ABSTRACT
The Texas General Land Office (GLO) awarded a Coastal Management Program Project of Special Merit grant (funded through the Gulf of Mexico Energy Security Act) to Ducks Unlimited, Inc. (DU), to coordinate with stakeholders and identify restoration sites for the beneficial use (BU) of dredged material. The Port of Corpus Christi Authority, a project partner, has also contributed staff and financial resources to expand project scope. Collectively, the project team has developed 10% designs for 20 sites in GLO Planning Regions 3 and 4 of the Texas coast. After completion of the 10% designs, 11 of the designs were selected to continue to 30% designs and at least five of those designs will be chosen for 60% designs and permit applications. Through coordination with stakeholders, selection and completion of the 10% designs, and selection of the sites for 30% designs, the team has identified methods and techniques for restoration and creation of marsh habitat at four sites, restoration and creation of rookery habitat at four sites, protection and restoration of seagrasses at one site, and restoration of tidal flats at three sites. The chosen sites have favorable indications of success as future BU sites along the lower Texas coast.

Keywords: Beneficial use, dredged material placement, marsh creation, marsh restoration, rookery island, bird island, maintenance dredging, feeder berm, seagrass restoration, seagrass protection, tidal flat restoration

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INTRODUCTION

Navigation channels along the Texas coast are in frequent need of dredging. In the past, the majority of dredged material has been placed in existing permitted upland or open bay placement areas, neither of which provide significant ecological benefits. This method results in the loss of a valuable resource that could be used to restore wetlands, rookeries, tidal flats, beaches, and other ecologically and economically important habitats.

The implementation of BU of dredged material projects typically requires a multi-year, collaborative effort. Through funding from a Coastal Management Program Gulf of Mexico Energy Security Act grant as well as the Port of Corpus Christi Authority; Ducks Unlimited, Inc.; and the Port of Corpus Christi Authority, with the support of Anchor QEA, LLC; Sarosdy Consulting, Inc.; and the Texas Department of Transportation, worked with stakeholders in the lower Texas coast to identify and prioritize more than 70 potential BU restoration sites. These sites span a wide range of restoration types and indicate a strong demand for dredged material along the lower Texas coast. Of these sites, 20 were selected for 10% design, 11 are currently being designed at the 30% level, and at least 5 of those 30% designs are being carried forward to 60% designs, cost estimates, and permit application packages. This effort will result in several high priority projects that will be strong candidates for final design and construction under future funding streams and will ultimately take advantage of the valuable material dredged annually from Texas navigation channels.

Simultaneously developing preliminary designs of 20 sites provides a unique opportunity to prioritize and coordinate restoration activities. Among the 11 sites selected for 30% designs are marsh creation and restoration sites, beach nourishment, rookery island creation and restoration, seagrass protection and restoration, and tidal flat restoration sites. Evaluations of the proposed type of BU by the stakeholders with the existing conditions within the lower Texas coast have led to the identification and initial designs of several promising techniques for future BU. This paper presents an overview of those techniques for 10 of the sites selected for 30% design.

Figure 1. Potential BU Restoration Sites
LAGUNA MADRE BIRD ISLANDS

Background

Conservationists identified the Laguna Madre as an important location for creating and restoring bird habitat (CBBEP 2020a). Four rookery island locations within Laguna Madre were selected for 10% designs. Two of those sites, Rabbit Island South and dredged material placement area (DMPA) #214 Bird Island, were selected to continue to the 30% design level due to existing productive rookery habitat as well as less potential impacts on adjacent sensitive habitat during construction (TPWD 2021). These sites, as well as many other islands along the Gulf Intracoastal Waterway (GIWW) in the Laguna Madre, were formed from sidecasted new work dredged material during the original construction of the GIWW (circa 1945). While these islands are degrading, as are similar nearby islands, they have shown a fairly high degree of resilience over several decades in the absence of armored protection (see Figure 3, which illustrates a chain of islands north of DMPA #214). This material is considered to have superior structural characteristics than the maintenance dredged material removed from the GIWW in this region (Morton et al. 2001).

Figure 2. Rabbit Island South and DMPA #214 Bird Island
Figure 3. Chain of islands Laguna Madre from 1995 (left image) to 2021 (right image)

Design Concept

The design concept for Rabbit Island South and DMPA #214 Bird Island is to use the readily accessible, higher-quality relict new work material (i.e., material placed during the original construction of the GIWW) to build a naturally resilient rookery island. The construction would take place in two main phases:

1. A containment berm would be built around the site using existing relict new work material within the footprint of the site.
2. The site would be filled with hydraulically dredged material from a combination of maintenance material from the GIWW and relict new work material from submerged mounds adjacent to the site.

