# RIVERINE SAND MINING / SCOFIELD ISLAND RESTORATION
# PRELIMINARY DESIGN REPORT
# LDNR NO. 2511-06-01
# PLAQUEMINES PARISH LOUISIANA

**For:**
**State of Louisiana**
**Office of Coastal Protection and Restoration**
**Engineering Branch**
**450 Laurel Street**
**North Chase Tower**
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**Prepared by:**

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**January 2010**

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# RIVERINE SAND MINING / SCOFIELD ISLAND RESTORATION PRELIMINARY DESIGN REPORT

## 1.0 INTRODUCTION

### 1.1 Background

The Preliminary Design Report summarizes the field work, data collection and detailed analyses; engineering, geotechnical and environmental studies; and comprehensive design work completed for the Riverine Sand Mining / Scofield Island Restoration Project (Project). The Project is sponsored by the Louisiana Department of Natural Resources (LDNR), State of Louisiana Office of Coastal Protection and Restoration (OCPR), and NOAA Fisheries. The Project design is funded and authorized in accordance with the provisions of the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) (16 U.S.C.A., Sections 3951-3956) and has been approved by the Public Law 101-646 Task Force. The Project's CWPPRA designation is BA-40.

Scofield Island is a 2.4 mile long barrier island located between Scofield Bayou and the merger of Bay Coquette and the Gulf of Mexico along the Plaquemines Barrier System. The Project is located in Region 2, southeastern edge of the Barataria Basin, Barataria Barrier Shorelines mapping unit, approximately 11 miles west-southwest of Venice. A location map of the Scofield Island is presented in Figure 1-1. The island is a critical component of the State of Louisiana's master plan for restoring and protecting the fragile ecosystem within the Barataria Basin.

The barrier shoreline at Scofield Island (Figure 1-1) has experienced a long-term gulf-side erosion rate of approximately 16.5 feet per year (Williams et al., 1992). Wetlands, dune, and swale habitats within the island have undergone substantial historic loss due to petroleum pipeline construction, geologic subsidence, sea level rise, and marine and wind-induced erosion. The combined effects of these factors have caused landward transgression of the shoreline, and more recently, island breaching and breakup. Development of fragmentary islands from breaches in the barrier headland, and subsequent inlet formation, has resulted in increased tidal prism and storm related impacts. Based on recent survey comparisons (SJB and CEC, 2008), the short-term gulf-side erosion rate averaged 49 feet per year between 2000 and 2008.

OCPR and NOAA Fisheries have co-sponsored multiple barrier island / ecosystem restoration projects in the Barataria Basin including the Chaland Headland (BA-38), recently completed Bay Joe Wise Headland (BA-35), and Pelican Island (BA-38) located adjacent to Scofield Island, which has completed Final Design and is awaiting bidding.

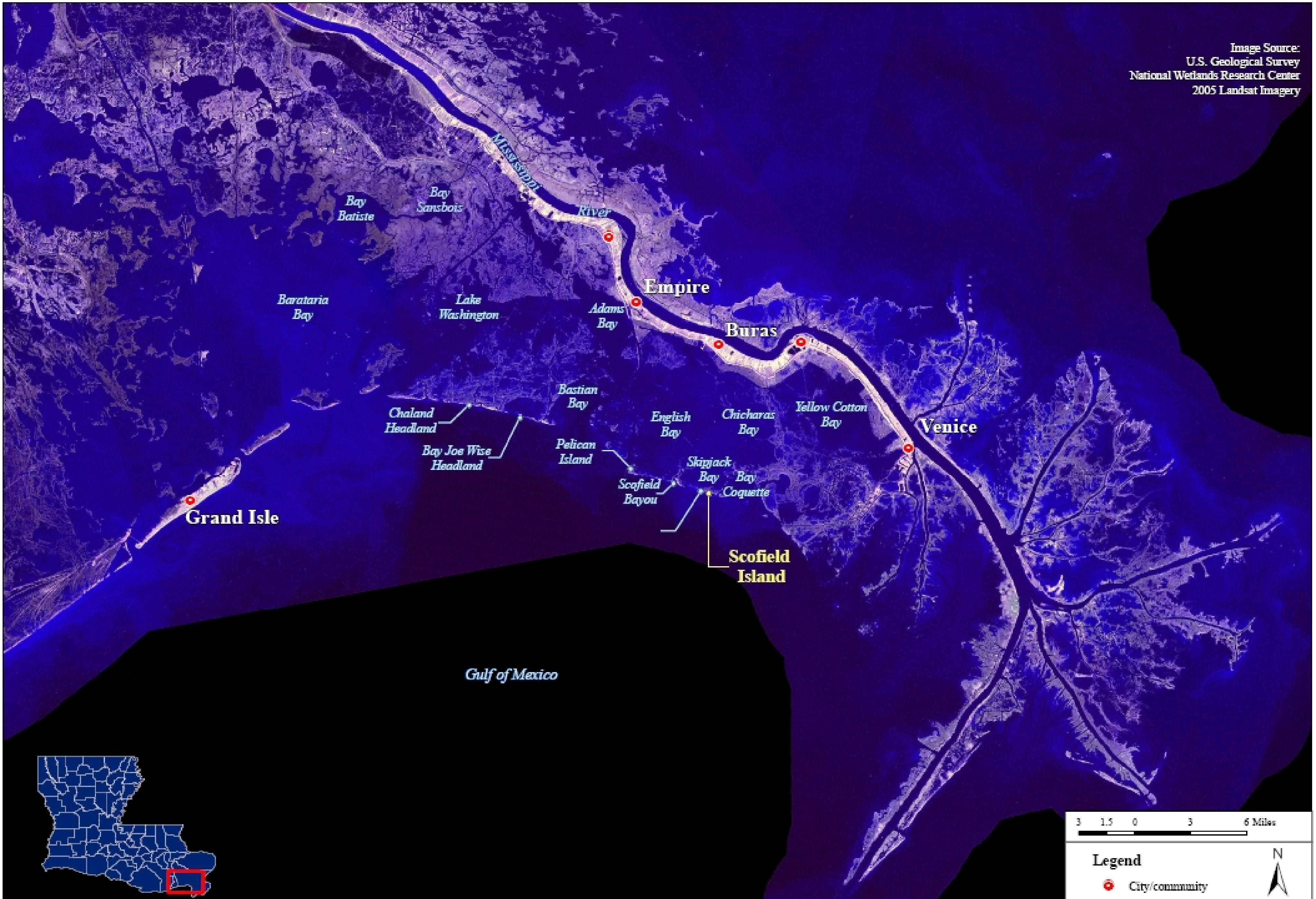



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**Figure 1-1**
**Riverine Sand Mining/Scofield Island Restoration Project Area**
**Vicinity Map**

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Recognizing the severity of erosion on Scofield Island and limited offshore sand resources within the Barataria Basin identified through these prior projects and studies, NOAA Fisheries commissioned two planning level assessments, the first to develop a conceptual restoration plan for Scofield Island and the second to evaluate the feasibility of mining sand resources within the Mississippi River and transporting the sand to construct the island restoration plan.

Based upon the results of these two studies, OCPR and NOAA Fisheries initiated the program development, feasibility analysis, and design of the Project to restore Scofield Island's geomorphologic and ecological form and function. The focus of the Plan Formulation and Feasibility Study Phases (CEC and SJB, 2008) was three-fold. First, assess the potential impacts of mining Riverine sand sources on river hydrodynamics, Second, determine the most efficient Conveyance Corridor from the river to the island based on technical feasibility, environmental impacts, infrastructure conflicts, and cost. Third, conduct extensive stakeholder coordination to solicit input, establish lines of communication, and build consensus among the diverse stakeholders with special interests in the Project especially the navigation industry.

## 1.2 Project Team

The development of the Preliminary Design Report was a joint effort between a team of scientists, engineers, and consultants lead by SJB Group, LLC. The Project team, collectively referred to as the SJB Team, consists of the following companies:

- Coastal Engineering Consultants, Inc. (CEC)
- C.H. Fenstermaker and Associates, Inc. (CHF)
- C-K and Associates, LLC (C-K)
- Alpine Ocean Seismic Surveys, Inc. (AOS)
- Coastal Technology Corporation (CTC)
- Archaeological Research, Inc. (ARI)
- Eustis Engineering Company, LLC (EEC)

## 1.3 Goals and Objectives

The goals of the Project are to restore and preserve the structural integrity of the barrier shoreline at Scofield Island for a 20-year Project life using sand dredged from the Mississippi River and create intertidal habitats utilizing sediment dredged from an offshore borrow area. In order to meet this goal, the SJB Team focused on the following objectives:

- Identify sources of compatible, cost-effective sediments for marsh creation
- Identify sources of Riverine sand for beach and dune restoration
- Construct intertidal marsh to increase the longevity of the Project by sustaining critical stabilizing habitat
- Restore beach and dune system
- Vegetate newly created marsh and dune areas
- Avoid impacts to adjacent shorelines from offshore borrow area excavation
- Avoid impacts to river hydrodynamics from Riverine borrow area excavation.

## 1.4 Project Area Location and Setting

### 1.4.1 Mississippi River Borrow Areas

Historical studies describe the Lower Mississippi River as naturally entrenched in the alluvial plain as it approaches the modern "bird's foot" delta. Average sediment grain size characteristics tend to decrease as the river approaches the gulf. As the river moves southward, mixed sediment associated with deltaic progradation becomes more predominant and overlies a sandy Pleistocene layer similar to sediments found on the inner continental shelf. Historical channel migrations have resulted in relict point bar sand deposits. Modern river modifications and channelization have resulted in Riverine sand deposition responses in the form of "mid-channel bars" or "sand waves." Many of these active deposits are found between Empire and Venice and are fed by bed load sands.

The segment of the Mississippi River containing the two borrow areas is bounded by River Mile Marker (MM) 22.0 and 32.0 above Head of Passes (AHP). The upstream borrow area, denoted for Preliminary Design as MR-B-09, is located on the east side of the Mississippi River near Empire, Plaquemines Parish, between approximate MM 29 to 31, and the downstream borrow area, denoted for Preliminary Design as MR-E-09, is located on the west side of the river south of Buras between approximate MM 23 to 24.

### 1.4.2 Conveyance Corridor

The Conveyance Corridor begins at the Mississippi River Levee at approximate MM 28.9 AHP and includes two segments. The Upland Segment is approximately 1,120 feet wide and extends approximately one mile from the western bank of the Mississippi River in Empire southwest to the rock breakwater at the Empire Locks. The Over Water Segment is approximately 8.8 miles long, beginning at the Empire Locks and extending south through the Empire Waterway, crossing the eastern side of Caprien Bay, and entering the Gulf of Mexico through the jetties just west of Pelican Island

### 1.4.3 Scofield Island Restoration Area

Scofield Island is a 2.4 mile long barrier island located approximately 11 miles west-southwest of Venice, in Plaquemines Parish. It is bordered on the west by Scofield Bayou, the east by Bay Coquette, the south by the Gulf of Mexico, and the north by Skipjack and English Bays. Scofield Island falls within CWPPRA Region 2, near the southeastern edge of the Barataria Basin, Plaquemines Barrier System, in the Barataria Barrier Shoreline Mapping Unit. This system has experienced significant erosion and undergone tremendous land loss due to the lack of sediment supply, storm impacts, subsidence, and human impacts. Scofield Island is the easternmost island within the Plaquemines Barrier System.

### 1.4.4 Scofield Offshore Borrow Area

The offshore borrow area is located in the Gulf of Mexico approximately 3 miles south of Scofield Island, in water depths ranging from -18 to -20 feet North American Vertical Datum of 1988 (NAVD88). It is located within the abandoned Plaquemines distributary network of the Mississippi river Modern delta complex.

## 2.0 PREVIOUS STUDIES

In 2004, Applied Technology and Management (ATM) conducted a conceptual design and engineering analysis of Scofield Island on behalf of NOAA Fisheries (ATM, 2004). ATM evaluated shoreline change, conducted cross-shore modeling, prepared a sediment budget, and developed a conceptual design for the restoration of Scofield Island (Figure 2-1). The conceptual design included potential beach/dune and marsh fill areas and two preliminary access channels for Project construction. Based on this assessment, the CWPPRA conceptual restoration plan included the construction of approximately 429 acres of dune and supratidal habitat and marsh platform.

Coastal Planning and Engineering, Inc. (CPE) prepared a second technical assessment for NOAA Fisheries in 2004 to determine whether the restoration of Scofield Island could be accomplished by mining and transporting sand from the Mississippi River (CPE, 2004). The technical assessment included preliminary investigations into a number of feasibility issues, such as available sand resources, sediment pipeline routes, sediment transportation alternatives, dredging methods, project coordination and constraints, and estimated construction costs. CPE identified potential sources of sand and two potential conveyance corridors. The sand sources are located between the communities of Nairn and Buras and are identified on Figure 2-2. The two corridors, referred to as the Empire Waterway and the Scofield Direct Routes, are also presented in Figure 2-2. These corridors utilize property situated between the Mississippi River levee and the Hurricane Protection levee that is owned by the Plaquemines Parish Government (PPG). The PPG has expressed a willingness to cooperate in the implementation of this Project, which will simplify the landrights acquisition process when compared to routes that cross numerous individual landowners.

In 2005, CPE conducted a geotechnical and geophysical investigation of the potential sand sources for LDNR. Based on these investigations, CPE identified and delineated seven potential borrow areas within the sand sources. The potential borrow areas, designated MR-A through MR-G, are also presented in Figure 2-2. CPE produced planning-level estimates of sediment grain size, thickness, and volume of the sand deposits available for Project construction. A summary of the potential borrow areas including location and estimated volumes is presented in Table 2-1 (Finkl et al., 2005).

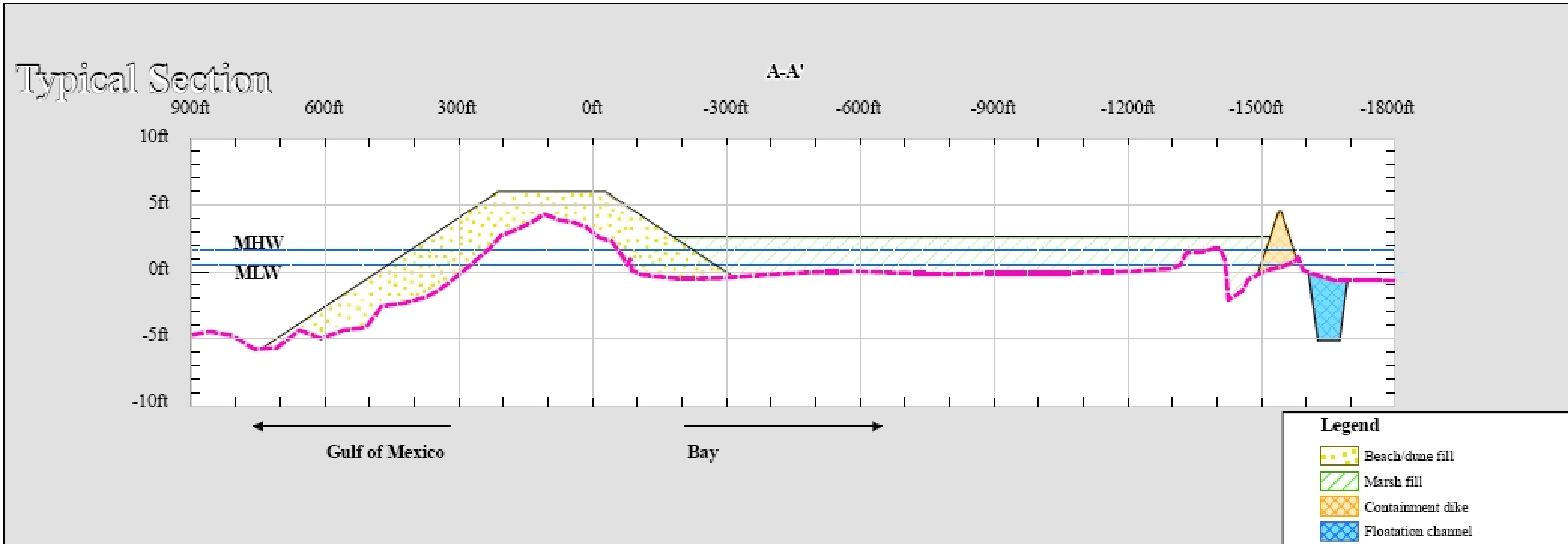



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**Figure 2-1**
**Scofield Island Conceptual Restoration Plan**
**Previously Developed by ATM (ATM, 2004)**

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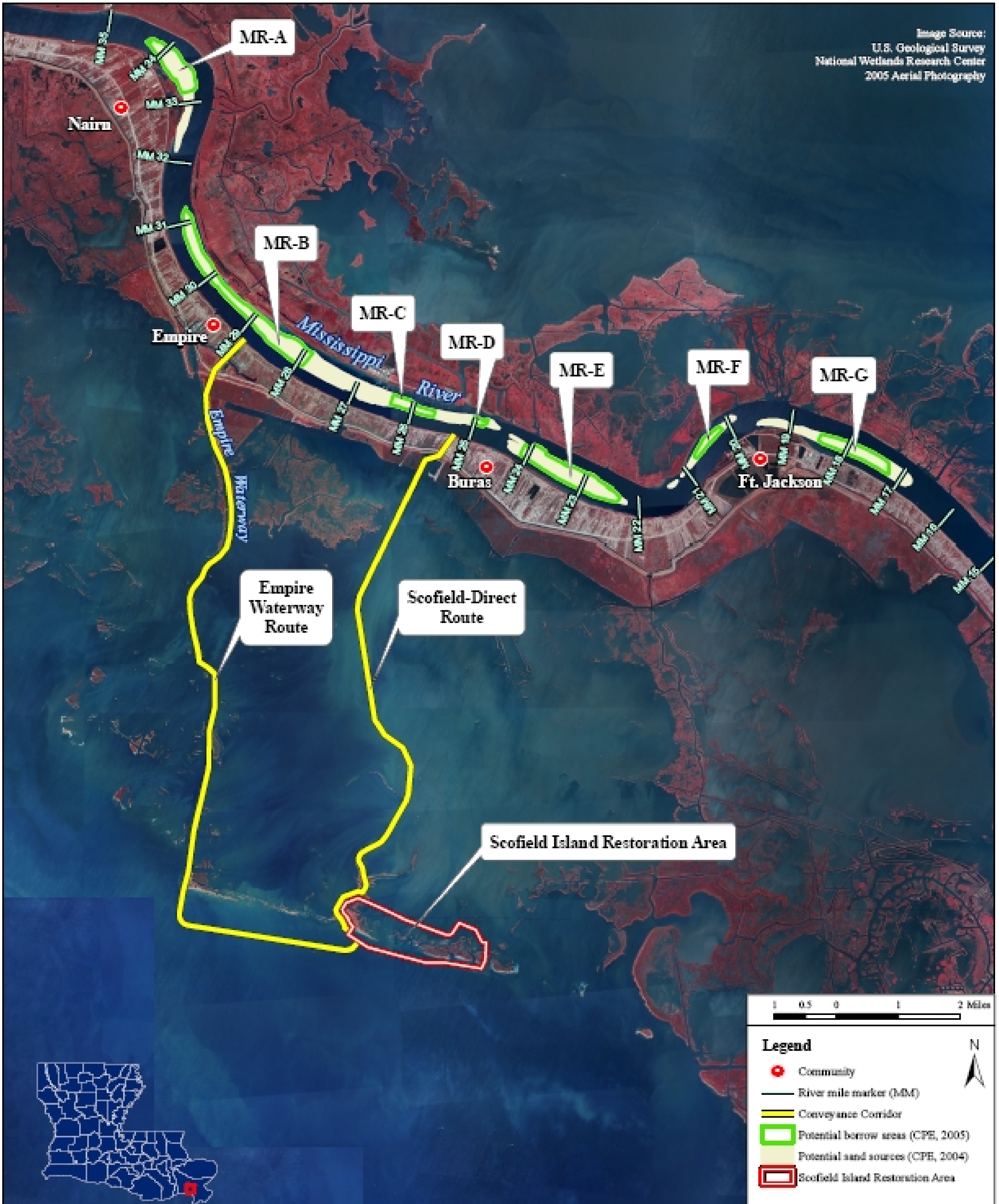


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**Figure 2-2**
**Riverine Sand Sources, Borrow Areas and Conveyance Corridors Previously Identified by CPE (CPE 2004, 2005)**

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**Table 2-1: Estimated sand volumes in potential borrow areas in the Lower Mississippi River (Finkl et al., 2005)**

| Borrow Area | Approximate Location* | Volume (cy) |
|---|---|---|
| MR-A | Nairn Point Bar, starting at MM 34.5 | 2,830,000 |
| MR-B | Adjacent to the Empire Waterway, between MM 31.5 and 28.0 | 14,940,000 |
| MR-C | Near MM 26 | 1,310,000 |
| MR-D | 500 feet upriver from MM 25 | 245,000 |
| MR-E | Upriver from the Fort Jackson Point Bar near MM 24 | 6,380,000 |
| MR-F | Northern segment of the Ft. Jackson Point Bar, near MM 20.5 | 945,000 |
| MR-G | Southern segment of the Ft. Jackson Point Bar, near MM 18.5 | 3,580,000 |
| Total | | 30,230,000 |

* MM = Mile Marker

# 3.0 PLAN FORMULATION

The primary goal of the Plan Formulation Phase was to develop a preliminary array of alternatives consisting of various combinations of borrow areas and sand mining/conveyance methods. Each of the alternatives was then evaluated and screened to develop a shortlist of alternatives for further evaluation in the Feasibility Study Phase.

## 3.1 Stakeholder Meetings

During the Plan Formulation Phase, the SJB Team, OCPR, and NOAA Fisheries attended meetings with stakeholders (Table 3-1) to obtain their input on various elements of the proposed project including Project implementation, conveyance corridor selection, logistics, borrow area placement, navigation and safety, dredge technology, infrastructure, regulatory issues, and impact analysis. Information obtained at these meetings was extremely valuable in evaluating the borrow area and conveyance method alternatives.

**Table 3-1: Stakeholder meetings attended by OCPR, NOAA Fisheries and the SJB Team**

| Stakeholder Group | Date of Meeting |
|---|---|
| Plaquemines Parish Government Kick-off Meeting | November 2006 |
| U.S. Army Corps of Engineers (USACE) – New Orleans District | January 2007 |
| Louisiana State Historic Preservation Officers | February 2007 |
| Ancil Taylor | February 2007 |
| Plaquemines Parish Government Coastal Zone Management | March 2007 |
| Maritime Navigation Safety Association | March 2007 |
| Mississippi River Maintenance Forum | March 2007 |
| Louisiana Department of Transportation and Development | May 2007 |
| Louisiana State Historic Preservation Officers | July 2007 |
| USACE – New Orleans District | July 2007 |
| Empire Waterway users local interest meeting | August 2007 |
| Maritime Navigation Safety Association | September 2007 |
| United States Coast Guard | October 2007 |
| Plaquemines Parish Government Coastal Zone Management | November 2007 |
| Mississippi River Maintenance Forum | January 2008 |
| Lower Mississippi River Waterway Safety Advisory Committee | March 2008 |
| Crescent City River Pilots | May 2008 |
| Gulf States Maritime Association | May 2008 |
| USACE – New Orleans District | September 2008 |
| Louisiana State Historic Preservation Officers | November 2008 |
| Maritime Navigation Safety Association | November 2008 |

## 3.2 Borrow Area Screening

In 2005, CPE identified seven potential borrow areas in the Mississippi River that could potentially function as sources of sediment for the Project (Figure 2-2). The borrow areas were identified as MR-A through MR-G (CPE, 2005). During Plan Formulation Phase, each of these potential borrow areas was evaluated and screened for consideration in the Feasibility Study Phase.

