E C O L O G I C A L   R E V I E W

Raccoon Island Shoreline Protection/Marsh Creation
Phase B - Marsh Creation
CWPPRA Priority Project List 11
(State No. TE-48)

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David C. Lindquist
Restoration Technology Section
Coastal Restoration Division
Louisiana Department of Natural Resources

This document reflects the project design as of the 95% Design Review meeting, incorporates all comments and recommendations received following the meeting, and is current as of January 2, 2008.

ECOLOGICAL REVIEW
Raccoon Island Shoreline Protection/Marsh Creation,
Phase B – Marsh Creation

In August 2000, the Louisiana Department of Natural Resources initiated the Ecological Review to improve the likelihood of restoration project success. This is a process whereby each restoration project's biotic benefits, goals, and strategies are evaluated prior to granting construction authorization. This evaluation utilizes monitoring and engineering information, as well as applicable scientific literature, to assess whether or not, and to what degree, the proposed project features will cause the desired ecological response.

I. Introduction

The Raccoon Island Shoreline Protection/Marsh Creation (TE-48) project is located in Terrebonne Parish, approximately 21 miles southwest of Cocodrie, Louisiana. Raccoon Island is the westernmost island in the Isles Dernieres, a 22-mile barrier island chain that also includes Whiskey Island, Trinity Island, East Island, and Wine Island (Figure 1). These five islands also constitute the Isles Dernieres Barrier Islands Wildlife Refuge, which was established in 1999 to protect nesting habitat for numerous species of waterbirds. Raccoon Island, in particular, exhibits a high species richness and abundance of nesting colonial waterbirds, and includes one of the most important brown pelican and roseate spoonbill nesting colonies in Louisiana. Raccoon Island also provides important nesting habitat for reddish egret, great egret, white ibis, black skimmer, least tern, sandwich tern, royal tern, and gull-billed tern (Mike Carloss, Natural Resources Conservation Service [NRCS], Personal Communication, June 18, 2004). By reducing the rate of gulf and bayside shoreline retreat, the TE-48 project will help protect these nesting colonies.

