MONITORING PLAN

PROJECT NO. TE-52 WEST BELLE PASS BARRIER HEADLAND RESTORATION

DATE: October 15, 2009

Preface

The Barrier Island Comprehensive Monitoring (BICM) program has been initiated under the Louisiana Coastal Area Science and Technology (LCA S&T) office as a component of the System-wide Assessment and Monitoring (SWAMP) program (USACE 2004). The BICM program is located along the Louisiana coastal shoreline, specifically those areas where barrier shorelines exist, from the northern tip of the Chandeleur Islands south to include all the Chandeleur Islands; and from Sandy Point west to Raccoon Point, as well as the Chenier Plain from Sabine pass east to the Mermentau Outlet. Currently the program is expected to monitor the sandy shorelines of the Louisiana coast every 5 years.

The advantage of BICM over the current project specific monitoring is that it will provide long term data on all of Louisiana's barrier islands, instead of just those islands with constructed projects. As a result, a greater amount of longer-term data will be available not only to evaluate constructed projects, but for planning and design of future barrier island projects, operations and monitoring (O&M) activities, and determining storm impacts. Because data will be collected for the entire barrier island system concurrently and with the same methodologies, those data will be more consistent, accurate, and complete than the current barrier island data collection efforts.

The objectives of BICM are to:

1. Determine the elevation, longevity, and conservation mass of the barrier islands.
2. Determine major habitat types and the distribution and quantity of each habitat over time on the barrier islands.
3. Determine geotechnical properties of sediments on the barrier islands.
4. Relate available data on environmental forces that affect the ecology and morphology of the barrier islands to other BICM data sets.
5. Determine species composition and diversity of vegetation within major habitat types on the barrier islands.

The BICM program will allow overall assessment of individual projects to be accomplished with additional monies needed only to address time sensitive issues or areas of specific interest not addressed by this comprehensive program such as survival of plantings, initial sediment transport, tidal channel development and fisheries use.

Project Description

The West Belle Pass Barrier Headland Restoration (TE-52) project is a marsh and dune creation restoration project. TE-52 is located at the western terminus of the 17 mi (27 km) long Caminada-Moreau Headland and is positioned approximately 2 mi (3 km) southwest of Port Fourchon and 0.5 mi (0.8 km) west of Belle Pass in Lafourche Parish, Louisiana (figures 1 & 2). The project area consists of supratidal, intertidal, and subtidal habitat found on the headland (figure 3). The marsh creation phase of the TE-52 restoration project will elevate subtidal and intertidal areas directly behind the dune to intertidal and supratidal elevations. The dune creation phase will extend for 9,300 ft (2,835 m) along the Gulf of Mexico shoreline raising the supratidal, intertidal, and subtidal environments to dune and supratidal elevations (figure 4). The western portion of the headland is separated from the vastly larger eastern part via the Belle Pass rock jetties and forms its southern border with the Gulf of Mexico and its northern border with Timbalier Bay (figures 2 & 3).

The formation of the Lafourche delta complex began approximately 3,500 years before present (Frazier 1967; Otvos 1969; Peyronnin 1962; Conaster 1971; Harper 1977). During this time, nutrient rich sediments were deposited along the banks of the Lafourche delta distributaries primarily through overbank flooding. This created a vast network of swamps, marshes, and ridges along its numerous subdeltas (Frazier 1967; Reed 1995). Bayou Lafourche was one of the final subdeltas to form during the Lafourche delta period before the river switched its flow to the Plaquemines and Modern delta complexes. This subdelta was an active distributary of the Mississippi River from approximately 1800 to 100 years before present (Frazier 1967; Morgan and Larimore 1957; Peyronnin 1962). At the mouth of the Bayou Lafourche subdelta, a regressing network of accretionary sand ridges developed to form the Caminada-Moreau Headland (figure 2). These ridges were geomorphodynamically formed by shaping delta front sheet sands through wind, wave, tidal, and longshore transport processes (Ritchie 1972; Otvos 1969; Conaster 1971; Bird 2000).

The soils in the project area are mostly composed of Felicity loamy fine sand soil. This soil is established along the Gulf of Mexico beaches and consists of a somewhat poorly drained sandy soil. Scatlake muck and Bellepass-Scatlake association soils are also found in or near the project area. The Scatlake muck soil is a very poorly drained mineral soil that is located along the Belle Pass and Bayou Lafourche shoreline while the Bellepass-Scatlake association is an organic and mineral soil that is found in very poorly drained saline marshes (USDA 1984).

Marsh vegetation in the project area is dominated by *Spartina alterniflora* Loisel. (smooth cordgrass) and *Avicennia germinans* (L.) L (black mangrove). *Spartina patens* (Ait.) Muhl. (marshhay cordgrass), *Salicornia virginica* L. (glasswort), *Solidago sempervirens* L. (seaside goldenrod), *Baccharis halimifolia* L. (eastern baccharis), *Iva frutescens* L. (bigleaf sumpweed), *Morella cerifera* (L.) Small (waxmyrtle), *Batis maritima* L. (saltwort), and *Distichlis spicata* (L.) Greene (seashore saltgrass) also inhabits the project area. Chabreck and Linscombe (1997) classified the project area as salt marsh habitat.

