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

Lake Borgne Shoreline Protection
CWPPRA Priority Project List 10
(State No. PO-30)

November 08, 2005

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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 November 22, 2005.

95% Ecological Review
Lake Borgne Shoreline Protection

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 Lake Borgne Shoreline Protection (PO-30) project is located in St. Bernard Parish, Louisiana. The proposed project is the result of merging the CWPPRA Priority Project List (PPL) - 10 project located at Shell Beach (PO-30) and the PPL-11 project located at Bayou Dupre (PO-31). The two projects were combined so as to have one concerted effort to protect two critical areas of shoreline and marsh between Lake Borgne and the Mississippi River Gulf Outlet (MRGO) (Figure 1). The marsh areas along the southern shoreline of Lake Borgne aid in protecting communities in the vicinity of Shell Beach and Bayou Dupre from direct exposure to wave energies and storm surges from the lake. However, because these marshes are receding this will result in the coalescence of the two water bodies. Erosion rates of 9 feet per year and 10 feet per year have been measured at Shell Beach and Bayou Dupre, respectively. The objective of this project is to preserve the existing marsh land bridge between Lake Borgne and the MRGO to prevent them from coalescing.

Prior to construction of the MRGO in the 1960s, the project area was most likely an intermediate to brackish marsh. After construction of the MRGO, the 1978 habitat classification data indicated that the area had converted entirely to brackish marsh (United States Environmental Protection Agency [EPA] 2000, 2001). Construction of the MRGO drastically altered salinity regimes in project area marshes, gradually converting the area to its present saline marsh state and steadily decreasing total wetland acreage (EPA 2000, 2001). The area will remain saline marsh and continue to erode unless the navigational dimensions of the MRGO are altered.

The Shell Beach site extends from Fort Bayou to Doulluts Canal and contains 111 acres of saline marsh (Louisiana Department of Natural Resources, Coastal Engineering Division [LDNR, CED 2005]). The Bayou Dupre site extends to the west and east of where the bayou opens into the lake and contains 56.3 acres of saline marsh (LDNR, CED 2005). Both sites contain reaches that have been classified as "strong" or "weak" based upon geotechnical analysis. The "strong" soil stretches would feature a single construction lift whereas the "weak" soil reaches would feature a phased construction design.

Coast 2050 has identified the maintenance of shoreline integrity of Lake Borgne, restoration and maintenance of the land bridge between MRGO and Lake Borgne with created marshes and shoreline protection, and restoration and stabilization of the entire north bank of the MRGO as Region 1 ecosystem strategies that will preserve marsh and maintain shoreline integrity

(Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation Restoration Authority 2001).

