Appendix K

12-Step Permittee Responsible Compensatory Mitigation 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.

12-STEP PERMITTEE RESPONSIBLE COMPENSATORY MITIGATION PLAN

Port of Corpus Christi Channel Deepening Project
U.S. Army Corps of Engineers SWG-2019-00067
Nueces & San Patricio Counties, Texas

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1.0 Background

The applicant, the Port of Corpus Christi Authority (Port Corpus Christi) is proposing to deepen an approximate 13.8-mile section of the Corpus Christi Ship Channel (CCSC). The purpose of the Channel Deepening Project (CDP) is to deepen the CCSC to accommodate the transit of fully laden Very Large Crude Carriers (VLCCs). The project area begins at the southern end of Harbor Island near Port Aransas, Nueces County, Texas and extends into the Gulf of Mexico (GOM; Figure 1). The existing channel will be deepened from the current authorized depth of -54 feet and -56 feet mean lower low water (MLLW) to a maximum depth of -79 feet and -81 feet MLLW, respectively. Further, the proposed project includes a 29,000-foot extension of the CCSC to a maximum depth of -81 feet MLLW to reach the -80-foot MLLW bathymetric contour in the Gulf of Mexico. The proposed project does not include widening the channel; however, some minor incidental widening is expected to meet side slope requirements and to maintain stability of the channel. Approximately 46 million cubic yards (MCY) of new work dredging material (17 MCY of clay and 29 MCY of sand) will be excavated during project construction. The dredged material is proposed for placement into the several Beneficial Use (BU) sites including Placement Area 4 (PA4), Shoreline Stabilization 1 (SS1), Shoreline Stabilization 2 (SS2), and Harbor Island East (HI-E). Beach nourishment will occur at Mustang Island (MI), San Jose Island (SJI), and Nearshore Berms B1-B9.

A draft environmental impact statement (DEIS) was prepared to document the impact of the CDP on its surrounding environment within the project area and to inform various regulatory and decision-making processes. Specifically, the DEIS outlines baseline environmental and habitat conditions within the CDP area to assess and quantify unavoidable project impacts to special aquatic sites (SAS) or water of the U.S. (WOUS) such as wetlands, submerged aquatic vegetation (SAV), and live oyster. According to Title 33 Code of Federal Regulations (CFR) § 332.3, appropriate compensatory mitigation must be implemented to offset unavoidable losses or impacts to WOUS authorized through the issuance of Department of the Army (DA) permits pursuant to section 404 of the Clean Water Act (33 U.S.C. 1344) and/or sections 9 or 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 401, 403).

The CDP will permanently impact 44.63-acres of SAS requiring compensatory mitigation to offset these permanent losses to SAS (USACE 2022). This includes 21.04-acres of palustrine wetlands and 23.59-acres of essential fish habitat (EFH) including 16.61-acres of estuarine wetlands, 6.88-acres of seagrass (i.e., SAV), and 0.10-acres of live oyster (USACE 2022). Port Corpus Christi proposes to utilize BU site SS1 to construct their permittee responsible mitigation site (PRMS). A high berm will be constructed to stabilize the shoreline at SS1, also serving to protect the re-established SAS within the proposed mitigation site and will further help protect and restore habitats within Redfish Bay, an area of critically important aquatic habitat immediately adjacent to the mitigation site.

The succeeding sections outline a permittee responsible compensatory mitigation (PRM) plan detailing all proposed actions and activities that will be implemented to compensate for unavoidable impacts to WOUS, including estuarine and palustrine wetlands, seagrass, and live oyster as a result of the CDP. All actions associated with PRM will be conducted in accordance with the 2008 Final Compensatory Mitigation Rule (Title 33 CFR § 332.3).

2.0 Objectives

The primary objective of the proposed PRM plan is to provide on-site, in-kind mitigation to fully compensate (i.e., no net loss) or exceed for the functional (i.e., physical, chemical, biological) loss of estuarine and palustrine wetlands, seagrass, and live oyster as a result of the placement of beneficial use dredged material. Specifically, the objective of the PRM is restoration through the re-establishment of 32.94-acres of estuarine marsh wetlands, 42.08-acres of palustrine wetlands, 6.88-acres of seagrass, and 0.10-acres of live oyster by returning historic functions to a degraded aquatic resource (i.e., SS1). These restorative mitigation actions will be accomplished through relocating and planting native estuarine and palustrine wetland vegetation at suitable reference grades and relocating (i.e., re-establishing) 6.88-acres of seagrass and 0.10-acres of live oyster that will be impacted within the CDP footprint.

Successful implementation of the proposed PRM plan will increase overall wetland functional capacity in the watershed, provide essential ecosystem services, and address several watershed needs. Of importance, the proposed PRM would provide essential habitat for marsh dependent wildlife, increase nekton and essential fish habitat (EFH), assist with wave energy and flood attenuation, improve stormwater absorption capacity, and provide important biogeochemical processes such as nutrient cycling, polishing, and overall improvements to water quality.

Furthermore, construction of the high berm at SS1 and beneficial use of dredged material, Port Corpus Christi will provide additional benefits to the areas immediately adjacent to the PRMS. Two of these auxiliary benefits include shoreline stabilization and erosion reduction improving coastal resiliency. Additionally, construction of the berm and associated shoreline stabilization will protect large expanses of wetlands and seagrass beds in Brown and Root Flats and Redfish Bay that directly contribute to improved water quality and provide thousands of acres of EFH. Moreover, additional ecosystem services and increased functional capacity (as outlined above) in the watershed will be established through the creation of additional beneficial use estuarine and palustrine wetlands, totaling 181.72-acres (Port Corpus Christi 2023).

In sum, the restoration of estuarine and palustrine wetlands, seagrass, and live oyster as proposed in the PRM plan will result in the re-establishment of wetland functions and values, and ultimately improve the quality and quantity of SAS and aquatic resources that contribute to the overall functional capacity within the Aransas Bay watershed.

3.0 Site Selection Criteria

Regarding type and determining the location of compensatory mitigation, the general compensatory mitigation requirements (Title 33 CFR § 332.3) state "in general, the required compensatory mitigation should be located within the same watershed as the impact site, and should be located where it is most likely to successfully replace lost functions and services, taking into account watershed scale features such as aquatic habitat diversity, habitat connectivity, relationships to hydrologic sources, land use, ecological benefits, and compatibility with adjacent land uses."

Port Corpus Christi proposes to construct the PRMS at BU site SS1 (Figure 2). The proposed mitigation site is situated within the Mid-Coast Barrier Islands and Coastal Marshes Level IV Ecoregion which is within the Western Gulf Coastal Plain Level III Ecoregion (Griffith et al. 2007). The PRMS is contained in the Aransas Bay watershed (TPWD 2023), located at the southern extent of Aransas Bay, adjacent to Brown and Root Flats (i.e., Redfish Bay) to the north and west and abutting the CCSC to the south and east. The mitigation site is located approximately 4 miles southeast of Aransas Pass and 3 miles west of Port Aransas in Nueces County, Texas. The approximate center of the PRMS is latitude -97.12170362370 West and longitude 27.83843869600 North (World Geodetic System 1984 [WGS84]).

Careful evaluation in determining the location of the mitigation site was given to ensure the compensatory mitigation was located within the same watershed and that the site was oriented to achieve a high likelihood of success in replacing lost wetland functions and services. In accordance with 33 CFR § 332.3 (b) compensatory mitigation hierarchy, and due to a lack of mitigation banks and in-lieu programs in the watershed, Port Corpus Christi selected permittee responsible on-site and in-kind mitigation within the watershed as the preferred compensatory mitigation. The proposed on-site PRM will restore habitats that have suffered significant erosion, loss, and degradation due to storm surge, sea-level rise, and wave action from increased ship traffic. An armored high berm will be installed along the southeastern boundary of the PRMS to provide shoreline stabilization and protect the site from erosive forces and ship-generated waves; thereby increasing the long-term resiliency of the mitigation site. The proposed PRMS will be situated to maintain important hydrologic connections necessary to sustain long-term, high-functioning wetlands. Further, the proposed mitigation site will be located adjacent to sensitive aquatic habitats and will thereby increase overall habitat diversity and connectivity. The proposed PRMS will aid in the capture and retention of sediments and contribute important biogeochemical processes. Overall, the proposed mitigation site exhibits high functional lift potential with the restoration and protection efforts as proposed, both within the site and also to adjacent special aquatic sites.

4.0 Site Protection Instruments

The Port Corpus Christi will serve as the property owner of the proposed PRMS. Upon approval of the permit (SWG-2019-00067), the permittee responsible mitigation site will be protected in perpetuity by a deed restriction which prohibits its alteration, except as required by the permit to bring the mitigation into compliance with the permit, or without express permission in writing from the USACE. The deed restrictions shall continue with the PRMS in perpetuity and be binding on all future owners, heirs, successors, administrators, assigns, lessees, agencies, or other occupiers and users. The USACE shall have the right to enter and go upon the mitigation property for purposes of inspection, and to take actions including but not limited to scientific or educational observations and studies, and collection of samples. A copy of the final deed restriction will be submitted to the USACE within 30 days of being filed by the County Clerk's Office. The deed restriction may not be modified without consent and prior approval of the USACE.

5.0 Baseline Information

The impact areas (SS1, SS2, PA4, and HI-E; Figure 2) and mitigation site (contained within SS1; Figures 2 & 3) are located in the Ecoregion Level IV, Mid-Coast Barrier Islands and Coastal Marshes (34h) (Griffith et al. 2007). This region is characterized by barrier islands, tidal marshes, dunes, and salt/brackish/freshwater marshes. Salt marsh and wind-tidal flats are mostly confined to the back side of the barrier islands with fresh or brackish marshes associated with river-mouth delta areas.

The Mid-Coast Barrier Islands and Coastal Marshes portion of the Texas coast is subhumid with annual precipitation ranging from 34 to 46 inches. Cordgrass (*Spartina spp*.), saltgrass/shoregrass (*Distichlis spp*.), and sedges (*Cyperaceae spp*.) are common vegetation typically found in marsh habitats that characterize this region. Seacoast bluestem (*Schizachyrium scoparium*) and sea oats (*Uniola paniculata*) are found on sandy barrier islands. Black mangrove (*Avicennia germinans*) begins to appear from Port O'Connor south.

The region encompasses primarily Holocene deposits with saline, brackish, and freshwater marshes, barrier islands with minor washover fans, and tidal flat sands and clays. Typical soils on the coastal marshes are Entisols, with a minor extent of Histosols. Mollisols occur on tidal flats and coastal marshes, and Entisols form in sandy barrier islands and dunes (Griffith et al. 2007).

Historical imagery and descriptions from Perkins (2019) suggest the initial formation of impact areas occurred as early the 1920's (SS1) and in the 1970's PA4 and HI-E were created through the placement of dredged material and construction of containment and training levees for de-watering material. Dredged material placement is evident via historical Google images each decade since construction of the placement areas PA4 and HI-E. As for SS2, a linear borrow pit was excavated within the interior of the SS2 sometime after 1956. Further, Piper Channel was dredged in the 1970's just west of SS2 for boat access to the Island Moorings residential canal subdivision in Port Aransas. A natural shoreline was present along SS2 until 2008, when the shoreline was stabilized with an armored stone revetment.

Figure 2 provides an overview of the impact areas, mitigation site, and associated coordinates. In 2021, a sensitive aquatic resources survey (Triton 2021) and formal WOUS survey (Mott 2021) was conducted and verified by the USACE for each BU footprint and their associated 500-foot buffers. Ecological characteristics and direct impacts to SAS of BU sites SS1, SS2, PA4, and HI-E resulting from the CDP are discussed in succeeding sections.

5.1 Ecological Characteristics of the CDP Impact Areas

5.1.1 PA4

The PA4 BU site (approx. 170.79-acres) is located along the northern shoreline of CCSC and conjoins SS1. Historical imagery suggests the initial formation of PA4 occurred in the 1970's through the placement of dredged material and construction of containment levees. Dredged material placement is evident via historical Google images each decade since construction of the placement area. Four levees on the northeastern portion of the site are present with no hydrological connection to Redfish Bay or the CCSC (Mott 2021).

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%) (Triton 2021). Soils observed were Twinpalms and Tidal flats that occasionally flood or pond. PA4 has 0 to 3 percent slopes and is somewhat poorly drained to poorly drained (Mott 2021). The depth of soft sediment averaged 0.2 feet and ranged from 0.0 to 1.8 feet. Bottom elevations averaged -1.42 feet and ranged from -7.52 feet to +0.68 feet MLLW (Triton 2021).

As documented in the 2021 Mott MacDonald WOUS report, a total of 18 resources were delineated with uplands, palustrine, estuarine, open water, and SAV dominant habitats. Coastal prairie uplands were typically located landward of the high marsh boundary and were dominated by little bluestem (*Schizachyrium scoparium*), prickly pear cactus (*Opuntia stricta*), Kleberg bluestem (*Dichanthium annulatum*), white sweetclover (*Melilotus alba*), silverleaf sunflower (*Helianthus argophyllus*), and honey mesquite (*Prosopis glandulosa*). Large expanses of coastal prairie uplands were found at PA4 and were mostly associated with higher elevations resulting from the historic placement of dredged material.

Coastal prairie wetlands were typically associated with the estuarine high marsh boundary and extended inland to the upland boundary. Coastal prairie wetlands were dominated by salt meadow cordgrass (*Spartina patens*), sea ox-eye daisy (*Borrichia frutescens*), Gulf cordgrass, (*Spartina spartinae*), seashore dropseed (*Sporobolus virginicus*), seashore paspalum (*Paspalum vaginatum*), and gulf dune paspalum (*Paspalum monostachyum*). The HTL demarcated during the 2021 surveys defined the limits of estuarine high marsh just below the HTL and palustrine wetlands above the HTL.

Coastal: Salt and Brackish High Tidal Marsh is described as irregularly flooded marsh dominated by graminoids such as marshhay cordgrass, saltgrass (*Distichlis spicata*), and bulrushes (*Schoenoplectus spp.*). Intermixes of other dominant vegetation includes shoregrass (*Distichlis littoralis*), dwarf glasswort (*Salicornia bigelovii*), saltwort (*Batis maritima*), Virginia glasswort (*Salicornia depressa*), annual seepweed (*Suaeda linearis*), seapurslane (*Sesuvium portulacastrum*), sea ox-eye daisy, Gulf cordgrass, and seashore dropseed.

Estuarine low marsh wetlands were dominated by Coastal: Salt and Brackish Low Tidal Marsh is described as marshes frequently inundated by tides and dominated by smooth cordgrass (*Spartina alterniflora*). Coastal: Mangrove Shrubland is described as shrublands dominated by black mangrove (*Avicennia germinans*). These tidal shrublands are often found as a dominant landscape feature in Redfish and Aransas Bays. Open Water is described as an open body of water, with little or no emergent vegetation.

Four SAV beds were delineated within the PA4 aquatic survey area and were dominated by shoalgrass (*Halodule wrightii*) and widgeon grass (*Ruppia maritima*). Non-dominant species observed were clover grass (*Halophila englemannii*) and turtle grass (*Thalassia testudinum*). The combined mean Braun-Blanquet (S) score was 2 (rounded from 1.6), indicating seagrass percent cover (i.e., relative abundance) of roughly 5 – 25% of the total PA4 aquatic survey area (Triton 2021).

The DEIS identified the following impacts to naturalized habitats resulting from the placement of dredged material within PA4 that will require mitigation as a result of the CDP. These include: 0.75-acres of estuarine wetlands, and 3.46-acres of seagrass (USACE 2022).

5.1.2 SS1

SS1 BU site (approx. 297.41-acres) conjoins PA4 to the east and is located along the northern shoreline of the CCSC. SS1 and PA4 are situated between the CCSC and Redfish Bay. Expansive sensitive habitats, including thousands of acres of wetlands and SAV, constitute the Redfish Bay State Scientific Area (RBSSA). Historical accounts indicate that SS1 was originally formed by the placement of spoil resulting from dredging of the CCSC between 1919 and 1926 (Perkins 2019). Subsequent placement of dredged material has occurred over time; however current conditions at SS1 indicate significant erosion of the southern shoreline and interior portions of the site from larger and increased frequency of vessel traffic through the CCSC.

Six substrate types found include mud, sand, clay, gravel, shell (gaping, halves, fragments of shell hash), and live oysters. Prevalent substrate observed include sand (73.5%), mud (15.0%), clay (6.6%) and shell (3.7%) (Triton 2021). 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 (Mott 2021). The depth of soft sediment averaged 0.2 feet and ranged from 0.0 to 1.8 feet. Bottom elevations varied from -6.42 feet to +1.58 feet, and average bottom elevation was calculated at -6.42 feet MLLW (Triton 2021).

As documented in the 2021 Mott MacDonald WOUS report, a total of 18 resources were delineated with open water, estuarine low marsh wetlands, estuarine high marsh wetlands, algal flats, and palustrine emergent wetlands (sea ox-eye daisy) comprising the dominant habitats. Unvegetated sand flats located above the HTL elevation were also present and determined to be upland (Mott 2021).

Three SAV beds were delineated within the SS1 aquatic survey area with five species identified; however, the SAV beds were primarily composed of shoal grass, widgeon grass, and turtle grass. The combined mean Braun-Blanquet (S) score was 2 (rounded from 1.9), indicating seagrass relative abundance (i.e., percent cover) of roughly 5 – 25% of the total SS1 aquatic survey area (Triton 2021).

The DEIS identified the following impacts to naturalized habitats resulting from the placement of dredged material within SS1 that will require mitigation as a result of the CDP. These include: 21.04-acres of palustrine wetlands, 3.92-acres of estuarine wetlands, and 0.01-acres of seagrass (USACE 2022).

5.1.3 SS2

The SS2 BU site (approx. 45.21-acres) 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 (Mott 2021). A linear borrow pit was excavated within the interior of the SS2 sometime after 1956. In addition, Piper channel was dredged in the 1970s just west of the SS2 BU site for boat access to the Island Moorings residential canal subdivision in Port Aransas. A natural shoreline was present along SS2 until 2008, when the shoreline was stabilized with an armored stone revetment. Hurricane Harvey, which occurred in 2017, caused two large breaches in the stone revetment and allowed tidal water from the CCSC to reach the interior of the SS2 BU site (Mott 2021).

Five substrates were identified within SS2 and include sand (94.7%), mud (2.3%), shell (1.7%), clay (0.8%), and gravel (0.5%) (Triton 2021). 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 (Mott 2021). The mean depth of soft sediment is 0.2 feet and ranges from 0.0 feet to 1.9 feet. Bottom elevations range from -11.22 feet to +0.68 feet and average -3.42 feet MLLW (Triton 2021).

As documented in the 2021 Mott MacDonald WOUS report, a total of 11 resources were delineated with uplands, palustrine, estuarine, and open water dominant habitats. Coastal prairie uplands were dominated by little bluestem; estuarine low marsh wetlands comprised primarily of smooth cordgrass, dwarf saltwort, and black mangrove. Palustrine emergent wetlands were dominated by sea ox-eye daisy, salt meadow cordgrass and gulf dune paspalum (Mott 2021).

The DEIS identified the following impacts to naturalized habitats resulting from the placement of dredged material within SS2 that will require mitigation as a result of the CDP. This includes: 1.25-acres of estuarine wetlands (USACE 2022).

5.1.4 HI-E

The HI-E BU site (approx. 138.73-acres) is located east of Harbor Island at the confluence of the Aransas and Lydia Ann Channels where they merge with the CCSC. Similar to PA4, historical imagery suggests the initial formation of HI-E occurred in the 1970's through the placement of dredged material and construction of containment and training levees for de-watering material. Dredged material placement is evident via historical Google images each decade since construction of the placement area (Mott 2021).

Five substrates observed within HI-E are sand (42.0%), mud (37.5%), clay (9.0%), shell (8.8%) and live oyster (2.6%) (Triton 2021). 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 (Mott 2021). The depth of soft sediment averages 0.3 feet and ranges from 0.0 to 2.6 feet with an average bottom elevation of -2.02 feet that ranges from -7.62 to +1.28 feet MLLW (Triton 2021).

As documented in the 2021 Mott MacDonald WOUS report, a total of 10 resources were delineated with open water, coastal prairie uplands, estuarine low marsh wetlands, estuarine high marsh wetlands, and palustrine emergent wetlands comprising the dominant habitats.

Four SAV beds were delineated within the HI-E aquatic survey boundary and were dominated by shoalgrass and widgeon grass. The mean Braun-Blanquet score was 2 (rounded from 1.7) and indicated seagrass relative abundance of roughly 5 –25% cover within the HI-E aquatic survey area (Triton 2021).

The DEIS identified the following impacts to naturalized habitats resulting from the placement of dredged material within HI-E that will require mitigation as a result of the CDP. These include: 10.69-acres of estuarine wetlands and 3.41-acres of seagrass (USACE 2022).

5.2 Ecological Characteristics of the Mitigation Site

The proposed mitigation site (75.12-acres; Figures 3 & 4) will be contained within the BU site SS1 footprint. The PRMS will be surrounded by the beneficial use of dredged material as outlined in the applicant's Beneficial Use Management Plan (BUMP; Port Corpus Christi 2023) on three sides and connect to the bayward edge of Brown and Root Flats to the north, which will provide a critical hydrologic connection. Historical descriptions indicate that the mitigation site was originally formed by the placement of spoil resulting from dredging of the CCSC between 1919 and 1926 (Perkins 2019). Subsequent placement of dredged material has occurred over time; however current conditions at SS1 indicate significant erosion of the southern shoreline and interior portions of the site from larger vessels and increased frequency of vessel traffic through the CCSC. Refer to Section 5.1.2 for a detailed description of ecological characteristics (i.e., soils, habitat features) of the mitigation site.

5.3 Direct Impacts

Port Corpus Christi proposes to provide PRM for unavoidable impacts to SAS as a result of CDP activities. These include impacts to palustrine emergent wetlands, estuarine wetlands, seagrass, and live oyster. Table 1 outlines the direct impacts to SAS that require compensatory mitigation, as outlined in the DEIS (USACE 2022).

Table 1. Summary of unavoidable direct impacts to special aquatic sites that require compensatory mitigation by site and resource feature, Port of Corpus Christi Authority, Channel Deepening Project, SWG-2019-00067.

Impact Summary Across Sites					
	Palustrine	**Estuarine**	**Seagrass**	**Oyster**	**Total**
PA4	0.00	0.75	3.46	0.00	**4.21**
SS1	21.04	3.92	0.01	0.00	**24.97**
SS2	0.00	1.25	0.00	0.00	**1.25**
HI-E	0.00	10.69	3.41	0.10	**14.20**
Total:	**21.04**	**16.61**	**6.88**	**0.10**	**44.63**

6.0 Determination of Credits

6.1 Estuarine Wetlands

The proposed PRM plan will mitigate for unavoidable impacts to estuarine wetlands through the re-establishment of estuarine wetland functions and services similar to those impacted as a result of the CDP. To ensure no net loss to wetland functions, the USACE Hydrogeomorphic (HGM) model for the Northwest (NW) Gulf of Mexico Tidal Fringe Wetlands (Shafer et al. 2002) was applied to calculate compensation requirements. The HGM assessment approach is a collection of concepts and methods for developing functional indices, and subsequently quantifying those indices to assess the capacity of a wetland to perform functions relative to similar wetlands contained in a region (Smith et al. 1995). As such, the Northwest GOM Tidal Fringe Wetland HGM utilizes a set of unique variables to quantify the functions a wetland performs within the subregion to help determine the required mitigation under the Compensatory Mitigation Rule (33 CFR § 332). Each HGM iteration consisted of a suite of quantifiable variables used to evaluate the functional capacity of impacted estuarine wetlands contained with CDP area. Based on the Cowardin coastal wetland vegetation classification system (Cowardin et al. 1979), Mangrove Shrubland (E2SS3N) and Salt and Brackish High Tidal Marsh (E2EM1P) were evaluated separately as two distinct tidal fringe wetland subclasses for analysis.

The fundamental unit for evaluating impacts within the HGM is the functional capacity index (FCI). The Northwest Gulf of Mexico Tidal Fringe Wetlands HGM uses several model variables to calculate FCI values for physical, chemical, and biological wetland functions. There are 9 functions identified to calculate corresponding FCI values for the NW GOM Tidal Fringe Wetlands HGM. These include: shoreline stabilization, sediment deposition, nutrient and organic carbon exchange, resident nekton utilization, non-resident nekton utilization, maintain invertebrate prey pool, provide wildlife habitat, characteristic plant community structure and composition, and plant biomass production. FCI values were quantified from 0.0 to 1.0 based on the various conditions observed within each wetland assessment area (WAA) – defined as a wetland within the proposed project area that is physically continuous and homogeneous in terms of hydrogeomorphic criteria (Smith et al. 1995). Eight (N = 8) WAA's were identified (Exhibit A) across four BU sites (PA4, SS1, SS2, and HI-E) within the CDP area and consisted of two wetland subclasses: Mangrove Shrubland (E2SS3N) and Salt and Brackish High Tidal Marsh (E2EM1P). Once FCIs were computed for each WAA, the FCI values were multiplied by the size of the WAA (in acres) to establish the amount of functional capacity units (FCU) contained within each WAA per wetland subclass. The total amount of pre-project FCUs was calculated by summing the respective FCUs measured for each WAA contained within the CDP footprint. As such, the total pre-project FCUs represents the compensatory mitigation requirements to replace the loss of estuarine wetland functions as a result of impacts associated with the CDP project. The pre-project HGM results were then compared to the model results derived from the proposed conceptual estuarine mitigation site (i.e., post-project baseline) to ensure no net loss of estuarine wetland functional capacity.

The pre-project HGM results indicated a combined 121.89 FCU for impacted estuarine wetlands. The total FCU for the proposed estuarine wetland mitigation site was 266.78, greatly exceeding the total pre-project FCU total resulting in a net gain of 144.89 FCU (Tables 2 & 3). Based on this analysis, Port Corpus Christi proposes to construct a 32.94-acre estuarine mitigation site within the PRMS (Figure 3) to fully compensate for direct estuarine wetland impacts described in Section 5.3 (Table 1). Additionally, the proposed 32.94-acre mitigation site will provide excess FCU providing ecological lift as well as offset to temporal loss and potential cumulative effects. A thorough summary of the pre- and post-project HGM results, summary data, and field data forms can be found in Exhibit A.

Table 2. Summary of total Pre- and Post-Project Functional Capacity Units (FCU) for proposed 32.94-acre mitigation site and net change in FCU between Pre- and Post-Project by function, Northwest Gulf of Mexico Tidal Fringe Wetlands, Port of Corpus Christi Authority, Channel Deepening Project, SWG-2019-00067.

Function	Pre-Project FCU	Post-Project FCU	Net FCU Change
Shoreline Stabilization	11.68	27.67	+15.99
Sediment Deposition	11.68	32.94	+21.26
Nutrient and Organic Carbon Exchange	13.92	32.94	+19.02
Resident Nekton Utilization	13.54	30.12	+16.58
Non-Resident Nekton Utilization	8.99	29.20	+20.21
Maintain Invertebrate Prey Pool	14.73	27.45	+12.72
Provide Wildlife Habitat	15.65	27.18	+11.53
Characteristic Plant Community Structure and Composition	15.10	26.35	+11.25
Plant Biomass Production	16.61	32.94	+16.33
Totals:	**121.89**	**266.78**	**+144.89**

Table 3. Summary of Wetland Assessment Area (WAA) Functional Capacity Index (FCI) and total FCU by WAA. Net difference is the net change in FCU between Pre- and Post-Project condition.

WAA Number	WAA Description	WAA Area (acres)	FCI	FCU
1	SS1 High Marsh (E2EM1P)	1.36	7.16	9.73
2	SS1 Mangrove Shrubland (E2SS3N)	2.56	8.57	21.94
3	SS2 High Marsh (E2EM1P)	0.30	6.63	1.99
4	SS2 Mangrove Shrubland (E2SS3N)	0.95	7.06	6.70
5	PA4 High Marsh (E2EM1P)	0.31	7.11	2.20
6	PA4 Mangrove Shrubland (E2SS3N)	0.44	7.72	3.40
7	HI-E High Marsh (E2EM1P)	8.02	7.02	56.29
8	HI-E Mangrove Shrubland (E2SS3N)	2.67	7.35	19.64
9	Proposed Estuarine Mitigation Site	32.94	8.10	266.78
Pre-Project FCU Total:				**121.89**
Post-Project FCU Total:				**266.78**
Net Difference:				**+144.89**

6.2 Palustrine Wetlands

To ensure no net loss of wetland function, Port Corpus Christi proposed a 2:1 mitigation ratio for impacts to palustrine wetlands. Approximately 42.08-acres of palustrine wetlands will be restored within the proposed PRMS (Figures 3 and 4) to compensate for 21.04-acres of unavoidable impacts to palustrine wetlands resulting from the CDP (Table 4). The proposed mitigation should fully compensate for any temporal loss in wetland functions.

6.3 Seagrass

Port Corpus Christi proposes the relocation of seagrass that will be directly impacted by the CDP to avoid impacts to seagrass. The applicant will relocate 6.88-acres of impacted seagrass from BU sites PA4, SS1, and HI-E and transplant 6.88-acres of seagrass within the PRMS, fully compensating for unavoidable impacts to seagrass as a result of the CDP (Table 4). The seagrass planting site will be contained within the 8.24-acres of tidal channels located in the estuarine mitigation site (Figures 3 & 4), providing a beneficial hydrologic connection to the site and adjacent tributary. The constructed berm and adjacent channel shorelines will provide protection from vessel traffic and predominant southeastern and northeasterly winds.

6.4 Live Oyster

Port Corpus Christi proposes the relocation of live oyster that will be directly impacted by the CDP to avoid impacts to live oyster. The applicant will relocate 0.10-acres of impacted live oyster from BU site HI-E to the PRMS for re-establishment. The relocation and re-establishment of 0.10-acres of live oyster will offset the losses from unavoidable project impacts (Table 4). The live oyster will be relocated to the northwestern boundary of BU SS1 which is oriented adjacent to the proposed estuarine mitigation site and near a previously delineated 1.88-acre live oyster reef (Figure 3; Triton 2021). Reference elevations collected during the 2021 aquatic survey indicate overlap between elevations where live oyster was detected at HI-E and SS1 (Triton 2021). Specifically, elevations ranged from -1.72 to -0.72 feet MLLW at HI-E and from -0.72 to -0.32 feet MLLW at SS1. The presence of live oyster immediately adjacent to the proposed oyster relocation site indicates suitable habitat conditions for re-establishment are present and bodes well for a successful relocation.

Table 4. Summary of direct impacts to special aquatic sites (acres), proposed mitigation ratio (if applicable), and mitigation re-establishment (acres).

Resource Feature	Direct Impacts	Mitigation Ratio	Mitigation Re-establishment
Palustrine wetlands	21.04	2:1	42.08
Estuarine wetlands	16.61	N/A[2]	32.94
Seagrass	6.88	1:1	6.88[1]
Live oyster	0.10	1:1	0.10[3]
Total:	**44.63**		**75.12[4]**

[1]6.88-acres of seagrass will be contained in tidal channels within the 32.94-acre estuarine mitigation area.
[2]Estuarine mitigation was determined by HGM (Shaffer et al. 2002). [3]The 0.10-acre live oyster will be placed immediately adjacent to the PRMS boundary (Figures 3 and 4). [4]Represents total acres of SAS to be restored through PRM.

7.0 Mitigation Work Plan

The proposed compensatory mitigation is guided by the restorative principles of beneficial use by rehabilitating and re-establishing historical SAS at SS1 subjected to years of erosive forces and through the protection of sensitive aquatic resources (i.e., seagrass and oyster) adjacent to the proposed mitigation site. The proposed plan is a pragmatic approach blending the application of beneficial use with existing topography and site conditions to create a long-term self-sustaining wetland complex with high functional capacity. The applicant is proposing to locate all mitigation features (i.e., estuarine, palustrine, SAV, and live oyster) nearest to the immediately adjacent high value, functioning habitats of the RBSSA. This approach promotes hydrologic connectivity, availability of local source material (i.e., seed sources for emergent and SAV transplants, live oysters), and numerous ecological processes all serving the vast expanses of the greater RBSSA ecosystem.

Beneficial Use SS1 will be the first BU site constructed and construction of the PRMS will commence within 60 days of the initiation of work in SAS. The following sections detail the specific work plan activities, which together comprise a complete and synergistic approach to mitigation site development and ultimate success in replacing lost ecological functions and services.

7.1 SS1 and Mitigation Site Development Plan

The geographic boundaries of the proposed mitigation components (estuarine, palustrine, seagrass, and oyster) are provided in Figure 3. Portions of dredged material associated with the CDP will be beneficially used in accordance with Port Corpus Christi's Dredge Material Management Plan (DMMP) and Beneficial Use Monitoring Plan (BUMP) to construct a 75.12-acre compensatory mitigation site. As outlined in Port Corpus Christi's DMMP and BUMP, the beneficial use design will provide ancillary contributions to the protection of approximately 2,400-acres of seagrass in the Brown and Root Flat and 5,000-acres of the seagrass-wetland complex of Lighthouse Lakes within Redfish Bay (Port Corpus Christi 2023).

This mitigation work plan describes the specifications related to the compensatory mitigation planned at SS1 for unavoidable impacts to SAS and WOUS. The WOUS and sensitive aquatic resources investigations conducted in 2021 provide valuable reference information as relates to surface hydrology, soils, desirable vegetative communities, long-term percent coverage targets, as well as species specific target elevations. This information has aided in the development of the proposed PRM plan with the primary goal to implement mitigation activities specific to improve ecological and hydrologic connectivity. Following construction completion, the PRMS is expected to exhibit sufficient hydrologic communication within the wetland mitigation areas which will be conducive in maximizing transplant survival and overall mitigation site success in achieving performance standards. A conceptual mitigation design overview is provided in Figures 3 and 4 and Figure 5 provides a detailed section view.

7.2 SS1 and Mitigation Site Construction Methods

A qualified dredging contractor will be selected by Port Corpus Christi for the CDP project. The qualified dredging contractor will be responsible for providing all necessary labor and equipment to source the material from within the limits of the CCSC, placing it within the SS1 and PRMS footprints, constructing the levee in accordance with approved specifications, meeting target grades, and implementing and maintaining all Best Management Practices (BMPs), as outlined by Port Corpus Christi.

Approximately 2,793,000 cubic yards of dredged material will be required to construct SS1. The BU levee will be constructed using stiff clay or sand. The channel-side levee will be constructed from the existing bay bottom to elevations that vary from +7 feet MLLW to +24 feet MLLW at a 4:1 slope. The berm will be approximately 100 feet in width with an interior slope of 10:1. The 2018 Fugro Geotechnical 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) (Fugro 2018). 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. Temporary berms are not anticipated if mechanical dredging methods are utilized. Once hydraulically placed sediment has dewatered, Port Corpus Christi will use heavy machinery (i.e., graders, marsh buggies, excavators, etc.) will be utilized on land to achieve target slopes and elevations after dredged material has been placed and dewatered (Port Corpus Christi 2023).

Following the construction of the berm, the channel facing slope will be armored with stone or similar revetment. The site will be hydraulically backfilled with sands and/or clays to +3.58 feet MLLW and graded to suitable elevations to sustain the target palustrine and estuarine wetland 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 a majority of the channel (BH-12 – BH-38). However, since the BU placement at SS1 will create wetland and upland habitats, some clays are acceptable for placement between the berm and 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 likely be mobilized from State Highway 361 (HWY 361) and drive to SS1 via an existing levee road on the north side of PA4. All vessel related mobilization will approach the site from the CCSC side. All equipment staging will occur above the HTL and within the footprint of SS1 or PA4 (Port Corpus Christi 2023).

In accordance with Port Corpus Christi's PRM plan and BUMP, dredged material will be utilized to create a mix of habitats (i.e., upland, palustrine, and estuarine) throughout BU site SS1. Of the 297.41-acres of SS1 BU site, 75.12-acres will be dedicated for the PRMS. This includes 42.08-acres for palustrine mitigation, and 32.94-acres of estuarine mitigation which includes 8.24-acres of tidal channels for the relocation of 6.88-acres of seagrass. The 0.10-acres of live oyster currently located at HI-E will be relocated at the SS1 boundary to an immediately adjacent 1.88-acre live oyster reef delineated in 2021 (Triton 2021).

7.3 Establishment of Wetland Mitigation Areas

Upon construction completion of the mitigation site, and a minimum 30 – 60-day site settling has been achieved, the mitigation areas will be ready for transplant. If additional site settling is needed prior to planting, the modified settling and planting timelines will be coordinated with the USACE. As detailed in Section 5.0 above, surveys conducted for the CDP, determined that high and low estuarine impacts (i.e., E2EM1P, E2SS3N) typically occurred at -0.72 feet MLLW for low marsh species to the lower edge of the USACE verified HTL (+2.76 feet NAVD88, +2.34 feet MLLW) for high marsh species. Palustrine impacts (i.e., PEM1C) were typically dominated by sea ox-eye daisy, but also included dominant intermixes of salt meadow cordgrass, Gulf cordgrass, and Gulf dune paspalum and typically occurred at elevations ranging from +2.34 feet MLLW (HTL) to +3.58 feet MLLW.

Planting with native vegetation will occur with species identified in Table 5. Proposed plantings will include a minimum of two estuarine wetland species and two palustrine wetland species. Prior to construction of the PRMS, Port Corpus Christi's contractor will re-confirm target elevations for all proposed species prior to initiating the transplanting effort. Further, Port Corpus Christi's contractor will conduct an as-built elevation survey to confirm target elevations within the mitigation site have been achieved.

Table 5. List of proposed native species for planting and target elevations by habitat type and species. Elevations in MLLW.

Common Name	Scientific Name	Habitat Type	Elevation Range[1]
Black mangrove	*Avicennia germinans*	Estuarine Low Marsh	-0.72 to +0.59
Smooth cordgrass	*Spartina alterniflora*	Estuarine Low Marsh	-0.72 to +0.59
Saltgrass	*Distichlis spicata*	Estuarine High Marsh	+0.59 to +2.34
Shoregrass	*Distichlis littoralis*	Estuarine High Marsh	+0.59 to +2.34
Dwarf glasswort	*Salicornia bigelovii*	Estuarine High Marsh	+0.59 to +2.34
Virginia glasswort	*Salicornia depressa*	Estuarine High Marsh	+0.59 to +2.34
Saltwort	*Batis maritima*	Estuarine High Marsh	+0.59 to +2.34
Annual seepweed	*Suaeda linearis*	Estuarine High Marsh	+0.59 to +2.34
Bullrushes	*Schoenoplectus spp.*	Estuarine High Marsh	+0.59 to +2.34
Seapurslane	*Sesuvium portulacastrum*	Estuarine High Marsh	+0.59 to +2.34
Sea ox-eye daisy[2]	*Borrichia frutescens*	Estuarine & Palustrine	+0.59 to +3.58
Gulf cordgrass[2]	*Spartina spartinae*	Estuarine & Palustrine	+0.59 to +3.58
Marshhay cordgrass[2]	*Spartina patens*	Estuarine & Palustrine	+0.59 to +3.58
Seashore dropseed[2]	*Sporobolus virginicus*	Estuarine & Palustrine	+0.59 to +3.58
Gulf dune paspalum	*Paspalum monostachyum*	Palustrine	+2.34 to +3.58
Seashore paspalum	*Paspalum vaginatum*	Palustrine	+2.34 to +3.58

[1]Target elevation range based on the 2021 WOUS survey (Mott 2021). Obtaining current elevations and adjacent target elevations prior to construction will be necessary.

[2]Indicates a species with wider elevation tolerances that may persist in both estuarine and palustrine habitats.

7.4 Estuarine Mitigation Area (32.94-Acres)

7.4.1 Estuarine Planting Area (24.70-Acres)

The 24.70-acre planting area comprises approximately 18.59-acres of area suitable for a mix of high and low marsh estuarine wetland species. The upper limit of the estuarine mitigation site should not exceed the USACE verified HTL elevation of +2.76 feet NAVD 88 (+2.34 feet MLLW). The lower limit should result in direct hydrologic communication with the adjacent RBSSA. It is anticipated this elevation will range from -0.72 to +0.59 feet MLLW. Gentle side slopes are proposed (Figure 5) along the tidal channels to accommodate elevations appropriate for low marsh species such as smooth cordgrass and black mangrove. The tidal channels result in 6.11-acres of low marsh vegetation to be installed on the side slopes. Port Corpus Christi will plant the site in the spring/fall in the season immediately following construction completion to take advantage of seasonal rainfall and more favorable survival and growing conditions.

Due to the importance of installation timing, the applicant requests flexibility in sourcing target species (Table 5) for the estuarine mitigation area. The following hierarchy is proposed for establishing vegetation at the estuarine mitigation site:

1) Harvest and transplant target species from impacts areas. The mitigation contractor will work closely with Port Corpus Christi and the dredge contractor to determine dredging and material placement sequence. All transplants will be installed on 3-foot centers and will contain live units with healthy, vigorous root mass. Planting units may vary in size based on target species (e.g.,

smooth cordgrass = single stem, marshhay cordgrass = several sprigs). This method will result in approximately 123,502 planting units within the estuarine mitigation site.

2) Borrowing transplant material from other Port Corpus Christi properties and/or nearby sources (i.e., GLO submerged lands). Preference will be given to sites contained within the Aransas Bay watershed.
3) Stockpiling source material from other BU sites for plant and/or seedbank utilization. If possible, the mitigation site contractor will harvest source material and stockpile it within a contained and protected, predesignated area of SS1. The material will be stored until the estuarine mitigation area is prepared and the source material can be transplanted and/or broadcast.
4) Seed mixes and/or planting unit purchase from a commercial nursery.

