Appendix C

Dredged Material Management Plan

Note: The Section 508 amendment of the Rehabilitation Act of 1973 requires that the information in Federal documents be accessible to individuals with disabilities. The USACE has made every effort to ensure that the information in this appendix is accessible. However, this appendix is not fully compliant with Section 508, and readers with disabilities are encouraged to contact Mr. Jayson Hudson at the USACE at (409) 766-3108 or at SWG201900067@usace.army.mil if they would like access to the information.

Appendix C1

Dredged Material Management Plan

5.2 <u>Placement Alternatives Evaluated Further</u>

The initial alternatives that were advanced or reconceived were refined. Given the large amount of materials that could be beneficially used, especially the large volume of sand in one the of the channel segments, and proximity of some of the desirable BU options, it became clear, a mix of existing offshore, expansion of existing BU sites and the Gulf side BU initiatives would be a viable, cost effective approach. Of 13 initiatives further refined, 11 were BU features that aimed to achieve a variety of shoreline restoration, land loss restoration, marsh cell expansion, and Gulf-side shoreline initiatives. The following alternatives were developed.

- ~~M3 – Creation of an estuarine/aquatic habitat extension at Pelican Island. This would bring the elevation of an extension at this BU site to an elevation suitable to restore either marsh or seagrass.~~

- ~~M4 – Restoring historic land and marsh loss at Dagger Island. This is an ecosystem restoration measure included in USACE's Coastal Texas study and the TGLO Coastal Resiliency Master Plan. Design of project elements will be coordinated to support TPWD's existing permit for this project.~~

- ~~PA9-S – This option will extend the upland placement of dredged material behind PA9. This area was originally identified as Site R in the CCSCIP for the creation of shallow water habitat, but current projections from the PCCA are that there will not be enough material from that project to create that site.~~

- ~~M10 – Creation of an estuarine/aquatic extension behind PA10. This would bring the elevation of an extension at this BU site to an elevation suitable to restore either marsh or seagrass.~~

- PA6 – Raising levees on PA6, after the CCSC CIP one-time use, by 5 feet and filling it with 4 feet of new work material at the existing PA6 location.

- SS1 – Restoring eroded shoreline to a higher elevation than what was previous to prevent future land breaches as a result of storm events, the restored feature will be armored to protect the very large seagrass area behind Harbor Island.

- SS2 – Restoring shoreline washouts along the Port Aransas Nature Preserve/Charlie's Pasture as a result of Hurricane Harvey. Piping plover sand flat critical habitat located behind this breach would be protected again. Design of project elements will be coordinated with TGLO's restoration efforts for this area.

- PA4 – Reestablish eroded shoreline and land loss in front of PA4 ~~(identified as SS1 extension)~~. The shoreline has undergone major erosion over the last few decades, and if it continues, would eventually expose the Harbor Island seagrass area to

DRAFT

erosion and loss. Additionally, raising levees on PA4 for placement of new work material that is unsuitable for BU.

- SJI – ~~Dune & sShoreline restoration~~ Beach nourishment at San Jose Island using new work ~~sands to repair severe damage caused by Hurricane Harvey~~.

- ~~NW~~ ODMDS – Placement in ~~New Work~~ ODMDS ~~(Homeport)~~.

- B1-B9 – Feeder berms offshore of SJI and Mustang Island that would be located within the -24ft to -30ft contours ~~active transport zone in front of the depth of closure, and~~ indirectly nourish these barrier islands.

- HI-E – Restore eroded bluff at the junction of the CCSC, Aransas Channel and Lydia Ann Channel and will be armored to prevent future erosion. The bluff will be restored to its historic shape and new work material will be placed behind the bluff with a levee raise around the site. According to USGS historical topographic maps for Port Aransas, Texas, SE/4 Aransas Pass 15' Quadrangle, this site appears to have been created from Aransas Channel spoils around 1967-1968.

- MI – Mustang Island beach nourishment, this feature is intended to directly place new work sands to enhance the shoreline from the south CCSC jetty five (5) miles along the Gulf side of Mustang Island.

5.3 Applicant's Proposed Placement Plan

All the proposed options would be viable due to proximity, material volume capacity, and need for material to achieve ecological restoration. The large volume of sands indicates that material placement would be better used for BU restoration of important coastal resources that were damaged by Hurricane Harvey and experience continuing erosion. The availability of other new work material such as clays could opportunely be used to stem land losses that would expose sensitive habitats to continual erosion. These materials would be better used in these initiatives than in upland placement that avoids the marine environment and provides no benefit. All options were selected, with M9 and M10 providing extra capacities as a contingency for unavailability of SJI. Therefore, more capacity was identified to provide flexibility in the plan. Table 5.1 lists the selected placement plan elements.

DRAFT

Table 5.2: Selected New Work Placement Plan (See Sheet 9 of 23)

Placement Option	Description	Placement Capacity (CY)	Proximity to New Work Dredging Operations	Environmental Benefit
~~M3~~	~~Estuarine/aquatic habitat creation adjacent to Pelican Island~~	~~3,798,000~~	~~Located approximately 6 miles from Harbor Island~~	~~This option will convert featureless bay bottom to approximately 300 acres of estuarine/aquatic habitat.~~
~~M4~~	~~Restoring historic land and marsh loss at Dagger Island~~	~~867,000~~	~~Located approximately 7 miles from Harbor Island~~	~~This option will restore eroding marsh habitat for native shorebirds and coastal wildlife. Design of project elements will be coordinated to support TPWD's existing permitted project.~~
~~PA9-S~~	~~Upland Placement Site Expansion behind PA9~~	~~9,000,000~~	~~Located approximately 8 miles from Harbor Island~~	~~This option does not restore aquatic habitat, it will convert featureless bay bottom to upland.~~
~~M10~~	~~Estuarine/aquatic habitat creation adjacent to PA10~~	~~10,933,600~~	~~Located approximately 10 miles from Harbor Island~~	~~This option will convert featureless bay bottom to approximately 770 acres of estuarine/aquatic habitat.~~
PA6	5 foot levee raise and fill	1,796,400	Located approximately 4 miles from Harbor Island	This option does not create any environmental benefit.
SS1	Restoring eroded and washed out shoreline	~~4,800,000~~ 2,793,000 (based on SS1-100% design drawings)	Located approximately 3 miles from Harbor Island	This option restores an eroded shoreline landmass and provides protection to Harbor Island Seagrass area.
SS2	Restore shoreline washouts along Port Aransas Nature Preserve as a result of Hurricane Harvey	~~669,700~~ ~~250,000~~ 374,000	Located approximately 2 miles from Harbor Island	Shoreline restoration that fills in the washouts caused by Hurricane Harvey that protects Piping Plover critical sand flat habitat.
PA4	Reestablish eroded shoreline and land loss in front of PA4	~~3,020,000~~ ~~1,676,000 (based on SS1 ext represented in SS1 100% design drawings)~~ 1,459,000	Located approximately 2 miles from Harbor Island	This option provides protection to Harbor Island seagrass area.
	Upland placement	2,861,400	Located approximately 2 miles from Harbor Island	This option does not create any environmental benefit.

DRAFT

Placement Option	Description	Placement Capacity (CY)	Proximity to New Work Dredging Operations	Environmental Benefit
HI-E	Bluff and Shoreline restoration with site fill	1,825,000	Located less than 1 mile from Harbor Island	This option restores an eroding bluff and shoreline to its historic profile.
SJI	Dune and beach restoration San Jose Island	~~4,000,000~~ 2,000,000	Located directly next to Channel Dredging Operations	This option restores several miles of beach profile that was washed away as a result of Hurricane Harvey.
~~NW~~ ODMDS	Place in ~~New Work~~ ODMDS ~~(Homeport)~~	~~13,800,000~~ ~~38,398,600~~ 38,888,600	Located directly next to Channel Dredging Operations	This option does not create any environmental benefit.
B1-B9	Feeder berms offshore of SJI and Mustang Island	~~8,100,000~~ 8,660,000	Located less than 10 miles from Channel Dredging Operations	This option will nourish beach shoreline by natural sediment transport processes.
MI	Beach Nourishment for Gulf side of Mustang Island	2,000,000	Located directly next to Channel Dredging Operations	This option will nourish beach shoreline by direct sediment placement.
Scenarios for new work placement capacity provided and needed.		64,609,700	Total Capacity Provided	
		60,609,700	Total capacity less SJI (should that option become unavailable)	
		~~46,283,590~~ 46,300,000	Total NW placement capacity required for Channel Preferred Alternative – Base Option	
		14,326,110	Additional Capacity less SJI (should that option become unavailable)	

DRAFT

Appendix C2

Beneficial Use Monitoring Plan

BENEFICIAL USE MONITORING PLAN

CHANNEL DEEPENING PROJECT: SWG-2019-00067

PORT CORPUS CHRISTI

AUTHOR(S): ENVIRONMENTAL PLANNING AND COMPLIANCE DEPARTMENT
DATE: JANUARY, 2024 | VERSION: 5

Nomenclature

BU	Beneficial Use
BUMP	Beneficial Use Monitoring Plan
BMP	Best Management Practices
CIP	Channel Improvement Plan
CDP	Channel Deepening Project
CCSC	Corpus Christi Ship Channel
cy	cubic yards
DMPA	Dredge Material Placement Area
DMMP	Dredge Material Management Plan
EPA	Environmental Protection Agency
GoM	Gulf of Mexico
HI-E	Harbor Island East
HTL	High Tide Line
MI	Mustang Island
lf	linear feet
PA	Placement Area
PA4	Placement Area 4
PSA	Project Study Area
MLLW	Mean Lower Low Water
NOAA	National Oceanic and Atmospheric Administration
ODMDS	Ocean Dredge Material Disposal Site
SS1	Shoreline Stabilization 1
SS2	Shoreline Stabilization 2
SJI	San Jose Island
TCEQ	Texas Commission on Environmental Quality
TPWD	Texas Parks and Wildlife Department
USACE	U.S. Army Corps of Engineers

Table of Contents

List of Figures

Page

List of Tables

Page

1. Project Background

This document details the beneficial use (BU) placement of material dredged from the deepening of the Corpus Christi Ship Channel (CCSC) entrance to -75ft. The proposed Channel Deepening Project (CDP) will increase the depth to allow the passage of fully laden, very large crude carriers. The CDP provides the opportunity to contribute to resource restoration through the BU of dredged material resulting from project actions. The proposed dredging for the CDP will not directly impact oyster reefs, seagrass, wetlands, or other special aquatic sites. However, dredged material placement in BU areas would directly impact wetlands, tidal flats, beaches, seagrass, and existing placement areas (PA). Although projects normally directly mitigate for impacts on habitats and resources, the CDP incorporates BU to protect sensitive habitats and restore shorelines, washouts, and dunes. The proposed BU sites promote resilient coastal ecosystems and offset both direct and indirect impacts of material placement. This monitoring plan details the specific monitoring parameters to determine the success of the constructed BU areas.

The Environmental Protection Agency's (EPA) Beneficial Use Planning Manual states: "Dredged material can be used beneficially for engineered, agricultural and product, and environmental enhancement purposes, as described on the beneficial uses website and in the seven categories described below:

1. **Habitat Restoration and Development**: using dredged material to build and restore wildlife habitat, especially wetlands or other water-based habitat (e.g., nesting islands and offshore reefs).
2. **Beach Nourishment**: using dredged material (primarily sandy material) to restore beaches subject to erosion.
3. **Parks and Recreation**: using dredged material as the foundation for parks and recreational facilities; for example, waterside parks providing such amenities as swimming, picnicking, camping, or boating.
4. **Agriculture, Forestry, Horticulture, and Aquaculture**: using dredged material to replace eroded topsoil, elevate the soil surface, or improve the physical and chemical characteristics of soils.
5. **Strip-Mine Reclamation and Solid Waste Management**: using dredged material to reclaim strip mines, cap solid waste landfills, or protect landfills.
6. **Construction/Industrial Development**: using dredged material for commercial or industrial activities (including brownfield redevelopment), primarily near waterways; for example, expanding or raising the height of the land base or providing bank stabilization. In addition, dredged material may be used in construction materials.
7. **Multiple-Purpose Activities**: using dredged material to meet a series of needs simultaneously, such as habitat development, recreation, and beach nourishment, which might all be supported by a single beneficial use project."

The Port of Corpus Christi Authority's (Port Corpus Christi) BU plan classifies these six sites into one of the following categories: habitat restoration and development, beach nourishment, and construction/industrial development. At the request of the U.S. Army Corps of Engineers (USACE), Port Corpus Christi developed this plan to describe the components and methodologies of BU sites and construction. Additionally, the USACE requested a 12-step compensatory mitigation plan for 44.63ac of special aquatic sites, which the BU sites will permanently impact.

2. Objectives

The overall objective of the BU sites is to restore shorelines so they efficiently address ongoing and historical impacts to seagrass, wetland, aquatic, and critical coastal habitats. BU site selection considered proximity to the CDP and the need for restoration. All BU sites are adjacent to the CDP and within a reasonable distance to hydraulically place dredged material effectively. Without the strategically placed dredged material, continued erosion of these shorelines will threaten substantial acreages of valuable habitat. Port Corpus Christi identified six sites to restore habitat, nourish beaches, and support industrial (DMPA) development. The CDP also includes the placement of dredge in an Ocean Dredge Material Disposal Site (ODMDS). Port Corpus Christi does not have the placement at ODMDS in this plan. A separate Site Management and Monitoring Plan with the conditions set forth by EPA will be monitored separately. The individual objectives for the below proposed BU sites are:

- **Shoreline Stabilization 1 (SS1)**: Restore and stabilize an eroded shoreline along the Corpus Christi Ship Channel (CCSC), increasing the elevation to prevent future land breaches by creating over 250ac of wetlands through BU placement. SS1 will also directly protect an approximate 2,400ac seagrass community in Redfish Bay, known as Brown and Root flats, thereby enhancing seagrass productivity.
- **Shoreline Stabilization 2 (SS2)**: Restore and stabilize shoreline washouts along the CCSC and Port Aransas Nature Preserve/Charlie's Pasture resulting from Hurricane Harvey by creating over 30ac wetlands through BU placement. Protect and restore piping plover and red knot critical habitat.
- **Placement Area 4 (PA4)**: Restore the levees and capacity of a deteriorating DMPA (industrial development) and stabilize the eroded south shoreline along CCSC to prevent future erosion. The material will beneficially raise the levees of the PA to allow upland placement of additional material unsuitable for BU. The restoration of PA4 will also indirectly protect the Brown and Root flats.
- **Harbor Island East (HI-E)**: Restore and stabilize an eroded bluff at the junction of the CCSC, Aransas Channel, and Lydia Ann Channel to prevent future erosion. Elevate an existing levee around the site to its historical profile to allow additional placement of material unsuitable for BU (industrial development). Protect a portion of an approximate 5,000ac wetland and seagrass complex known as Lighthouse Lakes.

- **San Jose Island (SJI)**: Nourish the critically eroded beach along the Gulf of Mexico (GoM) to pre-Hurricane Harvey conditions. Enhance coastal storm and erosion resilience by nourishing the beach and dune complex.
- **Mustang Island (MI)**: Nourish the critically eroded beach along the GoM to pre-Hurricane Harvey conditions. Enhance coastal storm and erosion resilience by nourishing the beach.
- **Nearshore Berms (B1-B9)**: Enhance coastal resilience during storm events by creating a series of stable nearshore berms that will aid in wave attenuation.

2.1 Needs of the Watershed

All BU sites are located within the same watershed and adjacent to the CDP. BU locations include shorelines adjacent to sensitive aquatic sites and critical habitat that have suffered significant erosion and washouts due to storm surge, sea-level rise, and increased vessel traffic.

The proposed BU construction will cause initial direct impacts to 139.07ac of wetlands, 6.88ac of seagrass, and 0.10ac of live oyster through the burial of benthic communities and increased turbidity near the sites. The long-term positive outcome of the fully constructed BUs will create protective barriers along the Gulf Shoreline. The BUs will provide shoreline stabilization that efficiently protects large seagrass communities and critical coastal habitats. The BU design will create suitable elevations for planting and natural recruitment of wetland and upland communities. BU dredged material volumes provided in the following sections are from January 11, 2021, Dredge Material Management Plan resubmittal to the U.S. Army Corps of Engineers (USACE). With the proposed BU placement, Port Corpus Christi will directly create 291ac of wetland habitat, restore151.8ac of coastal dune habitat, nourish 803.1ac of beach habitat as well as protect surrounding habitat complexes such as Redfish Bay, Lighthouse Lakes, and Charlie's Pasture. Additionally, the CDP will beneficially reuse dredge material to restore two DMPAs providing over 4.6 million cubic yards of capacity for material unsuitable for BU. Restoring the existing DMPAs is an environmentally practicable alternative to creating a new DMPA with a similar capacity within the project vicinity.

Table 1: *BU Placement Impact and Benefits Table. [1] See Table 2 for additional information.*

Site	Total Aquatic Impact Acres[1]	Impact Habitats	Direct Creation Acres	Habitats Created	EPA BU Category
SS1	25.0	Palustrine, Estuarine, and Seagrass	256.8*	Low Marsh, High Marsh, Marsh-Upland Fringe	Habitat Restoration
SS2	12.5	Palustrine, and Estuarine	34.3	Low Marsh	Habitat Restoration
PA4	46.0	Palustrine, Estuarine, and Seagrass	0	N/A	Industrial Development
HI-E	62.5	Palustrine, Estuarine, Seagrass, and Oyster	0	N/A	Industrial Development
SJI	0	Open Water/Beach	441.2	Beach Nourishment	Beach Nourishment
MI	0	Open Water/Beach	362.2	Beach Nourishment	Beach Nourishment
B1-B9	0	Open Water	N/A	N/A	Industrial Development

*This acreage includes 75.12ac of wetland mitigation. For further details on the mitigation, see the 12-Step Permittee Responsible Compensatory Mitigation Plan.

2.1.1 SS1

The original landmass near SS1 was formed by placing dredge material from the original construction of the CCSC. SS1 is located along the northern shoreline of the CCSC and southeast of Redfish Bay. Redfish Bay has approximately 14,000ac of seagrass beds that contribute to improved water quality and provide habitat for larvae and juvenile fish. Significant erosion and sediment deposition to the southern shoreline and interior portions of the site is present due to the increased frequency of vessel traffic through the CCSC as well as the recent hurricane storm surge. While the original land mass at SS1 served to protect the seagrass of Brown and Root flats, the continual erosion and overwash resulted in the deposition of sand, inward into the flats. Port Corpus Christi compared aerial imagery from 2008 to 2022 and estimated the current shoreline and seagrass edge. Based on these estimates, the erosion and overwashing, Port Corpus Christi estimates approximately 103ac of seagrass have been buried in the past 14 years, see Figure 1 below:

***Figure 1**: Historical and Recent Aerial Imagery Demonstrating Significant Erosion and Deposition of SS1, resulting in approximately 103ac seagrass burial.*

Continual erosion threatens seagrass within Redfish Bay's Brown and Root flat via vessel wave action and storm surge (See **Attachment A – Hurricane Harvey Damage Shoreline Assessment**). Estuarine low and high marsh wetlands and unvegetated sand flats comprise the site. Approximately 2,793,000 cubic yards (CY) of dredged material will be placed to construct the site and protect the 14,000ac of seagrass. By reducing the hydrologic exchange between Brown and Root flats and the CCSC, SS1 will improve the function of the adjacent seagrass complex. In constructing SS1, Port Corpus Christi will create 256.84ac of low marsh, high marsh, and seagrass habitat. Of the 256.84ac, Port Corpus Christi will reserve 75.12ac of the BU site for wetland mitigation for all project-related impacts. For further details on the mitigation, see the 12-Step Permittee Responsible Compensatory Mitigation Plan.

2.1.2 SS2

SS2 is located along the southern shoreline of the CCSC east of Piper Channel and incorporates part of the Port Aransas Nature Preserve at Charlie's Pasture. SS2's shoreline along CCSC has approximately 1,085 linear feet (lf) of erosion caused by direct impacts of large passing vessels and storm surges. Direct impacts from Hurricane Harvey compromised the existing revetment creating washouts and eroding sand/algal flats within Charlie's Pasture. Dominant habitat types at SS2 include open water, tidal/algal flats, estuarine marsh, and upland coastal prairie habitats. Historically, SS2 served as a hydrologic barrier between CCSC and Charlie's Pasture. SS2 construction will protect approximately 71.90ac of USFWS-designated critical habitat for the piping plover at Charlie's Pasture. Approximately 374,000cy of dredged material will be placed in a thin layer to construct the site. Port Corpus Christi will construct a berm to contain dredge material during the thin layer placement. The estimated volume and location of culverts/hydrologic connection through the berm will be determined in the final design. In constructing SS2, Port Corpus Christi will create 34.3ac of low marsh wetlands.

2.1.3 PA4

PA4 is located along the northern shoreline of the CCSC east of SS1. This site restores the eroded shoreline and land lost in front of PA4. Significant erosion along the PA4 southern shoreline is present due to the higher frequency of larger vessels passing and recent hurricane activity. The site is currently comprised of prairie coastal uplands, estuarine low marsh wetlands, and palustrine emergent wetlands. PA4 was originally formed through sediment placement from the dredging of the CCSC. Manipulation of PA4 over time includes containment levees for dredged material placement. Several borrow pits in placement areas have naturalized into shallow water ponds with depths ranging from 1 to 4ft. Portions of the site along the northeast shoreline are confined on four sides by levees with no hydrologic connections to Redfish Bay or CCSC. Constructing PA4 provides stabilization along the south shoreline, protects Redfish Bay seagrass that improves water quality, provides fish habitat, and reinforces the existing PA levee for placement of dredged material not suitable for BU. Approximately 4,320,400cy of dredged material will be placed to construct the site. Of this approximate 4.3mcy, 2,861,400cy is material that is unsuitable for BU. Restoring PA4 is an environmentally practicable alternative compared to creating a new DMPA with a similar capacity within the project vicinity.

2.1.4 HI-E

HI-E is located north of the CCSC at the confluence of the Aransas and Lydia Ann Channels. Originally formed from dredged materials resulting in the Aransas Channel construction, subsequent CCSC dredging shaped the site and, over time, incorporated training levees, drainage pipes, and linear-shaped borrow sites, all of which remain in place today. Borrow sites have naturalized into shallow ponds, with depths ranging from 1 to 4ft. Habitats present include coastal prairie uplands, estuarine low and high marsh wetlands, and palustrine emergent wetlands. Approximately 1,825,000cy of dredged material will be placed for the construction of HI-E. Of this approximate 1.8mcy, 1.6mcy is material that is unsuitable for BU. Restoring HI-E is an environmentally practicable alternative compared to creating a new DMPA with a similar capacity within the project vicinity.

2.1.5 SJI

SJI is located along the GoM, beginning at the CCSC and extending north approximately 7 miles. Sea level rise and hurricane storm surge resulted in critical beach erosion and breaches to the dune complexes along this shoreline. Hurricane Harvey created breaches resulting in the formation of unvegetated shallow water ponds within and behind the foredune ridge. The current beach width varies from 1,500 to 2,500ft along the 7-mile stretch of shoreline. Habitat present includes Gulf beach, upland coastal dunes, dune swale mosaic wetlands, coastal prairie upland, and estuarine low marsh wetlands. This coastal barrier island protects inland communities and infrastructure west of the dunes. Increased beach width will increase the natural buffer of the beach and provide protection during storm surge events. Approximately 2,000,000cy of dredged material will be placed for the construction of SJI. SJI will nourish 441.2ac of beach.

2.1.6 MI

MI is located along the GoM, approximately 5 miles south of the CCSC. Sea level rise and recent hurricane storm surge resulted in beach erosion along this shoreline. The current beach width varies from 1,000 to 1,400ft. Habitats present include Gulf beach, upland dune complexes, and palustrine emergent wetlands. This coastal barrier island provides protection to the community and infrastructure west of the dunes. Increased beach width will increase the natural buffer of the beach and provide protection during storm surge events. Approximately 2,000,000cy of dredged material will be placed to provide beach nourishment for this BU site. MI will nourish 362.2ac of beach.

2.1.7 B1 – B9

A series of nearshore berms will be located approximately 3,000-4,000ft offshore of SJI and MI typically near the -24ft bathymetric contour. Berms B1 through B6 will be located offshore of SJI, and berms B7 through B9 will be located offshore of MI. These berms will improve wave attenuation of the shoreline during storm surge events where the depth of closure for breaking waves increases beyond typical conditions. Constructing these berms will reduce erosion of MI and SJI during tropical storm events. Approximately 4,810,000cy of dredge material will be placed to construct B1-B6, and 3,850,000cy dredge material will be placed to construct B7-B9.

3. Baseline Information

Port Corpus Christi surveyed all the proposed BU sites for Waters of the United States (WOUS), including wetlands, seagrass, and oyster reefs. These surveys included a 500ft buffer around the sites for the purpose of monitoring secondary impacts that may occur during construction. This Beneficial Use Monitoring Plan (BUMP) quantifies the project in terms of direct impacts within the BU footprint. However, where applicable, Port Corpus Christi will monitor within the buffer to observe for any secondary or indirect impacts outside of the BU footprint. Port Corpus Christi does not anticipate secondary or indirect impacts within the buffer due to the use of best management practices (BMPs) (temporary dewatering berms, turbidity curtains, silt fences, etc.) in all sites. However, if secondary or indirect impacts are observed during the implementation of this BUMP, Port Corpus Christi will implement the Adaptive Management Plan described in Section 7 to ensure no net loss of sensitive habitat previously mentioned. For the purpose of determining direct impact, the resources identified within the buffer were excluded from consideration. Survey results are summarized in Table 2 below:

***Table 2**: Summary of Direct WOUS Impacts from Placement Area Construction (acres) Estuarine (E2EM, E2SS), Palustrine (PEM), Seagrass (E1ABL), and Oyster.*

Site	Estuarine	Palustrine	Seagrass	Oyster	Footprint Total
SS1	3.92	21.04	0.01		297.41
SS2	1.25	11.25	0		45.21
PA4	0.75	41.75	3.46		170.79
HI E	10.69	48.42	3.41		138.73
SJI	0	0	0		441.23
MI	0	0	0		362.21

Total	16.61	122.46	6.88	0.10	1,455.58

3.1 Ecological Characterization of the CCSC and BU Sites

The CCSC is an unvegetated bay bottom, actively dredged for maintenance. It is located in Corpus Christi Bay, Port Aransas Channel, and the GoM. The CCSC contains no wetlands and would not result in direct impacts on special aquatic sites (e.g., SAV, coral reef, oysters, mud flats). No major rivers flow into the CCSC. Rainfall is the main form of precipitation along the coast and tends to occur most frequently and in the greatest amounts in the spring and late summer/early fall. The climate of the Corpus Christi Bay area is humid subtropical. Humid, warm-to-hot conditions occur in the summer months, with average daily temperatures ranging from 75°F to 82°F. The relative sea level trend for Corpus Christi, Texas, is 0.21 inches per year with a 95 percent confidence interval of ±0.04 inches per year based on mean sea level data from 1983 to 2020 (NOAA Tidal Gauge #8775870), which is equivalent to a change of 1.78 feet over the course of 100 years.

The below sections describe the BU sites where material placement will occur. The placement of dredged material will initially cause impacts to wetlands and SAV at some proposed sites. The surveys cited include a 500ft buffer around each location referred to as the Project Study Areas (PSA).

3.1.1 SS1

SS1 PSA is located along the northern shoreline of CCSC. Six substrate types found include mud, sand, clay, gravel, shell (gaping, halves, fragments of shell hash), and live oysters. Prevalent substrates observed include sand (73.5%), mud (15.0%), clay (6.6%), and shell (3.7%). Soils present are Twinpalms and Tidal flats that occasionally flood or pond. The site has a 0 to 3 percent slope and is somewhat poorly drained to poorly drained. The depth of soft sediment averaged 0.2ft and ranged from 0.0 to 1.8ft. Bottom elevations vary from -6.0ft to +2.0ft, and bottom elevation was calculated at -6.0ft NAVD88. Habitat types present include a mixture of estuarine low and high marsh wetlands dominated by saltwort (*Batis maritima*), saltgrass (*Distichlis spicata*), and shoregrass (*Distichlis littoralis*) fringed by algal and sand flats. Palustrine emergent wetlands consist of sea ox-eye daisy (*Borrichia frutescens*). Uplands include unvegetated sand flats located above the high tide line (HTL) elevation.

SS1 has an approximate 297.41ac footprint. The site exhibits significant erosion at the southern shoreline and interior portions due to wave energy from large passing vessels (Mott 2021). The construction of SS1 will impact 219.45ac of open water, 34.64ac of sand flats below HTL, 3.92ac of estuarine wetlands, 21.04ac of palustrine wetlands, and 0.01ac of seagrass. See Figure 2 below:

Figure 2: *SS1 Existing Wetland and Aquatic Resources (WOUS). Refer to Table 2 for Additional Information.*

3.1.2 SS2

SS2 is located along the southern shoreline of the CCSC east of Piper Channel and incorporates part of the Port Aransas Nature Preserve at Charlie's Pasture. Five substrates identified include sand (94.7%), mud (2.3%), shell (1.7%), clay (0.8%), and gravel (0.5%). Soils present are Twinpalms and Tidal flats that occasionally flood or pond. The site has a 0 to 3 percent slope and is somewhat poorly drained to poorly drained. The mean depth of soft sediment is 0.2 and ranges from 0.0ft to 1.9ft. Bottom elevations range from -10.8ft to 1.1ft and average -3.0ft NAVD88. Habitat types present include coastal prairie uplands dominated by little bluestem (*Schizachyrium scoparium*); estuarine low marsh wetlands comprised primarily of smooth cordgrass (S*partina alterniflora*), dwarf saltwort (*Salicornia bigelovii*), and black mangrove (*Avicennia germinans*); and palustrine emergent wetlands dominated by sea ox-eye daisy, salt meadow cordgrass (*Spartina patens*) and Gulf dune paspalum (*Paspalum monostachyum*).

SS2 has an approximate 45.21ac footprint. The shoreline exhibits severe erosion due to wave energy from large passing vessels and two large breaches in the shoreline created by Hurricane Harvey. The construction of SS2 will impact 13.74ac of open water, 24.20ac of sand flats below HTL, 1.25ac of estuarine wetlands, and 11.25ac of palustrine wetlands. See Figure 3 below:

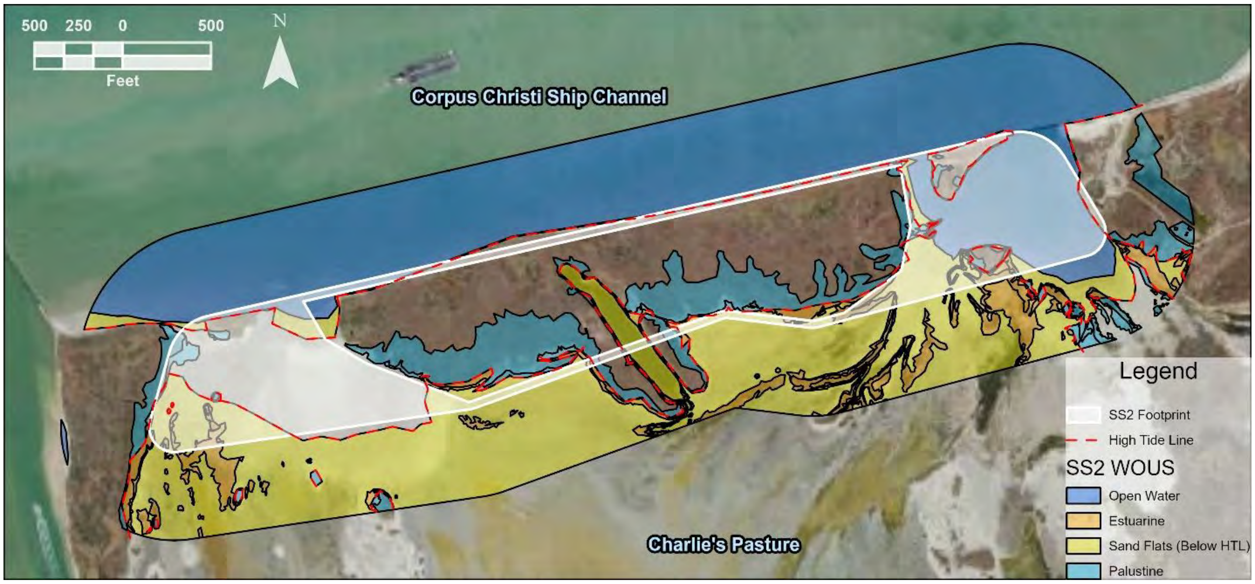


***Figure 3**: SS2 Existing Wetlands and Aquatic Resources (WOUS). Refer to Table 2 for additional information.*

3.1.3 PA4

The PA4 PSA is located along the northern shoreline of CCSC east of SS1. PA4 formation occurred through dredged material placement and included containment levees. Several borrow pits have naturalized into shallow water ponds. Four levees on the northeastern portion of the site are present, with no hydrological connection to Redfish Bay or CCSC. Six substrate types found include mud, sand, clay, gravel, shell (gaping, halves, fragments of shell hash), and live oysters. Predominant substrate types observed include sand (79.9%), mud (11.1%), and shell (6.6%). Soils present include Twinpalms and Tidal flats that occasionally flood or pond. The PSA has 0 to 3 percent slopes and is somewhat poorly drained to poorly drained. The depth of soft sediment averaged 0.2ft and ranged from 0.0 to 1.8ft. Bottom elevations averaged -1.0ft and ranged from -7.1ft to +1.1ft NAVD88. Habitat types present include coastal prairie uplands comprised primarily of little bluestem and prickly pear cactus (*Opuntia engelmanni*); estuarine high marsh wetlands dominated by saltwort, saltgrass, and sand spikerush (*Eleocharis montevidensis*); estuarine low marsh wetlands comprised primarily of smooth cordgrass and black mangrove; palustrine emergent wetlands, composed of sea ox-eye daisy; flats and coastal prairie wetlands, dominated by salt meadow cordgrass and Gulf dune paspalum.

PA4 has an approximate 170.79ac footprint. Severe erosion occurring along the southern shoreline is due to the increased frequency of larger vessels passing. The construction of PA4 will impact 42.14ac of open water, 2.80ac of flats/beach, 0.75ac of estuarine wetlands, 41.75ac of palustrine wetlands, and 3.46ac of seagrass (DEIS 2022). See Figure 4 below:

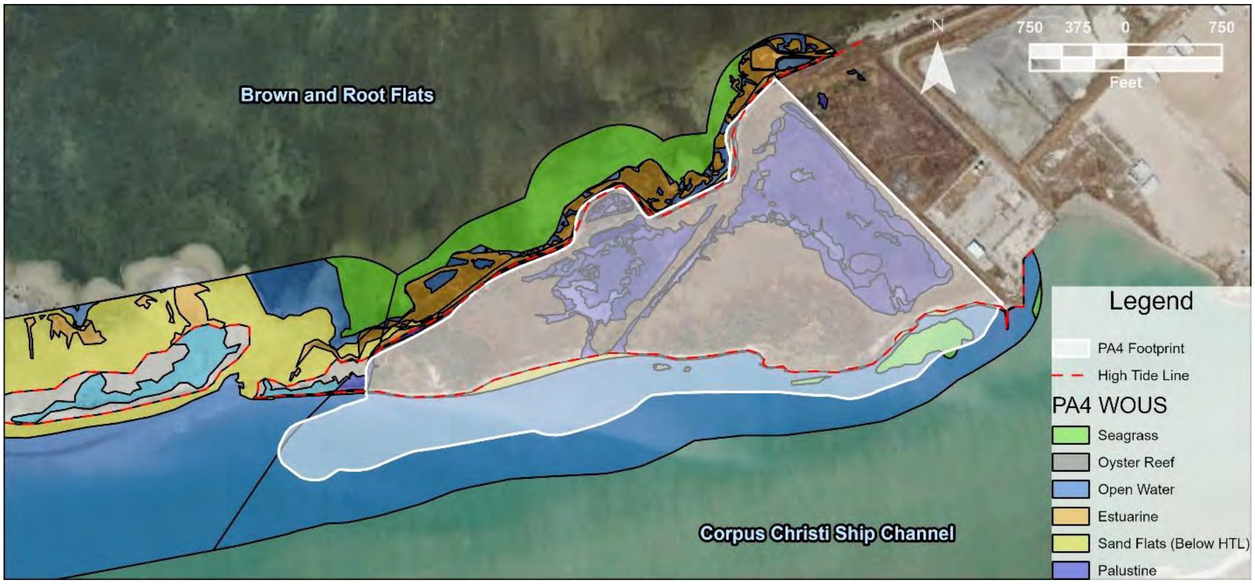


Figure 4: *PA4 Existing Wetlands and Aquatic Resources (WOUS). Refer to Table 2 for additional information.*

3.1.4 HI-E

HI-E PSA is approximately 269.4ac and located east of Harbor Island at the confluence of the Aransas and Lydia Ann Channels, where they flow into the CCSC. Created with dredged material, HI-E later included containment and training levees for placement and dewatering of dredged material. Borrow sites have naturalized into shallow ponds. The mean Braun Blanquet quadrat score is 2 indicating the seagrass relative abundance of roughly 25% cover. Five substrates observed are sand (42.0%), mud (37.5%), clay (9.0%), shell (8.8%), and live oysters (2.6%). Soils present are Barrada-Tatton, Ijam soils, Ijam clay loam, Mustang Fine Sand, Twinpalms Tidal flats, and Beaches. These soils range in drainage class from very poorly drained to somewhat poorly drained. The site has 0 to 3 percent slopes. The depth of soft sediment averages 0.3ft and ranges from 0.0 to 2.6ft with an average bottom elevation of -1.6ft that ranges from -7.2 to +1.7ft NAVD88. Habitat types present include coastal prairie uplands comprised primarily of little bluestem and prickly pear cactus; estuarine low marsh wetlands dominated by smooth cordgrass, dwarf saltwort, and black mangrove; estuarine high marsh wetlands dominated by saltwort, saltgrass, and shoregrass; and palustrine emergent wetlands dominated by salt meadow cordgrass, sea ox-eye daisy, and Gulf dune paspalum.