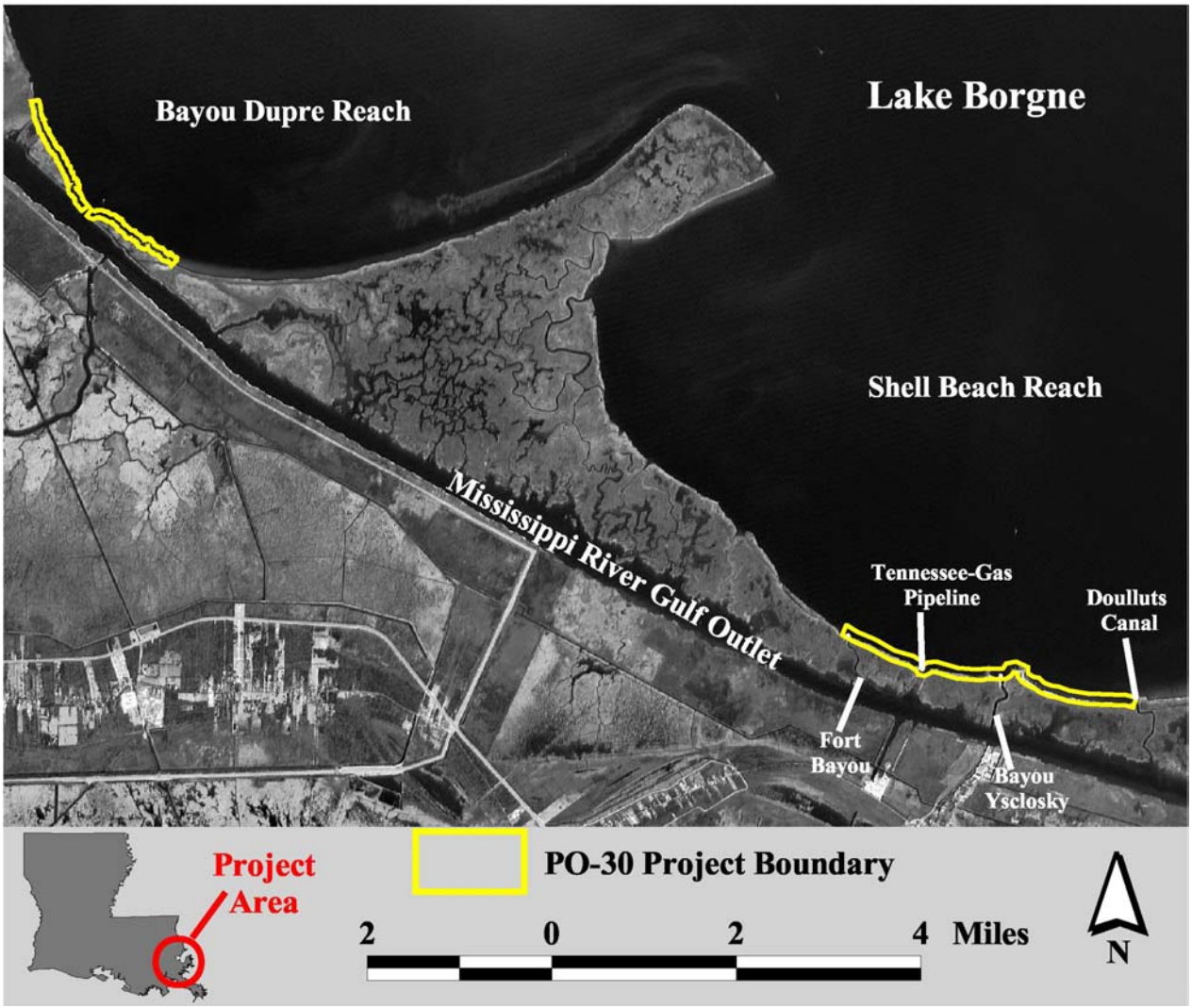

Figure 1. Shoreline Protection and Marsh Creation at Lake Borgne Project Boundaries (LDNR-CED 2005).

II. Goal Statement:

- Stop erosion along approximately 17,700 feet of shoreline at the Shell Beach site and along approximately 13,728 feet of shoreline at the Bayou Dupre site.

III. Strategy Statement:

- A continuous, onshore rock dike will be constructed along the Shell Beach and Bayou Dupre (6,262 feet for the western reach and 5,906 feet for the eastern reach) sites. Mechanically Stabilized Earthen Walls (MSEW) will be utilized at the ends of the Bayou Dupre structures (1,130 feet for the western reach and 430 feet for the eastern reach) to tie the proposed structures into the existing rock structures on the MRGO (Figure 2).

IV. Strategy-Goal Relationship:

Shoreline protection and stabilization in the form of an onshore rock dike would stop bank/shoreline retreat by baffling high-energy, wind-blown and boat-induced waves and provide protection for reestablishment of emergent vegetation on the shoreward side of the breakwater.