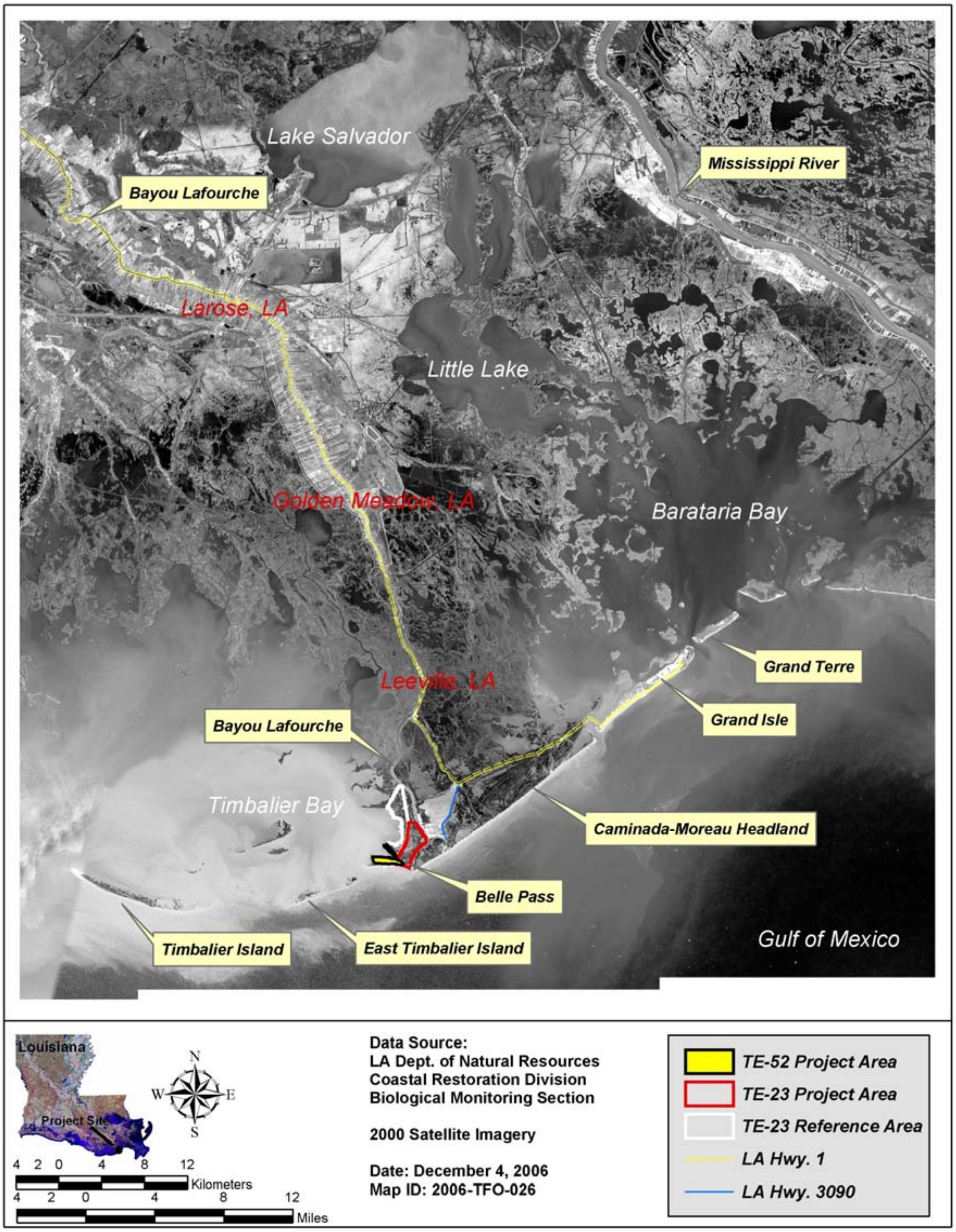

Figure 1. Location and vicinity of the West Belle Pass Barrier Headland Restoration (TE-52) project.