7.4.2 Tidal Channels (8.24-Acres)

The bottom elevation of the tidal channels will be constructed at -1.12 feet MLLW and/or elevations that mimic the adjacent RBSSA seagrass beds (e.g., -3.02 to -0.42 feet MLLW). A 50-foot bottom width of the channel will accommodate the 6.88-acres of seagrass to be relocated from SS1, PA4, and HI-E. As discussed in the preceding section, approximately 6.11-acres of gradual side slopes surrounding the channels will be constructed at elevations (approx. -0.72 to +0.59 feet MLLW) suitable for low mash species establishment.

The establishment of tidal channels throughout the estuarine mitigation area will create an important nexus between the mitigation area and the neighboring RBSSA tributary. This feature would allow wetland functions within the mitigation site to have a positive effect on the chemical, physical, and/or biological functions of traditionally navigable waters while also providing a permanent source of hydrology to the estuarine site.

7.5 Palustrine Mitigation Area (42.08-Acres)

The 42.08-acre palustrine planting area should comprise areas suitable for a mix of high marsh estuarine and palustrine wetland species. The upper limit of the 42.08-acre palustrine mitigation site should not exceed +3.58 feet MLLW (Figure 5) and the lower limit should slope down toward the HTL elevation of +2.76 feet NAVD88 (+2.34 feet MLLW). It is recommended that shallow depressions and/or low-profile berms be constructed in strategic locations within the site to promote hydrologic enhancement features which would aid in the handling of precipitation and retention of water within the wetland mitigation area. The location and objective of these low-profile berms and/or shallow depressional areas will be such that sheet-flow water as a result of precipitation will be retained and slowly released throughout the site. Port Corpus Christi will plant the site in the spring/fall in the season immediately following construction completion to take advantage of seasonal rainfall and more favorable survival and growing conditions.

Due to the importance of installation timing, the applicant requests flexibility in sourcing target species (Table 5) for the palustrine mitigation area. The following hierarchy is proposed for establishing vegetation at the palustrine mitigation site:

1) Harvest and transplant target species from impacts areas. Transplants will be installed within 72 hours of harvest. The mitigation contractor will work closely with Port Corpus Christi and the dredge contractor to determine dredging and material placement sequence. All transplants will be installed on 3-foot centers and will contain live units with healthy, vigorous root mass. Planting

units may vary in size based on target species. This method will result in approximately 210,400 planting units within the palustrine mitigation site.

2) Borrowing transplant material from other Port Corpus Christi properties and/or nearby sources (i.e., GLO submerged lands). Preference will be given to sites contained within the Aransas Bay watershed.
3) Stockpiling source material from other BU sites for plant and/or seedbank utilization. If possible, the mitigation site contractor will harvest source material and stockpile it within a contained and protected, predesignated area of SS1. The material will be stored until the palustrine mitigation area is prepared and the source material can be transplanted and/or broadcast.
4) Seed mixes and/or planting unit purchase from a commercial nursery.

7.6 Aquatic Resources (Seagrass & Live Oyster)

Port Corpus Christi will transplant the 6.88-acres of seagrass (SS1, PA4, and HI-E) and 0.10-acres of live oyster (HI-E) to SS1. Prior to any relocation activities, an aquatic resources relocation plan (ARRP) for oysters and a permit application to introduce aquatic plants into public waters for seagrass will be coordinated with and attained from Texas Parks and Wildlife Department (TPWD). The mitigation contractor will harvest and transplant seagrass from impact areas and store them in a container with in-situ water. All transplants will be installed in the estuarine mitigation site tidal channels within a 48-hour period. It is recommended that the seagrass relocation activities occur during the growing season (i.e., spring through summer).

Port Corpus Christi anticipates the oyster relocation to occur by hand. All translocated oysters will be gently placed into a large transport container with in-situ water. Every effort will be made to complete the oyster relocation within a 24-hour period to limit stress and potential mortality. The oyster will be relocated directly adjacent to the estuarine mitigation site and located within close proximity to an existing oyster bed (Figure 4).

7.7 Mitigation Site Timing & Sequence

Port Corpus Christi will coordinate with the selected dredging contractor to determine the appropriate construction timing and sequence. As outlined in Section 7.0, construction of the PRMS will commence within 60 days of the initiation of work in SAS. Port Corpus Christi will not know where dredging and construction vessels will be deployed until a dredging contractor is selected. Construction operations will occur during daylight hours for 8 to 12 hours per day. Special consideration will be given to available plant source material from each BU site and appropriate planning of its harvest and/or storage for the establishment of the mitigation sites.

Following the 30 – 60-day mitigation site settling and material dewatering timelines, Port Corpus Christi will plant the mitigation sites in either the spring or fall, whichever immediately follows the settling and dewatering timeline. Transplanting in the spring or fall can facilitate survival as temperatures are typically mild, threats of tropical weather are reduced, and seasonal rainfall is favorable. Further, the seagrass relocation will target their growing season (i.e., spring – summer) to reduce transplant stress.

7.8 Integrated Pest Management (IPM)

The overall management and control of woody invasive shrub and tree species will be executed utilizing an IPM plan. As such, invasive species control will be achieved by employing a variety of methodologies tailored to individual target species and plant size. Target species for control located within the proposed

PRMS (42.08-acre palustrine wetland site, and the 32.94-acre estuarine wetland site) include: Brazilian peppertree, white lead tree, huisache, honey mesquite and retama. Success criterion (i.e., performance standard) is established at ≤ 10% total invasive species cover across the PRMS boundary. Invasive species control efforts will be conducted annually (as needed) until performance success criterion are achieved. All invasive species control measures and methodologies will be developed with emphasis on minimizing impacts to current site conditions, including soil disturbance and current grades, while maximizing control on invasive species (e.g., individual plant treatment). Control measures will only be implemented within the terrestrial vegetation areas of the PRMS. Subtidal and other aquatic areas will be strictly avoided. Adaptive management will also be implemented if deemed necessary and/or success criteria are not consistently attained. Methodology, control measures, and application rates will be developed in accordance with a literature review, industry standards, and conducted only by qualified personnel.

7.9 Best Management Practices (BMPs)

Port Corpus Christi will implement appropriate BMPs during the construction of the mitigation site to minimize potential impacts to adjacent sensitive habitats and/or endangered species. Port Corpus Christi and their dredging contractor will adhere to the Southeast Regional Office National Marine Fisheries Service Protected Species Construction Conditions. BMPs will be developed and implemented in accordance with approved industry standards and may include, but are not limited to, secondary containment, spill prevention and control plans, 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 SS1 BU and mitigation site footprints. Prior to construction, the contractor will recommend the appropriate location of the BMPs to eliminate, to the most practicable extent, any secondary or indirect impacts to wetlands, seagrass, live oyster or other sensitive habitat within the SS1 BU buffer. The contractor and Port Corpus Christi will agree upon these recommendations prior to construction.

8.0 Maintenance Plan

Port Corpus Christi agrees to maintain the integrity of the mitigation site to ensure its continued viability and that the proposed PRM results in no net loss of wetland function. As such, Port Corpus Christi will be responsible for all maintenance activities to achieve the predetermined performance standards (Section 9.0). Maintenance activities may include the following:

- Conduct berm inspections to ensure the berm is intact and remains structurally sound and document any erosion or storm surge damage;
- Perform berm maintenance including repair and revetment;
- Visually inspect the mitigation site and adjacent shorelines for any imminent issues that may encroach into or negatively impact the mitigation site;
- Visually inspect, maintain, and repair access roads necessary for construction, maintenance, and monitoring of the mitigation site;
- Additional native vegetation plantings, if mitigation site fails to meet performance criteria;
- Monitor for encroachment of invasive species and implement control measures, as needed; and
- Visually inspect mitigation site signage; repair, as needed.

All maintenance inspections will be conducted annually, and/or after the passage of a tropical storm or other inclement weather event. Inspections (e.g., restoration signage) and/or monitoring (e.g., invasive species) may coincide with planned mitigation site monitoring, as outlined in Section 10.0. Land-based access to the mitigation site will be restricted by a locked gate to prohibit vehicular and pedestrian traffic from traversing the wetland re-establishment area. No trespassing signage will be posted at the site access entrance gate. Restoration signage will be posted at the seagrass and oyster restoration areas to disseminate information on the project specific restoration initiatives to the public.

9.0 Performance Standards

The ecologically based performance standards detailed in the following sections shall be used to determine and measure the minimum level of success in achieving the goals and objectives of the PRM plan.

9.1 Estuarine and Palustrine Wetlands

The restoration of estuarine and palustrine wetlands will be considered successful if the following conditions are met:

1. Post-construction as-built survey mean elevations fall within the target elevation range for estuarine (-0.72 to +2.34 feet MLLW) and palustrine (+2.34 to +3.58 feet MLLW) boundaries, respectively.
2. 45 – 90-days: ≥ 50% survival of transplanted wetland species;
3. 6-month: ≥ 10% vegetative cover of wetland species[1];
4. 1-year: ≥ 20% vegetative cover of wetland species, ≤ 10% cover of woody invasive species[2];
5. 2-year: ≥ 30% vegetative cover of wetland species, ≤ 10% cover of woody invasive species;
6. 3-year: ≥ 40% vegetative cover of wetland species, ≤ 10% cover of woody invasive species;
7. 4-year: ≥ 50% vegetative cover of wetland species, ≤ 10% cover of woody invasive species;
8. 5-year: ≥ 70% vegetative cover of wetland species, ≤ 10% cover of woody invasive species;

[1]Species FACW or wetter that were planted or naturally recruit to the PRMS.
[2]Woody invasive species include Brazilian peppertree, white lead tree, huisache, honey mesquite and retama.

If the percent survival or vegetative cover requirements are not satisfied, then additional planting of pre-approved species will be implemented to accomplish the described requirements. In the situation that additional planting is necessary, the area will be monitored for one additional year to establish performance standards. No more than two replanting's will occur prior to implementing adaptive management. If the woody invasive species cover requirement is not satisfied, Port Corpus Christi will implement an integrated invasive species pest management plan, as outlined in Section 7.8.

9.2 Seagrass

The restoration of seagrass will be considered successful if the following conditions are met:

1. Post-construction as-built survey mean elevation in the circulation channels is within the target elevation range for seagrass (-3.02 to -0.42 feet MLLW).
2. 45 – 60-days: ≥ 50% survival of transplanted seagrass;
3. 6-month: ≥ 10% vegetative cover of seagrass[1];

4. 1-year: ≥ 20% vegetative cover of seagrass;
5. 2-year: ≥ 30% vegetative cover of seagrass;
6. 3-year: ≥ 40% vegetative cover of seagrass;
7. 4-year: ≥ 50% vegetative cover of seagrass;
8. 5-year: ≥ 70% vegetative cover of seagrass;

[1]Seagrass species that were planted or naturally recruit to the PRMS.

If the percent survival or seagrass percent cover requirements are not satisfied, then additional planting of pre-approved seagrass species will be implemented to accomplish the described requirements. In the situation that additional planting is necessary, the area will be monitored for one additional year to establish performance standards. No more than two replanting's will occur prior to implementing adaptive management (e.g., recontouring).

9.3 Oyster

The restoration of oyster will be considered successful if the following conditions are met:

1. 6-month: density of live oyster ≥ 10% of the pre-construction density of live oyster, or if spat is present;
2. 1-year: density of live oyster ≥ 25% of the pre-construction density of live oyster, or if spat is present;
3. 2-year: density of live oyster ≥ 50% of the pre-construction density of live oyster, or if spat is present;
4. 3-year: density of live oyster ≥ 60% of the pre-construction density of live oyster, or if spat is present;
5. 4-year: density of live oyster ≥ 75% of the pre-construction density of live oyster, or if spat is present;
6. 5-year: density of live oyster to match or exceed pre-construction density of live oyster;

If neither the density or spat presence requirement is satisfied, then suitable substrate will be added to promote spat recruitment and/or increased density of live oyster to establish the desired condition. In the situation that adding substrate is required, the area will be monitored for one additional year or until performance standards are achieved.

10.0 Monitoring Requirements

Port Corpus Christi will monitor and report the progress toward meeting mitigation goals and objectives and performance metrics. All monitoring and reporting requirements will be conducted in accordance with the USACE Regulatory Guidance Letter (RGL) No. 08-03, "Minimum Monitoring Requirements for Compensatory Mitigation Projects Involving the Restoration, Establishment, and/or Enhancement of Aquatic Resources" which governs compensatory mitigation for activities authorized by permits issued by the Department of the Army (33 CFR, Parts 325 & 332), including monitoring for success criteria.

Monitoring details, including the parameters utilized to assess performance standards and associated monitoring and reporting timelines are outlined in the succeeding sub-sections and summarized in Table 6. Monitoring results will be utilized to document mitigation site success (i.e., meeting performance standards) or identify any deficiencies that may require corrective action and/or determine if adaptive management is needed.

10.1 Monitoring Schedule

10.1.1 Estuarine & Palustrine Wetlands

Port Corpus Christi will conduct survival monitoring surveys for estuarine and palustrine transplants, from 45 – 90 days post-construction. Survival monitoring will assess and quantify transplant percent survival (parameter) and be used to determine if the survival performance metrics were obtained. Additional monitoring events will be conducted at 6-months, then annually up to 5-years, post-construction (Table 6). The 6-month and subsequent annual monitoring events will assess species composition and quantify vegetative percent cover (parameter). Total native vegetative percent cover will be utilized to assess if the compensatory mitigation site has achieved the required performance standard, as outlined above (Table 6).

10.2.2 Aquatic Resources (Seagrass & Oyster)

The permittee will a conduct survival monitoring survey for seagrass transplanting, from 45 – 90 days post-construction. Survival monitoring will assess and quantify seagrass transplant percent survival (parameter). The percent survival parameter will be used to determine if the survival performance metric for seagrass transplanting was obtained. Additional monitoring events will be conducted at 6-months, then annually up to 5-years, post-construction (Table 6). For the seagrass mitigation, the 6-month and subsequent annual monitoring events will assess species composition and quantify seagrass percent cover (parameter). Total seagrass percent cover will be utilized to assess if the compensatory mitigation site has achieved the required performance standard, as outlined above in Section 9.2. For oyster mitigation, the density of live oyster or the presence of spat will be utilized to determine if live oyster has attained the required performance metric, as outlined in Section 9.3.

10.2 Reporting

Once monitoring has been completed, a subsequent monitoring report will be developed. All monitoring reports will include descriptions of the mitigation site, detailed methodologies, describe the quantitative assessments (i.e., survival, percent cover, density) as applicable, and discussions of the observed conditions in relation to performance standards. Included in the monitoring reports will be relevant project figures and site photographs documenting site conditions observed during the time of the assessment. Conditions indicative of a potential problem within the mitigation site will be evaluated and detailed in the annual monitoring reports. Solutions and recommendations outlining corrective actions will be provided which may include, but not limited to, additional planting efforts, the installation of devices to prevent predation of planted vegetation, and modifications to site contours and elevations. Should these remediating actions be necessary during the monitoring period, Port Corpus Christi will implement the appropriate mitigation measures to ensure the performance standards are achieved. Monitoring reports will be submitted to the USACE within 45 days, post-monitoring (Table 6).

Table 6. Permittee Responsible Compensatory Mitigation Surveying, Monitoring, and Reporting Schedule, Channel Deepening Project, SWG-2019-00067

Project Phase	Action Item	Timeline
Pre-construction	Baseline WOUS & Habitat Characterization Survey[1]	Completed
Pre-construction	Baseline WOUS & Habitat Characterization Report[2]	Completed
Pre-construction	Baseline Topographic and Bathymetric Survey (including target elevations for proposed vegetation and seagrass)	Prior to dredged material placement
Pre-construction	Baseline Topographic and Bathymetric Report	45-days after survey
Pre-construction	Baseline 0.10-Acre Oyster Survey (HI-E)	Prior to oyster relocation
Pre-construction	Baseline 0.10-Acre Oyster Report (HI-E)	45-days after survey
Construction	As-Built Topographic and Bathymetric Survey	Post dredged material placement
Construction	As-Built Topographic and Bathymetric Report	45-days after survey
Post-construction	Wetlands & Seagrass Transplanting Survival Monitoring	45 – 90-days, post-construction
Post-construction	Wetlands & Seagrass Transplanting Survival Reporting	45 – 90-days, 45-days after monitoring
Post-construction	Wetlands, Seagrass, & Oyster Monitoring[3]	6-months, post-construction
Post-construction	Wetlands, Seagrass, & Oyster Reporting[4]	6-months, 45-days after monitoring
Post-construction	Wetlands, Seagrass, Invasive Species[5], & Oyster Monitoring	Annually (1- to 5-years), post-construction
Post-construction	Wetlands, Seagrass, Invasive Species, & Oyster Reporting	Annually, 45-days after monitoring

[1]Baseline WOUS and Sensitive Aquatic Resource data collected as part of the DEIS (USACE 2022), [2]Mott McDonald 2021 & Triton 2021, [3]monitoring may occur simultaneously, or independently dependent on construction completion, [4]all mitigation site monitoring results will be consolidated into one report, [5] if invasive species percent cover exceeds 10%, corrective management action will be implemented.

11.0 Long-Term Management Plan

Once the PRMS has achieved the minimum performance standards (i.e., short-term goals), long-term management will be necessary to ensure the functionality, sustainability, and longevity of SAS.

11.1 Estuarine and Palustrine Wetlands

The permittee will be responsible for the long-term management of the estuarine and palustrine mitigation areas. In general, the long-term management of the estuarine and palustrine wetland mitigation areas would include monitoring natural succession and addressing threats that may negatively impact the site or be detrimental to the long-term success. Long-term management practices may include:

- Berm revetment, maintenance, and repair;
- Regrade damaged areas to suitable elevations;
- Plant native vegetation;
- Implement integrated pest management (IPM) of invasive woody invasive species including:
    - Herbicide applications

- Mechanical control
- Prescribed burns

11.2 Aquatic Resources (Seagrass & Oyster)

The permittee will be responsible for the long-term management of the seagrass mitigation area. In general, the long-term management of the seagrass mitigation area would include monitoring natural succession and addressing threats that may negatively impact the site or be detrimental to the long-term success. Long-term management practices may include:

- Berm revetment, maintenance, and repair;
- Regrade areas to suitable elevations;
- Plant SAV;

Once the short-term oyster PRM goals and objectives (i.e., satisfy performance standards) have been attained, the long-term management of the oyster site will transfer to the State of Texas; specifically, the Texas General Land Office (GLO; owner of submerged lands Tract 328) and the Texas Parks and Wildlife Department (TPWD; state natural resource manager of public aquatic resources).

11.3 Force Majeure

Nothing contained with this PRM plan shall be construed to authorize proceedings against Port Corpus Christi for any damages to the mitigation site that is caused by natural catastrophes such as hurricanes, flood, extreme drought, climatic instability, disease, etc., or human interference including but not limited to civil disorder that the USACE determines is beyond the reasonable control of Port Corpus Christi to prevent or abate. Should the mitigation site be significantly impacted or determined unsuccessful by a force majeure event, Port Corpus Christi will coordinate with the USACE to collectively determine an appropriate path forward or identify remediating action (if any).

12.0 Adaptive Management Plan

Adaptive management is a structured approach to decision making processes providing a mechanism for continuous evaluation and adaptations to mitigation efforts, as necessary, to ensure that compensatory mitigation performance standards are achieved. Should any of the mitigation areas fail to meet the established success criteria, Port Corpus Christi will initially intervene with additional planting initiatives, implementation an integrated invasive species pest management plan, or by adding suitable oyster substrate. However, if the above corrective actions do not remedy failing site performance, Port Corpus Christi will coordinate and implement an appropriate adaptive management plan. Specific strategies will be implemented on a case-by-case basis to address specific mitigation failings. Components of an adaptive management strategy to satisfy mitigation performance metrics may include contouring or regrading to suitable elevations for native plant recruitment, supplemental watering to promote vegetative growth and native recruitment, berm revetment and/or repair, alternative approaches to invasive species management, sediment remediation, or other novel approaches. As a last-ditch effort, relocating a failing component (e.g., oyster restoration) or all of the required mitigation to an alternative location will be considered. If necessary, mitigation performance standards may be revised in accordance with adaptive management to remedy shortcomings within the mitigation site.

13.0 Financial Assurances

Port Corpus Christi is an established subdivision of the state of Texas with adequate financial means to expend funds on the required permittee responsible mitigation as described herein. In the event of any changes to the financial assurances for the mitigation site, the USACE will be notified at least 120 days in advance of any termination or revocation.

14.0 References

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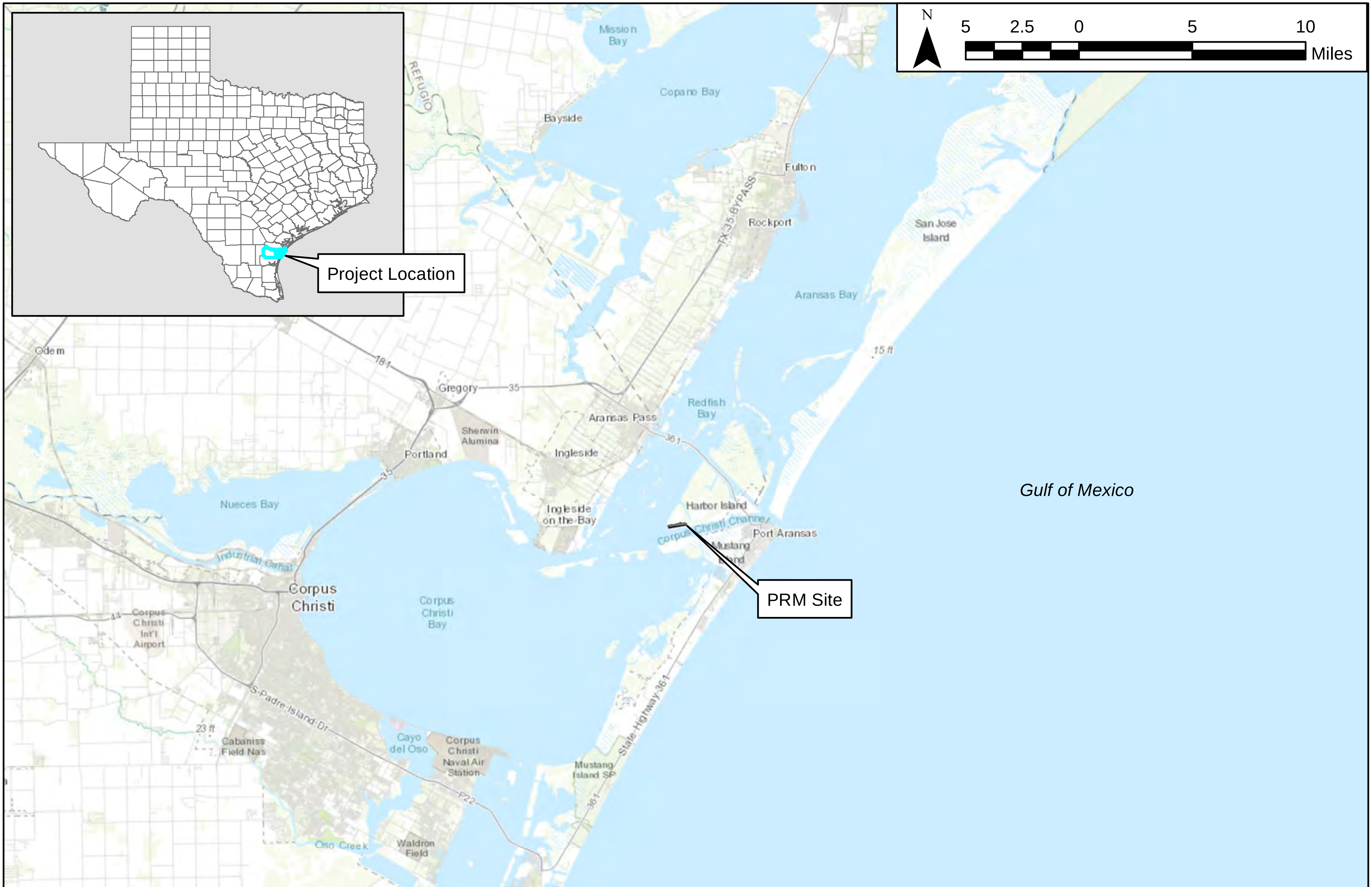
Figure 1.
Vicinity Map



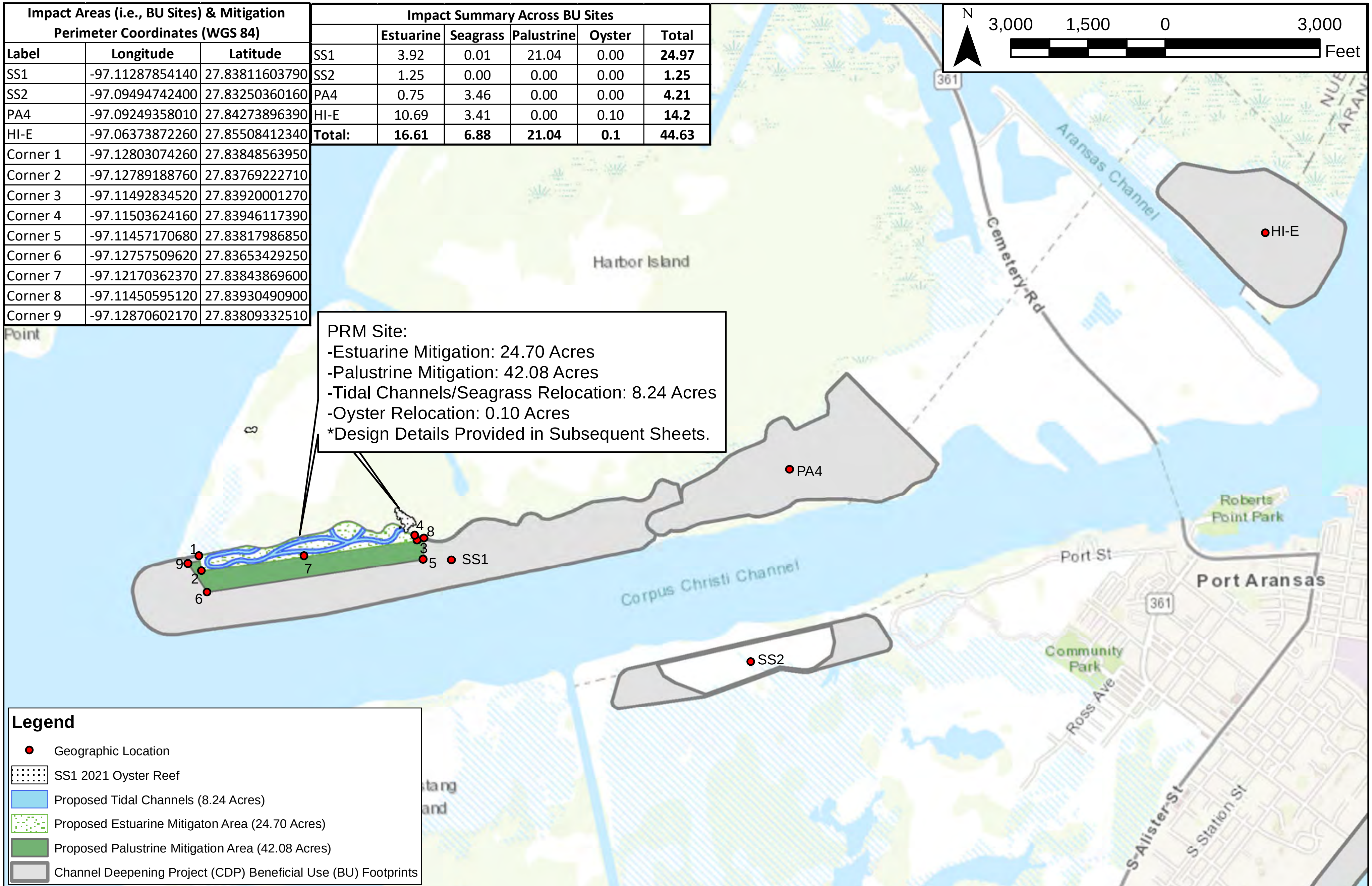
Vicinity Map: Permittee Responsible Mitigation (PRM) Plan **Corpus Christi Ship Channel Deepening Project (SWG-2019-00067)** **Nueces County, Texas**	Prepared By: Triton Environmental Solutions, LLC P.O. Box 1755 Rockport, TX 78381
Applicant: Port of Corpus Christi Authority 400 Harbor Drive Corpus Christi, Texas 78401	Map Notes: For planning and permitting purposes only, not for construction. Map Preparation Date: July 11, 2023 (ANB). Base Map Sources: ESRI topographic image.

Figure 2.
Impact and Compensatory Mitigation Sites Location Map

Impact Areas (i.e., BU Sites) & Mitigation Perimeter Coordinates (WGS 84)		
Label	Longitude	Latitude
SS1	-97.11287854140	27.83811603790
SS2	-97.09494742400	27.83250360160
PA4	-97.09249358010	27.84273896390
HI-E	-97.06373872260	27.85508412340
Corner 1	-97.12803074260	27.83848563950
Corner 2	-97.12789188760	27.83769222710
Corner 3	-97.11492834520	27.83920001270
Corner 4	-97.11503624160	27.83946117390
Corner 5	-97.11457170680	27.83817986850
Corner 6	-97.12757509620	27.83653429250
Corner 7	-97.12170362370	27.83843869600
Corner 8	-97.11450595120	27.83930490900
Corner 9	-97.12870602170	27.83809332510

Impact Summary Across BU Sites					
	Estuarine	Seagrass	Palustrine	Oyster	Total
SS1	3.92	0.01	21.04	0.00	**24.97**
SS2	1.25	0.00	0.00	0.00	**1.25**
PA4	0.75	3.46	0.00	0.00	**4.21**
HI-E	10.69	3.41	0.00	0.10	**14.2**
Total:	**16.61**	**6.88**	**21.04**	**0.1**	**44.63**

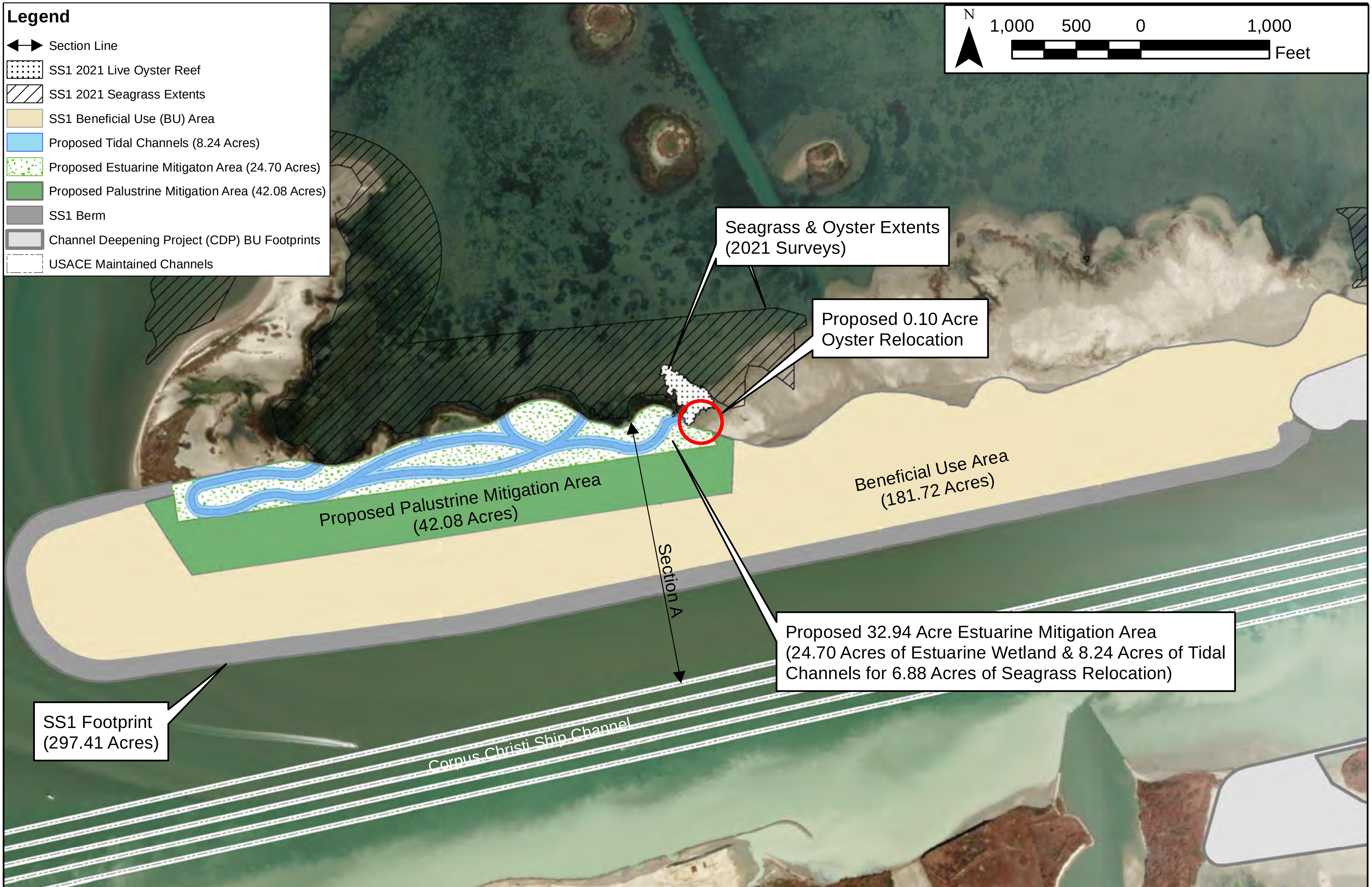
PRM Site:
-Estuarine Mitigation: 24.70 Acres
-Palustrine Mitigation: 42.08 Acres
-Tidal Channels/Seagrass Relocation: 8.24 Acres
-Oyster Relocation: 0.10 Acres
*Design Details Provided in Subsequent Sheets.



Location Map: Permittee Responsible Mitigation (PRM) Plan **Corpus Christi Ship Channel Deepening Project (SWG-2019-00067)** **Nueces County, Texas**	Prepared By: Triton Environmental Solutions, LLC P.O. Box 1755 Rockport, TX 78381
Applicant: Port of Corpus Christi Authority 400 Harbor Drive Corpus Christi, Texas 78401	Map Notes: For planning and permitting purposes only, not for construction. Map Preparation Date: July 11, 2023 (ANB). Base Map Sources: ESRI topographic image.

Figure 3.

Proposed Permittee Responsible Compensatory Mitigation Site Overview Map



Overview Map: SS1 Permittee Responsible Mitigation (PRM) Site
Corpus Christi Ship Channel Deepening Project (SWG-2019-00067)
Nueces County, Texas

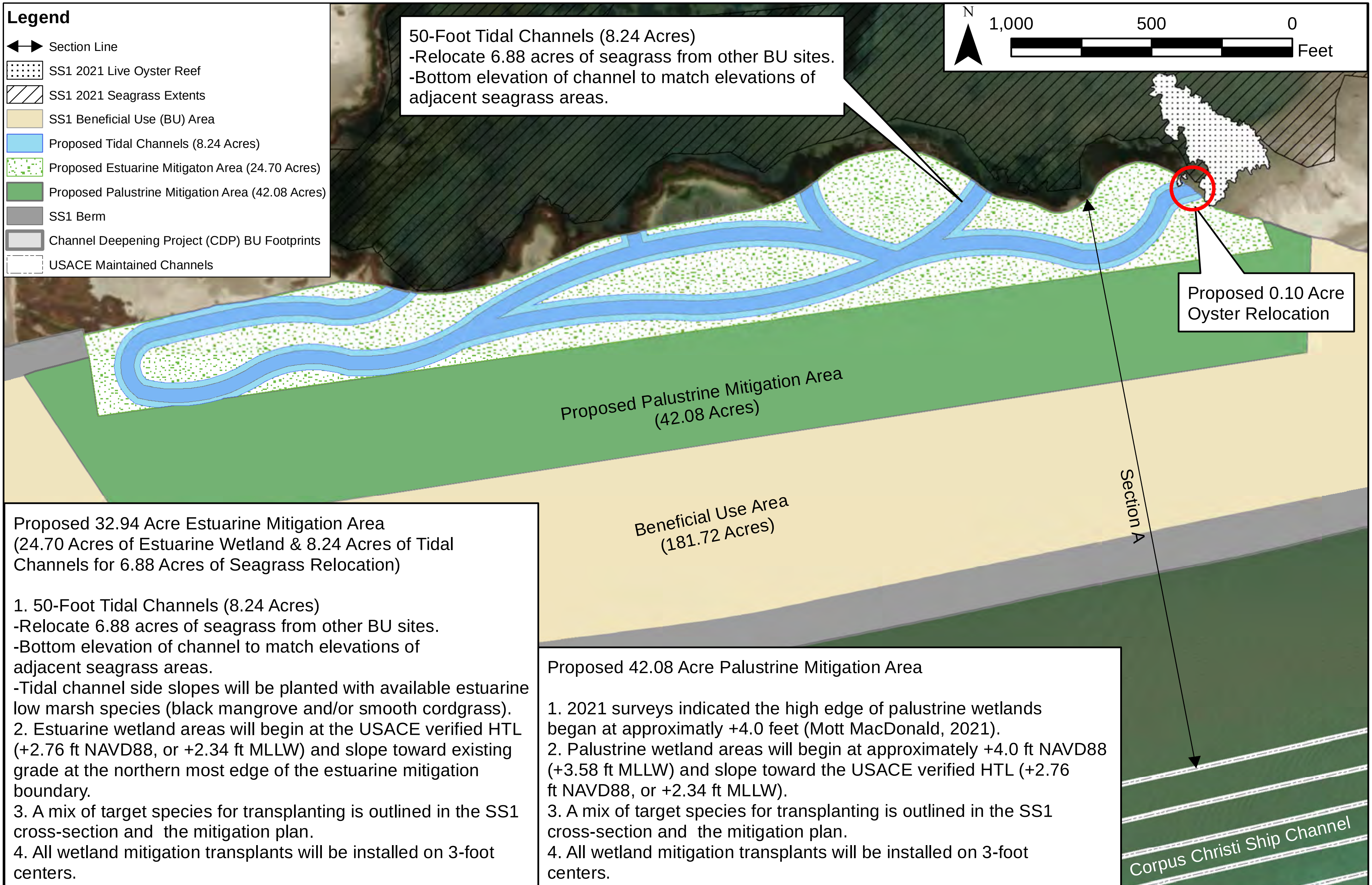
Prepared By: Triton Environmental Solutions, LLC
P.O. Box 1755
Rockport, TX 78381

Applicant: Port of Corpus Christi Authority
400 Harbor Drive
Corpus Christi, Texas 78401

Map Notes:
For planning and permitting purposes only, not for construction.
Map Preparation Date: July 11, 2023 (ANB).
Base Map Source: ESRI world imagery.

Figure 4.

Proposed Permittee Responsible Compensatory Mitigation Site Detail Map



Proposed 32.94 Acre Estuarine Mitigation Area
(24.70 Acres of Estuarine Wetland & 8.24 Acres of Tidal Channels for 6.88 Acres of Seagrass Relocation)

1. 50-Foot Tidal Channels (8.24 Acres)
-Relocate 6.88 acres of seagrass from other BU sites.
-Bottom elevation of channel to match elevations of adjacent seagrass areas.
-Tidal channel side slopes will be planted with available estuarine low marsh species (black mangrove and/or smooth cordgrass).
2. Estuarine wetland areas will begin at the USACE verified HTL (+2.76 ft NAVD88, or +2.34 ft MLLW) and slope toward existing grade at the northern most edge of the estuarine mitigation boundary.
3. A mix of target species for transplanting is outlined in the SS1 cross-section and the mitigation plan.
4. All wetland mitigation transplants will be installed on 3-foot centers.

Proposed 42.08 Acre Palustrine Mitigation Area

1. 2021 surveys indicated the high edge of palustrine wetlands began at approximatly +4.0 feet (Mott MacDonald, 2021).
2. Palustrine wetland areas will begin at approximately +4.0 ft NAVD88 (+3.58 ft MLLW) and slope toward the USACE verified HTL (+2.76 ft NAVD88, or +2.34 ft MLLW).
3. A mix of target species for transplanting is outlined in the SS1 cross-section and the mitigation plan.
4. All wetland mitigation transplants will be installed on 3-foot centers.

Overview Detail Map: SS1 Permittee Responsible Mitigation (PRM) Site
Corpus Christi Ship Channel Deepening Project (SWG-2019-00067)
Nueces County, Texas

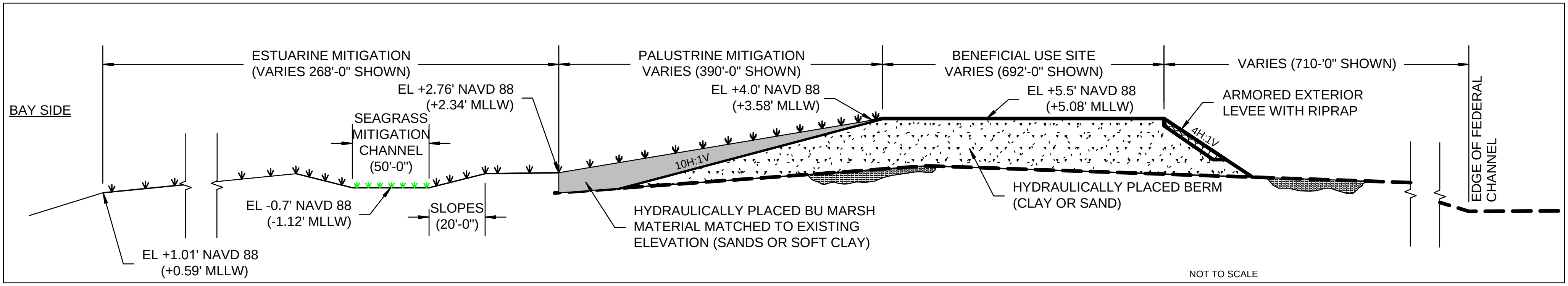
Prepared By: Triton Environmental Solutions, LLC
P.O. Box 1755
Rockport, TX 78381

Applicant: Port of Corpus Christi Authority
400 Harbor Drive
Corpus Christi, Texas 78401

Map Notes:
For planning and permitting purposes only, not for construction.
Map Preparation Date: July 11, 2023 (ANB).
Base Map Source: ESRI world imagery.