HI-E has an approximate 138.73ac footprint. Severe erosion and land mass loss along channel shorelines are due to the increased frequency of larger vessels passing. The construction of HI-E will impact 13.12ac of open water, 23.21ac of sand flats below HTL, 10.69ac estuarine wetlands, 48.42ac of palustrine wetlands, 3.41ac of seagrass and 0.10ac of oysters. See Figure 5 below:

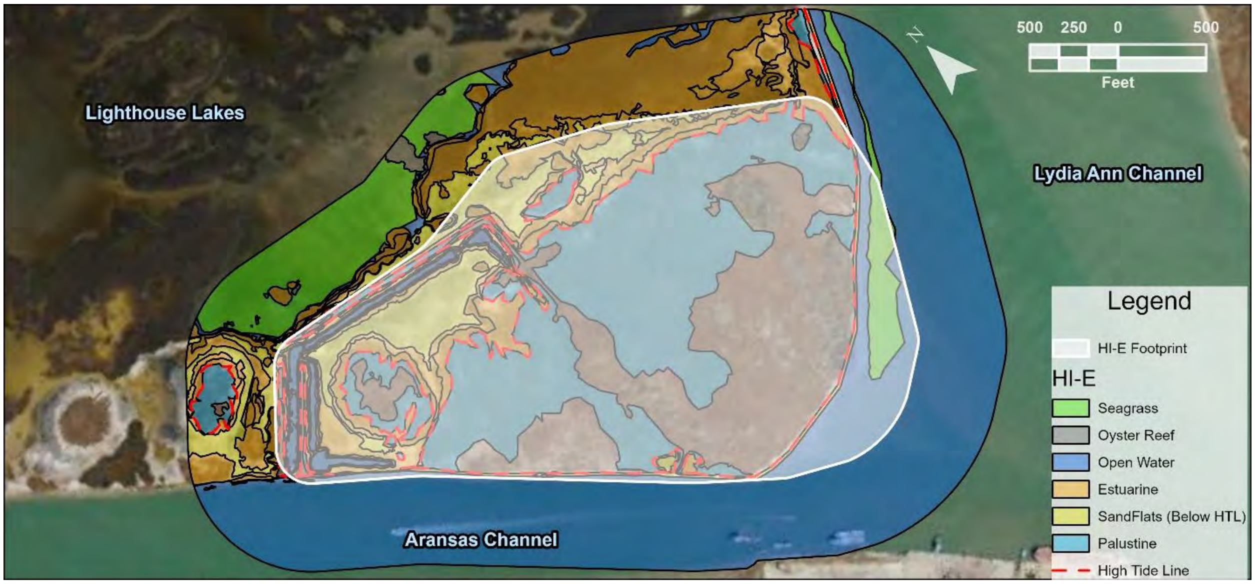


Figure 5: *HI-E Existing Wetlands and Aquatic Resources WOUS. Refer to Table 2 for additional information.*

3.1.5 SJI

The SJI PSA is approximately 1,480.2ac between the GoM and Aransas Bay along the GoM beach from the CCSC, extending north approximately 7mi. The bare substrate was encountered with 100.0% frequency, and sand (100%) was the only substrate type identified. Soils present are Beaches, Galveston-Mustang complex, and Psamments. These soils range in drainage class from very poorly drained to well drained. The site has a 0 to 3 percent slope. Soft sediments across the survey area are firm (mean depth of soft sediment = 0.0) with average bottom elevations of -0.8ft and ranges of -3.3ft to +2.8ft NAVD88. Habitat types present include coastal prairie uplands dominated by little bluestem, partridge pea (*Chamaecrista fasciculata*), four-spike fingergrass (*Eustachys neglecta*), honey mesquite (*Prosopsis glandulosa*), and perennial ragweed (*Ambrosia psilostachya*); coastal dune uplands and grasslands beach dominated by morning glory (*Ipomea pes-caprae*), bitter panicum (*Panicum amarum*), coastal groundcherry (*Physalis angustifolia*), Gulf croton (*Croton punctatus*), shoreline sea purslane (*Sesuvium portulacastrum*), and sea oats (*Uniola paniculata*); and upland sand flats and upland beach with less than five percent vegetative cover.

SJI has an approximate 441.2ac footprint. Hurricane Harvey significantly altered several locations within the footprint. Impacts include shoreline breaches resulting in unvegetated shallow ponded areas within and behind the foredune ridge. The construction of SJI will only impact open water and beach. The SJI footprint will be adjusted in final design to conclude at the waterward toe of the existing sand dune; this will account for any natural changes to the beach profile and avoid wetlands identified landward of the dune system. See Figure 6 below:

Figure 6: *SJI Existing Wetlands and Aquatic Resources (WOUS). Refer to Table 2 for additional information.*

3.1.6 MI

The MI PSA is approximately 986.0ac with an actual surveyed area of 764.5ac due to restricted property access. This location is approximately 5 miles long. The beach ranges in width from 1,000ft from mile marker 39 north to Beach Access Road 1A and 1,400ft between Beach Access Road 1A to the CCSC. The PSA includes Gulf beaches, dunes, and dune swale wetlands along the GoM. No seagrass or live oysters were observed. The bare substrate was encountered with 100.0% frequency, and sand (100%) was the only substrate type identified. Sediments are firm and bottom elevations range from -2.1ft to 2.1ft and average 0.2ft NAVD88. Soils are coastal dunes and coastal beaches ranging in drainage class from somewhat excessively drained to poorly drained. Habitat type present includes Gulf beach; robust upland dune complexes dominated by silver leaf sunflower (*Helianthus argophyllus*), bitter panicum, coastal groundcherry; and palustrine emergent wetlands dominated by salt meadow cordgrass and Gulf dune paspalum.

MI has an approximate 362.2ac footprint. Sea level rise and storm events have significantly eroded beach width along this shoreline. The construction of MI will impact 205.58ac of open water and 124.11ac of flats/beach. See Figure 7 below:

Figure 7: *MI Existing Wetlands and Aquatic Resources. Refer to Table 2 for additional information.*

3.1.7 B1-B9

B1-B9 are a series of stable nearshore berms designed to provide natural wave attenuation during storm events. All berms will typically be constructed near the -24ft bathymetric contour in subtidal waters. The construction of the berms will not impact any wetlands or special aquatic sites.

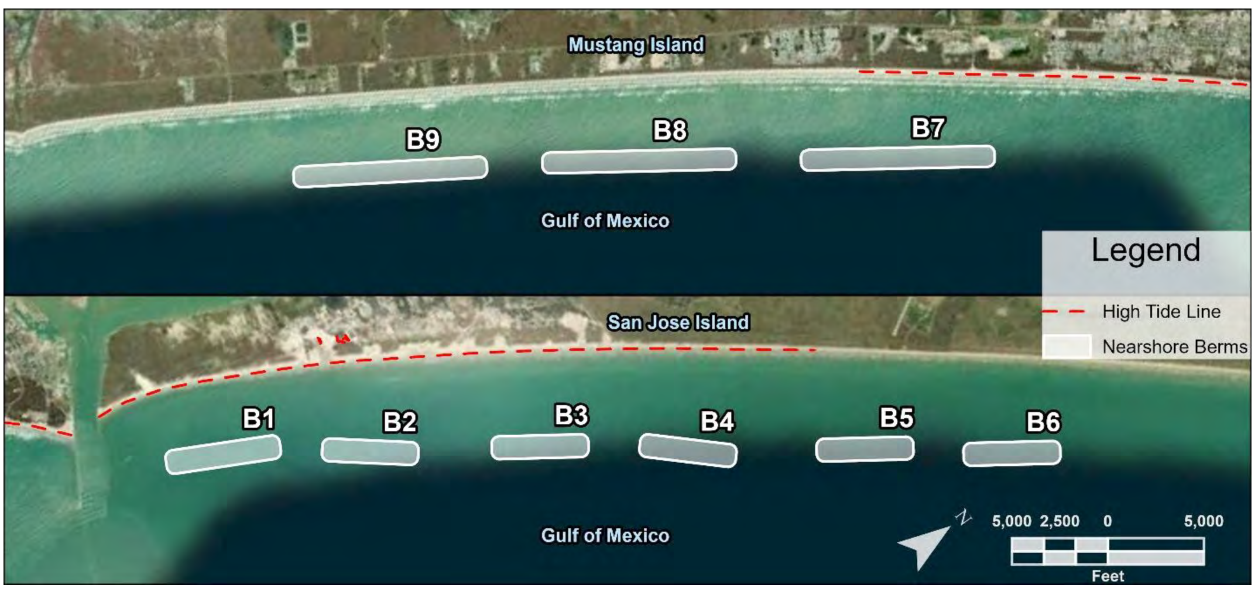


Figure 8*: B1-B9 Existing Wetlands and Aquatic Resources.*

4. Dredge Placement Work Plan

Dredged material placement will occur in approximately 1,455.58ac. area resulting in approximately 146.05ac of wetland and aquatic resource impacts; however, BU placement will create approximately 263.5ac of marsh habitat and protect other wetland and marsh habitats from erosion. Beneficial placement will also impact 6.88ac of seagrass and 0.10ac of oyster, which Port Corpus Christi will relocate (see the 12-Step Permittee Responsible Compensatory Mitigation Plan). However, the placement area design will protect approximately 2,400ac of seagrass in the Brown and Root Flat and 5,000ac of the seagrass-wetland complex of Lighthouse Lakes within Redfish Bay.

The source of dredge material is the CDP. Hydraulic dredgers will remove specified quantities of material at times of the year yet to be determined. As suitable material (i.e., sandy clays and clays) becomes available, it will be utilized for BU construction. Port Corpus Christi will likely utilize a large cutter head suction dredge (like that currently in use for the Channel Improvement Project (CIP)) but may utilize other dredging methodologies. Smaller barges will deploy and mobilize pipelines to transport hydraulically dredged material from the cutterhead to BU sites. Port Corpus Christi will use barges and other shallow-draft vessels for construction. These barges are typically 140ft by 40ft by 9ft and do not typically exceed 10 miles per hour. Barges will deploy once and remain in the location until completion of work. Port Corpus Christi will not know where dredging and construction vessels will deploy from until a dredging contractor is selected. Construction operations will occur for 8 to 12 hours per day. Port Corpus Christi will adhere to the Southeast Regional Office NMFS Protected Species Construction Conditions.

Due to the variety of BU objectives (habitat restoration, industrial development, and beach nourishment), a combination of mechanical and hydraulic dredging/placement will construct the BU sites. Equipment used to place materials mechanically will occur through barge or land. Dredged material placed through hydraulic methods will occur via pipeline. Port Corpus Christi will use barges and pipelines to transport equipment and materials. Material pumping distance depends on the material source location; however, the anticipated distance is no greater than 5 miles from BU sites. Booster pumps may extend the hydraulic dredge placement range, or a combination of hydraulic and mechanical dredging/placement may combine with barges to transport sediment of a particular grain size to a respective BU site. Additional heavy machinery (i.e., graders, excavators, etc.) will deploy on land to achieve target slopes and elevations after dredge material has been placed and dewatered.

Port Corpus Christi will implement available BMPs during the construction of BUs to minimize potential impacts on endangered species and nearby essential fish habitats. BMPs may include but are not limited to turbidity curtains during dredging, construction work window restrictions, and biological monitors. Port Corpus Christi will also deploy temporary cofferdams, silt fences, or similar devices to maintain hydraulically dredge material within the confines of the BU footprints. Before construction, the contractor will recommend the appropriate location of the turbidity and dewatering controls to eliminate, to the most practicable extent, any secondary or indirect impacts to wetlands, seagrass oyster reefs, or other sensitive habitats within the BU buffers. The contractor and Port

Corpus Christi will agree upon these recommendations before construction. Additionally, Port Corpus Christi previously agreed to multiple BMPs and conservation measures, to minimize potential impacts to threatened and endangered species[1]. Port Corpus Christi expects the activities to result in short-term minimum impacts on aquatic resource functions and services outside the BU footprint.

The following subsections detail the BU work plan, including equipment, mobilization, staging, demobilization, dredge sequencing, sediment quality parameters, and geotechnical investigations. Geotechnical investigations[2] conducted in 2018 provide the basis for these subsections, the Unified Soil Classification System, 31 TAC 15.4(c)(3), 31 TAC 15.7 (d)(2), 31 TAC 15.7 (e)(6)(A), and construction methodologies for a similar project previously conducted. Port Corpus Christi will not know the exact construction methodology until a contractor is selected for the work described below. However, if Port Corpus Christi determines that a contractor's methodology is significantly different, Port Corpus Christi will coordinate with USACE to ensure that the proposed work is still within the Environment Impact Statements analysis.

4.1 SS1

Approximately 2,793,000cy of dredged material will be placed to construct SS1. A berm will be constructed using stiff clay or sand. The channel-side berm will be constructed from the bay bottom to elevations ranging from +7ft mean lower low water (MLLW) to +24ft MLLW at a 4:1 slope. The top of the berm will be approximately 100ft in width with an interior slope of 10:1. The 2018 Geotech report identified suitable clay deposits for berm construction near the westernmost portion (BH-38, BH- 36, and BH- 22) of the CDP as well as significant amounts of suitable clays in the easternmost extent of the CDP (BH-01 – BH-12). These clays will be dredged hydraulically and directly placed within the footprint of SS1. Temporary containment berms may be constructed within the footprint of SS1 to dewater dredge material before placement. Clays may also be mechanically dredged and placed on a barge to transport to SS1. Should mechanical dredging and placement occur, temporary berms may not be required. Port Corpus Christi anticipates dewatering of hydraulically placed sediment over one week. Regardless of actual dewater time, Port Corpus Christi will adhere to state water quality regulations by ensuring return water is below 300mg/L of total suspended solids when released from confined areas. Once hydraulically placed sediment has dewatered, Port Corpus Christi will use heavy machinery (marsh buggies, excavators, graders, etc.) to achieve the design slopes and elevations for the berm at SS1.

[1] See USFWS and NMFS Biological Opinions, included in the Final Environmental Impact Statement

[2] See 2018 Fugro Geotechnical Data Report Ship Channel Deepening Project, included in the Final Environmental Impact Statement

Figure 9*: Proposed BU Placement at SS1. This plan excludes discussion on the acreage identified for mitigation. For additional information on the mitigation, see the 12-Step Permittee Responsible Compensatory Mitigation Plan.*

Following the construction of the berm, stone or similar revetment will armor the channel-facing slope. The site will be hydraulically backfilled with sands or clays to +3.8ft MLLW and graded to suitable elevations that sustain vegetation. Sandy material will be hydraulically placed and dewatered within the footprint of SS1, using the existing land mass as containment. Sand is the primary grain size for the CDP dredging and can be sourced from most of the channel (BH-12 – BH-38). Since the BU placement at SS1 will create wetland and upland habitats, some clays are acceptable for placement between the berm and the existing landmass. Following the placement of sand behind the berm, heavy machinery will shape the dredge material to the specified slope and elevation. Heavy machinery will mobilize from State Highway 361 (HWY 361) and drive to SS1 via an existing levee road on the north side of PA4. Should equipment be mobilized via barge, the barge will approach the site from the channel. All equipment staging will occur above HTL and within the footprint of SS1 or PA4.

Planting with native vegetation will occur with species, including but not limited to the species identified in Table 3. Port Corpus Christi will plant the site in the spring/fall immediately following construction to take advantage of South Texas's seasonal rainfall. Surveys conducted for the CDP indicated high marsh vegetation range from 0.4ft to 3.4ft MLLW, and low marsh range from -0.9ft to 2.3ft NAVD88, within the review areas. High marsh areas will directly abut the berm, gradually sloping to low marsh elevations before returning to natural grade at the edge of the project footprint. Shallow circulation channels, below MHW but within the elevation range for the low marsh, will allow for hydrologic exchange throughout SS1. Future design phases will determine the need and configuration of any circulation channels. Excluding the area identified for mitigation, SS1 will create approximately 110.1ac of low marsh and 71.7ac of high marsh.

***Table 3**: Proposed Planting Species for SS1 by Habitat Type.*

Common Name	Scientific Name	Habitat Type
Smooth cordgrass	*Spartina alterniflora*	Low marsh
Saltwort	*Batis maritima*	Low marsh
Glasswort	*Salicornia spp*	Low marsh
Shoregrass	*Distichlis littoralis*	Low Marsh
Annual seepweed	*Sueda linearis*	Low marsh
Marshhay cordgrass	*Spartina patens*	High marsh
Sea ox-eye daisy	*Borrichia frutescens*	High marsh
Salt marsh bulrush	*Scirpus maritimus*	High marsh
Saltgrass	*Distichlis spicata*	High marsh
Gulf cord grass	*Spartina spartinae*	High marsh

All planting will occur on 5ft centers during spring or fall following the construction of SS1 to take advantage of seasonal rainfall. The various habitat zones will be staked to provide visual demarcation for planting efforts. Transplants will likely be sourced from the adjacent PA4, given the proximity to the site. While natural recruitment is expected to occur due to the proximity of the naturally occurring vegetation on the existing landmass, a survival survey will be conducted to ensure the success of transplanting vegetation.

***Figure 10:** SS1 Proposed BU and Habitat Planting Zones. For additional information on the mitigation, see the 12-Step Permittee Responsible Compensatory Mitigation Plan.*

4.2 SS2

Approximately 374,000cy of dredged material will be placed to construct SS2. The berms will be constructed using stiff clay. The channel side will extend from the existing bay bottom to an elevation of +7 MLLW at a slope of 4:1. The top of the berm will be approximately 10ft in width. The interior berm will match interior elevations at a 10:1 slope. Placement of an armored exterior berm or riprap will occur after the completion of berms. The 2018 Geotech Report identified suitable clay deposits for berm construction neat the westernmost portion (BH-38, BH-36, and BH- 22) of the CDP as well as significant amounts of suitable clays in the easternmost extent of the CDP (BH-01 – BH-12). These clays will be dredged hydraulically and directly placed within the footprint of SS2. Temporary containment berms may be constructed within the footprint of SS2 to dewater dredge material before placement. Clays may also be mechanically dredged and placed on a barge to transport to SS2. Should mechanical dredging and placement occur, temporary berms may not be required. Following the placement of berm material with sediment will be mechanically manipulated with heavy machinery (marsh buggies, excavators, graders, etc.) to construct berms.

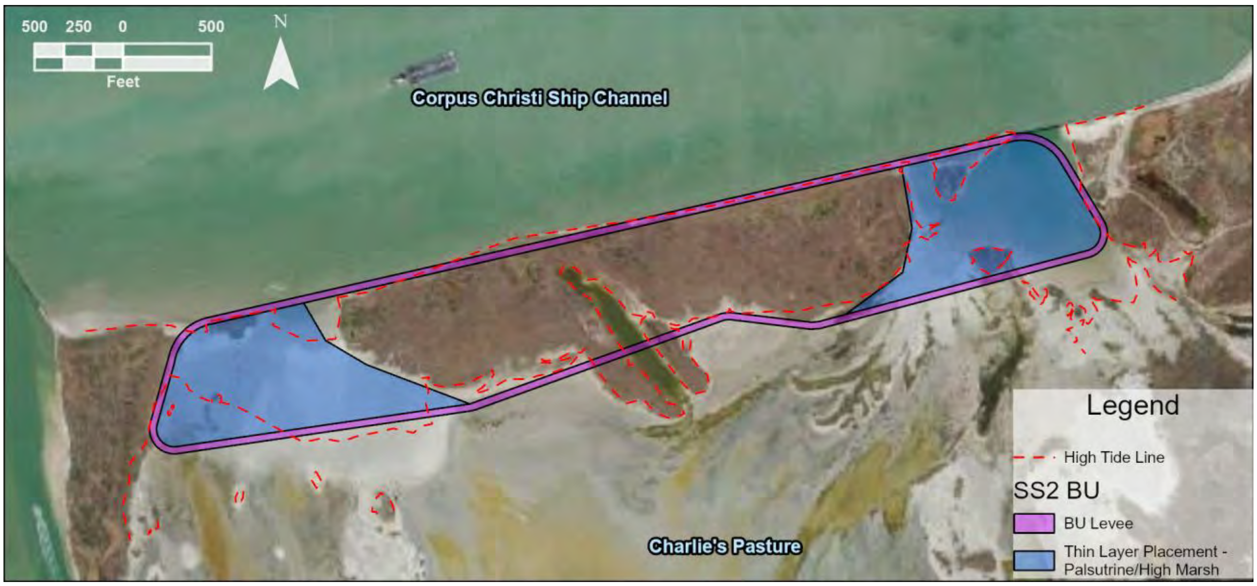


Figure 11: *Proposed BU placement at SS2.*

Thin layer placement of sand or soft clay will occur to elevations of +2.4ft MLLW behind the interior berm throughout approximately 34.3ac. Based on the 2018 Geotech Report, suitable material can be found throughout the channel. The material will be hydraulically dredged and placed within the berm of SS2. Once dewatered (approximately one week), this material, as well as the southern face of the berm, will be mechanically graded to achieve target elevations and natural hydrologic exchange. Port Corpus Christi is not proposing to create inlets or outlets to manage hydroperiod or residence time because the purpose of SS2 is to protect the relatively static environment of Charlie's Pasture from the highly dynamic environment of the CCSC. Historically SS2 has served as a hydrologic barrier between these two systems; the proposed placement would continue to serve this relationship. A natural hydrologic exchange will occur from Piper Channel, southwest of SS2, to inundate the surrounding tidal flats and marsh habitats. Port Corpus Christi will plant the entire 34.3ac with high marsh vegetation to create palustrine wetlands, utilizing transplants from similar wetlands identified within the survey area. A survival survey will be conducted to ensure the success of transplanting vegetation. Heavy machinery will likely mobilize via barge from Piper Channel or the CCSC. Should heavy machinery require access across tidal flats or wetlands outside the footprint of SS2, timber mats will prevent habitat degradation. All equipment staging will occur above HTL, in uplands, and within the footprint of SS2.

4.3 PA4

Approximately 4,320,400cy of dredged material will be placed to construct PA4. The channel side will be constructed from the existing bay bottom to an elevation of +24ft MLLW at a 4:1 slope. The top of the levee width will be approximately 10ft, and the interior levee will match existing interior elevations at a 4:1 slope. The 2018 Geotech Report identified suitable clay deposits for levee construction near the westernmost portion (BH-38, BH-36, and BH- 22) of the CDP as well as significant amounts of suitable clays in the easternmost extent of the CDP (BH-01 – BH-12). Clays will likely be mechanically dredged and placed on a barge to transport to PA4. The levees may also be constructed mechanically with in-situ material from PA4. Since the berms will be constructed mechanically, temporary berms for dewatering dredge material will not be required. Following the construction and restoration of the PA4 levees, unsuitable material for BU (approximately 2,861,400cy) will be hydraulically placed in a traditional confined placement area.

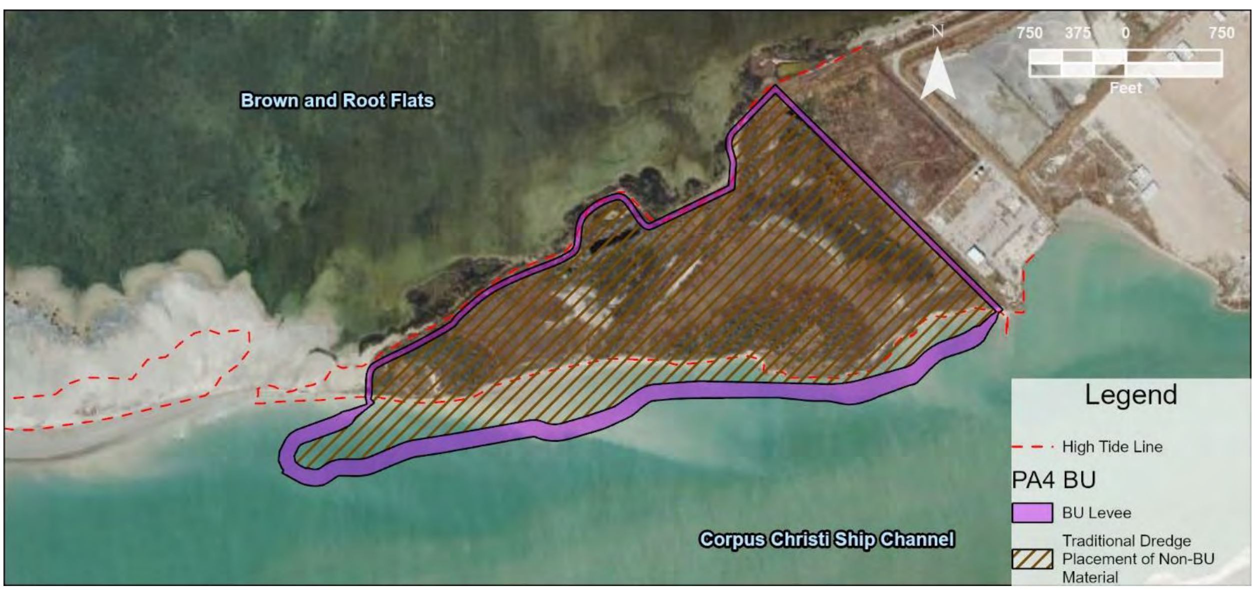


Figure 12: *Proposed BU Placement at PA4.*

Heavy machinery will likely be mobilized from State Highway 361 (HWY 361) and drive to PA4 via an existing levee road on the north side of PA4. Should equipment be mobilized via barge, the barge will approach the site from the channel side. All equipment staging will occur above HTL and within the footprint of PA4.

4.4 HI-E

Approximately 1,825,000cy of dredged material will be placed to construct the site. The existing eroded bluff will be raised using stiff clay. The exterior berm will be constructed from existing bay bottom elevations to varying heights of +8 MLLW to +15 MLLW at a 4:1 slope. The top of the berm width will be 15ft, and the interior berm will be constructed to match interior elevations at a 10:1 slope. The 2018 Geotech Report identified suitable clay deposits for levee construction near the westernmost portion (BH-38, BH-36, and BH- 22) of the CDP as well as significant amounts of suitable clays in the easternmost extent of the CDP (BH-01 – BH-12). Clays will likely be mechanically dredged and placed on a barge to transport to HI-E. The levees may also be constructed mechanically with in-situ material from HI-E. Since the berms will be constructed mechanically, temporary berms for dewatering dredge material will not be required. Rip rap placement will occur along both channel sides after completing the berm construction. Unsuitable material for BU (approximately 1,647,200cy of total dredged material) will be hydraulically pumped within raised levees.

Figure 13*: Proposed BU Placement at HI-E.*

Due to the remote setting of HI-E, heavy machinery will access the site via barge. Equipment will be mobilized from either the north side of HI-E via the Aransas Channel or from the east side via the Lydia Anna Channel. All staging will occur within the footprint of HI-E above HTL. Should it be determined that the equipment must traverse wetlands or special aquatics sites outside the footprint to reach the site, timber mats will be deployed to minimize habitat degradation. The construction of HI-E would impact 0.10ac of oysters; however, Port Corpus Christi will relocate them. For additional information regarding the relocation of the 0.1ac of oyster reef, see the 12-Step Permittee Responsible Compensatory Mitigation Plan.

4.5 SJI

Approximately 2,000,000cy of dredged material is required to combat coastal erosion. For SJI, only beach-quality sand will be placed within the beach and dune system. For this plan, "beach quality sand" is defined as:

- "Depositing sand, soil, sediment, or dredged spoil which is of an unacceptable mineralogy or grain size when compared to the sediments found on the site (this prohibition does not apply to materials related to the installation or maintenance of public beach access roads running generally perpendicular to the public beach)" [31 TAC 15.4(c)(3)]
- "The sediment to be used is of effective grain size, mineralogy, and quality or the same as the existing beach material." [31 TAC 15.7 (d)(2)]
- "piles of sand having similar grain size and mineralogy as the surrounding beach" [31 TAC15.7 (e)(6)(A)]

Additionally, Port Corpus Christi will strive to adhere to the Texas General Land Office grain size parameters:

- Median grain size between 0.10 – 0.30 mm, based on the site conditions of the placement area
- No more than 10%, by weight, passing the #230 sieve
- No more than 5%, by weight, retained on the #4 sieve

The 2018 Geotech Report identified deposits of beach-quality sand within the CDP project (BH-17, BH-18, BH-19, BH-21, BH-22, and BH-31). A hydraulic dredge will target these deposits for beach nourishment fill. This material will be hydraulically dredged and placed within the SJI footprint. Temporary training berms will be excavated within the footprint to dewater the dredge slurry. After dewatering, sand will be mechanically redistributed to achieve target slopes and elevations.

Beach fill (sand) will be directly placed on the existing foreshore to +6ft MLLW and advance the beach seaward. The beach profile will be extended 200ft at a slope of 50:1 to match the existing bottom of GoM. Fill (sand to silty sand) will be graded seaward of the existing foredune from an elevation of +6ft to extend the beach profile into the GoM.

Figure 14: *Proposed BU Placement at SJI.*

Due to the remote setting of SJI, heavy machinery will access the site via barge. Equipment will be mobilized from the Gulf of Mexico beachfront, previous channel access routes, or the bay side via the Lydia Ann Channel. All heavy equipment will utilize timber mats to minimize habitat impacts if access is required via the Lydia Ann Channel. All staging will occur within the footprint of SJI, above the HTL.

4.6 MI

Approximately 2,000,000cy of dredged material is required to repair foreshore erosion. Beach-quality sand will be targeted for all beach nourishment placement as previously specified in Section 4.5 SJI. This material will be hydraulically dredged and placed within the MI footprint. Temporary training berms will be excavated within the footprint to dewater the dredge slurry.

Following the dewatering, sand will be mechanically redistributed to achieve target slopes and elevations. Dewatered sand will be directly placed on the existing foreshore to an elevation of +5 MLLW and advance the beach seaward. The beach profile will be extended 250ft at a slope of 50:1 to match the existing bottom.

4.7 B1-B9

The nearshore berms will be constructed with either hydraulic or mechanical dredging. Dredge material will be placed from the surface and settle within the footprint of berms. Turbidity curtains will minimize turbidity increases outside of the project area. Barges will be used to transport material for mechanical placement or manage slurry pipes for desired placement.

5. Monitoring Requirements

The BU component of the CDP can be divided into three main goals: erosion restoration/prevention, beach nourishment, and habitat creation. Based on these goals, Port Corpus Christi developed this plan to monitor the success of all BU sites proposed as part of the CDP. Port Corpus Christi will monitor each of these sites for up to 5 years to demonstrate project success.

5.1 Erosion Restoration and Prevention

Dredge material will restore erosion at SS1, SS2, PA4, and HI-E and create protective berms to prevent future erosion. A topographic survey will be undertaken before construction to document baseline conditions. A post-construction survey will document the environment and quantify shoreline accretion and successful installation of hardened armoring. Following the completion of the post-construction survey, Port Corpus Christi will complete a topographic survey of the four sites five years after construction to document the stability of the shoreline, noting any erosion if observed. USACE will receive all survey results on the frequency detailed in Section 6.

5.2 Beach Nourishment and Nearshore Berms

Like the monitoring proposed for erosion restoration, topographic surveys will record the elevation for the beach nourishment proposed at SJI and MI. Port Corpus Christi will submit the results of the surveys to USACE in tandem with the survey detailed above. Recognizing that beach nourishment, as a concept, is a continual effort, Port Corpus Christi will analyze the surveys to estimate the life span of nourishment. Port Corpus Christi will include this analysis in the reports to USACE.

5.3 Habitat Protection and Creation

Port Corpus Christi will monitor vegetation growth by quantifying vegetative aerial coverage within the BU sites that create new habitats (SS1 and SS2). Port Corpus Christi will document the initial planting effort, including the area planted, source location for species planted, and other pertinent environmental conditions within 90 days of any planting effort. Port Corpus Christi will also monitor vegetative cover at 1- and 3-years post-planting. A report will be submitted to USACE documenting the progress of the vegetative cover and comparing plant species to the surveys conducted before the project's construction.

Port Corpus Christi will monitor the buffer zone of all BU sites to evaluate secondary or indirect impacts. Port Corpus Christi will utilize the habitat surveys previously conducted for the BU sites for the DEIS as a pre-construction survey. Following the construction of a BU site, Port Corpus Christi will conduct post-construction habitat surveys to document any temporary impacts that may occur within the 500ft buffer of the site. This survey will follow a similar method to those detailed in the DEIS. Habitat surveys will occur within the 500ft buffer, following the same methodology as the post-construction surveys. Monitoring reports submitted to USACE will include the same data collected for the pre-construction survey, especially in vegetative cover and community composition. Additionally, monitoring reports will include a description of any observed change to the habitats within the buffer and a professional opinion by qualified environmental scientists on how BU sites impacted or potentially enhanced existing habitats within the buffer.

6. Performance Standards and Maintenance Plan

While not a direct goal of the BU plan, Port Corpus Christi designed certain sites (SS1, and SS2) to incorporate wetlands and upland plant communities. Where vegetation planting is proposed, Port Corpus Christi will monitor the vegetative aerial coverage to track site success. Transplanting efforts will be deemed successful if a 50% survival rate is met or exceeded following the survival survey. The final vegetation of these sites will be deemed successful if 60% aerial coverage is met or exceeded by year 3. Should vegetative aerial coverage fail to be 60% by year 3, Port Corpus Christi will determine the extent of failed revegetation and replant the areas to the original specification.

Where Port Corpus Christi proposes to monitor the habitat quality of the buffer around a BU, the project will be deemed successful if there is no net loss to wetlands or noted habitat degradation (erosion, upland conversion of wetlands, reduction in vegetative aerial cover, etc.). If impacts are observed in the buffer area, Port Corpus Christi will identify the cause before selecting a corrective action.

Beach nourishment will be considered a success if elevations show natural profiles post-construction survey. Port Corpus Christi identified sediment sources within the channel using extensive geotechnical surveys. However, if large deposits of unsuitable material are placed during dredging, such as clay deposits, they will be mechanically removed and placed in a traditional DMPA. Since any unsuitable material will be removed during construction, no corrective action is proposed for grain size criteria.

Erosion response (both prevention and nourishment) is a primary goal for all BU sites. Following the schedule detailed above for reporting natural recruitment and planting success, Port Corpus Christi will provide USACE with the most recent topographic surveys for all BU sites. In addition, Port Corpus Christi will include a comparison of the most recent survey to the baseline data collected and provide a written narrative comparing the two and quantifying project success.

As part of its asset management plan, Port Corpus Christi visually inspects all shorelines adjacent to Port-owned submerged property on an annual and post-tropical storm basis to document erosion and storm surge damage. Ongoing inspections include SS1, SS2, PA4, and HI-E. Port Corpus Christi will continue this practice in perpetuity, allowing for the identification of any maintenance issue in hardened shorelines associated with the BU sites. Should structural damage be identified that jeopardizes the integrity of a BU site, Port Corpus Christi will repair the damage with funds from the Port's budget or submit for reimbursements from the Federal Emergency Management Administration.

The construction of a nearshore berm will be determined by post-construction bathymetric surveys. Construction success will be determined individually for each berm by a comparison of as-built profiles to design profiles. Port Corpus Christi will include this data in the subsequent monitoring report. However, since the nearshore berms will provide utility even partially constructed, Port Corpus Christi does not propose corrective actions when the constructed berms do not coincide directly with the design profiles.