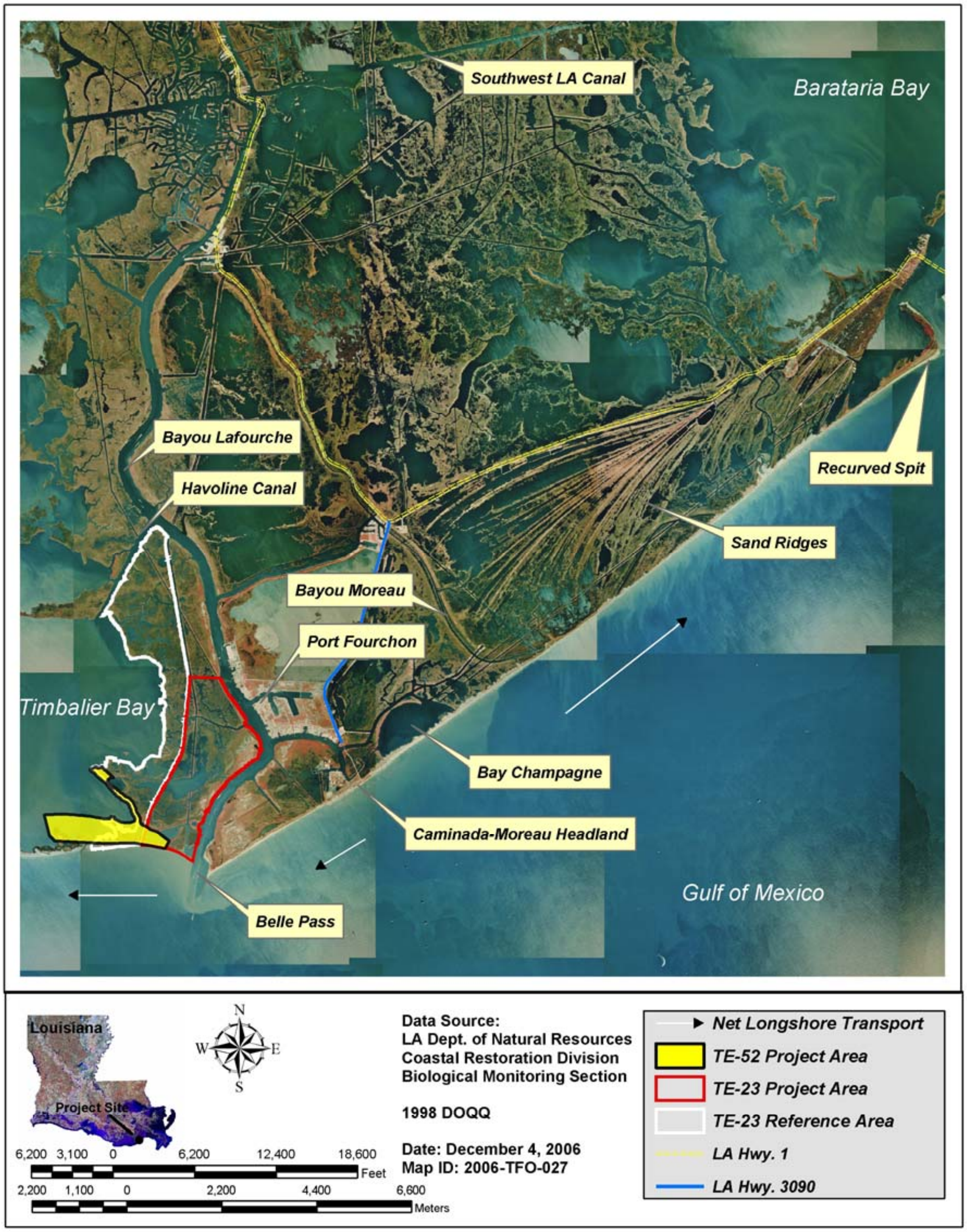

Figure 2. Geomorphic features of the Caminada-Moreau Headland.