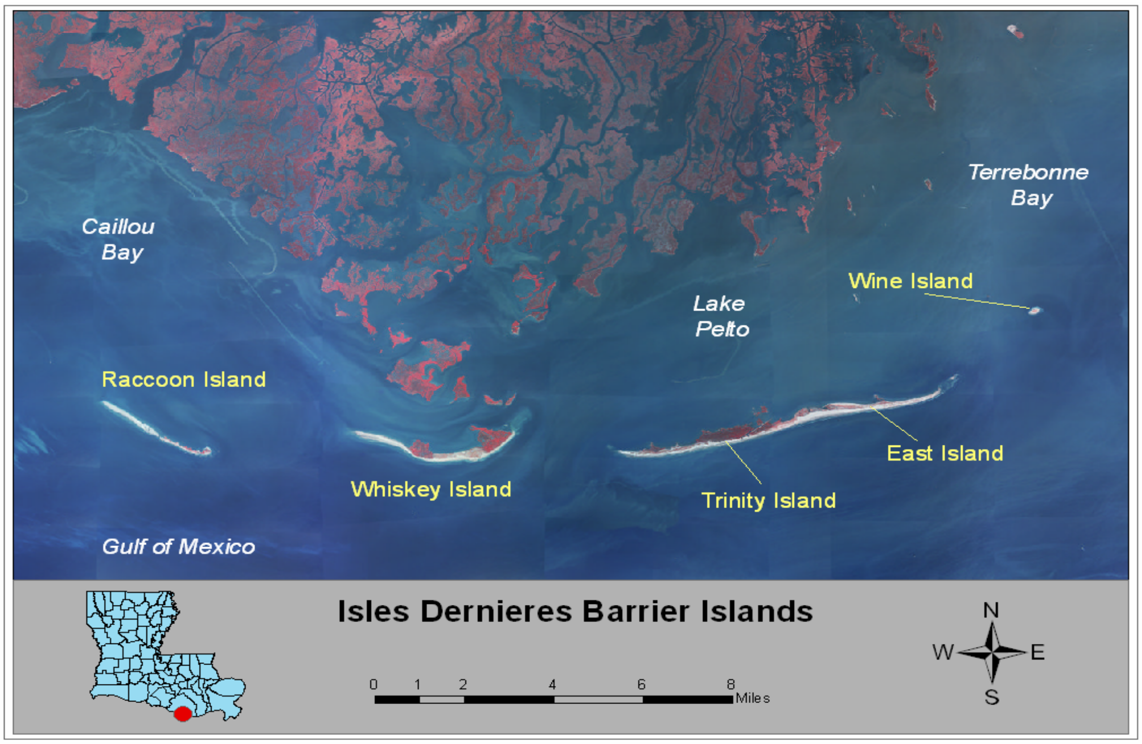

Figure 1. Isles Dernieres, Louisiana.

The Isles Dernieres is one of the most rapidly eroding barrier shorelines in the United States (McBride and Byrnes 1997). The islands are experiencing landward migration, island narrowing, and area loss due to the interaction of several factors (i.e., subsidence, eustatic sea level rise, wave processes, storm impacts, inadequate sediment supply and human disturbances; McBride and Byrnes 1997). The average long-term (1887 to 2002) rate of shoreline change for the Isles Dernieres was -34.7 feet/year, and -27.4 feet/year for Raccoon Island in particular (Penland et al. 2004). More recent rates (1988 to 2002), however, have been considerably higher, i.e., -61.9 feet/year for the Isles Dernieres and -60.5 feet/year for Raccoon Island (Penland et al. 2004). As these barrier islands disintegrate, nearby mainland marsh and human infrastructure will become increasingly exposed to the destructive effects of storm surge, wave energy, increased tidal prism, and saltwater intrusion (McBride and Byrnes 1997).

Restoring and maintaining the Isles Dernieres barrier island chain was recommended by *Coast 2050* as a Region 3 ecosystem strategy (Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority 1999). The typical barrier island restoration template involves increasing island height and width by using dredged material to nourish beaches, build dunes, and create back-barrier marsh (Campbell et al. 2005). However, the Raccoon Island Breakwaters Demonstration (TE-29) project, which was constructed in 1997, used segmented stone breakwaters to reduce erosion rates and promote sediment deposition along the island's eastern gulf shoreline (Armbruster 1999). The TE-48 project will expand upon the TE-29 project by constructing the following: eight additional breakwaters along the western shoreline, a terminal groin between the easternmost TE-29 breakwater and the island, and back-barrier marsh along the bayside shoreline (NRCS 2005) (Figure 2). Due to difficulties in identifying a suitable borrow area, the project was divided into Phase A, which included the construction of the breakwaters and terminal groin, and Phase B, which includes the placement of dredged material to create intertidal and supratidal habitat. This Ecological Review focuses exclusively on Phase B.

II. Goal Statement

By the end of project construction, create 54 acres of intertidal marsh and approximately 14 supratidal acres to increase the longevity of bayside habitats and serve as additional bird habitat.

III. Strategy Statement

Containment dikes will be constructed to enclose an area of open water on the bayside of Raccoon Island (Figure 2). This area will then be filled with sediment that is hydraulically-dredged from an offshore borrow area. The dikes and marsh platform will be planted with herbaceous and woody plant species that are native to Gulf coast barrier islands.

IV. Strategy-Goal Relationship

The placement of dredged material, construction of dikes, and subsequent vegetative planting of these features will result in the creation of intertidal and supratidal habitat. This newly created acreage will increase the size of Raccoon Island and will serve as a buffer against wave erosion, thus protecting existing habitats and increasing island longevity. It is anticipated that the project features will also provide suitable nesting, resting, and foraging habitat for colonial waterbirds and neotropical migratory birds.