Figure 5. Proposed Permittee Responsible Mitigation Site Section View

SITE PLAN - SS1 SECTION



1. HORIZONTAL COORDINATE SYSTEM IS NAD83 TEXAS STATE PLANE, SOUTH ZONE, US FEET.
2. VERTICAL DATUM IS REFERENCED TO NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) and MEAN LOWER LOW WATER (MLLW); 0' MLLW = -0.42' NAVD 88. DATUMS REFERENCED TO NOAA TIDES AND CURRENTS USS LEXINGTON, CORPUS CHRISTI BAY, TX - STATION ID: 8775296.
3. NO CONSTRUCTION ACCESS, EXCAVATION, OR FILL SHALL OCCUR OUTSIDE OF MITIGATION AREA OR BU FOOTPRINT.
4. USACE VERIFIED (2021) MEAN HIGH WATER (MHW) ELEVATION WAS +1.01 FEET NAVD88 AND THE HIGH TIDE LINE WAS +2.76 FEET NAVD88.
5. ILLUSTRATED ELEVATIONS ARE BASED ON A 2021 SURVEY. SS1 IS A DYNAMIC SITE. OBTAINING CURRENT ELEVATIONS AND ADJACENT TARGET ELEVATIONS PRIOR TO CONSTRUCTION WILL BE NECESSARY.
6. PROPOSED TIDAL CHANNELS WILL BE CONSTRUCTED TO MATCH SURROUNDING ELEVATIONS OF ADJACENT SEAGRASS BEDS.
7. APPROXIMATELY 6.88-ACRES OF SEAGRASS WILL BE RELOCATED FROM IMPACT AREAS AND TRANSPLANTED WITHIN THE TIDAL CHANNELS.
8. ESTUARINE AND PALUSTRINE MITIGATION AREAS WILL BE PLANTED ON 3-FOOT CENTERS. IT IS ANTICIPATED THAT TRANSPLANT MATERIAL WILL BE HARVESTED FROM IMPACT AREAS OR OTHER READILY AVAILABLE SOURCES (PORT AUTHORITY PROPERTIES, ADJACENT STATE SUBMERGED LANDS, NURSERIES, SEED MIXES, ETC.). TARGET SPECIES FOR PLANTING ESTUARINE AND PALUSTRINE MITIGATION AREAS MAY VARY DEPENDING ON AVAILABILITY.
9. PALUSTRINE TARGET SPECIES INCLUDES, BUT IS NOT LIMITED TO, MARSHHAY CORDGRASS (SPARTINA PATENS), SEA OX-EYE DAISY (BORRICHIA FRUTESCENS), GULF CORDGRASS, (SPARTINA SPARTINAE), GULF DUNE PASPALUM (PASPALUM MONOSTACHYUM), SEASHORE DROPSEED (SPOROBOLUS VIRGINICUS), AND SEASHORE PASPALUM (PASPALUM VAGINATUM).
10. TARGET ESTUARINE SPECIES INCLUDES, BUT IS NOT LIMITED TO, BLACK MANGROVE (AVICENNIA GERMINANS), SMOOTH CORDGRASS (SPARTINA ALTERNIFLORA), SALTGRASS (DISTICHLIS SPICATA), SHOREGRASS (DISTICHLIS LITTORALIS), DWARF GLASSWORT (SALICORNIA BIGELOVII), SALTWORT (BATIS MARITIMA), VIRGINIA GLASSWORT (SALICORNIA DEPRESSA), BULRUSHES (SCHOENOPLECTUS SPP.), ANNUAL SEEPWEED (SUAEDA LINEARIS), SEAPURSLANE (SESUVIUM PORTULACASTRUM), SEA OX-EYE DAISY, GULF CORDGRASS, MARSHHAY CORDGRASS, AND SEASHORE DROPSEED.
11. IF POSSIBLE, THE MITIGATION SITES WILL BE PLANTED DURING SPRING OR FALL MONTHS TO AVOID SUMMER HEAT AND TAKE ADVANTAGE OF SEASONAL RAINFALL.

Cross-Section: SS1 Permittee Responsible Mitigation (PRM) Site **Corpus Christi Ship Channel Deepening Project (SWG-2019-00067)** **Nueces County, Texas**	Prepared By: Triton Environmental Solutions, LLC P.O. Box 1755 Rockport, TX 78381
Prepared For: Port of Corpus Christi Authority 400 Harbor Drive Corpus Christi, Texas 78401	Map Notes: For planning and permitting purposes only, not for construction. Map Preparation Date: July 11, 2023 REV August 9, 2023 (RKW).

Exhibit A.
Impact and Mitigation HGM Results

Summary of Wetland Assessment Area (WAA) Functional Capacity Index (FCI) by WAA and function. Proposed 32.94-acre estuarine mitigation site.

			Functional Capacity Index (FCI)									
WAA Number	**WAA Description**	**WAA Area (acres)**	Shoreline Stabilization	Sediment Deposition	Nutrient and Organic Carbon Exchange	Resident Nekton Utilization	Non-Resident Nekton Utilization	Maintain Invertebrate Prey Pool	Provide Wildlife Habitat	Characteristic Plant Community Structure and Composition	Plant Biomass Production	**Total**
1	SS1 High Marsh (E2EM1P)	1.36	0.60	0.84	1.00	0.90	0.64	0.93	0.75	0.50	1.00	**7.16**
2	SS1 Mangrove Shrubland (E2SS3N)	2.56	0.76	1.00	1.00	1.00	0.93	1.00	0.88	1.00	1.00	**8.57**
3	SS2 High Marsh (E2EM1P)	0.30	0.58	0.49	0.77	0.69	0.33	0.77	1.00	1.00	1.00	**6.63**
4	SS2 Mangrove Shrubland (E2SS3N)	0.95	0.72	0.77	0.77	0.69	0.33	0.77	1.00	1.00	1.00	**7.06**
5	PA4 High Marsh (E2EM1P)	0.31	0.56	0.63	1.00	0.87	0.40	0.90	0.85	0.90	1.00	**7.11**
6	PA4 Mangrove Shrubland (E2SS3N)	0.44	0.68	1.00	1.00	0.87	0.40	0.90	0.88	1.00	1.00	**7.72**
7	HI-E High Marsh (E2EM1P)	8.02	0.70	0.55	0.77	0.77	0.36	0.87	1.00	1.00	1.00	**7.02**
8	HI-E Mangrove Shrubland (E2SS3N) Proposed	2.67	0.74	0.77	0.77	0.77	0.80	0.87	0.93	0.70	1.00	**7.35**
9	32.94-acre Estuarine Mitigation Site	32.94	0.84	1.00	1.00	0.91	0.89	0.83	0.83	0.80	1.00	**8.10**

Summary of Wetland Assessment Area (WAA) Functional Capacity Units (FCU) by WAA and function. Proposed 32.94-acre estuarine mitigation site.

			Functional Capacity Unit (FCU)									
WAA Number	**WAA Description**	**WAA Area (Acres)**	Shoreline Stabilization	Sediment Deposition	Nutrient and Organic Carbon Exchange	Resident Nekton Utilization	Non-Resident Nekton Utilization	Maintain Invertebrate Prey Pool	Provide Wildlife Habitat	Characteristic Plant Community Structure and Composition	Plant Biomass Production	**Total**
1	SS1 High Marsh (E2EM1P)	1.36	0.82	1.14	1.36	1.22	0.87	1.27	1.02	0.68	1.36	**9.73**
2	SS1 Mangrove Shrubland (E2SS3N)	2.56	1.95	2.56	2.56	2.56	2.39	2.56	2.24	2.56	2.56	**21.94**
3	SS2 High Marsh (E2EM1P)	0.30	0.17	0.15	0.23	0.21	0.10	0.23	0.30	0.30	0.30	**1.99**
4	SS2 Mangrove Shrubland (E2SS3N)	0.95	0.68	0.74	0.74	0.65	0.32	0.73	0.95	0.95	0.95	**6.70**
5	PA4 High Marsh (E2EM1P)	0.31	0.17	0.20	0.31	0.27	0.12	0.28	0.26	0.28	0.31	**2.20**
6	PA4 Mangrove Shrubland (E2SS3N)	0.44	0.30	0.44	0.44	0.38	0.17	0.40	0.39	0.44	0.44	**3.40**
7	HI-E High Marsh (E2EM1P)	8.02	5.61	4.39	6.21	6.19	2.88	6.95	8.02	8.02	8.02	**56.29**
8	HI-E Mangrove Shrubland (E2SS3N) Proposed	2.67	1.98	2.07	2.07	2.06	2.14	2.31	2.47	1.87	2.67	**19.64**
9	32.94-acre Estuarine Mitigation Site	32.94	27.67	32.94	32.94	30.12	29.20	27.45	27.18	26.35	32.94	**266.78**

Table A1. SS1 High Marsh (E2EM1P) Wetland Assessment Area (WAA) Functional Capacity Index (FCI) and Associated Functional Capacity Units (FCU) by function.

Function Number	Function	WAA Area (Acres)	FCI	FCU (Acres)
1	Shoreline Stabilization		0.60	0.82
2	Sediment Deposition		0.84	1.14
3	Nutrient and Organic Carbon Exchange		1.00	1.36
4	Resident Nekton Utilization		0.90	1.22
5	Non-Resident Nekton Utilization	1.36	0.64	0.87
6	Maintain Invertebrate Prey Pool		0.93	1.27
7	Provide Wildlife Habitat		0.75	1.02
8	Characteristic Plant Community Structure and Composition		0.50	0.68
9	Plant Biomass Production		1.00	1.36
Totals:			**7.16**	**9.73**

Table A2. SS1 Mangrove Shrubland (E2SS3N) Wetland Assessment Area (WAA) Functional Capacity Index (FCI) and Associated Functional Capacity Units (FCU) by function.

Function Number	Function	WAA Area (Acres)	FCI	FCU (Acres)
1	Shoreline Stabilization		0.76	1.95
2	Sediment Deposition		1.00	2.56
3	Nutrient and Organic Carbon Exchange		1.00	2.56
4	Resident Nekton Utilization		1.00	2.56
5	Non-Resident Nekton Utilization	2.56	0.93	2.39
6	Maintain Invertebrate Prey Pool		1.00	2.56
7	Provide Wildlife Habitat		0.88	2.24
8	Characteristic Plant Community Structure and Composition		1.00	2.56
9	Plant Biomass Production		1.00	2.56
Totals:			**8.57**	**21.94**

Table A3. SS2 High Marsh (E2EM1P) Wetland Assessment Area (WAA) Functional Capacity Index (FCI) and Associated Functional Capacity Units (FCU) by function.

Function Number	Function	WAA Area (Acres)	FCI	FCU (Acres)
1	Shoreline Stabilization		0.58	0.17
2	Sediment Deposition		0.49	0.15
3	Nutrient and Organic Carbon Exchange		0.77	0.23
4	Resident Nekton Utilization		0.69	0.21
5	Non-Resident Nekton Utilization	0.30	0.33	0.10
6	Maintain Invertebrate Prey Pool		0.77	0.23
7	Provide Wildlife Habitat		1.00	0.30
8	Characteristic Plant Community Structure and Composition		1.00	0.30
9	Plant Biomass Production		1.00	0.30
Totals:			**6.63**	**1.99**

Table A4. SS2 Mangrove Shrubland (E2SS3N) Wetland Assessment Area (WAA) Functional Capacity Index (FCI) and Associated Functional Capacity Units (FCU) by function.

Function Number	Function	WAA Area (Acres)	FCI	FCU (Acres)
1	Shoreline Stabilization		0.72	0.68
2	Sediment Deposition		0.77	0.74
3	Nutrient and Organic Carbon Exchange		0.77	0.74
4	Resident Nekton Utilization		0.69	0.65
5	Non-Resident Nekton Utilization	0.95	0.33	0.32
6	Maintain Invertebrate Prey Pool		0.77	0.73
7	Provide Wildlife Habitat		1.00	0.95
8	Characteristic Plant Community Structure and Composition		1.00	0.95
9	Plant Biomass Production		1.00	0.95
Totals:			**7.06**	**6.70**

Table A5. PA4 High Marsh (E2EM1P) Wetland Assessment Area (WAA) Functional Capacity Index (FCI) and Associated Functional Capacity Units (FCU) by function.

Function Number	Function	WAA Area (Acres)	FCI	FCU (Acres)
1	Shoreline Stabilization	0.31	0.56	0.17
2	Sediment Deposition		0.63	0.20
3	Nutrient and Organic Carbon Exchange		1.00	0.31
4	Resident Nekton Utilization		0.87	0.27
5	Non-Resident Nekton Utilization		0.40	0.12
6	Maintain Invertebrate Prey Pool		0.90	0.28
7	Provide Wildlife Habitat		0.85	0.26
8	Characteristic Plant Community Structure and Composition		0.90	0.28
9	Plant Biomass Production		1.00	0.31
Totals:			**7.11**	**2.20**

Table A6. PA4 Mangrove Shrubland (E2SS3N) Wetland Assessment Area (WAA) Functional Capacity Index (FCI) and Associated Functional Capacity Units (FCU) by function.

Function Number	Function	WAA Area (Acres)	FCI	FCU (Acres)
1	Shoreline Stabilization	0.44	0.68	0.30
2	Sediment Deposition		1.00	0.44
3	Nutrient and Organic Carbon Exchange		1.00	0.44
4	Resident Nekton Utilization		0.87	0.38
5	Non-Resident Nekton Utilization		0.40	0.17
6	Maintain Invertebrate Prey Pool		0.90	0.40
7	Provide Wildlife Habitat		0.88	0.39
8	Characteristic Plant Community Structure and Composition		1.00	0.44
9	Plant Biomass Production		1.00	0.44
Totals:			**7.72**	**3.40**

Table A7. HI-E Mangrove Shrubland (E2SS3N) Wetland Assessment Area (WAA) Functional Capacity Index (FCI) and Associated Functional Capacity Units (FCU) by function.

Function Number	Function	WAA Area (Acres)	FCI	FCU (Acres)
1	Shoreline Stabilization		0.70	5.61
2	Sediment Deposition		0.55	4.39
3	Nutrient and Organic Carbon Exchange		0.77	6.21
4	Resident Nekton Utilization		0.77	6.19
5	Non-Resident Nekton Utilization	8.02	0.36	2.88
6	Maintain Invertebrate Prey Pool		0.87	6.95
7	Provide Wildlife Habitat		1.00	8.02
8	Characteristic Plant Community Structure and Composition		1.00	8.02
9	Plant Biomass Production		1.00	8.02
Totals:			**7.02**	**56.29**

Table A8. HI-E Mangrove Shrubland (E2SS3N) Wetland Assessment Area (WAA) Functional Capacity Index (FCI) and Associated Functional Capacity Units (FCU) by function.

Function Number	Function	WAA Area (Acres)	FCI	FCU (Acres)
1	Shoreline Stabilization		0.74	1.98
2	Sediment Deposition		0.77	2.07
3	Nutrient and Organic Carbon Exchange		0.77	2.07
4	Resident Nekton Utilization		0.77	2.06
5	Non-Resident Nekton Utilization	2.67	0.80	2.14
6	Maintain Invertebrate Prey Pool		0.87	2.31
7	Provide Wildlife Habitat		0.93	2.47
8	Characteristic Plant Community Structure and Composition		0.70	1.87
9	Plant Biomass Production		1.00	2.67
Totals:			**7.35**	**19.64**

Table A9. Proposed 32.94-acre Estuarine Mitigation Site Wetland Assessment Area (WAA) Functional Capacity Index (FCI) Score and Associated Functional Capacity Units (FCU) by function.

Function Number	Function	WAA Area (Acres)	FCI	FCU (Acres)
1	Shoreline Stabilization	32.94	0.84	27.67
2	Sediment Deposition		1.00	32.94
3	Nutrient and Organic Carbon Exchange		1.00	32.94
4	Resident Nekton Utilization		0.91	30.12
5	Non-Resident Nekton Utilization		0.89	29.20
6	Maintain Invertebrate Prey Pool		0.83	27.45
7	Provide Wildlife Habitat		0.83	27.18
8	Characteristic Plant Community Structure and Composition		0.80	26.35
9	Plant Biomass Production		1.00	32.94
Totals:			**8.10**	**266.78**

Table A10. Exposure Indices by Site.

Site	Wind Station	Exposure Index
SS1 E2EM1P	Port Aransas	16.98
SS1 E2SS3N	Port Aransas	16.98
SS2 E2EM1P	Port Aransas	9.68
SS2 E2SS3N	Port Aransas	9.68
PA4 E2EM1P	Port Aransas	11.53
PA4 E2SS3N	Port Aransas	11.53
HI-E E2EM1P	Port Aransas	9.85
HI-E E2SS3N	Port Aransas	9.85
Estuarine Mitigation Site (32.94-Acre)	Port Aransas	14.69

Table A11. Average Marsh Width by Site.

Site	Average Width (m)
SS1 E2EM1P	5.60
SS1 E2SS3N	67.43
SS2 E2EM1P	12.65
SS2 E2SS3N	21.10
PA4 E2EM1P	6.80
PA4 E2SS3N	11.03
HI-E E2EM1P	79.43
HI-E E2SS3N	27.66
Estuarine Mitigation Site (32.94-Acre)	407.50

Table A12. Mean Emergent Vegetative Percent Cover by Site.

Site	Mean % Cover
SS1 E2EM1P	100.0
SS1 E2SS3N	78.0
SS2 E2EM1P	86.7
SS2 E2SS3N	100.0
PA4 E2EM1P	100.0
PA4 E2SS3N	81.8
HI-E E2EM1P	100.0
HI-E E2SS3N	100.0
Estuarine Mitigation Site (32.99-Acre)	70.0

Table A13. Edge Characteristics by Site.

Site	Total Edge (m/ha)[1]	Tidally Connected: Total Edge
SS1 E2EM1P	>800 VH	35%
SS1 E2SS3N	350 – 800 H	100%
SS2 E2EM1P	200 – 350 M	25%
SS2 E2SS3N	200 – 350 M	25%
PA4 E2EM1P	200 – 350 M	25%
PA4 E2SS3N	200 – 350 M	25%
HI-E E2EM1P	350 – 800 H	25%
HI-E E2SS3N	350 – 800 H	100%
Estuarine Mitigation Site (32.94-Acre)	257 M	83%
[1]L = low (<200 m/ha), M = moderate (200 – 350 m/ha), H = high (350 – 800 m/ha), and VH = very high (>800 m/ha)		

Table A14. Representative Invasive or Undesirable Species[1] Observed within Study Sites.

Scientific Name	Common Name
Melilotus alba	Annual white sweetclover
Melilotus indicus	Annual yellow sweetclover
Sarcocornia ambigua	Perrenial glasswort
Prosopis glandulosa	Honey mesquite
Schinus terebinthifolia	Brazilian peppertree
[1]Invasive or Undesirable species criteria: listed as a non-native via USDA, or listed as a Texas Invasive via Texas Parks and Wildlife Texas Invasives, or species commonly managed with integrated pest management.	

Table A15. Representative Plants Observed within Study Sites.

Scientific Name	**Common Name**	**Salinity Regime**[1]
Avicennia germinans	Black mangrove	L
Spartina alterniflora	Smooth cordgrass	L
Batis maritima	Saltwort	L,H
Distichlis spicata	Seashore saltgrass	L,H
Eleocharis montevidensis	Sand spikerush	L,H
Fimbristylis castanea	Marsh fimbry	L,H
Lycium carolinianum	Carolina wolfberry	L,H
Monanthochloe littoralis	Shoregrass	L,H
Sarcocornia ambigua	Perrenial glasswort	L,H
Ambrosia psilostachya	Western ragweed	H
Andropogon glomeratus	Bushy bluestem	H
Borrichia frutescens	Sea oxeye	H
Iva annua	Marsh elder	H
Linum medium	Stiff yellow flax	H
Limonium carolinianum	Sea-lavender	H
Paspalum monostachyum	Gulfdune paspalum	H
Salicornia bigelovii	Glasswort	H
Schizachyrium scoparium	Little bluestem	H
Spartina patens	Saltmeadow cordgrass	H
Spartina spartinae	Gulf cordgrass	H
Sueda linearis	Seepweed	H
Commelina erecta	Whitemouth dayflower	NA
Gaillardia pulchella	Indian blanket	NA
Melilotus alba	Annual white sweetclover	NA
Melilotus indicus	Annual yellow sweetclover	NA
Prosopis glandulosa	Honey mesquite	NA
Rayjacksonia phyllocephala	Camphor daisy	NA
Schinus terebinthifolia	Brazilian peppertree	NA
[1]Water regime: L = low (proximal, regularly flooded), H = high (distal, irregularly flooded), NA = plants with a wetland indicator of FACU or UPL.		

Table A16. Fetch Measurements (km) from 16 Directions by Study Site.

Wind Direction	SS1	SS2	PA4	HI-E	Mitigation
N	0.56	1.02	2.17	0.00	1.17
NNE	2.22	1.10	2.00	0.03	1.11
NE	3.50	1.53	0.10	2.00	3.29
ENE	0.20	3.16	0.00	1.04	3.47
E	0.04	0.00	0.00	0.81	0.01
ESE	0.01	0.00	0.00	0.71	0.00
SE	0.00	0.00	0.00	0.72	0.00
SSE	0.00	0.00	0.00	0.90	0.00
S	0.00	0.00	0.00	1.80	0.00
SSW	0.00	0.00	0.00	0.00	0.00
SW	0.00	0.00	0.00	0.00	0.00
WSW	0.00	0.00	0.01	0.00	0.17
W	0.02	0.27	1.83	0.00	0.61
WNW	1.27	0.39	6.88	0.00	0.53
NW	4.05	1.24	1.88	0.00	0.67
NNW	6.43	0.98	1.86	0.00	4.10

Table A17. Mean Annual Wind Speed (km/h) and Proportion of Time Wind Blew from 16 Directions for the Port Aransas Weather Station[1].

Wind Direction	Mean Wind Speed (km/h)	Percent Frequency
N	21.59	0.06
NNE	21.47	0.08
NE	19.01	0.06
ENE	16.04	0.06
E	14.00	0.07
ESE	12.06	0.11
SE	13.45	0.19
SSE	11.05	0.13
S	13.06	0.07
SSW	6.15	0.02
SW	8.06	0.01
WSW	10.03	0.01
W	10.39	0.01
WNW	17.03	0.02
NW	18.23	0.03
NNW	21.60	0.04
[1]Data obtained from Shafer et al. 2002		

Appendix B
Field Data Forms

FIELD DATA SHEET:
NORTHWEST GULF OF MEXICO TIDAL FRINGE MARSHES

Assessment Team: Triton Environmental Solutions

Project Name/Location: Channel Deepening Project/SS1 E2EM1P **Date:** 06/25/2023

Prior to conducting an assessment, establish the project area boundaries and delineate the wetland boundaries within the project area.

Sample variables 1-3 using aerial photos at a scale of 1 cm = 48 m (1: 4800 or 1 in. = 400 ft, digital ortho-photo quadrangle imagery, maps, etc.)

1. V_{EDGE} Degree of marsh dissection/edge:area ratio *Subindex* 0.8

(1) Using either the quantitative or qualitative approach, measure or estimate the edge:area ratio and assign a subindex value based on Table B1. See pictorial key in Appendix D (Figures D2-D9) for specific examples.

Table B1
Relationship Between Edge:Area and Functional Capacity

	Edge:Area		
Site Description	**Qualitative**	**Quantitative m/ha**	**Subindex**
1) Marsh shows signs of deterioration due to subsidence (i.e., highly fragmented with large amounts of open water. Vegetation occurs mainly in isolated hummocks or on natural levees along tidal creeks). Although edge:area is very high, this condition is not considered sustainable in the long term (Figure D2).	Very High	>800	0.8
1) Well-developed tidal drainage network present (Figure D3), OR **2)** Simple tidal drainage network (may consist of only a single channel) present with isolated ponds and depressions present in the marsh interior (Figures D4 and D5). **3)** Atypical geomorphic configuration with a large amount of shoreline relative to total area (i.e. small island or narrow peninsula) (Figure D7).	High	350-800	1.0
1) Simple tidal drainage network (may consist of only a single channel). Isolated ponds and depressions are few or lacking, OR **2)** Narrow fringe marsh that lacks tidal creeks. One lengthwise shoreline is exposed to tidal waters. Area of marsh is small relative to shoreline length (Figures D6 and D8).	Moderate	200-350	0.7
Marsh lacks both tidal creeks and isolated ponds and depressions. Shoreline is generally linear or smooth curvilinear without embayments or convolutions. Area of marsh is large relative to shoreline length (Figure D9).	Low	<200	0.4

*Note: High marsh shows considerable deterioration due to erosion, is highly fragmented, and vegetation occurs in isolated hummocks.

2. V_{OMA} Proportion of tidally connected edge to total edge *Subindex* 0.5

(1) Assign subindex value based on Table B2.

Table B2
Relationship Between Opportunity for Marsh Access and Functional Capacity

Tidally Connected Edge: Total Edge	Subindex
❑ 50-100%	1.0
❑ 35-50%	0.7
☒ 25-35%	0.5
❑ 1-25%	0.2
❑ No tidally connected edge present	0.0

3. V_{SIZE} Total Effective Patch Size *Subindex* 0.75

(1) If the core wetland size exceeds 200 ha, assign a variable subindex value of 1.0. The core wetland is defined as a contiguous patch of tidal fringe wetland that contains the WAA.

(2) If the core wetland size <200 ha, identify other patches of wetlands in the surrounding area, and record the size of each patch in hectares. These wetlands may be in a wetland subclass other than tidal fringe. Then, using the descriptions provided in Table B3, determine the degree of connectivity between each wetland patch and the core wetland.

Table B3
Determination of Corridor Connectivity

Corridor Type	Corridor Description	Multiplier
Contiguous corridor	**1)** Open water stretches <60 m (regardless of depth). **2)** Unvegetated stretches of shoreline or strips of other wetland subclasses <60 m in length that have an aquatic shelf at least 3 m wide and are <0.3 m deep at MSL. This discounts most tidal creeks and coves or unvegetated stretches of shoreline abutting uplands as barriers to wildlife that are traveling through their daily home range.	1.00
Partially impeded corridor	**1)** Open water stretches from 60-300 m (regardless of depth). **2)** Unvegetated shorelines or strips of other wetland subclasses from 60-500 m in length that have an aquatic shelf at least 3 m wide with water depths <0.3 m at MSL. Deeper stretches of water that interrupt the shelves are not considered impeding if they are <60 m wide. **3)** Stretches of undeveloped upland that are <30 m in width.	0.75
Impeded corridor	**1)** Shoreline shelves or wetland strips between 500-1200 m long. **2)** Stretches of undeveloped upland 30-300 m in width.	0.50
Corridor absent or barrier present	**1)** Open water stretches or undeveloped uplands >300 m in width. **2)** Shorelines >300 m long that contain no shelf with waters <0.3 m deep (i.e., long stretches of bulkheading). **3)** Roadways with >100 vehicle crossings per day that are unbridged or have a bridge opening <3 m wide. **4)** Highly developed urban, residential, or industrial areas.	0.0

(3) Multiply the size of the patch (ha) by the appropriate connectivity multiplier from the table above.

Size of Wetland (hectares)		Connectivity Multiplier	Product
Core wetland	30.1	1.0	1.0 (30.1)
Patch A	13.9	0.5	6.95
Patch B	43.1	0.75	32.325
Patch C			
Patch D			
Patch E			

(4) Obtain the sum of all the products above. SUM 69.375

(5) Using Table B4, assign a variable subindex based on the value of the sum calculated above.

Table B4
Relationship Between Total Effective Patch Size and Functional Capacity

Total Effective Patch Size	Subindex
>200 ha	1.00
5-200 ha	0.75
1-5 ha	0.50
0.2-1 ha	0.25
<0.2 ha	0.10

Sample variables 4-8 based on an onsite field inspection of the project area and WAA.

4. V_{HYDRO} Hydrologic regime *Subindex* 1.0

(1) Assign subindex value based on Table B5.

Table B5
Relationship Between Hydrologic Regime and Functional Capacity

Site Condition	Subindex
Site is open to free exchange of tidal waters. No obvious hydrologic alteration or restrictions present.	1.0
Moderate hydrologic restriction present (i.e., presence of low-elevation berm, which is frequently overtopped by high tide events or has multiple breaches or large culverts).	0.6
Severe hydrologic restriction present (i.e., presence of high-elevation berm, which is infrequently overtopped by high tide events or has a single opening, breach or small culvert).	0.3
Site receives tidal floodwaters only during extreme storm tide events.	0.1
Site is isolated from tidal exchange. The principal source of flooding is water sources other than tidal action (i.e., precipitation or groundwater). *Note: If this condition exists, another wetland assessment model should be strongly considered unless the site was formerly a tidal wetland prior to hydrologic modification.*	0.0

5. $V_{TYPICAL}$ Percent cover by typical plant species within the WAA 50.0 %

(1) Visually estimate the percentage of the site that is covered by nontypical, nonnative, or otherwise undesirable plant species (see Table B6). Subtract this number from 100 to estimate the percentage of the site that is occupied by plant species typical of the regional subclass. See the subclass profile in Chapter 2 for additional information. Appendix D also lists typical plant species that occur in saline, brackish, and intermediate marshes along the Texas coast.

Table B6
Possible Invasive or Undesirable Plant Species

Scientific Name	Common name	Salt/Brackish	Intermediate
Alternanthera philoxeroides	Alligator weed		L
Aster spinosus	Spiny aster		H
Phragmites australis	Common reed	H	L,H
Sesbania drummondii	Drummond's rattlebush		L,H
Typha spp.	Cattail	L	L
H = high marsh, L = low marsh.			

(2) Assign variable subindex based on Figure B1 *Subindex* 0.5

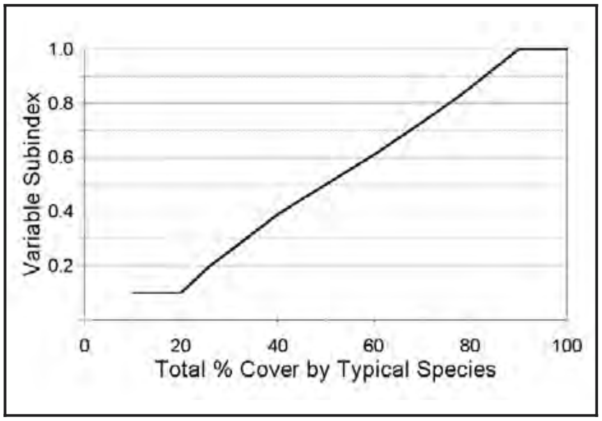


Figure B1. Relationship between percent cover by typical plant species and functional capacity

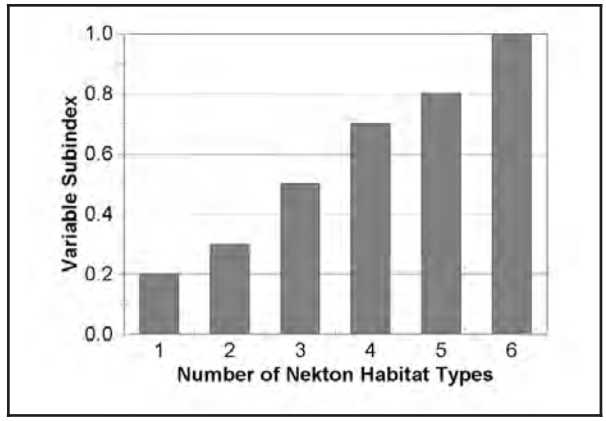


Figure B2. Relationship between nekton habitat complexity and functional capacity

6. V_{NHC} Nekton Habitat Complexity (# different habitat types)

(1) Check the habitats observed on or within a 30-m (100-ft) radius of project area perimeter.

Coarse woody debris	______	Unvegetated flats	X	Algal mats	______
Subtidal creeks/channels	______	Oyster reef	______	Mangroves	X
Intertidal creeks/channels	______	Low marsh	X	High marsh	X
Ponds or depressions	______	Submerged aquatic vegetation	______		

(2) Assign variable subindex based on the chart in Figure B2. *Subindex* 0.7

7. V_{WHC} Wildlife Habitat Complexity (total # different habitat types)

(1) Check those habitat types **IN ADDITION TO THOSE LISTED ABOVE** that are present on or within a 2-km radius of the project area perimeter.

Supratidal habitats (hummocks, logs)	X	Scrub-Shrub	X	Forested uplands	_____
Unvegetated beach	________	Grasslands	X		

*Note: Also present within 2 km radius include subtidal channels, supratidal, SAV, oyster, woody debris, and algal mats.

(2) Assign variable subindex based on the chart in Figure B3. *Subindex* 1.0

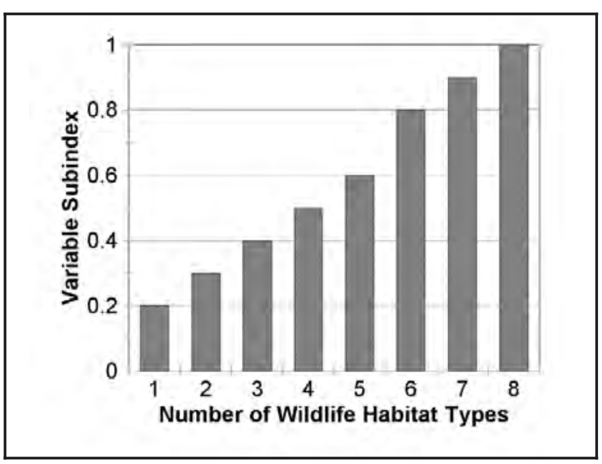


Figure B3. Relationship between wildlife habitat complexity and functional capacity

8. V_{ROUGH} Surface roughness (Manning's n)

(1) Choose a value for each of the three variables in the equation below based on the descriptions provided in Table B7.

$$\underline{0.025} + \underline{0.001} + \underline{0.050} = \underline{0.076}$$
$$n_{BASE} + n_{TOPO} + n_{VEG} = n$$

(2) Compute the sum of the three variables in the equation above.

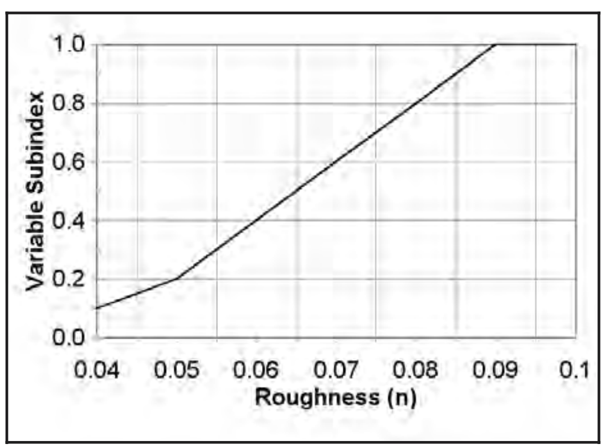
(3) Assign variable subindex based on the chart in Figure B4. *Subindex* 0.7

Table B7
Relationship Between Roughness and Functional Capacity

Roughness Component	Adjustment to *n* Value			Description of Terms
Sediment surface (n_{BASE})	0.025			Base value for bare marsh soil.
	0.03			More than 25% of sediment surface covered with gravel or broken shell.
Topographic relief (n_{TOPO})	0.001			Representative area is flat with essentially no microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds).
	0.005			Microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds) cover 5-25% of a representative area.
	0.010			Microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds) cover 26-50% of a representative area.
	0.020			Microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds) cover >50% of a representative area.
Roughness Component	**Percent Cover**			**Description of Conditions**
	<50	**50-75**	**76-100**	
Vegetation (n_{VEG})	0.025	0.030	0.035	Representative area predominantly short, flexible-stemmed grasses (i.e., short *Spartina alterniflora, S. patens, Distichlis spicata*).
	0.035	0.040	0.050	Vegetation in representative area predominantly short, with stiff, trailing stems (i.e., *Batis maritima*, *Salicornia virginica*).
	0.050	0.060	0.070	Representative area predominantly tall, flexible-stemmed grasses (i.e., tall *Spartina alterniflora, S. cynosuroides, Scirpus sp.*).
	0.070	0.100	0.160	Vegetation in representative area predominantly tall, with stiff leaves (i.e., *Juncus roemerianus*) or mixed woody shrubs (i.e., mangroves).

Note: Adapted from Arcement and Schneider (1989) and Gardiner and Dakombe (1983).

Figure B4. Relationship between surface roughness (n) and functional capacity



Sample variables 9 and 10 based on a representative number of locations in the WAA using a series of 1-m^2 plots arranged along one or more 30-m (100-ft) transects oriented perpendicular to the wetland shoreline or the hydrologic gradient.

9. V_{COVER} Mean Total Percent Vegetative Cover 100.0 %

(1) Select one or more representative areas within the site for sampling. Beginning at the shoreward edge of the marsh, establish one or more 30-m transects perpendicular to the shoreline or along the hydrologic gradient (e.g. increasing elevation). If there are multiple vegetation community types within the WAA, the transect should intersect each vegetation community, in order to ensure a representative sample.

(2) Using a standard 1-m^2 frame, estimate total percent cover by **both live and dead** emergent macrophytic plant species at intervals along the transect, excluding any areas where water depths are too deep to support the growth of emergent vegetation. The number of transects and plots needed will depend on the size and heterogeneity of the site; **a minimum of 10 plots should be used**.

(3) Calculate the average of all total percent cover estimates.

(4) Assign variable subindex for V_{COVER} based on the chart in Figure B5. *Subindex* 1.0

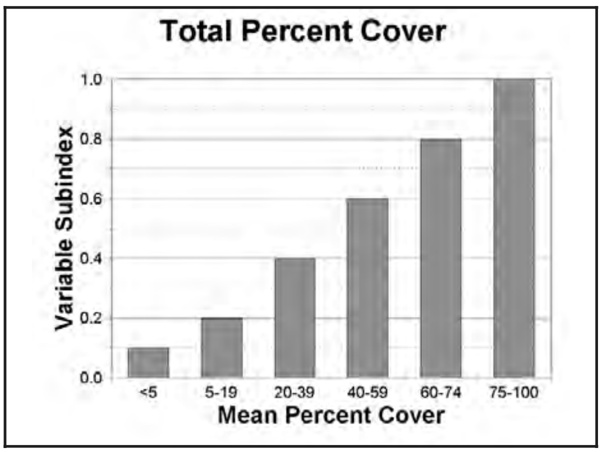


Figure B5. Relationship between mean total percent cover and functional capacity

10. V_{VEGSTR} Mean Vegetative Structure Index

(4) If the 1-m^2 sample plot above contains more than one species (i.e., *Spartina* and *Distichlis*), estimate the proportion of the 1-m^2 plot area covered by each species, omitting any species that occupies <10% cover. If the total percent cover above was estimated at 80%, the sum of the percent cover of each individual species should be 80%. There may be cases where there are several species that individually account for <10% cover, but collectively amount to 10%. In these cases, estimate the cumulative percent cover for the species group.

(5) For each species identified above, estimate the height in centimeters (rounded to the nearest 5 cm) at which the bulk of the biomass occurs (i.e., the most frequently occurring height) and record this value. For those species with trailing stems, the height should be measured in situ rather than extended vertically. Record an estimated height for the species group, if necessary.

(6) Calculate a vegetative structure index for **each** plot using the equation below.

$$V_{VEGSTR} = ((\text{Hgt}_1 \times \text{Proportion}_1) + (\text{Hgt}_2 \times \text{Proportion}_2) + \ldots.. (\text{Hgt}_x \times \text{Proportion}_x))$$

where: x = # plant species per plot.

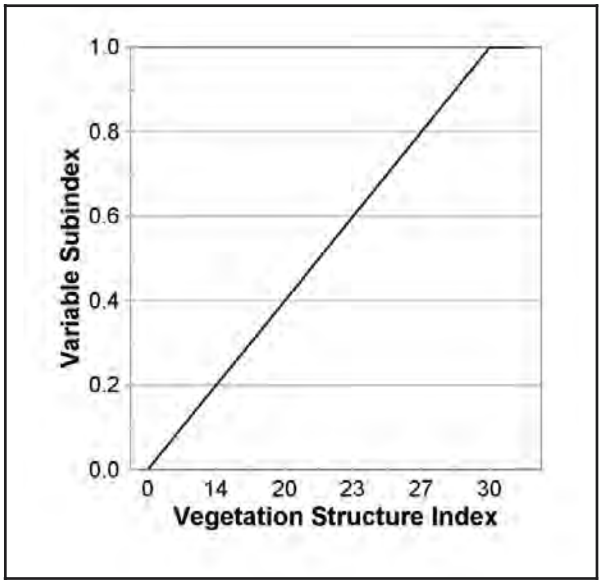
[(_____ × _____) + (_____ × _____) + (_____ × _____)] = _______

(7) Compute the sum of all the vegetative structure indices generated above. _________

(8) Divide by the total number of plots to determine the mean. _________

(9) Assign a subindex value based on the chart in Figure B6. *Subindex* 1.0*

Figure B6. Relationship between vegetation structure index and functional capacity



*Note: No direct vegetative height field measurement data collected for any species. Vegetative Structure Index assumed to be >30 = 1.0 Variable Subindex.

Variables 11-14 are assessed only for the Shoreline Stabilization Function.