The seven potential borrow areas were initially screened according to their available sand volumes and distance to Scofield Island. In their planning-level evaluation report, ATM estimated that 1,528,000 cubic yards of island compatible sand would required to restore the dune component of Scofield Island (ATM, 2004). This estimate was increased to 2,000,000 cubic yards to account for volumetric losses associated with the 2005 hurricanes. In the initial screening, only the potential borrow areas with estimated sand volumes in excess of this estimate were carried forward. Based on this criterion, MR-B, MR-E, and MR-G were carried forward and MR-A, MR-C, MR-D, and MR-F were eliminated from further consideration. Table 3-2 contains estimated sand volumes for these potential borrow areas.

A second screening analysis was conducted on MR-B, MR-E, and MR-G based on sediment volume, grain size characteristics, transport distance, petroleum pipeline and navigation channel crossings, and construction issues. Many of the scores were subjectively assigned based on experience with previous restoration efforts, input from stakeholders, professional judgment, and consideration of the Project objectives. The following sections describe the second-level borrow area screening process.

### 3.2.1 Sediment Volume

Based on ATM's prior work and the approximated erosion losses from 2004 through the present, the required fill volume was estimated to be 2,000,000 cubic yards. The required excavation volume was estimates as twice the required fill volume to account for dredging losses, unforeseen conditions of the borrow areas, potential infrastructure conflicts, and background erosion on the island from the date of the design survey to construction. Therefore, a volume of 4,000,000 cubic yards of compatible sand was used as the minimum borrow area search volume. Each potential borrow area was scored based on this criterion by normalizing the available volumes. The values were normalized by dividing 4,000,000 by the respective sediment volume. Normalized volumes were 1.11, 0.63, and 0.27 for MR-G, MR-E, and MR-B respectively (Table 3-2).

**Table 3-2: Scoring of estimated borrow volumes**

| Borrow Area | Available Volume (cy) | Normalized Volume Scoring* |
|---|---|---|
| MR-B | 14,940,000 | 0.27 |
| MR-E | 6,380,000 | 0.63 |
| MR-G | 3,580,000 | 1.11 |

* Sand volumes were normalized based on an estimated 4,000,000 cy of required excavation volume.

### 3.2.2 Grain Size Characteristics

Composite grain size was calculated for each borrow area using data from the 2005 CPE Geotechnical Investigation. Table 3-3 summarizes mean grain sizes determined for the vibracores which were taken in each of the borrow areas being evaluated. These mean values were then averaged to compute borrow area composite grain sizes. The composite grain sizes were then normalized to native beach grain size (mm). Because the mean native grain size for Scofield Island was not encountered in the literature search, an average from adjacent barrier island restoration projects was utilized as the basis for scoring. Native grain sizes for Chaland Headland and Pelican Island (BA-38) are both 0.11 mm (CPE, 2003a) and 0.20 mm for Pass Chaland to Grand Bayou Pass (BA-35) (SJB and CEC, 2005). The average native grain size for these three projects is 0.14 mm, which was used for normalization in Table 3-3. MR-E scored most favorably in terms of grain size characteristics.

**Table 3-3: Scoring of composite grain size**

| Borrow Area | Vibracore Name | Mean Grain Size (mm) | Composite Grain Size (mm) | Normalized Grain Size Scoring* |
|---|---|---|---|---|
| MR-B | MRVC-05-04 | 0.21 | 0.17 | 0.83 |
| | MRVC-05-05 | 0.16 | | |
| | MRVC-05-06 | 0.14 | | |
| MR-E | MRVC-05-07 | 0.22 | 0.22 | 0.64 |
| | MRVC-05-10 | 0.21 | | |
| MR-G | MRVC-05-12 | 0.13 | 0.14 | 1.00 |
| | MRVC-05-13 | 0.15 | | |

* Borrow area grain sizes were normalized by dividing the assumed native grain size of 0.14 mm by the composite grain size.

### 3.2.3 Transport Distance

Transport distances were measured as the shortest distance within established corridors between each borrow area and Scofield Island. The specific corridors are discussed in further detail in Section 3.4. The resulting transport distances for MR-B, MR-E, and MR-G were estimated at 17, 13, and 16 miles respectively. These values are normalized in Table 3-4.

**Table 3-4: Scoring of estimated borrow volumes**

| Borrow Area | Transport Distance (mi) | Normalized Distance Scoring* |
|---|---|---|
| MR-B | 17 | 1.32 |
| MR-E | 13 | 1.00 |
| MR-G | 16 | 1.23 |

* Transport distances were normalized to the shortest distance of 13 miles.

### 3.2.4 Mississippi River Navigation Channel Crossing

Crossing the navigation channel of the Mississippi River is a major obstacle because of safety and navigation issues. During the Mississippi River Maintenance Forum in March of 2007, the USACE indicated that installing a buried sediment pipeline across the river would be acceptable but that laying the sediment pipeline across the bottom of the riverbed would present significant regulatory challenges. The SJB Team also attended a Maritime Navigation Safety Association (MNSA) meeting in September of 2007. During that meeting, the majority of the members indicated that the most desirable option would be to utilize a hopper dredge in MR-B.

Since MR-E and MR-G both lay along the west bank, the sediment pipeline will not have to cross the Mississippi River. However, MR-B lies on the eastern side of the River. Therefore, sand excavated from MR-B for restoring Scofield Island must be transported to the west bank without interrupting ship traffic or posing any navigational hazards. This will have to be accomplished by either laying the sediment pipeline below a water depth of 45 feet or using a hopper dredge to transport the sand across the navigation channel. MR-B was assigned a score of 1.0 and MR-E and MR-G both received scores of 0.

### 3.2.5 Petroleum Pipeline Crossings

Petroleum pipeline crossings within the borrow areas are an obstruction to dredging and were used as a screening tool to evaluate the three borrow areas. The borrow areas which were identified in the 2005 Geotechnical Investigation (CPE 2005) were delineated to avoid petroleum pipeline crossings using 500-foot buffer zones. This strategy was utilized for the downstream boundary of Borrow Area MR-B and the upstream boundary of borrow area MR-G; while no pipeline buffers were needed to delineate borrow area MR-E. Two potential additional petroleum pipelines bisecting borrow area MR-B were identified subsequent to the 2005 Geotechnical Investigation. MR-B and MR-G were assigned a score of 0.5 points each for the pipeline buffers and MR-B was scored an additional 0.5 for the two potential additional petroleum pipelines identified.

### 3.2.6 Revetments

The riverbank revetments listed in Table 3-5 and shown in Figure 3-1 also present significant constraints to dredging. No matter which access route is chosen, transporting operations will have to contend with crossing revetments. In terms of dredging operations, only borrow area MR-E has been delineated close enough to raise concern over revetment stability. The Buras revetment is located on the upstream extent and the Fort Jackson revetment on the downstream extent of MR-E. Because these revetments do not actually cross into the borrow area and only affect a small portion of MR-E, it was scored 0.5 points. Any dredging and sediment transport activities conducted in the vicinity of the revetment locations shown in Figure 3-1 will be subject to the USACE buffer requirements and standards.

**Table 3-5: Revetments between MM 35 and MM 15 (USACE, 2003)**

| Revetment Name | River Bank | Upstream River Mile Marker | Downstream River Mile Marker |
|---|---|---|---|
| Bayou Lamoque | East | 34.8 | 31.3 |
| Tropical Bend | West | 32.0 | 28.2 |
| Buras | West | 28.2 | 24.4 |
| Neptune | East | 24.6 | 21.8 |
| Fort Jackson | West | 22.5 | 19.7 |
| Olga | East | 20.1 | 17.7 |


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## Figure 3-1
## Plan Formulation:
## Revetments and Anchorage Areas in the Mississippi River

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### 3.2.7 Anchorage Areas

The Ostrica and Boothville Anchorage Areas overlap significant portions of borrow area boundaries for MR-E and MR-G, respectively as shown on Figure 3-1. These anchorage areas were considered complicating factors due to the anticipated restrictions on dredging operations and coordination with regulatory agencies and the navigation industry. Attendees at the Mississippi River Maintenance Forum and MNSA meetings indicated that the Boothville and Ostrica Anchorage Areas are both heavily-used by ships. However, Lieutenant Commander Steven R. Keel, Chief of the Waterways Management Division, confirmed that the U.S. Coast Guard (USCG) could designate no-anchor zones on portions of the anchorages areas making them available for dredging (Keel, 2007). These two borrow areas were each scored 1.0 points in this category while MR-B was scored 0.

### 3.2.8 Scoring Summary

The overall results of the scoring analysis are presented in Table 3-6, with the lowest score being the most favorable. MR-E scored the lowest followed by MR-B with 3.76 and 4.41 points respectively. Based on this evaluation, MR-B and MR-E were carried forward for further investigation in the Feasibility Study Phase.

**Table 3-6: Scoring summary for the three borrow areas**

| | MR-B | MR-E | MR-G |
|---|---|---|---|
| Sediment Volume | 0.27 | 0.63 | 1.11 |
| Grain Size | 0.83 | 0.64 | 1.00 |
| Transport Distance | 1.32 | 1.00 | 1.23 |
| River Crossing | 1.00 | 0.00 | 0.00 |
| Pipeline Crossings | 1.00 | 0.00 | 0.50 |
| Revetments | 0.00 | 0.50 | 0.00 |
| Anchorage Areas | 0.00 | 1.00 | 1.00 |
| Totals | 4.41 | 3.76 | 4.85 |

## 3.3 Mississippi River Mining Impact Assessment

In order to assess the potential impacts of the mining operations on the Mississippi River, a preliminary impact assessment consisting of a permit review for similar projects was conducted. Nine environmental regulatory files for sand mining operations in the

Mississippi River were reviewed. Twenty-three Louisiana Department of Wildlife and Fisheries Fill Permit files were also reviewed. Many of the borrow areas evaluated in the documents exhibited characteristics that were similar to the proposed borrow areas for the Project.

According to the documents, neither hydraulic modeling nor post-construction impact assessments were required for any of the sand mining projects. Furthermore, the regulatory agencies concluded that these projects will have no direct or significant effect on coastal waters and generally did not require a Coastal Use Permit. However, the excavation volumes identified in the documents ranged from 75,000 cubic yards to 1.2 million cubic yards (mcy) annually, which is considerably smaller than the volume needed for the Project. Based on the uncertainty involved with mining such large quantities of sand from the Mississippi River, a second-level impact assessment was recommended to quantify the potential changes in river hydrodynamics caused by excavation and to assess the resulting impacts on nearby infrastructure, revetments, anchorages, and other navigational interests. The second-level impact assessment, which utilized a one-dimensional numerical model, was conducted in the Feasibility Study Phase and is presented in Chapter 4.

### 3.4 Sediment Mining and Conveyance Methodology Screening

During the Plan Formulation Phase, four potential Conveyance Corridors and a number of sediment mining and conveyance methodologies were evaluated. The potential Conveyance Corridors included the Empire Waterway and the Scofield Direct Routes previously identified by CPE (CPE, 2004) plus two additional routes, designated as Bayou Grand Liard and the Offshore-Southwest Pass, added by the SJB Team in coordination with OCPR and NOAA Fisheries. The four potential corridors are presented in Figure 3-2. The mining methods considered included cutterhead and hopper dredges while potential sediment conveyance methods included sediment pipelines and scow barges. The routes proposed for sediment conveyance were assessed based on water depths, oyster impacts, wetland impacts, petroleum pipeline crossings, number of landowners, levee corridor crossing complexities, and construction considerations.

For the Plan Formulation Phase it was assumed that if the corridor crossed an oyster lease or wetland it was considered an impact. Potential impacts to oyster leases included barge traffic crossing the lease or laying sediment pipeline through the lease. Potential impacts to wetlands included laying sediment pipeline through wetland areas on upland segments of the corridor.

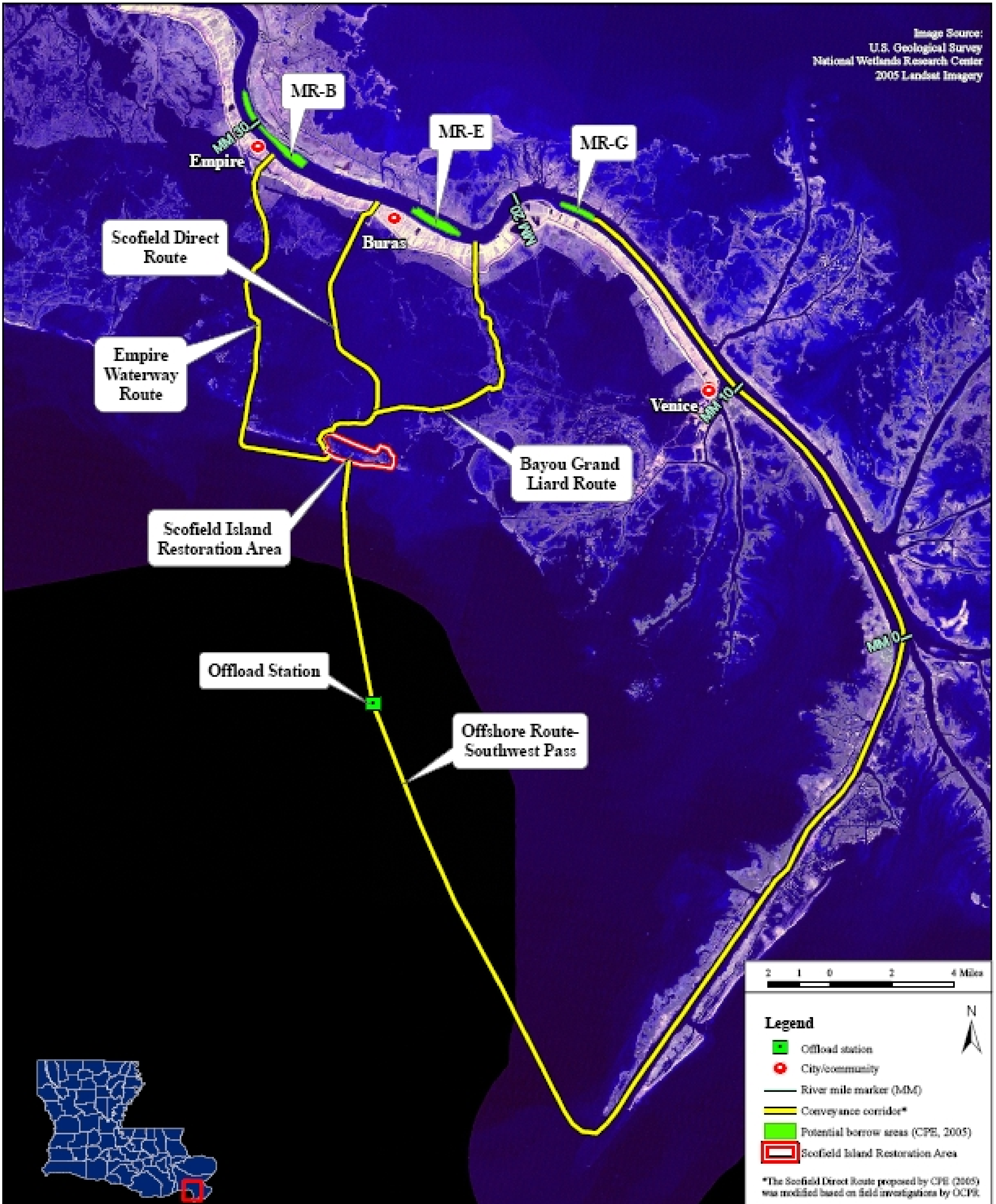


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**Figure 3-2**
**Plan Formulation:**
**Riverine Borrow Areas and Conveyance Corridors**

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### 3.4.1 Empire Waterway Route

The Empire Waterway branches off from the Mississippi River at MM 29.2 AHP and flows in a southwesterly direction for approximately 9 miles to the Gulf of Mexico. Five mining/conveyance options were proposed:

- Cutterhead Dredge/Sediment Pipeline and Barges
- Hopper Dredge/ Sediment Pipeline and Barges
- Cutterhead Dredge / Sediment Pipeline
- Cutterhead Dredge / Sediment Pipeline Across the River
- Hopper Dredge/ Sediment Pipeline

Each of the mining/conveyance options will require excavating the sediment from the Mississippi River and pumping the sediment through a pipeline to Scofield Island. The sediment pipeline will come ashore from the River at approximately MM 28.9 AHP, cross the Mississippi River Levee, and extend in a generally southwest direction for just under one mile while passing under the two-lane Highway 11, under the four-lane Highway 23, over the Hurricane Protection Levee, and enter the Empire Waterway. Although 40% of the land between the Mississippi River Levee and the Hurricane Protection Levee is developed, it is owned by the PPG. The PPG has expressed support of this Project and indicated that it would grant clearance for the temporary placement of the sediment pipeline on their property (SJB and CEC, 2007a). Therefore, gaining right-of-way access will be much less complex for this section than if the property was owned by private landowners.

Once over the Hurricane Protection Levee, the sediment would either be pumped down the Empire Waterway through a second sediment pipeline or loaded on a spider barge and hauled down the waterway. However, the depth of the Empire Waterway was a major concern for sediment transport via barges. Based on conversations with the USACE, it was assumed that the average water depth in the Empire Waterway is approximately 7 to 8 feet. Since fully loaded barges need approximately 10 feet of draft, the Empire Waterway would have to be dredged for the barge options. Furthermore, the barges would cross approximately 100 oyster leases. Therefore, the two barge options presented above were deemed to be an impractical means of conveyance and thus eliminated from future analyses (SJB and CEC 2007a).

The three sediment pipeline options were found to be more promising since the average depth of the Empire Waterway will accommodate most of the equipment needed for the sediment pipelines. Furthermore, the sediment pipeline options will only cross 26 oyster leases, which is considerably fewer than that of the two barge options (SJB and CEC 2007a). Consequently, the three sediment pipeline options were considered to be feasible methods of sediment mining and conveyance and were recommended for further evaluation in the Feasibility Study Phase.

Although the Empire Waterway Route crosses 52 existing petroleum pipelines along its route, the depth of the pipelines were not known at the time of the Plan Formulation Phase (SJB and CEC 2007a). Therefore, the potential impacts of the existing petroleum pipelines were considered significant.

### 3.4.2 Offshore Route - Southwest Pass

In this alternative, sediment will be excavated from the Mississippi River and hauled through the Southwest Pass to an offloading point approximately 8 miles south of Scofield Island. At that point, the sediment will be loaded in a pipeline and transported to the island. One of the benefits of this route is that it will not cross any wetlands. Furthermore, the route will avoid many of the oyster lease issues associated with the other routes. However, there are two oyster leases on the gulf-side of the island that still may be affected. Two mining/conveyance options were proposed for the Offshore Route - Southwest Pass:

- Hopper Dredge / Sediment Pipeline
- Scow Barges / Sediment Pipeline

Since the Hopper Dredge / Sediment Pipeline option was approximately 50% more expensive than the Scow Barge / Sediment Pipeline option, it was eliminated as a practical option for the Offshore Route - Southwest Pass.

A desktop analysis of the Scow Barges / Sediment Pipeline option was conducted to further analyze the feasibility of the Offshore Route – Southwest Pass alternative. The analysis consisted of an extensive review of petroleum pipeline maps, historical navigation charts, oyster lease maps, obstruction data obtained from NOAA Fisheries, and petroleum-related infrastructure data obtained from the Louisiana Oil Spill Coordinator's Office and the LDNR SONRIS website. A feasibility-level cost estimate was also conducted to obtain a more realistic cost of the alternative. Based on a cost estimate of $92.5 million dollars and the complexity of dealing with potentially rough seas in the Gulf, the Offshore Route – Southwest Pass alternative could not be justified when compared to the Empire Waterway and Direct Routes and thus was eliminated from further consideration (SJB and CHF, 2008a).

### 3.4.3 Scofield Direct Route

The Scofield Direct Route that was originally proposed by CPE (see Chapter 2.0) was modified based on field investigations by the OCPR in April 2007. The terminal end of the route was shifted to the east of Scofield Bayou to take advantage of deeper water and to avoid oyster reefs along the submerged bayou bank. The revised Scofield Direct Route begins approximately 4.3 miles downstream of the Empire Waterway Route and crosses the Mississippi River levee in Buras. The upland segment is approximately 0.8-miles long and extends from the western bank of the Mississippi River in Buras to Bay Pomme d'Or near Joshua's Marina. The open water segment extends from the eastern edge of Bay Pomme d'Or to Scofield Island.

The route crosses Highway 11 onto property owned by PPG which is primarily athletic fields, crosses Highway 23 and the Hurricane Protection Levee, traverses a narrow area of marsh, and runs just to the west of the Buras Boat Harbor before entering Bay Pomme d'Or.

The mining/conveyance methodology associated with the route includes a cutterhead dredge used to excavate material from the borrow area in the Mississippi River. The excavated material will be pumped through a sediment pipeline along the Scofield Direct Route to Scofield Island. The total pumping distance is approximately 13 miles.

Since the average water depth of the Scofield Direct Route is 6 feet, dredging will be required to provide adequate water depth (8 feet) for installing and maintaining the sediment pipeline.

The Scofield Direct Route was expected to encounter fewer wetlands than the Empire Waterway and the Bayou Grand Liard Routes. Therefore, the Scofield Direct Route was determined to be a viable route for the Project and was carried forward for further evaluation in the Feasibility Study Phase.

### 3.4.4 Bayou Grand Liard Route

Bayou Grand Liard is located approximately 8 miles downstream of the confluence of the Empire Waterway and the Mississippi River. For this alternative, Riverine sand will be excavated from the proposed borrow areas within the river using a cutterhead dredge and transported through Bayou Grand Liard to Scofield Island via a sediment pipeline. However, since the average depth of the Bayou Grand Liard Route is only 4 feet, the waterway could not accommodate the pipeline equipment without considerable dredging.

The Bayou Grand Liard Route crosses 19 tracts of land owned by 8 different landowners. The sediment pipeline will cross the Hurricane Protection Levee through privately-owned property. Coordination with a private owner could complicate the right-of-way process. Furthermore, this corridor crosses older well-established oyster leases. Even if the direction of the route was modified to minimize oyster lease crossings, the route would still impact a large number of leases. In addition, the Bayou Grand Liard is a relatively narrow, winding bayou whose natural levees and adjacent marshes form a natural landbridge between Yellow Cotton Bay to the east and Chicharas and Skipjack Bays to the west. It was determined that the potential impacts to these sensitive areas are much higher than either the Empire Waterway or Scofield Direct Routes.

Due to the large number of potential issues associated with the Bayou Grand Liard Route, it was eliminated from further consideration as a potential route.

### 3.5 Recommendations

Seven borrow areas were screened based on sediment volume and quality, transport distance, and navigation and dredging constraints. Likewise, four conveyance corridors and a number of sediment mining and conveyance methodologies were evaluated. Based on the screening methodologies employed, Borrow Areas MR-B and MR-E and the Empire Waterway and Scofield Direct Conveyance Corridors were recommended for further evaluation in the Feasibility Study Phase (Figure 3-3).