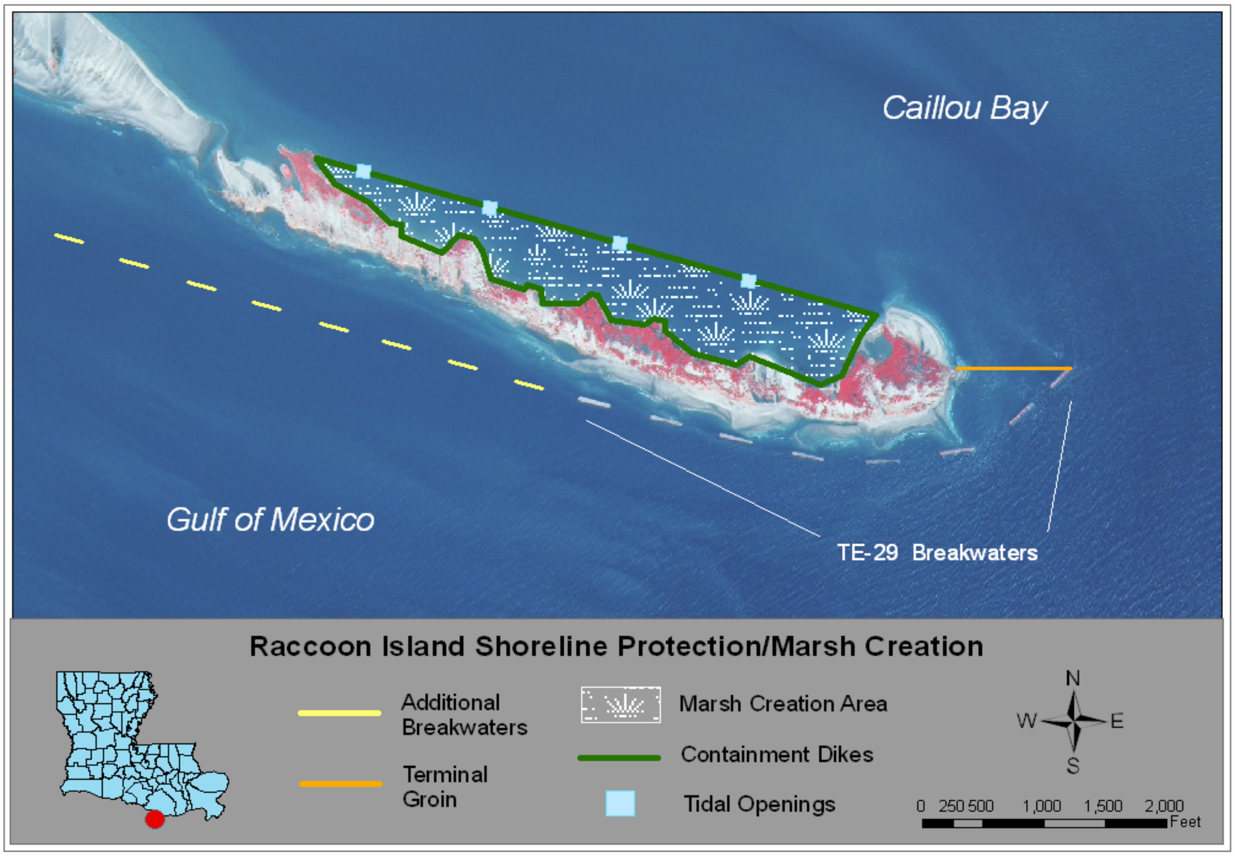

Figure 2. Raccoon Island Shoreline Protection/Marsh Creation (TE-48) project features.