First, conduct a field site inspection and determine if there are any visual indicators of shoreline erosion within the project area. Examples of this include slumping banks, undercut banks, exposed root mats, or vertical bluffs along the shoreline (See Figure D1 for examples). If any of these features exist, assign a variable subindex to each of the following variables using the procedures outlined below and calculate a functional capacity index for this function. Otherwise, assign a default functional capacity index of 1.0 to this function, indicating the presence of a stable, non-eroding shoreline.

11. V_{WIDTH} Mean width of the marsh

(1) Using a recent aerial photo or direct field survey, establish a baseline along the lengthwise axis that runs roughly parallel to the shoreline and/or perpendicular to the topographic gradient.

(2) Draw a series of transects perpendicular to this baseline from the shoreline to the nearest upland and measure or estimate the average width of the marsh in meters (Figure 4). The number of transects is determined by the length of the baseline (Table B8).

Table B8
Number of Transects for Estimating Mean Marsh Width

Baseline Length (m)	Number of Transects
<300	3
300-1,500	5
1,500-3,000	7
>3,000	9

1____ m 2 ____ m 3 ____ m 4 ____ m 5____ m *Note: Mean marsh width = 6.80 m

(3) Determine the average of the widths recorded above.

(4) Assign a variable subindex based on Figure B7. *Subindex* 0.1

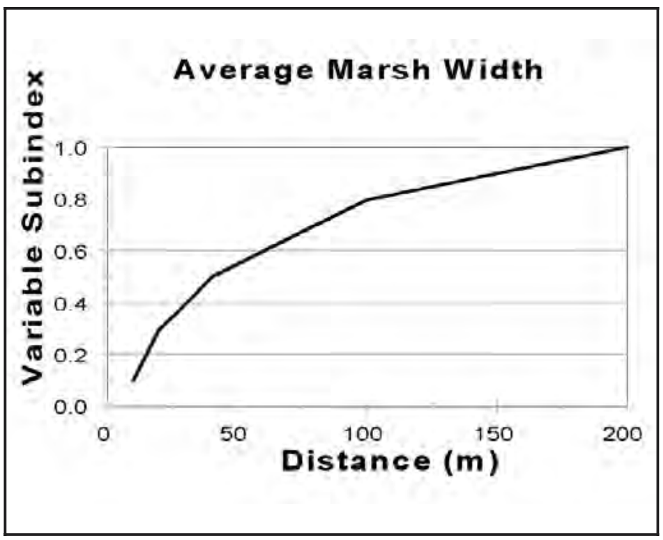


Figure B7. Relationship between average marsh width and functional capacity

12. V_{EXPOSE} Relative Exposure Index (REI)

(1) Measure fetch distances in kilometers for each of the 16 possible compass bearings.

(2) Using the map in Figure 3 in the main text (page 22), select the wind data station closest to your site.

(3) Using the supplemental information in Table E1 on mean annual wind speeds, calculate an REI using the equation below.

$$\text{Relative Exposure Index} = \sum_{i=1}^{16} V_i \times F_i \times P_i$$

where:

V_i = mean annual wind speed (km/hr)
F_i = fetch distance (km)
P_i = proportion of time wind blew from each of 16 cardinal and subcardinal compass directions

*Note: Relative Exposure Index (RSI) = 16.98.

(4) Assign variable subindex based on Figure B8. *Subindex* 0.8

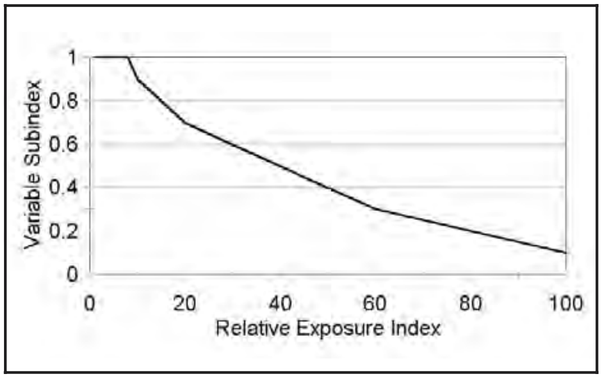


Figure B8. Relationship between relative exposure index and functional capacity

13. . V_{SLOPE} Distance to navigation channel OR water depths ≥2 m *Subindex* 1.0

Table B9
Relationship Between Shoreline Slope and Functional Capacity

Distance	Subindex
<50 m	0.1
50-150 m	0.5
>150 m	1.0

*Note: Distance to water depth of 2 m = 154 m.

14. V_{SOIL} Soil texture *Subindex* 0.4

Table B10
Relationship Between Soil Type and Functional Capacity

Predominant Soil Type	Subindex
Clay	1.0
Clay loam	0.8
Loam	0.6
Sandy loam	0.4
Sandy	0.2

TIDAL FRINGE MARSH HGM FUNCTIONAL ASSESSMENT

Sediment Deposition = $(V_{ROUGH} \times V_{HYDRO})^{1/2}$

(0.7 × 1.0) $^{1/2}$ = 0.837

Resident Nekton Utilization = $(V_{EDGE} + 2\ V_{HYDRO} + 0.5\ V_{NHC})$ / 3.5

(0.8 + 2 1.0 + 0.7 /2) / 3.5 = 0.9

Nonresident Nekton Utilization = $[(V_{EDGE} + 2\ V_{HYDRO} + 0.5\ V_{NHC}) / 3.5)\ V_{OMA}]^{1/2}$

[(0.8 + 2 1.0 + 0.5 0.7 / 3.5) × 0.5]$^{1/2}$ = 0.636

Invertebrate Prey Pool = $(V_{HYDRO} + V_{EDGE} + V_{COVER})$ / 3

(1.0 + 0.8 + 1.0) / 3 = 0.933

Nutrient and Organic Carbon Exchange = $(V_{VEGSTR} \times V_{HYDRO})^{1/2}$

(1.0 × 1.0)$^{1/2}$ = 1.0

Maintain Characteristic Plant Community Composition = V_{C0VER} or $V_{TYPICAL}$, whichever is lower

Min (1.0 or 0.5) = 0.5

Plant Biomass Production = V_{VEGSTR} = 1.0

Provide Wildlife Habitat = [2 V_{SIZE} + V_{WHC} + (Min (V_{COVER} OR $V_{TYPICAL}$))] / 4

(2 0.75 + 1.0 + 0.5) / 4 = 0.75

Shoreline Stabilization = $(V_{SLOPE} + V_{WIDTH} + V_{EXPOSE} + V_{ROUGH} + V_{SOIL})$ / 5

(1.0 + 0.1 + 0.8 + 0.7 + 0.4) / 5 = 0.6

FIELD DATA SHEET:
NORTHWEST GULF OF MEXICO TIDAL FRINGE MARSHES

Assessment Team: Triton Environmental Solutions

Project Name/Location: Channel Deepening Project/SS1 E2SS3N **Date:** 06/25/2023

Prior to conducting an assessment, establish the project area boundaries and delineate the wetland boundaries within the project area.

Sample variables 1-3 using aerial photos at a scale of 1 cm = 48 m (1: 4800 or 1 in. = 400 ft, digital ortho-photo quadrangle imagery, maps, etc.)

1. V_{EDGE} Degree of marsh dissection/edge:area ratio *Subindex* 1.0

(1) Using either the quantitative or qualitative approach, measure or estimate the edge:area ratio and assign a subindex value based on Table B1. See pictorial key in Appendix D (Figures D2-D9) for specific examples.

Table B1
Relationship Between Edge:Area and Functional Capacity

Site Description	Edge:Area		Subindex
	Qualitative	Quantitative m/ha	
1) Marsh shows signs of deterioration due to subsidence (i.e., highly fragmented with large amounts of open water. Vegetation occurs mainly in isolated hummocks or on natural levees along tidal creeks). Although edge:area is very high, this condition is not considered sustainable in the long term (Figure D2).	Very High	>800	0.8
1) Well-developed tidal drainage network present (Figure D3), OR **2)** Simple tidal drainage network (may consist of only a single channel) present with isolated ponds and depressions present in the marsh interior (Figures D4 and D5). **3)** Atypical geomorphic configuration with a large amount of shoreline relative to total area (i.e. small island or narrow peninsula) (Figure D7).	High	350-800	1.0
1) Simple tidal drainage network (may consist of only a single channel). Isolated ponds and depressions are few or lacking, OR **2)** Narrow fringe marsh that lacks tidal creeks. One lengthwise shoreline is exposed to tidal waters. Area of marsh is small relative to shoreline length (Figures D6 and D8).	Moderate	200-350	0.7
Marsh lacks both tidal creeks and isolated ponds and depressions. Shoreline is generally linear or smooth curvilinear without embayments or convolutions. Area of marsh is large relative to shoreline length (Figure D9).	Low	<200	0.4

*Note: Exhibits atypical geomorphic configuration with large amount of shoreline relative to total area (peninsula).

2. V_{OMA} Proportion of tidally connected edge to total edge *Subindex* 1.0

(1) Assign subindex value based on Table B2.

Table B2
Relationship Between Opportunity for Marsh Access and Functional Capacity

Tidally Connected Edge: Total Edge	Subindex
☒ 50-100%	1.0
☐ 35-50%	0.7
☐ 25-35%	0.5
☐ 1-25%	0.2
☐ No tidally connected edge present	0.0

3. V_{SIZE} Total Effective Patch Size *Subindex* 0.75

(1) If the core wetland size exceeds 200 ha, assign a variable subindex value of 1.0. The core wetland is defined as a contiguous patch of tidal fringe wetland that contains the WAA.

(2) If the core wetland size <200 ha, identify other patches of wetlands in the surrounding area, and record the size of each patch in hectares. These wetlands may be in a wetland subclass other than tidal fringe. Then, using the descriptions provided in Table B3, determine the degree of connectivity between each wetland patch and the core wetland.

Table B3
Determination of Corridor Connectivity

Corridor Type	Corridor Description	Multiplier
Contiguous corridor	**1)** Open water stretches <60 m (regardless of depth). **2)** Unvegetated stretches of shoreline or strips of other wetland subclasses <60 m in length that have an aquatic shelf at least 3 m wide and are <0.3 m deep at MSL. This discounts most tidal creeks and coves or unvegetated stretches of shoreline abutting uplands as barriers to wildlife that are traveling through their daily home range.	1.00
Partially impeded corridor	**1)** Open water stretches from 60-300 m (regardless of depth). **2)** Unvegetated shorelines or strips of other wetland subclasses from 60-500 m in length that have an aquatic shelf at least 3 m wide with water depths <0.3 m at MSL. Deeper stretches of water that interrupt the shelves are not considered impeding if they are <60 m wide. **3)** Stretches of undeveloped upland that are <30 m in width.	0.75
Impeded corridor	**1)** Shoreline shelves or wetland strips between 500-1200 m long. **2)** Stretches of undeveloped upland 30-300 m in width.	0.50
Corridor absent or barrier present	**1)** Open water stretches or undeveloped uplands >300 m in width. **2)** Shorelines >300 m long that contain no shelf with waters <0.3 m deep (i.e., long stretches of bulkheading). **3)** Roadways with >100 vehicle crossings per day that are unbridged or have a bridge opening <3 m wide. **4)** Highly developed urban, residential, or industrial areas.	0.0

(3) Multiply the size of the patch (ha) by the appropriate connectivity multiplier from the table above.

Size of Wetland (hectares)		Connectivity Multiplier	Product
Core wetland	30.1	1.0	1.0 (30.1)
Patch A	13.9	0.5	6.95
Patch B	43.1	0.75	32.325
Patch C			
Patch D			
Patch E			

(4) Obtain the sum of all the products above. SUM 69.375

(5) Using Table B4, assign a variable subindex based on the value of the sum calculated above.

Table B4
Relationship Between Total Effective Patch Size and Functional Capacity

Total Effective Patch Size	**Subindex**
>200 ha	1.00
5-200 ha	0.75
1-5 ha	0.50
0.2-1 ha	0.25
<0.2 ha	0.10

Sample variables 4-8 based on an onsite field inspection of the project area and WAA.

4. V_{HYDRO} Hydrologic regime *Subindex* 1.0

(1) Assign subindex value based on Table B5.

Table B5
Relationship Between Hydrologic Regime and Functional Capacity

Site Condition	Subindex
Site is open to free exchange of tidal waters. No obvious hydrologic alteration or restrictions present.	1.0
Moderate hydrologic restriction present (i.e., presence of low-elevation berm, which is frequently overtopped by high tide events or has multiple breaches or large culverts).	0.6
Severe hydrologic restriction present (i.e., presence of high-elevation berm, which is infrequently overtopped by high tide events or has a single opening, breach or small culvert).	0.3
Site receives tidal floodwaters only during extreme storm tide events.	0.1
Site is isolated from tidal exchange. The principal source of flooding is water sources other than tidal action (i.e., precipitation or groundwater). *Note: If this condition exists, another wetland assessment model should be strongly considered unless the site was formerly a tidal wetland prior to hydrologic modification.*	0.0

5. $V_{TYPICAL}$ Percent cover by typical plant species within the WAA 92.25 %

(1) Visually estimate the percentage of the site that is covered by nontypical, nonnative, or otherwise undesirable plant species (see Table B6). Subtract this number from 100 to estimate the percentage of the site that is occupied by plant species typical of the regional subclass. See the subclass profile in Chapter 2 for additional information. Appendix D also lists typical plant species that occur in saline, brackish, and intermediate marshes along the Texas coast.

Table B6
Possible Invasive or Undesirable Plant Species

Scientific Name	Common name	Salt/Brackish	Intermediate
Alternanthera philoxeroides	Alligator weed		L
Aster spinosus	Spiny aster		H
Phragmites australis	Common reed	H	L,H
Sesbania drummondii	Drummond's rattlebush		L,H
Typha spp.	Cattail	L	L
H = high marsh, L = low marsh.			

(2) Assign variable subindex based on Figure B1 *Subindex* 1.0

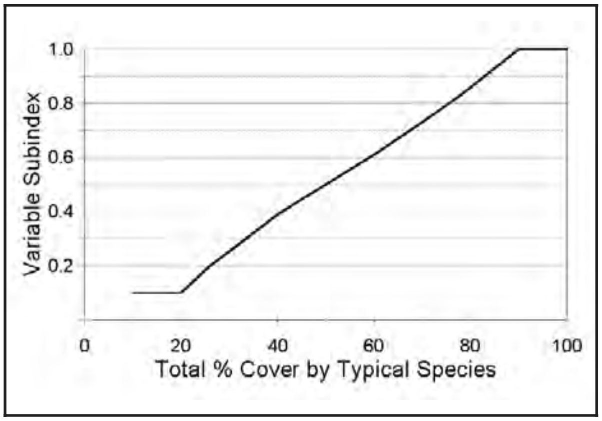


Figure B1. Relationship between percent cover by typical plant species and functional capacity

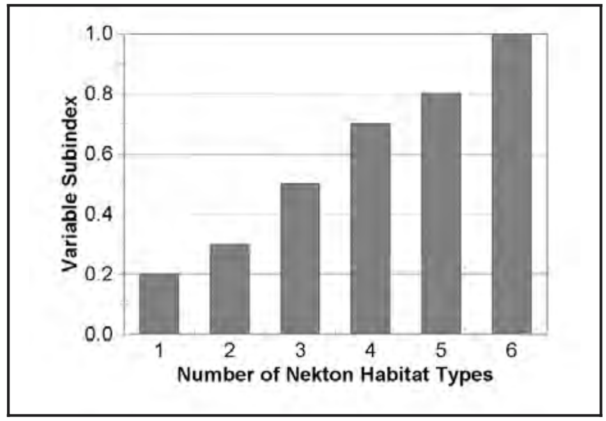


Figure B2. Relationship between nekton habitat complexity and functional capacity

6. V_{NHC} Nekton Habitat Complexity (# different habitat types)

(1) Check the habitats observed on or within a 30-m (100-ft) radius of project area perimeter.

Coarse woody debris	______	Unvegetated flats	X	Algal mats	X
Subtidal creeks/channels	______	Oyster reef	X	Mangroves	X
Intertidal creeks/channels	______	Low marsh	X	High marsh	______
Ponds or depressions	______	Submerged aquatic vegetation	X		

(2) Assign variable subindex based on the chart in Figure B2. *Subindex* 1.0

7. V_{WHC} Wildlife Habitat Complexity (total # different habitat types)

(1) Check those habitat types **IN ADDITION TO THOSE LISTED ABOVE** that are present on or within a 2-km radius of the project area perimeter.

Supratidal habitats (hummocks, logs)	X	Scrub-Shrub	X	Forested uplands	_____
Unvegetated beach	________	Grasslands	X		

*Note: Also present within 2 km radius include high marsh, subtidal channels, supratidal, and woody debris.

(2) Assign variable subindex based on the chart in Figure B3. *Subindex* 1.0

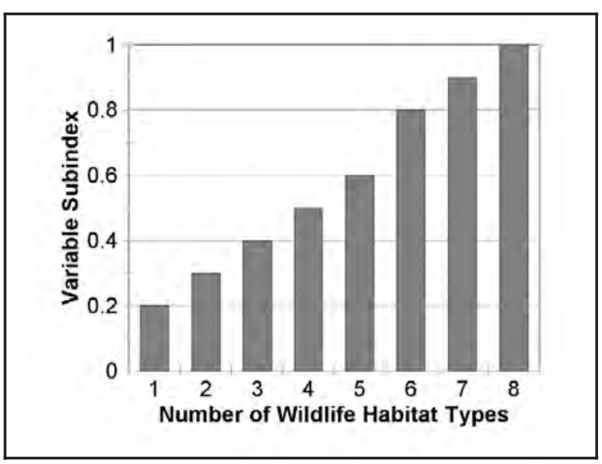


Figure B3. Relationship between wildlife habitat complexity and functional capacity

8. V_{ROUGH} Surface roughness (Manning's n)

(1) Choose a value for each of the three variables in the equation below based on the descriptions provided in Table B7.

$$\underline{0.025} + \underline{0.001} + \underline{0.160} = \underline{0.186}$$
$$n_{BASE} + n_{TOPO} + n_{VEG} = n$$

(2) Compute the sum of the three variables in the equation above.

(3) Assign variable subindex based on the chart in Figure B4. *Subindex* 1.0

Table B7
Relationship Between Roughness and Functional Capacity

Roughness Component	Adjustment to *n* Value			Description of Terms
Sediment surface (n_{BASE})	0.025			Base value for bare marsh soil.
	0.03			More than 25% of sediment surface covered with gravel or broken shell.
Topographic relief (n_{TOPO})	0.001			Representative area is flat with essentially no microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds).
	0.005			Microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds) cover 5-25% of a representative area.
	0.010			Microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds) cover 26-50% of a representative area.
	0.020			Microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds) cover >50% of a representative area.
Roughness Component	**Percent Cover**			
	<50	**50-75**	**76-100**	**Description of Conditions**
Vegetation (n_{VEG})	0.025	0.030	0.035	Representative area predominantly short, flexible-stemmed grasses (i.e., short *Spartina alterniflora, S. patens, Distichlis spicata*).
	0.035	0.040	0.050	Vegetation in representative area predominantly short, with stiff, trailing stems (i.e., *Batis maritima*, *Salicornia virginica*).
	0.050	0.060	0.070	Representative area predominantly tall, flexible-stemmed grasses (i.e., tall *Spartina alterniflora, S. cynosuroides, Scirpus sp.*).
	0.070	0.100	0.160	Vegetation in representative area predominantly tall, with stiff leaves (i.e., *Juncus roemerianus*) or mixed woody shrubs (i.e., mangroves).

Note: Adapted from Arcement and Schneider (1989) and Gardiner and Dakombe (1983).

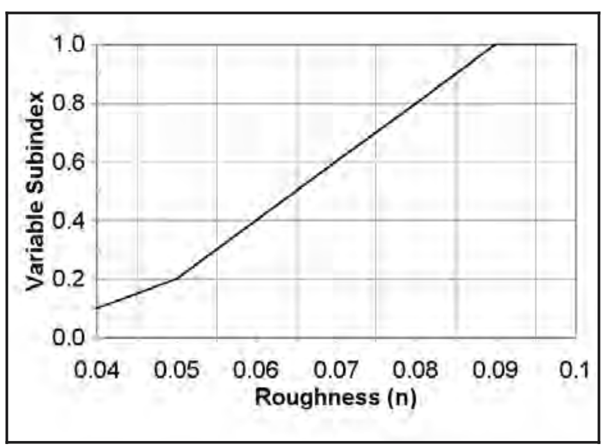


Figure B4. Relationship between surface roughness (n) and functional capacity

Sample variables 9 and 10 based on a representative number of locations in the WAA using a series of 1-m^2 plots arranged along one or more 30-m (100-ft) transects oriented perpendicular to the wetland shoreline or the hydrologic gradient.

9. V_{COVER} Mean Total Percent Vegetative Cover 78.0 %

(1) Select one or more representative areas within the site for sampling. Beginning at the shoreward edge of the marsh, establish one or more 30-m transects perpendicular to the shoreline or along the hydrologic gradient (e.g. increasing elevation). If there are multiple vegetation community types within the WAA, the transect should intersect each vegetation community, in order to ensure a representative sample.

(2) Using a standard 1-m^2 frame, estimate total percent cover by **both live and dead** emergent macrophytic plant species at intervals along the transect, excluding any areas where water depths are too deep to support the growth of emergent vegetation. The number of transects and plots needed will depend on the size and heterogeneity of the site; **a minimum of 10 plots should be used**.

(3) Calculate the average of all total percent cover estimates.

(4) Assign variable subindex for V_{COVER} based on the chart in Figure B5. *Subindex* 1.0

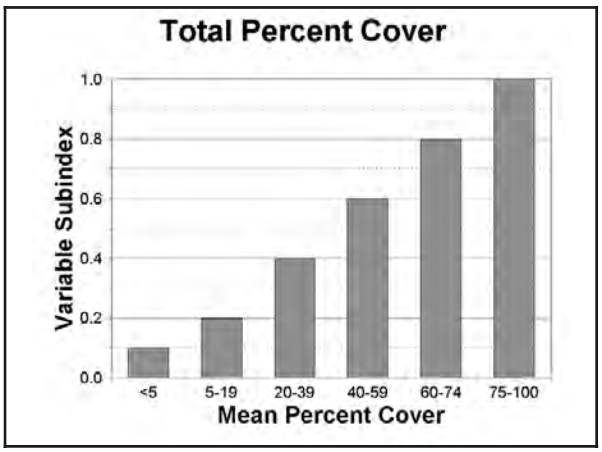


Figure B5. Relationship between mean total percent cover and functional capacity

10. V_{VEGSTR} Mean Vegetative Structure Index

(4) If the 1-m^2 sample plot above contains more than one species (i.e., *Spartina* and *Distichlis*), estimate the proportion of the 1-m^2 plot area covered by each species, omitting any species that occupies <10% cover. If the total percent cover above was estimated at 80%, the sum of the percent cover of each individual species should be 80%. There may be cases where there are several species that individually account for <10% cover, but collectively amount to 10%. In these cases, estimate the cumulative percent cover for the species group.

(5) For each species identified above, estimate the height in centimeters (rounded to the nearest 5 cm) at which the bulk of the biomass occurs (i.e., the most frequently occurring height) and record this value. For those species with trailing stems, the height should be measured in situ rather than extended vertically. Record an estimated height for the species group, if necessary.

(6) Calculate a vegetative structure index for **each** plot using the equation below.

$$V_{VEGSTR} = ((Hgt_1 \times Proportion_1) + (Hgt_2 \times Proportion_2) + \ldots\ldots (Hgt_x \times Proportion_x))$$

where: x = # plant species per plot.

$[(\_\_\_\_\_ \times \_\_\_\_\_) + (\_\_\_\_\_ \times \_\_\_\_\_) + (\_\_\_\_\_ \times \_\_\_\_\_)] = \_\_\_\_\_\_$

(7) Compute the sum of all the vegetative structure indices generated above. ________

(8) Divide by the total number of plots to determine the mean. ________

(9) Assign a subindex value based on the chart in Figure B6. *Subindex* 1.0*

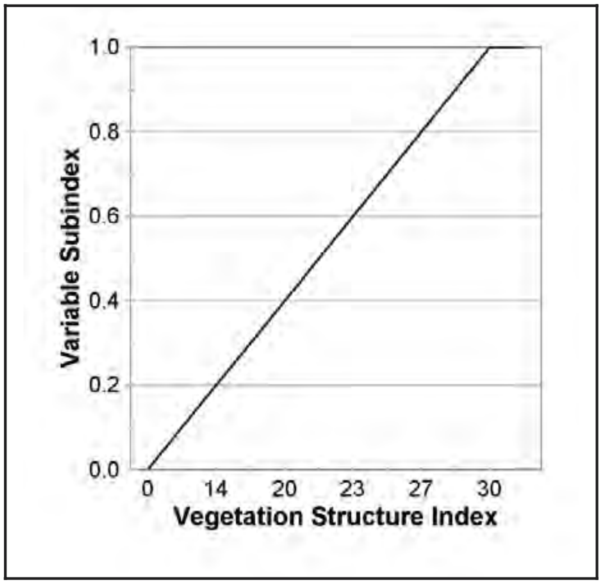


Figure B6. Relationship between vegetation structure index and functional capacity

*Note: No direct vegetative height field measurement data collected for any species. Vegetative Structure Index assumed to be >30 = 1.0 Variable Subindex.

Variables 11-14 are assessed only for the Shoreline Stabilization Function.

First, conduct a field site inspection and determine if there are any visual indicators of shoreline erosion within the project area. Examples of this include slumping banks, undercut banks, exposed root mats, or vertical bluffs along the shoreline (See Figure D1 for examples). If any of these features exist, assign a variable subindex to each of the following variables using the procedures outlined below and calculate a functional capacity index for this function. Otherwise, assign a default functional capacity index of 1.0 to this function, indicating the presence of a stable, non-eroding shoreline.

11. V_{WIDTH} Mean width of the marsh

(1) Using a recent aerial photo or direct field survey, establish a baseline along the lengthwise axis that runs roughly parallel to the shoreline and/or perpendicular to the topographic gradient.

(2) Draw a series of transects perpendicular to this baseline from the shoreline to the nearest upland and measure or estimate the average width of the marsh in meters (Figure 4). The number of transects is determined by the length of the baseline (Table B8).

Table B8
Number of Transects for Estimating Mean Marsh Width

Baseline Length (m)	Number of Transects
<300	3
300-1,500	5
1,500-3,000	7
>3,000	9

1____ m 2 ____ m 3 ____ m 4 ____ m 5____ m *Note: Mean marsh width = 67.43 m

(3) Determine the average of the widths recorded above.

(4) Assign a variable subindex based on Figure B7. *Subindex* 0.6

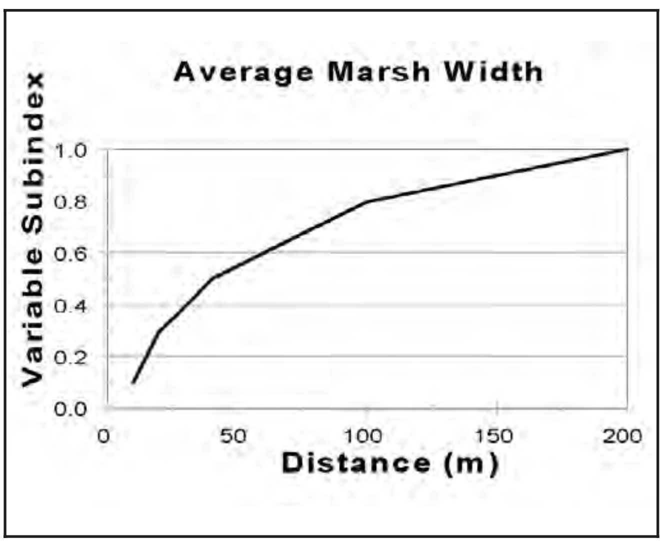


Figure B7. Relationship between average marsh width and functional capacity

12. V_{EXPOSE} Relative Exposure Index (REI)

(1) Measure fetch distances in kilometers for each of the 16 possible compass bearings.

(2) Using the map in Figure 3 in the main text (page 22), select the wind data station closest to your site.

(3) Using the supplemental information in Table E1 on mean annual wind speeds, calculate an REI using the equation below.

$$\text{Relative Exposure Index} = \sum_{i=1}^{16} V_i \times F_i \times P_i$$

where:

V_i = mean annual wind speed (km/hr)

F_i = fetch distance (km)

P_i = proportion of time wind blew from each of 16 cardinal and subcardinal compass directions

*Note: Relative Exposure Index (RSI) = 16.98.

(4) Assign variable subindex based on Figure B8. *Subindex* 0.8

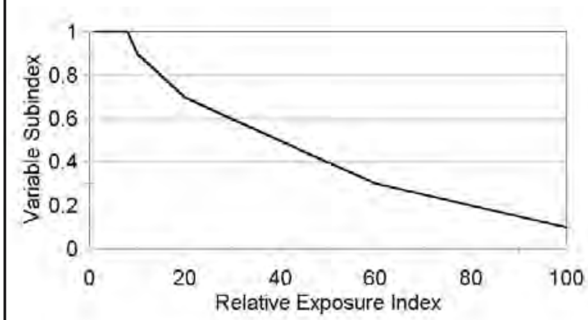


Figure B8. Relationship between relative exposure index and functional capacity

13. V_{SLOPE} Distance to navigation channel OR water depths ≥2 m *Subindex* 1.0

Table B9
Relationship Between Shoreline Slope and Functional Capacity

Distance	Subindex
<50 m	0.1
50-150 m	0.5
>150 m	1.0

*Note: Distance to water depth of 2 m = 154 m.

14. V_{SOIL} Soil texture *Subindex* 0.4

Table B10
Relationship Between Soil Type and Functional Capacity

Predominant Soil Type	Subindex
Clay	1.0
Clay loam	0.8
Loam	0.6
Sandy loam	0.4
Sandy	0.2

TIDAL FRINGE MARSH HGM FUNCTIONAL ASSESSMENT

Sediment Deposition = $(V_{ROUGH} \times V_{HYDRO})^{1/2}$

(__1.0______ × __1.0______) $^{1/2}$ = __1.0______

Resident Nekton Utilization = $(V_{EDGE} + 2\ V_{HYDRO} + 0.5\ V_{NHC})\ /\ 3.5$

(__1.0______ + 2 __1.0______ + __1.0__ /2) / 3.5 = __1.0______

Nonresident Nekton Utilization = $[(V_{EDGE} + 2\ V_{HYDRO} + 0.5\ V_{NHC})\ /\ 3.5)\ V_{OMA}]^{1/2}$

[(__1.0______ + 2 __1.0______ + 0.5 __1.0______ / 3.5) × __1.0__ $]^{1/2}$ = __0.934______

Invertebrate Prey Pool = $(V_{HYDRO} + V_{EDGE} + V_{COVER})\ /\ 3$

(__1.0______ + __1.0______ + __1.0______) / 3 = __1.0______

Nutrient and Organic Carbon Exchange = $(V_{VEGSTR} \times V_{HYDRO})^{1/2}$

(__1.0______ × __1.0______ $)^{1/2}$ = __1.0______

Maintain Characteristic Plant Community Composition = V_{C0VER} or $V_{TYPICAL}$, whichever is lower

Min (__1.0______ or __1.0______) = __1.0______

Plant Biomass Production = V_{VEGSTR} = __1.0________________

Provide Wildlife Habitat = $[\ 2\ V_{SIZE} + V_{WHC} + (\mathrm{Min}\ (V_{COVER}\ \mathrm{OR}\ V_{TYPICAL})\ )]\ /\ 4$

(2 __0.75______ + __1.0______ + __1.0______) / 4 = __0.875______

Shoreline Stabilization = $(V_{SLOPE} + V_{WIDTH} + V_{EXPOSE} + V_{ROUGH} + V_{SOIL})\ /\ 5$

(__1.0______ + __0.6______ + __0.8______ + __1.0______ + __0.4______) / 5 = __0.76______

FIELD DATA SHEET:
NORTHWEST GULF OF MEXICO TIDAL FRINGE MARSHES

Assessment Team: Triton Environmental Solutions

Project Name/Location: Channel Deepening Project/SS2 E2EM1P **Date:** 06/25/2023

Prior to conducting an assessment, establish the project area boundaries and delineate the wetland boundaries within the project area.

Sample variables 1-3 using aerial photos at a scale of 1 cm = 48 m (1: 4800 or 1 in. = 400 ft, digital ortho-photo quadrangle imagery, maps, etc.)

1. V_{EDGE} Degree of marsh dissection/edge:area ratio *Subindex* 0.7

(1) Using either the quantitative or qualitative approach, measure or estimate the edge:area ratio and assign a subindex value based on Table B1. See pictorial key in Appendix D (Figures D2-D9) for specific examples.

Table B1
Relationship Between Edge:Area and Functional Capacity

	Edge:Area		
Site Description	**Qualitative**	**Quantitative m/ha**	**Subindex**
1) Marsh shows signs of deterioration due to subsidence (i.e., highly fragmented with large amounts of open water. Vegetation occurs mainly in isolated hummocks or on natural levees along tidal creeks). Although edge:area is very high, this condition is not considered sustainable in the long term (Figure D2).	Very High	>800	0.8
1) Well-developed tidal drainage network present (Figure D3), OR **2)** Simple tidal drainage network (may consist of only a single channel) present with isolated ponds and depressions present in the marsh interior (Figures D4 and D5). **3)** Atypical geomorphic configuration with a large amount of shoreline relative to total area (i.e. small island or narrow peninsula) (Figure D7).	High	350-800	1.0
1) Simple tidal drainage network (may consist of only a single channel). Isolated ponds and depressions are few or lacking, OR **2)** Narrow fringe marsh that lacks tidal creeks. One lengthwise shoreline is exposed to tidal waters. Area of marsh is small relative to shoreline length (Figures D6 and D8).	Moderate	200-350	0.7
Marsh lacks both tidal creeks and isolated ponds and depressions. Shoreline is generally linear or smooth curvilinear without embayments or convolutions. Area of marsh is large relative to shoreline length (Figure D9).	Low	<200	0.4

*Note: Simple drainage network consisting of few channels and ponds/depressions.

2. V_{OMA} Proportion of tidally connected edge to total edge *Subindex* 0.2

(1) Assign subindex value based on Table B2.

Table B2
Relationship Between Opportunity for Marsh Access and Functional Capacity

Tidally Connected Edge: Total Edge	Subindex
❑ 50-100%	1.0
❑ 35-50%	0.7
❑ 25-35%	0.5
☒ 1-25%	0.2
❑ No tidally connected edge present	0.0

3. V_{SIZE} Total Effective Patch Size *Subindex* 1.0

(1) If the core wetland size exceeds 200 ha, assign a variable subindex value of 1.0. The core wetland is defined as a contiguous patch of tidal fringe wetland that contains the WAA.

(2) If the core wetland size <200 ha, identify other patches of wetlands in the surrounding area, and record the size of each patch in hectares. These wetlands may be in a wetland subclass other than tidal fringe. Then, using the descriptions provided in Table B3, determine the degree of connectivity between each wetland patch and the core wetland.

Table B3
Determination of Corridor Connectivity

Corridor Type	Corridor Description	Multiplier
Contiguous corridor	**1)** Open water stretches <60 m (regardless of depth). **2)** Unvegetated stretches of shoreline or strips of other wetland subclasses <60 m in length that have an aquatic shelf at least 3 m wide and are <0.3 m deep at MSL. This discounts most tidal creeks and coves or unvegetated stretches of shoreline abutting uplands as barriers to wildlife that are traveling through their daily home range.	1.00
Partially impeded corridor	**1)** Open water stretches from 60-300 m (regardless of depth). **2)** Unvegetated shorelines or strips of other wetland subclasses from 60-500 m in length that have an aquatic shelf at least 3 m wide with water depths <0.3 m at MSL. Deeper stretches of water that interrupt the shelves are not considered impeding if they are <60 m wide. **3)** Stretches of undeveloped upland that are <30 m in width.	0.75
Impeded corridor	**1)** Shoreline shelves or wetland strips between 500-1200 m long. **2)** Stretches of undeveloped upland 30-300 m in width.	0.50
Corridor absent or barrier present	**1)** Open water stretches or undeveloped uplands >300 m in width. **2)** Shorelines >300 m long that contain no shelf with waters <0.3 m deep (i.e., long stretches of bulkheading). **3)** Roadways with >100 vehicle crossings per day that are unbridged or have a bridge opening <3 m wide. **4)** Highly developed urban, residential, or industrial areas.	0.0

(3) Multiply the size of the patch (ha) by the appropriate connectivity multiplier from the table above.

Size of Wetland (hectares)		Connectivity Multiplier	Product
Core wetland	279.5	1.0	1.0 (279.5)
Patch A	______	______	______
Patch B	______	______	
Patch C	______	______	______
Patch D	______	______	______
Patch E	______	______	______

(4) Obtain the sum of all the products above. SUM 279.5

(5) Using Table B4, assign a variable subindex based on the value of the sum calculated above.

Table B4
Relationship Between Total Effective Patch Size and Functional Capacity

Total Effective Patch Size	Subindex
>200 ha	1.00
5-200 ha	0.75
1-5 ha	0.50
0.2-1 ha	0.25
<0.2 ha	0.10

Sample variables 4-8 based on an onsite field inspection of the project area and WAA.

4. V_{HYDRO} Hydrologic regime *Subindex* 0.6

(1) Assign subindex value based on Table B5.

Table B5
Relationship Between Hydrologic Regime and Functional Capacity

Site Condition	Subindex
Site is open to free exchange of tidal waters. No obvious hydrologic alteration or restrictions present.	1.0
Moderate hydrologic restriction present (i.e., presence of low-elevation berm, which is frequently overtopped by high tide events or has multiple breaches or large culverts).	0.6
Severe hydrologic restriction present (i.e., presence of high-elevation berm, which is infrequently overtopped by high tide events or has a single opening, breach or small culvert).	0.3
Site receives tidal floodwaters only during extreme storm tide events.	0.1
Site is isolated from tidal exchange. The principal source of flooding is water sources other than tidal action (i.e., precipitation or groundwater). *Note: If this condition exists, another wetland assessment model should be strongly considered unless the site was formerly a tidal wetland prior to hydrologic modification.*	0.0

*Note: Presence of berm, bulkheading, and revetment restricts free exchange. Several breaches present.

5. $V_{TYPICAL}$ Percent cover by typical plant species within the WAA 97.5 %

(1) Visually estimate the percentage of the site that is covered by nontypical, nonnative, or otherwise undesirable plant species (see Table B6). Subtract this number from 100 to estimate the percentage of the site that is occupied by plant species typical of the regional subclass. See the subclass profile in Chapter 2 for additional information. Appendix D also lists typical plant species that occur in saline, brackish, and intermediate marshes along the Texas coast.

Table B6
Possible Invasive or Undesirable Plant Species

Scientific Name	Common name	Salt/Brackish	Intermediate
Alternanthera philoxeroides	Alligator weed		L
Aster spinosus	Spiny aster		H
Phragmites australis	Common reed	H	L,H
Sesbania drummondii	Drummond's rattlebush		L,H
Typha spp.	Cattail	L	L
H = high marsh, L = low marsh.			

(2) Assign variable subindex based on Figure B1 *Subindex* 1.0

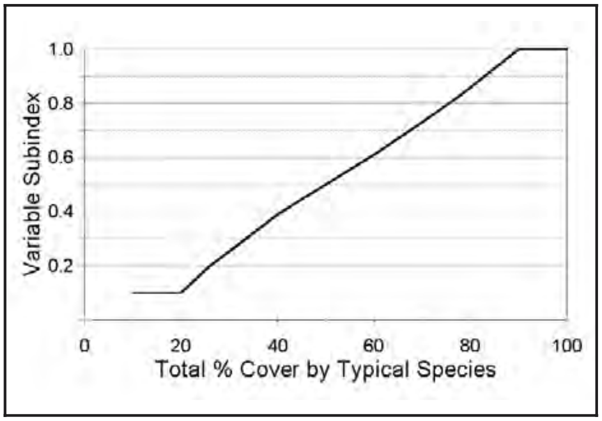


Figure B1. Relationship between percent cover by typical plant species and functional capacity

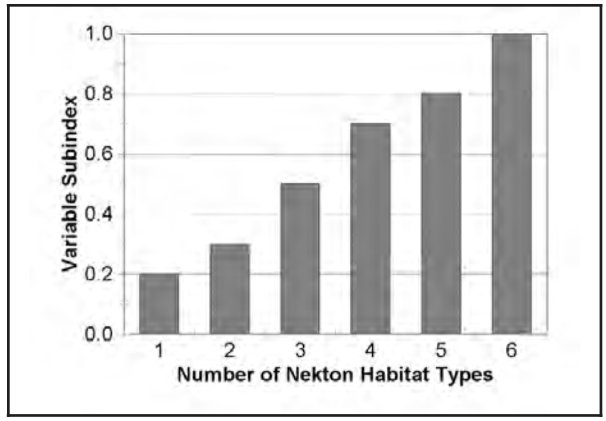


Figure B2. Relationship between nekton habitat complexity and functional capacity

6. V_{NHC} Nekton Habitat Complexity (# different habitat types)

(1) Check the habitats observed on or within a 30-m (100-ft) radius of project area perimeter.

Coarse woody debris	______	Unvegetated flats	X	Algal mats	X
Subtidal creeks/channels	______	Oyster reef	______	Mangroves	X
Intertidal creeks/channels	______	Low marsh	X	High marsh	X
Ponds or depressions	X	Submerged aquatic vegetation	_____		

(2) Assign variable subindex based on the chart in Figure B2. *Subindex* 1.0

7. V_{WHC} Wildlife Habitat Complexity (total # different habitat types)

(1) Check those habitat types **IN ADDITION TO THOSE LISTED ABOVE** that are present on or within a 2-km radius of the project area perimeter.

Supratidal habitats (hummocks, logs)	X	Scrub-Shrub	X	Forested uplands	_____
Unvegetated beach	________	Grasslands	X		

*Note: Also present within 2 km radius include subtidal channels, SAV, oyster, and woody debris.