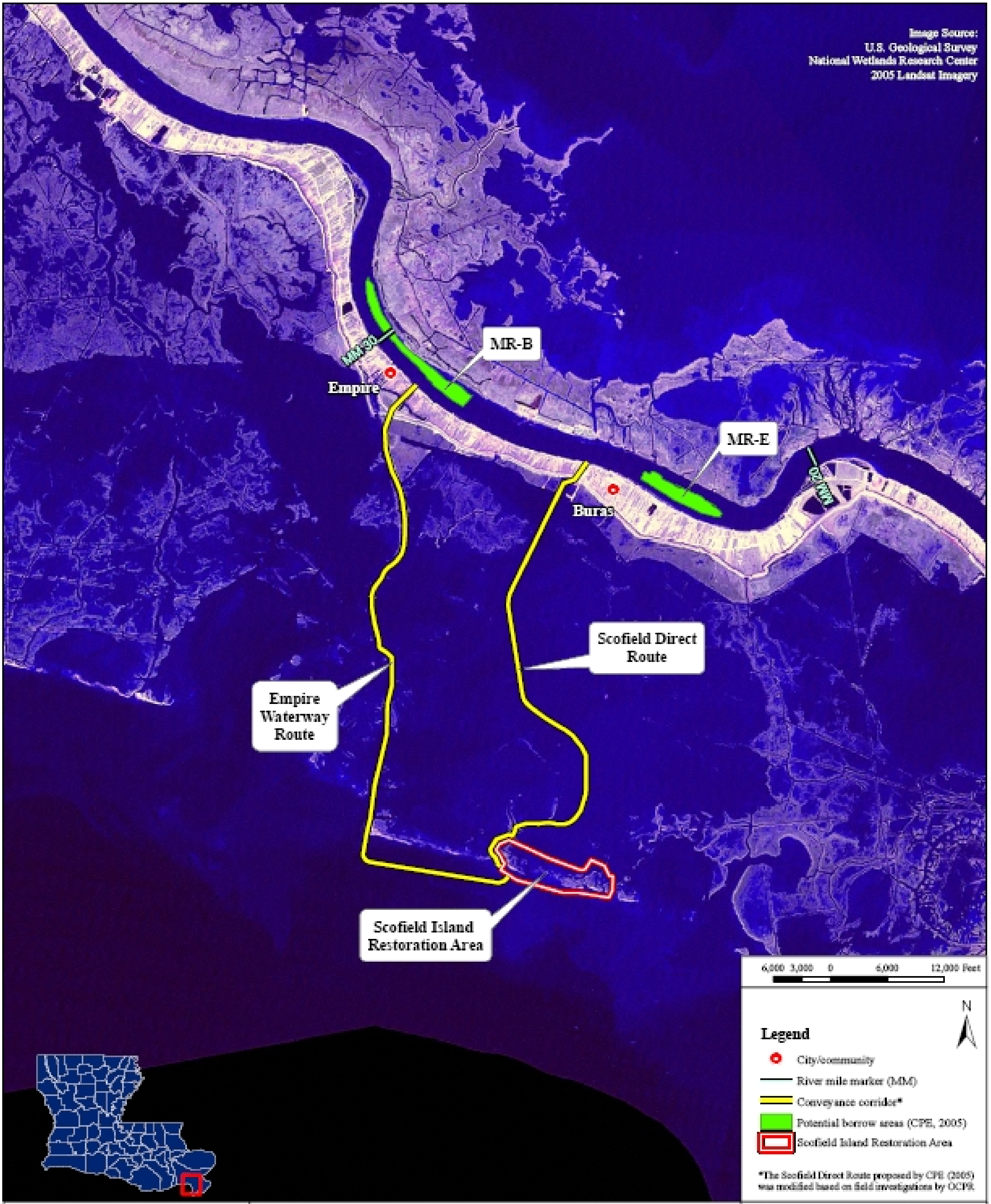


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**Figure 3-3**
**Plan Formulation: Recommended Borrow Areas and Conveyance Corridors**

January 2010 | Project Number: BA-40

SJB GROUP, LLC

## 4.0 FEASIBILITY STUDY

The Feasibility Study Phase was initiated in June 2007 to assess the technical, environmental, fiscal, and institutional parameters for the Borrow Areas and Conveyance Corridor alternatives along with the sediment mining/conveyance methodologies that were selected in the Plan Formulation Phase.

### 4.1 Alternatives Analysis

During the Feasibility Study, the SJB Team developed and evaluated eight specific alternatives for excavating and transporting sand from the Mississippi River to Scofield Island. Each alternative included one of the two potential borrow areas (MR-B or MR-E), one of two mining methodologies (cutterhead or hopper dredge) and one of the two proposed Conveyance Corridors (Empire Waterway or Scofield Direct Routes). The primary components of each alternative developed in the Feasibility Study are summarized in Table 4-1.

**Table 4-1: Summary of alternatives for the Feasibility Study**

| Alternative | Borrow Area | Dredge Method | Conveyance Route |
|---|---|---|---|
| ALT-1 | MR-B | Cutterhead Dredge | Empire Waterway |
| ALT-2 | MR-B | Hopper Dredge | Empire Waterway * |
| ALT-3 | MR-B | Hopper Dredge | Scofield Direct ** |
| ALT-4 | MR-E | Cutterhead Dredge | Scofield Direct |
| ALT-5 | MR-E | Hopper Dredge | Scofield Direct ** |
| ALT-6 | MR-E | Cutterhead Dredge | Empire Waterway |
| ALT-7 | MR-E | Hopper Dredge | Empire Waterway ** |
| ALT-8 | MR-E | Hopper Dredge | Empire Waterway * |

* Hopper dredge pump-out at the Empire Waterway
** Hopper dredge pump-out at the Ostrica Anchorage Area

When evaluating the feasibility of each alternative, a number of potential constraints that could hinder the construction of the Project were considered. Each potential constraint was evaluated and assigned a score to quantify the degree of impact. Lower scores indicated a lesser impact. The following constraints were analyzed:

- Borrow Area Sediment Volume
- Borrow Area Sediment Grain Size
- Navigation Channel Crossing
- Navigation Safety Issues
- Transport Distance

- Revetment Impacts
- Anchorage Area Impacts
- Preliminary Cultural Resources Assessment
- Transport Corridor Water Depths
- Oyster Lease Impacts
- Wetland Impacts
- Transport Corridor Pipeline Crossings
- Transport Corridor Obstructions
- Landowners Affected
- Levee Corridor Crossing Complexity
- Construction Duration
- Construction Cost

The following sections discuss the scoring methodology used for each of the potential constraints and the resulting scores.

#### 4.1.1 Borrow Area Sediment Volume

CPE (2004) and Finkl et al. (2005) identified potential sand sources within the lower Mississippi River including the two areas designated as MR-B and MR-E. Based on the subsequent analyses, the boundaries of the two areas were revised. The naming convention of each borrow area was modified. Borrow Area MR-B was redesignated MR-B-09 and Borrow Area MR-E was redesignated MR-E-09 to reflect that while the approximate locations remained the same, the design limits were refined. Refinements to the boundaries were made using USACE levee offset and slope requirements, maximum dredge depths, existing seismic and geotechnical data, and assumed buffers around suspected petroleum pipelines. Volumes were updated to reflect the new boundaries.

The seismic data indicated that MR-B-09 contains approximately 5.5 million cubic yards of sediment while maintaining a 500-foot buffer around two suspected petroleum pipelines. MR-E-09 was estimated to contain approximately 7.4 million cubic yards of sediment (SJB and CEC, 2008). These volumes represent feasibility level estimates.

Based on the conceptual restoration plan by ATM (2004), feasibility level surveys conducted on the island in 2008, and accounting for background erosion, it was estimated that the restoration design template will require approximately 2.3 million cubic yards of sand for beach and dune fill. The volumetric goal for identifying sufficient sand quantities for Project construction was set equal to two times the required fill volume, equal to 4.6 million cubic yards. Doubling the required fill volume is a conservative practice to account for dredge losses, infrastructure conflicts, and background erosion from the date of the design survey to Project construction, Table 4-2 scores each alternative by dividing the volumetric goal by the available sediment volume in each borrow area.

**Table 4-2: Scoring of estimated borrow volumes for each alternative**

| Alternative | Borrow Area | Available Volume (cy) | Normalized Volume Score* |
|---|---|---|---|
| ALT-1 | MR-B-09 | 5,500,000 | 0.84 |
| ALT-2 | | | |
| ALT-3 | | | |
| ALT-4 | MR-E-09 | 7,400,000 | 0.62 |
| ALT-5 | | | |
| ALT-6 | | | |
| ALT-7 | | | |
| ALT-8 | | | |

* Sand volumes were normalized based on 4,600,000 cubic yards of required excavation volume.

### 4.1.2 Borrow Area Sediment Grain Size

Composite grain sizes were calculated for MR-B-09 and MR-E-09 using data from Finkl et al. (2005). However, the mean native grain size for Scofield Island was not encountered in the literature and was thus estimated using data from adjacent barrier island restoration projects (SJB and CEC, 2008). Based on these projects, an average native grain size of 0.14 mm was assumed for Scofield Island. The resulting normalized grain size scores for each alternative are shown in Table 4-3.

**Table 4-3: Scoring of composite grain size**

| Alternative | Borrow Area | Vibracore Name | Mean Grain Size (mm) | Composite Grain Size (mm) | Normalized Grain Size Scoring** |
|---|---|---|---|---|---|
| ALT-1<br>ALT-2<br>ALT-3 | MR-B | MRVC-05-04 | 0.21 | 0.17 | 0.83 |
| | | MRVC-05-05 | 0.16 | | |
| | | MRVC-05-06 | 0.14 | | |
| ALT-4<br>ALT-5<br>ALT-6<br>ALT-7 | MR-E | MRVC-05-07 | 0.22 | 0.22 | 0.64 |
| | | MRVC-05-10 | 0.21 | | |

* Borrow area grain sizes were normalized by dividing the assumed native grain size of 0.14 mm by the composite grain size.

### 4.1.3 Navigation Safety Issues

Each of the eight alternatives will utilize active waterways and thus must be analyzed in terms of potential navigational safety hazards. The following sections discuss the potential hazards associated with each alternative.

#### 4.1.3.1 Dredge Mobility

The basis of analysis for Alternatives ALT-1, ALT-4, and ALT-6 was use of a 30" cutterhead dredge for excavation of sediment for the Project while the basis of analysis for Alternatives ALT-2, ALT-3, ALT-5, ALT-7, and ALT-8 was use of a 6,000-cubic yard hopper dredge. The primary drawback of the cutterhead dredge is that vessels transiting the area must remain clear of the anchor cable alignment, discharge pipeline, and support vessels during dredging operations. In comparison, the hopper dredge can be mobilized relatively quickly since it requires no support vessels or discharge pipelines leading from the borrow area to the levee corridor. Therefore, the alternatives utilizing a cutterhead dredge were ranked with a score of 0.25 points and all those utilizing a hopper dredge were given a score of 0.00 points.

#### 4.1.3.2 Borrow Area Location

All alternatives utilizing MR-B-09 were given a score of 0.25 points since the borrow area is located in a constricted section of the river that could potentially hinder vessel navigation. Alternatively, MR-E-09 is located in a straight section of the Mississippi River, partially within the Ostrica Anchorage area and does not pose a significant risk to vessel navigation. Therefore, all alternatives utilizing MR-E-09 were ranked with a score of 0.00 points.

#### 4.1.3.3 Hopper Dredge Discharge Location

The proposed hopper dredge discharge locations within the Mississippi River could potentially hinder small vessels and barge tows that utilize the outside perimeters of the river for passage of larger vessels. Therefore, the alternatives with a discharge location near the Empire Waterway Route were given an additional score of 0.25 points. All other alternatives were given a score of 0.00.

#### 4.1.3.4 Navigation Channel Crossing

Since MR-B-09 is on the east bank of the Mississippi River, any sand excavated from the borrow area must be transported to the west bank of the river without disrupting navigational traffic. This will be accomplished by either installing a sediment pipeline at a water depth of 45 feet or by using a hopper dredge to transport the sand across the navigation channel. ALT-1 is the only alternative that will necessitate the use of a submerged sediment pipeline crossing the navigational channel of the Mississippi River and was therefore given a score of 0.50. ALT-2 and ALT-3 will utilize a hopper dredge to excavate and transport the sediment to the western side of the river. Due to the navigational concerns of crossing vessel traffic lanes, ALT-2 and ALT-3 were scored 0.25 points. ALT-4 through ALT-8 will not transport sediment across the navigational channel and were thus given a score of 0.00 points (Table 4-4).

**Table 4-4: Scoring of navigation safety concerns**

| Alternative | Borrow Area | Dredge Type | Hopper Discharge Location | Scores | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Dredge Mobility | Borrow Area Location | Hopper Discharge Location | Navigation Channel Crossing | Total |
| ALT-1 | MR-B | Cutterhead | N/A | 0.25 | 0.25 | 0.00 | 0.50 | 1.00 |
| ALT-2 | MR-B | Hopper | Empire Waterway | 0.00 | 0.25 | 0.25 | 0.25 | 0.75 |
| ALT-3 | MR-B | Hopper | Ostrica Anchorage | 0.00 | 0.25 | 0.00 | 0.25 | 0.50 |
| ALT-4 | MR-E | Cutterhead | N/A | 0.25 | 0.00 | 0.00 | 0.00 | 0.25 |
| ALT-5 | MR-E | Hopper | Ostrica Anchorage | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ALT-6 | MR-E | Cutterhead | N/A | 0.25 | 0.00 | 0.00 | 0.00 | 0.25 |
| ALT-7 | MR-E | Hopper | Ostrica Anchorage | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ALT-8 | MR-E | Hopper | Empire Waterway | 0.00 | 0.00 | 0.25 | 0.00 | 0.25 |

### 4.1.4 Transport Distance

The sediment transport distances for each alternative were estimated by adding the distance from the farthest end of the assigned borrow area to the conveyance corridor levee crossing and the length of the assigned transportation route. The estimated travel distances and associated scores for each alternative are provided in Table 4-5.

**Table 4-5: Scoring of transportation distances**

| Alternative | Transportation Distance (mi) | Normalized Distance |
|---|---|---|
| ALT-1 | 18 | 1.13 |
| ALT-2 | 18 | 1.13 |
| ALT-3 | 21 | 1.31 |
| ALT-4 | 16 | 1.00 |
| ALT-5 | 16 | 1.00 |
| ALT-6 | 22 | 1.38 |
| ALT-7 | 22 | 1.38 |
| ALT-8 | 22 | 1.38 |

* Transportation distances were normalized to the shortest distance of 16 miles

### 4.1.5 Revetments Impacts

All alternatives were formulated to avoid penetrating revetments. The cutterhead dredge alternatives were given a scope of 0.00 points as there are no revetment impacts associated with this dredging operation. The hopper dredge discharge pipes for the alternatives along the Scofield Direct Route could be moored at the Ostrica Anchorage Area to prevent impacts to the revetment during dredging operations. These alternatives were given score of 0.00. Alternatives requiring the use of a hopper dredge discharge point near the Empire Waterway Route were given a score of 0.50 points to account for potential mooring impacts to the revetment. Table 4-6 provides revetment impact scores for each alternative.

**Table 4-6: Scoring of potential revetment impacts**

| Alternative | Borrow Area | Revetment Name | Hopper Discharge Location Consideration Score | Total Score |
|---|---|---|---|---|
| ALT-1 | MR-B | Tropical Bend / Buras | 0.00 | 0.00 |
| ALT-2 | MR-B | Tropical Bend / Buras | 0.50 | 0.50 |
| ALT-3 | MR-B | Buras / Ft. Jackson | 0.00 | 0.00 |
| ALT-4 | MR-E | Buras / Ft. Jackson | 0.00 | 0.00 |
| ALT-5 | MR-E | Buras / Ft. Jackson | 0.00 | 0.00 |
| ALT-6 | MR-E | Buras / Ft. Jackson | 0.00 | 0.00 |
| ALT-7 | MR-E | Buras / Ft. Jackson / Tropical Bend | 0.00 | 0.00 |
| ALT-8 | MR-E | Tropical Bend / Buras | 0.50 | 0.50 |

#### 4.1.6 Anchorage Area Coordination Complexities

The Ostrica Anchorage Area overlaps a considerable portion of MR-E-09. Dredging operations within the anchorage area must be coordinated with the USACE and other appropriate stakeholders. Since ALT-4 through ALT-8 utilize MR-E-09, they were given a score of 0.50 to account for potential coordination complexities associated with anchorage area. Alternatives ALT-1 through ALT-3 were given a score of 0.00 since the associated borrow area (MR-B-09) does not encroach into the anchorage area.

#### 4.1.7 Preliminary Cultural Resources Assessment

The Project Team conducted an assessment of cultural resources using guidelines established by the Louisiana Department of Recreation, Culture, and Tourism (LDRCT), Division of Archaeology. Primary and secondary literature sources included over a dozen sources of private, state, and federal shipwreck, obstruction, and submerged cultural material information (SJB and ARI, 2007).

Through this preliminary assessment, seventeen wrecks, wells, and obstructions were identified in the general vicinity of MR-B-09. Of the seventeen sites identified, two shipwrecks were found within 500 feet of the borrow area boundary while one well was found within the boundary. Based on the locations of these three cultural resource sites, ALT-1 through ALT-3 (which utilize MR-B-09) were given a score of 0.50 points.

Twenty-nine wrecks, derelicts, and well locations were recorded in the general vicinity of MR-E-09. Of these twenty-nine targets, only one historic pipeline (found in 1978) was identified within 500 feet of the borrow area boundary. Therefore, ALT-4 through ALT-8 (which utilize MR-E-09) were given a score of 0.00 points.

#### 4.1.8 Conveyance Corridor Water Depths

Bathymetric survey data collected from the Empire Waterway and Scofield Direct Routes were evaluated to ensure that each conveyance corridor could accommodate the proposed sediment pipelines. The design criteria for water depths to accommodate the anticipated pipeline installation barges and machinery was -8 ft NAVD88.

Review of the bathymetric survey data Empire Waterway Route revealed that no dredging will be required for barge access to lay the sediment pipeline. In contrast, data collected along Scofield Direct Route revealed that significant dredging will be required for barge access to lay the sediment pipeline. Therefore, the Empire Waterway and Scofield Direct Routes were assigned scores of 0.00 and 1.00 respectively.

### 4.1.9 Oyster Lease Impacts

A 300-foot buffer was applied to each oyster lease along the Empire Waterway and Scofield Direct Routes to identify the areas susceptible to direct impacts. The 300-foot buffer was based on LDNR oyster lease negotiations for past projects. Each conveyance corridor was assigned a width of 300 feet. Oyster lease impacts were then quantified by determining the acreage of oyster leases (including the 300-feet buffer area) falling within the 300-foot wide conveyance corridors. Potential impacts to oyster leases included barge traffic crossing the lease or laying sediment pipeline through the lease. The results are summarized in Table 4-7. Figure 4-1 identifies the oyster leases along each corridor.

**Table 4-7: Scoring of oyster lease impacts**

| Alternative | Route | No. of Leases Crossed | Oyster Area Impacted (acres) | Normalized Score* |
|---|---|---|---|---|
| ALT-1<br>ALT-2 | Empire Waterway Route | 26 | 348 | 1.00 |
| ALT-3<br>ALT-4<br>ALT-5 | Scofield Direct Route | 66 | 481 | 1.38 |
| ALT-6<br>ALT-7<br>ALT-8 | Empire Waterway Route | 26 | 348 | 1.00 |

* Impacted areas were normalized to the smallest area of 348 acres.

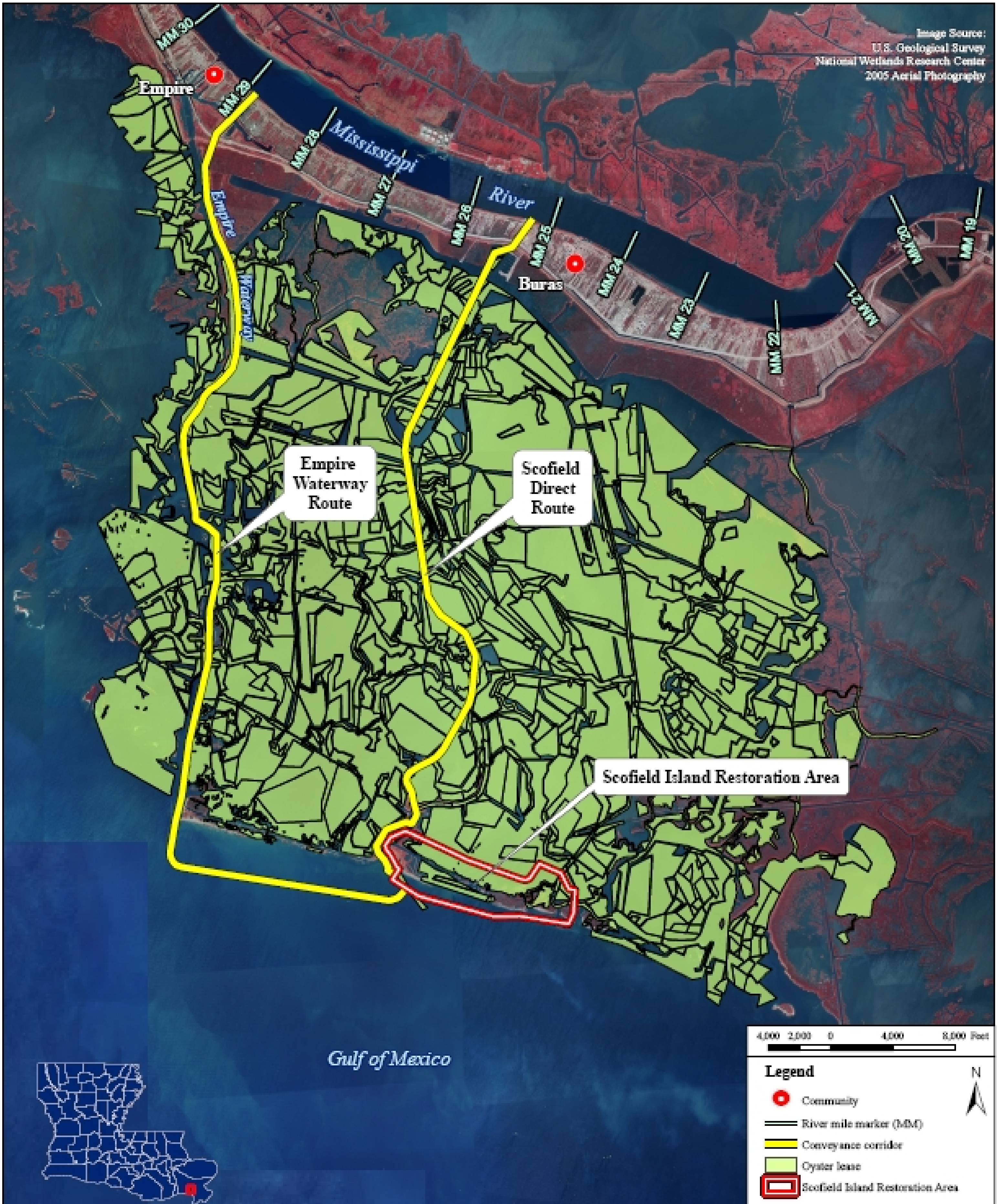


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**Figure 4-1**
**Feasibility Study:**
**Oyster Leases**

SJB GROUP, LLC

| January 2010 | Project Number: BA-40 |
|---|---|

### 4.1.10 Wetland Impacts

Potential wetland impacts were subjectively scored by visually assessing the area of wetlands located within the Empire Waterway and Scofield Direct Routes. Potential impacts to wetlands included laying sediment pipeline through wetland areas on upland segments of the corridor. The visual assessment was conducted using a 2005 aerial photograph of the routes.

The aerial photograph revealed a 250-foot wide band of scrub/shrub and forested wetland habitat between the Mississippi River and the levees along both routes. In addition, the Empire Waterway Route will cross between 700 and 1,700 feet of saline marsh on the west side of the Hurricane Protection Levee. Saline marsh is also present along the Scofield Direct Route, west of the Buras Boat Harbor parking lot. However, impacts to the existing marsh may be avoided altogether by utilizing the Buras Boat Harbor parking lot.

Considering that the Scofield Direct Route alignments could be adjusted during construction to minimize wetland impacts (i.e. use of the parking lot), ALT-3, ALT-4, and ALT-5 were scored at 0.5 points. Alternatives utilizing the Empire Waterway Route (i.e. ALT-1, ALT-2, ALT-6, ALT-7, and ALT-8) are expected to impact the largest area of wetlands and were thus assigned a score of 1.00 points.