V. Project Feature Evaluation

Borrow Area

The borrow area for the TE-48 project is located approximately 4 miles south of Raccoon Island in a relict distributary channel. Sediment cores collected from the borrow area to a depth of 20 feet below the sea floor had an average grain size of 0.10 mm and contained approximately 16.5% sand (SJB Group, Inc. and Coastal Engineering Consultants, Inc. [SJB/CEC] 2006). A greater percentage of sand (24.6%) was found in the upper ten feet of a subsection of the borrow area. Consequently, material from this subsection will represent the primary dredge cut and the remainder of the borrow area will represent the secondary dredge cut. After incorporating cut to fill ratios appropriate for the sediment characteristics, a total of 393,436 and 1,153,798 cubic yards of sediment will be available from the primary and secondary cuts, respectively (SJB/CEC 2006). These amounts should be sufficient to fill the marsh creation area, which would require an estimated 477,986 cubic yards of sediment (NRCS 2007).

The Steady-State Spectral Wave Model was used to evaluate potential changes to wave refraction and sediment transport patterns resulting from excavation of the proposed borrow area (SJB/CEC 2006). Simulations were performed using average wind and wave conditions for the area as well as storm conditions. Results from these analyses indicated that the proposed borrow area would have only minor effects on wave characteristics and sediment transport patterns, and therefore would have no adverse impacts on Raccoon Island's shoreline (SJB/CEC 2006).

Marsh Creation Design

Material from the borrow area will be used to construct a back-barrier marsh platform approximately 4,800 feet long and 150 to 700 feet wide (Figure 2). The amount of foundation settlement caused by this material was estimated from sediment cores collected from within the marsh creation area (SJB Group, Inc. and Soil Testing Engineers, Inc. 2003). Based on these analyses, it was determined that a construction fill elevation of +2.5 feet NAVD 88 would yield desirable marsh elevations for most of the project life (Figure 3). Filling to this elevation, the created marsh platform would settle to an elevation of approximately +1.6 feet NAVD 88 by the end of the 20-year project life. Including relative sea level rise, the created marsh platform would become intertidal around year 3, and would be in the upper intertidal zone (i.e., between Mean High Water [MHW] and Mean Tide Level [MTL]) for the remainder of the project life.

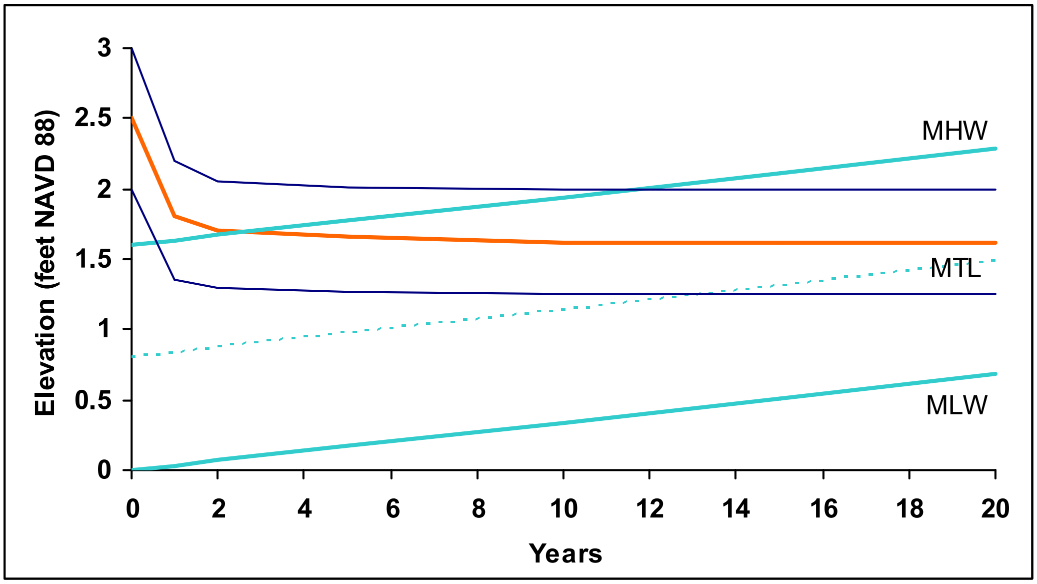

Figure 3. Estimated elevation change of the created marsh platform over the 20-year project life for different fill elevations (adapted from NRCS 2007). The desired fill elevation is indicated in orange. Increases to Mean High Water (MHW), Mean Tide Level (MTL) and Mean Low Water (MLW) are based on predicted rates of relative sea level rise (0.034 feet/year) from Penland and Ramsey (1990).