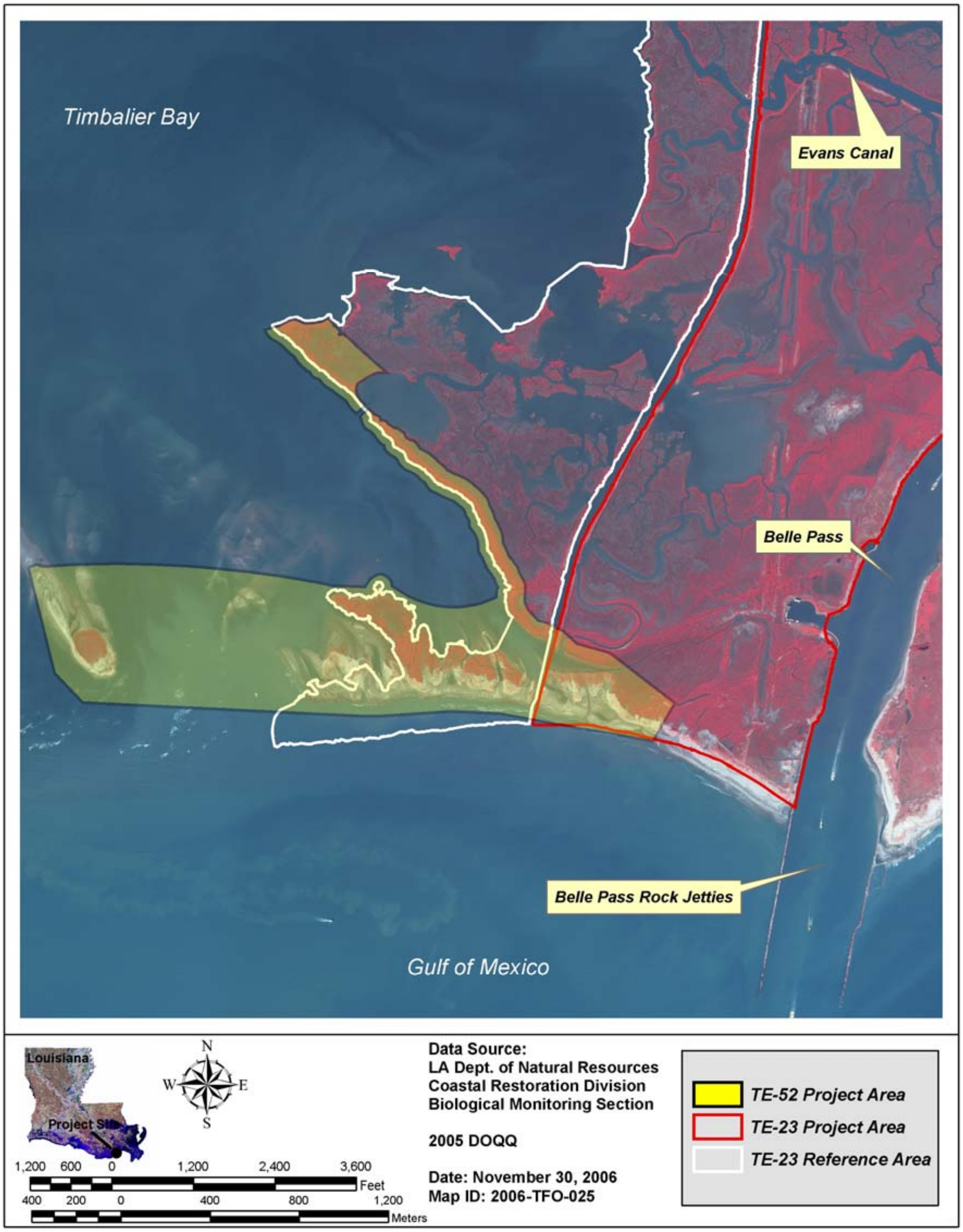

Figure 3. **Location of the West Belle Pass Barrier Headland Restoration (TE-52) project area.**

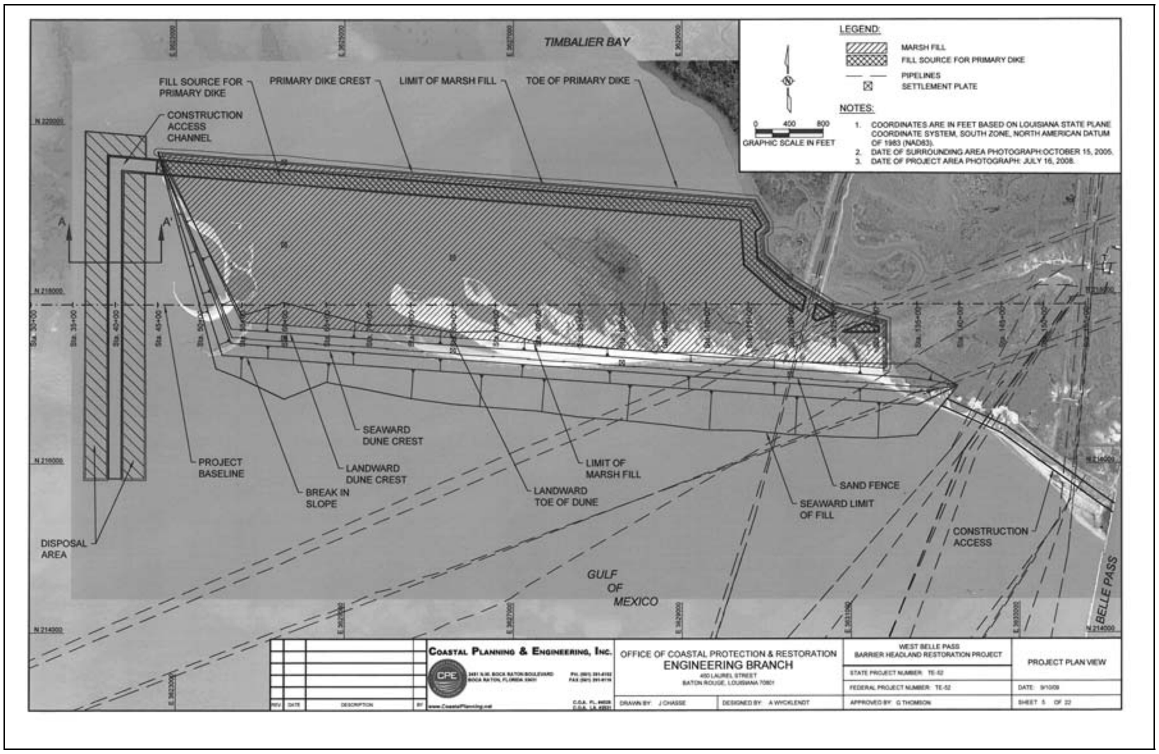

Figure 4. **Location of the West Belle Pass Barrier Headland Restoration (TE-52) project features.**