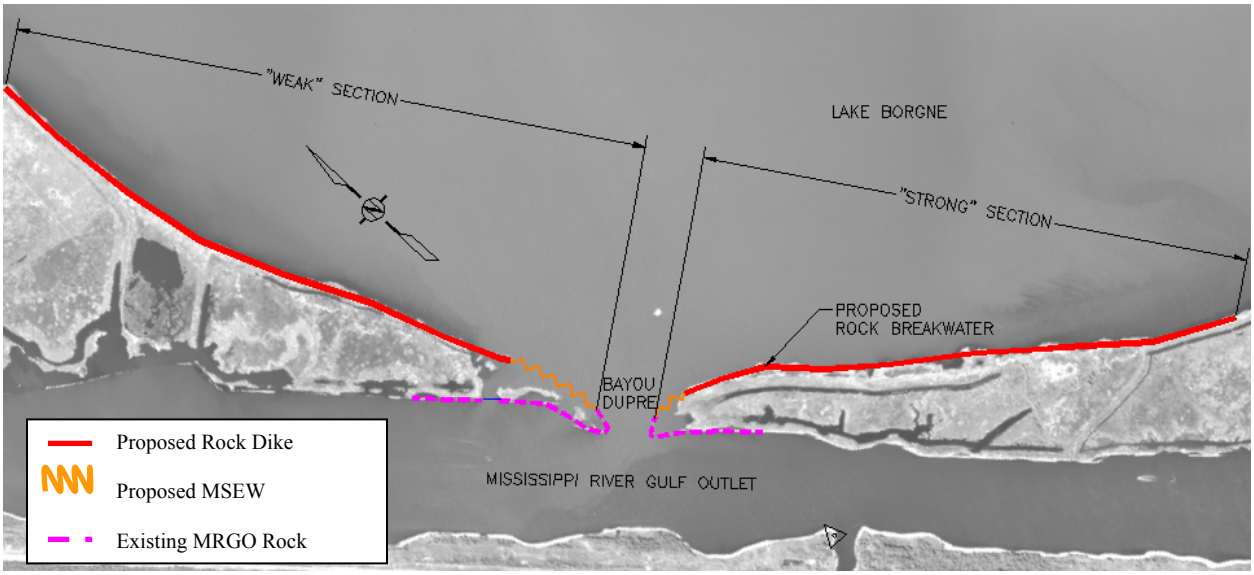

Figure 2. Depiction of features and "weak" or "strong" soil reaches along the Bayou Dupre Reach and proposed structures (LDNR, CED 2005).

V. Project Feature Evaluation:

Geotechnical Investigation

A geotechnical investigation was conducted for the Bayou Dupre and Shell Beach sites. A total of 24 borings (10 borings at Bayou Dupre and 14 borings at Shell Beach) were collected and evaluated to determine the bearing capacity, settlement, shear strength, and slope stability (Capozzoli and Associates, Inc. 2002). The Bayou Dupre soils were very soft, slightly organic clay, organic clay, and peat to about elevation -10 feet NAVD 88. The soils along the Shell Beach site were clays and silts of the slightly organic or organic nature in the upper 3 to 4 feet underlain by very soft to soft clay and slightly organic clay (Capozzoli and Associates, Inc 2002). In general, the soils at the Shell Beach site are not as compressible as those encountered along the profiles at the Bayou Dupre site.

The geotechnical investigation revealed that rock could not be placed at the initially preferred alignment along the -5 foot contour nor would the soils along the -2-foot contour (secondary alignment) support the weight of rock with the exception of a few stretches due to high settlement rates. A second geotechnical investigation ensued to determine if onshore placement was more feasible. Capozzoli and Associates, Inc. (2003) recommended that the rip-rap material be placed at the marsh edge where the soil bearing capacities were more suitable and minimal settlement would occur. To further minimize settlement and construction costs, the alignment of the structure was moved onshore (except for areas where the structure was to tie into the rock structures along the MRGO). The second investigation resulted in the area soils being

classified as “strong” or “weak” based on their bearing and shearing strengths and their slope stabilities (Figures 2 and 3).

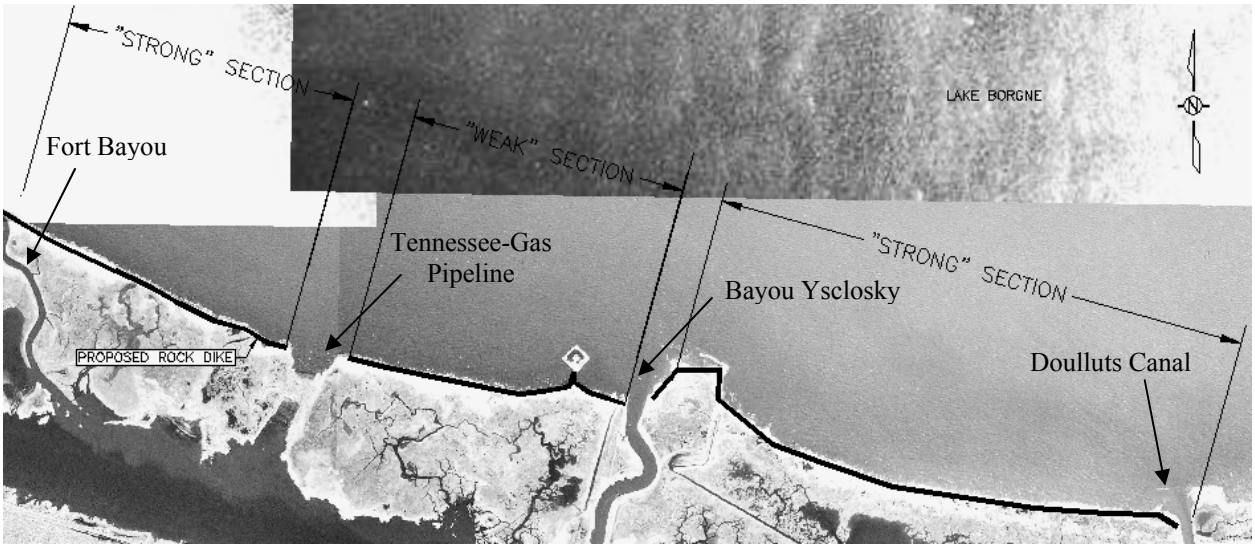

Figure 3. Depiction of the “weak” and “strong” stretches along the Shell Beach reach (LDNR, CED 2005).