It is expected that once placed, the site would stabilize at a natural slope similar to other islands formed with relict new work material within the Laguna Madre. The target acreage for these sites identified by the stakeholders is 4 to 10 acres. This strategy takes advantage of a readily available source of favorable sediment found throughout the Laguna Madre and would benefit by the U.S. Army Corps of Engineers (USACE) paying for dredge mobilization costs during a maintenance dredge cycle. Conceivably, this relict new work material could be used at many sites throughout the region.

CORPUS CHRISTI SHIP CHANNEL PLACEMENT AREAS

Background

Two sites directly adjacent to the Corpus Christi Ship Channel (CCSC) were selected at the 10% design level and were subsequently carried over to 30% designs: PA9-S and Pelican Island (M3) (Figure 4). These sites are planned to provide both intertidal marsh and tidal flat habitats within Corpus Christi Bay. These sites have favorable characteristics for restoration due to readily accessible maintenance material dredged
from the CCSC as well as potential new work material from the proposed CCSC Channel Deepening Project.

![PA9-S and Pelican Island (M3)](image)

**Figure 4. PA9-S and Pelican Island (M3)**

*Design Concept*

The southern end of the PA9-S site was extended into water depth greater than 10 feet mean lower low water (MLLW) to maximize the quantity of material that could be received at the site. This ensures that not only is valuable habitat being created, but that there is significant capacity for material from the CCSC. Pelican Island (M3) was extended to the furthest depth that could be achieved without encroaching on submerged pipelines. These pipelines will be evaluated during subsequent design phases, and the footprint of Pelican Island (M3) may be extended. Due to the lack of protection from the predominant southeast winds and relatively deep water conditions surrounding the sites (greater than 6 feet North American Vertical Datum of 1988 [NAVD88]), similar armoring and containment is proposed for hydraulic placement of material from the CCSC for both sites. The construction for these sites would occur in three main phases:

1. An earthen dike would be hydraulically constructed of stiff clay dike fill surrounding the bay facing the perimeter of the site.
2. Once settlement and consolidation of the dike has completed, marsh buggies would be used to shape the dike above the MLLW level, and a rock breakwater would be placed below the MLLW level on the gradually sloped submerged portion of the dike (see Figure 5 for Typical Dike from PA9-S 10% design).
3. Hydraulically dredged fill material from the CCSC would be placed at marsh and tidal flat elevations within the dike over several dredging events.

Placing a breakwater on the bay side of the earthen dike allows for easier maintenance of the dike in the event of a storm event. The breakwater along the dike provides added protection for storm events. Any dike maintenance that is necessary post-storm events could occur by reshaping with a marsh buggy. If the
armoring was placed as a revetment, potential failure from the back side of the dike could result in failure of the armoring. Constructing PA9-S will create approximately 150 acres of marsh and tidal flat habitat with a dredged material capacity of 3.6 million cubic yards (cy). Pelican Island (M3) will provide 1.2 million cy of capacity and create approximately 170 acres of marsh and tidal flat habitat.

![Diagram of Typical dike PA9-S](image)

**Figure 5. Typical dike PA9-S**

**FEEDER BERM NORTH OF FISH PASS**

**Background**

The stretch of shoreline on Mustang Island from Fish Pass to Port Aransas is in an erosive environment resulting in coastline retreat (BEG 2019). Erosion of these beaches causes damage to both humans and wildlife because the beach provides economic value as well as habitat for breeding and foraging wildlife (Marbán et al. 2019). This is especially important for beaches on Mustang Island because the island serves as a habitat for threatened and endangered species including all five species of sea turtles (USFWS 2021; NPS 2022). Conversations with Deidre Williams of the Conrad Blucher Institute resulted in the identification of an area north of Fish Pass (a shoaled in, relict channel on Mustang Island) as an ideal location for a feeder berm (Williams 2021). Figure 6 shows an approximate location of the proposed feeder berm.
Design Concept

The conceptual berm is designed to be rectangular in shape oriented parallel to the shore. The proposed area of the site is 75 acres and would consist of approximately 500,000 cy of dredged material. The fill material could be sourced from the CCSC Entrance Channel or Ocean Dredged Material Disposal Sites. Designing the berm within the -10 to -15 feet NAVD88 contour is proposed to reduce the volume of sediment transported beyond the depth of closure and out of the active beach system (Williams 2022). One of the benefits of using a feeder berm for this site instead of direct beach placement is that a wider range of borrow sources can be used. Non-beach quality, but mostly sandy material can be placed within the berm with the expectation that sandy material will be transported to the beach while finer particles will be transported offshore (Gailani et al. 2019).