In the years since the creation of the Lafourche delta, the sediment and freshwater supply to the Caminada-Moreau Headland has decreased considerably while the shoreline has noticeably transgressed. The Mississippi River gradually changed its course to form the Plaquemine and Modern delta lobes significantly reducing the sediment supply to the Caminada-Moreau Headland (Frazier 1967; Reed 1995). By 1850, the Bayou Lafourche subdelta was discharging only 15.0 % of the Mississippi River's flow (Reed 1995). In 1904, a dam was placed at the junction of the Mississippi River and Bayou Lafourche essentially eliminating the source of river sediments to the headland (Frazier 1967; Morgan and Larimore 1957; Peyronnin 1962; Dantin et al. 1978; Reed 1995). Therefore, Bayou Lafourche has become a sediment starved, relict distributary of the Mississippi River (Peyronnin 1962; Dantin et al. 1978; Reed 1995; Harper 1977; Ritchie 1972; Pilkey and Fraser 2003; Ritchie and Penland 1988a; Ritchie and Penland 1988b; Penland and Ritchie 1979; Boyd and Penland 1981; Penland and Ramsey 1990). This sediment deficit and eustatic sea level rise (Scavia et al. 2002) has caused the subsidence rate along the Caminada-Moreau Headland to exceed 0.4 in/yr (1.0 cm/yr) (Coleman and Smith 1964; Swanson and Thurlow 1973; Penland and Ramsey 1990; Roberts et al. 1994). In addition, the placement of the Belle Pass jetties (figures 2 & 3) and the net longshore transport have impeded the movement of sediments to the project area. Jetties and groins have been found to obstruct sand transport along beaches causing erosion on the downdrift side of these structures (Komar 1998; Conaster 1971) and are likely contributors to alterations in sediment transport in the project area. Net longshore transport west of the rock jetties is in the western direction (figures 2 and 4) (Stone and Zhang 2001; Ritchie and Penland 1988b; Peyronnin 1962; Dantin et al. 1978; Thomson et al. 2009) (figure 2). Longshore transport processes have caused extensive shoreface erosion along the West Belle Pass area shifting sediments to downdrift barrier islands and tidal passes (McBride and Byrnes 1997; List et al. 1997; Stone and Zhang 2001; Peyronnin 1962; Levin 1993). Numerous tropical storms (Peyronnin 1962; Stone et al. 1997) and cold fronts (Boyd and Penland 1981; Ritiche and Penland 1998b; Dingler and Reiss 1990; Georgiou et al. 2005) have elevated water levels high enough to cause partial or total overwash along the low profile Caminada-Moreau Headland. Moreover, this area has been classified as a storm dominated coast (Harper 1977; Boyd and Penland 1981) consisting of ephemeral dunes shaped by storm events (Harper 1977; Ritchie 1972; Penland and Ritchie 1979; Ritchie and Penland 1988a; Ritchie and Penland 1988b). The sediment deficit, subsidence, longshore transport, and the high frequency of storm events have resulted in high shoreline erosion rates along the low profile Caminada-Moreau Headland. The shoreline change rate on western Caminada-Moreau Headland has been estimated to be -82 ft/yr (25 m/yr) in the long-term (1887-2002) (Penland et al. 2005) and -36 ft/yr (11 m/yr) in the short-term (1996-2008) (Thomson et al. 2009).

In 1998, the Louisiana Department of Natural Resources/Coastal Restoration Division (LDNR/CRD) and the U. S. Army Core of Engineers (USACE) initiated the West Belle Pass Headland Restoration (TE-23) project (figures 1, 2, and 3). This project discharged approximately 1.4 million yd^3 (1.1 million m^3) of sediment into three disposal areas creating 160 acres (64.6 ha) of supratidal, intertidal, and subtidal habitats and armored 17,000 ft (5,182 m) of Belle Pass and Bayou Lafourche. The TE-23 project was not successful creating marsh habitat, but the shoreline protection structures reduced erosion and maintained their structural stability (Curole and Huval 2005). However, the marsh creation phase of the TE-23 project was enhanced by a 2007 maintenance event that discharged additional sediments into two of the TE-23 disposal areas.

Project Goals and Strategies/Coast 2050 Strategies Addressed

Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) projects are reviewed prior to authorization of construction funds for compatibility of project goals with those in Coast 2050, and for probability that proposed restoration strategies will accomplish those goals. The West Belle Pass Barrier Headland Restoration (TE-52) project goals are consistent with the Coast 2050 Region 3 ecosystem strategy to restore barrier islands and gulf shorelines. Project goals and strategies are provided to the Louisiana Department of Natural Resources (LDNR) by the sponsoring federal agency through the environmental assessment (EA) and/or wetland value assessment (WVA).

Project Goals:

1. Reestablish and increase headland longevity via dune and marsh creation.

2. Restore shoreline, dune, and back-barrier marsh to increase habitat utilization by essential fish and wildlife species both on the barrier headland and in the consequently developed quiescent bays through the creation of 150 acres of marsh habitat.

3. Prevent breaching along 9,300 feet of the headland over the 20-year project life.

4. Promote the re-establishment of historic longshore transport patterns along the Gulf shoreline.

Project Strategies:

1. Placement of sand on top of supratidal, intertidal, and subtidal habitats to increase the height and width of the headland.

2. Construction of a marsh platform through the use of material dredged in the vicinity of the Caminada-Moreau Headland.

3. Planting of vegetation and construction of sand fencing to stabilize and conserve newly placed sediments.

Placement and settlement of dredged sediments will create intertidal and supratidal back barrier marsh and will appreciably increase the width and sustainability of the western part of the Caminada-Moreau Headland. Vegetative plantings in back barrier marsh area will hasten the development of marsh communities and will support sediment retention. Dune formation, vegetative plantings, and sand fencing will aid in sediment retention and prevent overwash during small cross-shore events.

<u>Project Features</u>

The West Belle Pass Barrier Headland Restoration (TE-52) project consists of two major features, a marsh creation area and a dune creation area. The marsh creation phase of the TE-52 project will elevate subtidal and intertidal areas directly behind the dune to intertidal and supratidal elevations (figure 4). The dune feature of this restoration project extends 9,300 ft (2,835 m) along the Gulf of Mexico shoreline raising subtidal, intertidal, and supratidal habitat to a dune elevation (figure 4).

The marsh creation phase of this project will consist of three project components: containment dikes, marsh creation in open water areas, and vegetation plantings. Earthen containment dikes will be placed along the border of the marsh creation area (figures 4 & 5). These structures will be built to an elevation of 5.0 ft (1.5 m) NAVD 88, have a 10.0 ft (3.0 m) crown, and a 1V:8H slope on each side (Thomson et al. 2009). The containment dikes will be constructed using sediments bucket dredged from the marsh creation area. The borrow area for the containment dikes will be dredged to a depth not to exceed -6 ft (-1.8 m) NAVD, and will be located approximately 20 ft (6.1 m) from the toe of the earthen structures (figure 5) (Thomson et al. 2009) .