### 4.1.11 Petroleum Pipeline Crossings

The Empire Waterway and Scofield Direct Routes were additionally evaluated based on the number of petroleum pipeline crossings. Since the depths of these petroleum pipelines were unknown at the time of analysis, they were not accounted for in the scoring. However, the petroleum pipeline depths are a very important factor in determining the practicability of each alternative and will be assessed in the Preliminary Design Phase. Table 4-8 provides the number of petroleum pipelines crossed by each alternative and the associated score.

**Table 4-8: Scoring of petroleum pipeline crossings for each alternative**

| Alternative | Route | No. of Pipelines Crossed | Normalized Score* |
|---|---|---|---|
| ALT-1<br>ALT-2 | Empire Waterway Route | 52 | 1.53 |
| ALT-3<br>ALT-4<br>ALT-5 | Scofield Direct Route | 34 | 1.00 |
| ALT-6<br>ALT-7<br>ALT-8 | Empire Waterway Route | 52 | 1.53 |

* Petroleum pipeline crossings were normalized to the least number of pipelines equal to 34.

#### 4.1.12 Corridor Obstructions

Magnetometer surveys were conducted by CHF to detect obstructions along the Empire Waterway and Scofield Direct Routes. Several of the magnetic anomalies detected in the magnetometer surveys were most likely associated with petroleum pipelines bisecting each route. Of the magnetic anomalies recorded in the survey of the Empire Waterway Route, 15% had a gamma reading above 200. Anomalies with gamma readings above 200 represent relatively large objects or objects with high ferrous material densities. In comparison, 24% of the anomalies along the Scofield Direct Route exhibited anomaly amplitudes greater than 200 gammas. Table 4-9 provides the obstruction scores for each route.

**Table 4-9: Scoring of transport corridor obstructions**

| Alternative | Route | % of Magnetic Anomaly Amplitudes > than 200 gamma | Normalized Magnetic Anomaly Amplitude Score* |
|---|---|---|---|
| ALT-1<br>ALT-2 | Empire Waterway Route | 15% | 1.00 |
| ALT-3<br>ALT-4<br>ALT-5 | Scofield Direct Route | 24% | 1.60 |
| ALT-6<br>ALT-7<br>ALT-8 | Empire Waterway Route | 15% | 1.00 |

* Anomaly amplitudes were normalized to the lowest percentage equal to 15%.

#### 4.1.13 Landowner Considerations

Property data provided by the LDNR was used to determine the number of tracts crossed and property owners encountered by the Empire Waterway and Scofield Direct Routes. The results of the assessment are summarized in Table 4-10, including normalized scores. Alternatives encountering a larger number of tracts and property owners could potentially require more coordinating efforts during the right-of-way process.

**Table 4-10: Scoring of landowner impacts**

| Alternative | Route | No. of Tracts Crossed | No. of Owners Crossed | Sum of Tracts and Owners Crossed | Normalized Score* |
|---|---|---|---|---|---|
| ALT-1<br>ALT-2 | Empire Waterway Route | 12 | 5 | 17 | 1.00 |
| ALT-3<br>ALT-4<br>ALT-5 | Scofield Direct Route | 14 | 7 | 21 | 1.24 |
| ALT-6<br>ALT-7<br>ALT-8 | Empire Waterway Route | 12 | 5 | 17 | 1.00 |

* Sum of Land Tracts and Owners crossed were normalized to the least sum of 17.

#### 4.1.14 Levee Crossing Construction Complexity

Each alternative was evaluated based on the complexity of sediment pipeline installation within the levee crossings. The sediment pipeline used to transport sand through the conveyance corridors will cross the Mississippi River Levee as an above ground pipe. On the other side of the levee, the above ground sediment pipeline will transition to a below ground sediment pipeline beneath Highway 11 and Highway 23. Although both routes have sufficient room to make the transition, there is less room and flexibility with the Scofield Direct Route. For example, jack and bore or directional drilling will only be feasible from the west side of the road in the alternatives utilizing the Scofield Direct Route.

The sediment pipeline will surface on the western side of Highway 23 and cross the Hurricane Protection Levee as an above ground pipe. There is sufficient space between the Hurricane Protection Levee and the highway exceeding the minimal distance for both routes. The Empire Waterway Route crossing at Louisiana Highway 23 is much longer than the Scofield Direct Route, and would take more time to complete. An existing sewer line will need to be avoided in the Scofield Direct Route.

Based on these considerations, the alternatives along the Empire Waterway Route (ALT-1, ALT-2, ALT-6, ALT-7, and ALT-8) were subjectively assigned a score of 0.50 while the alternatives along the Scofield Direct Route (ALT-3, ALT-4, and ALT-5) were given a score of 1.00.

### 4.1.15 Construction Duration

The duration of construction was estimated using mining capacities, sediment pipeline flow rates, expected weather delays, mobilization rates, and demobilization rates for each alternative. The construction durations and associated scores are provided in Table 4-11.

**Table 4-11: Scoring of construction duration**

| Alternative | Estimated Construction Duration (days) | Normalized Score* |
|---|---|---|
| ALT-1 | 239 | 1.06 |
| ALT-2 | 251 | 1.12 |
| ALT-3 | 282 | 1.25 |
| ALT-4 | 225 | 1.00 |
| ALT-5 | 247 | 1.10 |
| ALT-6 | 257 | 1.14 |
| ALT-7 | 247 | 1.10 |
| ALT-8 | 267 | 1.19 |

* Construction durations were normalized to the shortest duration of 225 days.

### 4.1.16 Construction Costs

Feasibility level estimates of total construction cost were prepared for each alternative based on the cost of mobilization and demobilization, fuel, levee crossings, conveyance corridor access, island access, marsh fill, beach and dune fill, containment dike construction, surveying, supervision, inspection, and construction administration (SJB and CEC, 2008). The normalized scores are provided in Table 4-12.

**Table 4-12: Scoring of construction costs**

| Alternative | Normalized Score* |
|---|---|
| ALT-1 | 1.26 |
| ALT-2 | 1.22 |
| ALT-3 | 1.19 |
| ALT-4 | 1.00 |
| ALT-5 | 1.06 |
| ALT-6 | 1.41 |
| ALT-7 | 1.31 |
| ALT-8 | 1.20 |

## 4.2 Recommendations

The scores assigned to each of the potential constraints discussed in Section 4.1 were summed for each alternative to identify which alternative is expected to encounter the fewest constraints during construction. The scores are summarized in Table 4-13.

Based on the findings of the Feasibility Study, ALT-7 was recommended as the preferred alternative for the Preliminary Design Phase. A summary of ALT-7 is provided in Table 4-14. The components of ALT-7 are presented in Figures 4-2 and 4-3. As seen in Table 4-13, ALT-7 yielded the lowest score among all eight alternatives and therefore is expected to have the fewest number of constraints during construction.

For ALT-7, sediment will be excavated from MR-E-09 using a hopper dredge. The sediment pipeline transporting the sand from the dredge will surface at the Ostrica Anchorage Area and will cross the Mississippi River Levee as an above ground pipe. The sediment pipeline will transition to a below ground sediment pipeline below Highway 11. On the west side of Highway 11, the sediment pipeline will surface and run along the northern edge of a closed landfill and the Empire Boat Harbor before transitional back to a subsurface pipeline and crossing below Highway 23. The sediment pipeline will then surface to cross over the Hurricane Protection Levee and then parallel the Empire Waterway to Scofield Island. The total estimated transport distance from the southernmost edge of Borrow Area MR-E-09 to the easternmost edge of Scofield Island is approximately 22 miles.

**Table 4-13: Scoring summary of the eight alternatives**

| | | ALT-1 | ALT-2 | ALT-3 | ALT-4 | ALT-5 | ALT-6 | ALT-7 | ALT-8 |
|---|---|---|---|---|---|---|---|---|---|
| Components | Borrow Area | MR-B-09 | MR-B-09 | MR-B-09 | MR-E-09 | MR-E-09 | MR-E-09 | MR-E-09 | MR-E-09 |
| | Dredge Method | Cutter-head | Hopper | Hopper | Cutter-head | Hopper | Cutter-head | Hopper | Hopper |
| | Conveyance Corridor | Empire | Empire | Scofield | Scofield | Scofield | Empire | Empire | Empire |
| Normalized Scores | Borrow Area Sediment Volume | 0.84 | 0.84 | 0.84 | 0.62 | 0.62 | 0.62 | 0.62 | 0.62 |
| | Borrow Area Sediment Grain Size | 0.82 | 0.82 | 0.82 | 0.64 | 0.64 | 0.64 | 0.64 | 0.64 |
| | Navigation Safety Issues | 1.00 | 0.75 | 0.50 | 0.25 | 0.00 | 0.25 | 0.00 | 0.25 |
| | Transport Distance | 1.13 | 1.13 | 1.31 | 1.00 | 1.00 | 1.38 | 1.38 | 1.38 |
| | Revetment Impacts | 0.00 | 0.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.50 |
| | Anchorage Areas Impacts | 0.00 | 0.00 | 0.00 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| | Preliminary Cultural Resources Assessment | 0.50 | 0.50 | 0.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Transport Corridor Water Depths | 0.00 | 0.00 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 |
| | Oyster Lease Impacts | 1.00 | 1.00 | 1.38 | 1.38 | 1.38 | 1.00 | 1.00 | 1.00 |
| | Wetland Impacts | 1.00 | 1.00 | 0.50 | 0.50 | 0.50 | 1.00 | 1.00 | 1.00 |
| | Transport Corridor Pipeline Crossings | 1.53 | 1.53 | 1.00 | 1.00 | 1.00 | 1.53 | 1.53 | 1.53 |
| | Transport Corridor Obstructions | 1.00 | 1.00 | 1.60 | 1.60 | 1.60 | 1.00 | 1.00 | 1.00 |
| | Landowners Affected | 1.00 | 1.00 | 1.24 | 1.24 | 1.24 | 1.00 | 1.00 | 1.00 |
| | Levee Corridor Crossing Complexity | 0.50 | 0.50 | 1.00 | 1.00 | 1.00 | 0.50 | 0.50 | 0.50 |
| | Construction Duration | 1.06 | 1.12 | 1.25 | 1.00 | 1.10 | 1.14 | 1.10 | 1.19 |
| | Construction Cost | 1.26 | 1.22 | 1.19 | 1.00 | 1.06 | 1.41 | 1.31 | 1.20 |
| Totals | | 12.64 | 12.91 | 14.13 | 12.73 | 12.64 | 11.97 | 11.58 | 12.31 |

**Table 4-14: Summary of ALT-7**

| Component | ALT-7 |
|---|---|
| Borrow Area | MR-E-09 |
| Dredge Method | Hopper Dredge |
| Pump-out Location | Ostrica Anchorage Area near MR-E-09 |
| Conveyance Corridor | Empire Waterway |
| Pipeline Distance | 22 miles |
| Estimated Construction | 247 days |
| Estimated Construction Costs | $51,613,000 |

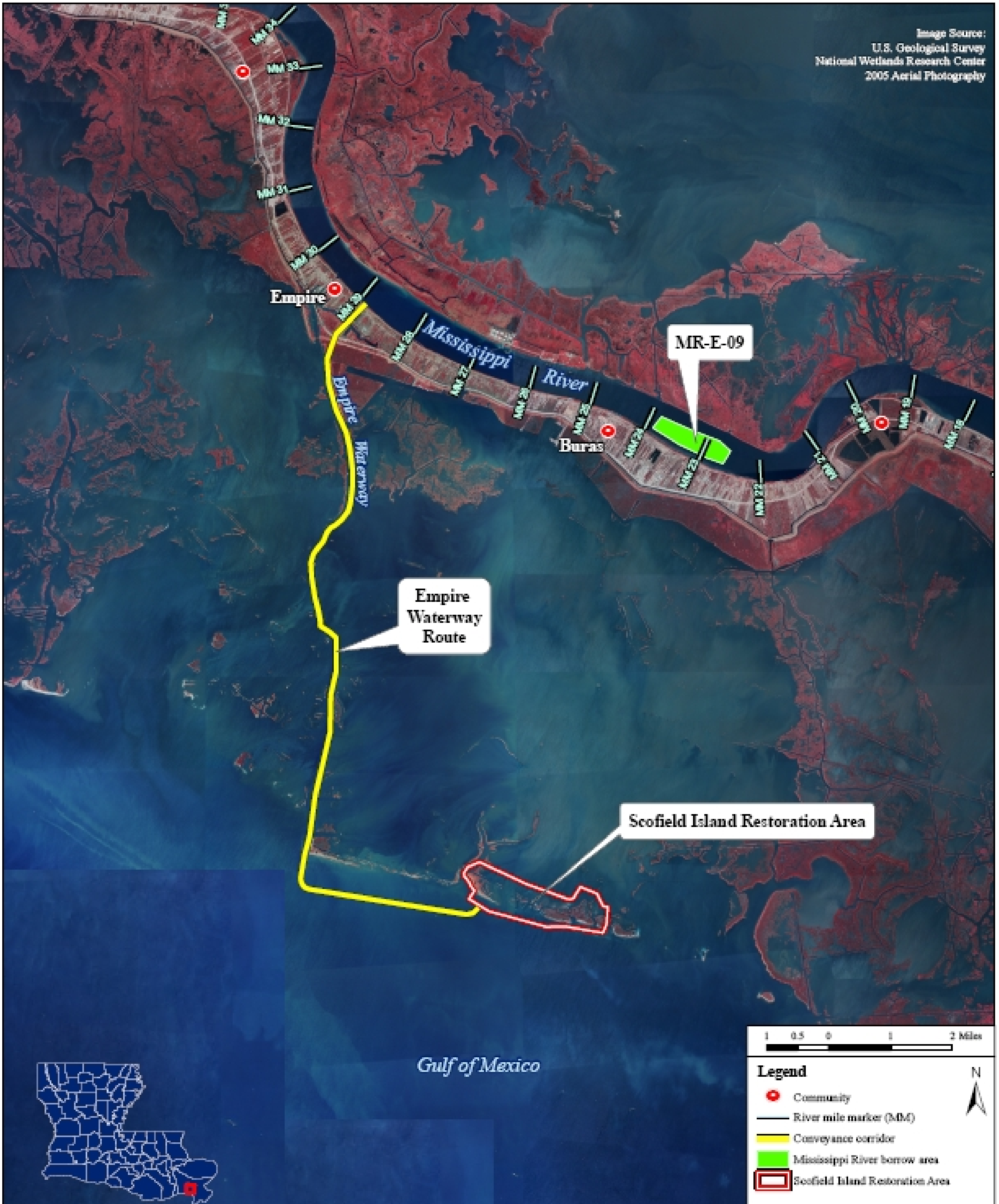


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**Figure 4-2**
**Feasibility Study:**
**Preferred Alternative (ALT-7) - Overview**

January 2010 | Project Number: BA-40

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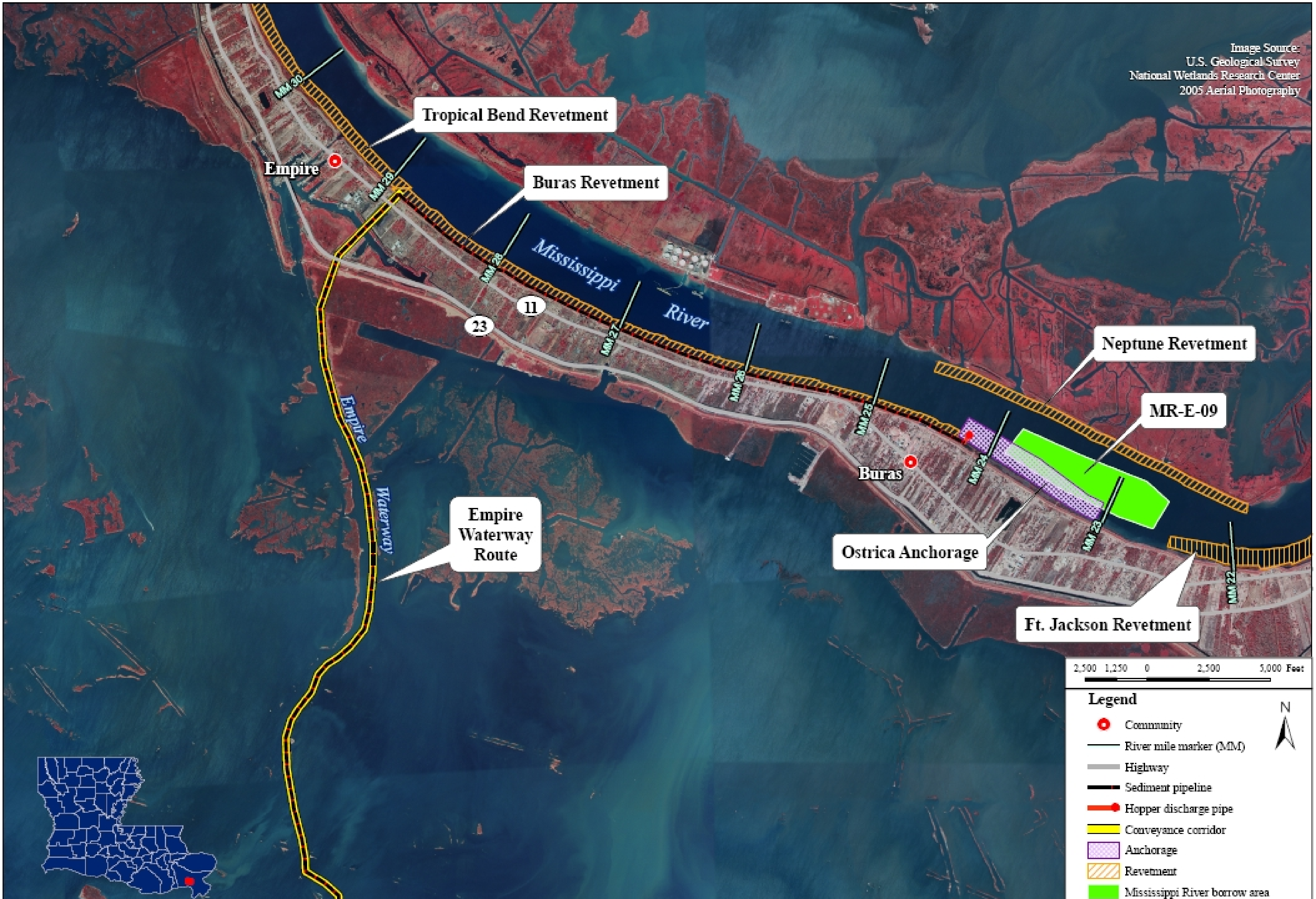


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**Figure 4-3**
**Feasibility Study:**
**Preferred Alternative (ALT-7) - Mississippi River Features**

January 2010 | Project Number: BA-40

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The corridor section between the Mississippi River and Hurricane Protection Levees that is to be crossed is owned by the PPG, which should simplify negotiations with the landowners associated with the Project.

ALT-7 provided an optimal balance of compatible sediment availability, logistical viability, revetment and anchorage protection, and navigational safety while minimizing environmental impacts and maximizing cost effectiveness.  .

Alternatives ALT-6 and ALT-8, which both included MR-E-09 and the Empire Waterway Route, also scored well in the analysis.  These alternatives were recommended for further consideration in the Preliminary Design Phase if the potential navigation and revetment issues can be resolved.

## 5.0 PRELIMINARY DESIGN SUMMARY

The focus of the Plan Formulation and Feasibility Study Phases was three-fold: assess the potential impacts of mining Riverine sand sources on river hydrodynamics, determine the most efficient Conveyance Corridor from the river to the island, and conduct extensive stakeholder coordination to solicit input, establish lines of communication, and build consensus among the diverse stakeholders.

The assessment of impacts on river hydrodynamics was shifted in the Project design schedule from the Preliminary Design Phase to the Feasibility Study Phase. The modeling analysis presented in Appendix D and summarized in Section 6.3 predicted that excavation of the two borrow areas, MR-B-09 or MR-E-09, yielded subtle changes in river hydrodynamics on the same order of magnitude as natural variability in the river. The model results provided reasonable assurance that mining these borrow areas would not result in negative impacts to river hydrodynamics. Based on the modeling results, it was concluded there was no need to perform two- or three-dimensional numerical modeling analyses to further assess the potential impacts of dredging MR-B-09 or MR-E-09.

Two conveyance corridors were analyzed in great detail, Empire Waterway and Scofield Direct Routes. Due to shallow water depths, potential oyster lease impacts, obstructions, significant landowner considerations, and complexity of the levee crossings associated with the Scofield Direct Route, the Empire Waterway Route was selected as the most efficient corridor that provided the optimal balance of technical feasibility, environmental impacts, infrastructure conflicts, and cost.

Extensive stakeholder coordination was conducted by OCPR, NOAA Fisheries, and the SJB Team. Over 20 meetings were attended to solicit input from the diverse interest groups and regulatory agencies. The discussions typically focused on the borrow areas in the river. The regulatory side was concerned with the impacts on river hydrodynamics from mining the sand, which was addressed as noted above. The navigation interests were concerned with the dredge methodology and borrow area locations. Discussions centered on the pros and cons of MR-B-09 and MR-E-09, with mixed concerns from the various group. The results of these meetings did not rule out either borrow area.

MR-E-09 was recommended by the Feasibility Study Phase alternatives analysis as the borrow area that provided the optimal balance of technical, environmental, and institutional parameters noting it was less cost effective than MR-B-09 (SJB and CEC, 2008). Because MR-B-09 did not get ruled out by the stakeholder coordination efforts specific to quantifying potential navigation impacts nor by the mining impact assessment, and because of its close proximity to the recommended Conveyance Corridor making it more cost effective than MR-E-09, it was decided to advance both borrow areas to Preliminary Design with the goal of offering greater flexibility at the time of construction and providing the opportunity for a more cost effective Project.

The proceeding chapters present the additional field work, data collection and detailed analyses; engineering, geotechnical and environmental studies; and comprehensive design work for the four Project components: Mississippi River Borrow Areas, Conveyance Corridor, Scofield Offshore Borrow Area, and Scofield Island Restoration Area.

A value engineering analysis was completed for the Scofield Island Restoration Area that optimized the habitat acres created versus Project cost to yield a more cost effective plan meeting and exceeding the CWPPRA conceptual restoration goals.

A photographic summary of key Project elements and the preliminary design plans for the Project are presented at the end of the Report.

# 6.0 MISSISSIPPI RIVER BORROW AREAS

This chapter presents the preliminary design plans, cross-sections, and available sand volumes for MR-B-09 and MR-E-09. Detailed geophysical and geotechnical surveys of MR-E-09 were conducted to assist in the development of the borrow area preliminary design. Because of the extensive field work completed by the USACE (CGA, 2008), limited additional geophysical and geotechnical data collection was conducted in MR-B-09 concurrently with the detailed surveys of MR-E-09. The purpose of the MR-B-09 surveys was to confirm the presence or absence of two potential petroleum pipelines in the borrow area and assess the potential borrow area sediment along the northeastern bank of the river for use in beach and dune restoration on Scofield Island.

The surveys and analyses completed in support of the Preliminary Design included the Mississippi River Borrow Area Geophysical Survey (Appendix A), Mississippi River Borrow Area Geotechnical Survey (Appendix B), Mississippi River Borrow Area Sediment Analyses (Appendix C), Mississippi River One-Dimensional Modeling Analysis (Appendix D), and Mississippi River Borrow Area Design Analysis (Appendix E). Details of the full geophysical and geotechnical surveys are described in AOS (2009a and 2009b). Native sediment and Riverine vibracore sample testing results are presented in CTC (2008) and CTC (2009), respectively.

The following terms are used to describe the bedforms observed in the sidescan and subbottom survey data. The values for bedform wave height and length are general characterizations and may vary.

- Megaripples: Mounds or ridges of sand which are asymmetrical and produced subaqueously by flowing water. The external morphology is similar to the larger sand wave, with a gently sloping, upstream side and a steeper downstream side. The crestline elongation extends transverse to the flow direction and is sinuous or lunate in plan. The wave height varies between 0.3 feet and 4 feet, while the wave length (spacing) between crests ranges from 3 feet to 40 feet. The down-current migration of the bedforms leads to the formation of cross-bedding in sediments which is the source of steeply dipping reflectors in the seismic records.