Containment Dikes

Approximately 11,000 feet of dikes will be constructed to contain the dredge fill material. Dikes on the island-side of the marsh platform will be placed on the existing shoreline, whereas the bayside dikes will be placed on subtidal bottoms with an average depth of -1.5 feet NAVD 88. The dikes will be constructed using sandy sediment mechanically-dredged from within the marsh creation area. The dikes will have a crest elevation of +5.0 feet NAVD 88, a crest width of 20 feet, and minimum side slopes of 5H:1V (except for the exterior slope of the bayside dike which will be 6H:1V to provide for additional wave attenuation; Figure 4) (NRCS 2007). At the end of construction, openings will be cut in the bayside dikes at the locations indicated in Figure 2 to allow tidal exchange between Caillou Bay and the created back-barrier marsh. These tidal openings will have 10H:1V side slopes, a bottom width of 10 feet, and will be excavated to a bottom elevation of +2.5 feet NAVD 88 (NRCS 2007).

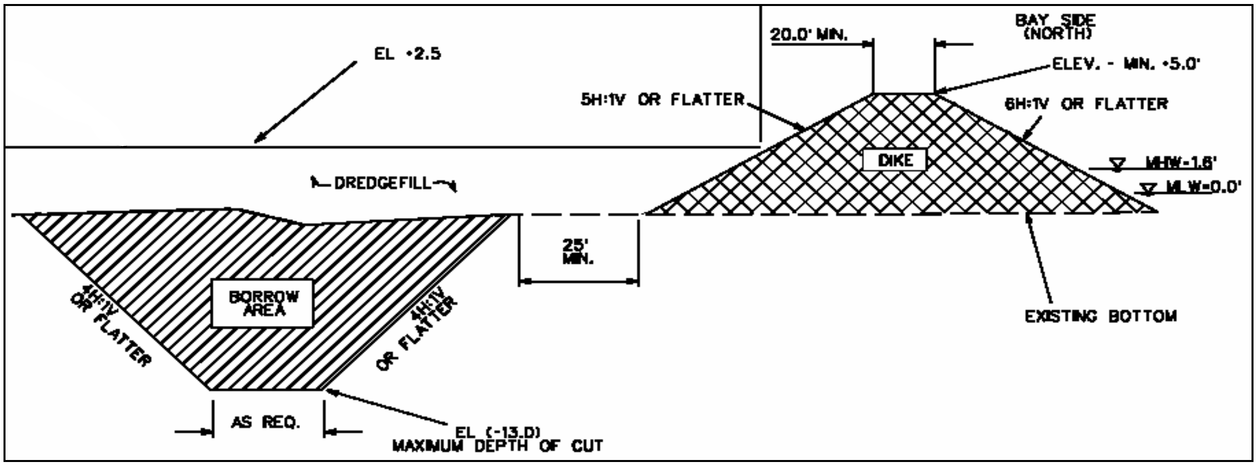

Figure 4. Details of the bayside containment dike and containment dike borrow area (NRCS 2007).

<u>Vegetation Plantings</u>

Vegetation will be planted during two or three phases, the timing and species composition of which will depend on the existing elevation, hydrology, and soil conditions (NRCS 2007). The first phase of plantings will occur immediately post-construction and will consist of plugs or four-inch containers of native herbaceous species. These plants will be installed on the marsh platform, at the toes of the containment dikes, and possibly on the side slopes and crests of the dikes. Plantings will also be concentrated around the tidal openings to protect against tidal scour. The second phase of plantings, if deemed necessary, will occur about 1 to 2 years post-construction and will consist of additional herbaceous plants on the marsh platform. The third phase of plantings will occur 2 to 3 years post-construction and will consist of trade gallon-sized containers of native woody species. These plants will be installed on the island-side dike, on the interior side slope of the bayside dike, and possibly on the marsh platform. All plants will be fertilized with a slow-release tablet or packet (NRCS 2007).