(2) Assign variable subindex based on the chart in Figure B3. *Subindex* 1.0

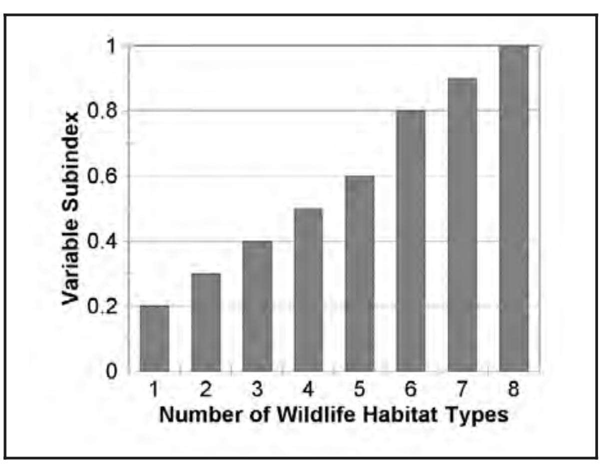


Figure B3. Relationship between wildlife habitat complexity and functional capacity

8. V_{ROUGH} Surface roughness (Manning's n)

(1) Choose a value for each of the three variables in the equation below based on the descriptions provided in Table B7.

$$\underline{0.025} + \underline{0.001} + \underline{0.035} = \underline{0.061}$$
$$n_{BASE} + n_{TOPO} + n_{VEG} = n$$

(2) Compute the sum of the three variables in the equation above.

(3) Assign variable subindex based on the chart in Figure B4. *Subindex* 0.4

Table B7
Relationship Between Roughness and Functional Capacity

<table>
<tr><th>Roughness Component</th><th colspan="3">Adjustment to n Value</th><th>Description of Terms</th></tr>
<tr><td rowspan="2">Sediment surface (n_{BASE})</td><td colspan="3">0.025</td><td>Base value for bare marsh soil.</td></tr>
<tr><td colspan="3">0.03</td><td>More than 25% of sediment surface covered with gravel or broken shell.</td></tr>
<tr><td rowspan="4">Topographic relief (n_{TOPO})</td><td colspan="3">0.001</td><td>Representative area is flat with essentially no microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds).</td></tr>
<tr><td colspan="3">0.005</td><td>Microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds) cover 5-25% of a representative area.</td></tr>
<tr><td colspan="3">0.010</td><td>Microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds) cover 26-50% of a representative area.</td></tr>
<tr><td colspan="3">0.020</td><td>Microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds) cover >50% of a representative area.</td></tr>
<tr><th rowspan="2">Roughness Component</th><th colspan="3">Percent Cover</th><th rowspan="2">Description of Conditions</th></tr>
<tr><th><50</th><th>50-75</th><th>76-100</th></tr>
<tr><td rowspan="4">Vegetation (n_{VEG})</td><td>0.025</td><td>0.030</td><td>0.035</td><td>Representative area predominantly short, flexible-stemmed grasses (i.e., short Spartina alterniflora, S. patens, Distichlis spicata).</td></tr>
<tr><td>0.035</td><td>0.040</td><td>0.050</td><td>Vegetation in representative area predominantly short, with stiff, trailing stems (i.e., Batis maritima, Salicornia virginica).</td></tr>
<tr><td>0.050</td><td>0.060</td><td>0.070</td><td>Representative area predominantly tall, flexible-stemmed grasses (i.e., tall Spartina alterniflora, S. cynosuroides, Scirpus sp.).</td></tr>
<tr><td>0.070</td><td>0.100</td><td>0.160</td><td>Vegetation in representative area predominantly tall, with stiff leaves (i.e., Juncus roemerianus) or mixed woody shrubs (i.e., mangroves).</td></tr>
<tr><td colspan="5">Note: Adapted from Arcement and Schneider (1989) and Gardiner and Dakombe (1983).</td></tr>
</table>

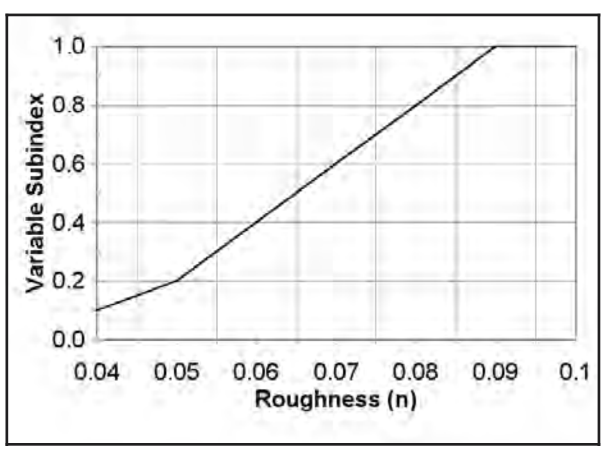


Figure B4. Relationship between surface roughness (n) and functional capacity

Sample variables 9 and 10 based on a representative number of locations in the WAA using a series of 1-m^2 plots arranged along one or more 30-m (100-ft) transects oriented perpendicular to the wetland shoreline or the hydrologic gradient.

9. V_{COVER} Mean Total Percent Vegetative Cover 86.7 %

(1) Select one or more representative areas within the site for sampling. Beginning at the shoreward edge of the marsh, establish one or more 30-m transects perpendicular to the shoreline or along the hydrologic gradient (e.g. increasing elevation). If there are multiple vegetation community types within the WAA, the transect should intersect each vegetation community, in order to ensure a representative sample.

(2) Using a standard 1-m^2 frame, estimate total percent cover by **both live and dead** emergent macrophytic plant species at intervals along the transect, excluding any areas where water depths are too deep to support the growth of emergent vegetation. The number of transects and plots needed will depend on the size and heterogeneity of the site; **a minimum of 10 plots should be used**.

(3) Calculate the average of all total percent cover estimates.

(4) Assign variable subindex for V_{COVER} based on the chart in Figure B5. *Subindex* 1.0

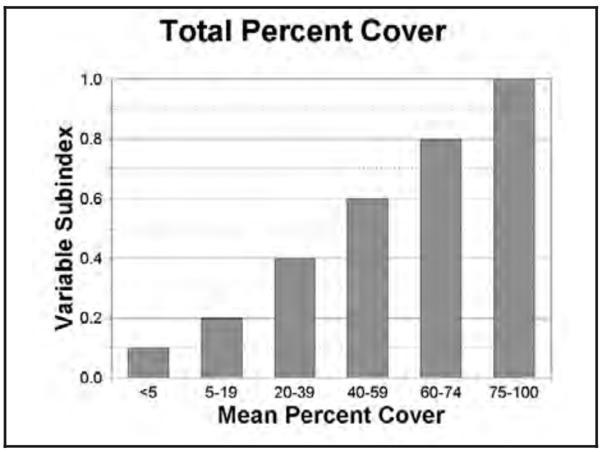


Figure B5. Relationship between mean total percent cover and functional capacity

10. V_{VEGSTR} Mean Vegetative Structure Index

(4) If the 1-m^2 sample plot above contains more than one species (i.e., *Spartina* and *Distichlis*), estimate the proportion of the 1-m^2 plot area covered by each species, omitting any species that occupies <10% cover. If the total percent cover above was estimated at 80%, the sum of the percent cover of each individual species should be 80%. There may be cases where there are several species that individually account for <10% cover, but collectively amount to 10%. In these cases, estimate the cumulative percent cover for the species group.

(5) For each species identified above, estimate the height in centimeters (rounded to the nearest 5 cm) at which the bulk of the biomass occurs (i.e., the most frequently occurring height) and record this value. For those species with trailing stems, the height should be measured in situ rather than extended vertically. Record an estimated height for the species group, if necessary.

(6) Calculate a vegetative structure index for **each** plot using the equation below.

V_{VEGSTR} = ((Hgt$_1$ × Proportion$_1$) + (Hgt$_2$ × Proportion$_2$) + ... (Hgt$_x$ × Proportion$_x$))

where: x = # plant species per plot.

[(_____ × _____) + (_____ × _____) + (_____ × _____)] = _______

(7) Compute the sum of all the vegetative structure indices generated above. _________

(8) Divide by the total number of plots to determine the mean. _________

(9) Assign a subindex value based on the chart in Figure B6. *Subindex* 1.0*

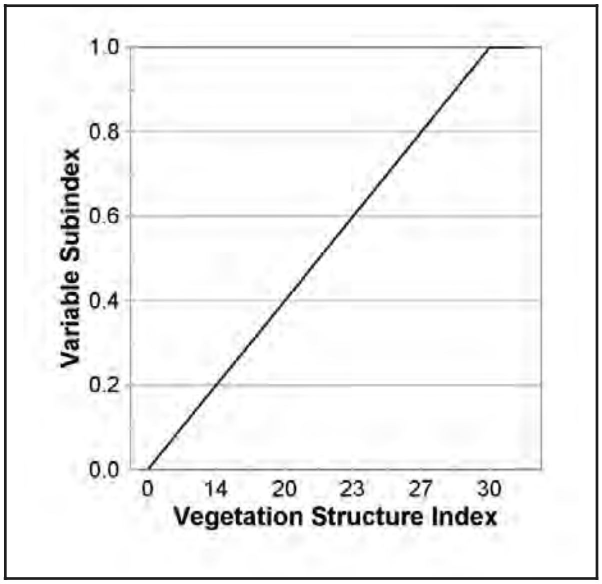


Figure B6. Relationship between vegetation structure index and functional capacity

*Note: No direct vegetative height field measurement data collected for any species. Vegetative Structure Index assumed to be >30 = 1.0 Variable Subindex.

Variables 11-14 are assessed only for the Shoreline Stabilization Function.

First, conduct a field site inspection and determine if there are any visual indicators of shoreline erosion within the project area. Examples of this include slumping banks, undercut banks, exposed root mats, or vertical bluffs along the shoreline (See Figure D1 for examples). If any of these features exist, assign a variable subindex to each of the following variables using the procedures outlined below and calculate a functional capacity index for this function. Otherwise, assign a default functional capacity index of 1.0 to this function, indicating the presence of a stable, non-eroding shoreline.

11. V_{WIDTH} Mean width of the marsh

(1) Using a recent aerial photo or direct field survey, establish a baseline along the lengthwise axis that runs roughly parallel to the shoreline and/or perpendicular to the topographic gradient.

(2) Draw a series of transects perpendicular to this baseline from the shoreline to the nearest upland and measure or estimate the average width of the marsh in meters (Figure 4). The number of transects is determined by the length of the baseline (Table B8).

Table B8
Number of Transects for Estimating Mean Marsh Width

Baseline Length (m)	Number of Transects
<300	3
300-1,500	5
1,500-3,000	7
>3,000	9

1____ m 2 ____ m 3 ____ m 4 ____ m 5____ m *Note: Mean marsh width = 12.65 m

(3) Determine the average of the widths recorded above.

(4) Assign a variable subindex based on Figure B7. *Subindex* 0.2

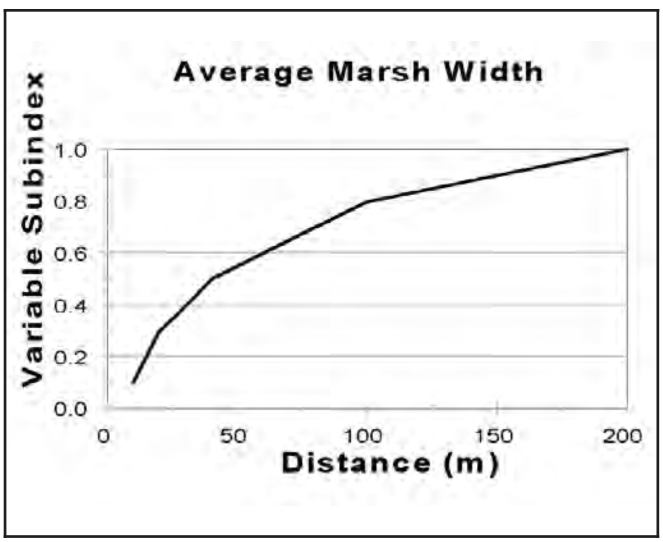


Figure B7. Relationship between average marsh width and functional capacity

12. V_{EXPOSE} Relative Exposure Index (REI)

(1) Measure fetch distances in kilometers for each of the 16 possible compass bearings.

(2) Using the map in Figure 3 in the main text (page 22), select the wind data station closest to your site.

(3) Using the supplemental information in Table E1 on mean annual wind speeds, calculate an REI using the equation below.

$$\text{Relative Exposure Index} = \sum_{i=1}^{16} V_i \times F_i \times P_i$$

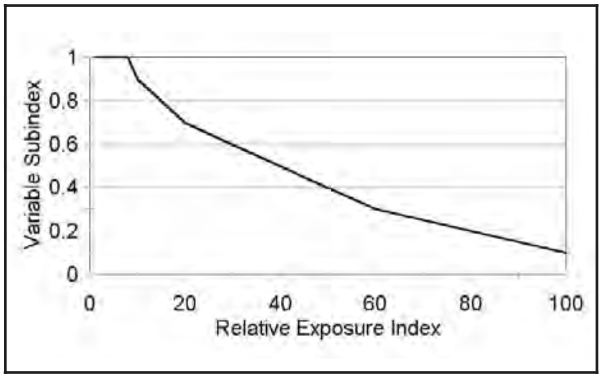
where:

- V_i = mean annual wind speed (km/hr)
- F_i = fetch distance (km)
- P_i = proportion of time wind blew from each of 16 cardinal and subcardinal compass directions

*Note: Relative Exposure Index (RSI) = 9.68

(4) Assign variable subindex based on Figure B8. *Subindex* 0.9

Figure B8. Relationship between relative exposure index and functional capacity



13. V_{SLOPE} Distance to navigation channel OR water depths ≥2 m *Subindex* 1.0

Table B9
Relationship Between Shoreline Slope and Functional Capacity

Distance	Subindex
<50 m	0.1
50-150 m	0.5
>150 m	1.0

*Note: Distance to navigation channel = 225.5 m.

14. V_{SOIL} Soil texture *Subindex* 0.4

Table B10
Relationship Between Soil Type and Functional Capacity

Predominant Soil Type	Subindex
Clay	1.0
Clay loam	0.8
Loam	0.6
Sandy loam	0.4
Sandy	0.2

TIDAL FRINGE MARSH HGM FUNCTIONAL ASSESSMENT

Sediment Deposition = $(V_{ROUGH} \times V_{HYDRO})^{1/2}$

(0.4 × 0.6) $^{1/2}$ = 0.489

Resident Nekton Utilization = $(V_{EDGE} + 2\ V_{HYDRO} + 0.5\ V_{NHC})$ / 3.5

(0.7 + 2 0.6 + 1.0 /2) / 3.5 = 0.686

Nonresident Nekton Utilization = $[(V_{EDGE} + 2\ V_{HYDRO} + 0.5\ V_{NHC}) / 3.5)\ V_{OMA}]^{1/2}$

[(0.7 + 2 0.6 + 0.5 1.0 / 3.5) × 0.2]$^{1/2}$ = 0.334

Invertebrate Prey Pool = $(V_{HYDRO} + V_{EDGE} + V_{COVER})$ / 3

(0.6 + 0.7 + 1.0) / 3 = 0.767

Nutrient and Organic Carbon Exchange = $(V_{VEGSTR} \times V_{HYDRO})^{1/2}$

(1.0 × 0.6)$^{1/2}$ = 0.775

Maintain Characteristic Plant Community Composition = V_{C0VER} or $V_{TYPICAL}$, whichever is lower

Min (1.0 or 1.0) = 1.0

Plant Biomass Production = V_{VEGSTR} = 1.0

Provide Wildlife Habitat = [2 V_{SIZE} + V_{WHC} + (Min (V_{COVER} OR $V_{TYPICAL}$))] / 4

(2 1.0 + 1.0 + 1.0) / 4 = 1.0

Shoreline Stabilization = $(V_{SLOPE} + V_{WIDTH} + V_{EXPOSE} + V_{ROUGH} + V_{SOIL})$ / 5

(1.0 + 0.2 + 0.9 + 0.4 + 0.4) / 5 = 0.58

FIELD DATA SHEET:
NORTHWEST GULF OF MEXICO TIDAL FRINGE MARSHES

Assessment Team: Triton Environmental Solutions

Project Name/Location: Channel Deepening Project/SS2 E2SS3N **Date:** 06/25/2023

Prior to conducting an assessment, establish the project area boundaries and delineate the wetland boundaries within the project area.

Sample variables 1-3 using aerial photos at a scale of 1 cm = 48 m (1: 4800 or 1 in. = 400 ft, digital ortho-photo quadrangle imagery, maps, etc.)

1. V_{EDGE} Degree of marsh dissection/edge:area ratio *Subindex* 0.7

(1) Using either the quantitative or qualitative approach, measure or estimate the edge:area ratio and assign a subindex value based on Table B1. See pictorial key in Appendix D (Figures D2-D9) for specific examples.

Table B1
Relationship Between Edge:Area and Functional Capacity

	Edge:Area		
Site Description	**Qualitative**	**Quantitative m/ha**	**Subindex**
1) Marsh shows signs of deterioration due to subsidence (i.e., highly fragmented with large amounts of open water. Vegetation occurs mainly in isolated hummocks or on natural levees along tidal creeks). Although edge:area is very high, this condition is not considered sustainable in the long term (Figure D2).	Very High	>800	0.8
1) Well-developed tidal drainage network present (Figure D3), OR **2)** Simple tidal drainage network (may consist of only a single channel) present with isolated ponds and depressions present in the marsh interior (Figures D4 and D5). **3)** Atypical geomorphic configuration with a large amount of shoreline relative to total area (i.e. small island or narrow peninsula) (Figure D7).	High	350-800	1.0
1) Simple tidal drainage network (may consist of only a single channel). Isolated ponds and depressions are few or lacking, OR **2)** Narrow fringe marsh that lacks tidal creeks. One lengthwise shoreline is exposed to tidal waters. Area of marsh is small relative to shoreline length (Figures D6 and D8).	Moderate	200-350	0.7
Marsh lacks both tidal creeks and isolated ponds and depressions. Shoreline is generally linear or smooth curvilinear without embayments or convolutions. Area of marsh is large relative to shoreline length (Figure D9).	Low	<200	0.4

*Note: Simple drainage network consisting of few channels and ponds/depressions.

2. V_{OMA} Proportion of tidally connected edge to total edge *Subindex* 0.2

(1) Assign subindex value based on Table B2.

Table B2
Relationship Between Opportunity for Marsh Access and Functional Capacity

Tidally Connected Edge: Total Edge	Subindex
❑ 50-100%	1.0
❑ 35-50%	0.7
❑ 25-35%	0.5
☒ 1-25%	0.2
❑ No tidally connected edge present	0.0

3. V_{SIZE} Total Effective Patch Size *Subindex* 1.0

(1) If the core wetland size exceeds 200 ha, assign a variable subindex value of 1.0. The core wetland is defined as a contiguous patch of tidal fringe wetland that contains the WAA.

(2) If the core wetland size <200 ha, identify other patches of wetlands in the surrounding area, and record the size of each patch in hectares. These wetlands may be in a wetland subclass other than tidal fringe. Then, using the descriptions provided in Table B3, determine the degree of connectivity between each wetland patch and the core wetland.

Table B3
Determination of Corridor Connectivity

Corridor Type	Corridor Description	Multiplier
Contiguous corridor	**1)** Open water stretches <60 m (regardless of depth). **2)** Unvegetated stretches of shoreline or strips of other wetland subclasses <60 m in length that have an aquatic shelf at least 3 m wide and are <0.3 m deep at MSL. This discounts most tidal creeks and coves or unvegetated stretches of shoreline abutting uplands as barriers to wildlife that are traveling through their daily home range.	1.00
Partially impeded corridor	**1)** Open water stretches from 60-300 m (regardless of depth). **2)** Unvegetated shorelines or strips of other wetland subclasses from 60-500 m in length that have an aquatic shelf at least 3 m wide with water depths <0.3 m at MSL. Deeper stretches of water that interrupt the shelves are not considered impeding if they are <60 m wide. **3)** Stretches of undeveloped upland that are <30 m in width.	0.75
Impeded corridor	**1)** Shoreline shelves or wetland strips between 500-1200 m long. **2)** Stretches of undeveloped upland 30-300 m in width.	0.50
Corridor absent or barrier present	**1)** Open water stretches or undeveloped uplands >300 m in width. **2)** Shorelines >300 m long that contain no shelf with waters <0.3 m deep (i.e., long stretches of bulkheading). **3)** Roadways with >100 vehicle crossings per day that are unbridged or have a bridge opening <3 m wide. **4)** Highly developed urban, residential, or industrial areas.	0.0

(3) Multiply the size of the patch (ha) by the appropriate connectivity multiplier from the table above.

Size of Wetland (hectares)		Connectivity Multiplier	Product
Core wetland	279.5	1.0	1.0 (279.5)
Patch A	______	______	______
Patch B	______	______	
Patch C	______	______	______
Patch D	______	______	______
Patch E	______	______	______

(4) Obtain the sum of all the products above. SUM 279.5

(5) Using Table B4, assign a variable subindex based on the value of the sum calculated above.

Table B4
Relationship Between Total Effective Patch Size and Functional Capacity

Total Effective Patch Size	Subindex
>200 ha	1.00
5-200 ha	0.75
1-5 ha	0.50
0.2-1 ha	0.25
<0.2 ha	0.10

Sample variables 4-8 based on an onsite field inspection of the project area and WAA.

4. V_{HYDRO} Hydrologic regime *Subindex* 0.6

(1) Assign subindex value based on Table B5.

Table B5
Relationship Between Hydrologic Regime and Functional Capacity

Site Condition	Subindex
Site is open to free exchange of tidal waters. No obvious hydrologic alteration or restrictions present.	1.0
Moderate hydrologic restriction present (i.e., presence of low-elevation berm, which is frequently overtopped by high tide events or has multiple breaches or large culverts).	0.6
Severe hydrologic restriction present (i.e., presence of high-elevation berm, which is infrequently overtopped by high tide events or has a single opening, breach or small culvert).	0.3
Site receives tidal floodwaters only during extreme storm tide events.	0.1
Site is isolated from tidal exchange. The principal source of flooding is water sources other than tidal action (i.e., precipitation or groundwater). *Note: If this condition exists, another wetland assessment model should be strongly considered unless the site was formerly a tidal wetland prior to hydrologic modification.*	0.0

*Note: Presence of berm, bulkheading, and revetment restricts free exchange. Several breaches present.

5. $V_{TYPICAL}$ Percent cover by typical plant species within the WAA 100.0 %

(1) Visually estimate the percentage of the site that is covered by nontypical, nonnative, or otherwise undesirable plant species (see Table B6). Subtract this number from 100 to estimate the percentage of the site that is occupied by plant species typical of the regional subclass. See the subclass profile in Chapter 2 for additional information. Appendix D also lists typical plant species that occur in saline, brackish, and intermediate marshes along the Texas coast.

Table B6
Possible Invasive or Undesirable Plant Species

Scientific Name	Common name	Salt/Brackish	Intermediate
Alternanthera philoxeroides	Alligator weed		L
Aster spinosus	Spiny aster		H
Phragmites australis	Common reed	H	L,H
Sesbania drummondii	Drummond's rattlebush		L,H
Typha spp.	Cattail	L	L
H = high marsh, L = low marsh.			

(2) Assign variable subindex based on Figure B1 *Subindex* 1.0

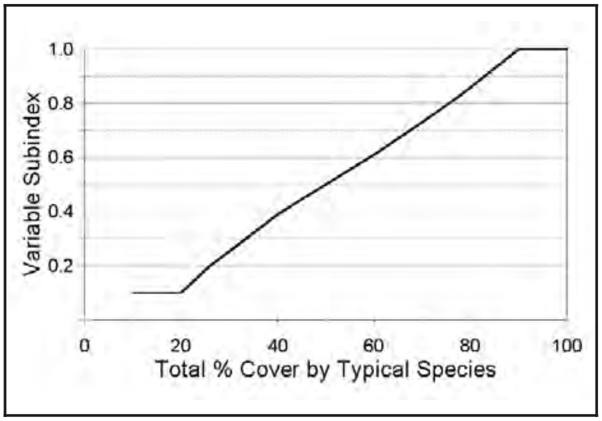


Figure B1. Relationship between percent cover by typical plant species and functional capacity

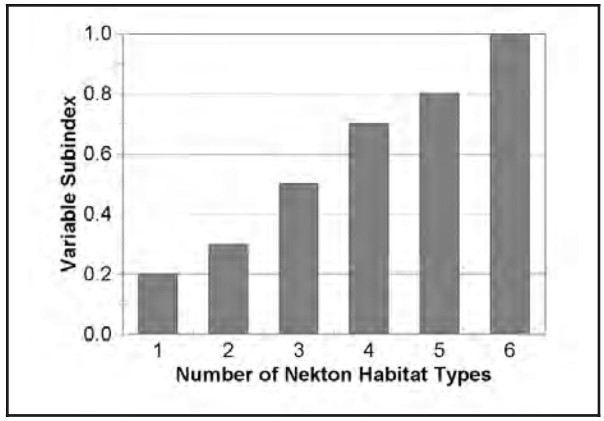


Figure B2. Relationship between nekton habitat complexity and functional capacity

6. V_{NHC} Nekton Habitat Complexity (# different habitat types)

(1) Check the habitats observed on or within a 30-m (100-ft) radius of project area perimeter.

Coarse woody debris	______	Unvegetated flats	X	Algal mats	X
Subtidal creeks/channels	______	Oyster reef	______	Mangroves	X
Intertidal creeks/channels	______	Low marsh	X	High marsh	X
Ponds or depressions	X	Submerged aquatic vegetation	_____		

(2) Assign variable subindex based on the chart in Figure B2. *Subindex* 1.0

7. V_{WHC} Wildlife Habitat Complexity (total # different habitat types)

(1) Check those habitat types **IN ADDITION TO THOSE LISTED ABOVE** that are present on or within a 2-km radius of the project area perimeter.

Supratidal habitats (hummocks, logs)	X	Scrub-Shrub	X	Forested uplands	_____
Unvegetated beach	________	Grasslands	X		

*Note: Also present within 2 km radius include subtidal channels, SAV, oyster, and woody debris.

(2) Assign variable subindex based on the chart in Figure B3. *Subindex* 1.0

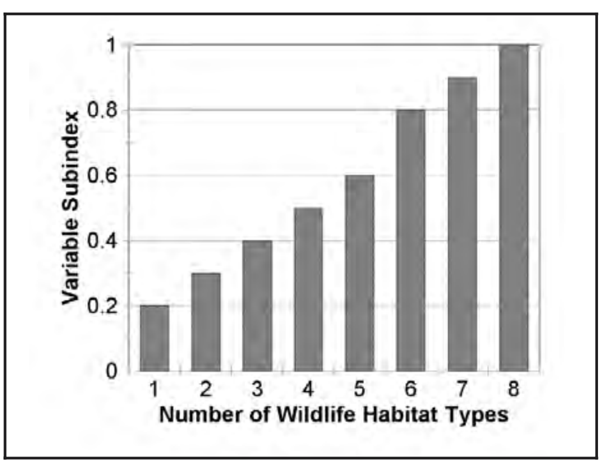


Figure B3. Relationship between wildlife habitat complexity and functional capacity

8. V_{ROUGH} Surface roughness (Manning's *n*)

(1) Choose a value for each of the three variables in the equation below based on the descriptions provided in Table B7.

$$\frac{}{}\underline{0.025} + \underline{0.001} + \underline{0.160} = \underline{0.186}$$
$$n_{BASE} + n_{TOPO} + n_{VEG} = n$$

(2) Compute the sum of the three variables in the equation above.

(3) Assign variable subindex based on the chart in Figure B4. *Subindex* 1.0

Table B7
Relationship Between Roughness and Functional Capacity

Roughness Component	Adjustment to *n* Value			Description of Terms
Sediment surface (n_{BASE})	0.025			Base value for bare marsh soil.
	0.03			More than 25% of sediment surface covered with gravel or broken shell.
Topographic relief (n_{TOPO})	0.001			Representative area is flat with essentially no microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds).
	0.005			Microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds) cover 5-25% of a representative area.
	0.010			Microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds) cover 26-50% of a representative area.
	0.020			Microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds) cover >50% of a representative area.
Roughness Component	**Percent Cover**			**Description of Conditions**
	<50	**50-75**	**76-100**	
Vegetation (n_{VEG})	0.025	0.030	0.035	Representative area predominantly short, flexible-stemmed grasses (i.e., short *Spartina alterniflora, S. patens, Distichlis spicata*).
	0.035	0.040	0.050	Vegetation in representative area predominantly short, with stiff, trailing stems (i.e., *Batis maritima*, *Salicornia virginica*).
	0.050	0.060	0.070	Representative area predominantly tall, flexible-stemmed grasses (i.e., tall *Spartina alterniflora, S. cynosuroides, Scirpus sp.*).
	0.070	0.100	0.160	Vegetation in representative area predominantly tall, with stiff leaves (i.e., *Juncus roemerianus*) or mixed woody shrubs (i.e., mangroves).
Note: Adapted from Arcement and Schneider (1989) and Gardiner and Dakombe (1983).				

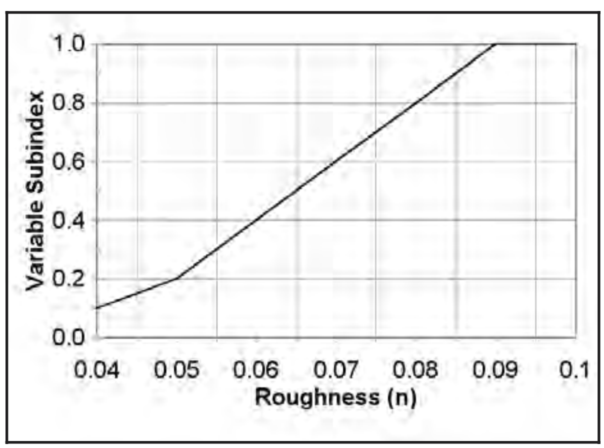


Figure B4. Relationship between surface roughness (*n*) and functional capacity

Sample variables 9 and 10 based on a representative number of locations in the WAA using a series of 1-m² plots arranged along one or more 30-m (100-ft) transects oriented perpendicular to the wetland shoreline or the hydrologic gradient.

9. V_{COVER} Mean Total Percent Vegetative Cover 100.0 %

(1) Select one or more representative areas within the site for sampling. Beginning at the shoreward edge of the marsh, establish one or more 30-m transects perpendicular to the shoreline or along the hydrologic gradient (e.g. increasing elevation). If there are multiple vegetation community types within the WAA, the transect should intersect each vegetation community, in order to ensure a representative sample.

(2) Using a standard 1-m^2 frame, estimate total percent cover by **both live and dead** emergent macrophytic plant species at intervals along the transect, excluding any areas where water depths are too deep to support the growth of emergent vegetation. The number of transects and plots needed will depend on the size and heterogeneity of the site; **a minimum of 10 plots should be used**.

(3) Calculate the average of all total percent cover estimates.

(4) Assign variable subindex for V_{COVER} based on the chart in Figure B5. *Subindex* 1.0

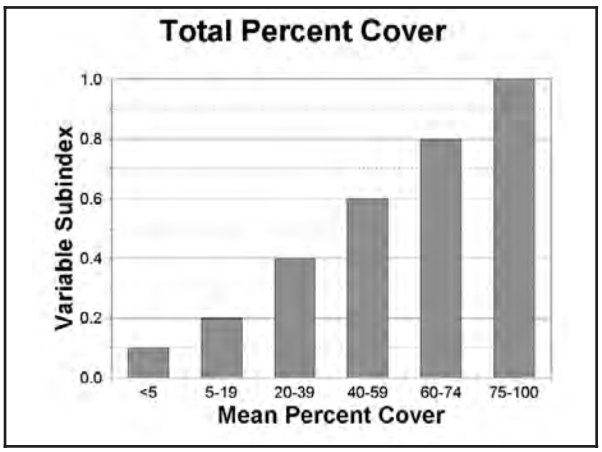


Figure B5. Relationship between mean total percent cover and functional capacity

10. V_{VEGSTR} Mean Vegetative Structure Index

(4) If the 1-m^2 sample plot above contains more than one species (i.e., *Spartina* and *Distichlis*), estimate the proportion of the 1-m^2 plot area covered by each species, omitting any species that occupies <10% cover. If the total percent cover above was estimated at 80%, the sum of the percent cover of each individual species should be 80%. There may be cases where there are several species that individually account for <10% cover, but collectively amount to 10%. In these cases, estimate the cumulative percent cover for the species group.

(5) For each species identified above, estimate the height in centimeters (rounded to the nearest 5 cm) at which the bulk of the biomass occurs (i.e., the most frequently occurring height) and record this value. For those species with trailing stems, the height should be measured in situ rather than extended vertically. Record an estimated height for the species group, if necessary.

(6) Calculate a vegetative structure index for **each** plot using the equation below.

$$V_{VEGSTR} = ((Hgt_1 \times Proportion_1) + (Hgt_2 \times Proportion_2) + \ldots.. (Hgt_x \times Proportion_x))$$

where: x = # plant species per plot.

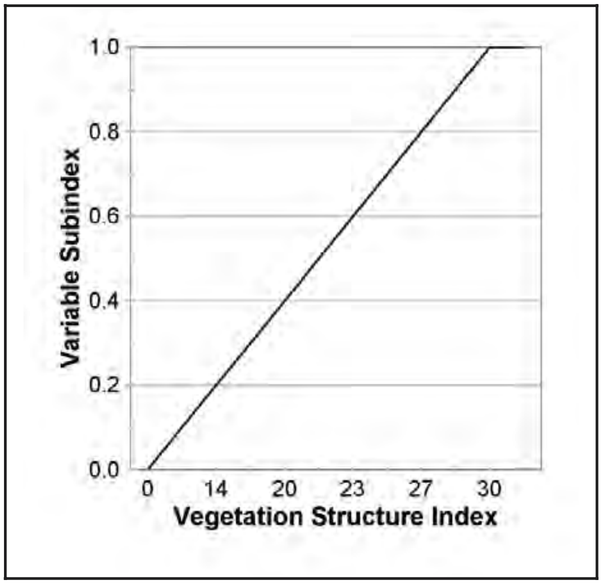
[(______ × ______) + (______ × ______) + (______ × ______)] = _______

(7) Compute the sum of all the vegetative structure indices generated above. _________

(8) Divide by the total number of plots to determine the mean. _________

(9) Assign a subindex value based on the chart in Figure B6. *Subindex* 1.0*

Figure B6. Relationship between vegetation structure index and functional capacity



*Note: No direct vegetative height field measurement data collected for any species. Vegetative Structure Index assumed to be >30 = 1.0 Variable Subindex.

Variables 11-14 are assessed only for the Shoreline Stabilization Function.

First, conduct a field site inspection and determine if there are any visual indicators of shoreline erosion within the project area. Examples of this include slumping banks, undercut banks, exposed root mats, or vertical bluffs along the shoreline (See Figure D1 for examples). If any of these features exist, assign a variable subindex to each of the following variables using the procedures outlined below and calculate a functional capacity index for this function. Otherwise, assign a default functional capacity index of 1.0 to this function, indicating the presence of a stable, non-eroding shoreline.

11. V_{WIDTH} Mean width of the marsh

(1) Using a recent aerial photo or direct field survey, establish a baseline along the lengthwise axis that runs roughly parallel to the shoreline and/or perpendicular to the topographic gradient.

(2) Draw a series of transects perpendicular to this baseline from the shoreline to the nearest upland and measure or estimate the average width of the marsh in meters (Figure 4). The number of transects is determined by the length of the baseline (Table B8).

Table B8
Number of Transects for Estimating Mean Marsh Width

Baseline Length (m)	Number of Transects
<300	3
300-1,500	5
1,500-3,000	7
>3,000	9

1____ m 2 ____ m 3 ____ m 4 ____ m 5____ m *Note: Mean marsh width = 21.10 m

(3) Determine the average of the widths recorded above.

(4) Assign a variable subindex based on Figure B7. *Subindex* 0.3

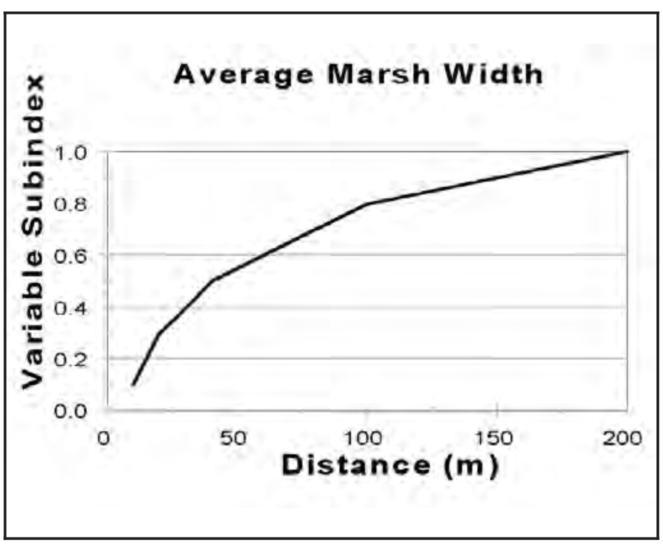


Figure B7. Relationship between average marsh width and functional capacity

12. V_{EXPOSE} Relative Exposure Index (REI)

(1) Measure fetch distances in kilometers for each of the 16 possible compass bearings.

(2) Using the map in Figure 3 in the main text (page 22), select the wind data station closest to your site.

(3) Using the supplemental information in Table E1 on mean annual wind speeds, calculate an REI using the equation below.

$$\text{Relative Exposure Index} = \sum_{i=1}^{16} V_i \times F_i \times P_i$$

where:

V_i = mean annual wind speed (km/hr)
F_i = fetch distance (km)
P_i = proportion of time wind blew from each of 16 cardinal and subcardinal compass directions

*Note: Relative Exposure Index (RSI) = 9.68

(4) Assign variable subindex based on Figure B8. *Subindex* 0.9

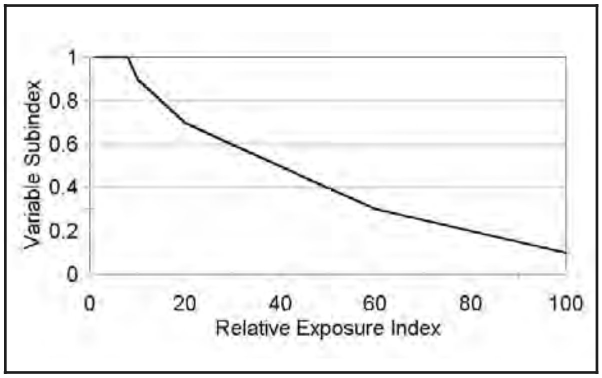


Figure B8. Relationship between relative exposure index and functional capacity

13. V_{SLOPE} Distance to navigation channel OR water depths ≥2 m *Subindex* 1.0

Table B9
Relationship Between Shoreline Slope and Functional Capacity

Distance	Subindex
<50 m	0.1
50-150 m	0.5
>150 m	1.0

*Note: Distance to navigation channel = 225.5 m.

14. V_{SOIL} Soil texture *Subindex* 0.4

Table B10
Relationship Between Soil Type and Functional Capacity

Predominant Soil Type	Subindex
Clay	1.0
Clay loam	0.8
Loam	0.6
Sandy loam	0.4
Sandy	0.2

TIDAL FRINGE MARSH HGM FUNCTIONAL ASSESSMENT

Sediment Deposition $= (V_{ROUGH} \times V_{HYDRO})^{1/2}$

(1.0 × 0.6) $^{1/2}$ = 0.775

Resident Nekton Utilization = $(V_{EDGE} + 2\ V_{HYDRO} + 0.5\ V_{NHC})$ / 3.5

(0.7 + 2 0.6 + 1.0 /2) / 3.5 = 0.686

Nonresident Nekton Utilization = $[(V_{EDGE} + 2\ V_{HYDRO} + 0.5\ V_{NHC}) / 3.5)\ V_{OMA}]^{1/2}$

[(0.7 + 2 0.6 + 0.5 1.0 / 3.5) × 0.2]$^{1/2}$ = 0.334

Invertebrate Prey Pool = $(V_{HYDRO} + V_{EDGE} + V_{COVER})$ / 3

(0.6 + 0.7 + 1.0) / 3 = 0.767

Nutrient and Organic Carbon Exchange = $(V_{VEGSTR} \times V_{HYDRO})^{1/2}$

(1.0 × 0.6)$^{1/2}$ = 0.77

Maintain Characteristic Plant Community Composition = V_{C0VER} or $V_{TYPICAL}$, whichever is lower

Min (1.0 or 1.0) = 1.0

Plant Biomass Production = V_{VEGSTR} = 1.0

Provide Wildlife Habitat = [2 V_{SIZE} + V_{WHC} + (Min (V_{COVER} OR $V_{TYPICAL}$))] / 4

(2 1.0 + 1.0 + 1.0) / 4 = 1.0

Shoreline Stabilization = $(V_{SLOPE} + V_{WIDTH} + V_{EXPOSE} + V_{ROUGH} + V_{SOIL})$ / 5

(1.0 + 0.3 + 0.9 + 1.0 + 0.4) / 5 = 0.72

FIELD DATA SHEET:
NORTHWEST GULF OF MEXICO TIDAL FRINGE MARSHES

Assessment Team: Triton Environmental Solutions

Project Name/Location: Channel Deepening Project/PA4 E2EM1P **Date:** 06/25/2023

Prior to conducting an assessment, establish the project area boundaries and delineate the wetland boundaries within the project area.

Sample variables 1-3 using aerial photos at a scale of 1 cm = 48 m (1: 4800 or 1 in. = 400 ft, digital ortho-photo quadrangle imagery, maps, etc.)