- Sand waves: Large-scale, transverse ridge of sand, with external morphology similar to that of the smaller-scale megaripple. The wave height is typically greater than 4 feet, while the wave length may range from 100 feet to over 1500 feet.

## 6.1 Borrow Area MR-B-09 Analysis

The following sections summarize the geophysical and geotechnical surveys that were completed in support of the Preliminary Design for MR-B-09. A discussion of cultural resources and excavation considerations is also provided. The preliminary design for MR-B-09 is described at the end of the section.

### 6.1.1 MR-B-09 Geophysical Analysis

Following the submittal of the Feasibility Study Report, USACE released a draft marine archeological survey conducted in the vicinity of MR-B-09 that was completed by CGA. The data included bathymetric, magnetometer, sidescan sonar, and subbottom profiles at a transect spacing of 50 feet (CGA, 2008). The sidescan sonar and magnetometer data acquired by CGA was used to identify potential hazards to the sand mining operations and to determine whether there were any exposed portions of two purportedly removed petroleum pipelines near the head of the Empire Waterway. During the surveys, numerous minor magnetic and acoustic anomalies were recorded. However, only four targets of significance were located near the edge of the Borrow Area MR-B-09 (CGA, 2008). To avoid these, the borrow area boundaries were refined by placing a perimeter buffer around each target.

To complement and calibrate the data collected by CGA, AOS conducted selective geophysical surveys (magnetometer, sidescan sonar, bathymetric, and seismic subbottom) in specific areas of MR-B-09 (AOS, 2009a & 2009b). Magnetometer surveys were conducted to verify the presence or absence of existing facilities, pipelines, and other obstructions that might affect use of the borrow area. As with CGA, AOS identified a number of magnetic anomalies within the survey boundary. The lack of a clear linear correlation between the anomalies confirmed there were no exposed pipelines or segments of pipe within the southern portion of MR-B-09 (AOS 2009a). A small cluster of sidescan targets was found near one of the magnetic anomalies. However, this area is already being protected by one of the four buffers described above. The remaining anomalies likely represent scattered debris that naturally collects in the area (CGA, 2008 and AOS, 2009a).

AOS also recorded subbottom profile cross-lines and long lines during their field reconnaissance (AOS, 2009a). The data revealed a series of relatively steeply dipping reflectors. Such features are generally indicative of sediment deposition in a more active current regime. These data were useful in defining the limits of MR-B-09.

### 6.1.2 MR-B-09 Geotechnical Analysis

In order to determine the suitability of the sediment and to assist in the development of the borrow area preliminary design plans, vibracore data previously obtained by CPE (Finkl et al, 2005) were reviewed. Analysis of the data revealed clean, fine grain sand, with an average grain size of 0.17 mm (ranging from 0.14 to 0.21 mm).

To further define the characteristics of the borrow area, six additional vibracores were collected by AOS (2009b) along the northeastern bank of the Mississippi River. The cores were shipped to CTC for processing and analysis (CTC, 2008 and 2009). Two of the six cores, MRB-08-05 and MRB-08-06, were collected within the boundary of MR-B-09. These cores were located in the areas where the subbottom and sidescan sonar data indicated sand waves. Since the majority of the borrow area was delineated in accordance with the sand waves, the two cores likely provided a better representation of the borrow area's sediment composition than the other four. Furthermore, it was noted that these two cores had the best sand percentage of all the cores collected in the area. The weighted mean grain size for the two cores was 0.13 mm and 0.14 mm (Table 6-1).

Based on the data collected by CPE (2005) and AOS (2009b), an average grain size of 0.16 mm was assumed for the noncohesive sediments in MR-B-09 (Table 6-1). The data also suggest that approximately 94.3% of the material is comprised of fine sand (i.e. greater than or equal to a minimum sand grain size of 0.0625 mm).

**Table 6-1: Grain characteristics of cores collected in MR-B-09**

| Core ID | Collected by: | Weighted Mean Grain Size (mm) | Weighted % Sand (230)* |
|---|---|---|---|
| MRVC-05-04 | CPE, 2005 | 0.21 | 99.5 |
| MRVC-05-05/05A | CPE, 2005 | 0.16 | 92.7 |
| MRVC-05-06/06A | CPE, 2005 | 0.14 | 86.0 |
| MRB-08-05 | AOS, | 0.13 | 96.2 |
| MRB-08-06 | AOS, | 0.14 | 97.4 |
| Average | | 0.16 | 94.3 |

*Wentworth Size Class, minimum sand grain size 0.0625 mm, #230 sieve size

As summarized by AOS (2009a), the MR-B-09 survey area is characterized by sand bounded by prodelta and interdistributary silt and clays. The main body of sand thins to the northwest and southeast of the borrow area, as well as on the northeast flank of the borrow area near the shoreline. The sand body extends beyond the southeastern limits of the borrow area. The thickest observed sand sequence is on the southwestern edge of the borrow area. The main sand body is covered in sand waves with superimposed megaripples. The sediments are cross-bedded due to active bedform migration in the down-current direction. Vibracore samples collected by AOS along the boundary of MR-B-09 not only confirmed the presence of sand, but also revealed older swamp or quiet water silt- and clay-rich sediment environments along the eastern edge of the river. Core boring logs were prepared and laboratory testing of representative samples from MR-B-09 and MR-E-09 was completed (CTC, 2008 and 2009).

Based on the supporting information provided herein, it was concluded that the sediment in MR-B-09 is suitable for use in restoring the beach and dune system on Scofield Island.

#### 6.1.3 MR-B-09 Cultural Resource Impacts

The preliminary assessment of cultural resources for Borrow Area MR-B-09 was conducted as part of the Feasibility Study Phase and followed reporting guidelines established by the LDRCT (SJB and ARI, 2007) (Section 4.1.7). CGA later conducted a series of surveys to collect bathymetry, magnetometer, sidescan sonar, and subbottom profiling data in support of the draft marine archeological survey developed for the USACE (CGA, 2008). The survey identified four magnetic and acoustic anomalies within the boundary of Borrow Area MR-B-09. As previously stated, these targets will be avoided by placing a perimeter buffer around each anomaly. The data collected by CGA provides the sufficient level of detail required for the archaeological assessment of Borrow Area MR-B-09.

#### 6.1.4 Excavation Standards

Borrow Area MR-B-09 is situated near the eastern bank of the Mississippi River. The borrow area is not adjacent to a levee and thus is not constrained by the permissible excavation limits defined in the “Limits of Permissible Excavation in River” (USACE, 1974). However, the excavation plan proposed for Borrow Areas MR-B-09 still meets or exceeds the minimum standards set forth in the document.

#### 6.1.5 MR-B-09 Tier I Contaminant Analysis

The purpose of the Tier I Analysis is to establish the potential hazards of the proposed dredged material, as required by 40 CFR 230.60. A Tier I Analysis can be completed either by assessing the applicability of exclusion criteria, by compiling data to determine that the dredge material is not a carrier of contaminants, or by evaluating further tiers in order to ascertain the environmental characteristics associated with the dredge material.

In order to meet the appropriate exclusions, at least one of the following criteria must be met:

- The dredged material is composed primarily of sand, gravel, rock, or any other naturally occurring bottom material with particle sizes larger than silt. This material must be found in areas of high current or wave energy.

- The dredge material is for beach nourishment or restoration and is composed predominantly of sand, gravel, or shell with particle sizes compatible with material on the receiving beaches.

- The material proposed for discharge is substantially the same as the substrate at the discharge site, and the proposed dredging site is far removed from known existing and historical sources of pollution to provide reasonable assurance that such material has not been contaminated by such pollution.

Based on vibracore samples collected from MR-B-09, Criteria #1 is met because the borrow material is primarily composed of fine sand. Furthermore, the Mississippi River produces high currents, which has contributed to the production of the mid–channel sand bars and sand waves that comprise the source material in MR-B-09 (SJB and C-K, 2007).

Borrow Area MR-B-09 also met Criteria #2. The vibracore samples exhibited an average grain size of 0.16 mm. As previously stated, Scofield Island is assumed to have a native grain size of 0.14 mm (Section 4.1.2). Therefore, the material is compatible between the sediment source and the restoration area (SJB and C-K, 2007).

Based upon the information gathered from the Tier I Contaminant Analysis, it was determined that Borrow Area MR-B-09 met the exemption criteria based upon 40 CFR 230.60 (SJB and C-K, 2007).

### 6.1.6 MR-B-09 Design

The boundary of Borrow Area MR-B-09 has undergone a number of refinements from the initial configuration proposed in the Plan Formulation Phase. The primary change was the borrow area was shifted toward the center of the Mississippi River. This was done for three reasons. The first was to accommodate the required USACE setbacks. Second, there was some concern regarding the stability of the side slopes of the river. Third, a few of the vibracore samples indicated non-compatible material in the upper sediment layer within the original location.

Additional refinements were made to the boundary of the borrow area using the seismic data and sidescan imagery which showed the limits of sand wave bedforms and analysis of magnetometer data to develop buffers as avoidance areas around potential targets. The preliminary design plan and typical cross-sections for Borrow Area MR-B-09 are shown in Figure 6-1 and Figure 6-2, respectively.

The MR-B-09 refined plan is linear and narrow, extending around the river bend. It is approximately 14,700 feet long, the width ranges from 360 feet to 800 feet, and the thickness is up to 24 feet.

Historical water surface elevation data in the Mississippi River at Venice (USACE, 2009) demonstrates that the water elevation in the summer and fall typically fluctuates between +3 to +4 feet NAVD88. Assuming the nominal cut depth of the dredge plant anticipated to be utilized for Project construction is 70 feet below the water surface, the design depth of cut was determined to be -66 feet NAVD88. This will occur during periods of elevated water levels. Preliminary isopach studies conducted for this design cut depth indicate that Borrow Area MR-B-09 contains approximately 2.36 million cubic yards of sediment at -66 feet NAVD88.

During periods of low water levels, the maximum depth of excavation is –73 feet NAVD88, which includes an allowable overdredge of 3 feet. Overdredge is defined as a dredge cut section below (deeper than) the delineated sediment source. This section contains compatible sediments, identified through geophysical data analysis, that are permitted for use as a supplement if dredging losses are higher than expected. The estimated sediment volume at a depth of –73 feet NAVD88 is 3.77 million cubic yards. This volume represents the maximum volume available for excavation and will thus be used for cost estimates and permitting purposes.

The maximum available volume of 3.77 million cubic yards was refined based on the additional data collection and detailed design analyses in Preliminary Design, which replaces the original estimate of 5.5 million cubic yards presented in Section 4.1.1.

Based on the value engineering analysis (Section 9.8), the required excavation volume for the recommended beach and dune restoration plan on Scofield Island is approximately 2.44 million cubic yards. Due to the anticipated construction window extending through periods of high, average and low water, it is anticipated that Borrow Area MR-B-09 contains sufficient volume, up to 3.77 million cubic yards, of compatible sand for restoring the beach and dune system. A summary of the design parameters for MR-B-09 is presented in Table 6-2.

**Table 6-2: Summary of design parameters for MR-B-09**

| Parameter | Value |
|---|---|
| Average Grain Size | 0.16 mm |
| Borrow Area Length | 14,700 feet |
| Borrow Area Width | 360 to 800 feet |
| Borrow Area Thickness | 24 feet |
| Borrow Area Volume (-73 feet NAVD88)* | 3.77 mcy |

*Maximum depth of excavation (includes 3-foot overdredge)

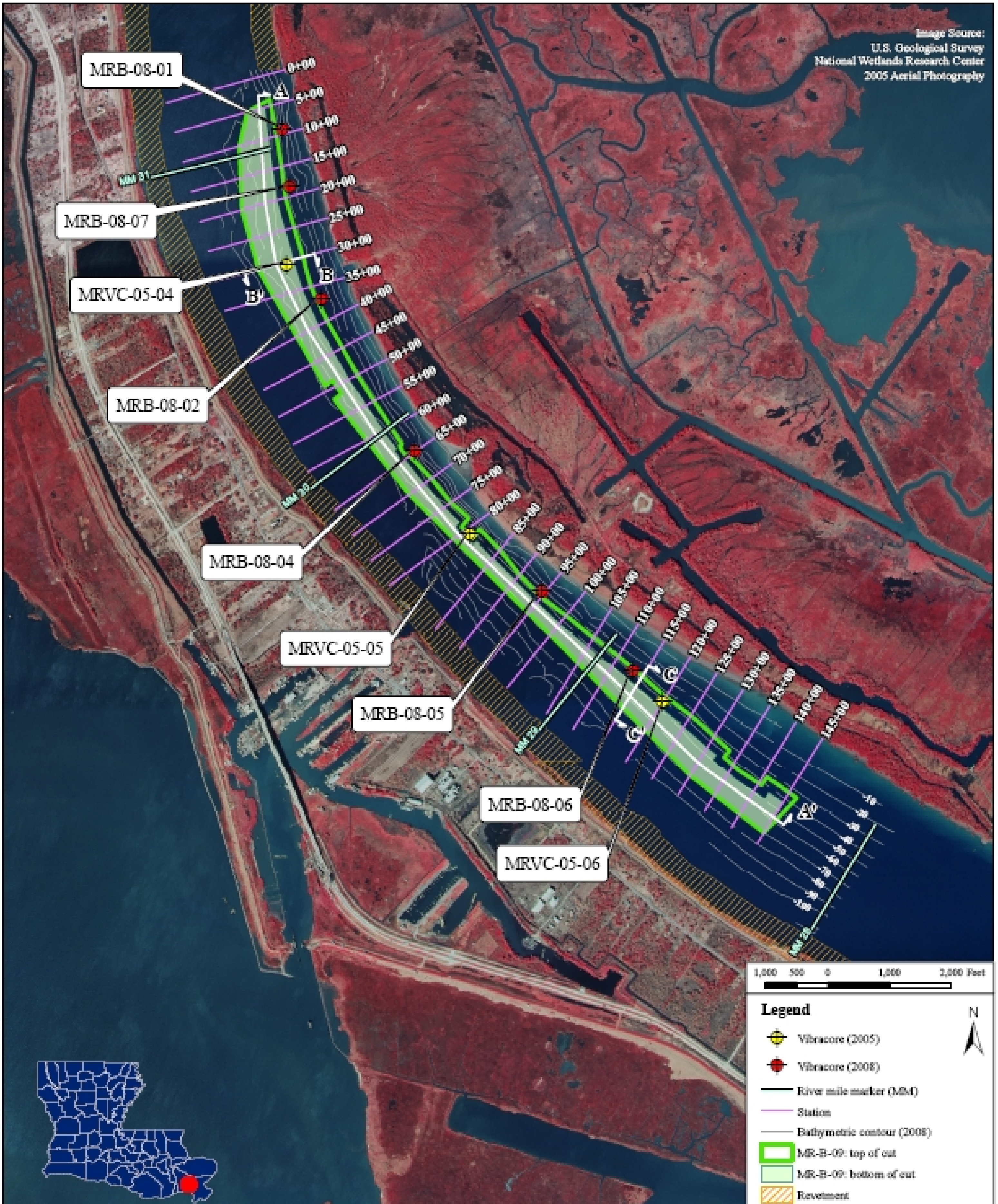


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**Figure 6-1**
**Preliminary Design:**
**Borrow Area MR-B-09 Design Plan**

| January 2010 | Project Number: BA-40 |
|---|---|

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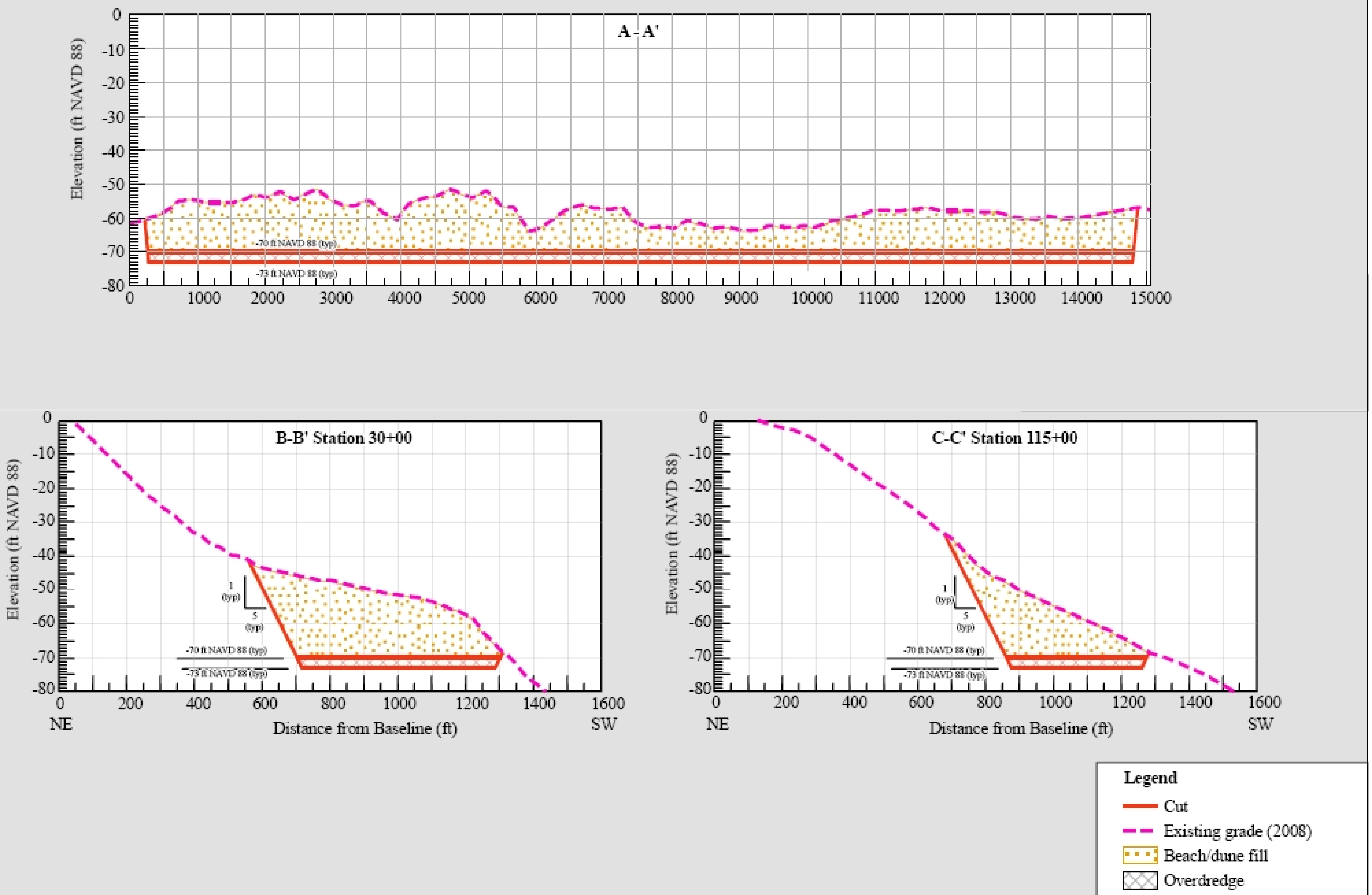


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# Figure 6-2
## Preliminary Design:
## MR-B-09 Typical Cross-sections

January 2010

Project Number: BA-40

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### 6.2 Borrow Area MR-E-09 Analysis

The preferred alternative that was recommended in the Feasibility Study consisted of dredging Borrow Area MR-E-09 using a hopper dredge and transporting the sand via the sediment pipeline in the Conveyance Corridor through the Empire Waterway. The following sections summarize the detailed geophysical and geotechnical surveys that were completed in support of the Preliminary Design for MR-E-09. A discussion of cultural resources and excavation considerations is also provided. The preliminary design for MR-E-09 is described at the end of the section.

#### 6.2.1 MR-E-09 Geophysical Analysis

The sidescan survey and magnetometer data were used to define sediment bedforms and to identify infrastructure and debris that could interfere with dredging operations. As reported by AOS (2009a), numerous scattered magnetic anomalies were found within the survey area. However, none of the anomalies showed a definitive alignment. The size and character of the anomalies is consistent with small scattered debris.

The sidescan sonar data identified sand waves with superimposed megaripples throughout most of MR-E except near the southwestern edge. Review of the subbottom profile data confirmed that the majority of the borrow area consists of sand waves with superimposed megaripples migrating downstream. The distribution of sand is generally uniform along the borrow area, with the main sand body thinning to the southwestern edge of the borrow area as the riverbed rapidly shoals. The surface sand waves provided a good guide in defining the borrow area perimeter along the shallow-water side of the river. The deep-water boundary of the borrow area was delineated to minimize dredging depths and impacts to vessel traffic.

#### 6.2.2 MR-E-09 Geotechnical Analysis

A review of historic sampling data collected within the vicinity of the borrow area (USACE, 1971) was conducted. The data confirmed that Borrow Area MR-E-09 contains good sand at depths up to and in excess of -70 feet NAVD88 for beach and dune reconstruction.

Vibracore data collected by CPE in 2005 was also included in the geotechnical analysis (Finkl et al., 2005). Two of the vibracores, MRVC-05-07/07A and MRVC-05-10, were collected within the borrow area. These two cores exhibited weighted-average grain sizes of 0.21 mm and 0.24 mm, which confirmed the presence of compatible sand.

To supplement these data, AOS collected seven additional vibracores along the western bank of the river (AOS, 2009b). The cores were transferred to CTC for processing and analysis (CTC, 2008 and 2009). Of the seven cores collected, two cores, MRE-08-10 and MRE-08-11, were selected for further analysis since they were collected within the boundary of the borrow area. These cores exhibited weighted average grain sizes of 0.15 mm and 0.16 mm.

Based on these two surveys, an average grain size of 0.19 mm was computed for the noncohesive sediments in MR-E-09 (Table 6-3). The data also suggest that approximately 98.8% of the material is comprised of fine sand, i.e. greater than or equal to a minimum sand grain size of 0.0625 mm.

**Table 6-3: Grain characteristics of cores collected in MR-E-09**

| Core | Collected by: | Weighted Mean Grain Size (mm) | Weighted % Sand (230)* |
|---|---|---|---|
| MRVC-05- | CPE, 2005 | 0.24 | 99.6 |
| MRVC-05-10 | CPE, 2005 | 0.21 | 98.4 |
| MRE-08-10 | AOS, | 0.16 | 99.1 |
| MRE-08-11 | AOS, | 0.15 | 98.1 |
| Average | | 0.19 | 98.8 |

*Wentworth Size Class, minimum sand grain size 0.0625 mm, #230 sieve size

MR-E-09 is characterized by sand bounded by prodelta and interdistributary silt and clays on the western bank. The main body of sand thins to the west of the borrow area near the shoreline. It then extends beyond the southeastern limits of the borrow area, eventually dropping off into deeper water. The main sand body is covered in sand waves with superimposed megaripples. The sediments are cross-bedded due to active bedform migration in the down-current direction (AOS, 2009a).

Based on the geophysical and geotechnical data and grain size analysis, the sediments are compatible with the native beach sediments and are suitable for use in restoring the beach and dune system on Scofield Island.

### 6.2.3 MR-E-09 Cultural Resource Impacts

The preliminary assessment of cultural resources for Borrow Area MR-E-09 was also conducted as part of the Feasibility Study Phase and followed reporting guidelines established by the LDRCT (SJB and ARI, 2007) (Section 4.1.7). As stated in the

Feasibility Study Report (SJB and CEC, 2008), twenty-nine wrecks, derelicts, and well locations were recorded in the general vicinity of MR-E-09. Of these twenty-nine targets, only one historic pipeline (found in 1978) was identified within 500 feet of the borrow area boundary. Subsequent surveys conducted by AOS (2009a) revealed numerous scattered magnetic anomalies near the borrow area. The size and character of the anomalies suggests that they are small scattered debris. Further detailed cultural resources surveys of MR-E-09 are currently under consideration by OCPR and NOAA Fisheries.