DAGGER ISLAND

Background

Dagger Island is located in Redfish Bay, Aransas Pass (Figure 7). The bay has several areas of seagrasses that are protected by strings of islands that have suffered shoreline erosion from storm events and wave energy from wind and ship traffic. The areas targeted for this project are open water areas to the southwest of Dagger Island that currently provide limited protection for the more than 700 acres of seagrasses within Redfish Bay.
Figure 7. Dagger Island

**Design Concept**

The proposed design is to fill breaches with a protective berm for the seagrasses to the north of the site and fill open water areas inside the berm up to healthy marsh or existing island elevations with dredged material from the CCSC. The berm would be armored with a rock revetment to mitigate erosion due to wind waves and vessel wakes from the CCSC. The selected area for the berm is situated between potential seagrasses (TPWD 2021), and seagrass surveys are planned to evaluate current sensitive habitat near the site footprint. The site footprint may be modified depending on an evaluation of potential seagrass impacts during construction of the berm.

**LITTLE BIRD ISLAND NORTH**

**Background**

Little Bird Island North is a rookery island creation site located within San Antonio Bay (Figure 8). The bay has been identified as an important location for rookery island creation and restoration (CBBEP 2020a; Hardegree 2014). There is an existing Little Bird Island in San Antonio Bay across the GIWW from the Little Bird Island North location; however, it is surrounded by oyster habitat (GLO 2021) and has limited natural protection from wind waves, making it less favorable for restoration than the Little Bird Island North Site.
**Design Concept**

The concept for Little Bird Island North is to use maintenance dredged material from the adjacent GIWW and the nearby Channel to Victoria. As shown in Figure 8, there are oyster habitats on two sides of the site on shallow mounds of sediment, which are expected to act as a natural barrier and reduce wave heights from those directions. Due to this natural protection, proposed armoring is a rock breakwater with an open end on the southwest of the site. This open end would be temporarily contained with an earthen berm during construction to contain fines during fill material placement. The temporary berm would be removed after settling and consolidation of the fill material, and the contained fill would transition to a natural angle of repose, creating habitat for wading birds and allowing ingress and egress of aquatic organisms and wildlife to the site. Armoring on the northwest and east of the site may be reduced during subsequent designs.

**NUECES DELTA**

**Background**

The Nueces Delta is an area containing more than 10,000 acres of wetlands on the western end on Nueces Bay. Stakeholders have identified rapid degradation of this marsh (Dunton et al. 2019), which is supported via aerial imagery shown in Figure 9. Placing material in this degrading marsh has been an unsolved problem due to relatively shallow water depths and long sail distances from consistent supplies of dredged material. Stakeholders have suggested constructing a permanent pipeline from the Port of Corpus Christi Authority Viola Turning Basin directly to the delta beneath the Joe Fulton corridor (composed of county road, railroad tracks, and the Nueces River). The delta end of this pipe could be extended with traditional pipelines to discharge dredged material from the CCSC into targeted areas of the delta. This proposed restoration is a single use of the pipeline to create an area of marsh behind breakwaters planned for construction on the edge of a portion of the marsh.
Design Concept

The concept of the marsh fill design is to use dredged material from the CCSC to create marsh habitat behind breakwaters that will be constructed along the edge of the Nueces Delta. This material would be contained behind the breakwaters, with temporary containment along sections of the perimeter to contain placed fines. With construction of the pipeline directly from the Viola Turning Basin to the delta, the approximate pipeline distance to the site would be 2 to 3 miles. Feasibility of the pipeline is currently under evaluation and will inform the current marsh restoration plans as well as future marsh restoration opportunities within the Nueces Delta.

PORTLAND NUECES BAY MARSH

Background

Nueces Bay is a shallow bay averaging less than 3 feet of depth and is dominated by mudflats and oyster reefs (CBBEP 2005). Coastal Bend Bays & Estuaries Program (CBBEP) stakeholders noted the success of the Nueces Bay Marsh Creation Project in nearby areas of Nueces Bay and indicated a desire for expanded marsh creation in the same area. In the southeast corner of the bay adjacent to the City of Portland, there is a narrow existing marsh that stakeholders identified as a favorable location for marsh expansion. This site is also in a favorable location for access to dredged material due to its proximity to the La Quinta Channel. Figure 10 shows the location of the site in yellow. The gray areas to the west and northwest of the site show potential existing oyster habitat (GLO 2021).
**Figure 10. Portland Nueces Bay Marsh**