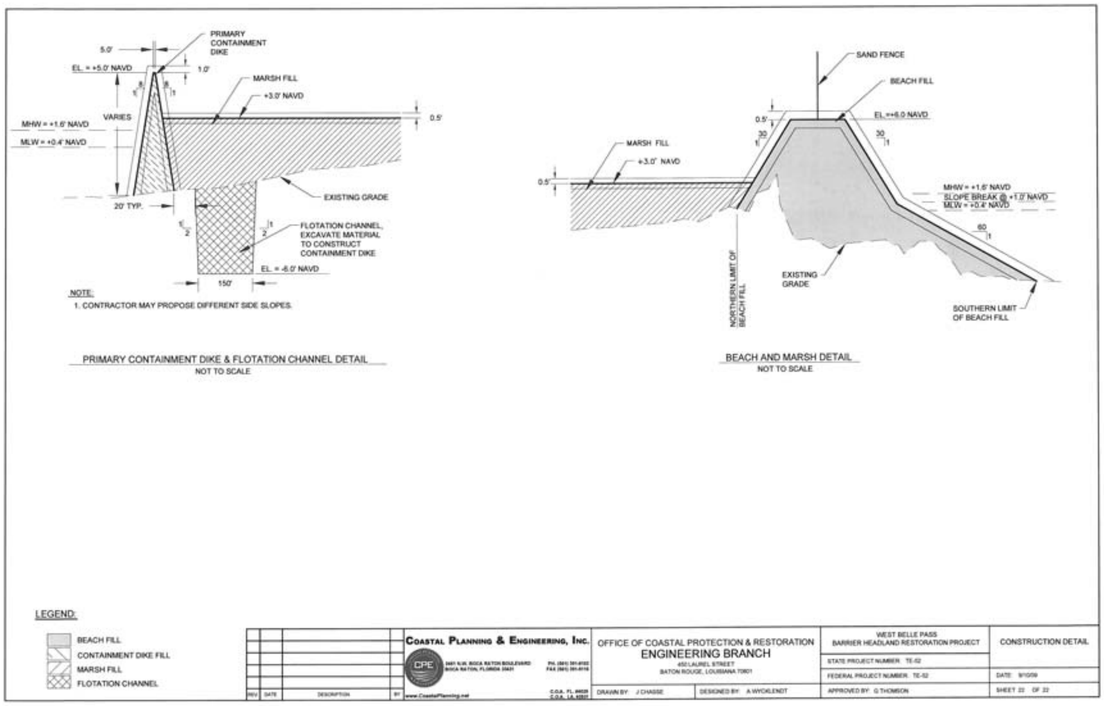

Figure 5. **Typical cross sections showing the West Belle Pass Barrier Headland Restoration (TE-52) containment dike and dune features.**

The sediments dredged from the marsh creation borrow area will be pumped into the TE-52 disposal area. This borrow area is located 2.8 mi (4.5 km) south of the project area. Open water areas in the disposal area will be filled to a maximum elevation of 3.0 ft (0.9 m) NAVD 88 to create new marsh (figures 4 and 6). Approximately, 1,903,000 yd^3 (1,454,948 m^3) of dredged material will be used to create 305 acres (123 ha) of intertidal and supratidal habitat. Following consolidation, the disposal area is anticipated to have an average elevation of 1.5 ft (0.5 m) NAVD 88 (Thomson et al. 2009).

To stabilize the marsh creation disposal area and increase emergent marsh vegetation cover, multi-stem *Spartina alterniflora* Loisel. (smooth cordgrass) plugs will be planted. Plantings will begin as soon as the dredged sediments have consolidated and will be conducted in phases (Thomson et al. 2009).

The dune creation phase of this project will consist of three project components: dune creation, sand fencing, and vegetation plantings. Dune creation activities will be initiated by dredging sediments from a borrow area positioned 9.0 mi (14.5 km) west of the TE-52 project area. Sediments will be dredged to a maximum depth of -22.0 ft (-6.7 m) NAVD 88. The subsurface media in the portion of borrow area that will be used to construct the dune creation area consists of sand deposits (Thomson et al. 2009).

The sand dredged from the dune borrow area will be pumped into the dune creation area (figure 4). Supratidal, intertidal, and subtidal habitat in the disposal area will be filled and shaped to form the dune (figures 5 & 6). The dune will have an elevation of 6 ft (1.8

m) NAVD 88, a 100 ft (30.5 m) crown, and a 1V:30H side slope above 1.0 ft (0.3 m) and a 1V:60H side slope below 1.0 ft (0.3 m) (figures 5 & 6). Approximately, 1,180,000 yd^3 (902,175m^3) of sand will be used to create 52 acres (21 ha) of dune and 41 (17 ha) acres of supratidal habitats (Thomson et al. 2009).

Once the dune has been constructed, sand fencing will be installed along the entire 9,300 ft (2,835 m) length of the dune. A single fence will be built and will be located in the center of the dune crown (Thomson et al. 2009) (figure 5).

To stabilize the dune and increase vegetation cover, *Panicum amarum* Ell. (bitter panicum) will be planted. In addition, *Spartina patens* (Ait.) Muhl. (marshhay cordgrass), and *Uniola paniculata* L. (sea oats) will also be planted on the dune. Plantings will begin as soon as dune construction is complete and will extend for 3 years (Thomson et al. 2009).