Table 4: *Survey Summary Table.*

Site	Survey Type	Pre-Construction	Post-Construction	1-year	3-year	Success Criteria	Correct Action
SS1	Topographic	√	√	X	X	Revetment and Berm Condition	Revetment Repairs or Maintenance
	Planting Success	Completed	√	√	√	Vegetative Cover and Composition	Replanting
	Buffer Habitat	Completed	√	X	X	Vegetative Cover and Composition	EOT Monitoring, Direct Compensation
SS2	Topographic	√	√	X	X	Revetment and Berm Condition	Revetment Repairs or Maintenance
	Planting Success,	Completed	√	√	√	Vegetative Cover and Composition	Replanting
	Buffer Habitat	Completed	√	X	X	Vegetative Cover and Composition	EOT Monitoring, Direct Compensation
PA4	Topographic	√	√	X	X	Revetment and Berm Condition	Revetment Repairs or Maintenance
HI-E	Topographic	√	√	X	X	Revetment Condition	Revetment Repair
	Oyster Relocation	√	√	X	X	Oyster Survival	EOT Monitoring, Direct Compensation
SJI	Topographic	√	√	X	X	N/A	N/A
MI	Topographic	√	√	X	X	N/A	N/A

7. Adaptive Management

To ensure the successful completion of all components of this BUMP, Port Corpus Christi included adaptive management criteria to allow for expedited corrective action. This adaptive management section of the plan addresses three major sources that may prevent project success and proposed remedies: improper elevation, vegetation failure, and improper grain size.

If, following the post-construction survey, Port Corpus Christi determines target elevations were not met during construction, Port Corpus Christi will add or remove dredge material to achieve the desired elevation. Target elevations may also be met by adding clean, locally sourced fill from offsite. Port Corpus Christi may also elect not to address the elevation delta should it be determined in the survey that the elevation achieved will likely naturalize into other sensitive habitats, such as sand flats or seagrass beds. This determination will be based on topographic and planting success monitoring surveys and compared to target elevations derived from pre-construction surveys (see Table 5). Port Corpus Christi will detail any of these conversions exceeding 0.5ac to USACE within the subsequent monitoring report.

Table 5*: Target Elevations for Sensitive Habitats as Determined by Habitat Surveys within the BU sites.*

Habitat	Elevation (FT MLLW)			
	Min	Max	Mean	Median
Seagrass	0.5	-5.8	-1.0	-0.9
Sand/Algal Flat	-0.1	2.4	1.6	2.3
Mangrove	-0.5	2.5	0.9	0.6
Low Marsh	-0.7	2.5	1.4	2.3
High Marsh	0.6	3.6	2.3	2.4
Palustrine	1.8	3.6	2.4	2.4

Should initial vegetation transplants fail to meet a 50% survival rate Port Corpus Christi may supplement with a second transplanting effort. Port Corpus Christi may also elect to seed the site with hydroseed, or similar material, using a mix of the species listed in Table 3. Should initial transplanting succeed but vegetation fails to meet final vegetative coverage, Port Corpus Christi may elect to undertake a supplemental planting at a lower density of plugs or use a hydroseed mixture. Port Corpus Christi may also elect to install temporary watering devices to promote increased vegetative coverage. Additionally, Port Corpus Christi may elect to extend the monitoring period of one or more sites to ensure success criteria are met. Should the monitoring period be extended, Port Corpus Christi will notify USACE in writing with the 3yr monitoring report.

Each BU site requires different grain sediment for successful construction, i.e., SJI and MI require coarse to silty sands, whereas the levees or PA4 and HI-E require stiff clays. The wrong grain size will have different implications for each site; Port Corpus Christi will respond to deposits of unsuitable material relative to the impact. Should unsuitable material be placed in an area of habitat creation, Port Corpus Christi may elect to leave the material in place to determine if successful vegetation may still occur. Should target vegetation fail due to unsuitable sediment, Port Corpus Christi may elect to remove up to the top 1ft of material and replace it with suitable dredge material or locally sourced clean fill from offsite. Should unsuitable material, such as clay balls, be deposited on SJI or MI, Port Corpus Christi will remove the deposits for disposal in a confined placement area such as PA4 or HI-E. Additional sand may or may not be placed in these BU sites depending on the availability of additional suitable material. Should unsuitable material be placed for levee construction, a qualified engineer will assess whether this material compromises the levee's integrity. Port Corpus Christi may remove this material for placement in a confined PA and replace it with additional suitable dredge material or clean, locally sourced fill.

Attachment A – Hurricane Harvey Damage Shoreline Assessment

MOTT MACDONALD

PCCA Hurricane Harvey Damage Shoreline Assessment

Port of Corpus Christi Authority
222 Power Street
Corpus Christi, TX 78401

711 North Carancahua
Suite 1610
Corpus Christi TX 78401
United States of America

T +1 (361) 661 3061

mottmac.com

January 17, 2018

Mr. Flint,

Mott MacDonald assessed the Port of Corpus Christi Authority (PCCA) property shoreline and identified areas impacted by Hurricane Harvey. First, we performed a desktop analysis to quantify the erosion pre- and post-hurricane Harvey and delineate any areas with severe erosion. Then, we reviewed aerials to identify areas where coastal structures, such as revetments and geotextile tubes, may have been damaged. Once the areas were identified, we conducted a site visit to document the structure's condition. After our inspection, we developed a conceptual level engineer's cost estimate for measures needed to stabilize the areas observed.

To identify areas of concern, we reviewed aerials taken prior to hurricane Harvey and those collected immediately post- storm to identify any significant changes to the shoreline. As part of this analysis, the shoreline position was derived by delineating the visible waterline from aerials obtained from publicly available sources. The shoreline positions (referenced to a baseline landward of all the shorelines) were determined at orthogonal transects spaced 100 feet along the baseline. The results were plotted on a map with areas flagged for additional review where extreme changes were observed.

The long-term erosion of the shoreline was also determined using several years of aerial imagery to identify any areas where severe long-term erosion was evident and may be of concern. This process involved the use of GIS software to first derive digital shorelines by delineating the visible waterline in each of the georeferenced aerials. A total of seven shorelines covering the entire PCCA property shoreline were delineated from aerial images from 1995 to 2017. The shoreline analysis involved casting transects across the shorelines from a baseline, measuring the shoreline positions, and ultimately quantifying the average shoreline change rates. The results of this analysis are contained in a GIS file which will be submitted to the PCCA accompanying this letter.

Following the pre-and-post hurricane Harvey shoreline change analysis, 11 areas of concern were identified throughout the PCCA shoreline. The areas were selected based on observed high erosion, proximity to infrastructure such as roads, and/or observed damage to shoreline stabilization structures. The areas of concern selected are as follows:

- East Harbor Island Point
- Harbor Island Geotextile Tube
- West Harbor Island
- West of Piper Channel
- Pelican Island
- La Quinta Island Levee (PA-13)
- BUS6 Offshore Emergent Levee
- Inner Harbor Revetment
- Rincon B Shoreline
- South Shore DMPA Cell B Shoreline
- Nueces Bay Shoreline

The following section of this letter describes the areas of concern and summarizes observations from the site visits. Preliminary cost estimates were made for preliminary repair or stabilization alternatives where needed. These estimates and alternatives were developed based on best engineering judgement and observations of the site and are for preliminary planning purposes only.

East Harbor Island Point

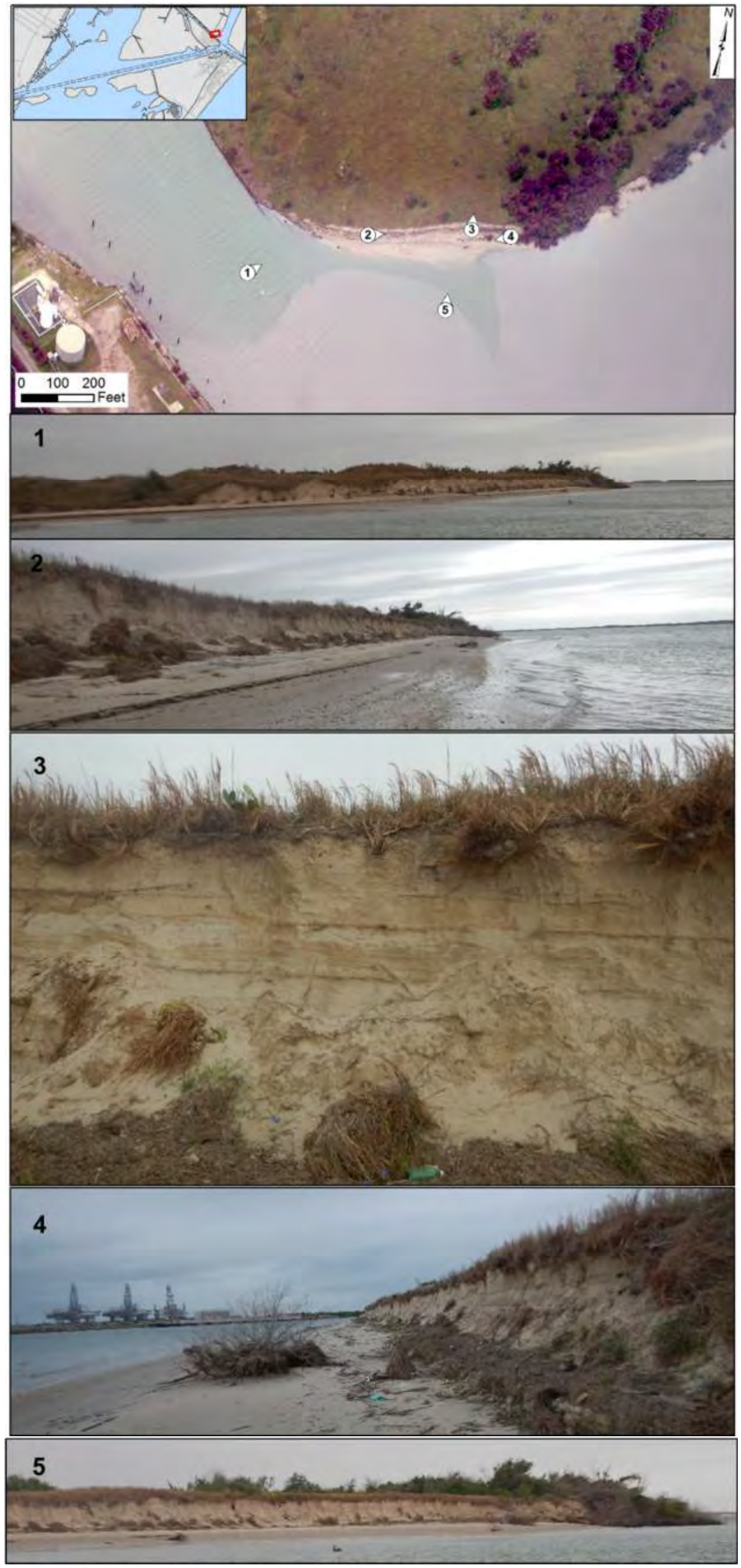


Figure 1. East Harbor Island Point

MOTT MACDONALD

This area is located at the point where the Aransas and Lydia Ann Channels intersect just east of Port Aransas as shown in Figure 1. The desktop analysis showed erosion rates in excess of 30' at this location due to Hurricane Harvey. An escarpment was visible along the shoreline which was approximately 7' tall and 750' long. Based on the observed long-term erosion rates in this area, continual erosion is expected. If allowed to continue unmitigated, this erosion will lead to additional loss of PCCA property as well as potential sedimentation of the adjacent Lydia Ann and Aransas channels.

Three options are presented below to stabilize the shoreline in this area. The first option would be to place fill in this area to return the shoreline to pre-damage conditions. The fill would cover the approximate 750' long shoreline where the escarpment was observed. A probable cost estimate for this option can be found in the table below.

East Harbor Island Point

Probable Construction Cost Estimate (Beach Fill - Option 1)

Item	Item Description	Quantity	Unit	Unit Cost	Total Costs[2]
1	Mobilization and Demobilization	1	LS	$ 300,000	$ 150,000
2	Construction Surveying	1	LS	$ 50,000	$ 50,000
	Geotextile Tube Fill	25,000	CY	$14	$ 350,000
6	Performance Bonds[1]	1	LS	$ 27,500	$ 27,500
		Subtotal			$ 577,500
		30% Contingency			$ 173,250
		Total			**$ 750,750**
	Notes:	[1] Bonds assumed at 5% of the repair work. [2] All costs include a contractor overhead and profit of 10%			

The second option would be to install a 750' long geotextile tube and scour apron in this area to prevent further erosion of the shoreline. A probable cost estimate for this option can be found in the table below.

East Harbor Island Point

Probable Construction Cost Estimate (Geotextile Tube - Option 2)

Item	Item Description	Quantity	Unit	Unit Cost	Total Costs[2]
1	Mobilization and Demobilization	1	LS	$ 300,000	$ 200,000

2	Construction Surveying	1	LS	$ 50,000	$ 50,000
3	Geotextile Tube	750	LF	$ 90	$ 67,500
4	Scour Apron	750	LF	$ 45	$ 33,750
	Geotextile Tube Fill	25,000	CY	$14	$ 350,000
6	Performance Bonds[1]	1	LS	$ 35,063	$ 35,063
		Subtotal			$ 736,313
		30% Contingency			$ 220,894
		Total			**$ 957,207**
	Notes:	[1] Bonds assumed at 5% of the repair work. [2] All costs include a contractor overhead and profit of 10%			

The third option would be to install a riprap revetment along the eroded 750' of shoreline. Although this option is more expensive than the geotextile tube, revetments are much more durable and not susceptible to vandalism which reduces the life of a geotextile tube. Due to the high wave energy from passing vessel wakes, a revetment is the recommended option for stabilizing the shoreline in this area. A cost estimate for the installation of approximately 750' feet of riprap revetment at this location can be found in the table below.

East Harbor Island Point

Probable Construction Cost Estimate (Riprap Revetment - Option 3)

Item	Item Description	Quantity	Unit	Unit Cost	Total Costs[2]
1	Mobilization and Demobilization	1	LS	$ 300,000	$ 200,000
2	Construction Surveying	1	LS	$ 50,000	$ 50,000
3	Armor Stone	8,200	TON	$ 125	$ 1,025,000
4	Bedding Stone	2,100	TON	$ 125	$ 262,500
5	Geotextile	5,000	SY	$11	$55,000
6	Performance Bonds[1]	1	LS	$ 79,625	$ 79,625

MOTT MACDONALD

	Subtotal	$ 1,672,125
	30% Contingency	$ 501,638
	Total	**$ 2,173,763**
Notes:	[1] Bonds assumed at 5% of the repair work. [2] All costs include a contractor overhead and profit of 10%	

Finally, the engineering and design process for all alternatives would be similar as the same environmental and regulatory restrictions apply. Also, we anticipate construction timelines to be similar for both options so the estimate provided below for probable engineering costs is applicable to both alternatives presented in this section.

Harbor Island Geotextile Tube

Probable Engineering Cost Estimate

Item Description	Total Costs
Data Collection, Preliminary Engineering, Permitting	$ 46,000
Final Engineering, Bidding	$ 60,000
Construction Oversight	$ 40,000
Total	**$ 146,000**

Harbor Island Geotextile Tube

MOTT MACDONALD

Figure 2. Harbor Island geotextile tube

There is approximately 1,800 feet of geotextile tube along harbor island, just northwest of Port Aransas. Figure 2 shows sections of the geotextile tube had been damaged prior to Hurricane Harvey, but some areas have sustained further damage due to the storm. Along the east end of this area, the geotextile tube was no longer intact and only the scour apron remained (photos 1-4 in Figure 2). The shoreline at this location had begun to erode and an escarpment is clearly visible. Although the remainder of the geotextile tube was mostly intact, some visible damage to the geotextile fabric is present. The area seaward of the tube appears to have eroded since it's installation because there was a significant elevation difference from the land behind the tube and the seaward edge of the scour apron (approximately 12 feet to 15 feet). Signs that the tube has started to collapse seaward where the tube has rolled seaward slightly to the point where the sections not covered by the UV shroud are visible. There was also localized erosion at the locations where adjacent tubes met as material could wash out through the gaps in the joints (Photo 7 of Figure 2. There were some areas where the tube had failed and had lost fill material, evidenced by the observed loss in crest elevation.

A section of geotextile tube (approximately 100 feet long) at the eastern end of the structure, where the tube had failed and had rolled into the water (photos 8 and 9 in Figure 2). The scour apron was exposed and the land behind had begun to erode. Even though this occurred prior to the hurricane, additional erosion at the shoreline in this location was observed. The land adjacent to the east terminus of the tube had also eroded noticeably and a large escarpment had formed (approximately 300 feet long and 40 feet tall).

Three options are presented below to stabilize the shoreline in this area. The first option would be to replace the existing geotextile tube (in-kind) with a new geotextile tube and scour apron. The new tube would cover the same footprint of the existing geotextile tube to return the area to pre-damage conditions. A probable cost estimate for this option can be found in the table below.

Harbor Island Geotextile Tube

Probable Construction Cost Estimate (Geotextile Tube - Option 1)

Item	Item Description	Quantity	Unit	Unit Cost	Total Costs[2]
1	Mobilization and Demobilization	1	LS	$ 300,000	$ 300,000
2	Construction Surveying	1	LS	$ 50,000	$ 50,000
3	Geotextile Tube	2,000	LF	$ 90	$ 180,000
4	Scour Apron	2,000	LF	$ 45	$ 90,000
	Geotextile Tube Fill	65,000	CY	$14	$ 910,000
6	Performance Bonds[1]	1	LS	$ 81,350	$ 76,500
		Subtotal			$ 1,606,500
		30% Contingency			$ 481,950
		Total			**$ 2,088,450**
	Notes:	[1] Bonds assumed at 5% of the repair work. [2] All costs include a contractor overhead and profit of 10%			

The second option would be to replace the existing geotextile tube with the addition of approximately 200' of new tube to the western end of the structure to protect the shoreline at that location, which would increase the total length of the structure to 2,200 feet. The new tube would have an approximate circumference of 32 feet based on observation of the existing geotextile tube. The probable cost estimate for this alternative can be found in the table below.

Harbor Island Geotextile Tube

Probable Construction Cost Estimate (Geotextile Tube - Option 2)

Item	Item Description	Quantity	Unit	Unit Cost	Total Costs[2]

MOTT MACDONALD

1	Mobilization and Demobilization	1	LS	$ 300,000	$ 300,000
2	Construction Surveying	1	LS	$ 50,000	$ 50,000
3	Geotextile Tube	2,200	LF	$ 90	$ 198,000
4	Scour Apron	2,200	LF	$ 45	$ 99,000
	Geotextile Tube Fill	70,000	CY	$14	$ 980,000
6	Performance Bonds[1]	1	LS	$ 81,350	$ 81,350
		Subtotal			$ 1,708,350
		30% Contingency			$ 512,505
		Total			**$ 2,220,855**
	Notes:	[1] Bonds assumed at 5% of the repair work. [2] All costs include a contractor overhead and profit of 10%			

The third option would be to install a riprap revetment along the shoreline where the geotextile tube is currently located. This alternative would also extend an additional 200 linear feet to cover the unprotected area to the west. Although this option is more expensive than the geotextile tube, revetments are much more durable and not susceptible to vandalism which reduces the life of a geotextile tube. Due to the high wave energy from passing vessel wakes and the scour at the toe of the existing geotextile tube, a revetment is the recommended option for stabilizing the shoreline in this area. A cost estimate for the installation of approximately 2,200 feet of riprap revetment at this location can be found in the table below.

Harbor Island Geotextile Tube

Probable Construction Cost Estimate (Riprap Revetment - Option 3)

Item	Item Description	Quantity	Unit	Unit Cost	Total Costs[2]
1	Mobilization and Demobilization	1	LS	$ 300,000	$ 300,000
2	Construction Surveying	1	LS	$ 50,000	$ 50,000
3	Armor Stone	24,000	TON	$ 125	$ 3,000,000

4	Bedding Stone	6,000	TON	$ 125	$ 750,000
5	Geotextile	14,000	SY	$11	$154,000
6	Performance Bonds[1]	1	LS	$ 212,700	$ 212,700
		Subtotal			$ 4,466,700
		30% Contingency			$ 1,340,010
		Total			**$ 5,806,710**
	Notes:	[1] Bonds assumed at 5% of the repair work. [2] All costs include a contractor overhead and profit of 10%			

Finally, the engineering and design process for both alternatives would be similar as the same environmental and regulatory restrictions apply. Also, we anticipate construction timelines to be similar for all options so the estimate provided below for probable engineering costs is applicable to both alternatives presented in this section.

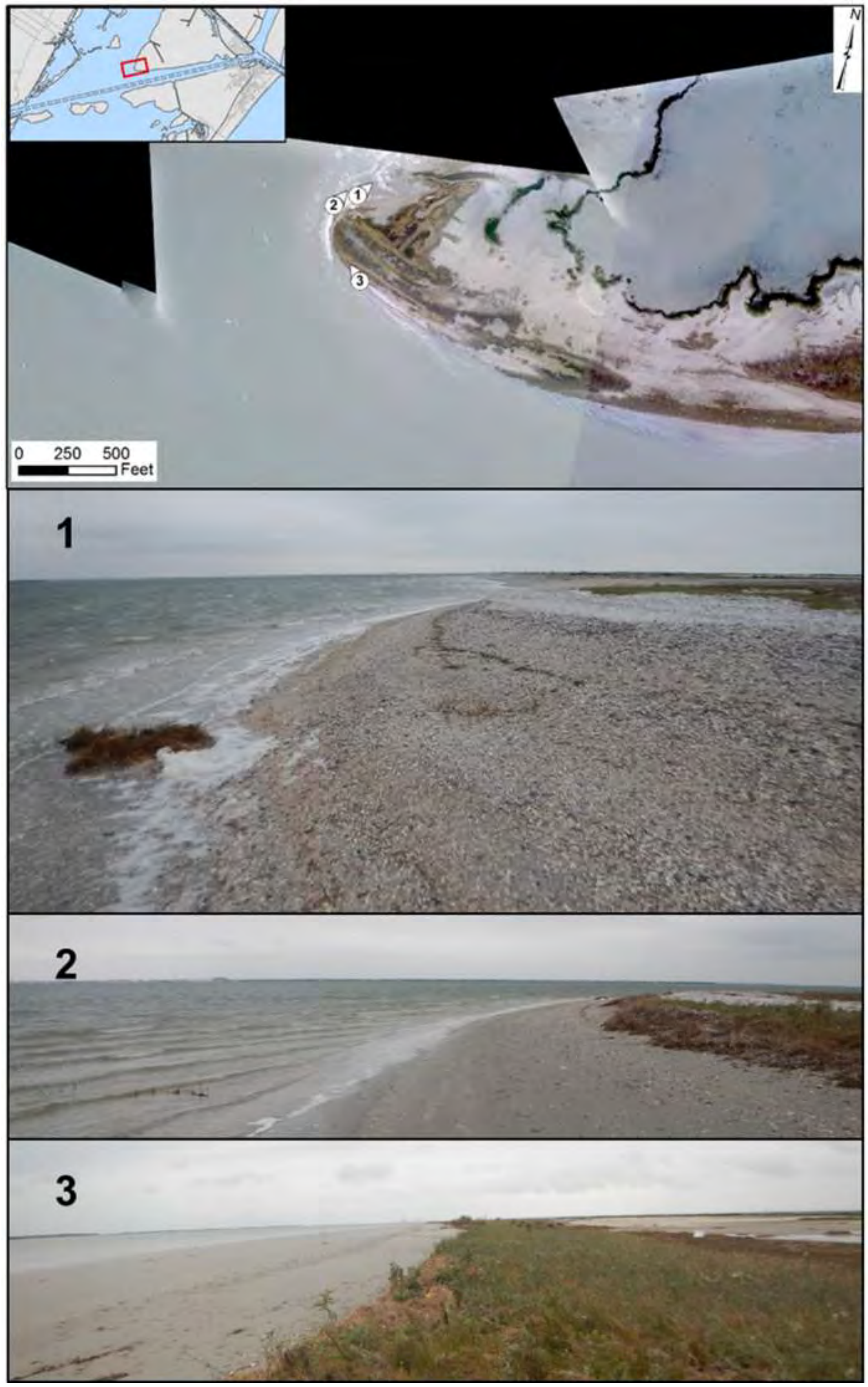
Harbor Island Geotextile Tube

Probable Engineering Cost Estimate

Item Description	Total Costs
Data Collection, Preliminary Engineering, Permitting	$ 46,000
Final Engineering, Bidding	$ 80,000
Construction Oversight	$ 54,000
Total	**$ 180,000**

MOTT MACDONALD

West Harbor Island



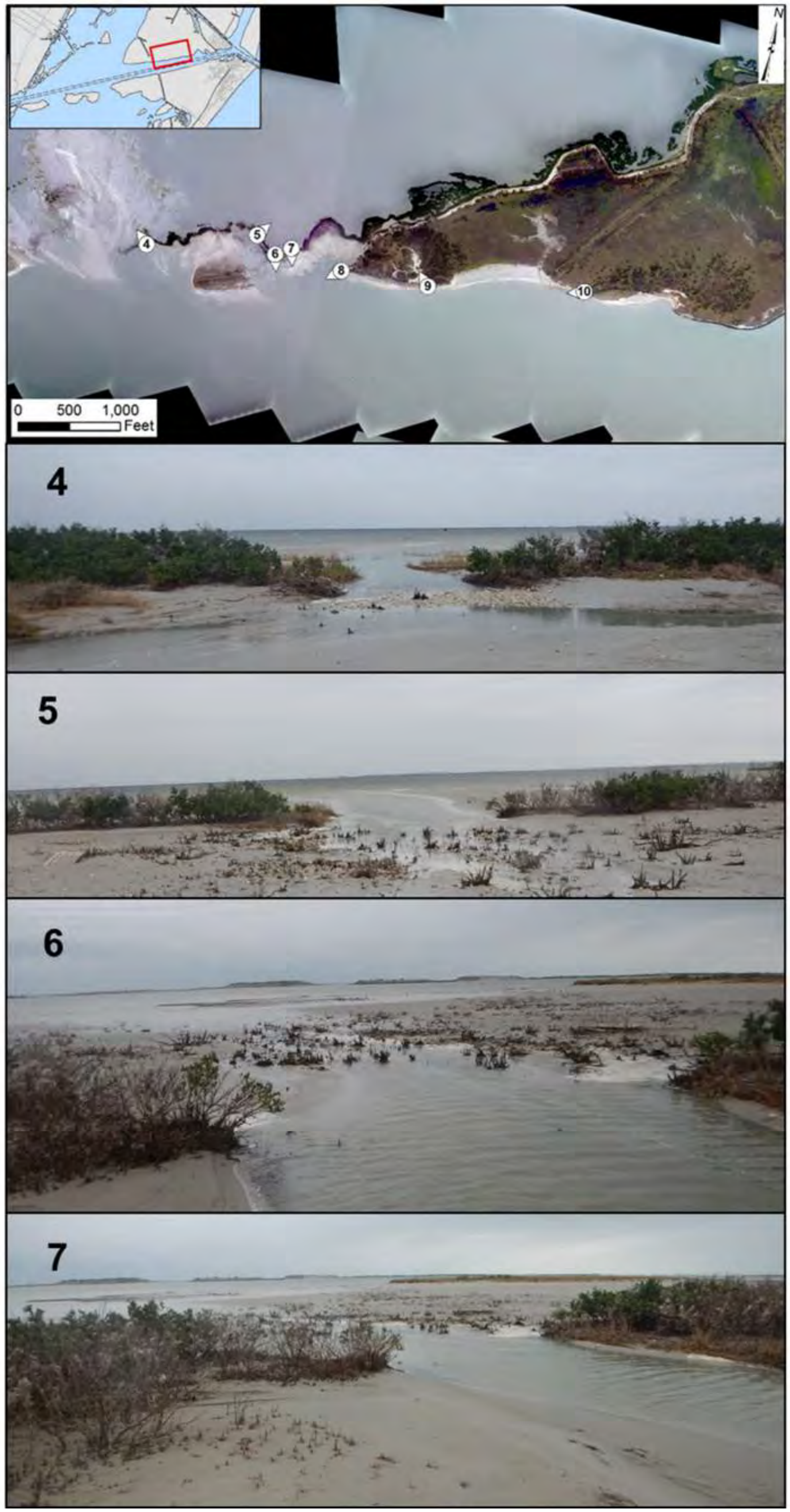

N
4
5
6
7
8
9
10
0 500 1,000
Feet
4
5
6
7

Figure 3. West Harbor Island

The shoreline along the western end of Harbor Island also experienced additional erosion due to Hurricane Harvey as indicated in Figure 3. The land in this area is at a much lower elevation than the other adjacent areas within Port Aransas which make it more susceptible to storm surge. The storm surge from Hurricane Harvey caused several breaches to form, connecting Redfish Bay to the Corpus Christi Ship Channel. Some existing breaches had also expanded due to the hurricane.

At the time of the site visit, the tide was low enough that the breach locations were not submerged however, there was evidence that the land was submerged because water had ponded during higher tides in several locations as noted in picture 4-8 of Figure 3. The breaching and low elevation also led to severe erosion of the shoreline from the storm which was estimated to range on average between 50 and 100 feet and up to a maximum of approximately 200 feet along the western point of harbor island.

If no action is taken, it is likely that the breaches will continue to deepen due to erosion caused by water flowing through the area. That, coupled by the rapid erosion of the shoreline, will likely result in the disappearance of this section of harbor island in the near future.

Two options are presented for the stabilization and restoration of the western Harbor Island shoreline. The first would be to install approximately 12,000 linear feet of geotextile tube along the shoreline of Harbor Island, covering the area shown in Figure 4. The tube is assumed to have an approximate circumference of 32 feet based on observations of similar structures in the area.

Figure 4. West harbor island shoreline stabilization area

The table below shows the probable construction cost estimate for 12,000 feet of geotextile tube along the shoreline of West Harbor Island.

West Harbor Island

Probable Construction Cost Estimate (Geotextile Tube)

Item	**Item Description**	**Quantity**	**Unit**	**Unit Cost**	**Total Costs[2]**
1	Mobilization and Demobilization	1	LS	$ 300,000	$ 300,000
2	Construction Surveying	1	LS	$ 50,000	$ 50,000
3	Geotextile Tube	12,000	LF	$ 90	$ 1,080,000
4	Scour Apron	12,000	LF	$ 45	$540,000
5	Geotextile Tube Fill	375,000	CY	$14	$ 5,250,000
6	Performance Bonds[1]	1	LS	$ 361,000	$ 361,000
		Subtotal			$ 7,581,000
		30% Contingency			$ 2,274,300
		Total			**$ 9,855,300**
	Notes:	[1] Bonds assumed at 5% of the repair work. [2] All costs include a contractor overhead and profit of 10%			

The second alternative would be to fill the breach areas and along the shoreline to raise the elevation of Harbor Island to pre- damage conditions, reducing its exposure to storm waves and passing vessel wakes. This would be done by constructing a low crested earthen berm using beach quality sand dredged from the adjacent channel. The berm would have an approximate crest elevation of +5' MLT and a crest width of approximately 250 feet and would extend 12,000 feet along the west harbor island shoreline. Note that this alternative would only be a temporary solution because it does not address the continual erosion of the shoreline and potential storm events which will

MOTT MACDONALD

likely result in future breaching. A preliminary cost estimate for this alternative is presented in the table below.

West Harbor Island

Probable Construction Cost Estimate (Beach Fill)

Item	Item Description	Quantity	Unit	Unit Cost	Total Costs[2]
1	Mobilization and Demobilization	1	LS	$ 300,000	$ 300,000
2	Construction Surveying	1	LS	$ 50,000	$ 50,000
3	Beach Fill	600,000	CY	$ 14	$ 8,400,000
4	Performance Bonds[1]	1	LS	$ 437,500	$ 437,500
		Subtotal			$ 9,187,500
		30% Contingency			$ 2,756,250
		Total			**$ 11,943,750**
	Notes:	[1] Bonds assumed at 5% of the repair work. [2] All costs include a contractor overhead and profit of 10%			

The alternatives for West Harbor Island are preliminary and further investigation will be necessary to determine the best option for protection of this area. Alternatives will need to be evaluated on their effectiveness, cost, environmental impact, etc. prior to selection of a preferred stabilization alternative for this area. The engineer's estimate of probable cost, below, includes the effort necessary to conduct this analysis.

West Harbor Island

Probable Engineering Cost Estimate

Item Description	Total Costs
Data Collection, Preliminary Engineering, Permitting	$ 75,000
Final Engineering, Bidding	$ 80,000
Construction Oversight	$ 54,000
Total	**$ 209,000**

West of Piper Channel

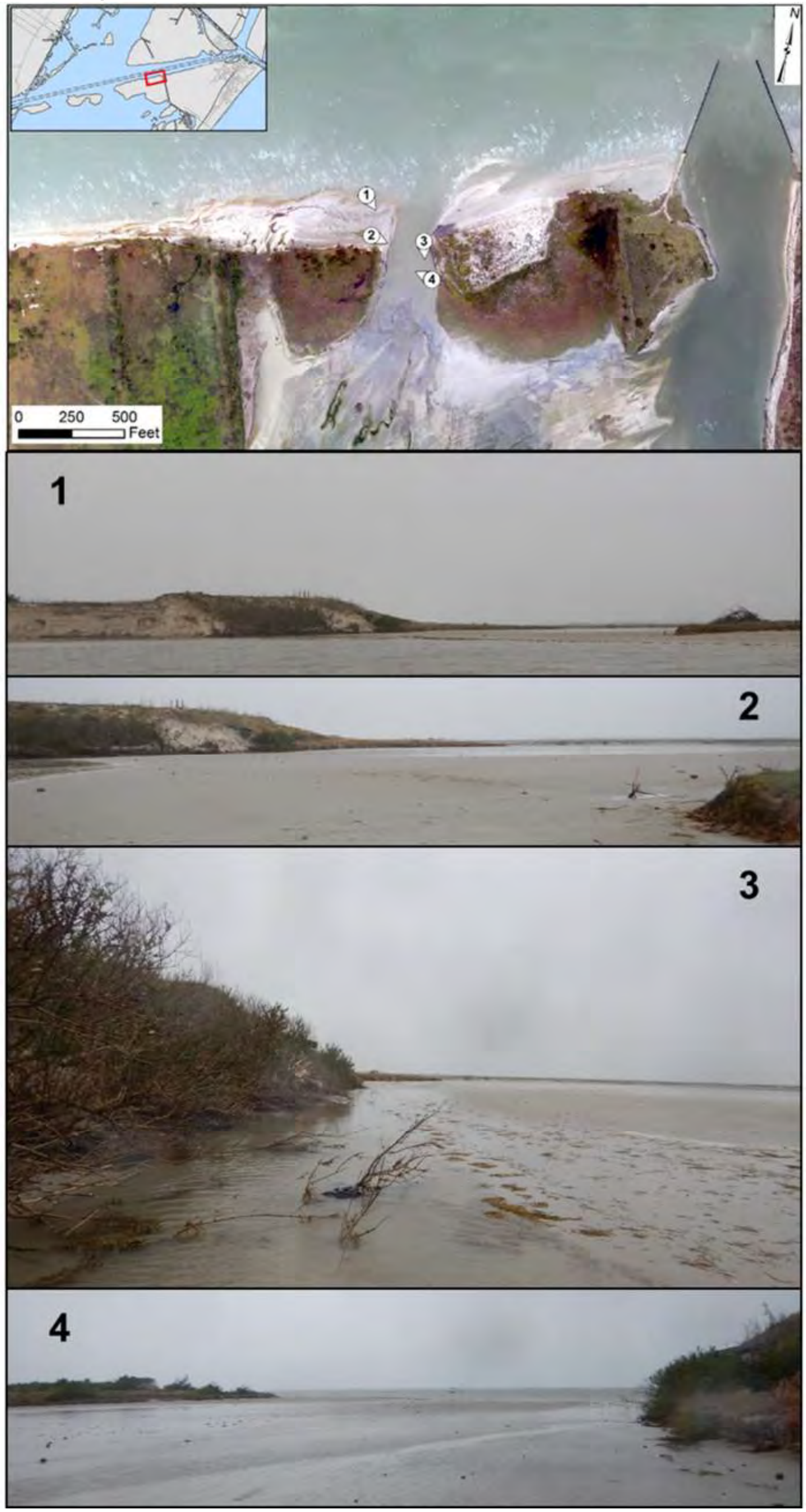


Figure 5. West of Piper Channel Breach

A breach approximately 300 feet wide has formed along the shoreline just west of Piper Channel (Figure 5). A large escarpment had formed just east of the breach where a large dune prevents breaching in that location. At the time of the site visit, the breach area was not submerged, but the elevation along this area remains low enough to allow flooding of this area during higher tides. The presence of flotsam and jetsam in the area gave further evidence that the breach was partially submerged recently. If no action is taken, it is likely that this breach will continue to deepen due to erosion caused by hydraulic conductivity through the area.