### 6.2.4 MR-E-09 Excavation Standards

Borrow Area MR-E-09 is situated along the western bank of the Mississippi River. Since the borrow area is adjacent to a levee, it is constrained by the permissible excavation limits defined in the standards for excavation in the Mississippi River document titled "Limits of Permissible Excavation in River" (USACE, 1974). Based on review of the document, it was determined that the excavation plan proposed for Borrow Areas MR-E-09 meets or exceeds these minimum standards.

### 6.2.5 MR-E-09 Tier I Contaminant Analysis

As previously stated, the purpose of the Tier I Analysis is to establish the potential hazards of the proposed dredged material in accordance with 40 CFR 230.60. A Tier I Analysis requires an analysis of existing geotechnical data to characterize the physical properties of the material. The dredge material can be excluded from further testing if at least one of the following criteria must be met:

- The dredged material is composed primarily of sand, gravel, rock, or any other naturally occurring bottom material with particle sizes larger than silt. This material must be found in areas of high current or wave energy.

- The dredge material is for beach nourishment or restoration and is composed predominantly of sand, gravel, or shell with particle sizes compatible with material on the receiving beaches.

- The material proposed for discharge is substantially the same as the substrate at the discharge site, and the proposed dredging site is far removed from known existing and historical sources of pollution to provide reasonable assurance that such material has not been contaminated by such pollution.

Similar to MR-B-09, sediment from MR-E-09 met Criteria #1 because the borrow material is primarily composed of fine sand and is subject to high currents (SJB and C-K, 2007).

Borrow Area MR-E-09 also met Criteria #2. The sediment collected from the borrow area exhibited an average grain size of 0.19 mm, which is compatible with native sands (average grain size of 0.14 mm) at Scofield Island (SJB and C-K, 2007).

Based upon the information gathered from the Tier I Contaminant Analysis, it was determined that Borrow Area MR-E-09 also met the exemption criteria based upon 40 CFR 230.60 (SJB and C-K, 2007).

#### 6.2.6 MR-E-09 Design

As with MR-B-09, the boundary of Borrow Area MR-E-09 has undergone a number of refinements from the initial configuration proposed in the Plan Formulation Phase. These refinements were based on the detailed seismic and sidescan imagery which showed the limits of sand wave bedforms, vibracore data, and analysis of magnetometer data to develop buffers as avoidance areas around potential targets. The preliminary design plan and typical cross-sections for Borrow Area MR-E-09 are shown in Figures 6-3 and 6-4, respectively.

The MR-E-09 refined plan is a regular rectangular box in form and is approximately 9,500 feet long, 1,100 feet wide, and 25 feet thick.

By applying a potential water fluctuation of +4 feet and assuming a nominal cut depth for the dredge plant anticipated to be utilized for Project construction of 70 feet below the water surface, the design depth of cut was determined to be -66 feet NAVD88 during periods of high water. Preliminary isopach studies conducted for this design cut depth indicate that Borrow Area MR-E-09 contains approximately 3.86 million cubic yards of sediment at -66 feet NAVD88.

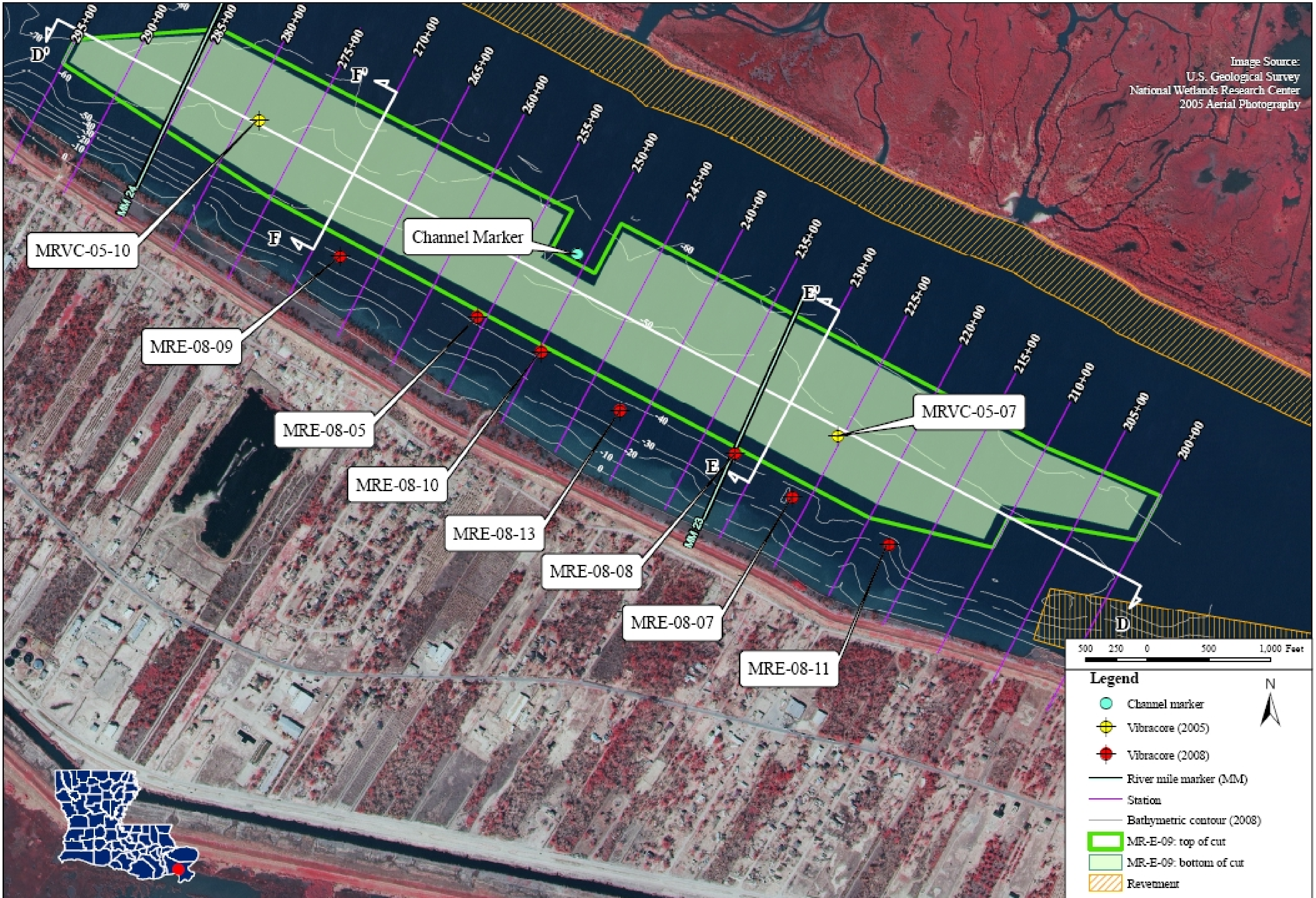
During periods of low water levels, the maximum depth of excavation is –73 feet NAVD88, which includes an allowable overdredge of 3 feet. The estimated sediment volume at this depth is 5.86 million cubic yards. This volume represents the maximum volume available for excavation and will thus be used for cost estimates and permitting purposes. The maximum available volume of 5.86 million cubic yards was refined based on the additional data collection and detailed design analyses in Preliminary Design, which replaces the original estimate of 7.4 million cubic yards presented in Section 4.1.1.

Based on the value engineering analysis (Section 9.8), the required excavation volume for the recommended beach and dune restoration plan on Scofield Island is approximately 2.44 million cubic yards. Based on the Preliminary Design, MR-E-09 contains sufficient volume, up to 5.86 million cubic yards, of compatible sand for restoring the beach and dune system. A summary of the design parameters for MR-E-09 is presented in Table 6-4.

**Table 6-4: Summary of design parameters for MR-E-09**

| Parameter | Value |
|---|---|
| Grain Size | 0.19 mm |
| Borrow Area Length | 9,500 feet |
| Borrow Area Width | 1,100 feet |
| Borrow Area Thickness | 25 feet |
| Borrow Area Volume (-73 feet | 5.86 mcy |

*Maximum depth of excavation (includes 3-foot overdredge)




COASTAL ENGINEERING CONSULTANTS INC.

# Figure 6-3
## Preliminary Design:
## Borrow Area MR-E-09 Design Plan

January 2010 | Project Number: BA-40

SJB GROUP, LLC
QUALITY BY DESIGN
P.O. BOX 1751 PHONE: (225) 769-3400
BATON ROUGE, LA. 70821 FAX: (225) 769-3596

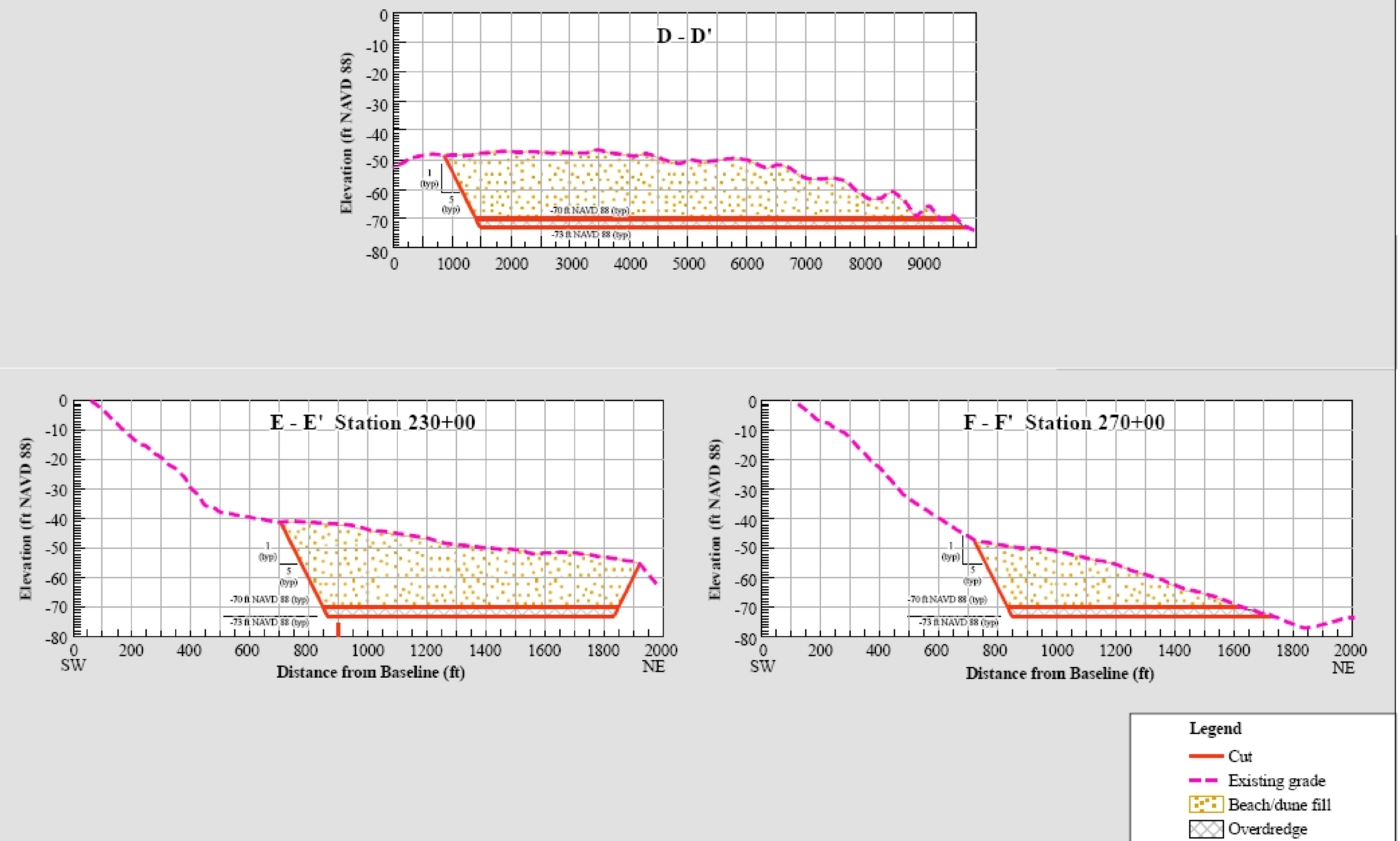



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**Figure 6-4**
**Preliminary Design:**
**MR-E-09 Typical Cross-sections**

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### 6.2.7 Mississippi River Modeling

In order to assess the potential impacts of the mining operations on the Mississippi River, a review of permits for similar projects was conducted (Section 3.3). According to the documents, neither hydraulic modeling nor post-construction impact assessments were required for any of the sand mining projects. However, the excavation volumes identified in the documents ranged from 75,000 cubic yards to 1.2 million cubic yards annually, which is considerably smaller than the volume needed for the Project. Based on the uncertainty involved with mining such large quantities of sand from the Mississippi River, a one-dimensional numerical model was recommended to quantify the potential changes in river hydrodynamics caused by excavation and to assess the resulting impacts on nearby infrastructure, revetments, anchorages, and other navigational interests.

### 6.2.8 Model Configuration

The Hydrologic Engineering Center – River Analysis System (HEC-RAS) version 4.0 was used to perform the one-dimensional modeling efforts. The model is designed to calculate the water surface elevations and discharges at selected locations along an open channel. The following sections describe the inputs and conditions that were applied to the model.

#### 6.2.8.1 Model Domain

Two different model domains were used to assess the impacts of dredging on the flow and sediment regimes of the Mississippi River. The larger scale model domain extended from Venice at MM 10.7 AHP to Tarbert Landing at MM 306 AHP, while the smaller scale model extended from Venice at MM 10.7 to Belle Chasse at MM 76.0 AHP.

#### 6.2.8.2 Channel Geometry

The bathymetric data used to simulate the channel geometry were based on 2003 single-beam surveys coordinated by the USACE. A total of 1,044 cross-sections of the Mississippi River between Venice and Tarbert Landing were extracted from the field surveys. The data covered a length of approximately 295 miles. The modeling team also used the 2000 LIDAR surveys as well as the USGS Digital Elevation Maps in order to capture the topographic features of the flood plain and to map the levee crests. Additional USACE cross-sections were incorporated into the model to simulate the erosion of the earthen sill for the period 1999 to 2000,

#### 6.2.8.3 Boundary Conditions

The daily hydrographs of water and sediment discharges measured at the USACE Tarbert Landing gage were used as upstream boundary conditions while daily water stage values measured at USACE Venice gage were used as downstream boundary condition. The Tarbert Landing and Venice gages are located at MM 306 AHP and MM 10 AHP, respectively.

#### 6.2.8.4 Initial Conditions

The thalweg line used in the HEC-RAS model was based on the 2003 survey data. Although the hydrodynamics and turbulence associated with irregular cross-sections were not addressed in the model, they are not believed to undermine the integrity of the analysis.

An initial Manning's roughness coefficient (Manning's n) of 0.030 was chosen for the reach between MM 306 and MM 50.2 AHP while 0.022 was used for the reach between MM 49.8 and MM 10.2 AHP.  Different roughness coefficients were used to reflect the fact that the bottom material of the Mississippi River gets finer in the downstream direction.  The coefficients were also varied based on flow rates.  Specifically, the correction factors used to adjust the roughness coefficients varied from 0.88 for a flow of 150,000 cubic feet per second to a value of 0.60 for flows equal to or greater than 1,050,000 cubic feet per second.

The initial size-class distribution of the sediment bottom material was assumed to be 20% very fine sand (0.0625 to 0.125 mm), 60% fine sand (0.125 to 0.25 mm) and 20% medium sand (0.25 to 0.5 mm) with an average value 0.19 mm.  These values were assumed based on reviews of historical sediment data.

### 6.2.9 Model Calibration and Validation

The Manning's n and the associated adjustment factors (relating Manning's n to the flow rate) were calibrated for the year 2003 in quasi-unsteady flow mode.  The final Manning's n value of 0.030 was assigned to the reach between MM 306 and 50.2 AHP, and a value of 0.022 was assigned to the reach between MM 49.8 and 10.2 AHP.  The final adjustment factor varied from 0.88, for a flow of 150,000 cubic feet per second, to a value of 0.60 for flows equal to or greater than 1,050,000 cubic feet per second.

A second independent simulation was performed from 1999 to 2000 without any further adjustments to the hydrodynamic model parameters to validate the model's performance. The results from the model were found to be consistent with water surface elevations recorded at Red River Landing (MM 302.8 AHP), Baton Rouge (MM 228.5 AHP), Bonnet Carré (MM 127.1 AHP) and West Pointe a La Hache (MM 48.8 AHP).

After the hydrodynamics had been calibrated and validated, effort was directed to calibrate the sediment module for the targeted section of the Mississippi River. Field data available at Belle Chase were compared with the model results for the period of 1978-1979. The calibration was initially performed with the Ackers-White sediment transport and the Toffaleti fall velocity formulas. Other sediment transport formulas, including the Engelund-Hansen, were also tested. Overall, the Engelund-Hansen gave the most favorable results when compared to the field measurements and was thus used as the sediment discharge predictor.

Three water years were used to validate the model for sediment transport: 1977 to 1978, 1979 to 1980, and 1992 to 1993. The annual sediment loads calculated by the model varied between approximately 50% and 165% of the estimated annual load based on field data. Considering the scarcity of the field data and the challenges associated with sediment transport predictions, these results are considered to be reasonable, as the error does not exceed a factor of 2. A review of relevant literature revealed that sediment load estimates between 200% and 50% of the field measurements are acceptable (Van Rijn, 1982).

### 6.2.10 Model Results

To assess the impact of dredging, three simulations were performed; one with no dredging (Base Run), a second with only MR-B-09 dredged, and a third with only MR-E-09 dredged. The results of the modeling efforts indicate that local deposition was predicted at both borrow areas. Although the model predicted erosion downstream of both borrow areas, it was contained within a short distance of 0.5 to 1 mile in each case. The model also predicted minor erosion upstream (head-cutting) of MR-E-09. Overall, the bed changes predicted by the HEC-RAS model were in the same order of magnitude as the migrating bed forms in the Lower Mississippi River, therefore they were considered to be within the range of the natural variability exhibited by seasonal changes in flow rates.

Immediately after dredging, the model predicted a 10% decrease in the average velocity at both borrow areas. As the borrow areas started to aggrade over the two-year simulation period, the change in velocity declined to within 5% of the Base Run.

The numerical modeling results showed that both borrow areas exhibited similar responses to dredging. However, it should be noted the one-dimensional models provided total quantities of erosion and deposition and that spatial transverse distributions cannot be inferred. Moreover, the one-dimensional numerical model did not provide quantitative pictorials of local hydraulics at the river bends.

In summary, excavation of the two borrow areas yielded subtle changes in river hydrodynamics on the same order of magnitude as natural variability in the river. The model results provide reasonable assurance that mining these borrow areas will not result in negative impacts to river hydrodynamics. Based on the modeling results, it was concluded there was no need to perform two- or three-dimensional numerical modeling analyses to further assess the potential impacts of dredging MR-B-09 or MR-E-09.

# 7.0 CONVEYANCE CORRIDOR

This chapter summaries the design level surveys and environmental evaluations and presents the preliminary design plans and details for the Conveyance Corridor which shall serve as the route for the sediment pipeline to transport sand from the Mississippi River Borrow Areas to the Scofield Island Restoration Area. Design level surveys were conducted to complement the Feasibility Study surveys to assist in the design. The corridor plan was refined in preliminary design to provide maximum flexibility at the time of construction including the use of MR-B-09 and/or MR-E-09, and the use of a hydraulic cutterhead dredge and/or a hopper dredge. Further, the Conveyance Corridor was configured to minimize issues associated with environmental impacts, infrastructure conflicts, land ownership, oyster leases, and costs.

The Conveyance Corridor includes two segments. The Upland Segment is approximately 1,120 feet wide and extends approximately one mile from the western bank of the Mississippi River in Empire, Plaquemines Parish, southwest to the rock breakwater at the Empire Locks. The Over Water Segment is approximately 8.8 miles long, beginning at the Empire Locks and extending south through the Empire Waterway, crossing the eastern side of Caprien Bay, and entering the Gulf of Mexico through the jetties just west of Pelican Island.

The surveys and analyses completed in support of the Preliminary Design Phase for the corridor included the Conveyance Corridor Survey – Upland Segment (Appendix F), Conveyance Corridor Survey – Over Water Segment (Appendix G), Environmental Mapping of the Conveyance Corridor and Scofield Island (Appendix H), and Conveyance Corridor Design Analysis (Appendix I).

## 7.1 Design Level Survey

### 7.1.1 Upland Segment Survey

SJB conducted a design level survey on the terrestrial portion of the Upland Segment between the Mississippi River and Empire Waterway (Appendix F). Additional data were collected along the northwestern edge of the corridor to better define the elevations and locations of features that represent potential engineering constraints. These included the Mississippi River Batture and Levee, Highway 11, Empire Pit (Hurricane Katrina landfill), Empire/Doullut Canal, Empire Boat Harbor, Highway 23, Hurricane Protection Levee, a saltwater marsh, and a rock breakwater at the edge of the Empire Waterway adjacent to the locks.

Existing monuments and field control were used to establish a horizontal and vertical control network to establish additional monuments and controls relative to North American Datum 1983 and NAVD88. An existing LDNR monument for the Empire Waterway Route survey was utilized to establish a new deep-rod secondary monument following the protocols established in "A Contractor's Guide to Minimum Standards" (LDNR, 2007).

### 7.1.2 Empire Waterway Survey

Additional bathymetric, magnetometer, and pipeline probing surveys were conducted by CHF on the Open Water Segment from the Empire Locks to the Gulf of Mexico through the Empire Waterway to supplement survey data that was collected during the Feasibility Study Phase. This information is detailed in Appendix G and was used for the preliminary design of the Conveyance Corridor. Benchmark control points for the surveys were provided by SJB.

The bathymetric survey involved performing a localized rectangular grid survey at each of the significant points of interest, including the proposed booster pump sites, intersecting navigation channels, and petroleum pipeline crossings. Additional bathymetry data were also collected along the western boundary of the Empire Waterway during the magnetometer surveys. The newly collected data were then combined with the data collected during the Feasibility Study to construct bottom profiles of the Empire Waterway.

The bottom elevation profiles indicated that the elevation of the channel bottom generally ranges from -10 to -14 feet NAVD88. However, some areas especially in the southern portion, were as deep as -15 to -18 feet NAVD88.

Cross-sectional data were collected at each of the proposed booster pump sites and at the confluences of the navigation crossings. According to the profiles, the two booster pump sites that were surveyed could accommodate the installation of the booster pumps and their associated cooling mechanisms based on the design criteria for water depth of -8 feet NAVD88.

The magnetometer survey was conducted along the western boundary of the Empire Waterway. The data revealed several hundred magnetic anomalies over the survey grid. An alignment correlation was performed using the new and old data to define possible petroleum pipeline signatures and to identify areas requiring physical probing verification. Based on the correlation analysis, the anomalies that could have a possible impact on the sediment pipeline were probed to a depth of at least 10 feet below the channel bottom.

A number of petroleum pipelines were encountered during the physical probing. Each of the petroleum pipelines was buried at a depth greater than 6 feet with the exception of one pipe that was found at a depth of 2 feet. One of the pipelines that was identified crossed the Empire Waterway near its intersection with a side access channel. This 26-inch pipeline, referred to as the Tennessee Gas Pipeline (TGP), was buried at depths of 11 feet and 13 feet at the two probe location where it was encountered. However, the pipeline owner is only requiring an 18-inch buffer between the TGP and the sediment pipeline.