VI. Assessment of Goal Attainability

When addressing the likelihood that the proposed project features will provide the desired ecological response, it is important to evaluate the lessons learned from scientific research and past projects that are similar in scope to the Raccoon Island Shoreline Protection/Marsh Creation (TE-48), Phase B project. The findings of this review are detailed below.

There have been a number of constructed barrier island restoration projects in Louisiana whose goals included increasing island width through the creation of back-barrier marsh (see Appendix). Several of these projects were reviewed by Penland et al. (2003), including: the Isles Dernieres Restoration East Island (TE-20), Isles Dernieres Restoration Trinity Island (TE-24), Whiskey Island Restoration (TE-27), and East Timbalier Island Restoration, Phase 1 and 2 (TE-25 and TE-30) projects. This review determined that the projects successfully increased the width and, therefore, longevity of the islands relative to background rates of erosion. However, with the exception of TE-25 and TE-30, the projects created very little marsh, but instead created a large amount of scrub/shrub habitat and bare land. This was because the elevations of the constructed platforms were generally too high (>+2.0 feet NAVD 88) to establish back-barrier marsh (Penland et al. 2003). Consequently, Penland et al. (2003) recommended that future back-barrier marsh creation projects not exceed a platform elevation of +2.0 feet NAVD 88.

Because barrier islands are exposed to harsh, erosive conditions, it is important to quickly establish vegetation in order to stabilize newly-placed sediment and maintain island integrity. Marsh vegetation was planted for the TE-20, TE-24, and TE-27 projects after a period of 6 to 12 months, during which the fill material dewatered and consolidated. Survival rates of these plantings were good; however, after three growing seasons they had not expanded significantly into the unplanted areas of the project, resulting in a loss of sediment through aeolian processes (Khalil and Lee 2004). The lack of vegetative expansion may have been related to the unsuitable elevation of the constructed platforms as well as the high percentage of sand present in the projects' fill material, which was significantly greater than that found in natural back-barrier marsh (93% for created marsh vs. 57% for natural marsh; Fearnley 2004). Sandy substrates typically do not have the nutrient concentrations necessary for rapid plant establishment (Broome et al. 1988, Streever 2000). Therefore, fertilizer applications have been recommended to overcome these deficiencies and accelerate marsh development (Broome et al. 1988, Fearnley 2004).

Although not a barrier island project, the Queen Bess Island (BA-05b) project is similar to the TE-48 project in that the BA-05b project used dredged material to increase island size, reduce erosion rates, and create additional habitat for nesting brown pelicans. Six months after construction, the dikes and portions of the marsh platform were planted with woody vegetation to create nesting habitat for pelicans. Survival rates of these plantings varied by species, with black mangrove, marsh elder, matrimony vine, and groundsel bush having the highest survival rates, and dune sumpweed and wax myrtle having the lowest survival rates (Alonzo 1996). In general, the surviving plants grew vigorously, resulting in an increase in the amount of pelican nesting habitat (Alonzo 1996). The population of nesting pelicans on Queen Bess Island increased considerably after construction of this project, although it is likely that other factors besides increased nesting habitat contributed to the population growth (Curole 2001).