The reach to the west of Bayou Dupre along with the reaches of Shell Beach from Fort Bayou eastward to the Tennessee Gas Pipeline and from Bayou Ysclosky eastward to Doulluts Canal are all classified as “strong” and would require only one construction lift (top elevation +4.0 feet NAVD 88) to maintain an elevation of +3.0 feet NAVD 88 throughout the duration of the project life. The reach to the east of Bayou Dupre along with a reach of Shell Beach from the Tennessee Gas Pipeline eastward to Bayou Ysclosky are classified as “weak”. These reaches would require a phased construction approach.

Structure Design

The final construction dimensions of the rock structures on the “strong” soils (Figure 4) would have a crest width of 4 feet, with 1(V):2(H) side slopes, and top elevation of +4.0 feet NAVD 88. Those dikes would settle approximately 2 inches immediately after construction. The structure is estimated to only experience an additional 10 inches of settlement over the remainder of the 20-year project life. The dikes would not settle below the 90th percentile wave height (+2.0 feet NAVD 88) for the duration of the project life nor would the structures settle lower than the one foot freeboard (elevation +3.0 feet NAVD 88) that would provide added protection in the event of a storm or unexpected increased settlement.

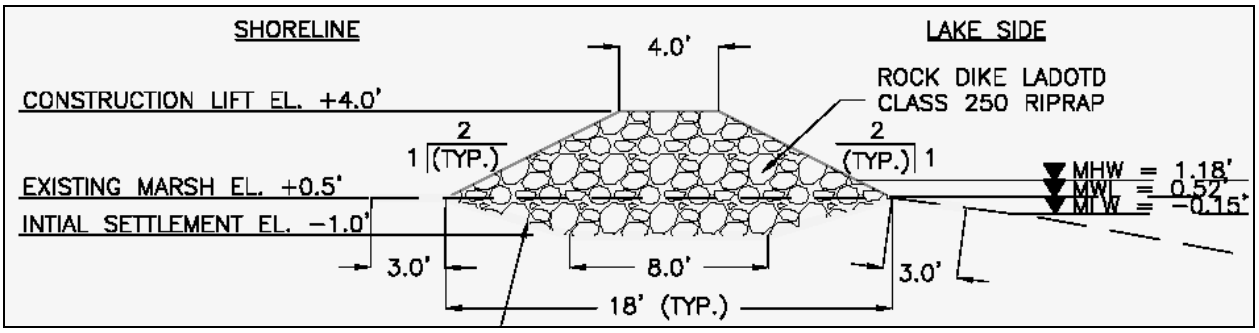

Figure 4. Typical section of the rock structure along "strong" soil reaches (LDNR, CED 2005).

The first construction lift of the rock on the "weak" soils (Figure 5) would have dimensions of an 8-foot crest width, 1(V):2(H) side slopes, and top elevation of +3 feet NAVD 88. It is estimated that those dikes would settle approximately 1.5 feet in the first 30 days. That abrupt amount of settlement would place the structures below the 90th percentile design wave height (+2 feet NAVD 88) requiring additional lifts. The second construction lift would have dimensions of a 7-foot crest width, 1(V):2(H) side slopes, and top elevation of +3.25 feet NAVD 88. The second construction lift would settle an additional 1.25 feet by project year 1. At project year 1, a maintenance lift would be applied that would raise the dike to an elevation of +4 feet NAVD 88. The final dimension of the maintenance lift would have a 4-foot crest width, 1(V):2(H) side slopes, and a top elevation of +4 feet NAVD 88. The dike would remain at an elevation higher than the 90th percentile design wave height beyond project year 20 but would settle below the one foot of freeboard (elevation +3 feet NAVD 88) during project year 8.