Two alternatives were considered to close the breach just west of Piper Channel. The first alternative involves installation of a geotextile tube along the shoreline. Based on visual estimates, the tube would need to be a minimum of 500 feet long to stabilize the area shown in Figure 6. It was assumed that a 32-foot circumference geotextile tube with scour apron will be required.

Figure 6. West of Piper Channel breach

The table below shows the probable cost estimate for installation of a geotextile tube along the shoreline in front of the breach which has formed just west of Piper Channel.

MOTT MACDONALD

West of Piper Channel

Probable Construction Cost Estimate (Geotextile Tube)

Item	Item Description	Quantity	Unit	Unit Cost	Total Costs[2]
1	Mobilization and Demobilization	1	LS	$ 150,000	$ 150,000
2	Construction Surveying	1	LS	$ 25,000	$ 25,000
3	Geotextile Tube	500	LF	$ 90	$ 45,000
4	Scour Apron	500	LF	$ 45	$225,000
5	Geotextile Tube Fill	16,000	CY	$14	$ 224,000
6	Performance Bonds[1]	1	LS	$ 33,450	$ 33,450
		Subtotal			$ 702,450
		30% Contingency			$ 210,735
		Total			**$ 913,185**
	Notes:	[1] Bonds assumed at 5% of the repair work. [2] All costs include a contractor overhead and profit of 10%			

The second option involves construction of an earthen berm using beach quality material to close the newly formed breach. We assume that the berm will require a minimum crest elevation of +5' MLT based on similar breach fill designs used in the area. This berm would be approximately 500 feet long along the shoreline and approximately 250 feet wide for proper closure of this breach to return the are to pre-damage conditions. This alternative does not mitigate the current erosion of the shoreline so future breaching from advanced erosion and storm events will become more likely throughout the life of the berm, creating a shorter design life.

MOTT MACDONALD

West of Piper Channel

Probable Construction Cost Estimate (Fill)

Item	Item Description	Quantity	Unit	Unit Cost	Total Costs[2]
1	Mobilization and Demobilization	1	LS	$ 150,000	$ 150,000
2	Construction Surveying	1	LS	$ 25,000	$ 25,000
3	Breach Fill	26,000	CY	$ 14	$ 364,000
4	Performance Bonds[1]	1	LS	$ 26,950	$ 26,950
	Subtotal				$ 565,950
	30% Contingency				$ 169,785
	Total				**$ 735,735**
	Notes:	[1] Bonds assumed at 5% of the repair work. [2] All costs include a contractor overhead and profit of 10%			

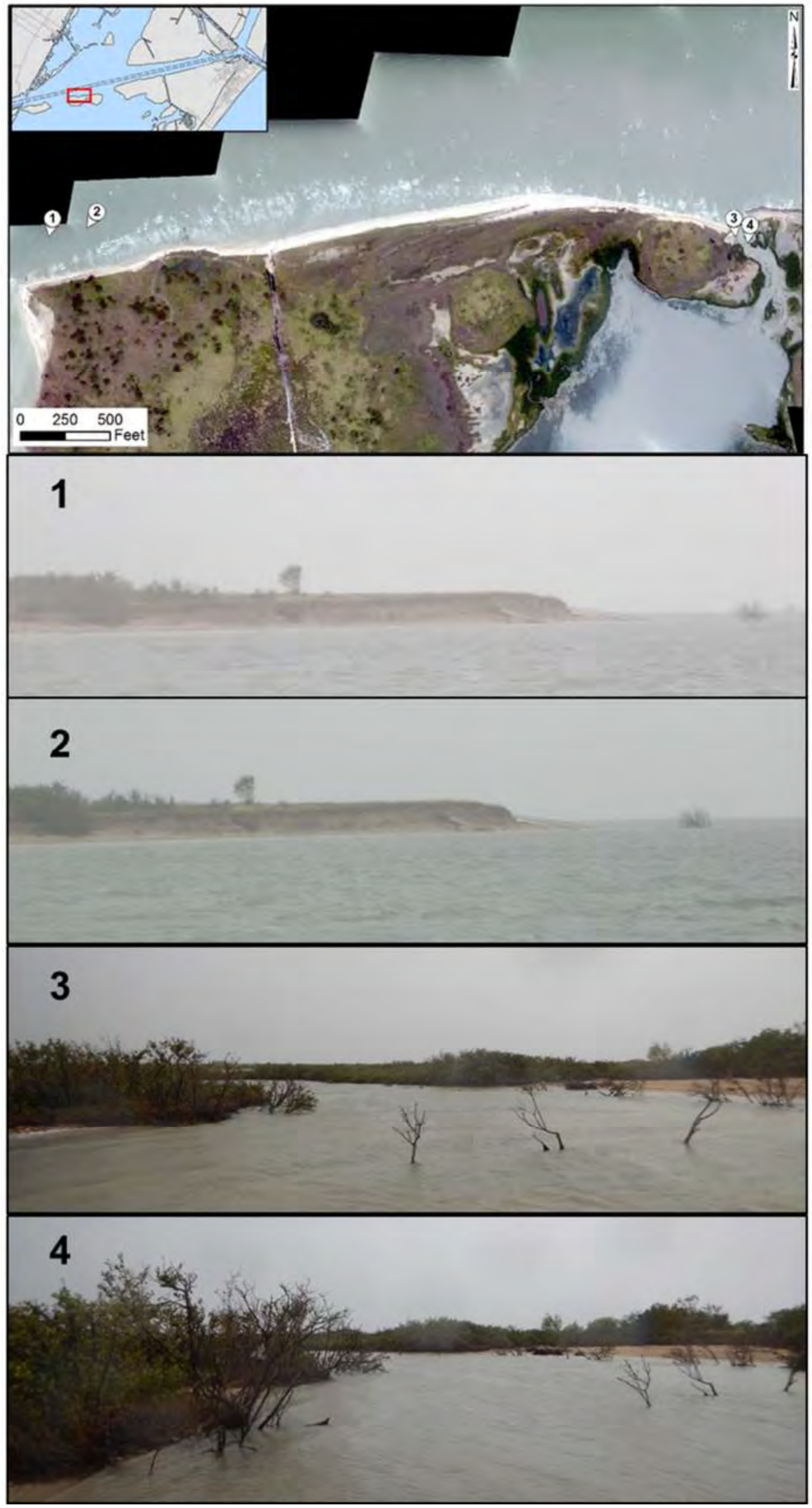
The alternatives for filling the breach west of Piper Channel are preliminary and further investigation will be necessary to determine the best option for protection of this area. Alternatives will need to be evaluated on their effectiveness, cost, environmental impact, etc. prior to selection of a preferred stabilization alternative for this area. The engineer's estimate of probable cost, below, includes the effort necessary to conduct this analysis.

West of Piper Channel

Probable Engineering Cost Estimate

Item Description	Total Costs
Data Collection, Preliminary Engineering, Permitting	$ 46,000
Final Engineering, Bidding	$ 60,000
Construction Oversight	$ 35,000
Total	**$ 141,000**

Pelican Island




N
0 100 200 Feet
5
6
7
8

Figure 7. Pelican Island

As previously mentioned in our letter sent on October 30, 2017, Pelican Island sustained excessive erosion in the wake of Hurricane Harvey. Although damage to the existing breakwater was no observed, there were signs of excessive erosion to the unprotected shoreline adjacent to the structure (Figure 7). The east end of Pelican Island suffered erosion greater than 100 feet; while a large breach formed on the western end of the existing breakwater as shown in pictures 3 and 4 of Figure 7). The desktop analysis also showed excessive erosion along the western and southwestern shorelines. Due to the low elevation of Pelican Island, few escarpments were observed on the east end. However, there were obvious signs of erosion such as submerged vegetation that were previously in the uplands and the observed breach.

There was no observable damage to the existing breakwater, and erosion in this area was minimal.

Pictures 6 and 7 of Figure 7 indicate a large escarpment had formed on the western end of the island where the shoreline was also significantly eroded due to Hurricane Harvey. In fact, the desktop shoreline analysis has shown consistent erosion all around Pelican Island. If allowed to continue unabated, the exposed shoreline along Pelican Island will continue to erode and the island will continue to reduce in size.

Results from this analysis showed three main locations, apart from the locations discussed in our previous letter, where the shoreline has been eroding at a significant rate. These areas have been delineated in Figure 8. Stabilization of these areas will require construction of riprap breakwater sections spanning a total length of 6,100 feet. We assume that the breakwater design for these areas will be similar to the existing breakwater along the north-east end of Pelican Island.

Figure 8. Pelican Island additional breakwater locations

The table below shows the estimate of probable cost for construction of an additional 6,100 feet along the western and southern ends of Pelican Island.

Pelican Island Breakwater

Probable Construction Cost Estimate (Option 1 – Breakwaters)

Item	Item Description	Quantity	Unit	Unit Price	Total Costs[2]
1	Mobilization and Demobilization	1	LS	$ 300,000	$ 300,000
2	Construction Surveying	1	LS	$ 50,000	$ 50,000
3	Armor Stone	42,700	TON	$ 165.00	$7,045,500
4	Bedding Stone	12,200	TON	$ 150.00	$ 1,830,000
5	Geotextile Fabric	30,500	SY	$ 16.00	$ 488,000
6	Performance Bonds[1]	1	LS	$ 485,675	$ 485,675
	Subtotal				$ 10,199,175
	30% Contingency				$ 3,059,753
	Total Amount with Contingency				**$ 13,258,928**
	Notes:		[1] Bonds assumed to cost 5% of the repair work. [2] All costs include a contractor overhead and profit of 10%		

Based on the observed erosion rates along Pelican Island, fill material should only be installed after construction of shoreline stabilization structures such as breakwaters, but for assessment purposes, an estimate for placing fill along Pelican Island to return the shoreline to pre-damage conditions. The fill would involve placing material along 6,100' of shoreline along pelican island to construct a berm with crest elevation of +5 MLT and a width of 75'.

Pelican Island Breakwater

Probable Construction Cost Estimate (Option 2 – Fill)

Item	Item Description	Quantity	Unit	Unit Price	Total Costs[2]
1	Mobilization and Demobilization	1	LS	$ 300,000	$ 300,000
2	Construction Surveying	1	LS	$ 50,000	$ 50,000
3	Beach Fill	100,000	CY	$ 14	$1,400,000
6	Performance Bonds[1]	1	LS	$ 485,675	$ 87,500
	Subtotal				$ 1,837,500

30% Contingency	$ 551,250
Total Amount with Contingency	**$ 2,388,750**
Notes:	[1] Bonds assumed to cost 5% of the repair work. [2] All costs include a contractor overhead and profit of 10%

The table below shows the probable cost estimate for engineering, design, and construction oversight necessary for construction of the additional breakwaters along Pelican Island. This estimate assumes that these additional breakwaters are designed and constructed independently from the breakwaters discussed in our previous letter. Cost savings for engineering and construction would be achieved by designing and constructing all additional breakwaters simultaneously.

Pelican Island

Probable Engineering Cost Estimate

Item Description	Total Costs
Data Collection, Final Design and Bidding	$ 62,500
Construction Oversight	$ 60,000
Total	**$ 122,500**

La Quinta Island Levee (PA-13)

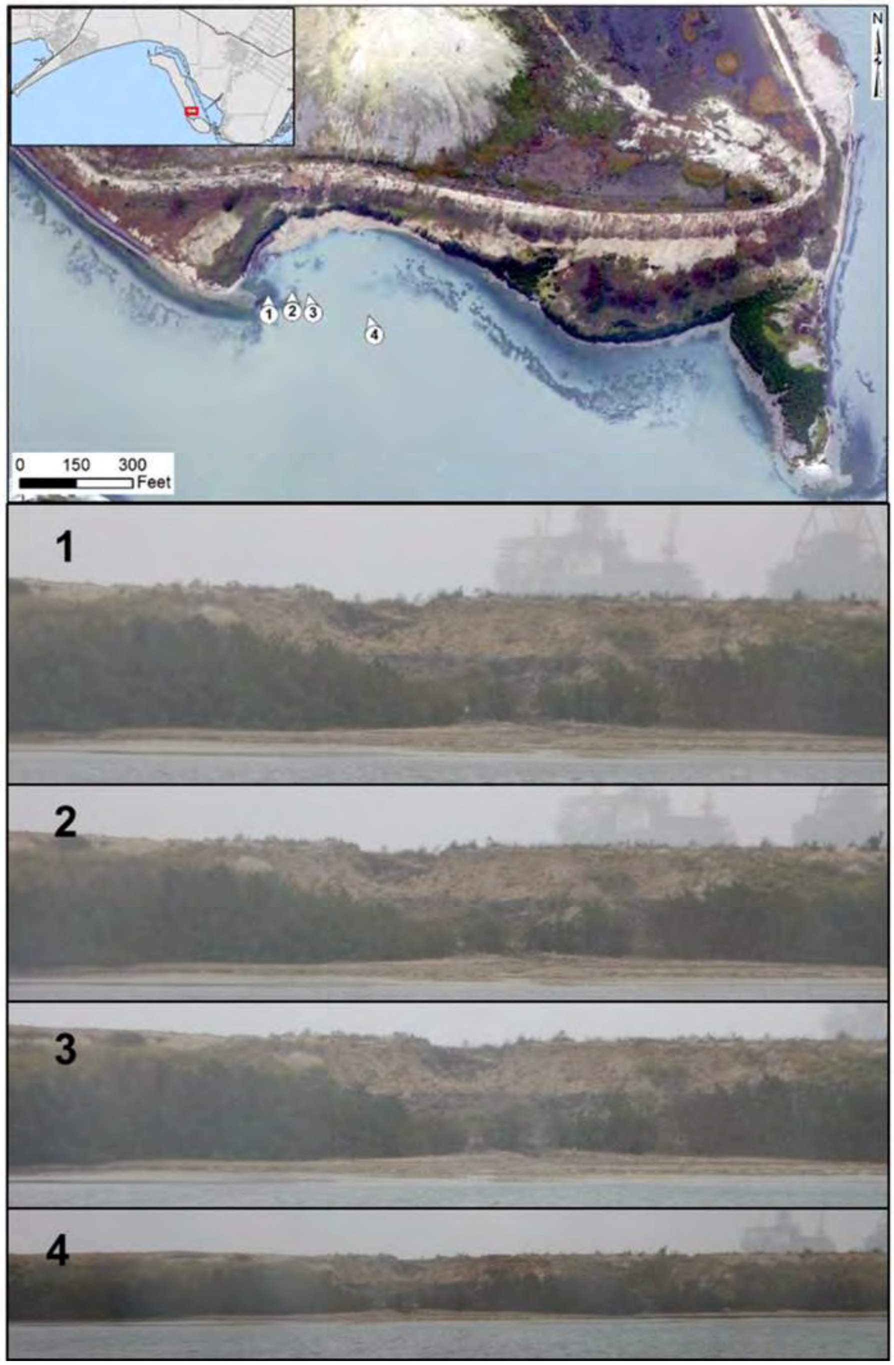


Figure 9. La Quinta Island Levee

Figure 9 shows the levee near the southwest corner of La Quinta island had breached after Hurricane Harvey. The breach caused material from the placement area to wash out onto the adjacent shoreline. This breach was approximately 150 feet wide after the storm, and likely formed due to rain water washing over the levee at this location. Repairs to the breached levee will be necessary before placing any dredged material in this area. At the time of the site visit, equipment was on La Quinta Island working on the levee, but had not yet repaired the newly formed breach. As this area is currently being repaired, a cost estimate was not provided.

BUS6 Offshore Emergent Levee

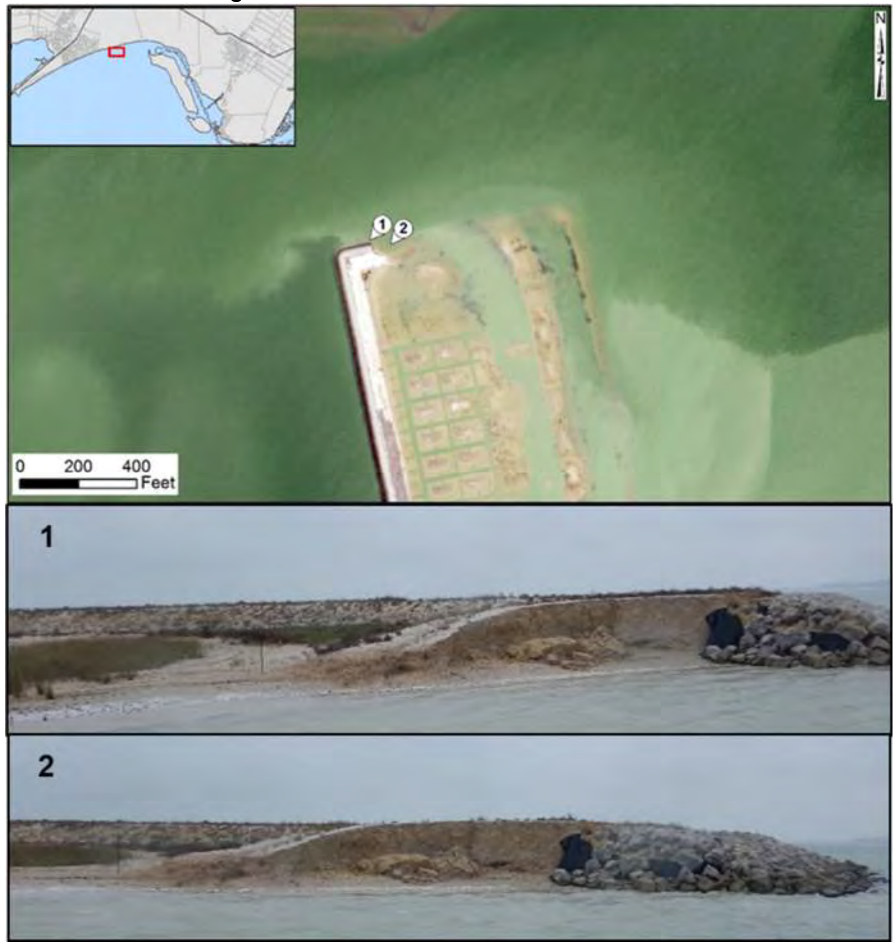


Figure 10. BUS6 Offshore Emergent Levee

As shown in Figure 10, the terminal end of the offshore emergent levee within Cell F of BUS6 has suffered damage due to erosion. This area was damaged prior to the storm due to erosion of the adjacent shoreline. This erosion is likely caused by waves refracting around the structure, creating a focal point for wave energy adjacent to the structure. Typically, armored structures incorporate radial ends in their design to avoid this kind of failure, but the levee in this location did not include that in the design. Hurricane Harvey resulted in additional erosion, which has caused the armor stone to collapse into the adjacent channel and geotextile to become exposed. If a remedy is not constructed, erosion will continue to cause the collapse of the levee which will expose the adjacent mitigation area to sustain damage from increased wave energy reaching the site.

A remedy to this would be to install additional armor stone in this area to construct a radial end and stop the collapse of the structure. This would mitigate erosion behind the structure and ensure that the remaining armor stone remains in place. The table below includes the probable cost estimate for installing additional riprap and geotextile at the end of the existing levee.

BUS6 Offshore Emergent Levee

Probable Construction Cost Estimate

Item	Item Description	Quantity	Unit	Unit Price	Total Costs[2]
1	Mobilization and Demobilization	1	LS	$ 50,000	$ 50,000
2	Construction Surveying	1	LS	$ 15,000	$ 15,000
3	Armor Stone	290	TON	$ 165.00	$ 47,850
4	Bedding Stone	150	TON	$ 150.00	$ 22,500
5	Geotextile Fabric	285	SY	$ 16.00	$ 4,560
6	Performance Bonds[1]	1	LS	$ 10,583	$ 6,996
	Subtotal				$ 146,906
	30% Contingency				$ 44,072
	Total Amount with Contingency				**$ 190,978**
	Notes:	[1] Bonds assumed to cost 5% of the repair work. [2] All costs include a contractor overhead and profit of 10%			

The table below shows the probable cost estimate for engineering of the levee repair. We assume that no regulatory coordination is required for this work as it is a repair of an existing structure and thus would be covered by a US Army Corps of Engineers Nationwide permit.

BUS6 Offshore Emergent Levee

Probable Engineering Cost Estimate

Item Description	Total Costs
Data Collection, Final Design and Bidding	$ 35,000
Construction Oversight	$ 25,000
Total	**$60,000**

Inner Harbor Revetment

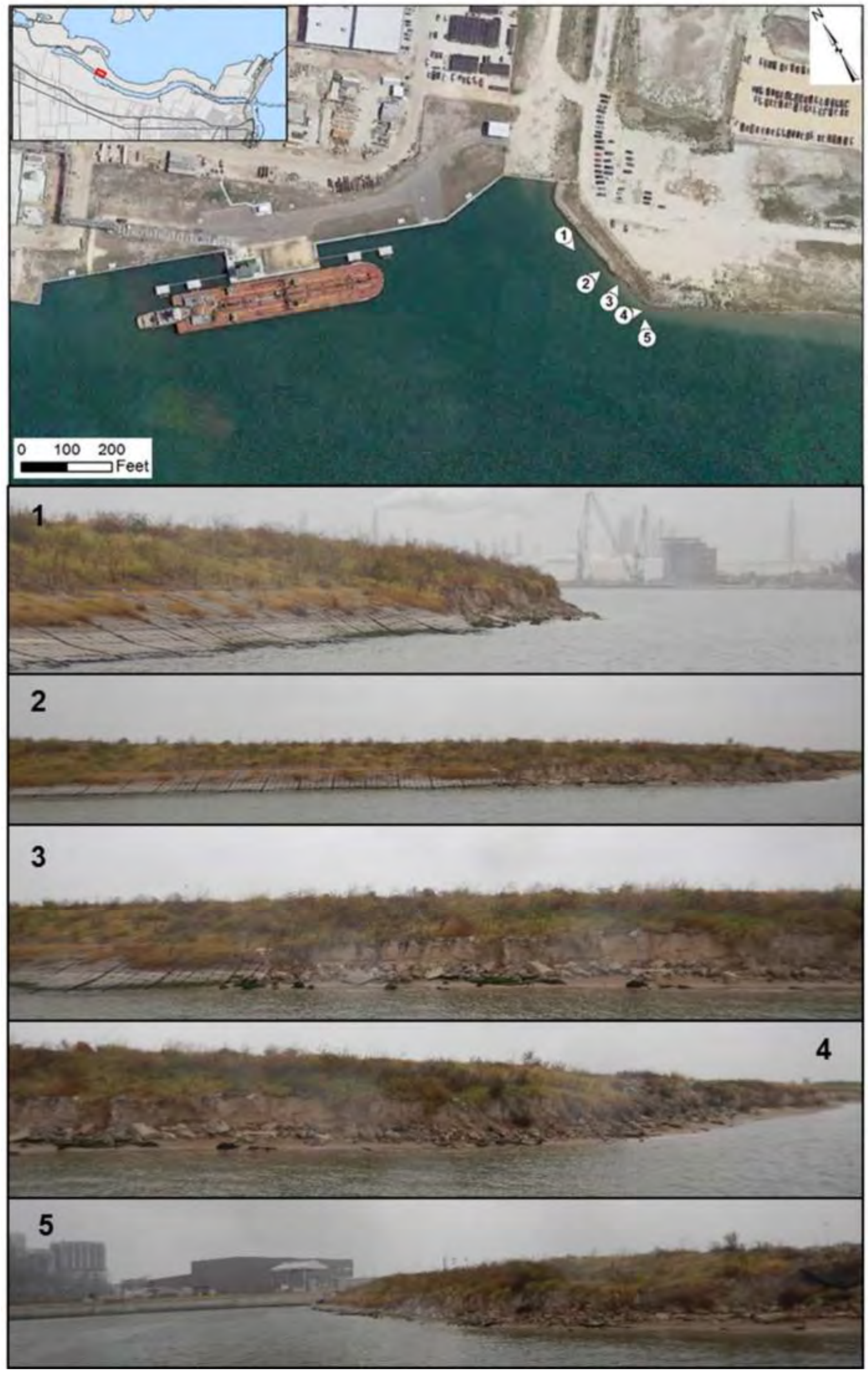


Figure 11. Inner harbor revetment

Overall, erosion of the PCCA shoreline within the inner harbor due to Hurricane Harvey's impacts was minimal. However, one section along the shoreline, where 250 feet of closed cell Articulated Concrete Block Mat (ACBM) and 150 feet of rip rap was installed prior to Hurricane Harvey sustained considerable damage as illustrated in Figure 11. The rip rap along the southern end of the structure had been displaced and was no longer visible along the slope. An escarpment had formed from erosion of the shoreline where the rip rap had once been. The ACBM was intact and succeeded in protecting the shoreline at this location, but had subsided in certain areas likely due to scour at the toe of the structure. It is likely that this location sustained more damage compared to other areas in the inner harbor because of the orientation of the shoreline. The ACBM and riprap are directly facing toward the end of the channel, which has substantial fetch for wind driven waves to form, and are in the direct path of any waves that can form due to a

MOTT MACDONALD

strong northwest wind. Hurricane Harvey likely produced these strong northwesterly winds which clearly impacted the structure.

Based on review of the site, the ACBM appears to be intact and functioning, thus repair would only involve reconstructing 150 linear feet of revetment. A preliminary estimate for reconstructing of the riprap revetment is shown below.

Inner Harbor Revetment

Probable Construction Cost Estimate

Item	Item Description	Quantity	Unit	Unit Cost	Total Costs[2]
1	Mobilization and Demobilization	1	LS	$ 50,000	$ 50,000
2	Construction Surveying	1	LS	$ 15,000	$ 15,000
2	Armor Stone	620	TON	$ 125	$ 77,500
3	Bedding Stone	310	TON	$ 125	$ 38,750
4	Geotextile fabric	350	SY	$ 10	$ 3,500
5	Structural fill	600	CY	$ 18	$ 10,800
6	Performance Bonds[1]	1	LS	$ 9,778	$ 9,778
		Subtotal			$ 205,328
		30% Contingency			$ 61,599
		Total			**$ 266,927**

Notes: [1] Bonds assumed at 5% of the repair work.

[2] All costs include a contractor overhead and profit of 10%

The table below shows the probable cost estimate of engineering for the repair of the inner harbor revetment.

Inner Harbor Revetment

Probable Engineering Cost Estimate

Item Description	Total Costs
Data Collection, Final Design and Bidding	$ 45,000
Construction Oversight	$ 15,000
Total	**$ 60,000**

MOTT MACDONALD

Rincon B Shoreline

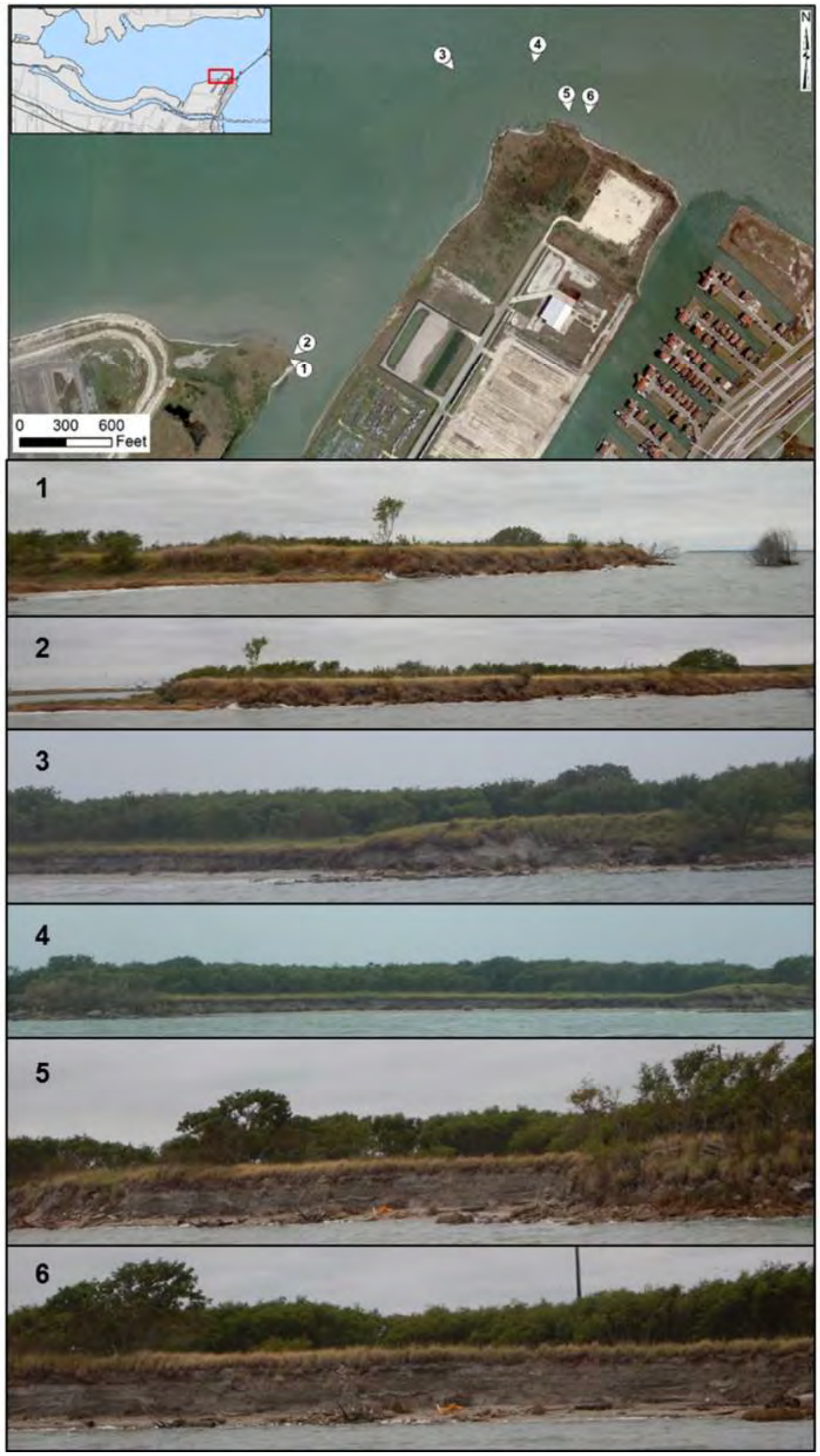


Figure 12. Rincon B shoreline

As demonstrated in Figure 12, the shoreline along Nueces Bay adjacent to the Rincon B placement area experienced some localized erosion due to Hurricane Harvey. The erosion occurred at the point just east of the Rincon B placement area and at the point just west of the end of Rincon Rd. These areas are exposed to energy from waves forming along the northwest portion of Nueces Bay. Erosion from Hurricane Harvey ranged on average from approximately 10 feet to 25 feet in these locations.

Three alternatives were considered for stabilization of the shoreline along this location. The first included installation of a geotextile tube along the shoreline to mitigate further erosion. We estimate that approximately 810 feet of geotextile tube will need to be installed. The tube was assumed to have a circumference of approximately 32 feet. The table below shows the probable cost estimate for this alternative.

Rincon B Shoreline

Probable Construction Cost Estimate (Geotextile Tube)

Item	Item Description	Quantity	Unit	Unit Cost	Total Costs[2]
1	Mobilization and Demobilization	1	LS	$ 75,000	$ 75,000
2	Construction Surveying	1	LS	$ 25,000	$ 25,000
3	Geotextile Tube	810	LF	$ 90	$ 72,900
4	Scour Apron	810	LF	$ 45	$ 36,450
5	Geotextile Tube Fill	25,000	CY	$ 18	$ 450,000
6	Performance Bonds[1]	1	LS	$ 32,968	$ 32,968
	Subtotal				$ 692,318
	30% Contingency				$ 207,696
	Total				**$ 900,014**
	Notes: [1] Bonds assumed at 5% of the repair work. [2] All costs include a contractor overhead and profit of 10%				

The second alternative considered was the installation of fill along the eroded areas to mitigate the effects of erosion in this area. We assume that an earthen berm with an approximate crest elevation of +5 MLT will be necessary to stabilize the shoreline and protect the area behind the structure and bring the area to pre-damage conditions. The berms will span a total length of 810 feet and will be approximately 75 feet wide. The table below shows the probable cost estimate for this alternative.

MOTT MACDONALD

Rincon B Shoreline

Probable Construction Cost Estimate (Fill)

Item	Item Description	Quantity	Unit	Unit Cost	Total Costs[2]
1	Mobilization and Demobilization	1	LS	$ 75,000	$ 75,000
2	Construction Surveying	1	LS	$ 25,000	$ 25,000
3	Breach Fill	12,000	CY	$ 18	$ 216,000
4	Performance Bonds[1]	1	LS	$ 15,800	$ 15,800
		Subtotal			$ 331,800
		30% Contingency			$ 99,540
		Total			**$ 431,340**
	Notes:	[1] Bonds assumed at 5% of the repair work. [2] All costs include a contractor overhead and profit of 10%			

The final alternative considered was for construction of a riprap revetment along the shoreline of the areas considered. This revetment would also span a total approximate length of 810 feet. The table below shows the probable cost estimate for this alternative.

Rincon B Shoreline

Probable Construction Cost Estimate (Revetment)

Item	Item Description	Quantity	Unit	Unit Cost	Total Costs[2]
1	Mobilization and Demobilization	1	LS	$ 75,000	$ 75,000
2	Construction Surveying	1	LS	$ 25,000	$ 25,000
3	Armor Stone	3,060	TON	$ 125	$ 382,500
4	Bedding Stone	1,225	TON	$ 125	$ 153,125
5	Geotextile fabric	4,900	SY	$ 10	$ 49,000
6	Structural fill	5,200	CY	$ 18	$ 93,600

MOTT MACDONALD

7	Performance Bonds[1]	1	LS	$ 38,912	$ 38,912
	Subtotal				$ 817,137
	30% Contingency				$ 245,142
	Total				**$ 1,062,279**
Notes:	[1] Bonds assumed at 5% of the repair work.				
	[2] All costs include a contractor overhead and profit of 10%				

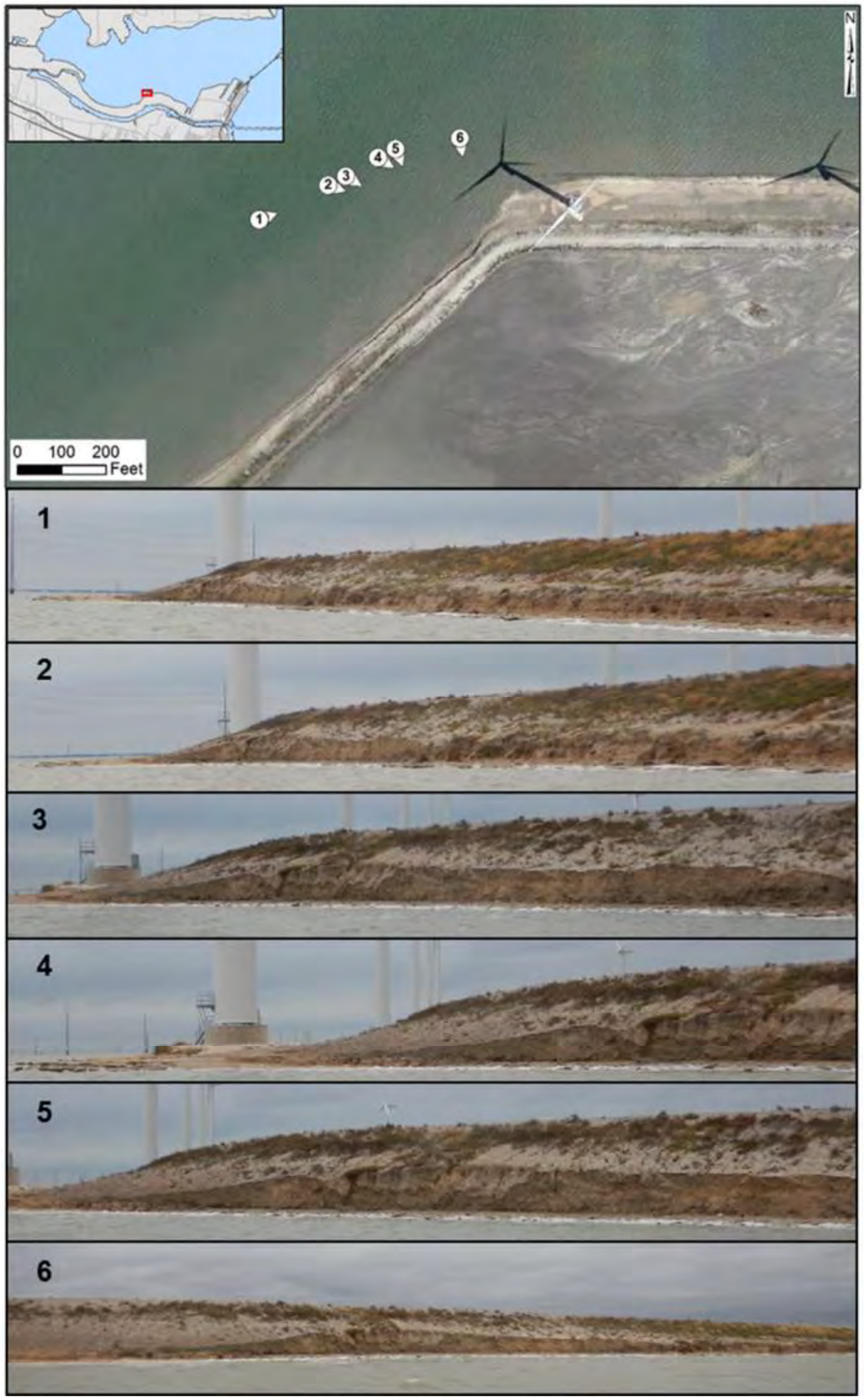
Due to the limited data available for this site, the alternatives presented are preliminary and further investigation will be necessary to determine the best option for protection of this area. Alternatives will need to be evaluated on their effectiveness, cost, environmental impact, etc. prior to selection of a preferred stabilization alternative for this area. The engineer's estimate of probable cost, below, includes the effort necessary to conduct this analysis.