Summary and Conclusions

Proper elevation is essential for the successful development of back-barrier marsh (Campbell et al. 2004). Earlier plans for the TE-48 project called for a fill elevation of +3.0 feet NAVD 88, which after accounting for foundation settlement would result in a platform elevation of around +2.0 feet NAVD 88 (Figure 3). This elevation is at the upper limit of the range found to be suitable for back-barrier marsh from previous barrier island projects (Penland et al. 2003). However, if the marsh platform receives additional sediment during overwash events, then the platform elevation may become too high for successful marsh development. Consequently, the design team decided to lower the fill elevation to +2.5 feet NAVD 88. The resulting marsh platform should be able to accommodate some overwashed sediment and still remain in the intertidal zone for most of the project life. Furthermore, the platform should be high enough that the developing marsh would not be excessively inundated by tides, which often causes reduced net primary productivity, plant stress and plant death (Mendelssohn and McKee 1988).

The ability of the TE-48 project to achieve its desired goals is highly dependent on the rapid establishment of vegetation on the project's features. Without vegetation to stabilize it, a percentage of the newly placed sediment will likely be lost to erosive processes. This would reduce the net acreage created and, subsequently, the project's benefit to the island's longevity. Unlike previous barrier island projects, the sediment that will be used to construct the TE-48 project's marsh platform is predominantly silt and fine sand. Because these substrates are more likely to have adequate nutrient concentrations, the project's vegetative plantings should become rapidly established, particularly with the proposed fertilizer amendments. In addition, the project's planting approach will increase the chances that vegetation becomes established by tailoring the types and locations of the plantings to the existing environmental conditions.

Another important factor controlling marsh development is the maintenance of hydrologic exchange between the marsh and adjacent water bodies. Tidal exchange imports sediments and nutrients to the marsh, whereas flushing prevents harmful sulfide concentrations and hypersaline conditions from developing (Osgood and Zieman 1998). Because of these processes, vegetation in young marshes usually develops faster in areas with consistent hydrologic exchange, such as tidal creeks (Tyler and Zieman 1999). For the TE-48 project, the tidal openings cut into the containment dikes will allow hydrologic exchange between the developing marsh and Caillou Bay, and tidal creeks will eventually form as flow is channeled through the openings (Williams and Orr 2002). The tidal openings will be excavated to the elevation of the marsh platform post-construction, and it is anticipated that they will settle along with the marsh platform. Although it is possible that the openings may settle at a slower rate than the platform, erosion from waves and storm events should continue to degrade the openings so that hydrologic exchange is maintained.

VII. Recommendations

Based on the evaluation of available ecological, geological, and engineering information, and a review of scientific literature and similar restoration projects, the proposed strategies of the Raccoon Island Shoreline Protection/Marsh Creation, Phase B project will likely achieve the desired ecological goals. At this time, it is recommended that this project be considered for Phase 2 authorization.

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Appendix. Previously constructed barrier island projects that created marsh (sorted by construction date).

Project Name	Program	Project Number	Construction Date	Dredged Material (cubic yards)	Marsh Platform Elevation (ft)	Marsh Platform Width (ft)	Dune Elevation (ft)	Dune Width (ft)	Vegetation Planted	Project Summary
Wine Island Restoration	WRDA	DSR-81558	1991							Material from a scheduled maintenance dredging project in the Houma Navigational Canal was used to restore the island. Vegetation was planted to stabilize the sediment.
Raccoon Island Repair	State	RI	1994	1.2 million					*Avicennnia germinans*	Dredged material and vegetation were used to repair damage to the island from Hurricane Andrew.
Wine Island (FEMA)	FEMA	DSR-81558	1995							The island was repaired to pre-Hurricane Andrew condition with the beneficial use of dredged material from Houma Navigational Canal maintenance. Vegetation was planted to stabilize the sediment.
Barataria Bay Waterway, Grand Terre Island (Phase I)	WRDA	N/A	1996	500,000						This project involved the beneficial placement of dredged material from the Barataria Bay Waterway to create wetlands on West Grand Terre Island.
East Island Repair Protection (FEMA)	FEMA	DSR-81560	1996							An elevated marsh platform was constructed in an area of a Terrebonne Parish project destroyed by Hurricane Andrew. Vegetation was planted to stabilize the sediment.
Timbalier Island Repair (FEMA)	FEMA	DSR-81559	1996			300				A major breach created by Hurricane Andrew was closed. A 300-feet wide elevated marsh platform was constructed. Vegetation was planted to stabilize the sediment.
Isles Dernieres Restoration, East Island	CWPPRA	TE-20	1999	3.9 million	+2 to +4 NAVD 88	100-350	+8.0 NAVD 88	300-500	*Cynodon dactylon* *Spartina patens* *Spartina alterniflora* *Panicum amarum*	The project objective was to restore the coastal dunes and wetlands on East Island. Sand was dredged from Lake Pelto and used to build a retaining dune and an elevated marsh platform. Sand fences and vegetation were used to stabilize the sand and minimize wind-driven transport.
Isles Dernieres Restoration, Trinity Island	CWPPRA	TE-24	1999	2.9 million	>4.0 NAVD 88	100-350	+8.0 NAVD 88	300	*Cynodon dactylon* *Spartina patens* *Spartina alterniflora* *Panicum amarum*	The project objective was to restore the coastal dunes and wetlands on Trinity Island. Sand dredged from adjacent waters was used to build dunes and an elevated marsh platform. Sand fences and vegetation were used to stabilize the sand and minimize wind-driven transport.