1. V_{EDGE} Degree of marsh dissection/edge:area ratio *Subindex* 0.7

(1) Using either the quantitative or qualitative approach, measure or estimate the edge:area ratio and assign a subindex value based on Table B1. See pictorial key in Appendix D (Figures D2-D9) for specific examples.

Table B1
Relationship Between Edge:Area and Functional Capacity

	Edge:Area		
Site Description	**Qualitative**	**Quantitative m/ha**	**Subindex**
1) Marsh shows signs of deterioration due to subsidence (i.e., highly fragmented with large amounts of open water. Vegetation occurs mainly in isolated hummocks or on natural levees along tidal creeks). Although edge:area is very high, this condition is not considered sustainable in the long term (Figure D2).	Very High	>800	0.8
1) Well-developed tidal drainage network present (Figure D3), OR **2)** Simple tidal drainage network (may consist of only a single channel) present with isolated ponds and depressions present in the marsh interior (Figures D4 and D5). **3)** Atypical geomorphic configuration with a large amount of shoreline relative to total area (i.e. small island or narrow peninsula) (Figure D7).	High	350-800	1.0
1) Simple tidal drainage network (may consist of only a single channel). Isolated ponds and depressions are few or lacking, OR **2)** Narrow fringe marsh that lacks tidal creeks. One lengthwise shoreline is exposed to tidal waters. Area of marsh is small relative to shoreline length (Figures D6 and D8).	Moderate	200-350	0.7
Marsh lacks both tidal creeks and isolated ponds and depressions. Shoreline is generally linear or smooth curvilinear without embayments or convolutions. Area of marsh is large relative to shoreline length (Figure D9).	Low	<200	0.4

*Note: Narrow fringe marsh lacking tidal creeks, one shoreline exposed to tidal waters, combined marsh area is small relative to the shoreline length.

2. V_{OMA} Proportion of tidally connected edge to total edge *Subindex* 0.2

(1) Assign subindex value based on Table B2.

Table B2
Relationship Between Opportunity for Marsh Access and Functional Capacity

Tidally Connected Edge: Total Edge	Subindex
☐ 50-100%	1.0
☐ 35-50%	0.7
☐ 25-35%	0.5
☒ 1-25%	0.2
☐ No tidally connected edge present	0.0

3. V_{SIZE} Total Effective Patch Size *Subindex* 0.75

(1) If the core wetland size exceeds 200 ha, assign a variable subindex value of 1.0. The core wetland is defined as a contiguous patch of tidal fringe wetland that contains the WAA.

(2) If the core wetland size <200 ha, identify other patches of wetlands in the surrounding area, and record the size of each patch in hectares. These wetlands may be in a wetland subclass other than tidal fringe. Then, using the descriptions provided in Table B3, determine the degree of connectivity between each wetland patch and the core wetland.

Table B3
Determination of Corridor Connectivity

Corridor Type	Corridor Description	Multiplier
Contiguous corridor	**1)** Open water stretches <60 m (regardless of depth). **2)** Unvegetated stretches of shoreline or strips of other wetland subclasses <60 m in length that have an aquatic shelf at least 3 m wide and are <0.3 m deep at MSL. This discounts most tidal creeks and coves or unvegetated stretches of shoreline abutting uplands as barriers to wildlife that are traveling through their daily home range.	1.00
Partially impeded corridor	**1)** Open water stretches from 60-300 m (regardless of depth). **2)** Unvegetated shorelines or strips of other wetland subclasses from 60-500 m in length that have an aquatic shelf at least 3 m wide with water depths <0.3 m at MSL. Deeper stretches of water that interrupt the shelves are not considered impeding if they are <60 m wide. **3)** Stretches of undeveloped upland that are <30 m in width.	0.75
Impeded corridor	**1)** Shoreline shelves or wetland strips between 500-1200 m long. **2)** Stretches of undeveloped upland 30-300 m in width.	0.50
Corridor absent or barrier present	**1)** Open water stretches or undeveloped uplands >300 m in width. **2)** Shorelines >300 m long that contain no shelf with waters <0.3 m deep (i.e., long stretches of bulkheading). **3)** Roadways with >100 vehicle crossings per day that are unbridged or have a bridge opening <3 m wide. **4)** Highly developed urban, residential, or industrial areas.	0.0

(3) Multiply the size of the patch (ha) by the appropriate connectivity multiplier from the table above.

Size of Wetland (hectares)		Connectivity Multiplier	Product
Core wetland	13.9	1.0	1.0 (13.9)
Patch A	43.1	0.75	32.325
Patch B	30.1	0.5	15.05
Patch C			
Patch D			
Patch E			

(4) Obtain the sum of all the products above. SUM 61.275

(5) Using Table B4, assign a variable subindex based on the value of the sum calculated above.

Table B4
Relationship Between Total Effective Patch Size and Functional Capacity

Total Effective Patch Size	Subindex
>200 ha	1.00
5-200 ha	0.75
1-5 ha	0.50
0.2-1 ha	0.25
<0.2 ha	0.10

Sample variables 4-8 based on an onsite field inspection of the project area and WAA.

4. V_{HYDRO} Hydrologic regime *Subindex* 1.0

(1) Assign subindex value based on Table B5.

Table B5
Relationship Between Hydrologic Regime and Functional Capacity

Site Condition	Subindex
Site is open to free exchange of tidal waters. No obvious hydrologic alteration or restrictions present.	1.0
Moderate hydrologic restriction present (i.e., presence of low-elevation berm, which is frequently overtopped by high tide events or has multiple breaches or large culverts).	0.6
Severe hydrologic restriction present (i.e., presence of high-elevation berm, which is infrequently overtopped by high tide events or has a single opening, breach or small culvert).	0.3
Site receives tidal floodwaters only during extreme storm tide events.	0.1
Site is isolated from tidal exchange. The principal source of flooding is water sources other than tidal action (i.e., precipitation or groundwater). *Note: If this condition exists, another wetland assessment model should be strongly considered unless the site was formerly a tidal wetland prior to hydrologic modification.*	0.0

5. $V_{TYPICAL}$ Percent cover by typical plant species within the WAA 84.3 %

(1) Visually estimate the percentage of the site that is covered by nontypical, nonnative, or otherwise undesirable plant species (see Table B6). Subtract this number from 100 to estimate the percentage of the site that is occupied by plant species typical of the regional subclass. See the subclass profile in Chapter 2 for additional information. Appendix D also lists typical plant species that occur in saline, brackish, and intermediate marshes along the Texas coast.

Table B6
Possible Invasive or Undesirable Plant Species

Scientific Name	Common name	Salt/Brackish	Intermediate
Alternanthera philoxeroides	Alligator weed		L
Aster spinosus	Spiny aster		H
Phragmites australis	Common reed	H	L,H
Sesbania drummondii	Drummond's rattlebush		L,H
Typha spp.	Cattail	L	L
H = high marsh, L = low marsh.			

(2) Assign variable subindex based on Figure B1 *Subindex* 0.9

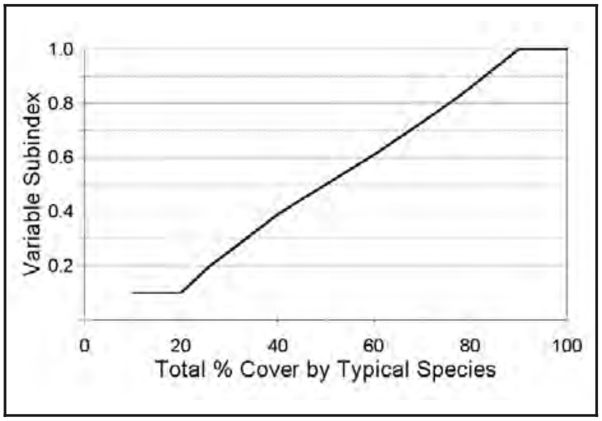


Figure B1. Relationship between percent cover by typical plant species and functional capacity

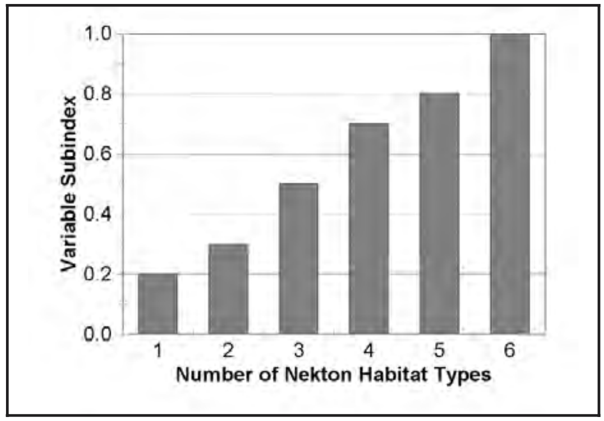


Figure B2. Relationship between nekton habitat complexity and functional capacity

6. V_{NHC} Nekton Habitat Complexity (# different habitat types)

(1) Check the habitats observed on or within a 30-m (100-ft) radius of project area perimeter.

Coarse woody debris	______	Unvegetated flats	______	Algal mats	______
Subtidal creeks/channels	______	Oyster reef	______	Mangroves	X
Intertidal creeks/channels	______	Low marsh	X	High marsh	X
Ponds or depressions	______	Submerged aquatic vegetation	X		

(2) Assign variable subindex based on the chart in Figure B2. *Subindex* 0.7

7. V_{WHC} Wildlife Habitat Complexity (total # different habitat types)

(1) Check those habitat types **IN ADDITION TO THOSE LISTED ABOVE** that are present on or within a 2-km radius of the project area perimeter.

Supratidal habitats (hummocks, logs)	X	Scrub-Shrub	X	Forested uplands	_____
Unvegetated beach	________	Grasslands	X		

*Note: Also present within 2 km radius include subtidal channels, ponds/depressions, unvegetated flats, oyster, woody debris, and algal mats.

(2) Assign variable subindex based on the chart in Figure B3. *Subindex* 1.0

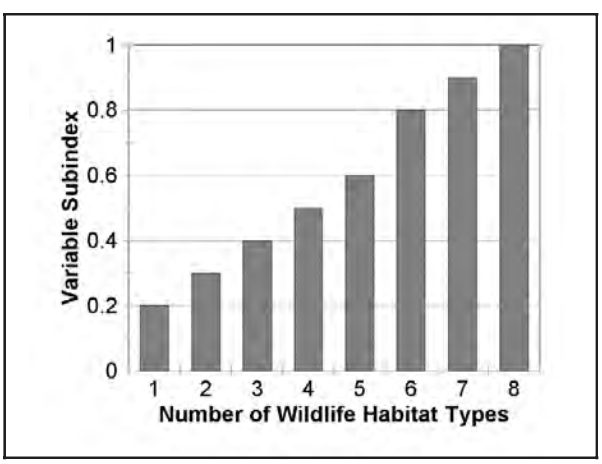


Figure B3. Relationship between wildlife habitat complexity and functional capacity

8. V_{ROUGH} Surface roughness (Manning's n)

(1) Choose a value for each of the three variables in the equation below based on the descriptions provided in Table B7.

$$\underline{0.025} + \underline{0.001} + \underline{0.035} = \underline{0.061}$$
$$n_{BASE} + n_{TOPO} + n_{VEG} = n$$

(2) Compute the sum of the three variables in the equation above.

(3) Assign variable subindex based on the chart in Figure B4. *Subindex* 0.4

Table B7
Relationship Between Roughness and Functional Capacity

Roughness Component	Adjustment to *n* Value			Description of Terms
Sediment surface (n_{BASE})	0.025			Base value for bare marsh soil.
	0.03			More than 25% of sediment surface covered with gravel or broken shell.
Topographic relief (n_{TOPO})	0.001			Representative area is flat with essentially no microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds).
	0.005			Microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds) cover 5-25% of a representative area.
	0.010			Microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds) cover 26-50% of a representative area.
	0.020			Microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds) cover >50% of a representative area.
Roughness Component	**Percent Cover**			
	<50	**50-75**	**76-100**	**Description of Conditions**
Vegetation (n_{VEG})	0.025	0.030	0.035	Representative area predominantly short, flexible-stemmed grasses (i.e., short *Spartina alterniflora, S. patens, Distichlis spicata*).
	0.035	0.040	0.050	Vegetation in representative area predominantly short, with stiff, trailing stems (i.e., *Batis maritima*, *Salicornia virginica*).
	0.050	0.060	0.070	Representative area predominantly tall, flexible-stemmed grasses (i.e., tall *Spartina alterniflora, S. cynosuroides, Scirpus sp.*).
	0.070	0.100	0.160	Vegetation in representative area predominantly tall, with stiff leaves (i.e., *Juncus roemerianus*) or mixed woody shrubs (i.e., mangroves).

Note: Adapted from Arcement and Schneider (1989) and Gardiner and Dakombe (1983).

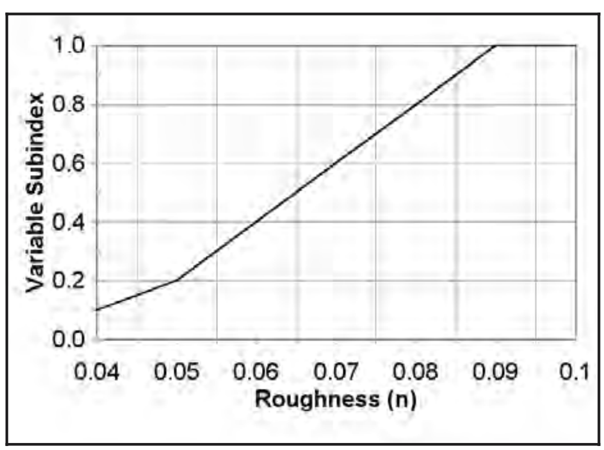


Figure B4. Relationship between surface roughness (n) and functional capacity

Sample variables 9 and 10 based on a representative number of locations in the WAA using a series of 1-m² plots arranged along one or more 30-m (100-ft) transects oriented perpendicular to the wetland shoreline or the hydrologic gradient.

9. V_{COVER} Mean Total Percent Vegetative Cover 100.0 %

(1) Select one or more representative areas within the site for sampling. Beginning at the shoreward edge of the marsh, establish one or more 30-m transects perpendicular to the shoreline or along the hydrologic gradient (e.g. increasing elevation). If there are multiple vegetation community types within the WAA, the transect should intersect each vegetation community, in order to ensure a representative sample.

(2) Using a standard 1-m^2 frame, estimate total percent cover by **both live and dead** emergent macrophytic plant species at intervals along the transect, excluding any areas where water depths are too deep to support the growth of emergent vegetation. The number of transects and plots needed will depend on the size and heterogeneity of the site; **a minimum of 10 plots should be used**.

(3) Calculate the average of all total percent cover estimates.

(4) Assign variable subindex for V_{COVER} based on the chart in Figure B5. *Subindex* 1.0

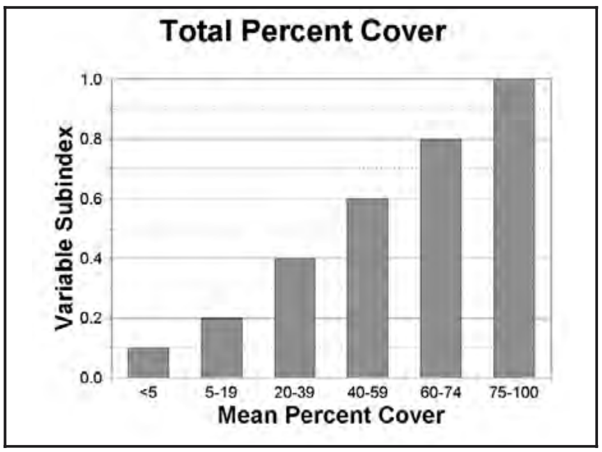


Figure B5. Relationship between mean total percent cover and functional capacity

10. V_{VEGSTR} Mean Vegetative Structure Index

(4) If the 1-m^2 sample plot above contains more than one species (i.e., *Spartina* and *Distichlis*), estimate the proportion of the 1-m^2 plot area covered by each species, omitting any species that occupies <10% cover. If the total percent cover above was estimated at 80%, the sum of the percent cover of each individual species should be 80%. There may be cases where there are several species that individually account for <10% cover, but collectively amount to 10%. In these cases, estimate the cumulative percent cover for the species group.

(5) For each species identified above, estimate the height in centimeters (rounded to the nearest 5 cm) at which the bulk of the biomass occurs (i.e., the most frequently occurring height) and record this value. For those species with trailing stems, the height should be measured in situ rather than extended vertically. Record an estimated height for the species group, if necessary.

(6) Calculate a vegetative structure index for **each** plot using the equation below.

$$V_{VEGSTR} = ((Hgt_1 \times Proportion_1) + (Hgt_2 \times Proportion_2) + \ldots.. (Hgt_x \times Proportion_x))$$

where: x = # plant species per plot.

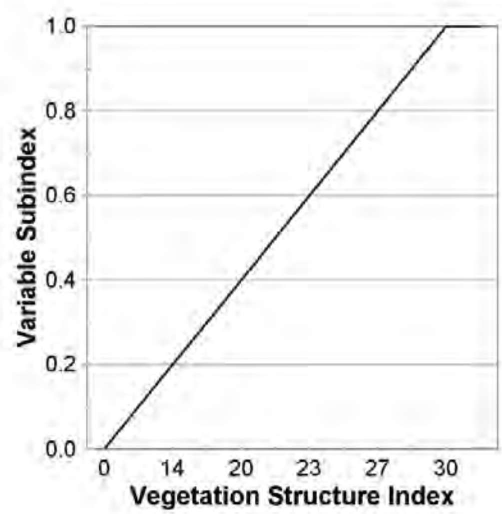
[(______ × ______) + (______ × ______) + (______ × ______)] = ________

(7) Compute the sum of all the vegetative structure indices generated above. __________

(8) Divide by the total number of plots to determine the mean. __________

(9) Assign a subindex value based on the chart in Figure B6. *Subindex* 1.0*

Figure B6. Relationship between vegetation structure index and functional capacity



*Note: No direct vegetative height field measurement data collected for any species. Vegetative Structure Index assumed to be >30 = 1.0 Variable Subindex.

Variables 11-14 are assessed only for the Shoreline Stabilization Function.

First, conduct a field site inspection and determine if there are any visual indicators of shoreline erosion within the project area. Examples of this include slumping banks, undercut banks, exposed root mats, or vertical bluffs along the shoreline (See Figure D1 for examples). If any of these features exist, assign a variable subindex to each of the following variables using the procedures outlined below and calculate a functional capacity index for this function. Otherwise, assign a default functional capacity index of 1.0 to this function, indicating the presence of a stable, non-eroding shoreline.

11. V_{WIDTH} Mean width of the marsh

(1) Using a recent aerial photo or direct field survey, establish a baseline along the lengthwise axis that runs roughly parallel to the shoreline and/or perpendicular to the topographic gradient.

(2) Draw a series of transects perpendicular to this baseline from the shoreline to the nearest upland and measure or estimate the average width of the marsh in meters (Figure 4). The number of transects is determined by the length of the baseline (Table B8).

Table B8
Number of Transects for Estimating Mean Marsh Width

Baseline Length (m)	Number of Transects
<300	3
300-1,500	5
1,500-3,000	7
>3,000	9

1____ m   2 ____ m   3 ____ m   4 ____ m   5____ m *Note: Mean marsh width = 6.79 m

(3) Determine the average of the widths recorded above.

(4) Assign a variable subindex based on Figure B7. *Subindex* 0.1

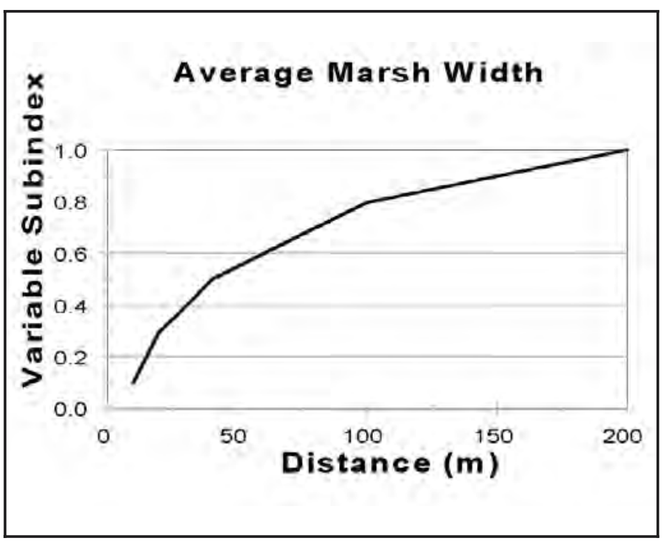


Figure B7. Relationship between average marsh width and functional capacity

12. V_{EXPOSE} Relative Exposure Index (REI)

(1) Measure fetch distances in kilometers for each of the 16 possible compass bearings.

(2) Using the map in Figure 3 in the main text (page 22), select the wind data station closest to your site.

(3) Using the supplemental information in Table E1 on mean annual wind speeds, calculate an REI using the equation below.

$$\text{Relative Exposure Index} = \sum_{i=1}^{16} V_i \times F_i \times P_i$$

where:
V_i = mean annual wind speed (km/hr)
F_i = fetch distance (km)
P_i = proportion of time wind blew from each of 16 cardinal and subcardinal compass directions

*Note: Relative Exposure Index (RSI) = 11.53

(4) Assign variable subindex based on Figure B8. *Subindex* 0.9

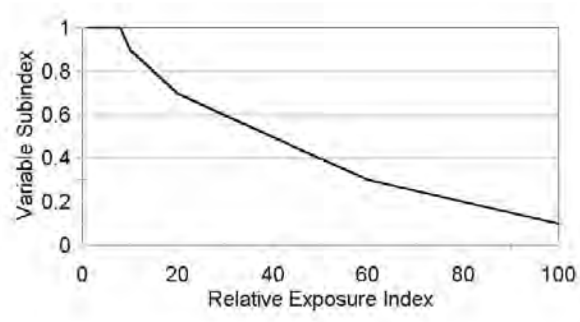


Figure B8. Relationship between relative exposure index and functional capacity

13. V_{SLOPE} Distance to navigation channel OR water depths ≥2 m *Subindex* 1.0

Table B9
Relationship Between Shoreline Slope and Functional Capacity

Distance	Subindex
<50 m	0.1
50-150 m	0.5
>150 m	1.0

*Note: Distance to navigation channel = 2,711.5 m.

14. V_{SOIL} Soil texture *Subindex* 0.4

Table B10
Relationship Between Soil Type and Functional Capacity

Predominant Soil Type	Subindex
Clay	1.0
Clay loam	0.8
Loam	0.6
Sandy loam	0.4
Sandy	0.2

TIDAL FRINGE MARSH HGM FUNCTIONAL ASSESSMENT

Sediment Deposition $= (V_{ROUGH} \times V_{HYDRO})^{1/2}$

(0.4 × 1.0) $^{1/2}$ = 0.632

Resident Nekton Utilization = $(V_{EDGE} + 2\ V_{HYDRO} + 0.5\ V_{NHC})$ / 3.5

(0.7 + 2 1.0 + 0.7 /2) / 3.5 = 0.871

Nonresident Nekton Utilization = $[(V_{EDGE} + 2\ V_{HYDRO} + 0.5\ V_{NHC}) / 3.5)\ V_{OMA}]^{1/2}$

[(0.7 + 2 1.0 + 0.5 0.7 / 3.5) × 0.2]$^{1/2}$ = 0.395

Invertebrate Prey Pool = $(V_{HYDRO} + V_{EDGE} + V_{COVER})$ / 3

(1.0 + 0.7 + 1.0) / 3 = 0.9

Nutrient and Organic Carbon Exchange = $(V_{VEGSTR} \times V_{HYDRO})^{1/2}$

(1.0 × 1.0)$^{1/2}$ = 1.0

Maintain Characteristic Plant Community Composition = V_{C0VER} or $V_{TYPICAL}$, whichever is lower

Min (1.0 or 0.9) = 0.9

Plant Biomass Production = V_{VEGSTR} = 1.0

Provide Wildlife Habitat = [2 V_{SIZE} + V_{WHC} + (Min (V_{COVER} OR $V_{TYPICAL}$))] / 4

(2 0.75 + 1.0 + 0.9) / 4 = 0.85

Shoreline Stabilization = $(V_{SLOPE} + V_{WIDTH} + V_{EXPOSE} + V_{ROUGH} + V_{SOIL})$ / 5

(1.0 + 0.1 + 0.9 + 0.4 + 0.4) / 5 = 0.56

FIELD DATA SHEET:
NORTHWEST GULF OF MEXICO TIDAL FRINGE MARSHES

Assessment Team: Triton Environmental Solutions

Project Name/Location: Channel Deepening Project/PA4 E2SS3N **Date:** 06/25/2023

Prior to conducting an assessment, establish the project area boundaries and delineate the wetland boundaries within the project area.

Sample variables 1-3 using aerial photos at a scale of 1 cm = 48 m (1: 4800 or 1 in. = 400 ft, digital ortho-photo quadrangle imagery, maps, etc.)

1. V_{EDGE} Degree of marsh dissection/edge:area ratio *Subindex* 0.7

(1) Using either the quantitative or qualitative approach, measure or estimate the edge:area ratio and assign a subindex value based on Table B1. See pictorial key in Appendix D (Figures D2-D9) for specific examples.

Table B1
Relationship Between Edge:Area and Functional Capacity

Site Description	Edge:Area Qualitative	Edge:Area Quantitative m/ha	Subindex
1) Marsh shows signs of deterioration due to subsidence (i.e., highly fragmented with large amounts of open water. Vegetation occurs mainly in isolated hummocks or on natural levees along tidal creeks). Although edge:area is very high, this condition is not considered sustainable in the long term (Figure D2).	Very High	>800	0.8
1) Well-developed tidal drainage network present (Figure D3), OR **2)** Simple tidal drainage network (may consist of only a single channel) present with isolated ponds and depressions present in the marsh interior (Figures D4 and D5). **3)** Atypical geomorphic configuration with a large amount of shoreline relative to total area (i.e. small island or narrow peninsula) (Figure D7).	High	350-800	1.0
1) Simple tidal drainage network (may consist of only a single channel). Isolated ponds and depressions are few or lacking, OR **2)** Narrow fringe marsh that lacks tidal creeks. One lengthwise shoreline is exposed to tidal waters. Area of marsh is small relative to shoreline length (Figures D6 and D8).	Moderate	200-350	0.7
Marsh lacks both tidal creeks and isolated ponds and depressions. Shoreline is generally linear or smooth curvilinear without embayments or convolutions. Area of marsh is large relative to shoreline length (Figure D9).	Low	<200	0.4

*Note: Narrow fringe marsh lacking tidal creeks, one shoreline exposed to tidal waters, combined marsh area is small relative to the shoreline length.

2. V_{OMA} Proportion of tidally connected edge to total edge *Subindex* 0.2

(1) Assign subindex value based on Table B2.

Table B2
Relationship Between Opportunity for Marsh Access and Functional Capacity

Tidally Connected Edge: Total Edge	Subindex
☐ 50-100%	1.0
☐ 35-50%	0.7
☐ 25-35%	0.5
☒ 1-25%	0.2
☐ No tidally connected edge present	0.0

3. V_{SIZE} Total Effective Patch Size *Subindex* 0.75

(1) If the core wetland size exceeds 200 ha, assign a variable subindex value of 1.0. The core wetland is defined as a contiguous patch of tidal fringe wetland that contains the WAA.

(2) If the core wetland size <200 ha, identify other patches of wetlands in the surrounding area, and record the size of each patch in hectares. These wetlands may be in a wetland subclass other than tidal fringe. Then, using the descriptions provided in Table B3, determine the degree of connectivity between each wetland patch and the core wetland.

Table B3
Determination of Corridor Connectivity

Corridor Type	Corridor Description	Multiplier
Contiguous corridor	**1)** Open water stretches <60 m (regardless of depth). **2)** Unvegetated stretches of shoreline or strips of other wetland subclasses <60 m in length that have an aquatic shelf at least 3 m wide and are <0.3 m deep at MSL. This discounts most tidal creeks and coves or unvegetated stretches of shoreline abutting uplands as barriers to wildlife that are traveling through their daily home range.	1.00
Partially impeded corridor	**1)** Open water stretches from 60-300 m (regardless of depth). **2)** Unvegetated shorelines or strips of other wetland subclasses from 60-500 m in length that have an aquatic shelf at least 3 m wide with water depths <0.3 m at MSL. Deeper stretches of water that interrupt the shelves are not considered impeding if they are <60 m wide. **3)** Stretches of undeveloped upland that are <30 m in width.	0.75
Impeded corridor	**1)** Shoreline shelves or wetland strips between 500-1200 m long. **2)** Stretches of undeveloped upland 30-300 m in width.	0.50
Corridor absent or barrier present	**1)** Open water stretches or undeveloped uplands >300 m in width. **2)** Shorelines >300 m long that contain no shelf with waters <0.3 m deep (i.e., long stretches of bulkheading). **3)** Roadways with >100 vehicle crossings per day that are unbridged or have a bridge opening <3 m wide. **4)** Highly developed urban, residential, or industrial areas.	0.0

(3) Multiply the size of the patch (ha) by the appropriate connectivity multiplier from the table above.

Size of Wetland (hectares)		Connectivity Multiplier	Product
Core wetland	13.9	1.0	1.0 (13.9)
Patch A	43.1	0.75	32.325
Patch B	30.1	0.5	15.05
Patch C			
Patch D			
Patch E			

(4) Obtain the sum of all the products above. SUM 61.275

(5) Using Table B4, assign a variable subindex based on the value of the sum calculated above.

Table B4
Relationship Between Total Effective Patch Size and Functional Capacity

Total Effective Patch Size	Subindex
>200 ha	1.00
5-200 ha	0.75
1-5 ha	0.50
0.2-1 ha	0.25
<0.2 ha	0.10

Sample variables 4-8 based on an onsite field inspection of the project area and WAA.

4. V_{HYDRO} Hydrologic regime *Subindex* 1.0

(1) Assign subindex value based on Table B5.

Table B5
Relationship Between Hydrologic Regime and Functional Capacity

Site Condition	Subindex
Site is open to free exchange of tidal waters. No obvious hydrologic alteration or restrictions present.	1.0
Moderate hydrologic restriction present (i.e., presence of low-elevation berm, which is frequently overtopped by high tide events or has multiple breaches or large culverts).	0.6
Severe hydrologic restriction present (i.e., presence of high-elevation berm, which is infrequently overtopped by high tide events or has a single opening, breach or small culvert).	0.3
Site receives tidal floodwaters only during extreme storm tide events.	0.1
Site is isolated from tidal exchange. The principal source of flooding is water sources other than tidal action (i.e., precipitation or groundwater). *Note: If this condition exists, another wetland assessment model should be strongly considered unless the site was formerly a tidal wetland prior to hydrologic modification.*	0.0

5. $V_{TYPICAL}$ Percent cover by typical plant species within the WAA 97.0 %

(1) Visually estimate the percentage of the site that is covered by nontypical, nonnative, or otherwise undesirable plant species (see Table B6). Subtract this number from 100 to estimate the percentage of the site that is occupied by plant species typical of the regional subclass. See the subclass profile in Chapter 2 for additional information. Appendix D also lists typical plant species that occur in saline, brackish, and intermediate marshes along the Texas coast.

Table B6
Possible Invasive or Undesirable Plant Species

Scientific Name	Common name	Salt/Brackish	Intermediate
Alternanthera philoxeroides	Alligator weed		L
Aster spinosus	Spiny aster		H
Phragmites australis	Common reed	H	L,H
Sesbania drummondii	Drummond's rattlebush		L,H
Typha spp.	Cattail	L	L
H = high marsh, L = low marsh.			

(2) Assign variable subindex based on Figure B1 *Subindex* 1.0

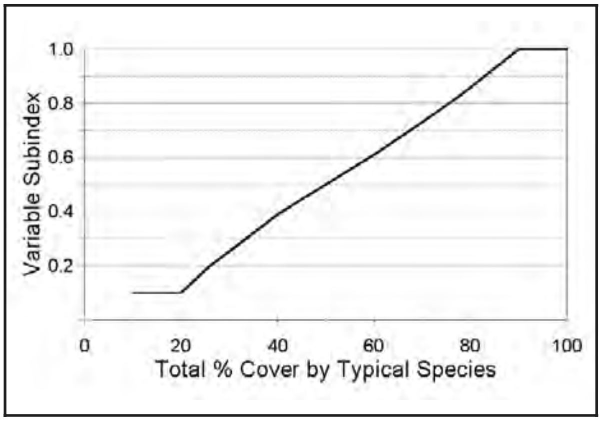


Figure B1. Relationship between percent cover by typical plant species and functional capacity

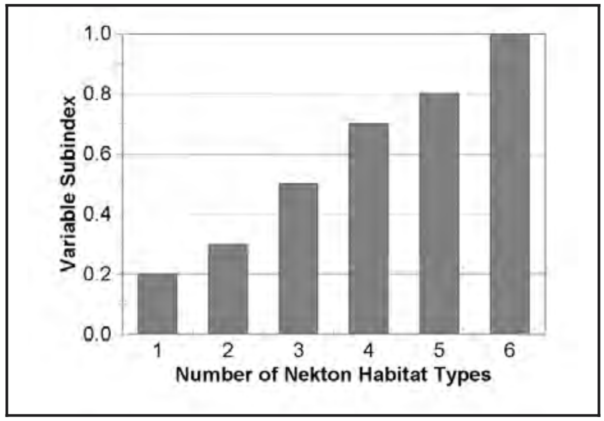


Figure B2. Relationship between nekton habitat complexity and functional capacity

6. V_{NHC} Nekton Habitat Complexity (# different habitat types)

(1) Check the habitats observed on or within a 30-m (100-ft) radius of project area perimeter.

Coarse woody debris	______	Unvegetated flats	______	Algal mats	______
Subtidal creeks/channels	______	Oyster reef	______	Mangroves	X
Intertidal creeks/channels	______	Low marsh	X	High marsh	X
Ponds or depressions	______	Submerged aquatic vegetation	X		

(2) Assign variable subindex based on the chart in Figure B2. *Subindex* 0.7

7. V_{WHC} Wildlife Habitat Complexity (total # different habitat types)

(1) Check those habitat types **IN ADDITION TO THOSE LISTED ABOVE** that are present on or within a 2-km radius of the project area perimeter.

Supratidal habitats (hummocks, logs)	X	Scrub-Shrub	X	Forested uplands	_____
Unvegetated beach	________	Grasslands	X		

*Note: Also present within 2 km radius include subtidal channels, ponds/depressions, unvegetated flats, oyster, woody debris, and algal mats.

(2) Assign variable subindex based on the chart in Figure B3. *Subindex* 1.0

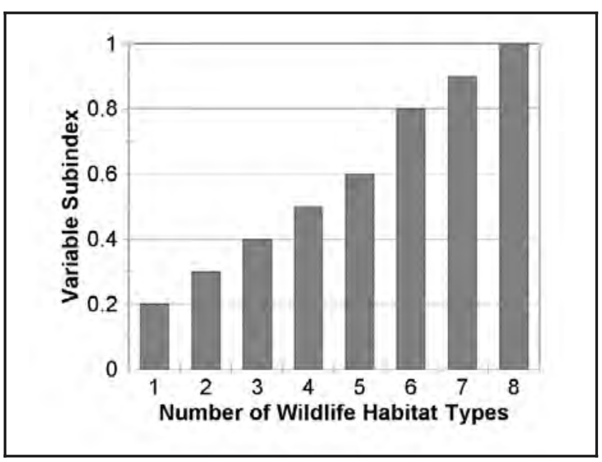


Figure B3. Relationship between wildlife habitat complexity and functional capacity

8. V_{ROUGH} Surface roughness (Manning's *n*)

(1) Choose a value for each of the three variables in the equation below based on the descriptions provided in Table B7.

$$\underline{0.025} + \underline{0.001} + \underline{0.160} = \underline{0.186}$$
$$n_{BASE} + n_{TOPO} + n_{VEG} = n$$

(2) Compute the sum of the three variables in the equation above.

(3) Assign variable subindex based on the chart in Figure B4. *Subindex* 1.0

Table B7
Relationship Between Roughness and Functional Capacity

Roughness Component	Adjustment to *n* Value	Description of Terms
Sediment surface (n_{BASE})	0.025	Base value for bare marsh soil.
	0.03	More than 25% of sediment surface covered with gravel or broken shell.
Topographic relief (n_{TOPO})	0.001	Representative area is flat with essentially no microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds).
	0.005	Microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds) cover 5-25% of a representative area.
	0.010	Microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds) cover 26-50% of a representative area.
	0.020	Microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds) cover >50% of a representative area.

Roughness Component	Percent Cover <50	50-75	76-100	Description of Conditions
Vegetation (n_{VEG})	0.025	0.030	0.035	Representative area predominantly short, flexible-stemmed grasses (i.e., short *Spartina alterniflora, S. patens, Distichlis spicata*).
	0.035	0.040	0.050	Vegetation in representative area predominantly short, with stiff, trailing stems (i.e., *Batis maritima*, *Salicornia virginica*).
	0.050	0.060	0.070	Representative area predominantly tall, flexible-stemmed grasses (i.e., tall *Spartina alterniflora, S. cynosuroides, Scirpus sp.*).
	0.070	0.100	0.160	Vegetation in representative area predominantly tall, with stiff leaves (i.e., *Juncus roemerianus*) or mixed woody shrubs (i.e., mangroves).

Note: Adapted from Arcement and Schneider (1989) and Gardiner and Dakombe (1983).

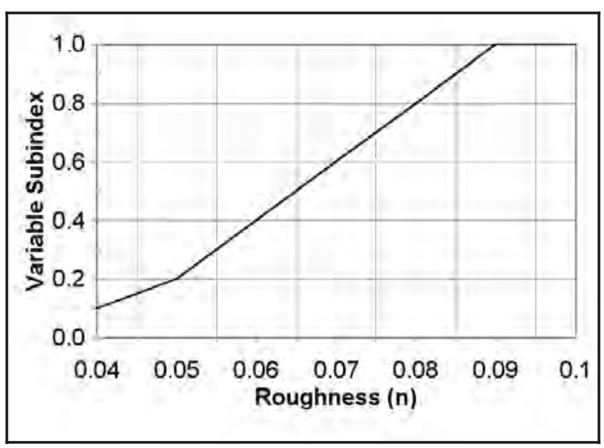


Figure B4. Relationship between surface roughness (*n*) and functional capacity

Sample variables 9 and 10 based on a representative number of locations in the WAA using a series of 1-m^2 plots arranged along one or more 30-m (100-ft) transects oriented perpendicular to the wetland shoreline or the hydrologic gradient.

9. V_{COVER} Mean Total Percent Vegetative Cover 81.8 %

(1) Select one or more representative areas within the site for sampling. Beginning at the shoreward edge of the marsh, establish one or more 30-m transects perpendicular to the shoreline or along the hydrologic gradient (e.g. increasing elevation). If there are multiple vegetation community types within the WAA, the transect should intersect each vegetation community, in order to ensure a representative sample.

(2) Using a standard 1-m^2 frame, estimate total percent cover by **both live and dead** emergent macrophytic plant species at intervals along the transect, excluding any areas where water depths are too deep to support the growth of emergent vegetation. The number of transects and plots needed will depend on the size and heterogeneity of the site; **a minimum of 10 plots should be used**.

(3) Calculate the average of all total percent cover estimates.

(4) Assign variable subindex for V_{COVER} based on the chart in Figure B5. *Subindex* 1.0

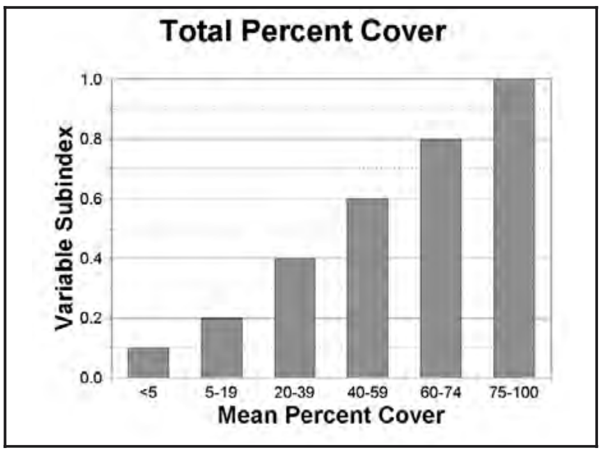


Figure B5. Relationship between mean total percent cover and functional capacity

10. V_{VEGSTR} Mean Vegetative Structure Index

(4) If the 1-m^2 sample plot above contains more than one species (i.e., *Spartina* and *Distichlis*), estimate the proportion of the 1-m^2 plot area covered by each species, omitting any species that occupies <10% cover. If the total percent cover above was estimated at 80%, the sum of the percent cover of each individual species should be 80%. There may be cases where there are several species that individually account for <10% cover, but collectively amount to 10%. In these cases, estimate the cumulative percent cover for the species group.

(5) For each species identified above, estimate the height in centimeters (rounded to the nearest 5 cm) at which the bulk of the biomass occurs (i.e., the most frequently occurring height) and record this value. For those species with trailing stems, the height should be measured in situ rather than extended vertically. Record an estimated height for the species group, if necessary.

(6) Calculate a vegetative structure index for **each** plot using the equation below.

V_{VEGSTR} = ((Hgt$_1$ × Proportion$_1$) + (Hgt$_2$ × Proportion$_2$) + ... (Hgt$_x$ × Proportion$_x$))

where: x = # plant species per plot.