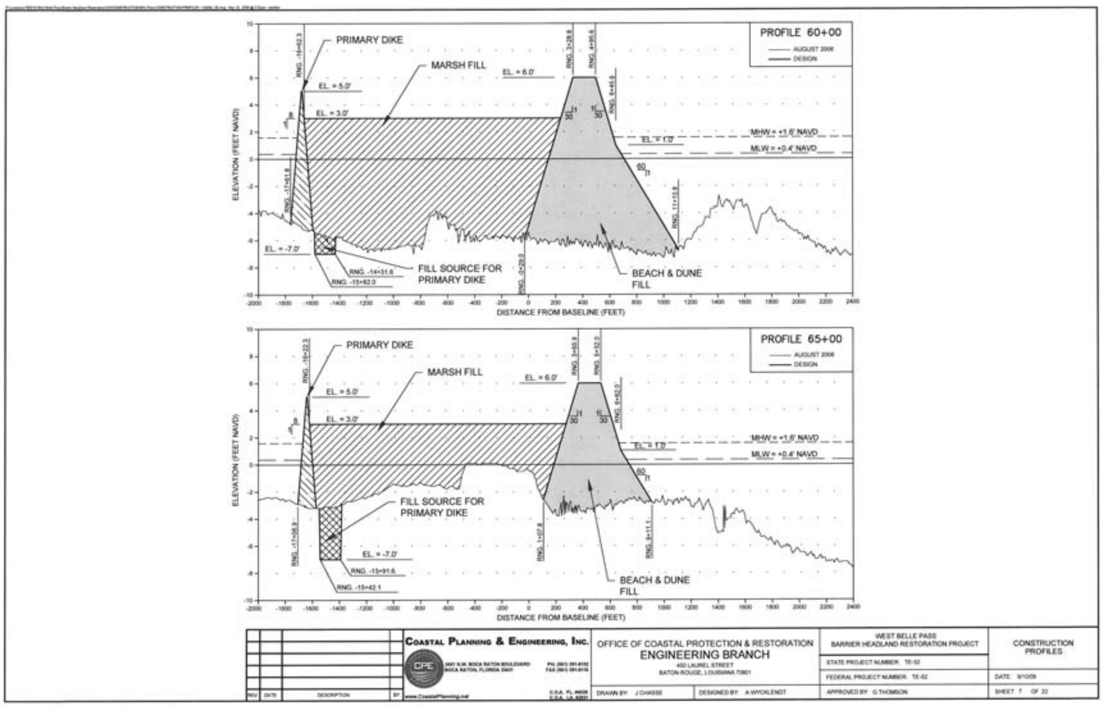

Figure 6. Typical cross sections showing the West Belle Pass Barrier Headland Restoration (TE-52) marsh and dune creation features.

<u>Monitoring Goals</u>

1. Determine the area, average width, and length of the western part of the Caminada-Moreau Headland and the project area over time.
2. Determine the effectiveness of project features in reducing the rate of erosion as compared to historical rates of erosion.
3. Determine species composition and diversity of vegetation within major habitat types on the headland.

4. Determine elevation, volume, and habitat classes in the project area.
5. Determine sediment characteristics and their change over time.

Reference Area:

Monitoring on both project and reference areas provides a means to establish performance standards that can compare wetland structure and ecological function, and is therefore the most effective means of assessing project effectiveness (Brinson and Rheinhardt 1996). Coastal salt marshes and barrier islands are very dynamic in nature. Therefore, reference areas in these saline environments need to be monitored over time to determine community structure and function (Moy and Levin 1991; Simenstad and Thom1996; Zelder 1993; Mitsch and Wilson 1996). However, no reference areas will be established for the West Belle Pass Barrier Headland Restoration (TE-52) project due to scientific and economic constraints.

<u>Monitoring Strategies</u>

The following monitoring strategies will provide the information necessary to evaluate the specific goals listed above:

1. Vegetation — To estimate species composition and percent cover over time, nine cross-shore transects will be established at 1000 ft (305 m) intervals in the project area bisecting dune and marsh creation areas. Each transect will contain five to ten randomly selected vegetation stations. The vegetation stations will be constructed and sampled using a modified version of the Braun-Blanquet method (Mueller-Dombois and Ellenberg 1974; Steyer et al. 1995). Vegetation species composition and cover will be sampled after construction in years 2011 (as-built), 2012, 2014, 2016, and 2021. The number of sampling stations may be adjusted by OCPR based on interpretation of preliminary data acquired from the area. Vegetation will be funded through the TE-52 monitoring budget.

2. Topography — To estimate elevation and volume changes in the project areas and other headland habitats over time, Light Detection and Ranging (LiDAR) and traditional ground surveys will be employed. LiDAR data will be collected, filtered, and analyzed by the United States Geological Survey/Coastal and Marine Geology Program (USGS/CMGP) and will topographically establish elevations for the subaerial extent of the island (Troutman et al. 2003). Since the LiDAR surveys include the dune and the marsh creation areas, these elevation data will be

used to conduct elevation and sediment volume analysis for both features as per Ormsby and Alvi (1999). Additionally, project specific topographic surveys will be performed along cross sectional survey transects in the dune and marsh creation areas in accordance with Steyer et al. (1995). Elevation and volume changes in the marsh creation area will be detected using both the cross section and LiDAR surveys (Ormsby and Alvi 1999). LiDAR surveys will be flown in 2006 (pre-construction) and post-construction in 2011 (as-built), 2016, and 2021. The cross sectional topographic survey data will be collected in 2008 (pre-construction) and post-construction in 2011 (as-built), 2012, 2014, 2016, and 2021. LiDAR data will be funded through BICM while the topographic surveys will be funded by the TE-52 construction and operation and maintenance (O&M) budgets.