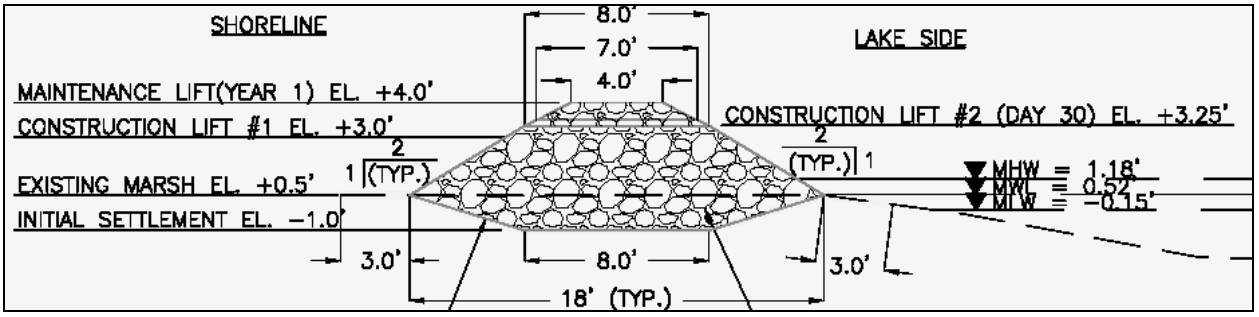

Figure 5. Typical section of the rock structure along "weak" soil reaches (LDNR, CED 2005).

Mechanically stabilized earthen walls (MSEW) would be used to connect the rock structures placed onshore of the lake with existing structures along the MRGO. The structures would be used in deep water areas of the project where rock placement was not feasible. The open-water areas in question are at the ends of the Bayou Dupre project reaches where the bayou connects the lake to MRGO. MSEW's consist of two steel sheetpile panels driven to depths of 30-40 feet. The panels would be held together with tie rods and walers and would then be in-filled with sand that would be capped with rock up to a top elevation of +2.5 feet NAVD 88 (Figure 6 [LDNR, CED 2005]). This elevation is only 0.5 feet higher than the 90th percentile design wave height, but very little settlement of the structure is expected once the sand has been wet and reaches equilibrium. Weep holes would be drilled into the structure at elevation 0.0 feet NAVD 88 to reduce the effects of shearing forces and allow water to passively impact the structure.