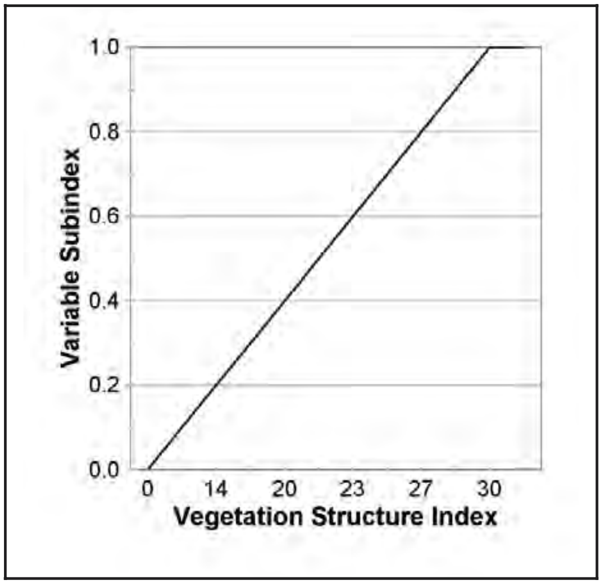
[(______ × ______) + (______ × ______) + (______ × ______)] = ________

(7) Compute the sum of all the vegetative structure indices generated above. __________

(8) Divide by the total number of plots to determine the mean. __________

(9) Assign a subindex value based on the chart in Figure B6. *Subindex* 1.0*

Figure B6. Relationship between vegetation structure index and functional capacity



*Note: No direct vegetative height field measurement data collected for any species. Vegetative Structure Index assumed to be >30 = 1.0 Variable Subindex.

Variables 11-14 are assessed only for the Shoreline Stabilization Function.

First, conduct a field site inspection and determine if there are any visual indicators of shoreline erosion within the project area. Examples of this include slumping banks, undercut banks, exposed root mats, or vertical bluffs along the shoreline (See Figure D1 for examples). If any of these features exist, assign a variable subindex to each of the following variables using the procedures outlined below and calculate a functional capacity index for this function. Otherwise, assign a default functional capacity index of 1.0 to this function, indicating the presence of a stable, non-eroding shoreline.

11. V_{WIDTH} Mean width of the marsh

(1) Using a recent aerial photo or direct field survey, establish a baseline along the lengthwise axis that runs roughly parallel to the shoreline and/or perpendicular to the topographic gradient.

(2) Draw a series of transects perpendicular to this baseline from the shoreline to the nearest upland and measure or estimate the average width of the marsh in meters (Figure 4). The number of transects is determined by the length of the baseline (Table B8).

Table B8
Number of Transects for Estimating Mean Marsh Width

Baseline Length (m)	Number of Transects
<300	3
300-1,500	5
1,500-3,000	7
>3,000	9

1____ m 2 ____ m 3 ____ m 4 ____ m 5____ m *Note: Mean marsh width = 11.03 m

(3) Determine the average of the widths recorded above.

(4) Assign a variable subindex based on Figure B7. *Subindex* 0.1

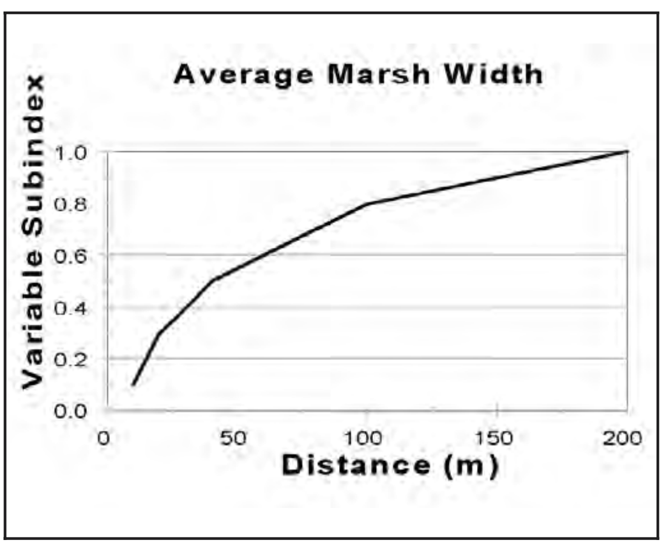


Figure B7. Relationship between average marsh width and functional capacity

12. V_{EXPOSE} Relative Exposure Index (REI)

(1) Measure fetch distances in kilometers for each of the 16 possible compass bearings.

(2) Using the map in Figure 3 in the main text (page 22), select the wind data station closest to your site.

(3) Using the supplemental information in Table E1 on mean annual wind speeds, calculate an REI using the equation below.

$$\text{Relative Exposure Index} = \sum_{i=1}^{16} V_i \times F_i \times P_i$$

where:

V_i = mean annual wind speed (km/hr)
F_i = fetch distance (km)
P_i = proportion of time wind blew from each of 16 cardinal and subcardinal compass directions

*Note: Relative Exposure Index (RSI) = 11.53

(4) Assign variable subindex based on Figure B8. *Subindex* 0.9

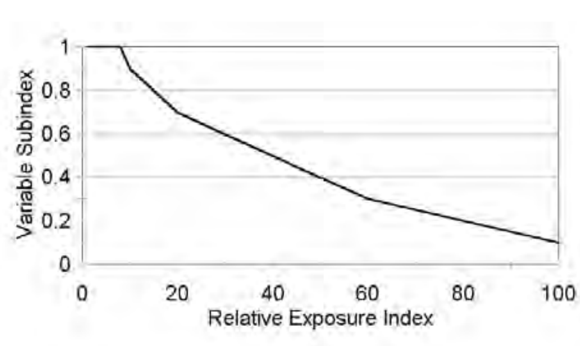


Figure B8. Relationship between relative exposure index and functional capacity

13. V_{SLOPE} Distance to navigation channel OR water depths ≥2 m *Subindex* 1.0

Table B9
Relationship Between Shoreline Slope and Functional Capacity

Distance	Subindex
<50 m	0.1
50-150 m	0.5
>150 m	1.0

*Note: Distance to navigation channel = 2,711.5 m.

14. V_{SOIL} Soil texture *Subindex* 0.4

Table B10
Relationship Between Soil Type and Functional Capacity

Predominant Soil Type	Subindex
Clay	1.0
Clay loam	0.8
Loam	0.6
Sandy loam	0.4
Sandy	0.2

TIDAL FRINGE MARSH HGM FUNCTIONAL ASSESSMENT

Sediment Deposition $= (V_{ROUGH} \times V_{HYDRO})^{1/2}$

(1.0 × 1.0) $^{1/2}$ = 1.0

Resident Nekton Utilization = $(V_{EDGE} + 2\ V_{HYDRO} + 0.5\ V_{NHC}) / 3.5$

(0.7 + 2 1.0 + 0.7 /2) / 3.5 = 0.871

Nonresident Nekton Utilization = $[(V_{EDGE} + 2\ V_{HYDRO} + 0.5\ V_{NHC}) / 3.5)\ V_{OMA}]^{1/2}$

[(0.7 + 2 1.0 + 0.5 0.7 / 3.5) × 0.2]$^{1/2}$ = 0.395

Invertebrate Prey Pool = $(V_{HYDRO} + V_{EDGE} + V_{COVER}) / 3$

(1.0 + 0.7 + 1.0) / 3 = 0.9

Nutrient and Organic Carbon Exchange = $(V_{VEGSTR} \times V_{HYDRO})^{1/2}$

(1.0 × 1.0)$^{1/2}$ = 1.0

Maintain Characteristic Plant Community Composition = V_{C0VER} or $V_{TYPICAL}$, whichever is lower

Min (1.0 or 1.0) = 1.0

Plant Biomass Production = V_{VEGSTR} = 1.0

Provide Wildlife Habitat = [2 V_{SIZE} + V_{WHC} + (Min (V_{COVER} OR $V_{TYPICAL}$))] / 4

(2 0.75 + 1.0 + 1.0) / 4 = 0.875

Shoreline Stabilization = $(V_{SLOPE} + V_{WIDTH} + V_{EXPOSE} + V_{ROUGH} + V_{SOIL}) / 5$

(1.0 + 0.1 + 0.9 + 1.0 + 0.4) / 5 = 0.68

FIELD DATA SHEET:
NORTHWEST GULF OF MEXICO TIDAL FRINGE MARSHES

Assessment Team: Triton Environmental Solutions

Project Name/Location: Channel Deepening Project/HI-E E2EM1P **Date:** 06/25/2023

Prior to conducting an assessment, establish the project area boundaries and delineate the wetland boundaries within the project area.

Sample variables 1-3 using aerial photos at a scale of 1 cm = 48 m (1: 4800 or 1 in. = 400 ft, digital ortho-photo quadrangle imagery, maps, etc.)

1. V_{EDGE} Degree of marsh dissection/edge:area ratio *Subindex* 1.0

(1) Using either the quantitative or qualitative approach, measure or estimate the edge:area ratio and assign a subindex value based on Table B1. See pictorial key in Appendix D (Figures D2-D9) for specific examples.

Table B1
Relationship Between Edge:Area and Functional Capacity

	Edge:Area		
Site Description	**Qualitative**	**Quantitative m/ha**	**Subindex**
1) Marsh shows signs of deterioration due to subsidence (i.e., highly fragmented with large amounts of open water. Vegetation occurs mainly in isolated hummocks or on natural levees along tidal creeks). Although edge:area is very high, this condition is not considered sustainable in the long term (Figure D2).	Very High	>800	0.8
1) Well-developed tidal drainage network present (Figure D3), OR **2)** Simple tidal drainage network (may consist of only a single channel) present with isolated ponds and depressions present in the marsh interior (Figures D4 and D5). **3)** Atypical geomorphic configuration with a large amount of shoreline relative to total area (i.e. small island or narrow peninsula) (Figure D7).	High	350-800	1.0
1) Simple tidal drainage network (may consist of only a single channel). Isolated ponds and depressions are few or lacking, OR **2)** Narrow fringe marsh that lacks tidal creeks. One lengthwise shoreline is exposed to tidal waters. Area of marsh is small relative to shoreline length (Figures D6 and D8).	Moderate	200-350	0.7
Marsh lacks both tidal creeks and isolated ponds and depressions. Shoreline is generally linear or smooth curvilinear without embayments or convolutions. Area of marsh is large relative to shoreline length (Figure D9).	Low	<200	0.4

*Note: Simple drainage network with isolated ponds/depressions present.

2. V_{OMA} Proportion of tidally connected edge to total edge *Subindex* 0.2

(1) Assign subindex value based on Table B2.

Table B2
Relationship Between Opportunity for Marsh Access and Functional Capacity

Tidally Connected Edge: Total Edge	Subindex
❑ 50-100%	1.0
❑ 35-50%	0.7
❑ 25-35%	0.5
☒ 1-25%	0.2
❑ No tidally connected edge present	0.0

3. V_{SIZE} Total Effective Patch Size *Subindex* 1.0

(1) If the core wetland size exceeds 200 ha, assign a variable subindex value of 1.0. The core wetland is defined as a contiguous patch of tidal fringe wetland that contains the WAA.

(2) If the core wetland size <200 ha, identify other patches of wetlands in the surrounding area, and record the size of each patch in hectares. These wetlands may be in a wetland subclass other than tidal fringe. Then, using the descriptions provided in Table B3, determine the degree of connectivity between each wetland patch and the core wetland.

Table B3
Determination of Corridor Connectivity

Corridor Type	Corridor Description	Multiplier
Contiguous corridor	**1)** Open water stretches <60 m (regardless of depth). **2)** Unvegetated stretches of shoreline or strips of other wetland subclasses <60 m in length that have an aquatic shelf at least 3 m wide and are <0.3 m deep at MSL. This discounts most tidal creeks and coves or unvegetated stretches of shoreline abutting uplands as barriers to wildlife that are traveling through their daily home range.	1.00
Partially impeded corridor	**1)** Open water stretches from 60-300 m (regardless of depth). **2)** Unvegetated shorelines or strips of other wetland subclasses from 60-500 m in length that have an aquatic shelf at least 3 m wide with water depths <0.3 m at MSL. Deeper stretches of water that interrupt the shelves are not considered impeding if they are <60 m wide. **3)** Stretches of undeveloped upland that are <30 m in width.	0.75
Impeded corridor	**1)** Shoreline shelves or wetland strips between 500-1200 m long. **2)** Stretches of undeveloped upland 30-300 m in width.	0.50
Corridor absent or barrier present	**1)** Open water stretches or undeveloped uplands >300 m in width. **2)** Shorelines >300 m long that contain no shelf with waters <0.3 m deep (i.e., long stretches of bulkheading). **3)** Roadways with >100 vehicle crossings per day that are unbridged or have a bridge opening <3 m wide. **4)** Highly developed urban, residential, or industrial areas.	0.0

(3) Multiply the size of the patch (ha) by the appropriate connectivity multiplier from the table above.

Size of Wetland (hectares)		Connectivity Multiplier	Product
Core wetland	62.6	1.0	1.0 (62.6)
Patch A	0.8	0.75	0.6
Patch B	0.07	0.50	0.035
Patch C	198.0	1.0	198.0
Patch D			
Patch E			

(4) Obtain the sum of all the products above. SUM 261.235

(5) Using Table B4, assign a variable subindex based on the value of the sum calculated above.

Table B4
Relationship Between Total Effective Patch Size and Functional Capacity

Total Effective Patch Size	**Subindex**
>200 ha	1.00
5-200 ha	0.75
1-5 ha	0.50
0.2-1 ha	0.25
<0.2 ha	0.10

Sample variables 4-8 based on an onsite field inspection of the project area and WAA.

4. V_{HYDRO} Hydrologic regime *Subindex* 0.6

(1) Assign subindex value based on Table B5.

Table B5
Relationship Between Hydrologic Regime and Functional Capacity

Site Condition	Subindex
Site is open to free exchange of tidal waters. No obvious hydrologic alteration or restrictions present.	1.0
Moderate hydrologic restriction present (i.e., presence of low-elevation berm, which is frequently overtopped by high tide events or has multiple breaches or large culverts).	0.6
Severe hydrologic restriction present (i.e., presence of high-elevation berm, which is infrequently overtopped by high tide events or has a single opening, breach or small culvert).	0.3
Site receives tidal floodwaters only during extreme storm tide events.	0.1
Site is isolated from tidal exchange. The principal source of flooding is water sources other than tidal action (i.e., precipitation or groundwater). *Note: If this condition exists, another wetland assessment model should be strongly considered unless the site was formerly a tidal wetland prior to hydrologic modification.*	0.0

*Note: Presence of berms, restricts free exchange in some portions of WAA. Several breaches present.

5. $V_{TYPICAL}$ Percent cover by typical plant species within the WAA 92.0 %

(1) Visually estimate the percentage of the site that is covered by nontypical, nonnative, or otherwise undesirable plant species (see Table B6). Subtract this number from 100 to estimate the percentage of the site that is occupied by plant species typical of the regional subclass. See the subclass profile in Chapter 2 for additional information. Appendix D also lists typical plant species that occur in saline, brackish, and intermediate marshes along the Texas coast.

Table B6
Possible Invasive or Undesirable Plant Species

Scientific Name	Common name	Salt/Brackish	Intermediate
Alternanthera philoxeroides	Alligator weed		L
Aster spinosus	Spiny aster		H
Phragmites australis	Common reed	H	L,H
Sesbania drummondii	Drummond's rattlebush		L,H
Typha spp.	Cattail	L	L
H = high marsh, L = low marsh.			

(2) Assign variable subindex based on Figure B1 *Subindex* 1.0

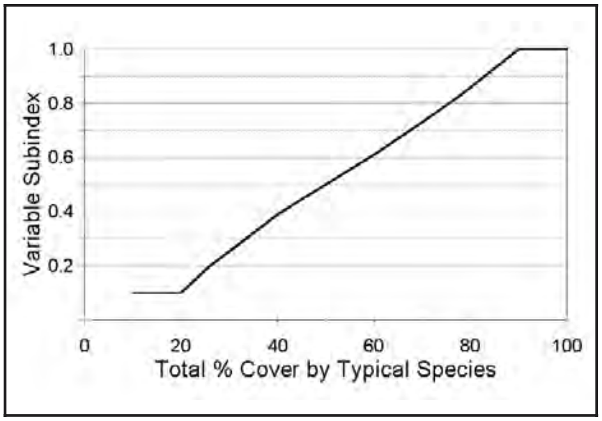


Figure B1. Relationship between percent cover by typical plant species and functional capacity

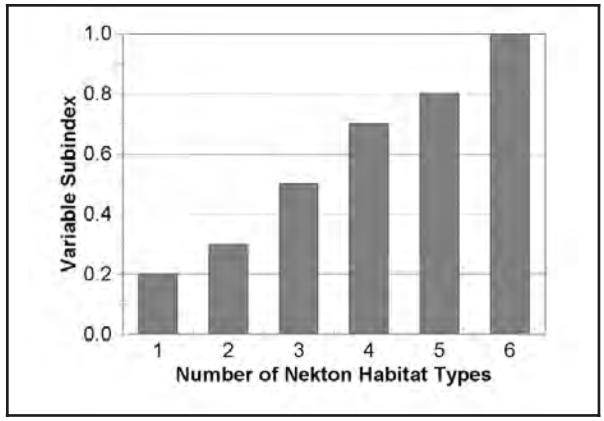


Figure B2. Relationship between nekton habitat complexity and functional capacity

6. V_{NHC} Nekton Habitat Complexity (# different habitat types)

(1) Check the habitats observed on or within a 30-m (100-ft) radius of project area perimeter.

Coarse woody debris ______ Unvegetated flats X Algal mats ______
Subtidal creeks/channels X Oyster reef X Mangroves X
Intertidal creeks/channels ______ Low marsh X High marsh X
Ponds or depressions ______ Submerged aquatic vegetation X

(2) Assign variable subindex based on the chart in Figure B2. *Subindex* 1.0

7. V_{WHC} Wildlife Habitat Complexity (total # different habitat types)

(1) Check those habitat types **IN ADDITION TO THOSE LISTED ABOVE** that are present on or within a 2-km radius of the project area perimeter.

Supratidal habitats (hummocks, logs) X Scrub-Shrub X Forested uplands _____
Unvegetated beach ________ Grasslands X

*Note: Also present within 2 km radius include intertidal creeks/channels, ponds/depressions, algal mats, and woody debris.

(2) Assign variable subindex based on the chart in Figure B3. *Subindex* 1.0

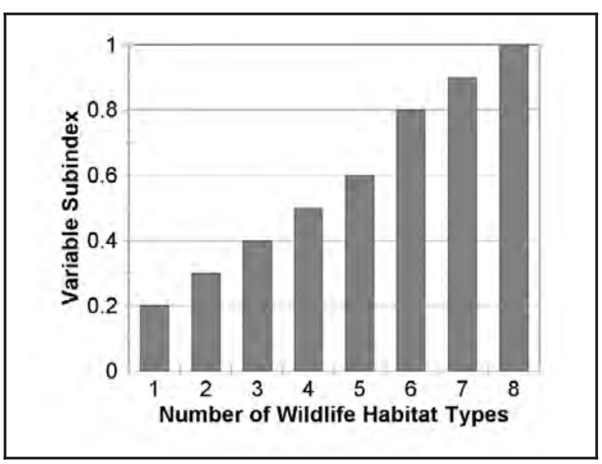


Figure B3. Relationship between wildlife habitat complexity and functional capacity

8. V_{ROUGH} Surface roughness (Manning's n)

(1) Choose a value for each of the three variables in the equation below based on the descriptions provided in Table B7.

$$\underline{0.025} + \underline{0.005} + \underline{0.035} = \underline{0.065}$$
$$n_{BASE} + n_{TOPO} + n_{VEG} = n$$

(2) Compute the sum of the three variables in the equation above.

(3) Assign variable subindex based on the chart in Figure B4. *Subindex* 0.5

Table B7
Relationship Between Roughness and Functional Capacity

Roughness Component	Adjustment to *n* Value			Description of Terms
Sediment surface (n_{BASE})	0.025			Base value for bare marsh soil.
	0.03			More than 25% of sediment surface covered with gravel or broken shell.
Topographic relief (n_{TOPO})	0.001			Representative area is flat with essentially no microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds).
	0.005			Microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds) cover 5-25% of a representative area.
	0.010			Microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds) cover 26-50% of a representative area.
	0.020			Microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds) cover >50% of a representative area.
Roughness Component	**Percent Cover**			
	<50	**50-75**	**76-100**	**Description of Conditions**
Vegetation (n_{VEG})	0.025	0.030	0.035	Representative area predominantly short, flexible-stemmed grasses (i.e., short *Spartina alterniflora, S. patens, Distichlis spicata*).
	0.035	0.040	0.050	Vegetation in representative area predominantly short, with stiff, trailing stems (i.e., *Batis maritima*, *Salicornia virginica*).
	0.050	0.060	0.070	Representative area predominantly tall, flexible-stemmed grasses (i.e., tall *Spartina alterniflora, S. cynosuroides, Scirpus sp.*).
	0.070	0.100	0.160	Vegetation in representative area predominantly tall, with stiff leaves (i.e., *Juncus roemerianus*) or mixed woody shrubs (i.e., mangroves).

Note: Adapted from Arcement and Schneider (1989) and Gardiner and Dakombe (1983).

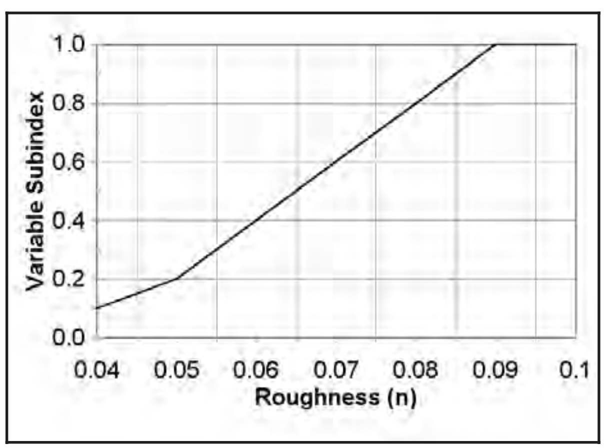


Figure B4. Relationship between surface roughness (n) and functional capacity

Sample variables 9 and 10 based on a representative number of locations in the WAA using a series of 1-m^2 plots arranged along one or more 30-m (100-ft) transects oriented perpendicular to the wetland shoreline or the hydrologic gradient.

9. V_{COVER} Mean Total Percent Vegetative Cover 100.0 %

(1) Select one or more representative areas within the site for sampling. Beginning at the shoreward edge of the marsh, establish one or more 30-m transects perpendicular to the shoreline or along the hydrologic gradient (e.g. increasing elevation). If there are multiple vegetation community types within the WAA, the transect should intersect each vegetation community, in order to ensure a representative sample.

(2) Using a standard 1-m^2 frame, estimate total percent cover by **both live and dead** emergent macrophytic plant species at intervals along the transect, excluding any areas where water depths are too deep to support the growth of emergent vegetation. The number of transects and plots needed will depend on the size and heterogeneity of the site; **a minimum of 10 plots should be used**.

(3) Calculate the average of all total percent cover estimates.

(4) Assign variable subindex for V_{COVER} based on the chart in Figure B5. *Subindex* 1.0

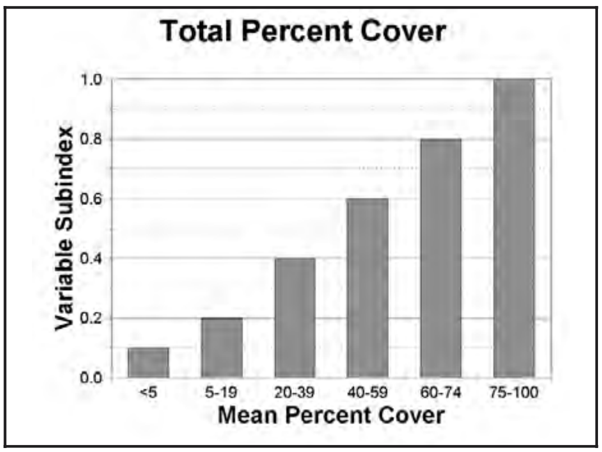


Figure B5. Relationship between mean total percent cover and functional capacity

10. V_{VEGSTR} Mean Vegetative Structure Index

(4) If the 1-m^2 sample plot above contains more than one species (i.e., *Spartina* and *Distichlis*), estimate the proportion of the 1-m^2 plot area covered by each species, omitting any species that occupies <10% cover. If the total percent cover above was estimated at 80%, the sum of the percent cover of each individual species should be 80%. There may be cases where there are several species that individually account for <10% cover, but collectively amount to 10%. In these cases, estimate the cumulative percent cover for the species group.

(5) For each species identified above, estimate the height in centimeters (rounded to the nearest 5 cm) at which the bulk of the biomass occurs (i.e., the most frequently occurring height) and record this value. For those species with trailing stems, the height should be measured in situ rather than extended vertically. Record an estimated height for the species group, if necessary.

(6) Calculate a vegetative structure index for **each** plot using the equation below.

V_{VEGSTR} = ((Hgt$_1$ × Proportion$_1$) + (Hgt$_2$ × Proportion$_2$) + ... (Hgt$_x$ × Proportion$_x$))

where: x = # plant species per plot.

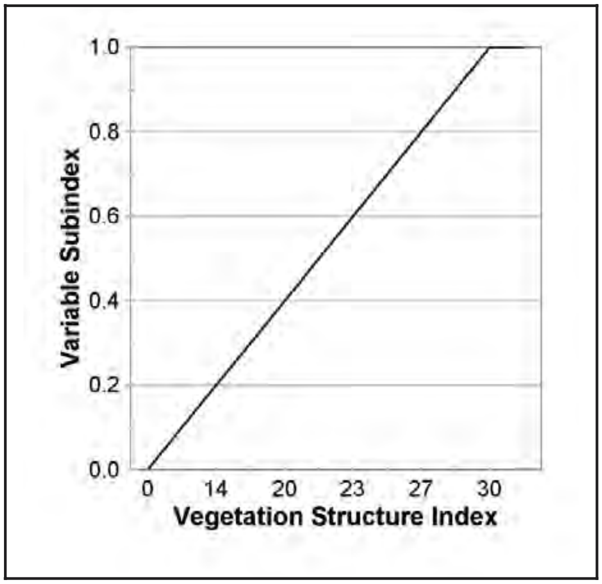
[(_____ × _____) + (_____ × _____) + (_____ × _____)] = _______

(7) Compute the sum of all the vegetative structure indices generated above. _________

(8) Divide by the total number of plots to determine the mean. _________

(9) Assign a subindex value based on the chart in Figure B6. *Subindex* 1.0*

Figure B6. Relationship between vegetation structure index and functional capacity



*Note: No direct vegetative height field measurement data collected for any species. Vegetative Structure Index assumed to be >30 = 1.0 Variable Subindex.

Variables 11-14 are assessed only for the Shoreline Stabilization Function.

First, conduct a field site inspection and determine if there are any visual indicators of shoreline erosion within the project area. Examples of this include slumping banks, undercut banks, exposed root mats, or vertical bluffs along the shoreline (See Figure D1 for examples). If any of these features exist, assign a variable subindex to each of the following variables using the procedures outlined below and calculate a functional capacity index for this function. Otherwise, assign a default functional capacity index of 1.0 to this function, indicating the presence of a stable, non-eroding shoreline.

11. V_{WIDTH} Mean width of the marsh

(1) Using a recent aerial photo or direct field survey, establish a baseline along the lengthwise axis that runs roughly parallel to the shoreline and/or perpendicular to the topographic gradient.

(2) Draw a series of transects perpendicular to this baseline from the shoreline to the nearest upland and measure or estimate the average width of the marsh in meters (Figure 4). The number of transects is determined by the length of the baseline (Table B8).

Table B8
Number of Transects for Estimating Mean Marsh Width

Baseline Length (m)	Number of Transects
<300	3
300-1,500	5
1,500-3,000	7
>3,000	9

1____ m   2 ____ m   3 ____ m   4 ____ m   5____ m *Note: Mean marsh width = 79.43 m

(3) Determine the average of the widths recorded above.

(4) Assign a variable subindex based on Figure B7.   *Subindex* 0.7

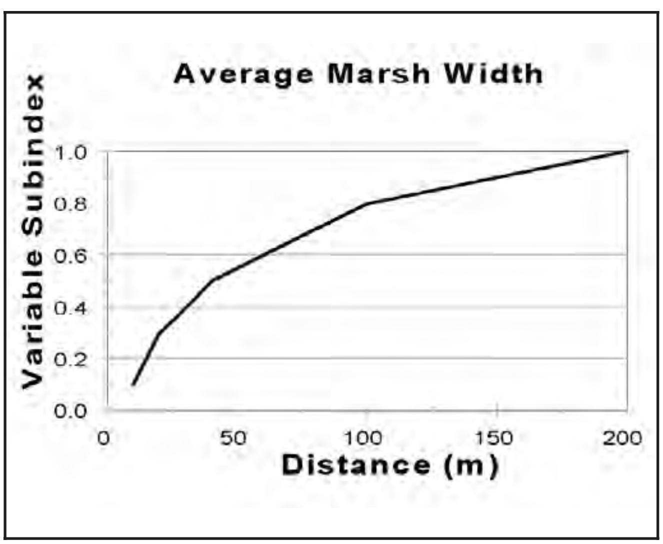


Figure B7. Relationship between average marsh width and functional capacity

12. V_{EXPOSE} Relative Exposure Index (REI)

(1) Measure fetch distances in kilometers for each of the 16 possible compass bearings.

(2) Using the map in Figure 3 in the main text (page 22), select the wind data station closest to your site.

(3) Using the supplemental information in Table E1 on mean annual wind speeds, calculate an REI using the equation below.

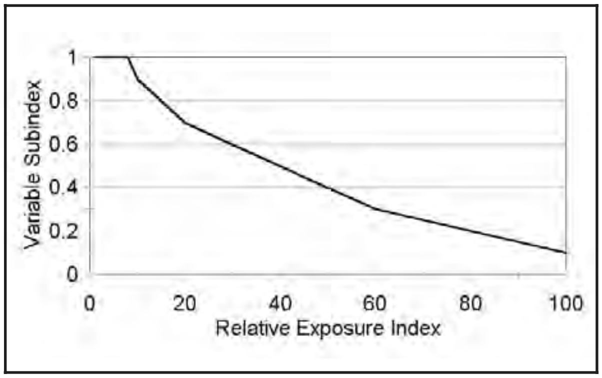
$$\text{Relative Exposure Index} = \sum_{i=1}^{16} V_i \times F_i \times P_i$$

where:
- V_i = mean annual wind speed (km/hr)
- F_i = fetch distance (km)
- P_i = proportion of time wind blew from each of 16 cardinal and subcardinal compass directions

*Note: Relative Exposure Index (RSI) = 9.85

(4) Assign variable subindex based on Figure B8. *Subindex* 0.9

Figure B8. Relationship between relative exposure index and functional capacity



13. V_{SLOPE} Distance to navigation channel OR water depths ≥2 m *Subindex* 1.0

Table B9
Relationship Between Shoreline Slope and Functional Capacity

Distance	Subindex
<50 m	0.1
50-150 m	0.5
>150 m	1.0

*Note: Distance to navigation channel = 178.8 m.

14. V_{SOIL} Soil texture *Subindex* 0.4

Table B10
Relationship Between Soil Type and Functional Capacity

Predominant Soil Type	Subindex
Clay	1.0
Clay loam	0.8
Loam	0.6
Sandy loam	0.4
Sandy	0.2

TIDAL FRINGE MARSH HGM FUNCTIONAL ASSESSMENT

Sediment Deposition = $(V_{ROUGH} \times V_{HYDRO})^{1/2}$

(0.5 × 0.6) $^{1/2}$ = 0.547

Resident Nekton Utilization = $(V_{EDGE} + 2\ V_{HYDRO} + 0.5\ V_{NHC})$ / 3.5

(1.0 + 2 0.6 + 1.0 /2) / 3.5 = 0.771

Nonresident Nekton Utilization = $[(V_{EDGE} + 2\ V_{HYDRO} + 0.5\ V_{NHC}) / 3.5)\ V_{OMA}]^{1/2}$

[(1.0 + 2 0.6 + 0.5 1.0 / 3.5) × 0.2]$^{1/2}$ = 0.358

Invertebrate Prey Pool = $(V_{HYDRO} + V_{EDGE} + V_{COVER})$ / 3

(0.6 + 1.0 + 1.0) / 3 = 0.867

Nutrient and Organic Carbon Exchange = $(V_{VEGSTR} \times V_{HYDRO})^{1/2}$

(1.0 × 0.6)$^{1/2}$ = 0.775

Maintain Characteristic Plant Community Composition = V_{C0VER} or $V_{TYPICAL}$, whichever is lower

Min (1.0 or 1.0) = 1.0

Plant Biomass Production = V_{VEGSTR} = 1.0

Provide Wildlife Habitat = [2 V_{SIZE} + V_{WHC} + (Min (V_{COVER} OR $V_{TYPICAL}$))] / 4

(2 1.0 + 1.0 + 1.0) / 4 = 1.0

Shoreline Stabilization = $(V_{SLOPE} + V_{WIDTH} + V_{EXPOSE} + V_{ROUGH} + V_{SOIL})$ / 5

(1.0 + 0.7 + 0.9 + 0.5 + 0.4) / 5 = 0.7

FIELD DATA SHEET:
NORTHWEST GULF OF MEXICO TIDAL FRINGE MARSHES

Assessment Team: Triton Environmental Solutions

Project Name/Location: Channel Deepening Project/HI-E E2SS3N **Date:** 06/25/2023

Prior to conducting an assessment, establish the project area boundaries and delineate the wetland boundaries within the project area.

Sample variables 1-3 using aerial photos at a scale of 1 cm = 48 m (1: 4800 or 1 in. = 400 ft, digital ortho-photo quadrangle imagery, maps, etc.)

1. V_{EDGE} Degree of marsh dissection/edge:area ratio *Subindex* 1.0

(1) Using either the quantitative or qualitative approach, measure or estimate the edge:area ratio and assign a subindex value based on Table B1. See pictorial key in Appendix D (Figures D2-D9) for specific examples.

Table B1
Relationship Between Edge:Area and Functional Capacity

	Edge:Area		
Site Description	**Qualitative**	**Quantitative m/ha**	**Subindex**
1) Marsh shows signs of deterioration due to subsidence (i.e., highly fragmented with large amounts of open water. Vegetation occurs mainly in isolated hummocks or on natural levees along tidal creeks). Although edge:area is very high, this condition is not considered sustainable in the long term (Figure D2).	Very High	>800	0.8
1) Well-developed tidal drainage network present (Figure D3), OR **2)** Simple tidal drainage network (may consist of only a single channel) present with isolated ponds and depressions present in the marsh interior (Figures D4 and D5). **3)** Atypical geomorphic configuration with a large amount of shoreline relative to total area (i.e. small island or narrow peninsula) (Figure D7).	High	350-800	1.0
1) Simple tidal drainage network (may consist of only a single channel). Isolated ponds and depressions are few or lacking, OR **2)** Narrow fringe marsh that lacks tidal creeks. One lengthwise shoreline is exposed to tidal waters. Area of marsh is small relative to shoreline length (Figures D6 and D8).	Moderate	200-350	0.7
Marsh lacks both tidal creeks and isolated ponds and depressions. Shoreline is generally linear or smooth curvilinear without embayments or convolutions. Area of marsh is large relative to shoreline length (Figure D9).	Low	<200	0.4

*Note: Simple drainage network with isolated ponds/depressions present.

2. V_{OMA} Proportion of tidally connected edge to total edge *Subindex* 1.0

(1) Assign subindex value based on Table B2.

Table B2
Relationship Between Opportunity for Marsh Access and Functional Capacity

Tidally Connected Edge: Total Edge	Subindex
☒ 50-100%	1.0
☐ 35-50%	0.7
☐ 25-35%	0.5
☐ 1-25%	0.2
☐ No tidally connected edge present	0.0

3. V_{SIZE} Total Effective Patch Size *Subindex* 1.0

(1) If the core wetland size exceeds 200 ha, assign a variable subindex value of 1.0. The core wetland is defined as a contiguous patch of tidal fringe wetland that contains the WAA.

(2) If the core wetland size <200 ha, identify other patches of wetlands in the surrounding area, and record the size of each patch in hectares. These wetlands may be in a wetland subclass other than tidal fringe. Then, using the descriptions provided in Table B3, determine the degree of connectivity between each wetland patch and the core wetland.

Table B3
Determination of Corridor Connectivity

Corridor Type	Corridor Description	Multiplier
Contiguous corridor	**1)** Open water stretches <60 m (regardless of depth). **2)** Unvegetated stretches of shoreline or strips of other wetland subclasses <60 m in length that have an aquatic shelf at least 3 m wide and are <0.3 m deep at MSL. This discounts most tidal creeks and coves or unvegetated stretches of shoreline abutting uplands as barriers to wildlife that are traveling through their daily home range.	1.00
Partially impeded corridor	**1)** Open water stretches from 60-300 m (regardless of depth). **2)** Unvegetated shorelines or strips of other wetland subclasses from 60-500 m in length that have an aquatic shelf at least 3 m wide with water depths <0.3 m at MSL. Deeper stretches of water that interrupt the shelves are not considered impeding if they are <60 m wide. **3)** Stretches of undeveloped upland that are <30 m in width.	0.75
Impeded corridor	**1)** Shoreline shelves or wetland strips between 500-1200 m long. **2)** Stretches of undeveloped upland 30-300 m in width.	0.50
Corridor absent or barrier present	**1)** Open water stretches or undeveloped uplands >300 m in width. **2)** Shorelines >300 m long that contain no shelf with waters <0.3 m deep (i.e., long stretches of bulkheading). **3)** Roadways with >100 vehicle crossings per day that are unbridged or have a bridge opening <3 m wide. **4)** Highly developed urban, residential, or industrial areas.	0.0

(3) Multiply the size of the patch (ha) by the appropriate connectivity multiplier from the table above.

Size of Wetland (hectares)		Connectivity Multiplier	Product
Core wetland	62.6	1.0	1.0 (62.6)
Patch A	0.8	0.75	0.6
Patch B	0.07	0.50	0.035
Patch C	198.0	1.0	198.0
Patch D			
Patch E			

(4) Obtain the sum of all the products above. SUM 261.235

(5) Using Table B4, assign a variable subindex based on the value of the sum calculated above.

Table B4
Relationship Between Total Effective Patch Size and Functional Capacity

Total Effective Patch Size	Subindex
>200 ha	1.00
5-200 ha	0.75
1-5 ha	0.50
0.2-1 ha	0.25
<0.2 ha	0.10

Sample variables 4-8 based on an onsite field inspection of the project area and WAA.

4. V_{HYDRO} Hydrologic regime *Subindex* 0.6

(1) Assign subindex value based on Table B5.

Table B5
Relationship Between Hydrologic Regime and Functional Capacity

Site Condition	Subindex
Site is open to free exchange of tidal waters. No obvious hydrologic alteration or restrictions present.	1.0
Moderate hydrologic restriction present (i.e., presence of low-elevation berm, which is frequently overtopped by high tide events or has multiple breaches or large culverts).	0.6
Severe hydrologic restriction present (i.e., presence of high-elevation berm, which is infrequently overtopped by high tide events or has a single opening, breach or small culvert).	0.3
Site receives tidal floodwaters only during extreme storm tide events.	0.1
Site is isolated from tidal exchange. The principal source of flooding is water sources other than tidal action (i.e., precipitation or groundwater). *Note: If this condition exists, another wetland assessment model should be strongly considered unless the site was formerly a tidal wetland prior to hydrologic modification.*	0.0

*Note: Presence of berms, restricts free exchange in some portions of WAA. Several breaches present.

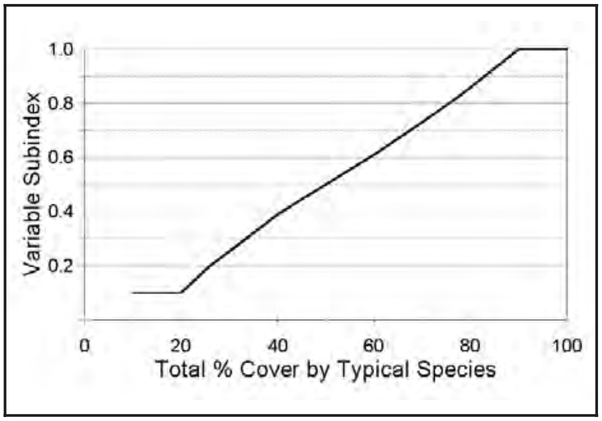
5. $V_{TYPICAL}$ Percent cover by typical plant species within the WAA 71.7 %

(1) Visually estimate the percentage of the site that is covered by nontypical, nonnative, or otherwise undesirable plant species (see Table B6). Subtract this number from 100 to estimate the percentage of the site that is occupied by plant species typical of the regional subclass. See the subclass profile in Chapter 2 for additional information. Appendix D also lists typical plant species that occur in saline, brackish, and intermediate marshes along the Texas coast.

Table B6
Possible Invasive or Undesirable Plant Species

Scientific Name	Common name	Salt/Brackish	Intermediate
Alternanthera philoxeroides	Alligator weed		L
Aster spinosus	Spiny aster		H
Phragmites australis	Common reed	H	L,H
Sesbania drummondii	Drummond's rattlebush		L,H
Typha spp.	Cattail	L	L
H = high marsh, L = low marsh.			

(2) Assign variable subindex based on Figure B1 *Subindex* 0.7



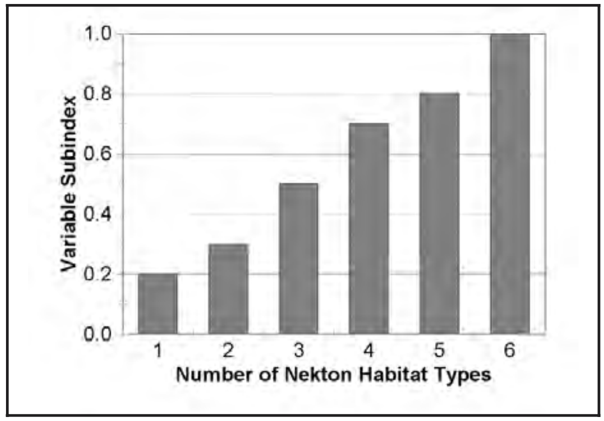


Figure B1. Relationship between percent cover by typical plant species and functional capacity

Figure B2. Relationship between nekton habitat complexity and functional capacity

6. V_{NHC} Nekton Habitat Complexity (# different habitat types)

(1) Check the habitats observed on or within a 30-m (100-ft) radius of project area perimeter.