Rincon B Shoreline

Probable Engineering Cost Estimate

Item Description	Total Costs
Data Collection, Preliminary Engineering, Permitting	$ 46,000
Final Engineering, Bidding	$ 60,000
Construction Oversight	$ 25,000
Total	**$ 131,000**

South Shore DMPA Cell B Shoreline



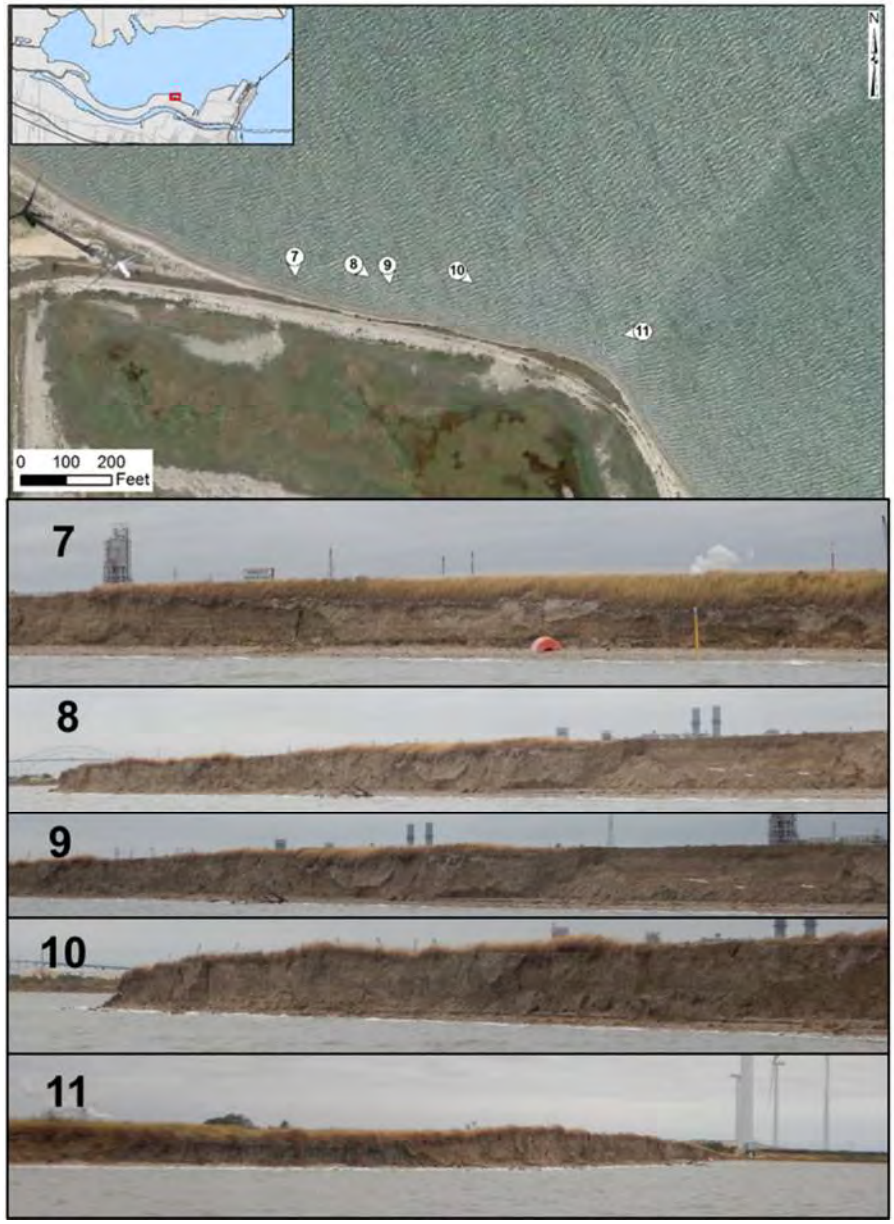


Figure 13. South Shore DMPA Cell B Shoreline

The shoreline along the west and east corners of South Shore DMPA Cell B suffered considerable erosion due to Hurricane Harvey. An escarpment spanning approximately 900 feet at the northwest corner of this DMPA was observed where erosion of the adjacent levee has begun as shown in pictures 1-6 of Figure 13. If erosion in this area is not mitigated, the levee may become compromised and will require repair prior to placing of dredged material in the DMPA.

A similar escarpment was observed at the northeast corner of the DMPA spanning approximately 900 feet (pictures 7-11 in Figure 13). Significant erosion of the levee was observed in this area and is currently at risk of further damage due to shoreline erosion.

The recommended alternative for stabilization of the shoreline in this area would be to install a riprap revetment similar to those previously installed throughout the Nueces Bay shoreline. Approximately 1,800 feet of revetment will need to be installed to stabilize the areas shown in Figure 14.

Figure 14. DMPA Cell B proposed revetment areas

The table below shows the probable cost estimate for construction of a revetment along the areas shown in Figure 14.

DMPA Cell B Shoreline

Probable Construction Cost Estimate (Revetment – Option 1)

Item	Item Description	Quantity	Unit	Unit Cost	Total Costs[2]
1	Mobilization and Demobilization	1	LS	$ 50,000	$ 50,000
2	Construction Surveying	1	LS	$ 25,000	$ 25,000
2	Armor Stone	6,800	TON	$ 125	$ 850,000
3	Bedding Stone	2,800	TON	$ 125	$ 350,000
4	Geotextile fabric	11,000	SY	$ 10	$ 110,000
5	Structural fill	12,000	CY	$ 18	$ 216,000
6	Performance Bonds[1]	1	LS	$80,050	$ 80,050
		Subtotal			$ 1,681,050
		30% Contingency			$ 504,315
		Total			**$ 2,185,365**

Notes: [1] Bonds assumed at 5% of the repair work.

[2] All costs include a contractor overhead and profit of 10%

As mentioned, a revetment is the preferred option for stabilizing the shoreline is this area as it prevents future erosion. Another option would be to return the shoreline to pre-

MOTT MACDONALD

damage conditions by placing fill. This option addresses the impacts from previous erosion but does not address the erosion which is expected to continue in the future. The table below provides an estimate for adding fill to 1,800’ of shoreline using compatible materials. The actual fill quantities will depend on the shoreline conditions at the time of construction, but the table below provides an estimate based on current observations.

DMPA Cell B Shoreline

Probable Construction Cost Estimate (Fill – Option 2)

Item	Item Description	Quantity	Unit	Unit Cost	Total Costs[2]
1	Mobilization and Demobilization	1	LS	$ 50,000	$ 50,000
2	Construction Surveying	1	LS	$ 25,000	$ 25,000
3	Fill	25,000	CY	$ 18	$ 450,000
4	Performance Bonds[1]	1	LS	$93,750	$ 26,250
	Subtotal				$ 551,250
	30% Contingency				$ 165,375
	Total				**$ 716,625**
	Notes: [1] Bonds assumed at 5% of the repair work. [2] All costs include a contractor overhead and profit of 10%				

The table below shows the estimate of probable cost for analysis and engineering of a revetment or fill along the eroded shoreline of DMPA Cell B.

DMPA Cell B Shoreline Revetment

Probable Engineering Cost Estimate

Item Description	Total Costs
Data Collection, Preliminary Engineering, Permitting	$ 46,000
Final Engineering, Bidding	$ 80,000
Construction Oversight	$ 50,000
Total	**$ 176,000**

Nueces Bay Shoreline


N
8
9
10
11
12
13
14
15
16
17
18
0 250 500
Feet
8
9
10

MOTT MACDONALD

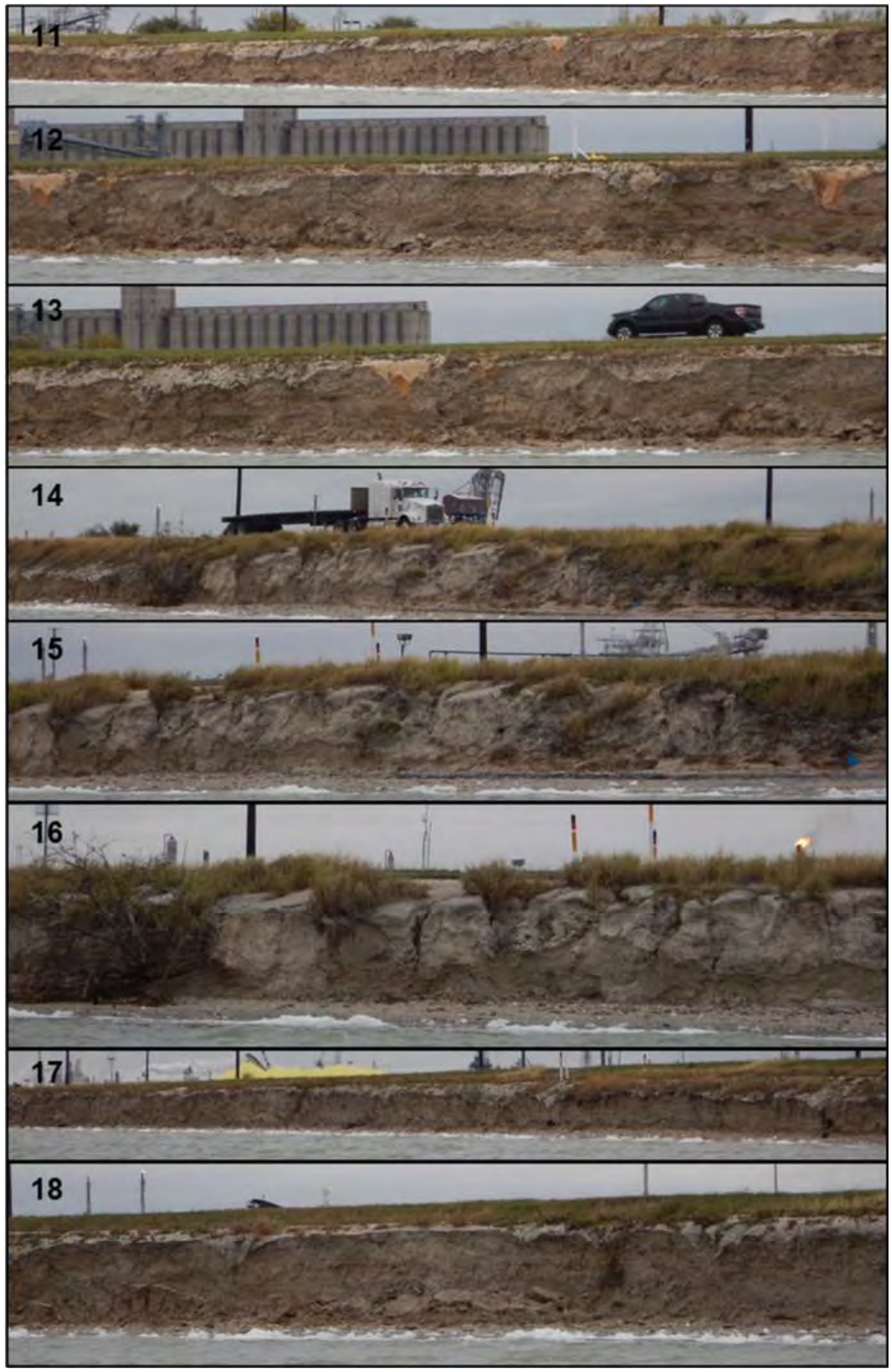


Figure 15. Nueces Bay shoreline

Figure 15 shows three areas along Nueces Bay adjacent to the Joe Fulton Corridor which had experienced noticeable erosion due to Hurricane Harvey. The three areas spanned a total length of 3,200 feet. The first and worst area was just west of the existing riprap revetment along the existing bike path as depicted in pictures 1-7 of Figure 15. Localized erosion in the lee of the structure led to the formation of a large escarpment and the exposure of the subgrade under the adjacent bike path. If erosion continues, the path will collapse into Nueces Bay at this location.

The second location is approximately 1200 feet west of the existing riprap revetment and is approximately 1500 feet long (pictures 8-13 of Figure 15). A large escarpment has formed in this area which is immediately adjacent to the bike path. Although the erosion has not yet reached the path, if allowed to continue, the subgrade will be eroded and the path will collapse into Nueces Bay.

The third location is approximately 1200 feet west of the second location and is also approximately 1500 feet long (pictures 14-18 in Figure 15). Similar to the second location, an escarpment has formed near to the existing path which, if not addressed, may eventually result in the undermining and collapse of the asphalt into Nueces Bay.

Cost estimates for the stabilization of this shoreline were provided in the letter submitted by Mott MacDonald on October 30, 2017. That letter estimated the cost for constructing a revetment along the entire 10,200 feet of exposed Nueces Bay shoreline. Analysis of erosion in this area indicates that stabilization of the full 10,200 feet will eventually be required to avoid damage to the adjacent bike path and road, but critical areas will need to be stabilized sooner as the shoreline has eroded up to the bike path. The estimate below is for armoring of just the 3,200 feet of critical shoreline identified as part of this assessment.

Nueces Bay Shoreline

Probable Construction Cost Estimate (Revetment – Option 1)

Item	Item Description	Quantity	Unit	Unit Cost	Total Costs[2]
1	Mobilization and Demobilization	1	LS	$ 50,000	$ 75,000
2	Construction Surveying	1	LS	$ 30,000	$ 30,000
3	Armor Stone	12,080	TON	$ 125	$ 1,510,000
4	Bedding Stone	4,832	TON	$ 125	$ 604,000
5	Geotextile fabric	19,200	SY	$ 10	$ 192,000
6	Structural fill	20,500	CY	$ 18	$ 369,000
7	Performance Bonds[1]	1	LS	$ 139,000	$ 139,000
		Subtotal			$ 2,919,000
		30% Contingency			$ 875,700
		Total			**$ 3,794,700**

Notes: [1] Bonds assumed at 5% of the repair work.

[2] All costs include a contractor overhead and profit of 10%

An alternate option would be to install fill along the shoreline in this area to return the shoreline to pre-damage conditions. This option would require the transport and placement of compatible material along the 3,200' of shoreline in this area. Although this option reverses the effects of erosion, the shoreline in this area will continue to recede and will need to be stabilized. The final quantity of fill material required will vary depending on the condition of the shoreline at the time of construction, but the table below provides an estimate based on current observations.

MOTT MACDONALD

Nueces Bay Shoreline

Probable Construction Cost Estimate (Revetment – Option 2)

Item	Item Description	Quantity	Unit	Unit Cost	Total Costs[2]
1	Mobilization and Demobilization	1	LS	$ 50,000	$ 75,000
2	Construction Surveying	1	LS	$ 30,000	$ 30,000
3	Structural fill	40,000	CY	$ 18	$ 720,000
4	Performance Bonds[1]	1	LS	$ 41,250	$ 41,250
	Subtotal				$866,250
	30% Contingency				$ 259,875
	Total				**$ 1,126,125**

Notes: [1] Bonds assumed at 5% of the repair work.

[2] All costs include a contractor overhead and profit of 10%

The table below shows the probable cost estimate for engineering of the structure. The change in effort for designing a revetment that is 10,200 feet long versus a 3,200-foot-long revetment, vs. design of fill would be minimal; thus, these costs are similar to those presented in our previous letter.

Nueces Bay Shoreline Revetment

Probable Engineering Cost Estimate

Item Description	Total Costs
Data Collection, Preliminary Engineering, Permitting	$ 46,000
Final Engineering, Bidding	$ 80,000
Construction Oversight	$ 45,000
Total	**$ 171,000**

MOTT MACDONALD

The alternatives and cost estimates presented herein are based on engineering best judgement and preliminary observations of the site. These estimates are for preliminary planning purposes only and are subject to change. Please let me know if you have any questions.

Kind regards,

Aaron Horine, P.E.
Associate Coastal Engineer
T +1 (361) 661 3061

aaron.horine@mottmac.com

Appendix C3

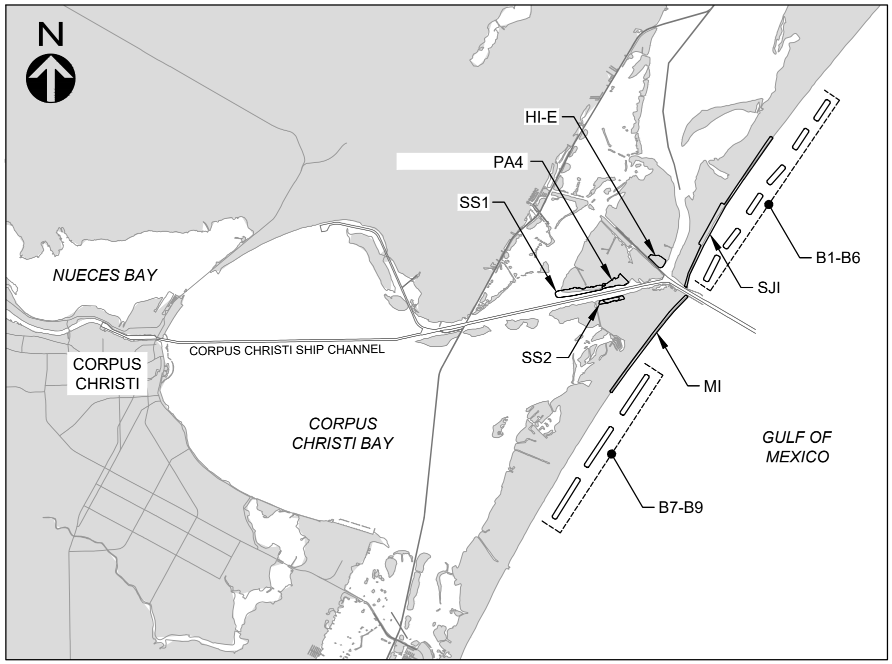
Beneficial Use Site Plan Drawings

BENEFICIAL USE SITES
CORPUS CHRISTI SHIP CHANNEL DEEPENING PROJECT

PORT OF CORPUS CHRISTI AUTHORITY

CORPUS CHRISTI, TEXAS

BY AUTHORITY OF THE PORT COMMISSIONERS
SEAN STRAWBRIDGE, CHIEF EXECUTIVE OFFICER



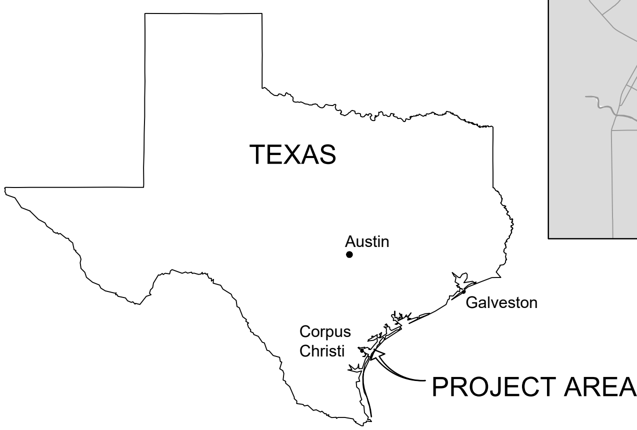
LOCATION MAP

0 20,000 40,000

SCALE IN FEET

DRAWING INDEX

SHEET NO.	TITLE
1	PROJECT LOCATION MAP
2	SITE PLAN - BU SITE SS1
3	SITE PLAN - BU SITE SS2
4	SITE PLAN - BU SITE PA4
5	SITE PLAN - BU SITE HI-E
6	SITE PLAN - BU SITE SJI
7	SITE PLAN - BU SITE MI
8	SITE PLAN - B1 TO B6 FEEDER BERMS
9	SITE PLAN - B7 TO B9 FEEDER BERMS



PERMIT SET

NO.	DATE	REVISION
0	12/6/22	PERMIT DRAWINGS

PORT CORPUS CHRISTI

PORT OF CORPUS CHRISTI AUTHORITY

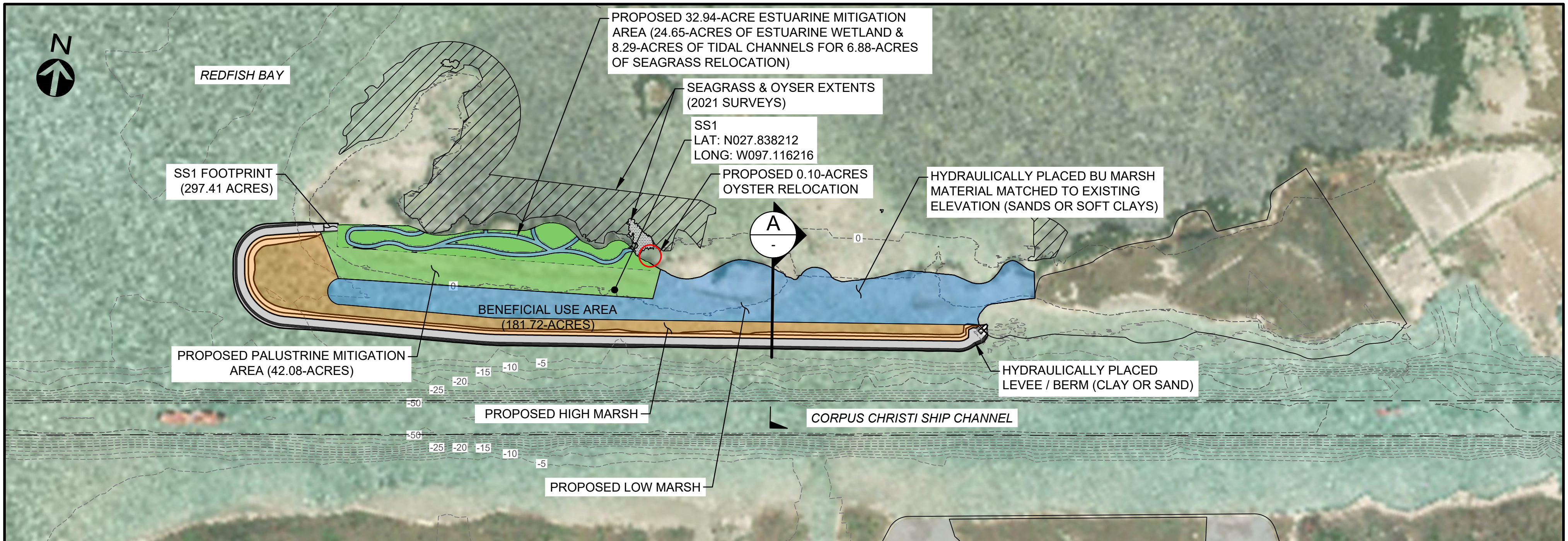
BENEFICIAL USE SITES
CORPUS CHRISTI SHIP CHANNEL
DEEPENING PROJECT
USACE PERMIT ACTION NUMBER SWG-2019-00067

SCALE: AS SHOWN
DWN. BY: T. MORRISON

PROJECT LOCATION MAP

DATE: JANUARY 2024
SHEET 1 OF 9

MOTT MACDONALD
802 N Carancahua Street
Suite 300
Corpus Christi, Texas 78401
Texas Registered Firm No. 12181
T +1 (361) 661-3061
www.mottmac.com



SITE PLAN - AREA SS1

0 1,000 2,000

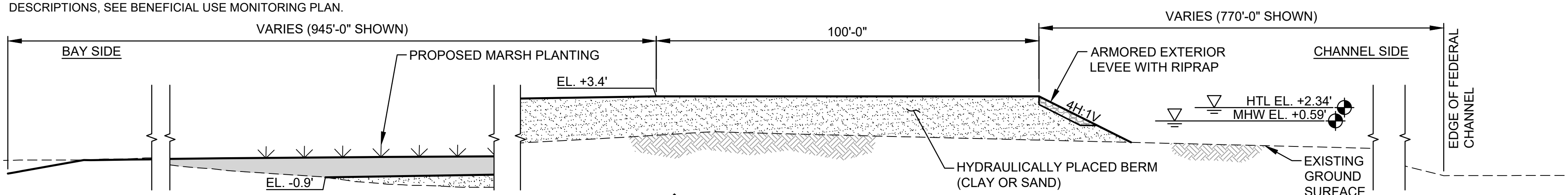
SCALE IN FEET

NOTES

1. BASE MAPPING SHOWN IS ESRI WORLD IMAGERY, RETRIEVED FROM ARCGIS TO AUTOCAD IN MAY 2019 - LAST UPDATED IN SEPT 2018.
2. HORIZONTAL COORDINATE SYSTEM IS NAD83 TEXAS STATE PLANE, SOUTH ZONE, US FOOT.
3. VERTICAL DATUM IS REFERENCED TO MEAN LOWER LOW WATER (MLLW).
4. PIPELINE DATA FOR ARANSAS AND NUECES COUNTIES RETRIEVED FROM RAILROAD COMMISSION OF TEXAS ON NOVEMBER 19, 2018.
5. VERTICAL DATUM CONVERSION FROM MLLW TO NAVD88 = +0.42' BASED ON NOAA TIDE STATION NO. 8775296 USS LEXINGTON.
6. FOR ADDITIONAL INFORMATION REGARDING HABITAT TYPES AND DESCRIPTIONS, SEE BENEFICIAL USE MONITORING PLAN.

LEGEND

- PLACED DREDGE MATERIAL
- PLACED BERM MATERIAL
- EXISTING GROUND SURFACE



A SECTION
SS1
N.T.S.

PLACEMENT SITE NEATLINE QUANTITY - SITE SSI	
DREDGED MATERIAL PLACEMENT FILL	**CONSTRUCTION VOLUME (CY)**
LEVEE FILL	1,140,000
INTERIOR FILL	1,653,000
TOTAL DREDGED MATERIAL FILL	2,793,000
ADDITIONAL (NON-DREDGE) FILL	**CONSTRUCTION VOLUME (CY)**
ARMORING	38,500

PERMIT SET

NO.	DATE	REVISION
0	12/6/22	PERMIT DRAWINGS

MOTT MACDONALD
802 N Carancahua Street
Suite 300
Corpus Christi, Texas 78401
Texas Registered Firm No. 12181
T +1 (361) 661-3061
www.mottmac.com

PORT CORPUS CHRISTI

PORT OF CORPUS CHRISTI AUTHORITY

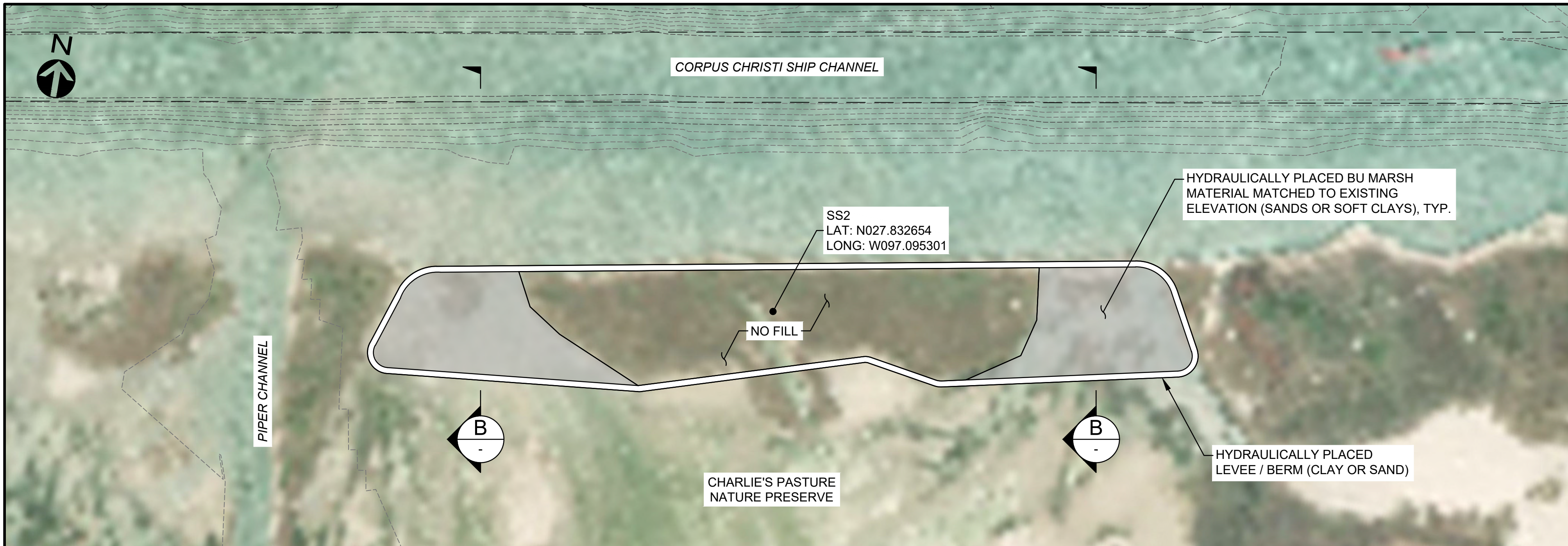
BENEFICIAL USE SITE AND SECTION SHORELINE STABILIZATION (SS1) USACE PERMIT ACTION NUMBER SWG-2019-00067

SCALE: AS SHOWN
DWN. BY: T. MORRISON

SITE PLAN - BU SITE SS1

DATE: JANUARY 2024

SHEET 2 OF 9



NOTES

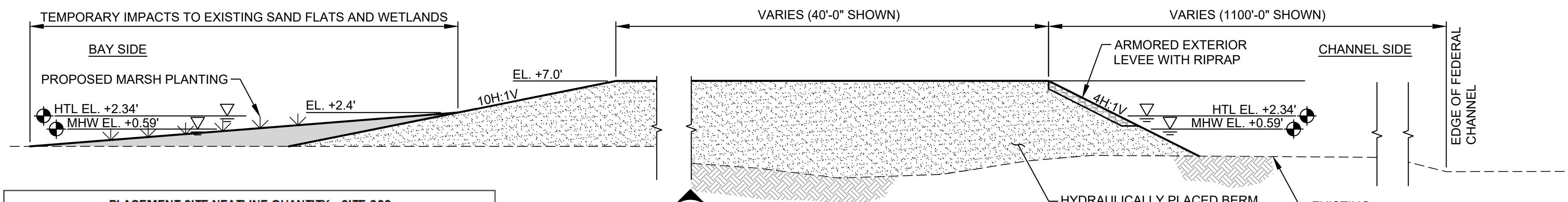
1. BASE MAPPING SHOWN IS ESRI WORLD IMAGERY, RETRIEVED FROM ARCGIS TO AUTOCAD IN MAY 2019 - LAST UPDATED IN SEPT 2018.
2. HORIZONTAL COORDINATE SYSTEM IS NAD83 TEXAS STATE PLANE, SOUTH ZONE, US FOOT.
3. VERTICAL DATUM IS REFERENCED TO MEAN LOWER LOW WATER (MLLW).
4. PIPELINE DATA FOR ARANSAS AND NUECES COUNTIES RETRIEVED FROM RAILROAD COMMISSION OF TEXAS ON NOVEMBER 19, 2018.
5. VERTICAL DATUM CONVERSION FROM MLLW TO NAVD88 = +0.42' BASED ON NOAA TIDE STATION NO. 8775296 USS LEXINGTON.

SS2 SITE PLAN

0 500 1,000
SCALE IN FEET

LEGEND

- PLACED DREDGE MATERIAL
- PLACED BERM MATERIAL
- EXISTING GROUND SURFACE



A
-
SECTION
SS2
N.T.S.

PLACEMENT SITE NEATLINE QUANTITY - SITE SS2	
DREDGED MATERIAL PLACEMENT FILL	**CONSTRUCTION VOLUME (CY)**
LEVEE FILL	124,000
INTERIOR FILL	250,000
TOTAL DREDGED MATERIAL FILL	374,000
ADDITIONAL (NON-DREDGE) FILL	**CONSTRUCTION VOLUME (CY)**
ARMORING	13,800

PERMIT SET

MOTT MACDONALD
802 N Carancahua Street
Suite 300
Corpus Christi, Texas 78401
Texas Registered Firm No. 12181
T +1 (361) 661-3061
www.mottmac.com

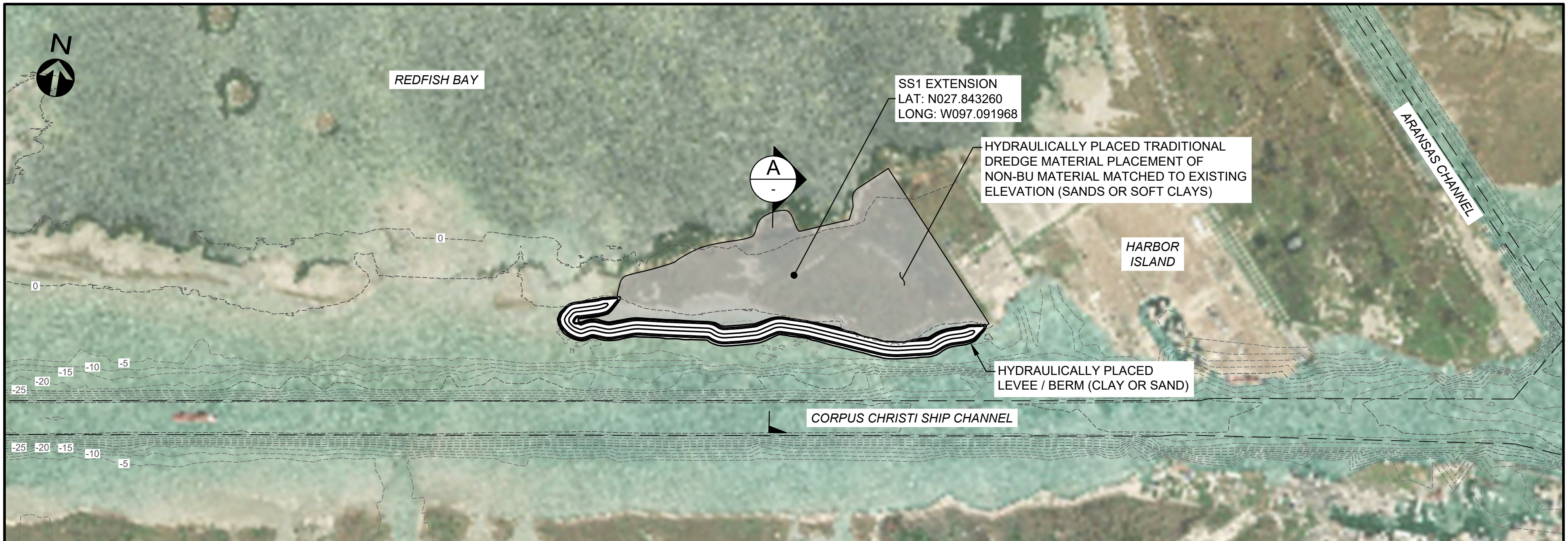
NO.	DATE	REVISION
0	12/6/22	PERMIT DRAWINGS

PORT CORPUS CHRISTI

PORT OF CORPUS CHRISTI AUTHORITY

BENEFICIAL USE SITE AND SECTION
SHORELINE STABILIZATION (SS2)
SHORELINE BREACH FILL
USACE PERMIT ACTION NUMBER SWG-2019-00067

SCALE: AS SHOWN	SITE PLAN - BU SITE SS2	DATE: JANUARY 2024	
DWN. BY: T. MORRISON		SHEET 3 OF 9	



PA4 SITE PLAN

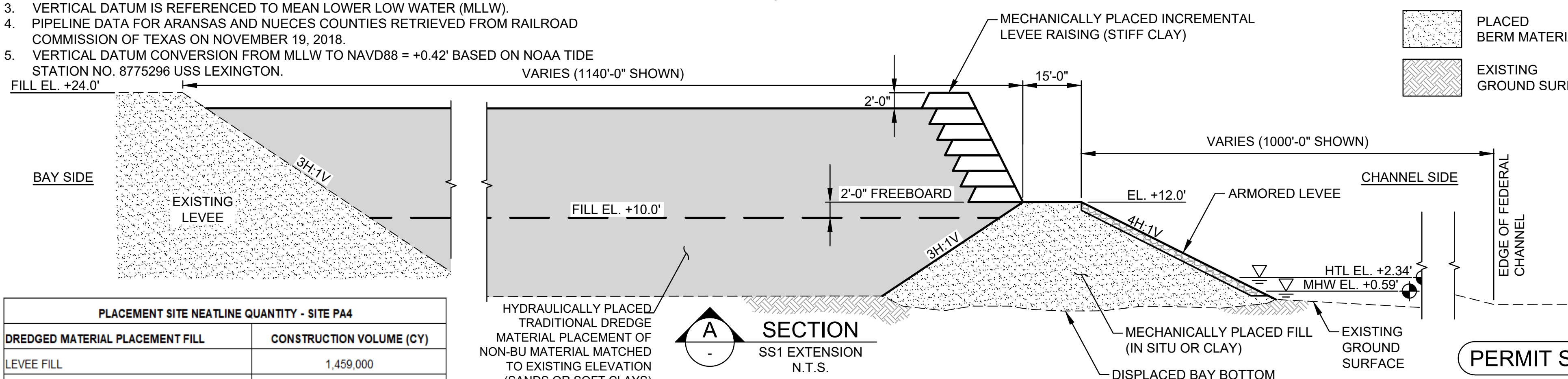
0 1,000 2,000
SCALE IN FEET

NOTES

1. BASE MAPPING SHOWN IS ESRI WORLD IMAGERY, RETRIEVED FROM ARCGIS TO AUTOCAD IN MAY 2019 - LAST UPDATED IN SEPT 2018.
2. HORIZONTAL COORDINATE SYSTEM IS NAD83 TEXAS STATE PLANE, SOUTH ZONE, US FOOT.
3. VERTICAL DATUM IS REFERENCED TO MEAN LOWER LOW WATER (MLLW).
4. PIPELINE DATA FOR ARANSAS AND NUECES COUNTIES RETRIEVED FROM RAILROAD COMMISSION OF TEXAS ON NOVEMBER 19, 2018.
5. VERTICAL DATUM CONVERSION FROM MLLW TO NAVD88 = +0.42' BASED ON NOAA TIDE STATION NO. 8775296 USS LEXINGTON.

