishment efforts would complement current and future marsh restoration efforts by State, Federal, non-government organizations, and private entities. With regards to ER measures, the cumulative effects of the TSP would be beneficial when combined with other past, present, and reasonably foreseeable restoration actions around Galveston Bay.

Negative environmental impacts may result from the Coastal Barrier CSRM measure as it would alter tidal dynamics by creating a constriction through Bolivar Roads. The tidal prism change with the project alternative in place is a 13.5 percent and 16.5 percent reduction for the present and future conditions, respectively. The tidal amplitudes are also reduced at all bayside locations — between 9 and 22 percent. These indicate that the proposed structures have potential to restrict the flow and limit the volume of water moving in and out of the bay at Bolivar Roads. The velocity magnitudes vary little between with- and without-project conditions. The mean surface and bottom velocity magnitude generally drops when the project is in place, but this change is 0.16 feet per second or less. The change from the without-project condition is greatest in areas at and immediately around where the structures are located. Eddies are also expected on the backside of the gate structures. There are changes to the magnitude of the velocity extending into the bay, but they are much smaller than the effects at the locations of the modifications. The models suggest that in certain situations the velocity differences between the with-project condition and the without-project condition could be as high as 6.6 feet per second. For example, a scenario that presented a combination of a high tide and strong winds could lead to such an increase in velocity. Future project refinements may minimize differences currently seen between with- and without project velocities. These alterations to the tidal system may result in impacts to some aquatic species, wetlands, and essential fish habitat, for example. Climate variability (e.g., drought and flood events) and RSLR also contribute to the uncertainties regarding the magnitude of TSP impacts, both positive and negative.

For past, present, and reasonably foreseeable projects that have altered, or have the potential to alter, tidal dynamics or hydrosalinity gradients, there exists the potential for the TSP to contribute to cumulative effects. For example, the Houston Ship Channel Expansion and Channel Improvement Project may alter hydrosalinity gradients slightly and may exacerbate any impacts that result from the Coastal Barrier CSRM measure forming the constriction at Bolivar Roads. Past and present projects, like GIWW construction and maintenance, Barbour's Cut, and other projects with dredging, also contribute to alterations to tidal dynamics, circulation, erosion, habitat, and storm buffer functions.

To reduce or eliminate the likelihood of the TSP contributing to cumulative effects, Habitat Evaluation Procedure and Wetland Value Assessment were applied to the Future Without-Project and Future With-Project conditions to identify the potential changes to some species' habitats and wetland, and appropriate mitigation was identified. Interagency coordination, regulatory compliance, mitigation, monitoring, and adaptive management strategies are intended to offset any detrimental impacts of the TSP and further reduce or eliminate contributions to cumulative effects. With these assumptions, modeling, and planning efforts, impacts of the TSP would not contribute considerably to the region's cumulative impacts, when combined with past, present, and reasonably foreseeable future actions. More information can be found in Section 5.10 (Cumulative Impacts, Appendix C-1) of the DIFR-EIS.

2.10 DETERMINATION OF SECONDARY EFFECTS ON THE AQUATIC ECOSYSTEM

No substantial adverse secondary effects on the aquatic ecosystem should occur as a result of implementing the TSP; beneficial secondary effects are anticipated due to the large-scale restoration actions that are part of the TSP. Interagency coordination, regulatory compliance, mitigation, monitoring, and adaptive management strategies are intended to offset any detrimental impacts of the TSP and further reduce or eliminate contributions to secondary effects. With these assumptions, modeling, and planning efforts, impacts of the TSP would not contribute considerably to the region's cumulative impacts, when combined with past, present, and reasonably foreseeable future actions. More information can be found in Section 5.10 (Cumulative Impacts, Appendix C-1) of the DIFR-EIS.

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Findings of Compliance with
Section 404(b)(1) Guidelines
Coastal Texas Protection and Restoration Study
U.S. Army Corps of Engineers

1. No significant adaptations of the Guidelines were made with respect to the evaluation completed for this project.

2. The Applicant's Proposed Project Alternative is the result of a thorough evaluation of alternatives.

3. The Applicant's Proposed Project Alternative will not violate any applicable State or Federal water quality criteria or toxic effluent standards of Section 307 of the Clean Water Act.

4. The Applicant's Proposed Project Alternative will not jeopardize the existence of any Federally or State-listed threatened or endangered species and/or their critical habitat or violate any protective measures for any sanctuary. Various resource agencies, including U.S. Fish and Wildlife Service and National Marine Fisheries Service, have been consulted regarding potential issues of any Federally or State-listed threatened or endangered species and/or their critical habitat. Appropriate avoidance and minimization measures would be implemented accordingly, based on agency coordination.

5. The Applicant's Proposed Project Alternative will not result in adverse effects on human health and welfare, including municipal and private water supplies, recreation and commercial fishing, plankton, fish, shellfish, wildlife, and special aquatic sites. There are no significant adverse impacts expected to the aquatic ecosystem diversity, productivity and stability, or recreational, aesthetic, and economic values.

6. Appropriate steps to minimize potential adverse impacts on the aquatic system include close coordination with State and Federal resource agencies during final Project design prior to construction to incorporate all valid suggestions.

7. Based on the guidelines, the Applicant's Proposed Project Alternative is specified as complying with the requirements of the Section 404(b)(1) guidelines.

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Douglas Sims Date
Chief, Environmental Compliance Section
U.S. Army Corps of Engineers, Fort Worth District