### 7.2 Environmental Impact Assessment

C-K conducted an environmental mapping survey of the Empire Waterway Route (SJB and C-K 2009) to identify wetlands, ecologically sensitive areas, and hazardous materials that could potentially be encountered along the Conveyance Corridor. This information is detailed in Appendix H. The survey along the corridor was divided into six regions:

- Region 1: Mississippi River Batture
- Region 2: Mississippi River Levee to Highway 11
- Region 3: Highway 11 to Empire Canal Spoil Bank
- Region 4: Empire Canal Spoil Bank to Highway 23
- Region 5: Highway 23 to the Rock Breakwater
- Region 6: Rock Breakwater to Scofield Island

The following sections discuss the findings in each of the regions.

#### 7.2.1 Region 1 - Mississippi River Batture

No visible hazards or ecologically sensitive areas were observed in Region 1. However, the batture between the Mississippi River and Mississippi River Levee was assessed as potential wetlands (SJB and C-K, 2009).

Due to complete inundation, soil hydrology and hydric soil data were not collected. The soil unit for the Mississippi River batture is Convent (CV), which includes three hydric soil types: Convent, Commerce, and Sharkey, which are frequently flooded, mineral, poorly drained soils (NRCS, 2008).

### 7.2.2 Region 2 - Mississippi River Levee to Highway 11

No ecologically sensitive areas were observed in Region 2. However, a number of visible hazards were identified, including a natural gas line paralleling Highway 11 and a hurricane fence. Both hazards bisected the route. A fire hydrant line was also found just north of Highway 11 (SJB and C-K, 2009).

Soil hydrology sampling indicated an absence of primary and secondary hydrologic indicators (>16 inches). Furthermore, the degree of compaction and the presences of oyster shells suggested the material overlaying the sampling point was historic fill material (SJB and C-K, 2009). The mapped soil unit was Commerce (CM), which is hydric, poorly drained, mineral soil in intermediate positions along the natural levees of the Mississippi River (NRCS, 2008)

### 7.2.3 Region 3 - Highway 11 to the Empire Canal Spoil Bank

Region 3 primarily consisted of a fenced landfill (Empire Pit) that was filled and capped. Prior to conducting the field survey, the SJB Team contacted Mr. Robert Thomas of the Louisiana Department of Environmental Quality (LDEQ) to determine that nature and status of the landfill. Mr. Thomas stated that the landfill is classified as a temporary disposal site and contained construction and demolition debris from Hurricane Katrina. Furthermore, Mr. Thomas stated that a sediment pipeline could be placed across the surface of the landfill without posing an environmental risk (Thomas, 2007). The SJB Team followed up with a telephone interview with Ms. Albertine Kimble, the Louisiana Coastal Zone Program Manager at Plaquemines Parish. Ms. Kimble stated that Plaquemines Parish would not be opposed to placing the temporary pipeline across the landfill (Kimble, 2007).

A shallow drainage canal was observed along the western side of the landfill. The northern boundary of the landfill consisted of a drainage ditch. At the west end of the landfill, there was a pile of exposed debris (outside of the fence) that was not covered by the landfill cap. Most of this debris consisted of household materials and commercial fishing nets. There also appeared to be an underground waterline running along the northern portion of the region, which services fire hydrants and an adjoining trailer park. No ecologically sensitive areas were observed in the region (SJB and C-K, 2009).

Soil hydrology analysis indicated an absence of primary and secondary hydrologic indicators (SJB and C-K, 2009). The mapped soil unit was Shriver (SK - Sharkey clay), which is hydric, level, poorly drained, mineral soil in low positions along the natural levees of the Mississippi River (NRCS, 2008).

### 7.2.4 Region 4 - Empire Canal Spoil Bank to Highway 23

The Empire Boat Harbor is located in Region 4. The surface of the area was compacted and improved with parking lots, boat docks, and municipal utilities consisting of water and electricity. Three fire hydrants were also seen in the region. The utility lines and fire hydrants are potential hazards that should be avoided. The survey team also identified an undisturbed, inter-tidal saltwater marsh in Region 4. The saltwater marsh represents an ecologically sensitive area (SJB and C-K, 2009).

Soil samples were not collected due to tidal inundation in the saltwater marsh and soil compaction in the Empire Boat Harbor (SJB and C-K, 2009). The mapped soil unit was dredged Aquents (AN), which are hydric, hydraulically dredged; poorly drained soils (NRCS, 2008).

### 7.2.5 Region 5 - Highway 23 to the Rock Breakwater

Visible hazards in Region 5 included a rock dike on the outside of the Empire Waterway Flood Control Structure, which will be crossed by the pipeline. A high saltwater marsh and inter-tidal saltwater marsh were also observed in Region 5. These areas represent ecologically sensitive areas (SJB and C-K, 2009).

The inter-tidal saltwater marsh soil hydrology was inundated and tidally dynamic and therefore could not be sampled (SJB and C-K, 2009). The high saltwater marsh soils were mapped as dredged Aquents. The inter-tidal saltwater marsh soils were mapped as dredged, frequently flooded Aquent soils (AT), which are hydric, hydraulically dredged, poorly drained soils (NRCS, 2008).

### 7.2.6 Region 6 - Rock Breakwater to Scofield Island

Region 6 consisted of two basic habitat components; open water and remnant inter-tidal saltwater marsh islands. Fragmented saltwater marsh islands and oyster beds were observed in the region. Both are considered to be ecologically sensitive areas (SJB and C-K, 2009).

Throughout Region 6, the Empire Waterway was lined on both sides with oyster leases. Also noted were pipeline bulkheads and riprap protection (SJB and C-K, 2009). These features represent the numerous hazards in the region that must be avoided.

Soil samples were not collected from the saltwater marsh or the oyster leases. The mapped soil units included Belle Passe (BE), Scatlake Muck (SC), and Timbalier Muck (TM), which are hydric soils (NRCS, 2008). Bell Passe soils are level, organic, poorly drained soils in tidal saltwater marshes. Scatlake muck soils are level, mineral, poorly drained soils in tidal saltwater marshes. Timbalier muck soils are level, organic, and very poorly drained soils in saltwater marshes.

## 7.3 Conveyance Corridor Design

Information gathered from the design-level surveys and environmental mapping efforts described above was used to develop a Conveyance Corridor alignment that would avoid hazards and impacts to ecologically sensitive areas while minimizing costs and construction complexities (Figure 7-1). The preliminary design for the Conveyance Corridor provides the contractor with considerable flexibility in choosing the borrow area (MR-B-09 and/or MR-E-09) and the dredging method (hydraulic cutterhead dredge and/or large hopper dredge).

### 7.3.1 Upland Segment

The Upland Segment of the Conveyance Corridor begins at the pump-out site for MR-B-09 or booster pump site for MR-E-09. The sediment pipeline will then cross the riverbank of the Mississippi River at approximately MM 28.9 AHP, a location determined primarily on the basis of land ownership. From this point the Conveyance Corridor extends in a general southwesterly direction for just under one mile to the Empire Waterway. In order to reach the Empire Waterway, the sediment pipeline will cross the Mississippi River Levee as an above ground pipeline. Once over the levee, the sediment pipeline will be routed beneath Highway 11 (which is a two-lane highway) and Highway 23 (which is a four-lane highway) by jack and bore. The sediment pipeline will then surface and cross the Hurricane Protection Levee as an above ground pipe.

The property along this route consists of the closed hurricane debris landfill operated by the PPG, the Empire Boat Harbor, Empire Harbor Canal, and a small area of marsh or the rock revetment at the head of the Empire Waterway. While seemingly complicated, much of the property is owned by the PPG, which will reduce the real estate complexity of the project. The primary design constraints that were identified were the levee, highway, and canal crossings.

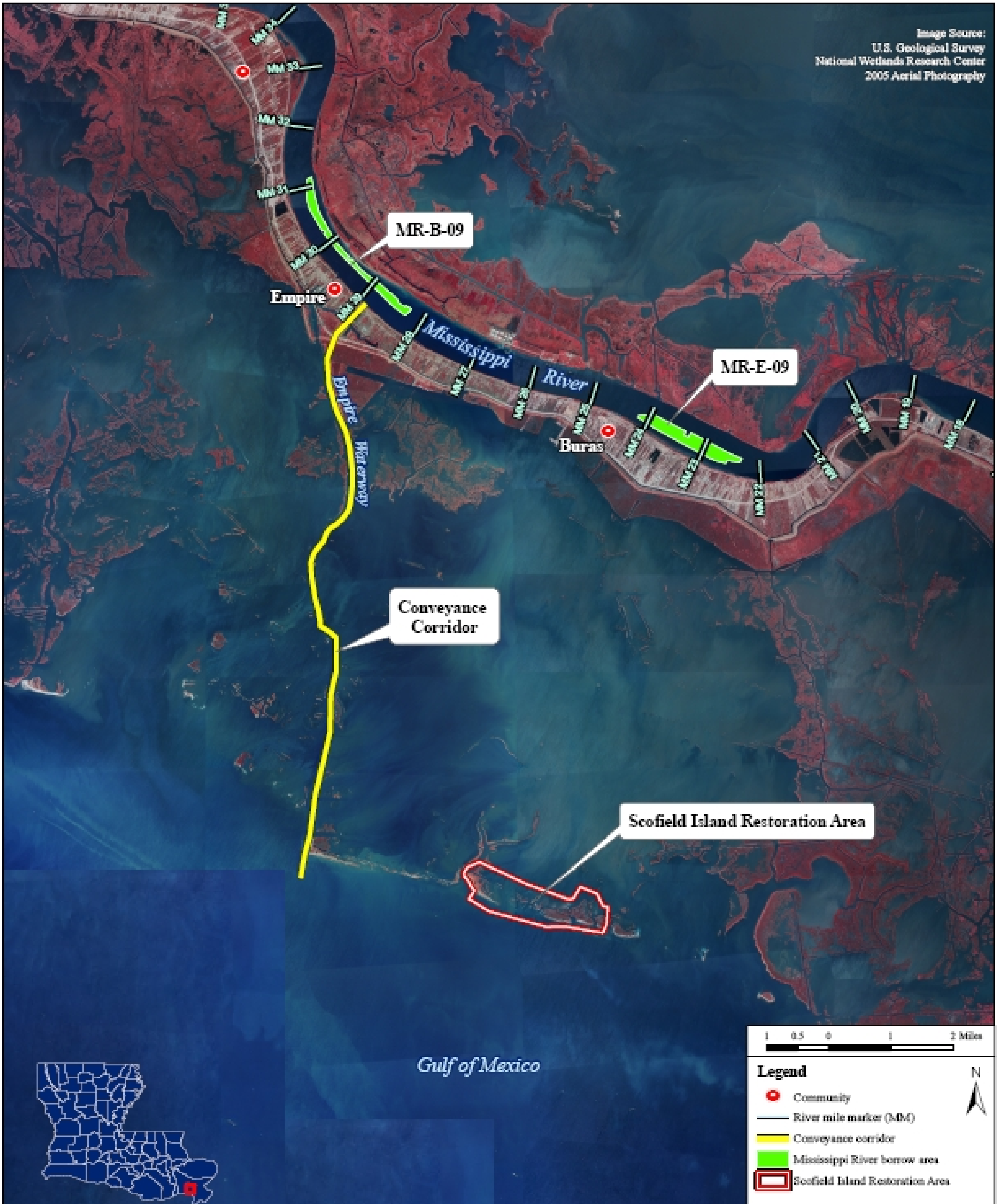


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**Figure 7-1**
**Preliminary Design:**
**Conveyance Corridor Design**

January 2010

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The Preliminary Design accounted for the detailed evaluation of the regulatory and engineering constraints associated with each of these features in the Feasibility Report (SJB and CEC 2008). This evaluation was based on the assumption that a 30-inch steel pipe would be used for the sediment pipeline and a 42-inch casing would be used for the highway crossings. The following sections summarize the evaluation of these constraints.

#### 7.3.1.1 Levee Crossings

Pipeline crossings over the Mississippi River and Hurricane Protection Levees are a fairly common occurrence. Mississippi River Levee crossings are under the jurisdiction of the USACE while the PPG maintains and has regulatory authority over the Hurricane Protection Levee. The permitting procedures in place for Hurricane Protection Levee crossings involve a technical review by Operations Division of the USACE and issuance of a letter of findings to the PPG who ultimately issues the levee-crossing permit. The USACE has developed specific requirements for pipeline crossings that serve to insure that the levee's structural integrity is not compromised. The PPG is concerned with access for continued patrolling and maintenance of the levee systems.

#### 7.3.1.2 Highway Crossings

Based on the regulatory and engineering constraints, minimum distances and required work areas were calculated to jack and bore under each of the highways. Distances between bore and receiving pits for highway crossings extended from the roadside ditch or from the toe of the highway embankment. Crossings for roadways adjacent to a levee crossing will require placement of the larger boring pit on the opposite side of the highway from the levee.

#### 7.3.1.3 Empire Harbor Canal Crossing

Navigation traffic in the canal consists mainly of the commercial menhaden fishing fleet operated by Daybrook Fisheries, Inc. A fully loaded menhaden purse seine boat requires approximately 12 feet to 15 feet of water (Wallace, 2007). Therefore, the sediment pipeline will have to be installed at a depth so that it does not hinder navigation.

### 7.3.2 Open Water Segment

The sediment pipeline will then parallel the Empire Waterway to the coastline of the Gulf of Mexico. The pipeline is expected to cross 28 petroleum pipelines. However, the 26-inch TGP was the only pipeline that was considered to be a potential hazard since it crossed the Empire Waterway near the intersection of the waterway and an access channel.  Based on discussions with the pipeline owner, the TGP will be protected with an 18-inch buffer. The sediment pipeline will be placed in a manner to provide for local navigational crossings at the six navigation crossings along the Empire Waterway.

From the mouth of the Empire Waterway, the pipeline will then extend into the Gulf of Mexico at a water depth that will not hinder vessel navigation. From this point the sediment pipeline will proceed eastward to Scofield Island. The portion of the Conveyance Corridor that extends from the mouth of the Empire Waterway, through the Gulf of Mexico to Scofield Island shall be considered in Final Design. This segment shall be subject to state and federal regulations and notification requirements.

The total transport distance ranges from 19 to 24 miles, depending on which borrow area will be utilized.  Two booster pump sites will likely be required in the Empire Waterway and one in the Mississippi River near MM 28 AHP if MR-E-09 is utilized.  Specific features of the Conveyance Corridor including the alignment for each segment, primary and secondary locations for booster pump sites, topographic and bathymetric data, and infrastructure are presented on the Preliminary Design Plans at the end of the Report.

Should the neighboring restoration project at Pelican Island (BA-38) be constructed, the sediment pipeline for Scofield Island could pass on the northern side of Pelican Island through the contractor access channels. The sediment pipeline would then turn in an easterly direction approximately 500 feet north of the jetties near the mouth of the Empire Waterway and cross the landward portion of Pelican Island as an above ground pipe.  The sediment pipeline would then cross beneath Scofield Bayou and link to the access channel for the Scofield Island Restoration Area (Appendix M). This alternative is recommended for further evaluation during the Final Design Phase.

# 8.0 SCOFIELD OFFSHORE BORROW AREA

This chapter presents the preliminary design plans, cross-sections, and available mixed sediment volumes for the SOBA that will be used to supply sediment for the restoration of the back-barrier marsh at Scofield Island. Geotechnical and geophysical analyses were performed using existing data to design the borrow area (Appendix J). Numerical modeling simulations were performed to assess potential impacts of mining the borrow area on adjacent shorelines.

The mixed grain size sediment excavated from the SOBA will be used to restore the natural soil of the marsh habitat on Scofield Island. A marsh platform will be constructed using the borrow area sediments to provide a future foundation for overwash beach and dune sediments during continued natural rollover processes during storms. The platform will also be designed to provide the optimal elevation for vegetation colonization. The marsh fill sediment will be compatible with the native vegetation and the native organisms that are supported by the marsh substrate.

## 8.1 Geophysical and Geotechnical Analysis

Previous offshore geotechnical and geophysical surveys had been conducted throughout the Barataria Basin area to evaluate potential sediment sources that could be used for beach and dune restoration (CPE, 2003a). Of the areas that were investigated, one was selected for further consideration because of its proximity to Scofield Island for a hydraulic cutterhead dredge to excavate and directly pump the sediment to the island. Analysis of the geotechnical and geophysical data indicated that this area contained an adequate volume of mixed sediment to create the marsh platform at Scofield Island.

CPE obtained five vibracores from the approximate location of the SOBA. The uppermost (overburden) stratum of all five cores consisted of clay. The other, less dominant strata were described as silt, silty sand, sandy silt, silty clay, clayey sand, and alternating mixtures. The composite data exhibited an average grain size of 0.10 mm, which is fine sand. However, the sediment in the cores ranged from fine sand to clay. The percent of silt ranged from 18.3 to 43.4%. This stratigraphic variability of silty sand, reinforced by the presence of the clay overburden suggested that the sediment, when mixed by the cutterhead dredging operations, will be appropriate for use as marsh fill on Scofield Island.

The bathymetry of the SOBA indicates that the ocean floor has low relief with minor changes in water depths from -18 to -20 feet NAVD88. The sidescan sonar survey in this area revealed a featureless surface, thus providing reasonable assurance that there are no surface areas of environmental concern or other man-made obstructions that might be adversely impacted by the dredging activities from the area indicated. Furthermore, the water depth is shallow enough to accommodate cutter-head dredging operations.

Review of magnetometer data revealed a number of anomalies that were linearly correlated in the vicinity of the SOBA (CPE, 2003a). Further, the LDNR pipeline database indicated a pipeline in this approximate location. Therefore, the boundary of the SOBA was refined to provide a minimum 500-foot buffer relative to the top of cut from the anomalies. If deemed necessary, field probes will be conducted during the Final Design to confirm the presence or absence of the pipe along with coordinating the appropriate buffer distance with the pipeline owner.

## 8.2 Wave Refraction Analysis

In order to predict the potential impacts of excavating the SOBA on wave and sediment transport patterns, a Steady-State Spectral Wave Model (STWAVE) wave refraction analysis was performed. STWAVE is a steady-state finite difference model (Smith et al, 2001). This model simulates depth-induced wave refraction and shoaling, current-induced refraction and shoaling, depth and steepness induced wave breaking, diffraction, wind driven wave growth, wave-wave interaction, and white-capping that redistributes and dissipates energy in a growing wave field.

### 8.2.1 Data Inputs

A series of model simulations were performed using various wave conditions. These conditions varied from mild/regular to severe/storm conditions based on the statistical analysis of historic data. The analysis illustrates that there are three dominant directions that the waves enter the computational domain: 135.0°, 157.5° and 180.0° (clockwise from true North). These are considered to be average conditions and were evaluated as three separate simulations in the model. Two storm conditions (the 1-year and the 20-years storms) were also simulated. The associated parameters for the five simulations, including offshore wave weight, offshore wave period, wind speed, and water stage are presented in Table 8-1.

**Table 8-1: Input wave parameters**

| Description | Real World Angle (deg) | Offshore Wave Height (ft) | Offshore Wave Period (sec) | Wind Speed (ft/sec) | Water Stage (ft, NAVD) |
|---|---|---|---|---|---|
| SE Average* | 135.0 | 2.2 | 4.1 | 20 | 1.0 |
| SSE Average* | 157.5 | 3.3 | 4.6 | 21 | 1.0 |
| S Average* | 180.0 | 3.6 | 4.9 | 20 | 1.0 |
| 1-year Storm** | 194.0 | 8.9 | 8.0 | 46 | 2.0 |
| 20-year Storm** | 194.0 | 22.5 | 12.0 | 82 | 4.3 |

* Average conditions
** Storm conditions

### 8.2.2 Model Results

Based on the evaluation of impacts of the borrow area on wave height and direction, it was predicted that under an "average" wave climate, changes in wave height and wave angle would be negligible. During storm events, however, minor changes in wave direction of up to 1.0º were predicted. These changes may have minor impacts on sediment transport. Further analysis of wave energy flux ratios and comparisons of pre- and post-excavation conditions revealed that the 1-year and 20-year storm conditions would result in insignificant impacts on longshore sediment transport within 11 feet of water. This was designated as the zone of active sediment transport.

## 8.3 Scofield Offshore Borrow Area Design

The SOBA lies approximately three miles south of Scofield Island, at depths ranging from -18 to -20 feet NAVD88 (Figure 8-1). As previously stated, both the distance and depth indicate that the project can be efficiently excavated by a hydraulic cutterhead dredge and directly pumped to create the Scofield Island back-barrier marsh platform.

The SOBA was delineated to include the interdigitated strata of sandy, silty, and clayey sediment (Figures 8-2 and 8-3). The cut is approximately 2,800 feet long and 1,900 feet wide at the top of cut, with a thickness ranging from 20 to 22 feet. Based on this delineation and a 2-foot overdredge tolerance, the total estimated volume in the SOBA is approximately 3.3 million cubic yards. Based on the value engineering analysis (Section 9.8), the required excavation volume for the recommended marsh platform on Scofield Island is approximately 2.70 million cubic yards. Based on the Preliminary Design, the

SOBA contains sufficient volume of suitable sediment for marsh restoration.  A summary of the design parameters for the SOBA is provided in Table 8.2.