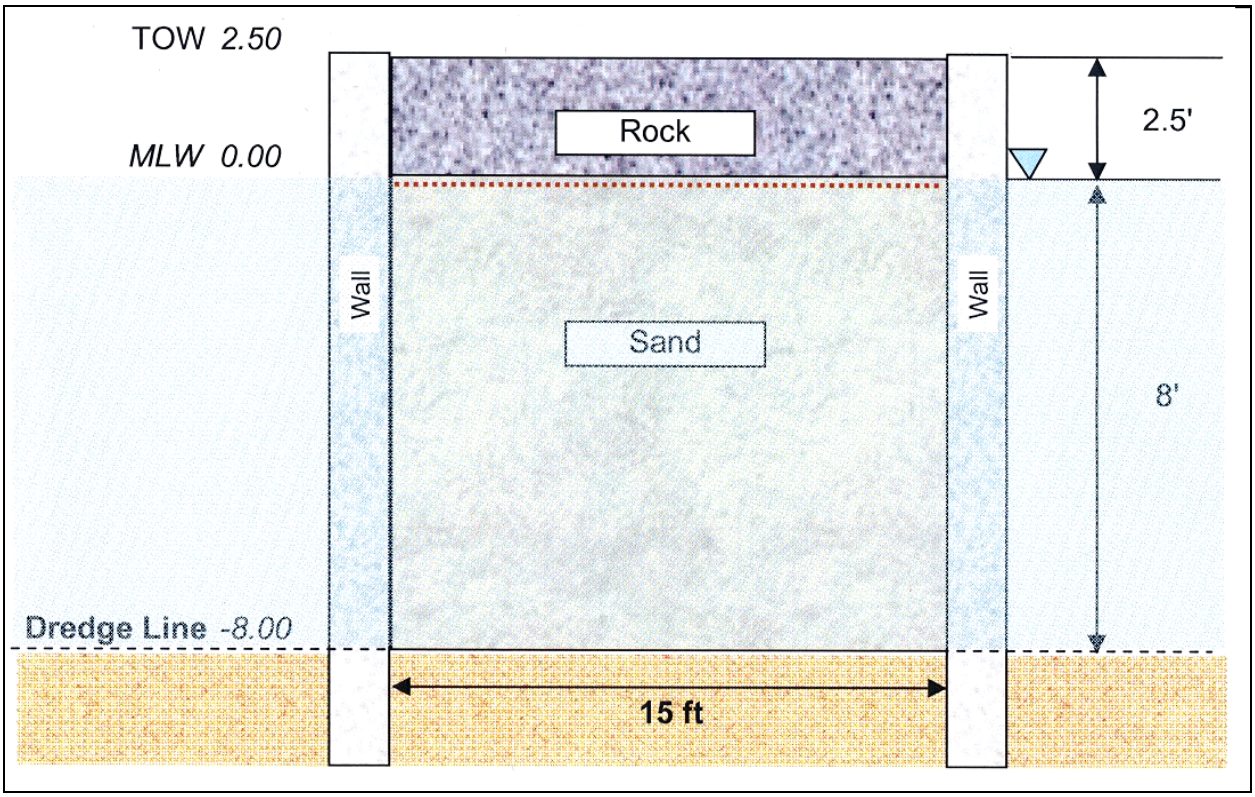

Figure 6. Cross-sectional depiction of MSEW (LDNR, CED 2005).

VI. Assessment of Goal Attainability:

Environmental data and scientific literature documenting the effects of the proposed project features in field application are included below to assess whether or not, and to what degree, the project features will cause the desired ecological response. Design parameters of previously constructed shoreline protection projects are summarized in Table 1. Several of those projects constructed along bays and lakes are discussed below.

Shoreline Protection on Bays and Lakes

CWPPRA and State-authorized shoreline protection projects similar to the Lake Borgne Shoreline Protection project have been built on lake and cove shorelines as a means of protecting those banks from erosion.

- Bayou Chevee Shoreline Protection (PO-22) is located on the southern shoreline of Lake Pontchartrain just west of Chef Menteur Pass within the northern section of the Bayou Sauvage National Wildlife Refuge. The project is broken into two coves (northern and southern). Construction was completed in 2001, with the initial as-built survey completed in 2002. The total length of the project was 8,875 feet with both rock dikes constructed using 200-400 pound rock placed at an elevation of +3.5 feet NGVD-29 (Carter 2003). The first post-construction survey work was completed in 2004, but the data has not yet been analyzed, limiting the ability to evaluate the effectiveness of the project at this time. After the 2004 shoreline position is documented, the rate of shoreline movement during

the first 2 years post-construction will be calculated from the project and reference areas to determine the project's effectiveness at addressing shoreline erosion (Carter 2003).

- Barataria Basin Landbridge Shoreline Protection (BA-27) Phases 1, 2, 3, and 4 are located in Jefferson and Lafourche Parishes and encompass a variety of shoreline protection techniques along approximately 107,500 feet of shoreline. Geotechnical investigations have revealed poor soil conditions throughout the area. These results prompted the testing of non-traditional protection techniques that included rock dikes consisting of either earthen cores, lightweight aggregate cores, or lightweight aggregate cores with a furrow (to reduce the load) beneath the rip-rap structure, as well as testing of concrete sheetpiles as an alternative to the rock dikes. In 2001, all of the test sections for Phase 1 of the project were completed. One year after all the test sections were constructed, surveys were conducted to determine the settlement rates and to estimate 10-year settlement. The concrete sheetpile wall sections showed very little movement vertically or horizontally but the rock and composite dike sections experienced significant amounts of settlement ranging from 2.7-3.5 feet over the first year (United States Department of Agriculture, Natural Resources Conservation Service 2002). Although the concrete sheetpile performed the best, a geotechnical analysis indicated that the soils were of a better quality in other areas of the project. Therefore, cost considerations led to the least expensive alternative of rock being chosen (Karim Belhadjali, LDNR, Personal Communication, May 23, 2005). A monitoring plan has been written, and once the 2006 surveys have been completed an analysis of structure effectiveness will be produced.

- The Lake Salvador Shore Protection Demonstration (BA-15) project evaluated a series of shoreline protection measures in Lake Salvador in St. Charles Parish, Louisiana. Phase two of this project was conducted in 1998 and evaluated the effectiveness of a rock berm to protect the lake shoreline from higher energy wave erosion. The rock structure itself appears to be holding up well, showing little sign of deterioration and subsidence. Surveys of the area revealed that the rock dike was successful in stabilizing the shoreline and some accretion is occurring behind the structure (Curole et al. 2001). However, the effectiveness of the structure over the long term may be in question since it was not built according to design specifications. The rock dike was designed to be constructed with a crest elevation of +4.0 feet NAVD 88 but was actually constructed with a crest elevation of 2.75 feet NAVD 88. Between 1998 and 2002, the structure settled an average of 0.26 feet. It was concluded that the rock dike was built to an inadequate crest elevation of +2.75 feet NAVD 88 (Darin Lee, LDNR, Personal Communication, July 14, 2002).