Appendix, continued. Previously constructed barrier island projects that created marsh (sorted by construction date).

Project Name	Program	Project Number	Construction Date	Dredged Material (cubic yards)	Marsh Platform Elevation (ft)	Marsh Platform Width (ft)	Dune Elevation (ft)	Dune Width (ft)	Vegetation Planted	Project Summary
Barataria Bay Waterway, Grand Terre Island (Phase II)	WRDA	N/A	1999	500,000						This project involved the beneficial placement of dredged material from the Barataria Bay Waterway to create wetlands on the bayside of West Grand Terre Island.
Whiskey Island Restoration	CWPPRA	TE-27	1999	2.8 million	+2 to +4 NAVD 88	800-1,500	+4 to +6 NAVD 88	300	*Spartina alterniflora* *Spartina patens* *Panicum amarum* *Avicennia germinans*	Back-barrier marsh was created and a breach at Coupe Nouvelle was filled using material dredged from the bay north of the island. Vegetation was planted in the back-bay areas.
East Timbalier Island Sediment Restoration, Phase I	CWPPRA	TE-25	2000	402,000	+2.0 NAVD 88	600	+5.0 NAVD 88	200	*Panicum amarum* *Spartina patens*	Dredged sediment was placed in three embayments along the bayside shoreline of East Timbalier Island. This project also included the aerial seeding of dunes, installation of sand fencing, and dune vegetation plantings.
East Timbalier Island Sediment Restoration, Phase II	CWPPRA	TE-30	2000	2.8 million	+2.0 NAVD 88	600				Dredged material was placed along the bayside shoreline of the island. Additional rock was placed on the existing breakwater on the gulfside of the island.
Vegetative Plantings of a Dredged Disposal Site on Grand Terre Island	CWPPRA	BA-28	2001						*Spartina alterniflora* *Spartina patens* *Panicum amarum* *Avicennia germinans*	The goal of this project is to stabilize dredged material deposited on West Grand Terre Island. This was achieved through vegetation plantings and by purchasing grazing rights on the island for the duration of the project (20 years).
Chandeleur Islands Marsh Restoration	CWPPRA	PO-27	2001						*Spartina alterniflora*	This project intends to accelerate the recovery period of barrier island areas overwashed by Hurricane Georges in 1998 through vegetation plantings. The overwash areas, which encompass 364 acres, are located at 22 sites along the Chandeleur Sound side of the island chain.
Timbalier Island Dune and Marsh Creation	CWPPRA	TE-40	2004	4.6 million	+1.6 NAVD 88	800	+8.0 NAVD 88	400	*Spartina alterniflora* *Panicum amarum* *Spartina patens* *Uniola paniculata*	The objective of this project is to restore the eastern end of Timbalier Island by the direct creation of beach, dunes, and marsh.