LEGEND

- PLACED DREDGE MATERIAL
- PLACED BERM MATERIAL
- EXISTING GROUND SURFACE



A
-
SECTION
SS1 EXTENSION
N.T.S.

PLACEMENT SITE NEATLINE QUANTITY - SITE PA4	
DREDGED MATERIAL PLACEMENT FILL	**CONSTRUCTION VOLUME (CY)**
LEVEE FILL	1,459,000
INTERIOR FILL	2,861,400
TOTAL DREDGED MATERIAL FILL	4,320,400
ADDITIONAL (NON-DREDGE) FILL	**CONSTRUCTION VOLUME (CY)**
ARMORING	217,000

PERMIT SET

MOTT MACDONALD
802 N Carancahua Street
Suite 300
Corpus Christi, Texas 78401
Texas Registered Firm No. 12181
T +1 (361) 661-3061
www.mottmac.com

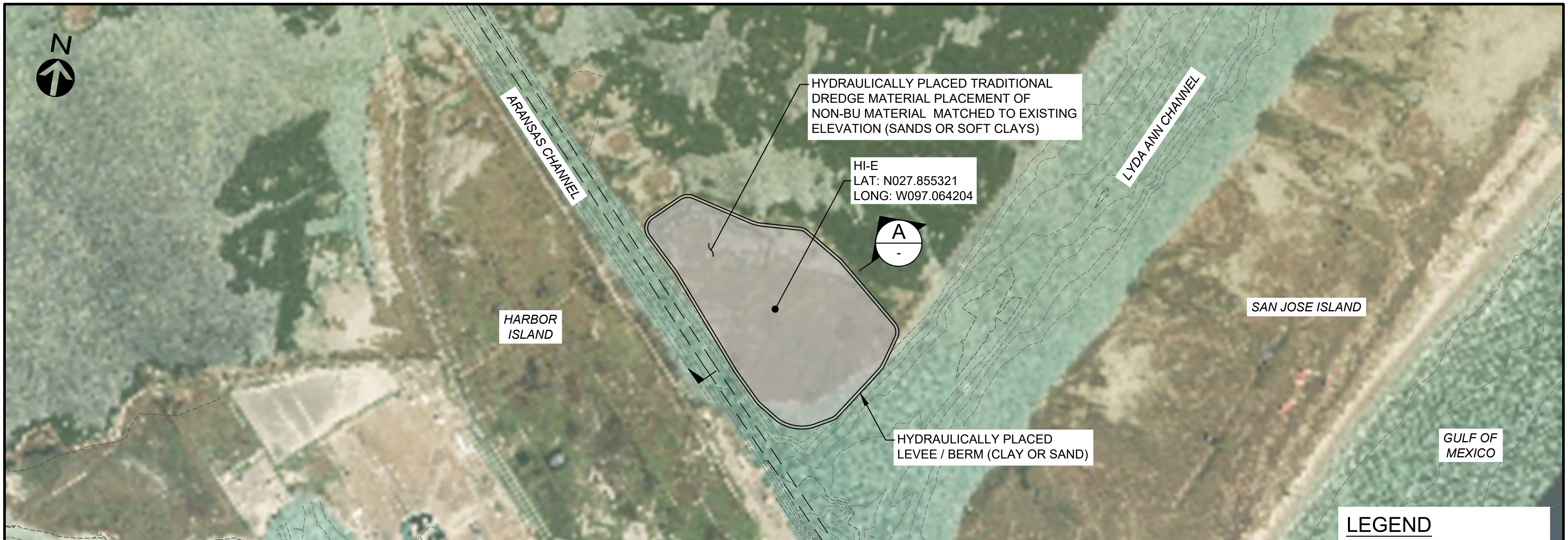
NO.	DATE	REVISION
0	12/6/22	PERMIT DRAWINGS

PORT CORPUS CHRISTI

PORT OF CORPUS CHRISTI AUTHORITY

DREDGE MATERIAL PLACEMENT SITE AND SECTION PLACEMENT AREA 4 (PA4) LEVEE CONSTRUCTION AND FILL USACE PERMIT ACTION NUMBER SWG-2019-00067

SCALE: AS SHOWN	SITE PLAN - BU SITE PA4	DATE: JANUARY 2024	
DWN. BY: T. MORRISON		SHEET 4 OF 9	



LEGEND

- PLACED DREDGE MATERIAL
- PLACED BERM MATERIAL
- EXISTING GROUND SURFACE

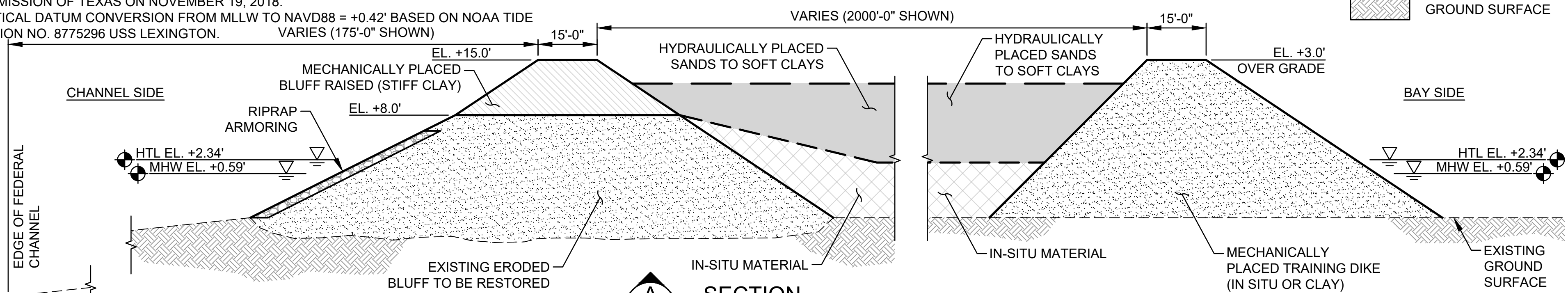
HI-E SITE PLAN

0 1,000 2,000

SCALE IN FEET

NOTES

1. BASE MAPPING SHOWN IS ESRI WORLD IMAGERY, RETRIEVED FROM ARCGIS TO AUTOCAD IN MAY 2019 - LAST UPDATED IN SEPT 2018.
2. HORIZONTAL COORDINATE SYSTEM IS NAD83 TEXAS STATE PLANE, SOUTH ZONE, US FOOT.
3. VERTICAL DATUM IS REFERENCED TO MEAN LOWER LOW WATER (MLLW).
4. PIPELINE DATA FOR ARANSAS AND NUECES COUNTIES RETRIEVED FROM RAILROAD COMMISSION OF TEXAS ON NOVEMBER 19, 2018.
5. VERTICAL DATUM CONVERSION FROM MLLW TO NAVD88 = +0.42' BASED ON NOAA TIDE STATION NO. 8775296 USS LEXINGTON.



A - SECTION

HI-E

N.T.S.

PLACEMENT SITE NEATLINE QUANTITY - SITE HI-E	
DREDGED MATERIAL PLACEMENT FILL	**CONSTRUCTION VOLUME (CY)**
LEVEE FILL	177,800
INTERIOR FILL	1,647,200
TOTAL DREDGED MATERIAL FILL	1,825,000
ADDITIONAL (NON-DREDGE) FILL	**CONSTRUCTION VOLUME (CY)**
ARMORING	23,400

PERMIT SET

MOTT MACDONALD

802 N Carancahua Street
Suite 300
Corpus Christi, Texas 78401
Texas Registered Firm No. 12181
T +1 (361) 661-3061
www.mottmac.com

NO.	DATE	REVISION
0	12/6/22	PERMIT DRAWINGS

PORT CORPUS CHRISTI

PORT OF CORPUS CHRISTI AUTHORITY

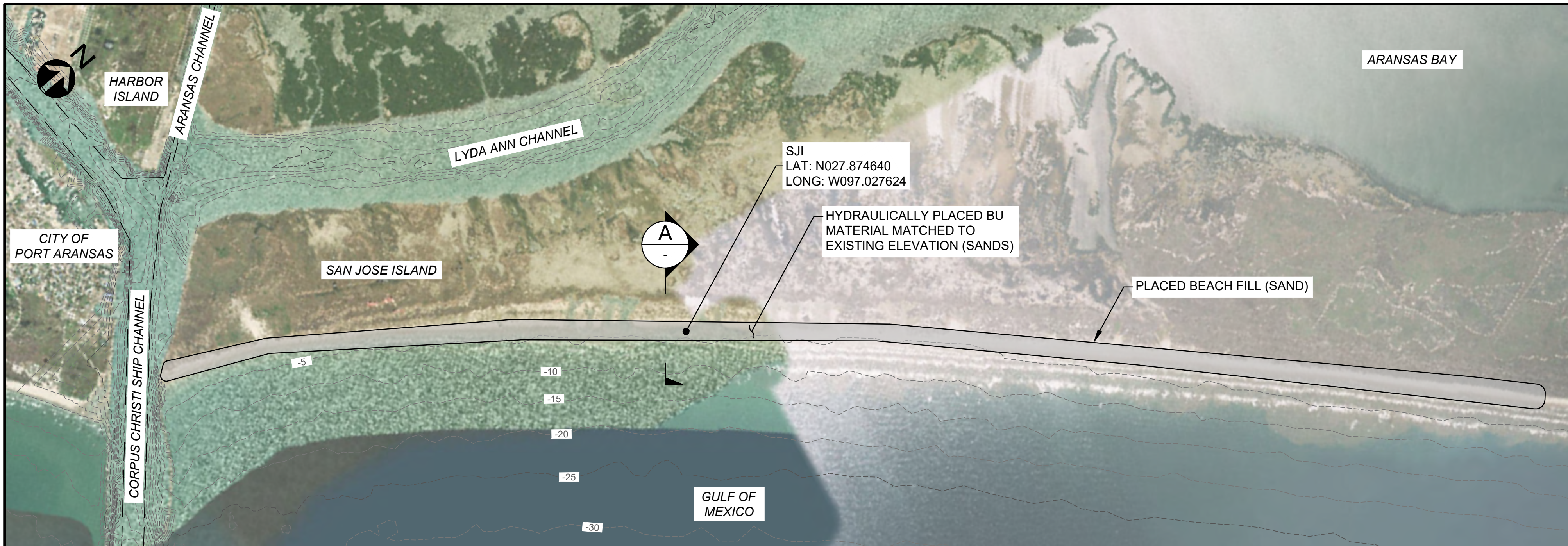
DREDGE MATERIAL PLACEMENT SITE AND SECTION HI-E SITE GRADING FILL AND SHORELINE RESTORATION USACE PERMIT ACTION NUMBER SWG-2019-00067

SCALE: AS SHOWN

DWN. BY: T. MORRISON

SITE PLAN - BU SITE HI-E

DATE: JANUARY 2024



SJI SITE PLAN

0 2,000 4,000

SCALE IN FEET

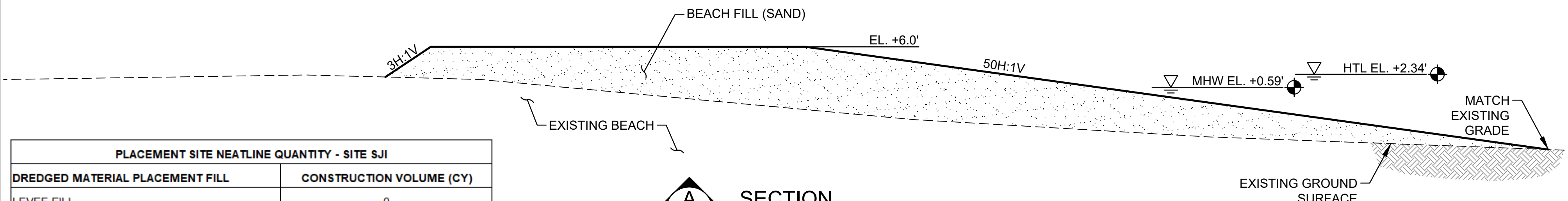
NOTES

1. BASE MAPPING SHOWN IS ESRI WORLD IMAGERY, RETRIEVED FROM ARCGIS TO AUTOCAD IN MAY 2019 - LAST UPDATED IN SEPT 2018.
2. HORIZONTAL COORDINATE SYSTEM IS NAD83 TEXAS STATE PLANE, SOUTH ZONE, US FOOT.
3. VERTICAL DATUM IS REFERENCED TO MEAN LOWER LOW WATER (MLLW).
4. PIPELINE DATA FOR ARANSAS AND NUECES COUNTIES RETRIEVED FROM RAILROAD COMMISSION OF TEXAS ON NOVEMBER 19, 2018.
5. VERTICAL DATUM CONVERSION FROM MLLW TO NAVD88 = +0.42' BASED ON NOAA TIDE STATION NO. 8775296 USS LEXINGTON.

LEGEND

PLACED BEACH FILL

EXISTING GROUND SURFACE



SECTION A -

SJI

N.T.S.

PLACEMENT SITE NEATLINE QUANTITY - SITE SJI	
DREDGED MATERIAL PLACEMENT FILL	**CONSTRUCTION VOLUME (CY)**
LEVEE FILL	0
INTERIOR FILL	2,000,000
TOTAL DREDGED MATERIAL FILL	2,000,000
ADDITIONAL (NON-DREDGE) FILL	**CONSTRUCTION VOLUME (CY)**
ARMORING	0

PERMIT SET

NO.	DATE	REVISION
0	12/6/22	PERMIT DRAWINGS

MOTT MACDONALD
802 N Carancahua Street
Suite 300
Corpus Christi, Texas 78401
Texas Registered Firm No. 12181
T +1 (361) 661-3061
www.mottmac.com

PORT CORPUS CHRISTI

PORT OF CORPUS CHRISTI AUTHORITY

BENEFICIAL USE SITE AND SECTION
SAN JOSE ISLAND (SJI) DUNE AND
BEACH RESTORATION
USACE PERMIT ACTION NUMBER SWG-2019-00067

SCALE: AS SHOWN
DWN. BY: T. MORRISON

SITE PLAN - BU SITE SJI

DATE: JANUARY 2024

NOTES

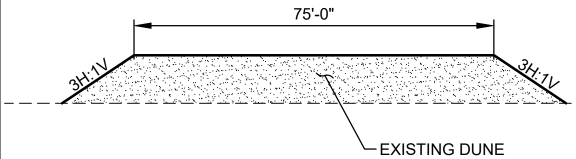
1. BASE MAPPING SHOWN IS ESRI WORLD IMAGERY, RETRIEVED FROM ARCGIS TO AUTOCAD IN MAY 2019 - LAST UPDATED IN SEPT 2018.
2. HORIZONTAL COORDINATE SYSTEM IS NAD83 TEXAS STATE PLANE, SOUTH ZONE, US FOOT.
3. VERTICAL DATUM IS REFERENCED TO MEAN LOWER LOW WATER (MLLW).
4. PIPELINE DATA FOR ARANSAS AND NUECES COUNTIES RETRIEVED FROM RAILROAD COMMISSION OF TEXAS ON NOVEMBER 19, 2018.
5. VERTICAL DATUM CONVERSION FROM MLLW TO NAVD88 = +0.42' BASED ON NOAA TIDE STATION NO. 8775296 USS LEXINGTON.

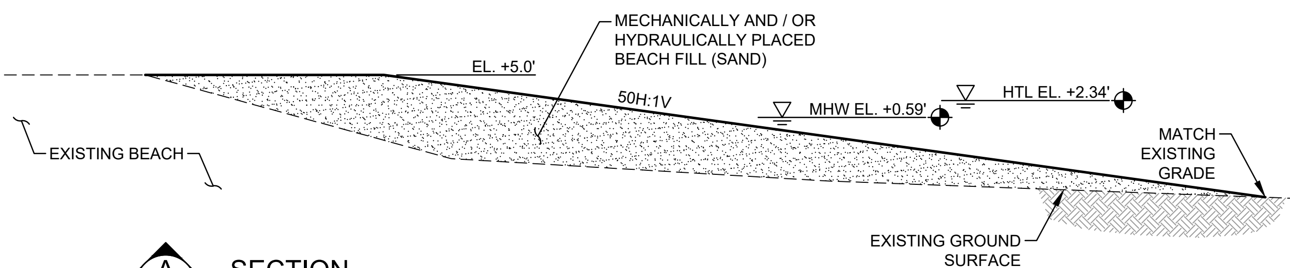
MI SITE PLAN

0 2,000 4,000
SCALE IN FEET

LEGEND

PLACED DUNE FILL
PLACED BEACH FILL
EXISTING GROUND SURFACE





A
-
SECTION
MI
N.T.S.

PLACEMENT SITE NEATLINE QUANTITY - SITE MI	
DREDGED MATERIAL PLACEMENT FILL	**CONSTRUCTION VOLUME (CY)**
LEVEE FILL	0
INTERIOR FILL	2,000,000
TOTAL DREDGED MATERIAL FILL	2,000,000
ADDITIONAL (NON-DREDGE) FILL	**CONSTRUCTION VOLUME (CY)**
ARMORING	0

PERMIT SET

NO.	DATE	REVISION
0	12/6/22	PERMIT DRAWINGS

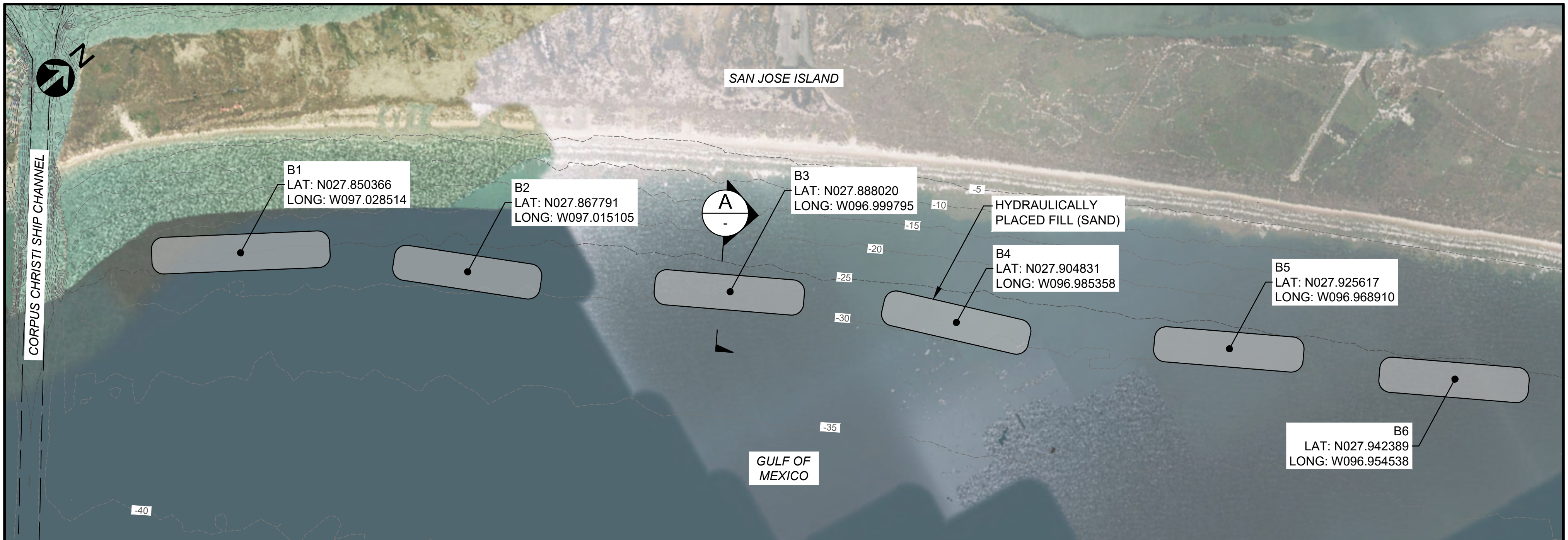
MOTT MACDONALD
802 N Carancahua Street
Suite 300
Corpus Christi, Texas 78401
Texas Registered Firm No. 12181
T +1 (361) 661-3061
www.mottmac.com

PORT CORPUS CHRISTI

PORT OF CORPUS CHRISTI AUTHORITY

BENEFICIAL USE SITE AND SECTION
MUSTANG ISLAND (MI) BEACH NOURISHMENT
USACE PERMIT ACTION NUMBER SWG-2019-00067

SCALE: AS SHOWN
DWN. BY: T. MORRISON
SITE PLAN - BU SITE MI
DATE: JANUARY 2024
SHEET 7 OF 9



NOTES

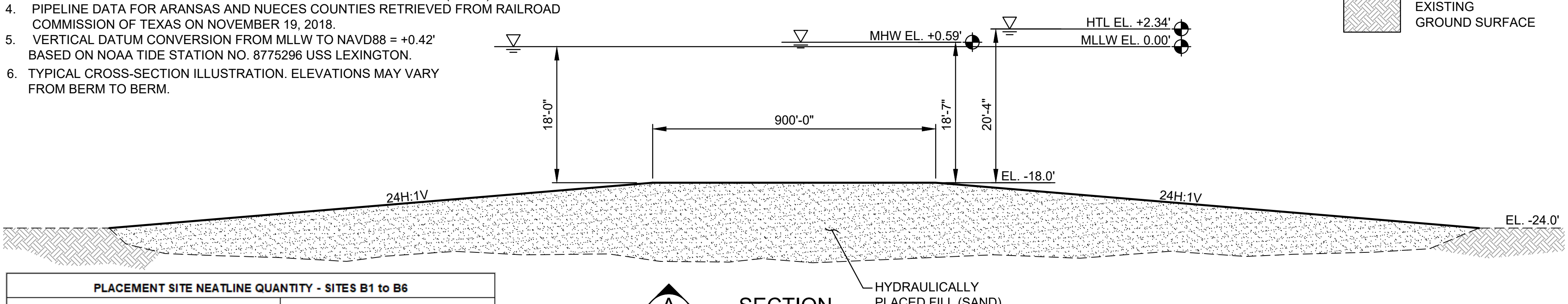
1. BASE MAPPING SHOWN IS ESRI WORLD IMAGERY, RETRIEVED FROM ARCGIS TO AUTOCAD IN MAY 2019 - LAST UPDATED IN SEPT 2018.
2. HORIZONTAL COORDINATE SYSTEM IS NAD83 TEXAS STATE PLANE, SOUTH ZONE, US FOOT.
3. VERTICAL DATUM IS REFERENCED TO MEAN LOWER LOW WATER (MLLW).
4. PIPELINE DATA FOR ARANSAS AND NUECES COUNTIES RETRIEVED FROM RAILROAD COMMISSION OF TEXAS ON NOVEMBER 19, 2018.
5. VERTICAL DATUM CONVERSION FROM MLLW TO NAVD88 = +0.42' BASED ON NOAA TIDE STATION NO. 8775296 USS LEXINGTON.
6. TYPICAL CROSS-SECTION ILLUSTRATION. ELEVATIONS MAY VARY FROM BERM TO BERM.

NEARSHORE BERMS SITE PLAN

0 2,000 4,000
SCALE IN FEET

LEGEND

PLACED FEEDER BERM
EXISTING GROUND SURFACE



SECTION A
FEEDER BERMS B1 TO B6
N.T.S.

PLACEMENT SITE NEATLINE QUANTITY - SITES B1 to B6	
DREDGED MATERIAL PLACEMENT FILL	**CONSTRUCTION VOLUME (CY)**
LEVEE FILL	0
INTERIOR FILL	4,810,000
TOTAL DREDGED MATERIAL FILL	4,810,000
ADDITIONAL (NON-DREDGE) FILL	**CONSTRUCTION VOLUME (CY)**
ARMORING	0

PERMIT SET

NO.	DATE	REVISION
0	12/6/22	PERMIT DRAWINGS

MOTT MACDONALD
802 N Carancahua Street
Suite 300
Corpus Christi, Texas 78401
Texas Registered Firm No. 12181
T +1 (361) 661-3061
www.mottmac.com

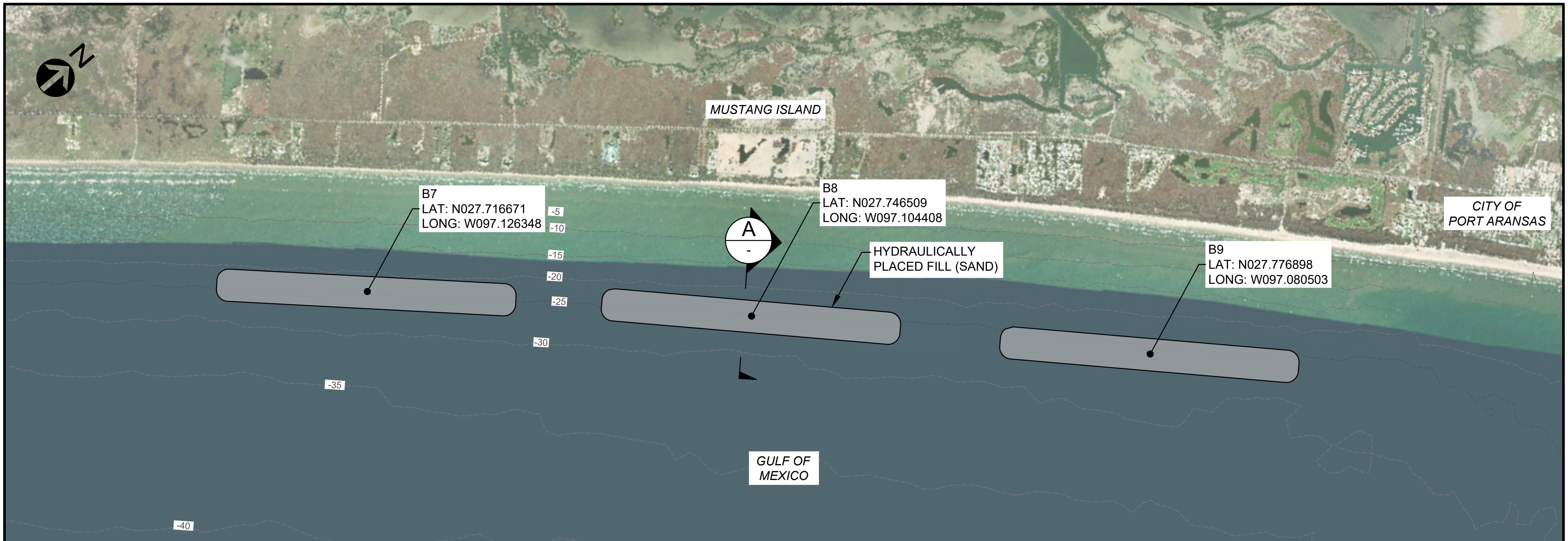
PORT CORPUS CHRISTI

PORT OF CORPUS CHRISTI AUTHORITY

BENEFICIAL USE SITE AND SECTION
USACE PERMIT ACTION NUMBER SWG-2019-00067

SCALE: AS SHOWN	DATE: JANUARY 2024
DWN. BY: T. MORRISON	SHEET 8 OF 9

SITE PLAN - B1 TO B6
NEARSHORE BERMS



NEARSHORE BERMS SITE PLAN

0 2,000 4,000
SCALE IN FEET

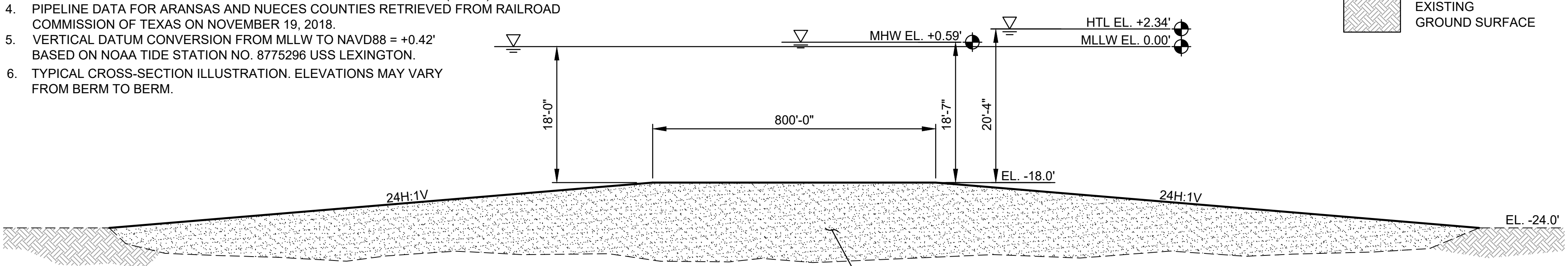
NOTES

1. BASE MAPPING SHOWN IS ESRI WORLD IMAGERY, RETRIEVED FROM ARCGIS TO AUTOCAD IN MAY 2019 - LAST UPDATED IN SEPT 2018.
2. HORIZONTAL COORDINATE SYSTEM IS NAD83 TEXAS STATE PLANE, SOUTH ZONE, US FOOT.
3. VERTICAL DATUM IS REFERENCED TO MEAN LOWER LOW WATER (MLLW).
4. PIPELINE DATA FOR ARANSAS AND NUECES COUNTIES RETRIEVED FROM RAILROAD COMMISSION OF TEXAS ON NOVEMBER 19, 2018.
5. VERTICAL DATUM CONVERSION FROM MLLW TO NAVD88 = +0.42' BASED ON NOAA TIDE STATION NO. 8775296 USS LEXINGTON.
6. TYPICAL CROSS-SECTION ILLUSTRATION. ELEVATIONS MAY VARY FROM BERM TO BERM.

LEGEND

PLACED FEEDER BERM

EXISTING GROUND SURFACE



A - SECTION
FEEDER BERMS B7 TO B9
N.T.S.

PLACEMENT SITE NEATLINE QUANTITY - SITES B7 to B9	
DREDGED MATERIAL PLACEMENT FILL	**CONSTRUCTION VOLUME (CY)**
LEVEE FILL	0
INTERIOR FILL	3,850,000
TOTAL DREDGED MATERIAL FILL	3,850,000
ADDITIONAL (NON-DREDGE) FILL	**CONSTRUCTION VOLUME (CY)**
ARMORING	0

PERMIT SET

NO.	DATE	REVISION
0	12/6/22	PERMIT DRAWINGS

MOTT MACDONALD
802 N Carancahua Street
Suite 300
Corpus Christi, Texas 78401
Texas Registered Firm No. 12181
T +1 (361) 661-3061
www.mottmac.com

PORT CORPUS CHRISTI

PORT OF CORPUS CHRISTI AUTHORITY

BENEFICIAL USE SITE AND SECTION
USACE PERMIT ACTION NUMBER SWG-2019-00067

SCALE: AS SHOWN
DWN. BY: T. MORRISON

SITE PLAN - B7 TO B9
NEARSHORE BERMS

DATE: JANUARY 2024
SHEET 9 OF 9

Appendix C4

Dredged Material Management Plan Matrix

PCCA CDP Description of Proposed Placement Sites - Dredged Material Management Plan Matrix

Placement Area	Description	Dredged Material Placement Area Capacity					Dredged Material Volume (cy)	Features Being Built			Construction Methods	
		Dike		Fill		Total						
		Volume (cy)	Material	Volume (cy)	Material	Volume (cy)		Purpose	From Dredged Material	Others (Armoring etc.)	PCCA Dredge Method	PCCA Other Construction Equipment
SS1	Restoring eroded and washed out shoreline	1,140,000	Stiff clay	1,653,000	Sand	2,793,000	2,793,000	Restore eroded shoreline landmass and provide protection to Harbor Island Seagrass area	Dikes, landmass backfill	Slope armoring/riprap	Cutterhead suction hydraulic with pipelines or barge for placement	• Temporary cofferdams, silt fencing or similar to confine hydraulically placed material in PA • Wetland plantings
SS2	Restore two shoreline breaches and landmass along Port Aransas Nature Preserve resulting from Hurricane Harvey. Would add land mass behind FEMA shoreline bulkhead project.	124,000	Sand/ Soft Clay	250,000	Sand/ Soft Clay	374,000	374,000	Restore shoreline washed out by Hurricane Harvey to protect Piping Plover sand flat Critical Habitat	Interior dikes, landmass backfill	Bulkhead by others	Cutterhead suction hydraulic with pipelines or barge for placement	• Hydraulically pump material behind armored bulkhead built by others • Hydraulically or mechanically construct interior containment levee to meet existing sand flats and wetlands • Temporary cofferdams, silt fencing or similar to confine hydraulically placed material in PA • Thin layer placement
PA4	Reestablish eroded shoreline and land loss in front of PA4	1,459,000	Stiff clay			1,459,000	1,459,000	Restore eroded shoreline and land loss, and provide protection to Harbor Island seagrass area. Raise levees for placement of new work material unsuitable for BU	Exterior containment dike, landmass backfill, interior levee raises	Slope armoring/riprap	• Large cutterhead suction hydraulic • Other methods possible	• Mechanically or hydraulically place exterior berms • Levee raising: Mechanically place stiff clays (barge or land). • Backfill: Hydraulically pump dredge material (pipeline <3 miles) Barges for pipeline mobilization • Heavy machinery for land-side grading and excavating of dewatered dredged material
	Upland placement within PA4			2,861,400	Material unsuitable for BU	2,861,400	2,861,400	No environmental benefit	PA interior fill		Cutterhead suction hydraulic with pipelines for placement	
HI-E	Bluff and shoreline land mass restoration with site fill on eastern Harbor Island	177,800	CDP for levee stiff clays	1,647,200	CDP for backfill sand to soft clays	1,825,000	1,825,000	Restore eroded bluff and shoreline to historic profiles	Containment levees, landmass backfill	Slope armoring/riprap	• Large cutterhead suction hydraulic dredge for dredged material • Barges for pipeline mobilization • Heavy machinery for land-side grading and excavating of dewatered dredged material	• Levees: Mechanically place stiff clays (barge or land) • Armor: Mechanically place rip-rap (barge or land) • Backfill: Hydraulically pump dredge material (pipeline <3 miles)
PA6	Raise PA dike 5 feet and fill with 4 feet of new work material	103,000	Mechanically placed stiff clay or in situ material	1,693,400	Hydraulically placed dredge material unsuitable for BU	1,796,400	1,796,400	No environmental benefit	Levee raise, PA interior fill		Cutterhead suction hydraulic with pipelines for placement	Mechanically placed or in situ borrow material for levee raise
SJI	Beach nourishment on San José Island		CDP new work sands	2,000,000	Sand	2,000,000	2,000,000	Restores several miles of beach profile that was washed away during Hurricane Harvey	Beach		Cutterhead suction hydraulic or hopper	Hydraulically placed fill
B1-B9	Nearshore berms offshore of San José Island and Mustang Island		CDP new work sands	8,660,000	Sand	8,660,000	8,660,000	Nearshore berms within transport zone to indirectly nourish barrier islands	Offshore berms		Cutterhead suction hydraulic or hopper	Hydraulically placed fill
MI	Beach Nourishment for Gulf side of Mustang Island		CDP new work sands	2,000,000	Sand	2,000,000	2,000,000	Mustang Island beach nourishment to enhance shoreline	Beach		Cutterhead suction hydraulic or hopper	Hydraulically or mechanically placed beach fill
New Work ODMDS	Place material in existing New Work ODMDS			38,888,600	Material suitable for ocean placement	38,888,600	22,531,200	No environmental benefit	Placement mound		Cutterhead suction hydraulic or hopper	
					TOTAL CAPACITY[1]	**62,657,400**	**46,300,000**	**TOTAL DREDGED MATERIAL VOLUME**				

[1] Based on PCCA's Dredged Material Management Plan (February 2024) with clarfication provided Beneficial Use Monitoring Plan (January 2024, Version 5), and Permit Drawings (January 2024).