**Design Concept**

The preliminary proposed design for this site is a uniform marsh extending from the existing marsh out into the bay with a natural angle of repose creating up to 40 acres of marsh habitat. Hydroseeding of the bayside edge of the marsh is proposed to increase resilience to erosion. CBBEP stakeholders indicated a potential need for armoring due to erosion seen on the previously unarmored protecting berms at the Nueces Bay Marsh Creation project to the west of the site. Due to shallow depths (2 to 3 feet NAVD88 at the edge of the site), the preliminary proposed armoring for the site is a rock berm to reduce the energy of incoming waves. The rock sill would not only reduce wave energy to the marsh but could also provide oyster habitat by recruiting oysters from adjacent identified oyster reefs. The proposed armoring will be further evaluated during subsequent phases of design based on wind wave modeling and geotechnical evaluation.

**CAUSEWAY BIRD ISLAND**

**Background**

Causeway Bird Island is located on state-owned submerged land adjacent to the Rincon Canal in Nueces Bay, Nueces County, Texas (Figure 12). The Nueces Bay rookery islands have been identified by conservationists as important locations for protecting and restoring bird habitat (CBBEP 2020b; Hackney et al. 2016). This area is favorable for BU because it has close proximity to source material from Rincon Canal and the CCSC and a rock breakwater, constructed in 2022, around the island (Figure 13). Placement of dredged material within the breakwaters was identified as an effective method to increase bird habitat in a region with degrading coastal bird habitat.
Figure 12. Causeway Bird Island

Figure 13. Submerged portion of Causeway Bird Island leading up to rock breakwater
**Design Concept**

Causeway Bird Island is an existing island with open water leading up to a surrounding breakwater. The proposed design is to fill the site with dredged material from the Rincon Canal and the CCSC to expand the current rookery island. To accommodate different species of birds, there will be channels cut into the fill at the locations of gaps in the breakwater. These cuts will follow a natural slope up to the existing elevation of the Bird Island. Channels with shallow angles of repose will generate habitat for wading birds while expanded upland areas at the existing elevation of the island will increase the acreage of habitat of already productive rookery habitat to approximately 16 acres. This will have beneficial effects on the regional ecosystem and will more than double the habitat for the herons, egrets, terns, skimmers, and pelicans that currently reside on the island (CBBEP 2020b)

**CONCLUSIONS**

Through the support of GLO and the Port of Corpus Christi Authority, and using input from numerous stakeholders, the project team was able to identify and prioritize more than 70 potential BU restoration sites. By evaluating these sites based on their need for dredged material and ability to become successful BU sites, the project team was able to select 20 sites for 10% designs. Of those 20 sites, 11 are currently being designed at the 30% level and at least 5 of the 30% designs will be taken to 60% designs and permitting. This paper focuses on those sites that were selected for 30% design.

Through this collaboration, several restoration types spanning marsh creation and restoration sites, beach nourishment, rookery island creation and restoration, seagrass protection and restoration, and tidal flat restoration sites were evaluated at the 10% level as well as are currently being evaluated at the 30% level for regions of the lower Texas coast. Several techniques and methods for restoration have been identified for each of the sites that have promising indications for success.

- The use of the abundant relict new work material with superior structural characteristics provides an opportunity to restore valuable rookery habitat throughout the Laguna Madre.
- The use of hydraulically placed stiff clay dike fill potentially from the proposed CCSC Channel Deepening Project to generate earthen dikes with rock breakwaters on their bayward toe, allowing for reduced costs to repair failed dikes during storm events than a traditional revetment.
- The use of feeder berms to nourish beaches along Mustang Island, and elsewhere, that have a strong need for nourishment, so that a potentially wider range of borrow sources could be used.
- The use of dredged material to plug holes in the shoreline along Redfish Bay, protecting more than 700 acres of seagrasses within the bay.
- The use of relatively shallow oyster reefs in San Antonio Bay to reduce costs for armoring rookery islands.
- The installation of a permanent pipeline to provide access to dredged material to areas of the Nueces Delta marsh that have experienced significant marsh degradation.
- The use of a rock berm in Nueces Bay to take advantage of the shallow depths and provide potential oyster habitat while protecting new marsh habitat.
- The use of existing breakwaters to expand existing rookery habitats.

**REFERENCES**


CBBEP (Coastal Bend Bays & Estuaries Program), 2005. Characterization of Potential Health Risks Associated with Consumption of Fish and Shellfish from Nueces Bay, Nueces County, TX. Publication


CITATION

DATA AVAILABILITY
Some data are available from the corresponding author by request.