3. Bathymetry

To approximate subaqueous elevation and volumetric alterations in the island shoreface, gulf, and bay environments, bathymetric surveys will be undertaken for the BICM program (USGS/CMGP) and for project specific data collection. The BICM bathymetric survey transects will be separated on 1500 ft (457.2 m) intervals and will extend for 1.2 miles (2.0 km) outward from the island into the gulf and bay habitats. On the gulf side of the island, the transects will stretch past the 1.2 mile (2.0 km) boundary to 3.7 miles (6.0 km) on 4500 ft (1371.6 m) intervals. In addition, project specific bathymetric surveys will be performed along cross sectional survey transects in the littoral zone as per Steyer et al. (1995). Data collected will be used to develop elevation models to compare elevation and volumetric changes using procedures established in Ormsby and Alvi (1999). BICM Bathymetric survey data will be collected in 2006 (pre-construction) and post-construction in 2011, 2016, and 2021. The project specific bathymetric survey data will be collected in 2008 (pre-construction) and post-construction in 2011 (as-built), 2012, 2014, 2016, and 2021. Bathymetry data collection will be funded through BICM, TE-52 construction, and TE-52 O&M budgets.

4. Habitat Classification

To document vegetated and non-vegetated island habitats, 1:24,000 scale color infrared aerial photography (CIR) will be obtained. The photography will be photointerpreted, scanned, mosaicked, georectified, and analyzed by University of New Orleans/Coastal Research Laboratory

(UNO/CRL) personnel according to the standard operating procedure described in (Fearnley & Westphal (2008), and Troutman et al. (2003). The photography will be obtained in 2005 (pre-construction), and post-construction in 2011 (as-built), 2016, and 2021. Habitat classification data will be funded through BICM.

5. Sediment Properties/ Geotechnical

To characterize the median grain size and grain size distributions in the shoreface and other barrier island habitats, grab or push core samples will be obtained along 8 cross-shore transects by UNO/CRL. These sediment transects will be separated on 3000 ft (914.4 m) intervals. The transect lines will begin on the gulf side of the island at the -15 ft (-4.6 m) contour and continue across the island into the back barrier marshes. One sample will be obtained from each distinguishable location: -15 ft (-4.6 m) contour, middle of shoreface, upper shoreface at mean low water, beach berm, dune, and back-barrier marsh. Each sample will measure sediment grain size, sorting, percent sand and fines, organic matter content, and bulk density (Troutman et al. 2003). Samples will be acquired and analyzed in 2008 (pre-construction) and post-construction in 2011 (as-built), 2016, and 2021. Geotechnical data will be funded through BICM.

<u>Anticipated Statistical Tests</u>

1. Descriptive and summary statistics for vegetation will be used to determine spatial and temporal differences in species composition and cover. Vegetation will be funded through the TE-52 monitoring budget.

Goal: Determine species composition and diversity of vegetation within major habitat types on the headland.

2. Descriptive and summary statistics for topography will be used to determine differences in mean elevations, habitat class, and width as evaluated by an elevation model that will consider both spatial and temporal changes. The basic model will determine changes in island elevation, habitat classes, volume of island sediment, width of the project area, and shoreline position. LiDAR data will be funded through BICM while the topographic surveys will be funded by the TE-52 construction and O&M budgets.

Goal: Determine the area, average width, and length of the western part of the Caminada-Moreau Headland and the project area over time.

Goal: Determine elevation, volume, and habitat classes in the project area.

3. Descriptive and summary statistics for bathymetry will be used to determine differences in mean elevations, as evaluated by an elevation model that will consider both spatial and temporal changes. This basic model will determine changes in elevation, and the volume of sediment. Bathymetry data collection will be funded through BICM, TE-52 construction, and TE-52 O&M budgets.

   Goal: Determine the area, average width, and length of the western part of the Caminada-Moreau Headland and the project area over time.

4. Descriptive and summary statistics using the habitat classification data will be used to determine spatial and temporal changes in barrier island habitats. Habitat classification data will be funded through BICM.

   Goal: Determine elevation, volume, and habitat classes in the project area.

   Goal: Determine the effectiveness of project features in reducing the rate of erosion as compared to historical rates of erosion.

5. Descriptive and summary statistics using the geotechnical and sediment property data will be used to determine spatial and temporal changes in the sediment content of the shoreface and other island habitats. Geotechnical data will be funded through BICM.

   Goal: Determine sediment characteristics and their change over time.

Notes:

1.	Planned Implementation:	Start Construction:	May 1, 2011
		End Construction:	November 1, 2011
	NMFS Point of Contact:	Cheryl Brodnax	225-578-7923
2.	DNR Project Manager:	Kenneth Bahlingler	225-342-7362
	DNR Monitoring Manager:	Glen Curole	985-447-0995

3. The twenty year monitoring plan development and implementation budget for this project is $120,000.00. Comprehensive reports will be available in 2013, 2015, 2017, and 2022. These reports will describe the status and effectiveness of the project.

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