Appendix C5

Depth of Closure and Nearshore Berm Analysis

800 N. Shoreline Blvd., Suite 1600N • Corpus Christi, Texas 78401 • 361-561-6500 • fax 361-561-6501 www.freese.com

October 11, 2021

Mr. Jayson Hudson
Regulatory Project Manager
USACE Galveston District
2000 Fort Point Road
Galveston, Texas 77550

Re: Port of Corpus Christi Authority Channel (PCCA) Deepening Project Third-Party EIS and 408 Permissions Analysis – PCCA Proposed Beneficial Use Nearshore Feeder Berms Review

Dear Mr. Hudson,

Freese and Nichols, Inc. (FNI) has reviewed PCCA's proposed beneficial use nearshore feeder berm configurations ahead of undertaking the scheduled sediment transport numerical modeling.

The originally proposed feeder berm considerations, configurations, and preliminary designs are reported in AECOM's Memorandum to USACE Galveston District dated November 14, 2019, Subject: "Corpus Christi Ship Channel Channel Deepening Project Feeder Berms for Shoreline Nourishment" (AECOM Memo).

In summary, AECOM proposed a series of nine (9) nearshore feeder berms to be located offshore of San José Island and Mustang Island at the –24 ft bathymetric contour as the outer seaward extent. Detailed dimensions of these originally proposed feeder berms are presented in Table 13 of the attached Depth of Closure and Nearshore Feeder Berm Analysis report.

FNI evaluated AECOM's preliminary designs of the originally proposed nearshore feeder berms to: 1) validate that the locations of the feeder berms are within an active zone for the potential shoreward migration of sediments; and, 2) validate the capacity of the feeder berms to receive the Corpus Christi Ship Channel (CCSC) Channel Deepening Project (CDP) dredged material quantities planned for nearshore placement.

FNI's findings from the evaluation are presented in the attached Depth of Closure and Nearshore Feeder Berm Analysis report. In summary, it was concluded:

1) The original nearshore feeder berms as proposed in the AECOM Memo are anticipated to be active berms, with a resulting expectation that the nearshore feeder berm sediments will migrate to shore.

2) The total capacity of nearshore feeder berms as proposed in the AECOM Memo is not sufficient to accommodate the total in-situ volume of dredged material planned to be placed within the nearshore (See Table 14, Depth of Closure and Nearshore Feeder Berm Analysis report).

Based on the original AECOM feeder berm cross-section geometry, FNI formulated a modification to the nearshore feeder berm configurations to accommodate the total amount of the planned CCSC CDP dredged material quantities to be beneficially placed within the nearshore. The modification requires siting of the nearshore feeder berms within deeper waters (See Figures 6 and 7, Depth of Closure and Nearshore Feeder Berm Analysis report), but remain within the active feeder zone, and elongating the lateral extent of each feeder berm (See Tables 15 and 16, Depth of Closure and Nearshore Feeder Berm Analysis report).

FNI is required to incorporate the nearshore feeder berm beneficial use features into the sediment transport modeling to assess potential 408 impacts to the existing CCSC. FNI requests guidance on the preferred nearshore feeder berm configurations to be used for the sediment transport modeling purposes.

It should be noted that if AECOM's original nearshore feeder berm configuration is selected for advancement into the sediment transport model, any CCSC CDP dredge material quantity in excess of the evaluated volumetric berm capacity may need to be repurposed to another dredged material placement area(s). It should be further noted that the FNI modification to the original feeder berm as an alternative configuration was not developed as an optimization feeder plan, but was developed to minimally meet the criteria of capacity and active transport.

Please feel free to contact me at 512.617.3158 should you have any questions regarding this matter.

Respectfully,

Lisa Vitale

Lisa Vitale, FP-C
Marine Biologist / Project Manager

CORPUS CHRISTI SHIP CHANNEL
CHANNEL DEEPENING PROJECT
DEPTH OF CLOSURE AND NEARSHORE FEEDER BERM ANALYSIS

DEFINITIONS

Inner Depth of Closure (DOC): The Inner DOC marks the seaward extent of the littoral zone, which is characterized by increased bed stresses and sediment transport due to waves near breaking and fluid circulation (U.S. Army Corps of Engineers [USACE], 2016).

Outer DOC: The Outer DOC is the seaward limit of the offshore zone, where wave shoaling is the dominant process and bed agitation remains relatively moderate (USACE, 2016).

Sediment Grain Sizes: Classifications of sediments are provided in Attachment A (Wentworth Grain Size Chart), and classifications of sand are detailed in Table 1.

Table 1
Sand Classifications

Sieve Size	Sand Sizes				
	Very Coarse	Coarse	Medium	Fine	Very Fine
mm	1.000 to 2.000	0.500 to 1.000	0.250 to 0.500	0.125 to 0.250	0.062 to 0.125
phi	0 to –1	1 to 0	2 to 1	3 to 2	4 to 3
Mesh (ASTM)	18 to 10	35 to 18	60 to 35	120 to 60	230 to 120

Source: Wentworth (1922).

Note: 200 sieve size is equivalent to 0.074 mm, which is very fine sand (Wentworth Grain Size Chart).

mm = millimeters; phi = negative log base 2 of the diameter in mm; ASTM = American Society for Testing and Materials

EMPIRICAL OBSERVATIONS (Hands and Allison, 1991)

Berms that were placed shallower than the Inner DOC (i.e., in the littoral zone) were always active while berms placed deeper than the Outer DOC were always stable.

If a berm was placed 50% shallower than the Outer DOC, the berm was also found to be active, but to significantly varying degrees. Berms placed in locations with less than half the water depth of the Outer DOC tended to be active, indicating a potential cutoff point for active feeder berms.

Hands and Allison (1991) concluded that, in general, if the 75 percentile velocity (udmax75) exceeds 1.3 ft/second (ft/sec) (40 centimeters/second [cm/sec]), or the 95 percentile (udmax95) exceeds 2.3 ft/sec (70 cm/sec), then sand berms should not be expected to remain stable, regardless of depth or sand size.

GRAIN SIZE STATISTICS

Median grain sizes for Mustang Island along the beach profile are provided in tables 2 and 3.

Table 2
North Padre and Mustang Island Beaches

Year	Mean Median Grain Size (mm) at Shore Profile Locations					
	Toe of Dune	Mid Berm	Shoreline	–3 feet (ft)	–12 ft	–24 ft
2003	0.15	0.15	0.15	0.14	0.14	0.13
2004	0.15	0.15	0.15	0.14	0.12	0.13

Source: Williams et al. (2005).

Table 3
Mustang Island Profile

Median Grain Size	Shore Profile Locations (x-ft)												
	Dune (-19)	Mid (48)	Surf (115)	Off-1 (258)	Off-2 (287)	Off-3 (404)	Off-4 (707)	Off-5 (1533)	Off-6 (2110)	Off-7 (2494)	Off-8 (2877)	Off-9 (3343)	Off-10 (3959)
d_{50}	0.159	0.157	0.183	0.163	0.149	0.135	0.139	0.121	0.130	0.127	0.132	0.129	0.134

Source: Knezek (1997).

In addition, review of the Texas Sediment Geodatabase (TxSed) (Texas General Land Office, 2021) of sediment grab samples taken within the nearshore of Mustang Island and San José Island indicate sand fractions in excess of 90% for each pertinent sample.

Based upon review of the Furgo (2018) data, it is estimated the average sand content of the new work dredged material that will be generated by the Port of Corpus Christi Authority (PCCA) Corpus Christi Ship Channel (CCSC) Channel Deepening Project (CDP) is 54% (PCCA, 2018), with a 0.13 mm median grain size.

DEPTH OF CLOSURE EQUATIONS (USACE, 2016)

Hallermeier Inner DOC (HIL): $d_l = 2.28H_e - 68.5(H^2_e/gT^2_e)$

Hallermeier Inner DOC - Simplified (HIL-S): $d_l = 2H_s+11\sigma_s$

Hallermeier Outer DOC (HOL): $d_i = (H_s-0.3\sigma_s)T_s(g/5000D)^{1/2}$

Birkmeier Inner DOC (BIR): $d_l = 1.75H_e - 57.9(H^2_e/gT^2_e)$

Birkmeier Simplified (BIR-S): $d_l = 1.57H_e$

DEPTH OF CLOSURE EQUATIONS VARIABLES DEFINITIONS (USACE, 2016)

d_l = Inner Depth of Closure

H_e = Effective Wave Height = Wave Condition exceeded only 12 hours in a year (or the greatest 0.137% waves in a year), or

H_e = Effective Wave Height = $Hs+5.6\sigma_s$

T_e = Effective Wave Period

g = acceleration due to gravity = 32.2 ft/s^2 = 9.81 m/s^2

H_s = Significant Wave Height = Mean of the Highest 1/3 of Waves

T_s = Significant Wave Period

σ_s = Standard Deviation of Significant Wave Height = $(\Sigma(x_i\text{-}u)^2/N)^{1/2}$

u = Hs
x_i = Each H to calculate H_s
N = Total No. of H to calculate H_s

DEPTH OF CLOSURE COMPUTATIONS FOR WIS STATION 73040

Table 4 shows Hallermeier and Birkmeier's calculated Inner DOCs for WIS ST73040's 2011 Wave Time Series Record.

Table 4
Inner Depths of Closure for Year 2011

Equation	2011	
	meters	ft
Hallermeier Inner DOC (HIL)	5.577	18
Hallermeier Inner DOC - Simplified (HIL-S)	8.146	27
Birkmeier Inner DOC (BIR)	4.203	14
Birkmeier Simplified (BIR-S)	4.522	15

Source: USACE (2021a).
GOM_DOC-yearly_0116 (2)_73040_waves.xlsx

Hallermeier's Outer DOC for WIS ST73040's 2011 Wave Time Series Record by grain size are provided in Table 5, with the associated 50% shallower depths of Hallermeier's Outer DOC Record is displayed in Table 6.

Table 5
Hallermeier Outer Depths of Closure by Median Grain Size for Year 2011

HOL = Hallermeier Outer Depth of Closure = $d_i = (H_s\text{-}0.3\sigma_s)T_s(g/5000D)^{1/2}$											
HOL (DOC)	D = d50 = Median Grain Size (mm/0.001 = m)										
	d50	d50	d50	d50	d50	d50	d50	d50	d50	d50	d50
	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20
2011 (meters)	26	24	23	22	22	21	20	20	19	19	18
2011 (ft)	84	80	77	74	71	69	66	64	63	61	59

Source: USACE (2021a).
GOM_DOC-yearly_0116 (2)_73040_waves2.xlsx

Table 6
50% Shallower Depths from Hallermeier's Outer Depths of Closure for Year 2011

50% Shallower Depth from Hallermeier Outer Depths of Closure											
HOL (DOC)	D = d50 = Median Grain Size (mm/0.001 = m)										
	d50	d50	d50	d50	d50	d50	d50	d50	d50	d50	d50
	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20
2011 (meters)	13	12	12	11	11	10	10	10	10	9	9
2011 (ft)	42	40	38	37	35	34	33	32	31	30	30

Source: USACE (2021a).

GOM_DOC-yearly_0116 (2)_73040_waves2.xlsx

Hallermeier's Outer DOC for the WIS ST73040 Wave Time Series Full Record (from 1980 to 2019) by grain size are provided in Table 7, with the associated 50% shallower depths of Hallermeier's Outer DOC Record is displayed in Table 8.

Table 7
Hallermeier Outer Depths of Closure by Median Grain Size for Full Record Years 1980 to 2019

HOL = Hallermeier Outer Depth of Closure = di = $(Hs-0.3\sigma_s)Ts(g/5000D)^{1/2}$											
HOL (DOC)	D = d50 = Median Grain Size (mm/0.001 = m)										
	d50	d50	d50	d50	d50	d50	d50	d50	d50	d50	d50
	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20
FullRec (m)	23	22	21	21	20	19	18	18	17	17	17
FullRec (ft)	77	73	70	67	65	63	61	59	57	56	54

Source: USACE (2021b).

ST73040_FullRecord_ajr_calcs.xlsm

Table 8
50% Shallower Depths from Hallermeier's Outer Depths of Closure for Full Record Years 1980 to 2019

50% Shallower Depth from Hallermeier Outer Depths of Closure											
HOL (DOC)	D = d50 = Median Grain Size (mm/0.001 = m)										
	d50	d50	d50	d50	d50	d50	d50	d50	d50	d50	d50
	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20
FullRec (m)	12	11	11	10	10	10	9	9	9	8	8
FullRec (ft)	38	37	35	34	32	31	30	29	29	28	27

Source: USACE (2021b).

ST73040_FullRecord_ajr_calcs.xlsm

NEAR BOTTOM VELOCITIES

If the 75th percentile velocity (udmax75) exceeds 1.3 ft/sec, or the 95th percentile (udmax95) exceeds 2.3 ft/sec, then sand berms should not be expected to remain stable, regardless of depth or sand size (Hands and Allison, 1991) (Table 9). The green shading reflects instances when both the udmax75 and udmax95 exceed the Hands and Allison (1991) bottom velocity thresholds for active sand berms, and the yellow shading reflect instances when only udmax75 exceeds the Hands and Allison (1991) bottom velocity threshold.

Table 9
WIS 73040 Udmax for 2011 Wave Time Series at Varying Depths

Depth (ft)	Percentile	Udmax (ft/sec)
25	95	3.10
	75	2.09
30	95	2.68
	75	1.79
35	95	2.34
	75	1.54
36	95	2.28
	75	1.50
40	**95**	**2.06**
	75	1.34
45	95	1.83
	75	1.17

Source: Hands and Allison (1991); USACE (2021b).
WIS-ocean_waves_ST73040_2011b.xlsx

SUMMARY OF DEPTH OF CLOSURES BY SAND GRAIN SIZE

Based on Hallermeier and Birkmeier's equations and Hands and Allison (1991), a summary of depths of closure and berm instability depths by sand grain size and by the 2011 wave time series at WIS Station 73040 is provided in Table 10. As noted earlier, the Outer DOC is dependent upon median grain size.

SEDIMENT MOBILITY TOOL

USACE's Sediment Mobility Tool (SMT) (2021c) was used as an application to provide additional scoping level analysis to site the nearshore feeder berm locations by depth. For the proposed PCCA CCSC CDP nearshore feeder berms located offshore of Mustang Island and San José Island the SMT defaulted to WIS 73039 to access 1980 to 2019 wave characteristics to predict cross-shore sediment migration by considering placement depths and median sediment grain sizes. For nearshore feeder berms located north and south of the CCSC Entrance Channel, the predicted percent of onshore movement of sediments are presented in Tables 11 (South) and 12 (North), and in Figure 1 (South) and Figure 2 (North).

Table 10
Depth of Closure/Berm Stability Summary by Sand Grain Size for Wave Year 2011

Grain Size	Inner DOC (Birkmeier)	Inner DOC – Simplified (Birkmeier)	Inner DOC (Hallermeier)	Inner DOC – Simplified (Hallermeier)	50% Outer DOC (Hands and Allison, 1991)	Max Depth for Berm Instability - (Udmax) (Hands and Allison, 1991)	Outer DOC (Hallermeier)
0.12 mm	14 ft	15 ft	18 ft	27 ft	38 ft	40 ft	77 ft
0.13 mm	14 ft	15 ft	18 ft	27 ft	37 ft	40 ft	74 ft
0.14 mm	14 ft	15 ft	18 ft	27 ft	35 ft	40 ft	71 ft
0.15 mm	14 ft	15 ft	18 ft	27 ft	34 ft	40 ft	69 ft
0.16 mm	14 ft	15 ft	18 ft	27 ft	33 ft	40 ft	66 ft
0.17 mm	14 ft	15 ft	18 ft	27 ft	32 ft	40 ft	64 ft

Table 11
SMT Predicted % Sediment Onshore Migration (South of CCSC Entrance Channel)

Median Grain Size (mm)	Depth (ft)							
	16	20	24	28	32	36	40	44
0.12	55%	57%	58%	59%	59%	60%	61%	61%
0.13	68%	70%	71%	72%	73%	73%	74%	74%
0.14	76%	78%	79%	80%	81%	81%	82%	82%
0.15	81%	83%	84%	84%	85%	86%	86%	86%

Table 12
SMT Predicted % Sediment Onshore Migration (North of CCSC Entrance Channel)

Median Grain Size (mm)	Depth (ft)							
	16	20	24	28	32	36	40	44
0.12	53%	55%	56%	57%	58%	59%	60%	60%
0.13	67%	68%	70%	71%	72%	73%	73%	74%
0.14	75%	77%	78%	79%	80%	81%	81%	82%
0.15	81%	82%	83%	84%	85%	85%	86%	86%

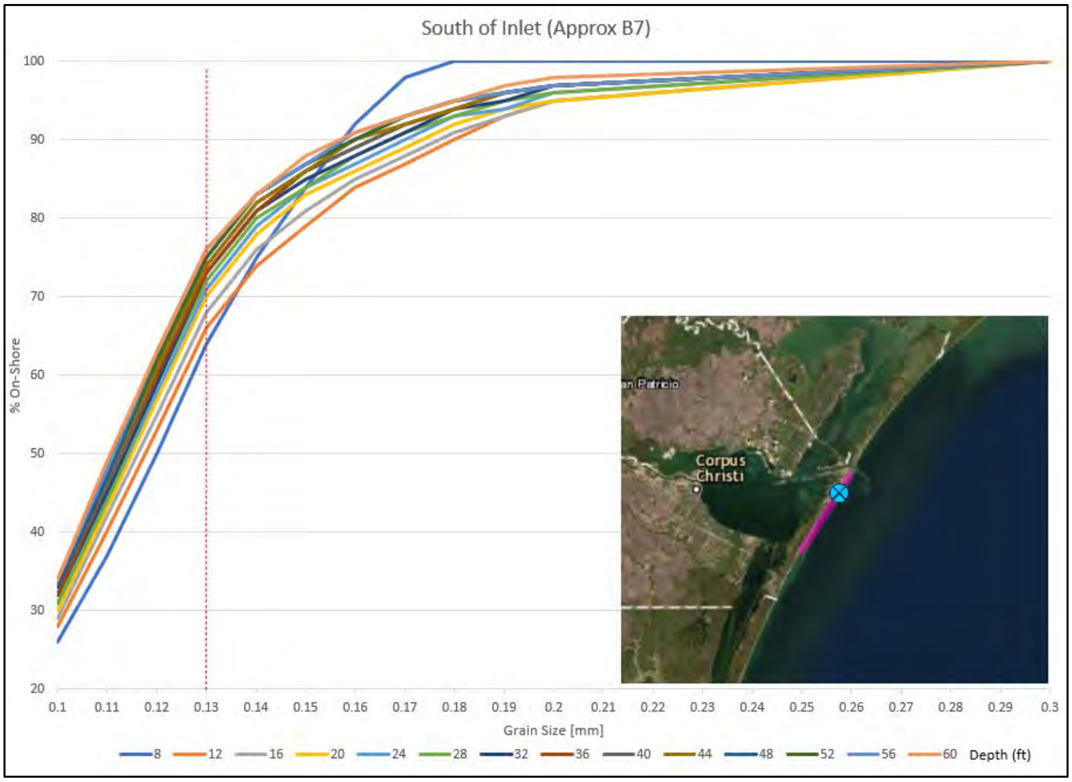


Figure 1. SMT Predicted % Sediment Onshore Migration Curves (South of CCSC Entrance)

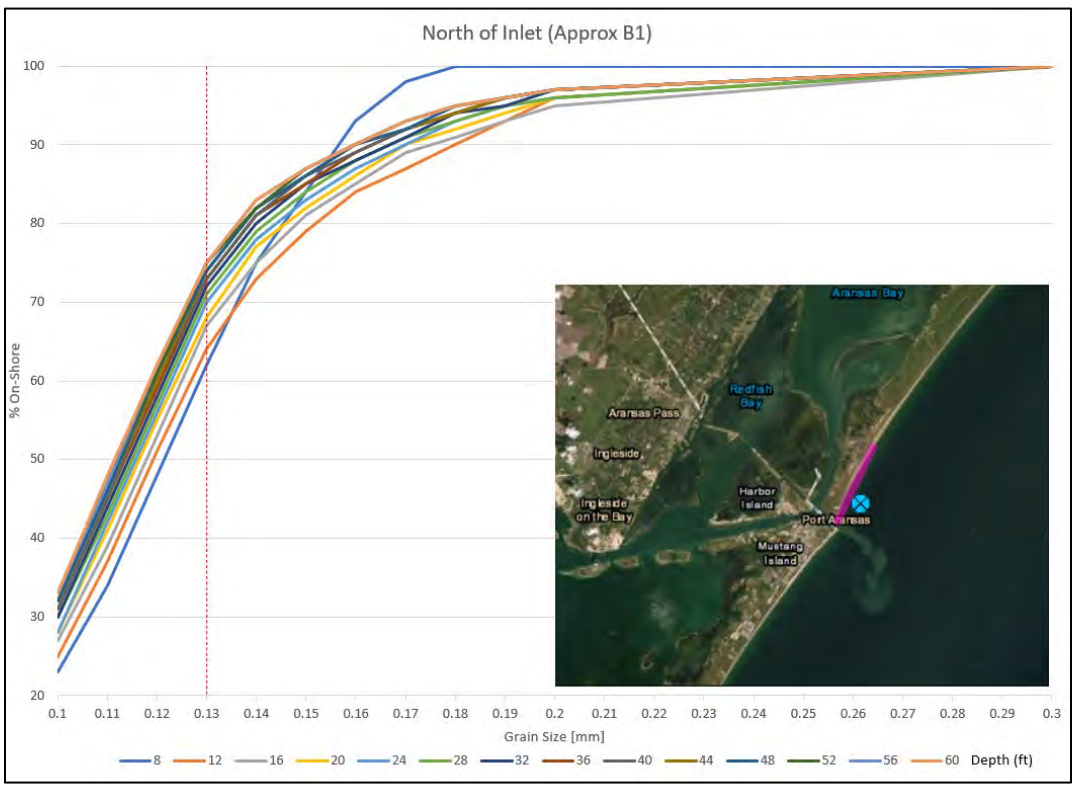


Figure 2. SMT Predicted % Sediment Onshore Migration Curves (North of CCSC Entrance)

CURRENT FEEDER BERM CONFIGURATIONS

AECOM (2019) proposed to place 4.5 million cubic yards (mcy) of CDP sediments within six nearshore feeder berms offshore of San José Island (Figure 3) and placing an additional 3.6 mcy of CDP sediments within three nearshore feeder berms offshore of Mustang Island (Figure 4). AECOM (2019) proposed the offshore toe of each feeder berm be located along the –24-ft elevation contour. AECOM (2019) dimensions for typical sections of the nearshore feeder berms north and south of the CCSC Entrance Channel are listed in Table 13.

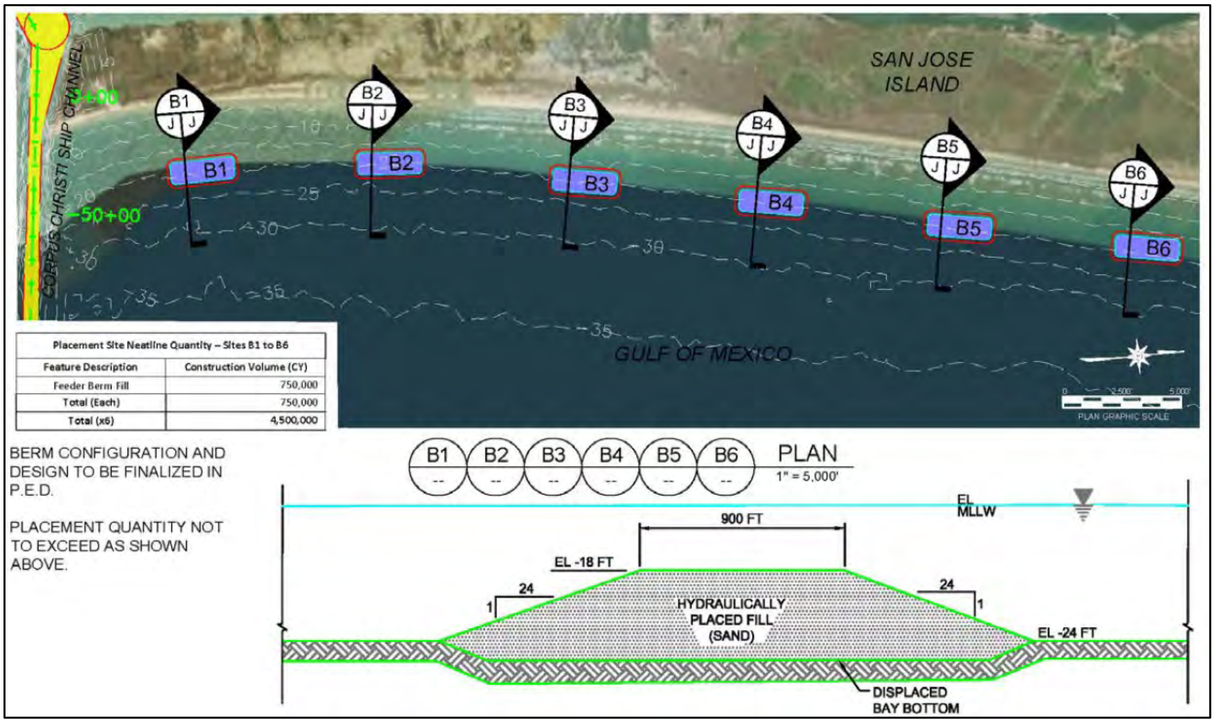


Figure 3. San José Island Proposed Nearshore Feeder Berms (AECOM, 2019)

Table 13
Dimensions for Typical Nearshore Feeder Berm Sections

Feeder Berm Features	North Feeder Berm	South Feeder Berm
Bottom Elevation (Offshore Toe)	–24 ft	–24 ft
Crest Elevation	–18 ft	–18 ft
Berm Height	6 ft	6 ft
Crest Width	900 ft	800 ft
Bottom Width	1,188 ft	1,088 ft
Berm Length	Approx. 3,000 ft	Appox. 5,000 ft
Side Slopes	1V:24H	1V:24H
Bottom Displacement	Yes	Yes

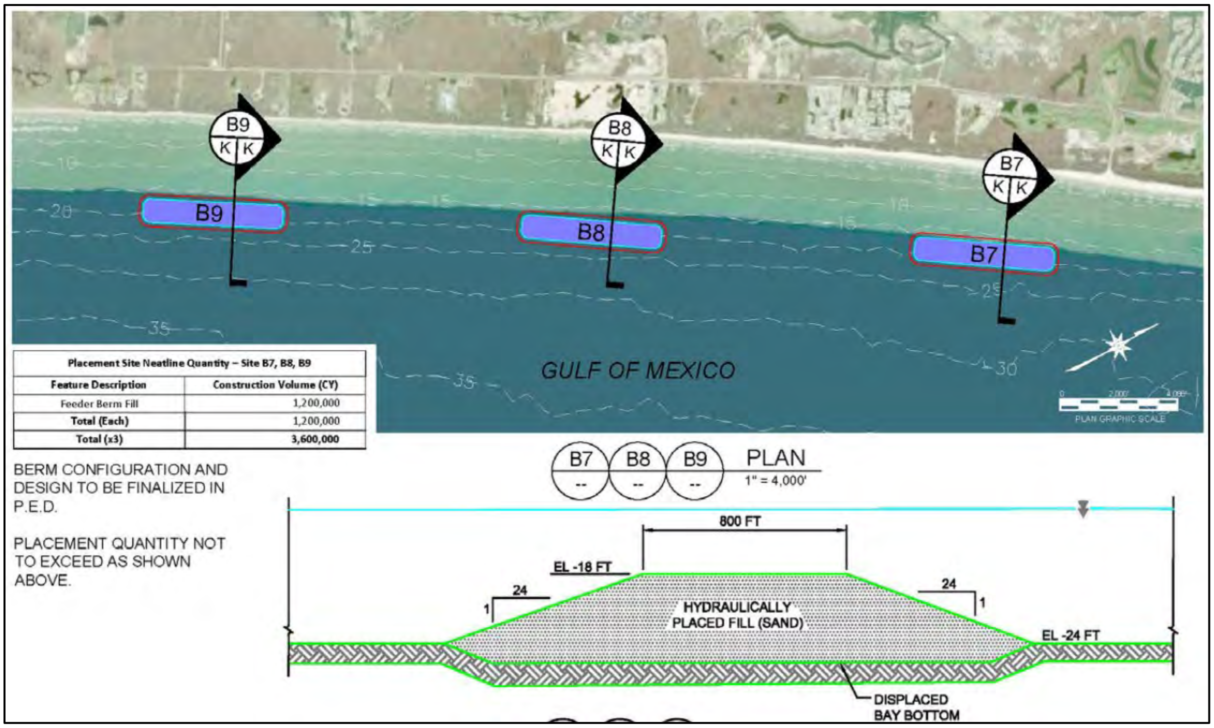


Figure 4. Mustang Island Proposed Nearshore Feeder Berms (AECOM, 2019)

Nearshore geotechnical data at the proposed feeder berm locations are not available, therefore geotechnical foundation properties are unknown. However, Williams et al. (2005) and Knezek (1997) report that median grain sizes for Mustang Island along the beach to nearshore profile consist of fine sand, and TxSed (Texas General Land Office, 2021) reports surficial sediments within the nearshore at Mustang Island and San José Island consist of over 90% sand fractions. If it is assumed that a fine sand condition is the representative geotechnical condition at the nearshore feeder berms proposed to be located offshore of Mustang Island and San José Island, then an additional assumption can be made that bottom displacement beneath the feeder berms will be minimal. Based on this assumption and the latest nearshore bathymetry, the following volumetric capacity for the nearshore feeder berms are 1.8 mcy offshore of San José Island and 1.4 mcy offshore of Mustang Island.

Figure 5 displays the profile of the typical feeder berm cross-sectional geometry when overlayed on the latest nearshore bathymetry at San José Island and Mustang Island, with the seaward toe of the berms located at the 24-ft depth contour. Because of the reduction in the cross-sectional area of the berm geometry, these capacities are much less than the proposed in-situ volume of dredged sediments to be placed in the nearshore.

Table 14 shows the comparison of the proposed in-situ volume to be placed in the nearshore versus capacity of the nearshore feeder berms.

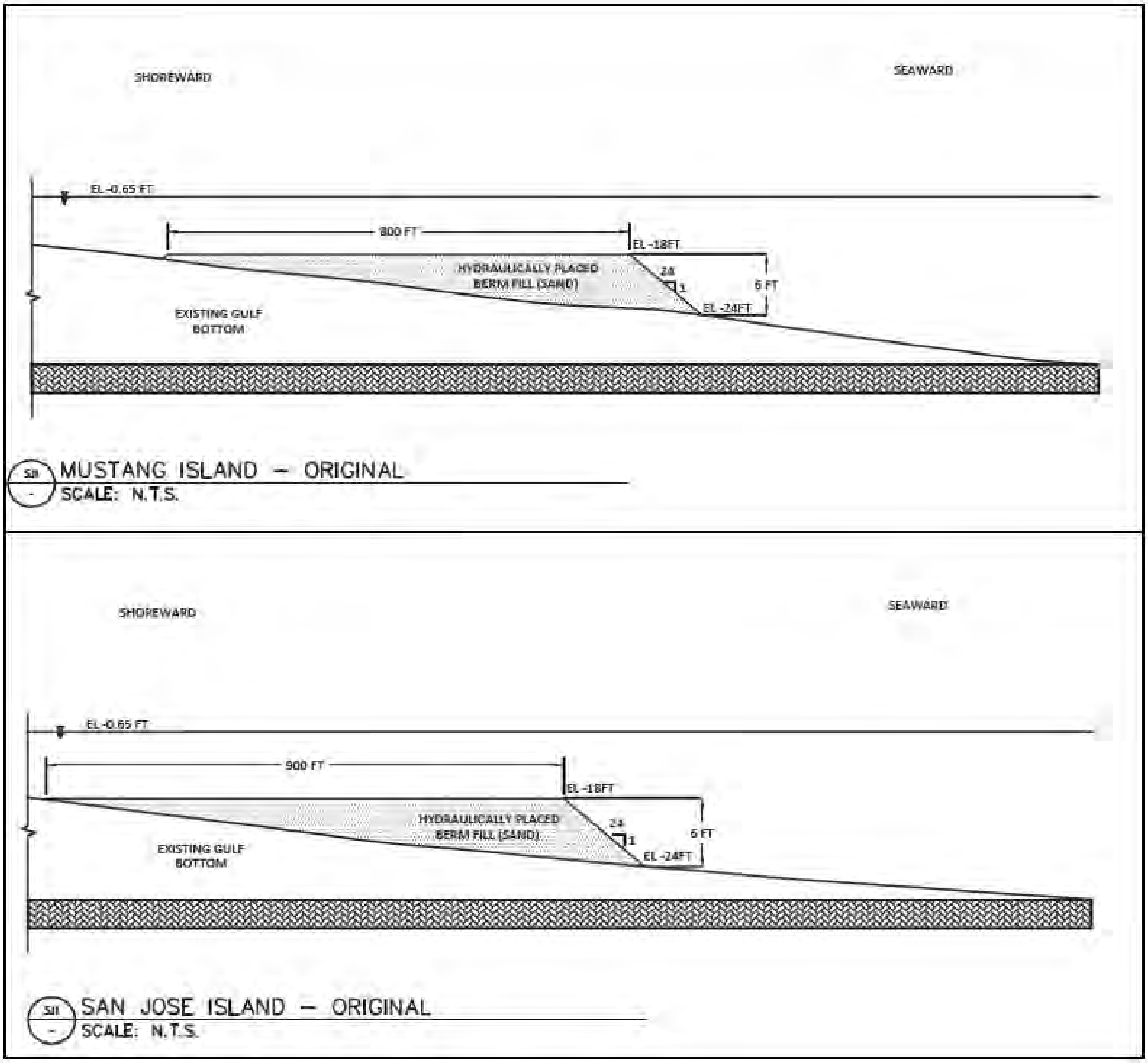


Figure 5. San José Island and Mustang Islands Nearshore Feeder Berm Bathymetry Overlay Profiles at the –24-ft Depth Contour (Elevations are Referenced to NAVD88)

Table 14
Nearshore Feeder Berms – Planned In-Situ Volume Placement vs. Actual Capacity

Nearshore Feeder Berm Location	In-Situ CDP Dredged Material Volume to be Placed	Nearshore Feeder Berm Capacity
San José Island	4.5 mcy	1.8 mcy
Mustang Island	3.6 mcy	1.4 mcy

ALTERNATIVE FEEDER BERM CONFIGURATIONS

In order to capture the total volume of in-situ CDP dredged material planned for placement within the nearshore feeder berms at San José and Mustang Islands, the lateral extent of the feeder berms and the bottom depth locations will require modifying, if the original typical cross-sectional templates for the berms are to remain fixed.