Coarse woody debris	____	Unvegetated flats	X	Algal mats	X
Subtidal creeks/channels	X	Oyster reef	X	Mangroves	X
Intertidal creeks/channels	____	Low marsh	X	High marsh	X
Ponds or depressions	____	Submerged aquatic vegetation	X		

(2) Assign variable subindex based on the chart in Figure B2. *Subindex* 1.0

7. V_{WHC} Wildlife Habitat Complexity (total # different habitat types)

(1) Check those habitat types **IN ADDITION TO THOSE LISTED ABOVE** that are present on or within a 2-km radius of the project area perimeter.

Supratidal habitats (hummocks, logs)	X	Scrub-Shrub	X	Forested uplands	____
Unvegetated beach	____	Grasslands	X		

*Note: Also present within 2 km radius include intertidal creeks/channels, ponds/depressions, and woody debris.

(2) Assign variable subindex based on the chart in Figure B3. *Subindex* 1.0

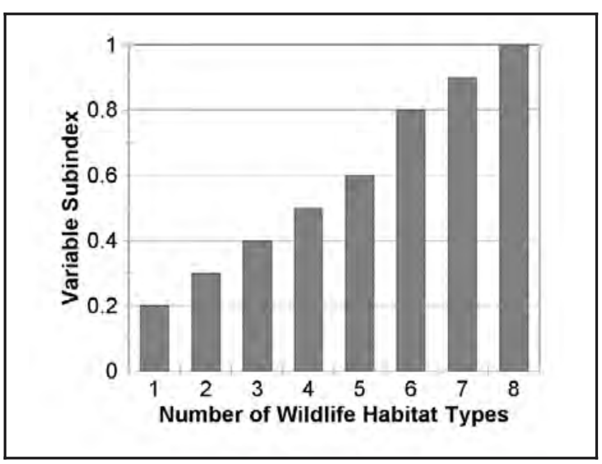


Figure B3. Relationship between wildlife habitat complexity and functional capacity

8. V_{ROUGH} Surface roughness (Manning's *n*)

(1) Choose a value for each of the three variables in the equation below based on the descriptions provided in Table B7.

$$\underline{0.025} + \underline{0.005} + \underline{0.160} = \underline{0.190}$$
$$n_{BASE} + n_{TOPO} + n_{VEG} = n$$

(2) Compute the sum of the three variables in the equation above.

(3) Assign variable subindex based on the chart in Figure B4. *Subindex* 1.0

Table B7
Relationship Between Roughness and Functional Capacity

Roughness Component	Adjustment to *n* Value			Description of Terms
Sediment surface (n_{BASE})	0.025			Base value for bare marsh soil.
	0.03			More than 25% of sediment surface covered with gravel or broken shell.
Topographic relief (n_{TOPO})	0.001			Representative area is flat with essentially no microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds).
	0.005			Microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds) cover 5-25% of a representative area.
	0.010			Microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds) cover 26-50% of a representative area.
	0.020			Microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds) cover >50% of a representative area.
Roughness Component	**Percent Cover**			**Description of Conditions**
	<50	**50-75**	**76-100**	
Vegetation (n_{VEG})	0.025	0.030	0.035	Representative area predominantly short, flexible-stemmed grasses (i.e., short *Spartina alterniflora, S. patens, Distichlis spicata*).
	0.035	0.040	0.050	Vegetation in representative area predominantly short, with stiff, trailing stems (i.e., *Batis maritima*, *Salicornia virginica*).
	0.050	0.060	0.070	Representative area predominantly tall, flexible-stemmed grasses (i.e., tall *Spartina alterniflora, S. cynosuroides, Scirpus sp.*).
	0.070	0.100	0.160	Vegetation in representative area predominantly tall, with stiff leaves (i.e., *Juncus roemerianus*) or mixed woody shrubs (i.e., mangroves).

Note: Adapted from Arcement and Schneider (1989) and Gardiner and Dakombe (1983).

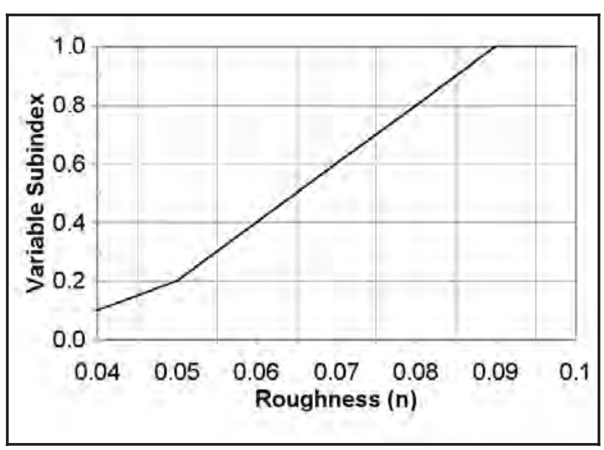


Figure B4. Relationship between surface roughness (*n*) and functional capacity

Sample variables 9 and 10 based on a representative number of locations in the WAA using a series of 1-m^2 plots arranged along one or more 30-m (100-ft) transects oriented perpendicular to the wetland shoreline or the hydrologic gradient.

9. V_{COVER} Mean Total Percent Vegetative Cover ___100.0___%

(1) Select one or more representative areas within the site for sampling. Beginning at the shoreward edge of the marsh, establish one or more 30-m transects perpendicular to the shoreline or along the hydrologic gradient (e.g. increasing elevation). If there are multiple vegetation community types within the WAA, the transect should intersect each vegetation community, in order to ensure a representative sample.

(2) Using a standard 1-m^2 frame, estimate total percent cover by **both live and dead** emergent macrophytic plant species at intervals along the transect, excluding any areas where water depths are too deep to support the growth of emergent vegetation. The number of transects and plots needed will depend on the size and heterogeneity of the site; **a minimum of 10 plots should be used**.

(3) Calculate the average of all total percent cover estimates.

(4) Assign variable subindex for V_{COVER} based on the chart in Figure B5. *Subindex* ___1.0___

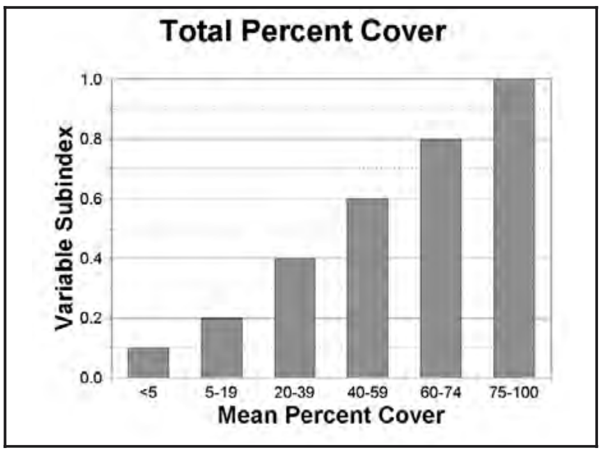


Figure B5. Relationship between mean total percent cover and functional capacity

10. V_{VEGSTR} Mean Vegetative Structure Index

(4) If the 1-m^2 sample plot above contains more than one species (i.e., *Spartina* and *Distichlis*), estimate the proportion of the 1-m^2 plot area covered by each species, omitting any species that occupies <10% cover. If the total percent cover above was estimated at 80%, the sum of the percent cover of each individual species should be 80%. There may be cases where there are several species that individually account for <10% cover, but collectively amount to 10%. In these cases, estimate the cumulative percent cover for the species group.

(5) For each species identified above, estimate the height in centimeters (rounded to the nearest 5 cm) at which the bulk of the biomass occurs (i.e., the most frequently occurring height) and record this value. For those species with trailing stems, the height should be measured in situ rather than extended vertically. Record an estimated height for the species group, if necessary.

(6) Calculate a vegetative structure index for **each** plot using the equation below.

V_{VEGSTR} = ((Hgt$_1$ × Proportion$_1$) + (Hgt$_2$ × Proportion$_2$) + ... (Hgt$_x$ × Proportion$_x$))

where: x = # plant species per plot.

[(_____ × _____) + (_____ × _____) + (_____ × _____)] = _______

(7) Compute the sum of all the vegetative structure indices generated above. _________

(8) Divide by the total number of plots to determine the mean. _________

(9) Assign a subindex value based on the chart in Figure B6. *Subindex* 1.0*

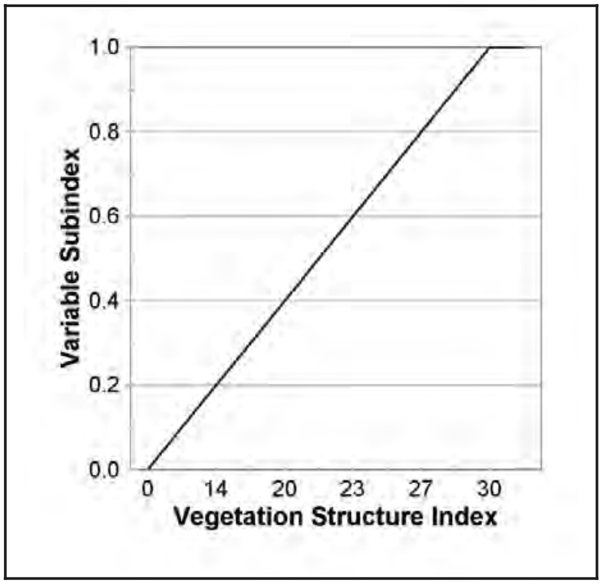


Figure B6. Relationship between vegetation structure index and functional capacity

*Note: No direct vegetative height field measurement data collected for any species. Vegetative Structure Index assumed to be >30 = 1.0 Variable Subindex.

Variables 11-14 are assessed only for the Shoreline Stabilization Function.

First, conduct a field site inspection and determine if there are any visual indicators of shoreline erosion within the project area. Examples of this include slumping banks, undercut banks, exposed root mats, or vertical bluffs along the shoreline (See Figure D1 for examples). If any of these features exist, assign a variable subindex to each of the following variables using the procedures outlined below and calculate a functional capacity index for this function. Otherwise, assign a default functional capacity index of 1.0 to this function, indicating the presence of a stable, non-eroding shoreline.

11. V_{WIDTH} Mean width of the marsh

(1) Using a recent aerial photo or direct field survey, establish a baseline along the lengthwise axis that runs roughly parallel to the shoreline and/or perpendicular to the topographic gradient.

(2) Draw a series of transects perpendicular to this baseline from the shoreline to the nearest upland and measure or estimate the average width of the marsh in meters (Figure 4). The number of transects is determined by the length of the baseline (Table B8).

Table B8
Number of Transects for Estimating Mean Marsh Width

Baseline Length (m)	Number of Transects
<300	3
300-1,500	5
1,500-3,000	7
>3,000	9

1____ m 2 ____ m 3 ____ m 4 ____ m 5____ m *Note: Mean marsh width = 27.66 m

(3) Determine the average of the widths recorded above.

(4) Assign a variable subindex based on Figure B7. *Subindex* 0.4

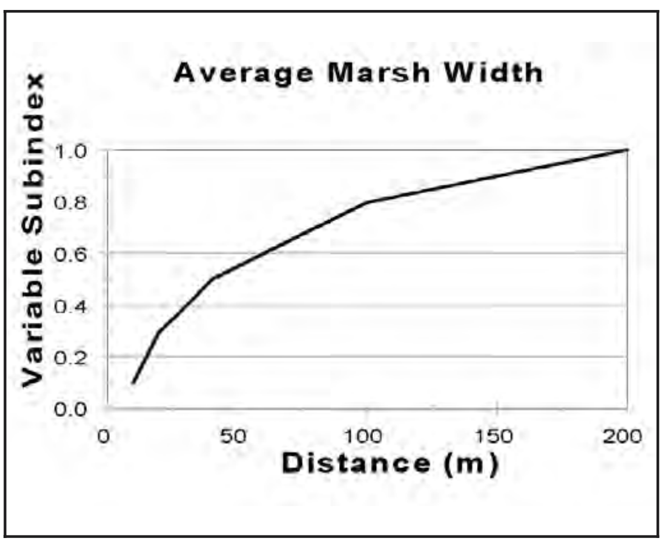


Figure B7. Relationship between average marsh width and functional capacity

12. V_{EXPOSE} Relative Exposure Index (REI)

(1) Measure fetch distances in kilometers for each of the 16 possible compass bearings.

(2) Using the map in Figure 3 in the main text (page 22), select the wind data station closest to your site.

(3) Using the supplemental information in Table E1 on mean annual wind speeds, calculate an REI using the equation below.

$$\text{Relative Exposure Index} = \sum_{i=1}^{16} V_i \times F_i \times P_i$$

where:

V_i = mean annual wind speed (km/hr)
F_i = fetch distance (km)
P_i = proportion of time wind blew from each of 16 cardinal and subcardinal compass directions

*Note: Relative Exposure Index (RSI) = 9.85

(4) Assign variable subindex based on Figure B8. *Subindex* 0.9

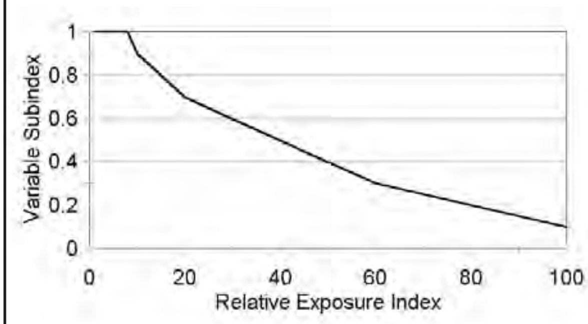


Figure B8. Relationship between relative exposure index and functional capacity

13. V_{SLOPE} Distance to navigation channel OR water depths ≥2 m *Subindex* 1.0

Table B9
Relationship Between Shoreline Slope and Functional Capacity

Distance	Subindex
<50 m	0.1
50-150 m	0.5
>150 m	1.0

*Note: Distance to navigation channel = 178.8 m.

14. V_{SOIL} Soil texture *Subindex* 0.4

Table B10 Relationship Between Soil Type and Functional Capacity	
Predominant Soil Type	**Subindex**
Clay	1.0
Clay loam	0.8
Loam	0.6
Sandy loam	0.4
Sandy	0.2

TIDAL FRINGE MARSH HGM FUNCTIONAL ASSESSMENT

Sediment Deposition = $(V_{ROUGH} \times V_{HYDRO})^{1/2}$

(1.0 × 0.6) $^{1/2}$ = 0.775

Resident Nekton Utilization = $(V_{EDGE} + 2\ V_{HYDRO} + 0.5\ V_{NHC})$ / 3.5

(1.0 + 2 0.6 + 1.0 /2) / 3.5 = 0.771

Nonresident Nekton Utilization = $[(V_{EDGE} + 2\ V_{HYDRO} + 0.5\ V_{NHC}) / 3.5)\ V_{OMA}]^{1/2}$

[(1.0 + 2 0.6 + 0.5 1.0 / 3.5) × 1.0 $]^{1/2}$ = 0.802

Invertebrate Prey Pool = $(V_{HYDRO} + V_{EDGE} + V_{COVER})$ / 3

(0.6 + 1.0 + 1.0) / 3 = 0.867

Nutrient and Organic Carbon Exchange = $(V_{VEGSTR} \times V_{HYDRO})^{1/2}$

(1.0 × 0.6 $)^{1/2}$ = 0.775

Maintain Characteristic Plant Community Composition = V_{C0VER} or $V_{TYPICAL}$, whichever is lower

Min (1.0 or 0.7) = 0.7

Plant Biomass Production = V_{VEGSTR} = 1.0

Provide Wildlife Habitat = [2 V_{SIZE} + V_{WHC} + (Min (V_{COVER} OR $V_{TYPICAL}$))] / 4

(2 1.0 + 1.0 + 0.7) / 4 = 0.925

Shoreline Stabilization = $(V_{SLOPE} + V_{WIDTH} + V_{EXPOSE} + V_{ROUGH} + V_{SOIL})$ / 5

(1.0 + 0.4 + 0.9 + 1.0 + 0.4) / 5 = 0.74

FIELD DATA SHEET:
NORTHWEST GULF OF MEXICO TIDAL FRINGE MARSHES

Assessment Team: Triton Environmental Solutions

Project Name/Location: Channel Deepening Project/32.94-acre Estuarine Mitigation Site **Date:** 07/08/2023

Prior to conducting an assessment, establish the project area boundaries and delineate the wetland boundaries within the project area.

Sample variables 1-3 using aerial photos at a scale of 1 cm = 48 m (1: 4800 or 1 in. = 400 ft, digital ortho-photo quadrangle imagery, maps, etc.)

1. V_{EDGE} Degree of marsh dissection/edge:area ratio *Subindex* 0.7

(1) Using either the quantitative or qualitative approach, measure or estimate the edge:area ratio and assign a subindex value based on Table B1. See pictorial key in Appendix D (Figures D2-D9) for specific examples.

Table B1
Relationship Between Edge:Area and Functional Capacity

Site Description	Edge:Area		Subindex
	Qualitative	**Quantitative m/ha**	
1) Marsh shows signs of deterioration due to subsidence (i.e., highly fragmented with large amounts of open water. Vegetation occurs mainly in isolated hummocks or on natural levees along tidal creeks). Although edge:area is very high, this condition is not considered sustainable in the long term (Figure D2).	Very High	>800	0.8
1) Well-developed tidal drainage network present (Figure D3), OR **2)** Simple tidal drainage network (may consist of only a single channel) present with isolated ponds and depressions present in the marsh interior (Figures D4 and D5). **3)** Atypical geomorphic configuration with a large amount of shoreline relative to total area (i.e. small island or narrow peninsula) (Figure D7).	High	350-800	1.0
1) Simple tidal drainage network (may consist of only a single channel). Isolated ponds and depressions are few or lacking, OR **2)** Narrow fringe marsh that lacks tidal creeks. One lengthwise shoreline is exposed to tidal waters. Area of marsh is small relative to shoreline length (Figures D6 and D8).	Moderate	200-350	0.7
Marsh lacks both tidal creeks and isolated ponds and depressions. Shoreline is generally linear or smooth curvilinear without embayments or convolutions. Area of marsh is large relative to shoreline length (Figure D9).	Low	<200	0.4

*Note: Quantitatively estimated - measurement of edge included proposed channel. Simple tidal drainage network, consisting of at least one channel, ponds/depression assumed to be lacking.

2. V_{OMA} Proportion of tidally connected edge to total edge *Subindex* 1.0

(1) Assign subindex value based on Table B2.

Table B2
Relationship Between Opportunity for Marsh Access and Functional Capacity

Tidally Connected Edge: Total Edge	Subindex
☒ 50-100%	1.0
☐ 35-50%	0.7
☐ 25-35%	0.5
☐ 1-25%	0.2
☐ No tidally connected edge present	0.0

3. V_{SIZE} Total Effective Patch Size *Subindex* 0.75

(1) If the core wetland size exceeds 200 ha, assign a variable subindex value of 1.0. The core wetland is defined as a contiguous patch of tidal fringe wetland that contains the WAA.

(2) If the core wetland size <200 ha, identify other patches of wetlands in the surrounding area, and record the size of each patch in hectares. These wetlands may be in a wetland subclass other than tidal fringe. Then, using the descriptions provided in Table B3, determine the degree of connectivity between each wetland patch and the core wetland.

Table B3
Determination of Corridor Connectivity

Corridor Type	Corridor Description	Multiplier
Contiguous corridor	**1)** Open water stretches <60 m (regardless of depth). **2)** Unvegetated stretches of shoreline or strips of other wetland subclasses <60 m in length that have an aquatic shelf at least 3 m wide and are <0.3 m deep at MSL. This discounts most tidal creeks and coves or unvegetated stretches of shoreline abutting uplands as barriers to wildlife that are traveling through their daily home range.	1.00
Partially impeded corridor	**1)** Open water stretches from 60-300 m (regardless of depth). **2)** Unvegetated shorelines or strips of other wetland subclasses from 60-500 m in length that have an aquatic shelf at least 3 m wide with water depths <0.3 m at MSL. Deeper stretches of water that interrupt the shelves are not considered impeding if they are <60 m wide. **3)** Stretches of undeveloped upland that are <30 m in width.	0.75
Impeded corridor	**1)** Shoreline shelves or wetland strips between 500-1200 m long. **2)** Stretches of undeveloped upland 30-300 m in width.	0.50
Corridor absent or barrier present	**1)** Open water stretches or undeveloped uplands >300 m in width. **2)** Shorelines >300 m long that contain no shelf with waters <0.3 m deep (i.e., long stretches of bulkheading). **3)** Roadways with >100 vehicle crossings per day that are unbridged or have a bridge opening <3 m wide. **4)** Highly developed urban, residential, or industrial areas.	0.0

(3) Multiply the size of the patch (ha) by the appropriate connectivity multiplier from the table above.

Size of Wetland (hectares)		Connectivity Multiplier	Product
Core wetland	34.72	1.0	1.0 34.72
Patch A	13.90	0.5	6.95
Patch B	41.30	0.75	32.33
Patch C			
Patch D			
Patch E			

(4) Obtain the sum of all the products above. SUM 57.93

(5) Using Table B4, assign a variable subindex based on the value of the sum calculated above.

Table B4
Relationship Between Total Effective Patch Size and Functional Capacity

Total Effective Patch Size	Subindex
>200 ha	1.00
5-200 ha	0.75
1-5 ha	0.50
0.2-1 ha	0.25
<0.2 ha	0.10

Sample variables 4-8 based on an onsite field inspection of the project area and WAA.

4. V_{HYDRO} Hydrologic regime *Subindex* 1.0

(1) Assign subindex value based on Table B5.

Table B5
Relationship Between Hydrologic Regime and Functional Capacity

Site Condition	Subindex
Site is open to free exchange of tidal waters. No obvious hydrologic alteration or restrictions present.	1.0
Moderate hydrologic restriction present (i.e., presence of low-elevation berm, which is frequently overtopped by high tide events or has multiple breaches or large culverts).	0.6
Severe hydrologic restriction present (i.e., presence of high-elevation berm, which is infrequently overtopped by high tide events or has a single opening, breach or small culvert).	0.3
Site receives tidal floodwaters only during extreme storm tide events.	0.1
Site is isolated from tidal exchange. The principal source of flooding is water sources other than tidal action (i.e., precipitation or groundwater). *Note: If this condition exists, another wetland assessment model should be strongly considered unless the site was formerly a tidal wetland prior to hydrologic modification.*	0.0

5. $V_{TYPICAL}$ Percent cover by typical plant species within the WAA 90.0 %

(1) Visually estimate the percentage of the site that is covered by nontypical, nonnative, or otherwise undesirable plant species (see Table B6). Subtract this number from 100 to estimate the percentage of the site that is occupied by plant species typical of the regional subclass. See the subclass profile in Chapter 2 for additional information. Appendix D also lists typical plant species that occur in saline, brackish, and intermediate marshes along the Texas coast.

Table B6
Possible Invasive or Undesirable Plant Species

Scientific Name	Common name	Salt/Brackish	Intermediate
Alternanthera philoxeroides	Alligator weed		L
Aster spinosus	Spiny aster		H
Phragmites australis	Common reed	H	L,H
Sesbania drummondii	Drummond's rattlebush		L,H
Typha spp.	Cattail	L	L
H = high marsh, L = low marsh.			

(2) Assign variable subindex based on Figure B1 *Subindex* 1.0

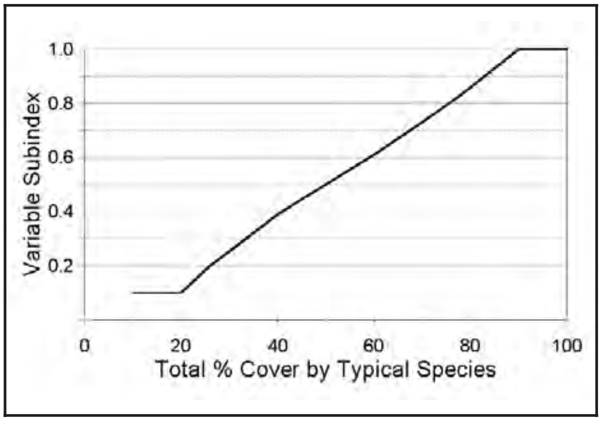


Figure B1. Relationship between percent cover by typical plant species and functional capacity

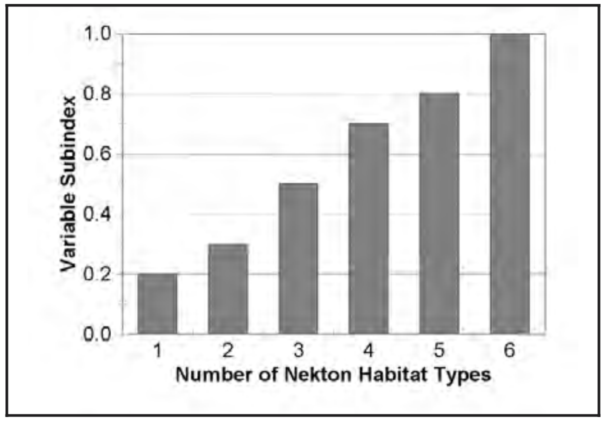


Figure B2. Relationship between nekton habitat complexity and functional capacity

6. V_{NHC} Nekton Habitat Complexity (# different habitat types)

(1) Check the habitats observed on or within a 30-m (100-ft) radius of project area perimeter.

Coarse woody debris	______	Unvegetated flats	x	Algal mats	x
Subtidal creeks/channels	x	Oyster reef	x	Mangroves	x
Intertidal creeks/channels	______	Low marsh	x	High marsh	x
Ponds or depressions	______	Submerged aquatic vegetation	x		

(2) Assign variable subindex based on the chart in Figure B2. *Subindex* 1.0

7. V_{WHC} Wildlife Habitat Complexity (total # different habitat types)

(1) Check those habitat types **IN ADDITION TO THOSE LISTED ABOVE** that are present on or within a 2-km radius of the project area perimeter.

Supratidal habitats (hummocks, logs)	x	Scrub-Shrub	x	Forested uplands	______
Unvegetated beach	______	Grasslands	x		

*Note: Also present within a 2 km radius include ponds/depressions and woody debris.

(2) Assign variable subindex based on the chart in Figure B3. *Subindex* 1.0

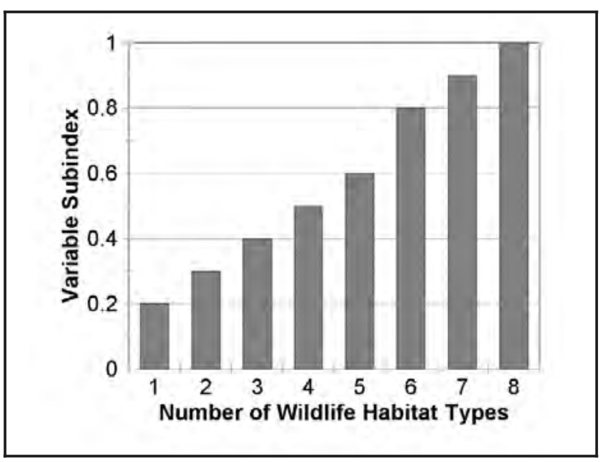


Figure B3. Relationship between wildlife habitat complexity and functional capacity

8. V_{ROUGH} Surface roughness (Manning's n)

(1) Choose a value for each of the three variables in the equation below based on the descriptions provided in Table B7.

$$\underline{0.025} + \underline{0.005} + \underline{0.060} = \underline{0.090}$$
$$n_{BASE} + n_{TOPO} + n_{VEG} = n$$

(2) Compute the sum of the three variables in the equation above.

(3) Assign variable subindex based on the chart in Figure B4. *Subindex* 1.0

Table B7
Relationship Between Roughness and Functional Capacity

Roughness Component	Adjustment to *n* Value			Description of Terms
Sediment surface (n_{BASE})	0.025			Base value for bare marsh soil.
	0.03			More than 25% of sediment surface covered with gravel or broken shell.
Topographic relief (n_{TOPO})	0.001			Representative area is flat with essentially no microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds).
	0.005			Microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds) cover 5-25% of a representative area.
	0.010			Microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds) cover 26-50% of a representative area.
	0.020			Microtopographic (i.e., hummocks) or macrotopographic relief (i.e., berms, tidal channels, ridges and swales, ponds) cover >50% of a representative area.
Roughness Component	**Percent Cover**			
	<50	**50-75**	**76-100**	**Description of Conditions**
Vegetation (n_{VEG})	0.025	0.030	0.035	Representative area predominantly short, flexible-stemmed grasses (i.e., short *Spartina alterniflora, S. patens, Distichlis spicata*).
	0.035	0.040	0.050	Vegetation in representative area predominantly short, with stiff, trailing stems (i.e., *Batis maritima*, *Salicornia virginica*).
	0.050	0.060	0.070	Representative area predominantly tall, flexible-stemmed grasses (i.e., tall *Spartina alterniflora, S. cynosuroides, Scirpus sp.*).
	0.070	0.100	0.160	Vegetation in representative area predominantly tall, with stiff leaves (i.e., *Juncus roemerianus*) or mixed woody shrubs (i.e., mangroves).

Note: Adapted from Arcement and Schneider (1989) and Gardiner and Dakombe (1983).

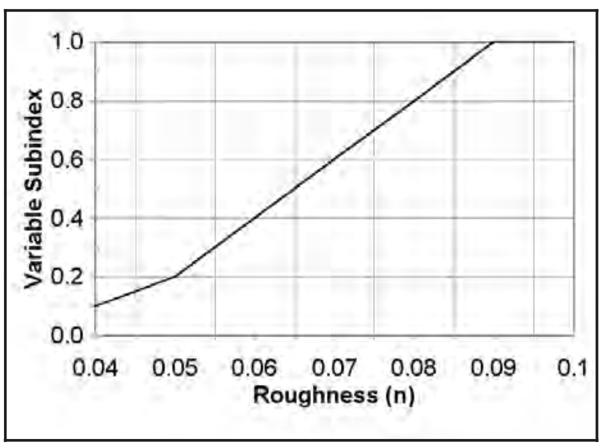


Figure B4. Relationship between surface roughness (n) and functional capacity

Sample variables 9 and 10 based on a representative number of locations in the WAA using a series of 1-m^2 plots arranged along one or more 30-m (100-ft) transects oriented perpendicular to the wetland shoreline or the hydrologic gradient.

9. V_{COVER} Mean Total Percent Vegetative Cover 70.0 %

(1) Select one or more representative areas within the site for sampling. Beginning at the shoreward edge of the marsh, establish one or more 30-m transects perpendicular to the shoreline or along the hydrologic gradient (e.g. increasing elevation). If there are multiple vegetation community types within the WAA, the transect should intersect each vegetation community, in order to ensure a representative sample.

(2) Using a standard 1-m^2 frame, estimate total percent cover by **both live and dead** emergent macrophytic plant species at intervals along the transect, excluding any areas where water depths are too deep to support the growth of emergent vegetation. The number of transects and plots needed will depend on the size and heterogeneity of the site; **a minimum of 10 plots should be used**.

(3) Calculate the average of all total percent cover estimates.

(4) Assign variable subindex for V_{COVER} based on the chart in Figure B5. *Subindex* 0.8

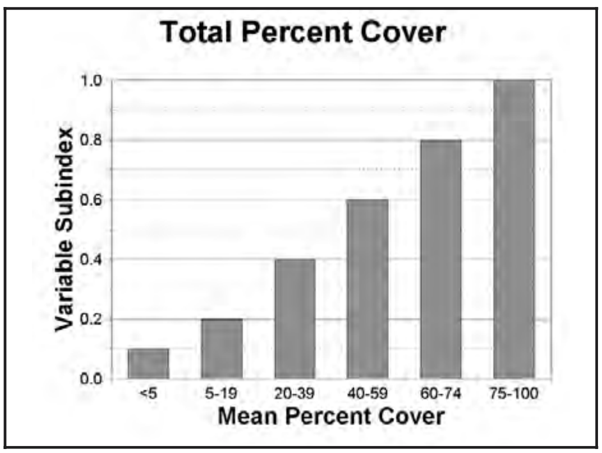


Figure B5. Relationship between mean total percent cover and functional capacity

10. V_{VEGSTR} Mean Vegetative Structure Index

(4) If the 1-m^2 sample plot above contains more than one species (i.e., *Spartina* and *Distichlis*), estimate the proportion of the 1-m^2 plot area covered by each species, omitting any species that occupies <10% cover. If the total percent cover above was estimated at 80%, the sum of the percent cover of each individual species should be 80%. There may be cases where there are several species that individually account for <10% cover, but collectively amount to 10%. In these cases, estimate the cumulative percent cover for the species group.

(5) For each species identified above, estimate the height in centimeters (rounded to the nearest 5 cm) at which the bulk of the biomass occurs (i.e., the most frequently occurring height) and record this value. For those species with trailing stems, the height should be measured in situ rather than extended vertically. Record an estimated height for the species group, if necessary.

(6) Calculate a vegetative structure index for **each** plot using the equation below.

V_{VEGSTR} = ((Hgt$_1$ × Proportion$_1$) + (Hgt$_2$ × Proportion$_2$) + ... (Hgt$_x$ × Proportion$_x$))

where: x = # plant species per plot.

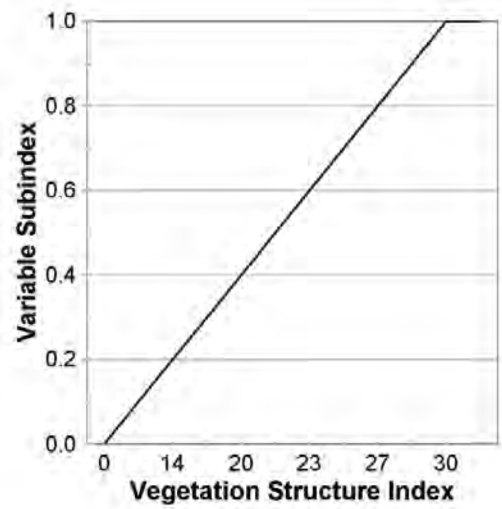
[(_____ × _____) + (_____ × _____) + (_____ × _____)] = _______

(7) Compute the sum of all the vegetative structure indices generated above. _________

(8) Divide by the total number of plots to determine the mean. _________

(9) Assign a subindex value based on the chart in Figure B6. *Subindex* 1.0*

Figure B6. Relationship between vegetation structure index and functional capacity



*Note: Making the assumption that Vegetative Structure (Vvegstr) variable > 30 (i.e., Subindex = 1) for mitigation site, as was assumed for all WAAs in pre-project HGM. No direct vegetative height field measurement data available for proposed site. Also, *Spartina alterniflora* mean height = 45-60 cm (from NWGOM reference marsh in Galveston Bay) * 70% cover = 31.5-42 vegetation structure index = Subindex of 1.0.

Variables 11-14 are assessed only for the Shoreline Stabilization Function.

First, conduct a field site inspection and determine if there are any visual indicators of shoreline erosion within the project area. Examples of this include slumping banks, undercut banks, exposed root mats, or vertical bluffs along the shoreline (See Figure D1 for examples). If any of these features exist, assign a variable subindex to each of the following variables using the procedures outlined below and calculate a functional capacity index for this function. Otherwise, assign a default functional capacity index of 1.0 to this function, indicating the presence of a stable, non-eroding shoreline.

11. V_{WIDTH} Mean width of the marsh

(1) Using a recent aerial photo or direct field survey, establish a baseline along the lengthwise axis that runs roughly parallel to the shoreline and/or perpendicular to the topographic gradient.

(2) Draw a series of transects perpendicular to this baseline from the shoreline to the nearest upland and measure or estimate the average width of the marsh in meters (Figure 4). The number of transects is determined by the length of the baseline (Table B8).

Table B8
Number of Transects for Estimating Mean Marsh Width

Baseline Length (m)	Number of Transects
<300	3
300-1,500	5
1,500-3,000	7
>3,000	9

1____ m 2 ____ m 3 ____ m 4 ____ m 5____ m *Note: Mean marsh width = 407.5

(3) Determine the average of the widths recorded above.

(4) Assign a variable subindex based on Figure B7. *Subindex* 1.0

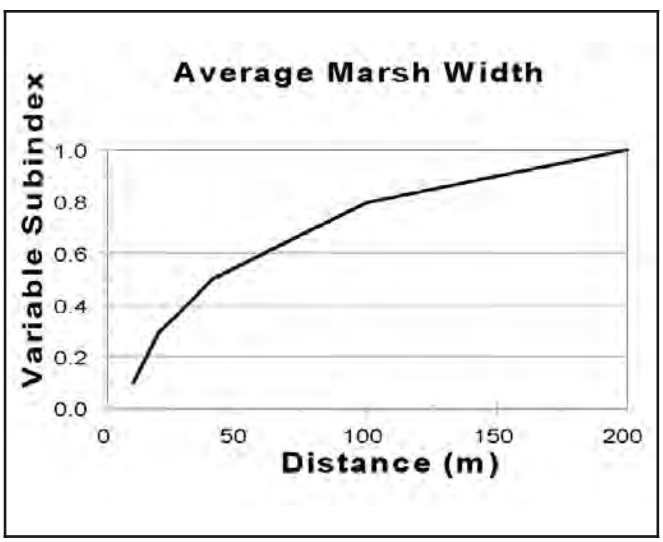


Figure B7. Relationship between average marsh width and functional capacity

12. V_{EXPOSE} Relative Exposure Index (REI)

(1) Measure fetch distances in kilometers for each of the 16 possible compass bearings.

(2) Using the map in Figure 3 in the main text (page 22), select the wind data station closest to your site.

(3) Using the supplemental information in Table E1 on mean annual wind speeds, calculate an REI using the equation below.

$$\text{Relative Exposure Index} = \sum_{i=1}^{16} V_i \times F_i \times P_i$$

where:
V_i = mean annual wind speed (km/hr)
F_i = fetch distance (km)
P_i = proportion of time wind blew from each of 16 cardinal and subcardinal compass directions

*Note: Relative Exposure Index (RSI) = 14.69

(4) Assign variable subindex based on Figure B8. *Subindex* 0.8

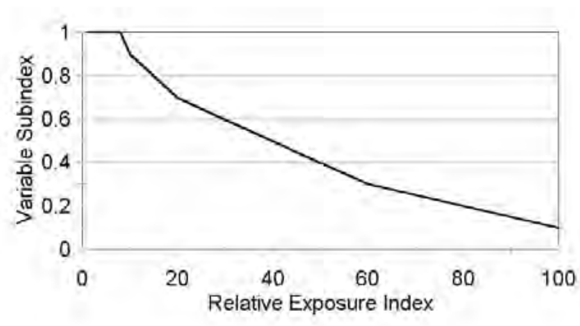


Figure B8. Relationship between relative exposure index and functional capacity

13. . V_{SLOPE} Distance to navigation channel OR water depths ≥2 m *Subindex* 1.0

Table B9
Relationship Between Shoreline Slope and Functional Capacity

Distance	Subindex
<50 m	0.1
50-150 m	0.5
>150 m	1.0

*Note: Distance to water depths > 2 m = 1,134 m

14. V_{SOIL} Soil texture *Subindex* 0.4

Table B10
Relationship Between Soil Type and Functional Capacity

Predominant Soil Type	Subindex
Clay	1.0
Clay loam	0.8
Loam	0.6
Sandy loam	0.4
Sandy	0.2

*Note: Port Corpus Christi Beneficial Use Management Plan (BUMP) and engineered drawings identify sand/soft clays will be utilized as beneficial use marsh material to construct the mitigation site. Assuming that a mix of sand and clay will result in a sandy loam soil texture.

TIDAL FRINGE MARSH HGM FUNCTIONAL ASSESSMENT

Sediment Deposition = $(V_{ROUGH} \times V_{HYDRO})^{1/2}$

(1.0 × 1.0) $^{1/2}$ = 1.0

Resident Nekton Utilization = $(V_{EDGE} + 2\ V_{HYDRO} + 0.5\ V_{NHC})$ / 3.5

(0.7 + 2 1.0 + 1.0 /2) / 3.5 = 0 . 9 1 4

Nonresident Nekton Utilization = $[(V_{EDGE} + 2\ V_{HYDRO} + 0.5\ V_{NHC}) / 3.5)\ V_{OMA}]^{1/2}$

[(0.7 + 2 1.0 + 0.5 1.0 / 3.5) × 1.0]$^{1/2}$ = 0.886

Invertebrate Prey Pool = $(V_{HYDRO} + V_{EDGE} + V_{COVER})$ / 3

(1.0 + 0.7 + 0.8) / 3 = 0.833

Nutrient and Organic Carbon Exchange = $(V_{VEGSTR} \times V_{HYDRO})^{1/2}$

(1.0 × 1.0)$^{1/2}$ = 1.0

Maintain Characteristic Plant Community Composition = V_{C0VER} or $V_{TYPICAL}$, whichever is lower

Min (0.8 or 1.0) = 0.8

Plant Biomass Production = V_{VEGSTR} = 1.0

Provide Wildlife Habitat = [2 V_{SIZE} + V_{WHC} + (Min (V_{COVER} OR $V_{TYPICAL}$))] / 4

(2 0.75 + 1.0 + 0.8) / 4 = 0.825

Shoreline Stabilization = $(V_{SLOPE} + V_{WIDTH} + V_{EXPOSE} + V_{ROUGH} + V_{SOIL})$ / 5

(1.0 + 1.0 + 0.8 + 1.0 + 0.4) / 5 = 0 . 8 4