- The Turtle Cove Shoreline Protection (PO-10) was initiated in 1993 to protect a narrow strip of land in the Manchac Wildlife Management Area that separates Lake Pontchartrain from an area known as "The Prairie" (O'Neil and Snedden 1999). Wind-induced waves contributed to a shoreline erosion rate of 12.5 feet per year. A 1,642-foot rock-filled gabion was constructed 300 feet from shore at an elevation of 3 feet above mean water level with the goal of reducing erosion and increasing sediment accretion behind the structure. Post construction surveys conducted during the period of October 1994 to December 1997 revealed that the shoreline had prograded at a rate of 3.47 feet per year in

the project area (O'Neil and Snedden 1999). The rate of sediment accretion, as determined from elevation surveys conducted in January 1996 and January 1997, was 0.26 feet per year (O'Neil and Snedden 1999). The soils in "The Prairie" and Turtle Cove area consist of Allemands-Carlin peat which is described as highly erodible organic peat and muck soils (USDA-SCS 1972). Due to the weak and compressible nature of the subsurface soils, the gabions settled 0.59 feet in just over two years (October 1994 to January 1997) (O'Neil and Snedden 1999). Also, seven years after construction, the rock- filled gabion structure exhibited numerous breaches and required extensive maintenance in August 2000 (John Hodnett, LDNR, Personal Communication August 2004).

- The Boston Canal/Vermilion Bay Bank Protection (TV-09) project was designed to abate wind-driven wave erosion along Vermilion Bay (estimated at 7 feet per year) and at the mouth of Boston Canal (Thibodeaux 1998). To accomplish that goal, a 1,405-foot foreshore rock dike was constructed in 1995 at an elevation of +3.8 feet NGVD-29 along the bank of Boston Canal extending into Vermilion Bay. The project appeared to be maintaining the integrity of approximately 466 acres of wetlands and stabilizing 14.3 miles of the Vermilion Bay shoreline (Thibodeaux and Guidry 2004). Sediment build-up behind the dike on the east and west sides has been noticed and vegetation has covered previously exposed mud flats (Thibodeaux and Guidry 2004). Elevation data also showed an increase in sedimentation behind the rock breakwater (Thibodeaux and Guidry 2004).

- The Mandalay Bank Protection Demonstration (TE-41) project consists of four low-cost treatments designed to halt bank erosion and encourage sedimentation and vegetation growth along the Gulf Intracoastal Waterway (GIWW [Lear and Dearmond 2004]). These nontraditional alternative treatments are being utilized in place of rip-rap structures which may be too heavy for the soil conditions encountered in these areas (Lear and Dearmond 2004). One of the treatments (submerged straight-walled fiberglass sheetpile) is very similar to the MSEW's proposed for the PO-30 project. Approximately 1,749 feet of submerged straight-walled fiberglass sheet pile system was constructed and in-filled with dredge material from the GIWW. Galvanized rods were bolted to timber walers to provide lateral bracing (Lear and Dearmond 2004). Site inspections were conducted during February and March 2005. On February 17th a high water event submerged the structures. The tops were visible on March 2nd and no structural damage or breaching was noticed (Lear and Dearmond 2004).

Table 1. Design parameters of constructed shoreline protection projects (sorted by construction date).