Additionally, the total volume of the placed sediments will need to account for bulking. The bulk volume is obtained by multiplying the in-situ volume by a bulking factor. The bulking factor (B) is computed from the following equation (Herbich, 1992):

$B = (w_cG_s+100)/(w_iG_s+100)$

where,

w_c = water content within the loaded barge

w_i = water content in-situ

G_s = specific gravity of solids

PCCA (2018) concluded the in-situ water content (w_i) of the CCSC CDP dredged material averages 35%, and the solids volume concentration within the disposal scow is anticipated to be 60% (w_c = 40%). Assuming the specific gravity of fine sand is 2.67, the bulking factor will equal 1.07. Therefore, the total bulk volume of dredged material to be placed within the nearshore feeder berms at San José Island and Mustang Island are 4.81 mcy and 3.85 mcy, respectively.

An alternative to achieve the required nearshore feeder berm volumetric capacities at San José Island and Mustang Island is to elongate each feeder berm and increase the depth of the offshore toe of the feeder berms, while for the most part keeping cross-sectional berm geometries fixed.

At San José Island, the offshore toe depth of the feeder berms would be located at the –31-ft elevation contour with feeder berms elongated to between 5,046 ft and 6,004 ft. Feeder berm B1 would require increasing the berm height from 6-ft to 7-ft. B2 to B6 would not require a change in berm height.

At Mustang Island, the offshore toe depth of the feeder berms would be located at the –28-ft elevation contour with feeder berms elongated to 10,088 ft. Nearshore feeder berms B7 to B9 would not require a change in berm height.

AECOM (2019) considered effects of wave focusing of nearshore berm designs and reported a berm length of at least 2.5 times the average wave length would most likely avoid wave focusing effects. For the 2011 wave time series representative year at WIS 73040, the average wave lengths at the 28-ft and 31-ft depths are 150.66 ft and 155.44 ft, respectively. The alternative berm lengths far exceed the 2.5 times the average wave length, therefore wave focusing is not expected to be induced.

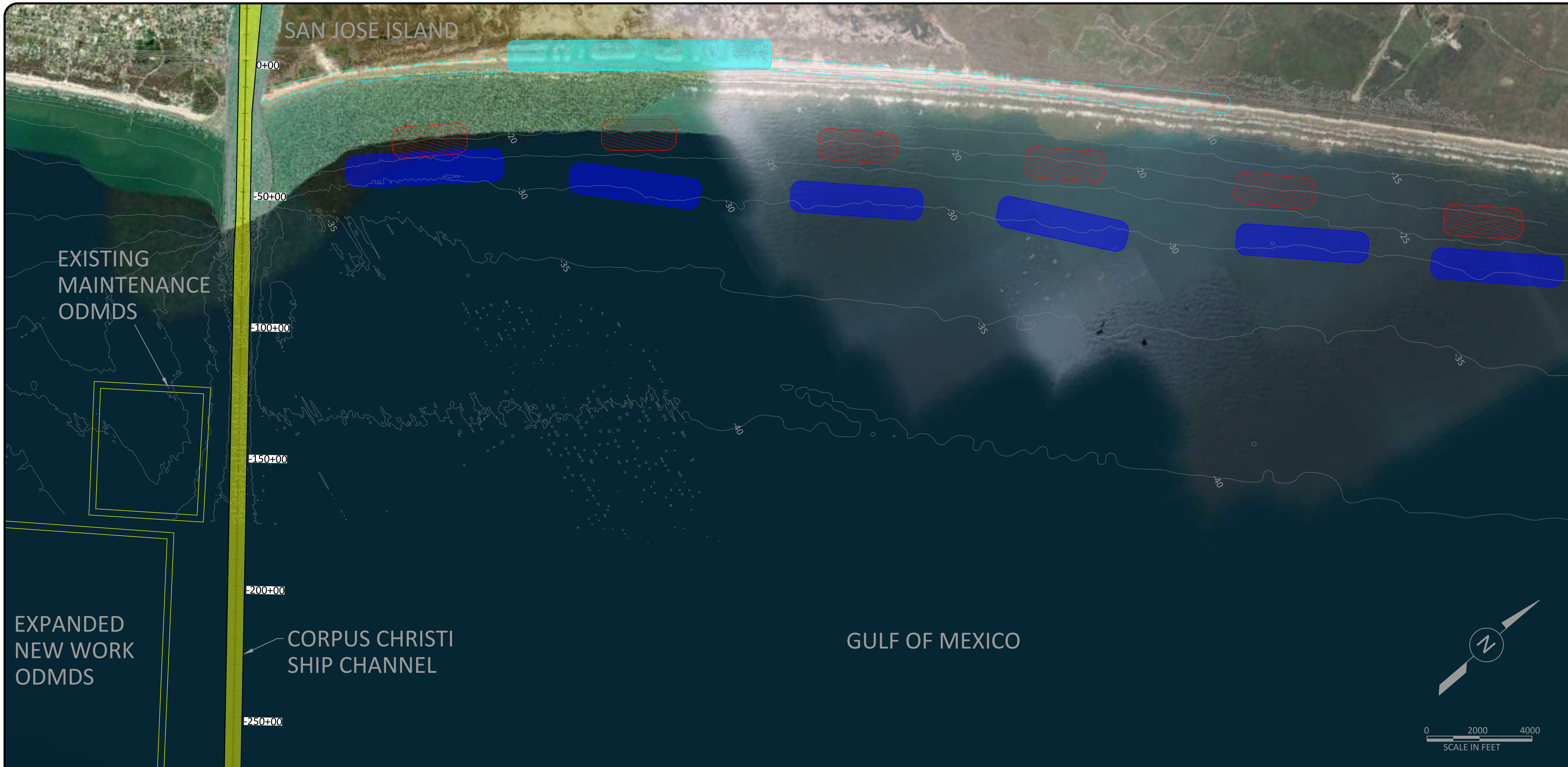
The resulting alternative configuration attributes for each nearshore feeder berm are listed in Table 15 (San José Island) and Table 16 (Mustang Island) with the plan views shown in Figure 6 (San José Island) and Figure 7 (Mustang Island). Profile views of the typical cross-sections for the alternative configurations overlayed on the latest bathymetry are shown in Figure 8.

Table 15
Dimensions and Capacity for Nearshore Feeder Berm Alternative Sections at San José Island

Feeder Berm Features (San José Island)	B1	B2	B3	B4	B5	B6
Bottom Elevation (Offshore Toe)	–31 ft	–31 ft	–31 ft	–31 ft	–31 ft	–31 ft
Crest Elevation	–24 ft	–25 ft	–25 ft	–25 ft	–25 ft	–25 ft
Berm Height	7 ft	6 ft	6 ft	6 ft	6 ft	6 ft
Crest Width	900 ft	900 ft	900 ft	900 ft	900 ft	900 ft
Bottom Width	1,188 ft	1,188 ft	1,188 ft	1,188 ft	1,188 ft	1,188 ft
Berm Length	6,004 ft	5,010 ft	5,046 ft	5,051 ft	5,046 ft	5,046 ft
Side Slopes	1V:24H	1V:24H	1V:24H	1V:24H	1V:24H	1V:24H
Bottom Displacement	No	No	No	No	No	No
Wave Focusing	No	No	No	No	No	No
Capacity	704,853 cy	799,768 cy	852,531 cy	891,612 cy	841,743 cy	791,844 cy
Total Capacity vs. Required Capacity	4,882,351 cy vs. 4,810,000 cy (bulked)					

Table 16
Dimensions and Capacity for Nearshore Feeder Berm Alternative Sections at Mustang Island

Feeder Berm Features (Mustang Island)	B7	B8	B9
Bottom Elevation (Offshore Toe)	–28 ft	–28 ft	–28 ft
Crest Elevation	–22 ft	–22 ft	–22 ft
Berm Height	6 ft	6 ft	6 ft
Crest Width	800 ft	800 ft	800 ft
Bottom Width	1,088 ft	1,088 ft	1,088 ft
Berm Length	10,088 ft	10,088 ft	10,088 ft
Side Slopes	1V:24H	1V:24H	1V:24H
Bottom Displacement	No	No	No
Wave Focusing	No	No	No
Capacity	1,641,918 cy	1,367,938 cy	1,109,521 cy
Total Capacity vs. Required Capacity	4,119,377 cy vs. 3,850,000 cy (bulked)		



SJI PLAN VIEW
SCALE: 1"=2000'

LEGEND

- SAN JOSE ISLAND
- ORIGINAL NEARSHORE FEEDER BERM CONFIGURATION
- MODIFICATION 1 NEARSHORE FEEDER BERM CONFIGURATION
- EXISTING BATHYMETRIC CONTOURS (FT)

SAN JOSE ISLAND NEARSHORE FEEDER BERM VOLUME	
FEATURE DESCRIPTION	CAPACITY VOLUME (CY)
Original	1,837,885
Modification 1	4,882,352

GENERAL NOTES

1. BASE MAPPING SHOWN IS MICROSOFT IMAGERY RETRIEVED FROM AUTOCAD IN AUGUST 2021.
2. BATHYMETRY SHOWN IS FROM NOAA NCEI CUDEM - $\frac{1}{9}$ ARC-SECOND RESOLUTION BATHYMETRIC-TOPOGRAPHIC TILES
3. HORIZONTAL COORDINATE SYSTEM IS NAD83 TEXAS STATE PLANE, SOUTH ZONE, US FOOT.
4. VERTICAL DATUM IS REFERENCED TO MEAN NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).

Freese and Nichols, Inc.
Texas Registered Engineering Firm F-2144
FREESE NICHOLS
10497 Town and Country Way, Suite 600
Houston, Texas 77024
Phone - (713) 600-6800
Web - www.freese.com

PORT OF CORPUS CHRISTI AUTHORITY
CORPUS CHRISTI SHIP CHANNEL
CHANNEL DEEPENING PROJECT
SAN JOSE ISLAND NEARSHORE FEEDER BERM BENEFICIAL USE SITE

F&N JOB NO. PCA20166
DATE OCTOBER 2021
DESIGNED
DRAWN
REVISED
CHECKED
FILE NAME Beneficial Use Sites_combined.dwg

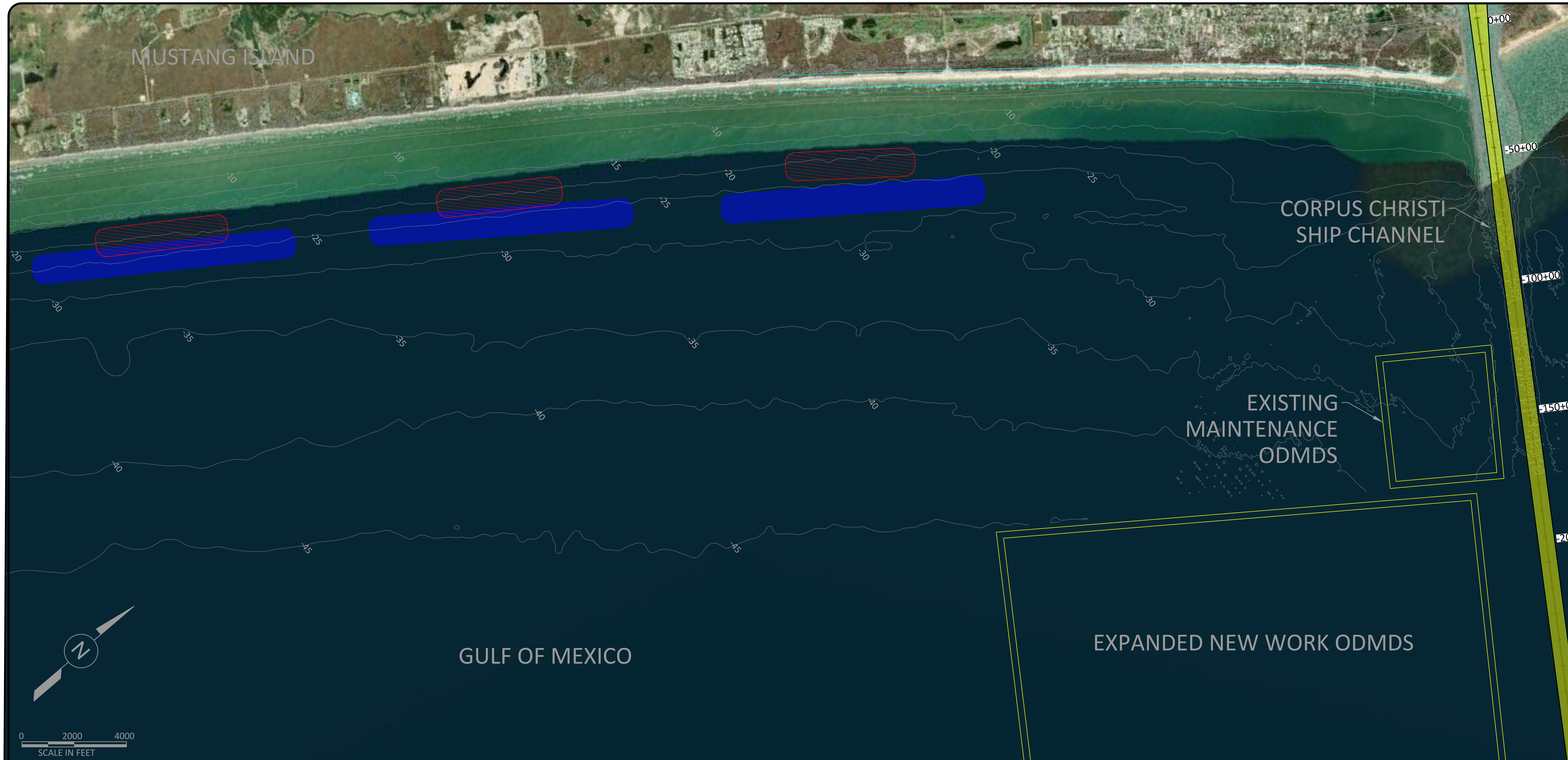
NO. ISSUE BY DATE

VERIFY SCALE 0 1
Bar is one inch on original drawing. If not one inch on this sheet, adjust scale.

SHEET
SEQ.

ACAD Rel: 23.1s (LMS Tech)
Filename: N:\ENG\Port of Corpus\Harbor Island\Beneficial Use Sites_combined.dwg
Last Saved: 10/7/2021 1:19 PM Saved By: 03775

Plot Date: 10/7/2021 2:34 PM Plot By: 03775 Filename: N:\ENG\Port of Corpus\Harbor Island\Beneficial Use Sites_combined.dwg



MI - PLAN VIEW
SCALE: 1"=2000'

LEGEND

- MUSTANG ISLAND
- ORIGINAL NEARSHORE FEEDER BERM CONFIGURATION
- MODIFICATION 1 NEARSHORE FEEDER BERM CONFIGURATION
- EXISTING BATHYMETRIC CONTOURS (FT)

MUSTANG ISLAND NEARSHORE FEEDER BERM VOLUME	
FEATURE DESCRIPTION	CAPACITY VOLUME (CY)
ORIGINAL	1,368,236
Modification 1	4,119,377

GENERAL NOTES

1. BASE MAPPING SHOWN IS MICROSOFT IMAGERY RETRIEVED FROM AUTOCAD IN AUGUST 2021.
2. BATHYMETRY SHOWN IS FROM NOAA NCEI CUDEM - $\frac{1}{9}$ ARC-SECOND RESOLUTION BATHYMETRIC-TOPOGRAPHIC TILES
3. HORIZONTAL COORDINATE SYSTEM IS NAD83 TEXAS STATE PLANE, SOUTH ZONE, US FOOT.
4. VERTICAL DATUM IS REFERENCED TO MEAN NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).

Freese and Nichols, Inc.
Texas Registered Engineering Firm F-2144

FREESE NICHOLS
10497 Town and Country Way, Suite 600
Houston, Texas 77024
Phone - (713) 600-6800
Web - www.freese.com

PORT OF CORPUS CHRISTI AUTHORITY
CORPUS CHRISTI SHIP CHANNEL
CHANNEL DEEPENING PROJECT

MUSTANG ISLAND NEARSHORE FEEDER BERM BENEFICIAL USE SITE

F&N JOB NO. PCA20166
DATE OCTOBER 2021
DESIGNED
DRAWN
REVISED
CHECKED
FILE NAME Beneficial Use Sites_combined.dwg

NO. | ISSUE | BY | DATE

VERIFY SCALE 0 1
Bar is one inch on original drawing. If not one inch on this sheet, adjust scale.

SHEET

SEQ.

ACAD Rel: 23.1s (LMS Tech)
Filename: N:\ENG\Port of Corpus\Harbor Island\Beneficial Use Sites_combined.dwg
Last Saved: 10/7/2021 1:19 PM Saved By: 03775

Plot Date: 10/7/2021 2:38 PM Plot By: 03775 Filename: N:\ENG\Port of Corpus\Harbor Island\Beneficial Use Sites_combined.dwg

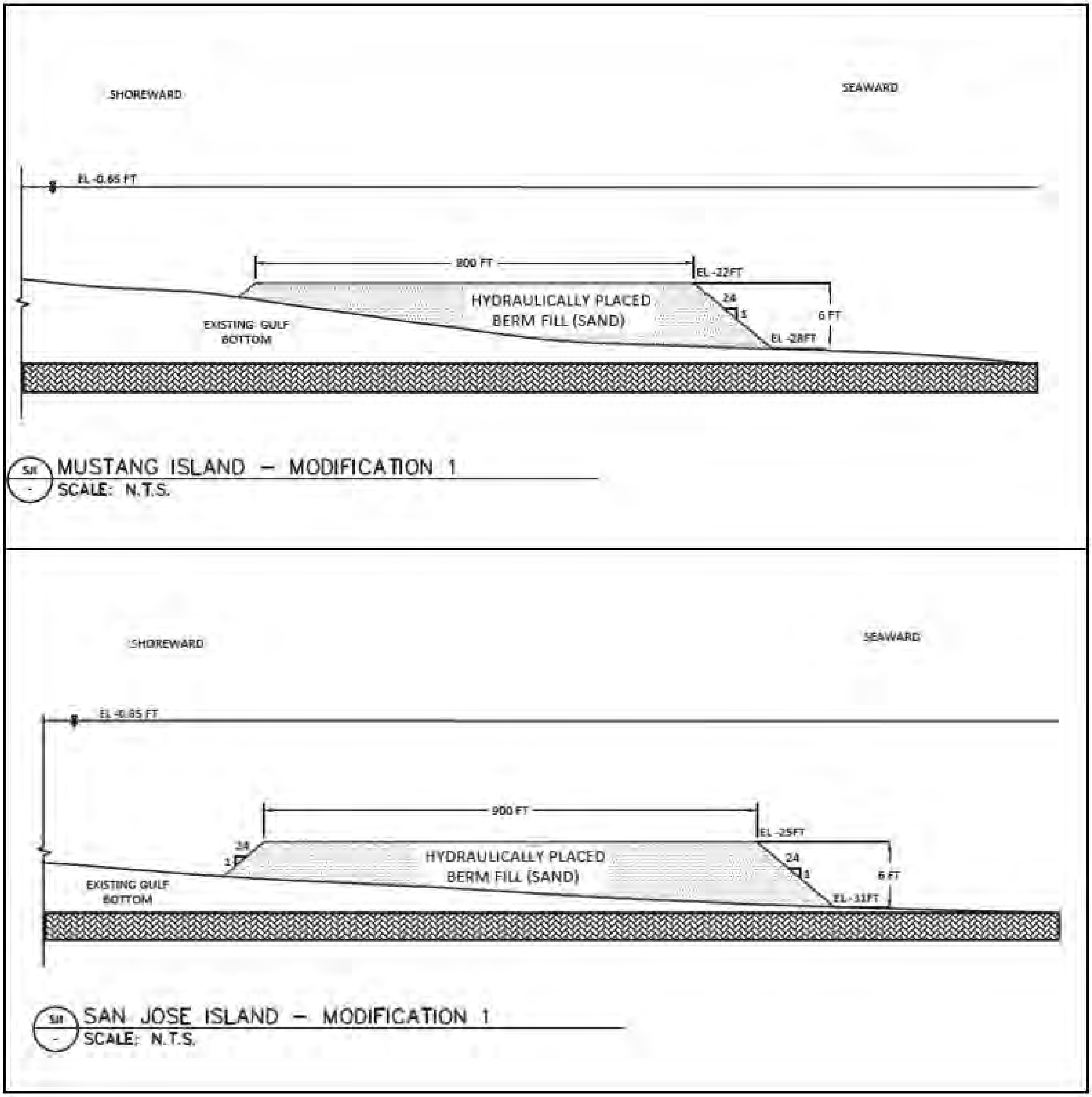


Figure 8. San José Island and Mustang Islands Nearshore Feeder Berm Bathymetry Overlay Profiles at the Alternative Depth Contours (Elevations are Referenced to NAVD88)

Attachment B shows the comparative nearshore feeder berm profile differences at San José Island and Mustang Island between the originally proposed berm depth (at 24-ft) and the alternative berm depths (at 28- and 31-ft).

BERM CONFIGURATION OPTIONS

The AECOM (2019) proposed locating the nearshore feeder berms with the offshore berm toe at the 24-ft elevation contour to accommodate 4.5 mcy of in-situ dredged material within the nearshore of San José Island and 3.6 mcy of in-situ dredged material within the nearshore of Mustang Island. Based on volumetric calculations of the AECOM (2019) proposed nearshore berm configurations, there is not sufficient capacity to receive the in-situ dredged material volumes planned for the nearshore feeder berms at San José and Mustang Islands.

To achieve the necessary capacity to receive the planned in-situ dredge material volumes requires the nearshore feeder berms be modified to be located in slightly deeper waters and laterally elongated, if the cross-sectional berm geometries are to remain fixed.

For the San José Island nearshore feeder berms the elevation of the berms' offshore toe will need to be located at the –31-ft bathymetric contour, and for the Mustang Island nearshore feeder berms the elevation of the berms' offshore toe will need to be located at the –28-ft bathymetric contour.

Based on the depth of closure analyses and the application of the Sediment Mobility Tool, as reported in this memorandum, it is expected that nearshore feeder berms consisting of a 0.13 mm median sediment grain size will be active at the 34-ft depth contour and shallower (Table 8), and that the percentage of onshore migration of sediments will be 70% or greater in water depths at 24-ft and deeper (Tables 11 and 12).

From the results of the analyses as reported in this memorandum, two options are presented to proceed forward with nearshore feeder berm configurations offshore of San José Island and Mustang Island:

1. Original Configurations: Proceed with the original nearshore feeder berm typical cross-sectional geometries, lateral extents, and depths as reported in AECOM (2019). For this option, the total volume of in-situ dredged material to be placed within the feeder berms will need to be reduced from a total 8.1 mcy to 3.0 mcy. The 3.0 mcy of in-situ material equates to a total in-place volume of 3.2 mcy due to slight bulking. The excess in-situ dredged material volume of 5.1 mcy would need to be reallocated to another placement area, such as the Corpus Christi Expanded New Work ODMDS and/or the San José Island washed out areas.
2. Modified Configurations: Proceed with the original nearshore feeder berm typical cross-sectional geometries as reported in AECOM (2019), with the exception of the B1 nearshore feeder berm. The B1 berm height would need to be raised from 6-ft to 7-ft. Modify the lateral extents and berm offshore toe depths as listed in Tables 15 and 16. Total in-situ dredged material volume that could be received based on these modifications is 8.1 mcy, which equates to a total in-place volume 8.66 mcy due to slight bulking.

REFERENCES

AECOM. 2019. Memorandum to USACE Galveston Regulatory (Jayson Hudson), Subject: Corpus Christi Ship Channel Deepening Project Feeder Berms for Shoreline Nourishment, dated November 14, 2019.

Fugro. 2018. Geotechnical Data Report Ship Channel Deepening Project Port of Corpus Christi Authority Corpus Christi, Texas. Report No. 04.10180080. Prepared for AECOM. Houston, Texas.

Hands, E.B., and Allison, M.C. 1991. Mound Migration in Deeper Water and Methods of Categorizing Active and Stable Depths. Preprint for Coastal Sediments '91, Proceedings of a Specialty Conference on Quantitative Approaches to Coastal Sediment Processes. American Society of Civil Engineers, June 24-28, 1991. Seattle, WA.

Herbich, J.B. 1992. Handbook of Dredging Engineering. McGraw-Hill, New York. 640 p.

Knezek, E.B. 1997. Equilibrium Beach Profile Analysis: Mustang Island, Texas. Major Report by ENS Erick B. Knezek, CEC, USN. Texas A&M University. December 1997.

Port of Corpus Christi Authority (PCCA). 2018. Draft Corpus Christi Channel Deepening Project, ODMDS Analysis. Prepared by AECOM for PCCA. November 18, 2018.

Texas General Land Office. 2021. Texas Coastal Sediment Geodatabase (TxSed). https://cgis.glo.texas.gov/txsed/index.html. Accessed October 2021.

U.S. Army Corps of Engineers (USACE). 2016. Calculating Depth of Closure Using WIS Hindcast Data, ERDC/CHL CHETN-VI-45. March 2016.

_______. 2021a. Coastal Inlets Research Program, U.S. Depth of Closure Information, Gulf of Mexico Region, Yearly Data. https://cirp.usace.army.mil/products/depth-of-closure.php. Accessed August 2021.

_______. 2021b. Coastal and Hydraulics Laboratory Thredds Website. https://chlthredds.erdc.dren.mil/thredds/catalog/wis/GulfOfMexico/catalog.html. Accessed August 2021.

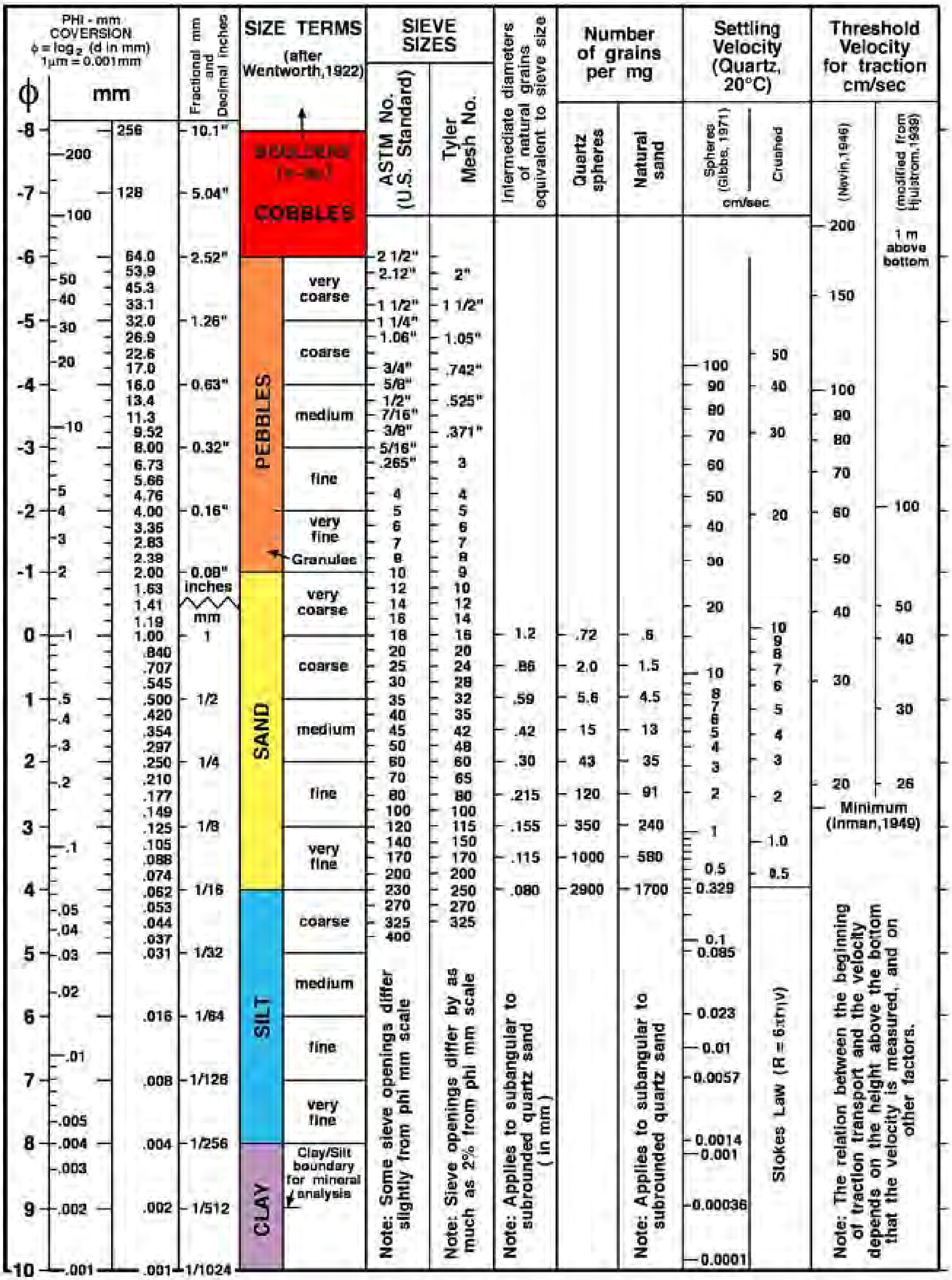
_______. 2021c. Coastal Inlets Research Program, Sediment Mobility Tool (SMT). https://cirp.usace.army.mil/products/sedmobility.php. Accessed August 2021.

Wentworth, C.K. 1922. A Scale of Grade and Class Terms for Clastic Sediments. The Journal of Geology 30: 377-392. https://www.journals.uchicago.edu/doi/pdfplus/10.1086/622910.

Williams, D.D., Kraus, N.C., Kelly, F.J., Smith, A.N., and Anderson, C.M. 2005. Baseline and Construction Monitoring of Packery Channel, Corpus Christi, Texas. Florida Shore and Beach Preservation Association. January 2005.

ATTACHMENT A

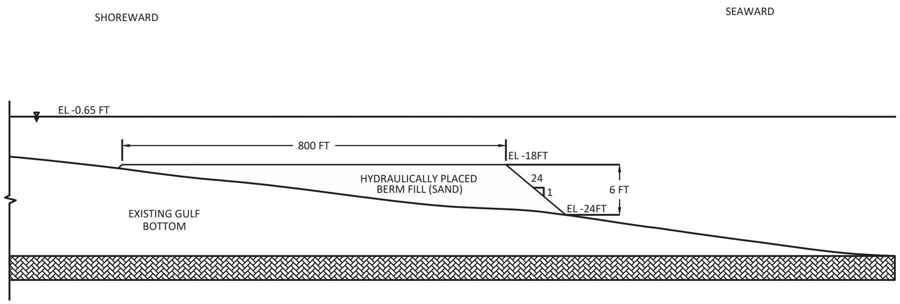
WENTWORTH GRAIN SIZE CHART



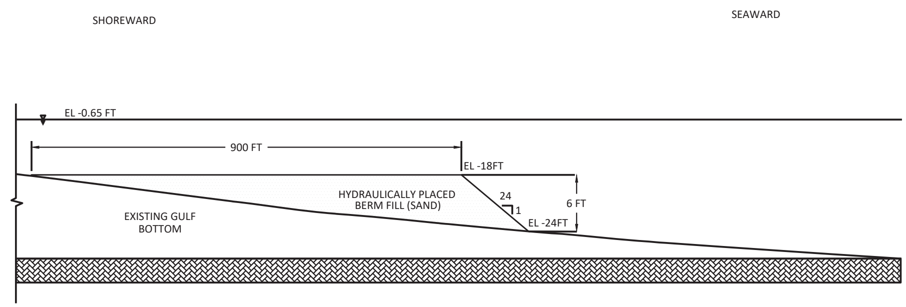
PHI - mm COVERSION
ϕ = log2 (d in mm)
1µm = 0.001mm
ϕ
mm
Fractional mm and Decimal inches
SIZE TERMS (after Wentworth,1922)
SIEVE SIZES
ASTM No. (U.S. Standard)
Tyler Mesh No.
Intermediate diameters of natural grains equivalent to sieve size
Number of grains per mg
Quartz spheres
Natural sand
Settling Velocity (Quartz, 20°C)
Spheres (Gibbs, 1971)
Crushed
cm/sec
Threshold Velocity for traction cm/sec
(Nevin,1946)
(modified from Hjulstrom,1939)
1 m above bottom
BOULDERS (≥ -8ϕ)
COBBLES
PEBBLES
very coarse
coarse
medium
fine
very fine
Granules
SAND
very coarse
coarse
medium
fine
very fine
SILT
coarse
medium
fine
very fine
CLAY
Clay/Silt boundary for mineral analysis
inches
mm
Minimum (Inman,1949)
Stokes Law (R = 6πrηv)
Note: Some sieve openings differ slightly from phi mm scale
Note: Sieve openings differ by as much as 2% from phi mm scale
Note: Applies to subangular to subrounded quartz sand (in mm)
Note: Applies to subangular to subrounded quartz sand
Note: The relation between the beginning of traction transport and the velocity depends on the height above the bottom that the velocity is measured, and on other factors.

ATTACHMENT B

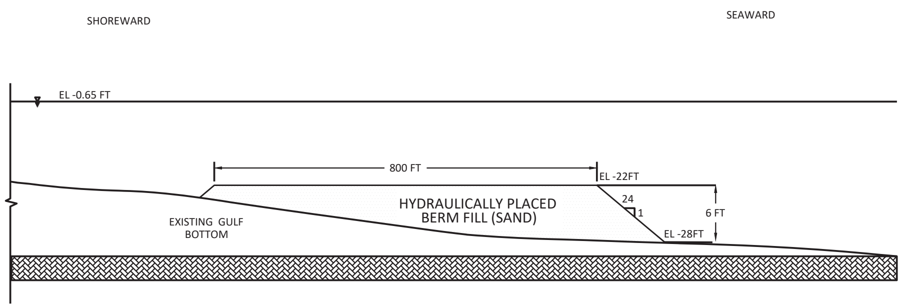
NEARSHORE FEEDER BERM TYPICAL SECTIONS



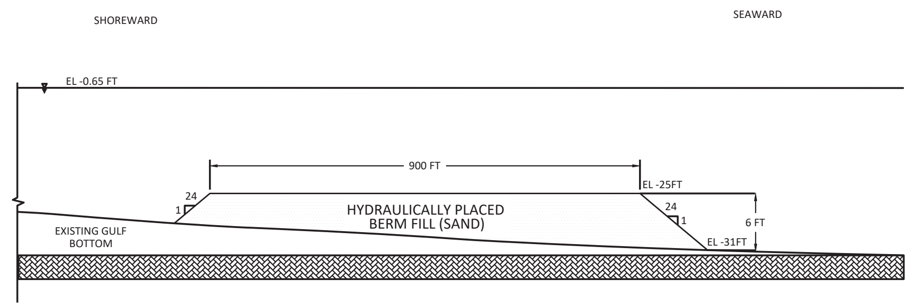
SJI - MUSTANG ISLAND – ORIGINAL
SCALE: N.T.S.



SJI - SAN JOSE ISLAND – ORIGINAL
SCALE: N.T.S.



SJI - MUSTANG ISLAND – MODIFICATION 1
SCALE: N.T.S.



SJI - SAN JOSE ISLAND – MODIFICATION 1
SCALE: N.T.S.

MUSTANG ISLAND NEARSHORE FEEDER BERM VOLUME	
FEATURE DESCRIPTION	CAPACITY VOLUME (CY)
ORIGINAL	1,368,236
Modification 1	4,119,377

SAN JOSE ISLAND NEARSHORE FEEDER BERM VOLUME	
FEATURE DESCRIPTION	CAPACITY VOLUME (CY)
Original	1,837,885
Modification 1	4,882,352

GENERAL NOTES

1. BATHYMETRY SHOWN IS FROM NOAA NCEI CUDEM - $\frac{1}{9}$ ARC-SECOND RESOLUTION BATHYMETRIC-TOPOGRAPHIC TILES
2. HORIZONTAL COORDINATE SYSTEM IS NAD83 TEXAS STATE PLANE, SOUTH ZONE, US FOOT.
3. VERTICAL DATUM IS REFERENCED TO MEAN NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).
4. WATER LEVEL IS THE MEAN LOWER LOW WATER LEVEL (MLLW) REFERENCED TO NAVD88 (+0.65 FT NAVD88= 0.0 FT MLLW).

Freese and Nichols, Inc.
Texas Registered Engineering Firm F-2144
FREESE NICHOLS
10497 Town and Country Way,
Suite 600
Houston, Texas 77024
Phone - (713) 600-6800
Web - www.freese.com

PORT OF CORPUS CHRISTI AUTHORITY
CORPUS CHRISTI SHIP CHANNEL
CHANNEL DEEPENING PROJECT

NEARSHORE FEEDER BERM TYPICAL SECTIONS

F&N JOB NO. PCA20166
DATE OCTOBER 2021
DESIGNED
DRAWN
REVISED
CHECKED
FILE NAME Beneficial Use Sites_combined.dwg

NO. ISSUE BY DATE

VERIFY SCALE 0 1
Bar is one inch on original drawing. If not one inch on this sheet, adjust scale.

SHEET
SEQ.