Project Name	Project Number	Coast 2050 Region	Construction Date	Depth Contour (ft)	Structure Length (ft)	Structure Elevation (ft NAVD 88)	Distance from Shoreline (ft)	Preliminary Monitoring Results
Point Au Fer Canal Plugs	TE-22	3	1997, 2000		3,600 (1997) 3,662 (2000)			
Barataria Bay Waterway East Side Shoreline Protection	BA-26	2	2001		17,054	4.0 ft NGVD-29		
Bayou Chevee Shoreline Protection	PO-22	1	2001		8,875	3.5 ft NGVD-29	300	
Chenier Au Tigre Sediment Trapping Demonstration	TV-16	3	2001					
GIWW Perry Ridge West Bank Stabilization	CS-30	4	2001		10,705			
Marsh Island Hydrologic Restoration	TV-14	3	2001		3,600 1,800	5.0 4.0	50 to 70	
Oaks/Avery Canals Hydrologic Restoration, Increment 1	TV-13a	3	2002		5,300 1,200 300	3.0 3.0 -24 to +5	0 to 30 0 to 30	
Oaks/Avery Structures (State)	TV-13b	3	2002		1,200	3.0	12 to 16 (onshore)	
Black Bayou Hydrologic Restoration	CS-27	4	2003		23,400	3.0	10 to 60	
Jonathan Davis Wetland Protection	BA-20	2	2001, 2003		1,385 (2001) 3,967 (2001) 13,088 (2003)	3.0 3.5 3.5		
Mandalay Bank Protection Demonstration	TE-41	3	2003	-1 to -3	1,494	1.5 to 3.0	10 to 200	
Grand-White Lake Land Bridge Protection	ME-19	4	2004	-1 to -2	12,000	2.5	50 to 200	
Barataria Basin Land Bridge Shoreline Protection, CU 1, CU 2, CU 3	BA-27 and BA-27c	2	2004 (CU 3) 2004 (CU 2) 2001 (CU 1)	0 (CU 3) -2 (CU 2) -2.5 (CU 1)	10,865 (CU 3) 6,403 (CU 2) 3,200 (CU 1)	3.5 (CU 3) 3.5 (CU 2) 3.0 (CU 1)	0 to 50 (CU 3) 50 to 600 (CU 2) 50 to 100 (CU 1)	CU 1 tested five different designs
						4.0 ft NGVD-29 (revetment)		
Cote Blanche Hydrologic Restoration	TV-04	3	1999		4,400	3.0	60 to 450	
Perry Ridge Shore Protection	CS-24	4	1999		12,000	3. to 4.0	60	
Barataria Bay Waterway West Side Shoreline Protection	BA-23	2	2000		9,900	4.0		

Table 1 continued. Design parameters of constructed shoreline protection projects (sorted by construction date).

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Oaks/Avery Canals Hydrologic Restoration, Increment 1	TV-13a	3	2002		5,300 1,200 300	3.0 3.0 -24 to +5	0 to 30 0 to 30	
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Summary and Conclusions

The geotechnical investigation of the Lake Borgne Shoreline Protection (PO-30) project area concluded that soils in open-water areas of the project would not support the weight of a rock structure. The investigation further classified the onshore soils within the project area as either "weak" or "strong" based on profile analyses measuring bearing and shearing strengths and slope stability. In "weak" soil reaches (soils with lower bearing capacities), the structure designs were engineered to address higher expected settlement. Engineering designs on this project have indicated that poor soil conditions can be offset by constructing dikes via phased construction (multiple lifts) which allow the structures to compress the underlying soils to a temporary state of equilibrium prior to adding more weight.

A review of both published and unpublished literature on previously constructed restoration projects similar in nature and design to the proposed project were used to confirm the effectiveness of rock dikes along lake and bay shorelines. Monitoring results for the Lake Salvador Shore Protection (BA-15) and Boston Canal/Vermilion Bay Bank Protection (TV-09) have shown that these projects have successfully reduced shoreline erosion in areas with similarly poor soil conditions as those found along some reaches of Lake Borgne. Conversely, the Turtle Cove Shoreline Protection (PO-10) has shown a lack of success (with respect to structure integrity) in areas with poor soil conditions which can be attributed to the use of substandard materials and inadequate maintenance. These findings provided insight into how effective constructed projects are at achieving their specified goals and assisted team scientists and engineers in predicting the performance of similar designs.

Only preliminary information exists on the use of MSEW's in coastal areas. Results from similarly designed structures used in the recently constructed Mandalay Bank Stabilization Demonstration Project (TE-41) will not be available until after the 2005 surveys are conducted. The success of those structures will lend some knowledge to otherwise uncertain performance potential of MSEW's. Despite this, the LDNR, CED still supports the usage of MSEW's along the ends (open water areas) of the proposed project reaches. Few options are left to protect those areas of the project because rock rip-rap would not stabilize; concrete sheetpile would be too costly; and articulated mats need to be placed on material and would be submerged in open water.

Breakwaters have been used to stop shoreline retreat in many areas of coastal Louisiana and could very well protect the proposed project reaches. The rock features proposed for this project have been engineered to counter the low bearing capacities of the underlying soils and should lessen the impacts of wind-induced and boat wake waves, thus protecting the marsh strip that separates Lake Borgne and the MRGO. While information is lacking on the potential of MSEW's, there are no other options available to link the proposed structures and existing MRGO structures, hence their inclusion in the project design.

VII. Recommendations

Based on the investigation of similar restoration projects and a review of engineering principles, the proposed strategies of the Lake Borgne Shoreline Protection (PO-30) project should achieve the goal of stopping shoreline erosion. A 95% Design Review meeting gave a favorable report; therefore LDNR concurs with the project moving towards Phase II funding.

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