**Table 8-2: Summary of design parameters for SOBA**

| Parameter | Value |
|---|---|
| Average Grain Size | 0.10 mm |
| Borrow Area Length | 2,800 ft |
| Borrow Area Width | 1,900 ft |
| Borrow Area Thickness | 20 to 22 ft |
| Borrow Area Volume | 3.3 mcy |


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**Figure 8-1**
**Preliminary Design:**
**Scofield Offshore Borrow Area (SOBA) Location Map**

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|---|---|

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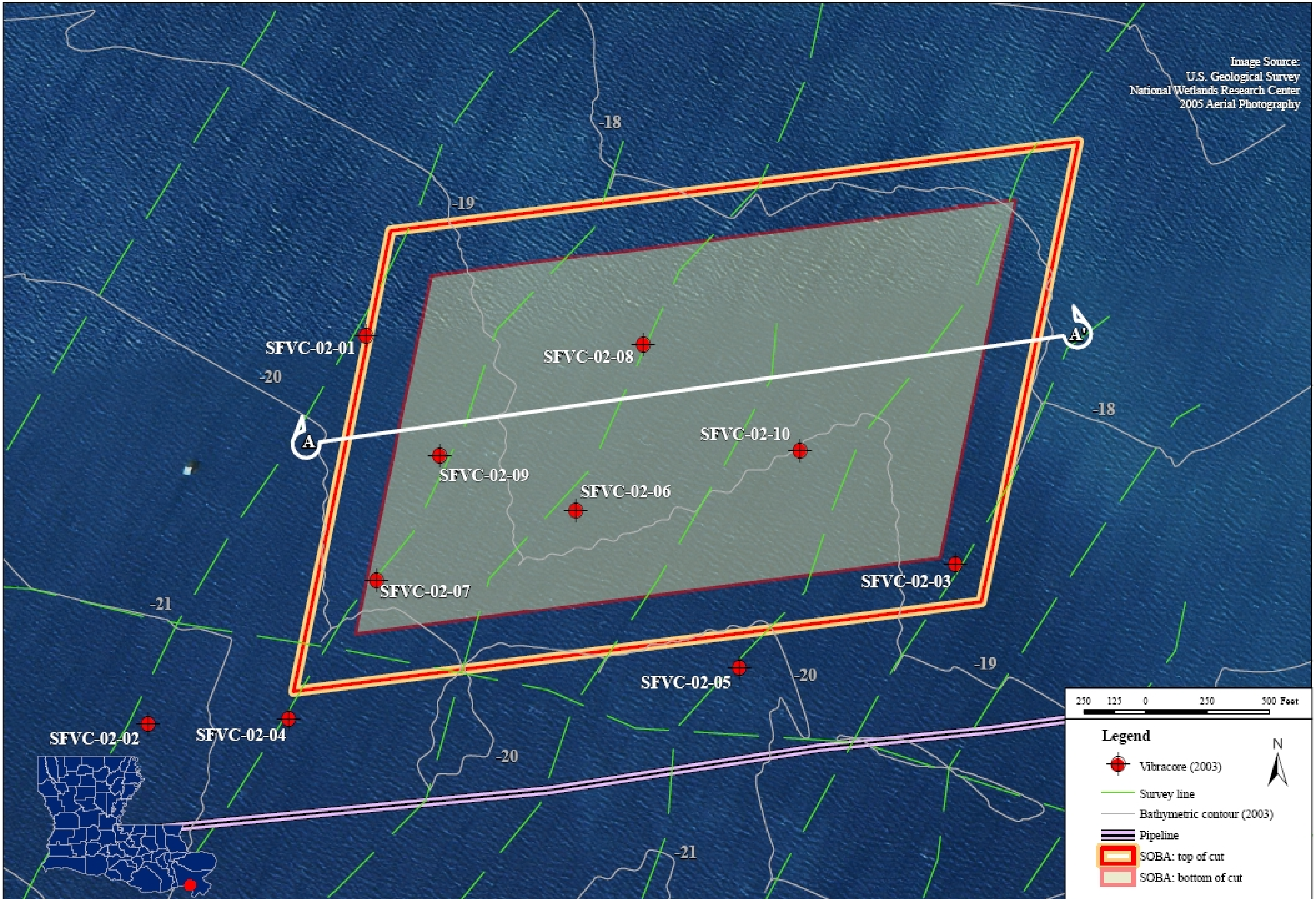


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**Figure 8-2**
**Preliminary Design:**
**Scofield Island Borrow Area (SOBA) Plan View**

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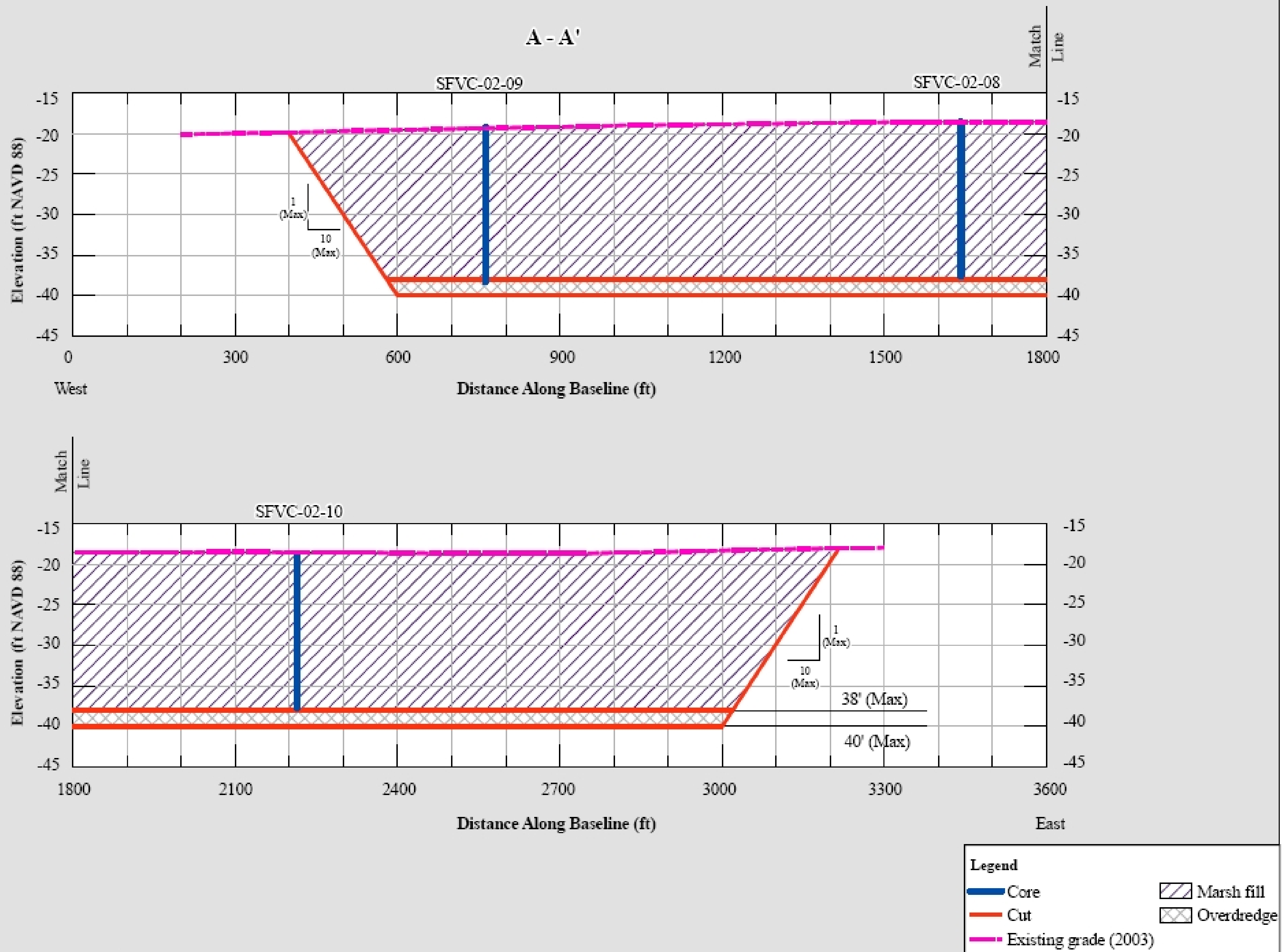


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**Figure 8-3**
**Preliminary Design:**
**Scofield Offshore Borrow Area (SOBA) Typical Cross-section**

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## 9.0 SCOFIELD ISLAND RESTORATION AREA

This chapter summarizes the coastal processes analyses, alternatives development and analysis, and environmental benefits derivations; and presents the preliminary design plans, cross sections, and volume requirements for the Scofield Island Restoration Area. The Preliminary Opinion of Cost is also presented along with a value engineering analysis conducted to yield a more cost effective plan that still met and exceeded the CWPPRA conceptual restoration goals. The specific objectives to achieve the CWPPRA goals for island restoration include:

- Create beach, dune, and back-barrier marsh to protect and preserve the structural integrity of the barrier shoreline for a Project life of 20 years.

- Achieve a marsh platform elevation such that by Year 3 the marsh elevation is within the tidal zone and remains within this zone through Year 20.

- Yield approximately 278 acres of back-barrier island habitat at Year 20.

The surveys and analyses completed in support of the Preliminary Design Phase for the Scofield Island Restoration Area included the Mississippi River Borrow Area Design Analysis (Appendix E), Environmental Mapping of the Conveyance Corridor and Scofield Island (Appendix H), Scofield Island Offshore Borrow Area Design Analysis (Appendix J), Scofield Island Back-Barrier Geotechnical Analysis (Appendix K), Scofield Island Native Beach Sediment Analysis (Appendix L), and Scofield Island Restoration Area Design Analysis (Appendix M).

### 9.1 Sediment Budget

Historical surveys collected in 2000 (LDNR, 2000) and 2004 (ATM, 2004) were compared to the design surveys completed in the Feasibility Study Phase (SJB and CEC, 2008) to determine shoreline and volumetric changes. Based on these surveys, the average erosion rate was approximately 18 feet per year between 2000 and 2004. This corresponded to a cumulative volume change of approximately -41,900 cubic yards per year. The gulf-side volume change for the same time period equaled approximately -135,500 cubic yards per year.

Between 2004 and 2008, the average erosion rate was approximated at 106 feet per year and the corresponding cumulative volume change was approximately -364,400 cubic yards per year. The gulf-side volume change for the same time period equaled approximately -335,200 cubic yards per year, which was 147% more than that of the 2000 to 2004 period. This significant increase was attributed to the hurricanes affecting Scofield Island in 2005 (Hurricanes Katrina and Rita).

The average erosion rate for the entire period (2000 to 2008) was approximated at 49 feet per year, with a cumulative and gulf-side volume change of -203,200 and -229,600 cubic yards per year, respectively. A summary of the shoreline and volume change rates is presented in Table 9-1.

**Table 9-1: Summary of shoreline and volume change rates**

| Period | Shoreline Change Rate (ft/yr) | Cumulative Volume Change Rate (ft/yr) | Gulf-Side Volume Change Rate (ft/yr) |
|---|---|---|---|
| 2000 - 2004 | -17.9 | -41,900 | -133,500 |
| 2004 - 2008 | -106.3 | -364,400 | -335,200 |
| 2000 - 2008 | -48.8 | -203,200 | -229,600 |

The sediment budget for Scofield Island was developed using the historical volumetric changes measured between 2000 (LDNR, 2000) and 2004 (ATM, 2004). The budget consists of a gulf-side and a marsh-side cell. The gulf-side cell extends from the depth of closure to the gulf-side limits of the existing marsh area. The marsh-side cell extends from the gulf-side limits of the existing marsh area to the bay-side limits of the projected marsh area at Year 20.

The net erosion loss rate of -133,500 cubic yards per year that was measured between 2000 and 2004 was applied to the gulf-side cell. The westerly and easterly longshore transport rates were approximated at -15,000 and -9,600 cubic yards per year, respectively (ATM, 2004). Volumetric subsidence losses were quantified by assuming a subsidence rate of 0.025 feet per year. This yielded a subsidence loss rate of -39,400 and -34,000 cubic yards per year for the gulf-side and marsh-side cells, respectively.

The volumetric overwash loss rates were then computed by subtracting the subsidence rates and the longshore transport rates from the net gulf-side erosion rate, yielding approximately 69,500 cubic yards of overwash per year. The sediment budget served as design criteria for the beach and dune fill template and marsh platform.

## 9.2 Design Criteria: Beach and Dune Template

The beach and dune template will be constructed of Riverine sand dredged from Borrow Areas MR-B-09 and/or MR-E-09. The following sections present the design criteria that were developed based on the geotechnical properties of the sediments in these borrow areas.

### 9.2.1 Overfill Ratio

The compatibility of borrow area sediments was analyzed using Dean's overfill ratio method (Dean, 1986). An overfill ratio is a means of estimating the additional quantity of fill material required if the fill and native sediment are dissimilar. An overfill ratio of 1.05 means that 1.05 cubic yards of fill must be excavated for every 1.0 cubic yards of native sediment needed. The ratio does not account for losses due to the dredging process nor background erosion rates.

Native beach samples collected by CTC (Appendix L) were compared to the sediment within MR-B-09 and MR-E-09 to determine overfill ratios (Appendix M). The mean grain size of the sediments in MR-B-09 ranged from 0.13 to 0.21 mm (average 0.16 mm). For MR-E-09, the samples ranged from 0.15 to 0.22 mm (average 0.19 mm). When compared to the mean grain size of the native beach (average 0.14 mm), the resulting overfill ratios were determined to be 1.08 for MR-B-09 and 1.03 for MR-E-09.

### 9.2.2 Renourishment Factor

An additional analysis useful for the evaluation of noncohesive granular beach fill material is the renourishment factor (RJ) which provides an estimate of how often fill placement would be required to maintain a specific beach dimension (James, 1975). An RJ of 1.0 infers that the borrow material would perform the same as the native material. The average renourishment factors were 1.89 and 1.32 for the MR-B-09 and MR-E-09 Borrow Areas, respectively. The renourishment factors suggest that Borrow Area MR-E-09 will provide more suitable sand for the beach and dune fill than that of the MR-B-09.

### 9.2.3 Cut-to-Fill Ratio

The cut-to-fill ratio for the beach/dune fill was determined by examining the percent fines in the vibracores that were previously collected in MR-B-09 and MR-E-09. Analysis of the 11 cores revealed that the No. 200 sieve fraction ranged from 0.2 to 11.6%, the No. 230 screen fraction ranged from 0.1 to 5.4%, and the pan fraction ranged from 0.4 to

12.0%. Based on the measured percent silts and clays and professional experience, a cut-to-fill ratio of 1.3 was recommended for beach/dune fill.

### 9.2.4 Side Slopes

The beach (gulf-side slope) and dune will both have gradual side slopes of 1:45 (vertical: horizontal) based upon profile analysis of the existing gulf-side slopes along Scofield Island and the borrow area grain size distribution.

### 9.2.5 Target Elevation

The beach berm elevation of +4 feet NAVD88 was chosen to minimize overtopping caused by storm surge levels occurring between the 5 and 10-year storm events (see Appendix M).

## 9.3 Design Criteria: Containment Dikes

Two containment dikes will be needed for Project construction. The first will contain the marsh fill within the template and prevent fill diffusion into Skipjack Bay. The second will separate the beach and dune fill from the marsh fill to contain the Mississippi River sand placed in the seaward portion of the overall fill template. The significant majority of the material sources for the containment dikes shall be in-situ sediments collected from an onsite borrow/floatation channel.

EES collected back barrier sediment samples within the proposed restoration area to determine containment dike design criteria. Six 50-foot long soil borings were extracted throughout the proposed restoration area. From these samples, EES conducted detailed geotechnical analyses and determined the parameters necessary to design the containment dikes for stability and to predict the total effective settlement of both the dikes and the fill platforms in varying water depths throughout the 20-year life of the Project (EES, 2009). The following sections summarize the design criteria that are specific to the containment dikes. The marsh platform criteria are discussed in Section 9.4.

### 9.3.1 Settlement

Consolidation tests and settlement estimates were performed by EES to derive the settlement due to the weight of the marsh fill or dike and self-weight consolidation within the fill or dike over time. Geologic subsidence was factored in and time-rates of total effective settlement were computed for various dike and marsh platform elevations in varying bay bottom depths under varying water depths. Fairly rapid settlement caused by the weight of the dike and the influence of the recently placed fill along with self-weight consolidation occurs over the first two years following construction. Following the initial two years, a steadier settling takes place which is dominated by the fairly constant geologic subsidence. Thus, the containment dike design life is set at two years.

### 9.3.2 Slope Stability

EES conducted slope stability analyses by a two-dimensional limit equilibrium stability analysis of selected trial failure surfaces to evaluate containment dike and borrow channel side slopes. Their recommended factor of safety was 1.3 and was based on Spencer's Method of Slices. Based on their analyses, EES recommended a 1 vertical on 8 horizontal side slope for the containment dikes allowing for achieving a dike crest elevation of +4 and +6 feet NAVD88 for existing bay bottom elevations of -2 and 0 feet NAVD88, respectively. Applying the same factor of safety and assuming a 1 vertical on 3 horizontal side slope for the borrow channels, EES determined a recommended buffer distance from the toe of the containment dike to the top of the borrow channel cut equal to 30 and 40 feet for bay bottom depths of -2 and 0 feet NAVD88, respectively.

### 9.3.3 Cut-to-Fill Ratio

For the fill used in the containment dikes, EES recommended a cut-to-fill ratio of 2:1. The ratio was based on experience and professional judgment. Selection of the ratio assumes mechanical excavation and placement of in-situ sediments with natural moisture contents ranging from 40% to 60%. For sediments with higher moisture contents, a ratio of 3:1 should be used. The actual ratio that will be used in construction will be finalized during the Final Design Phase.

### 9.3.4 Target Elevation

The marsh fill containment dike will be sited along the northern boundary of the marsh fill platform. Since the bay bottom depths along this boundary range from -1.5 to -2.0 feet NAVD88, a conservative design toe elevation of -2 feet NAVD88 was assumed. Settlement calculations suggested that the dike is likely to settle as much as 0.8 to 1.0 feet (assume an average of 0.9 feet) within the first 6 months immediately following dike construction. Two feet of freeboard defined as the dike crest elevation minus the marsh fill platform was also accounted for in the design. The freeboard was assigned to provide storage capacity for standing water during filling operations and to reduce overtopping from wind driven waves from the north. Based on this analysis, a dike crest elevation of +4.9 feet NAVD88 was computed for preliminary design (Appendix M). The containment dikes along the perimeter of the marsh fill area may be degraded or gapped to promote hydrologic exchange after the marsh has been planted and has stabilized.

The containment dike for the beach/dune fill will be sited along the southern limit of the marsh fill platform, which corresponds to the northern limit of the beach/dune fill interface. The average native soil elevations along this boundary are approximately -0.6 feet NAVD88. The total effective subsidence was analyzed for dike crest elevations of +6.0 and +4.0 feet NAVD88. Based on the settlement relationships developed by EES, a crest elevation of +4.9 feet NAVD88 was computed for preliminary design (Appendix M). This elevation coincides with the marsh fill containment dike elevation. The containment dike separating the beach fill from the marsh fill will be degraded following fill placement to provide a smooth transition between the two areas.

## 9.4 Design Criteria: Marsh Platform

The marsh platform will be constructed of marsh fill dredged from SOBA. The following sections discuss the design criteria that are specific to the marsh platform (Appendix K).

### 9.4.1 Cut-to-Fill Ratio

The cut-to-fill ratio for the marsh fill was determined by examining the percent fines in the vibracores that were previously collected in SOBA. Based on this analysis, approximately 53.4% of the material (by dry weight) was determined to be silts and clays. In order to ensure adequate fill volume for the restoration efforts, a cut-to-fill ratio of 1.6 was recommended for marsh fill. This will account for losses due to excavation, placement, and dewatering.

### 9.4.2 Target Elevation

An iterative approach was utilized to determine the optimal marsh platform elevation such that by Year 3, the marsh elevation will be within the tidal zone and remain there through Year 20 (Table 9-2). The intertidal zone was defined as the zone between Mean High Water (MHW) and Mean Low Water (MLW). Based on the effective settlement relationships developed by EES (Section 9.3.1), a target marsh platform elevation of +3.0 feet NAVD88 will be used for the design.

**Table 9-2: Marsh platform duration within tidal zone**

| Proposed Marsh Fill Elevation (ft NAVD 88) | Time to Reach MHW (years) | Time to Reach MLW (years) | Time within Intertidal Zone (years) | Percentage of Project Life (%) |
|---|---|---|---|---|
| +3.5 | 6.0 | 20.0 | 14.0 | 70.0 |
| +3.0 | 3.2 | 17.3 | 14.1 | 70.5 |
| +2.5 | 1.1 | 13.3 | 12.2 | 61.0 |
| +2.0 | 0.0 | 9.7 | 9.7 | 48.5 |

## 9.5 Preliminary Design Alternatives

Four design alternatives were developed for consideration for the restoration area. The alternatives included the "no action" alternative and three beach/dune/marsh fill alternatives. With the exception of the "no action" alternative, each alternative includes a preliminary design for the marsh platform, beach, dune, containment dikes, and floatation channel. Where appropriate, the dune width and slope were designed to match existing healthy dunes at Scofield Island. For each alternative, sand fencing shall be installed along the beach/dune platform following construction. The fencing shall be 4 feet high with 50% porosity and placed shore-parallel along the entire length of the dune, to capture wind-blown sand and to help build and stabilize the mounds. The dune and marsh platform shall be planted with appropriate vegetation. Details for each alternative are provided in the following sections.

### 9.5.1 Alternative 1

Alternative 1 is the "no action" alternative. For this alternative, Scofield Island will not be restored or modified in any way. The island has been experiencing a loss rate of over 3.7 acres per year since 2000. By applying this loss rate, the short–term year of disappearance was predicted to be 2044. This alternative does not achieve any of the design objectives and was thus not considered to be a practical alternative.

### 9.5.2 Alternative 2

This alternative is designed to provide an approximate 11,400 foot long beach and dune fill with approximately 2,100 foot and 1,800 foot tapers on west and east end, respectively, to close the breach areas and restore and protect the erosive beach. The tapers are provided to blend the sediments into the existing grades and maintain a buffer from the inlets on both ends of Scofield Island. The dune component includes a 50 foot wide crest width at +6 feet NAVD88 with 1:45 side slopes. The beach fill template includes a 100 foot wide construction berm at +4 feet NAVD88 with 1:45 side slopes. The elevations were chosen to correspond to storm surge levels between the 5- and 10-year storm events to minimize overtopping into the marsh. The average beach fill width measured at MHW is approximately 640 feet, excluding the tapers. The surface area of the proposed beach platform is approximately 223 acres measured at +4 feet NAVD88. The required fill volume is approximately 2.03 million cubic yards including the preliminary design criteria for the overfill ratio and two years of background gulf-side erosion. The required excavation volume including the preliminary design criteria for the cut to fill ratio is approximately 2.64 million cubic yards.

This alternative is also designed to provide an approximately 11,800 foot long marsh platform on the bay side of Scofield Island. The marsh platform's width varies, ranging from approximately 1,000 feet on the west end of the island to approximately 2,100 feet near the east end of the island, to conform to the existing marsh geometry. The surface area of the proposed marsh platform is approximately 375 acres. The target marsh platform elevation is +3.0 feet NAVD88 accounting for the preliminary design criteria on average existing marsh elevation, sea level rise, subsidence and consolidation. The required fill volume is approximately 1.74 million cubic yards accounting for two years of background overwash into the marsh cell. The required excavation volume including the preliminary design criteria for the cut to fill ratio is approximately 2.79 million cubic yards.

A summary of the design parameters is presented in Table 9-3.

**Table 9-3: Summary of beach, dune and marsh parameters for Alternative 2**

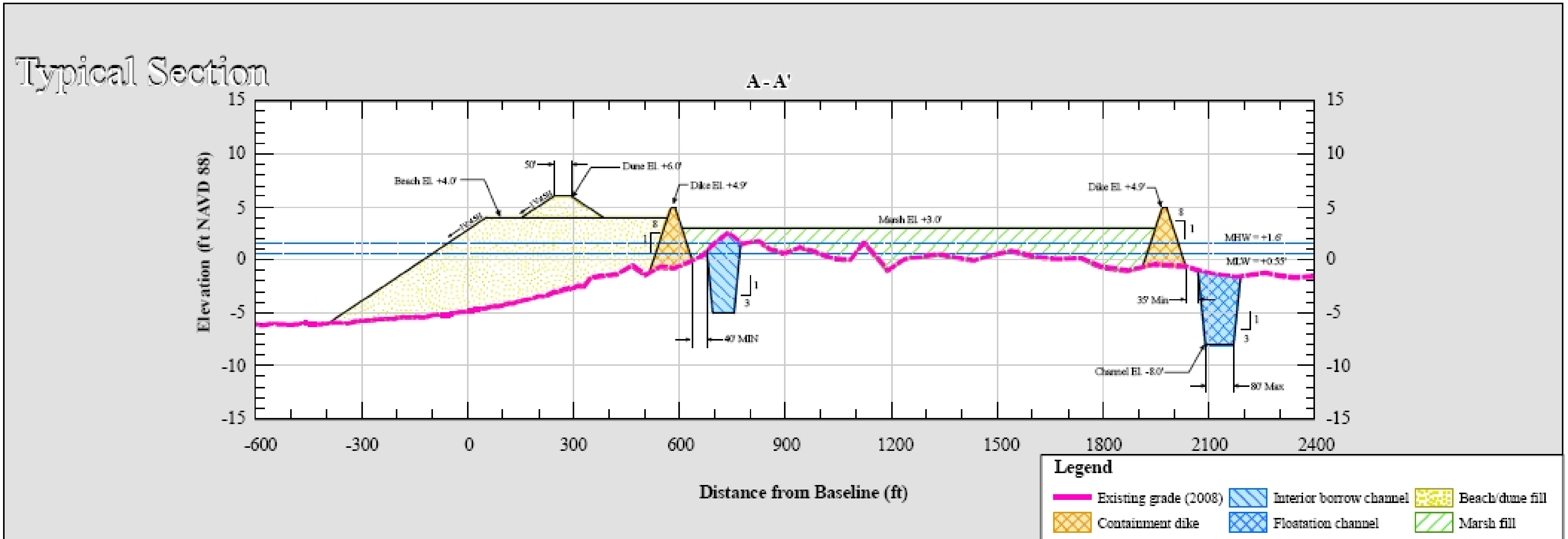
| | Beach /Dune | Marsh Platform |
|---|---|---|
| Average Length (ft) | 11,400 | 11,800 |
| Average Width (ft) | 640 / 50 | 1,000 – 2,100 |
| Elevation (feet NAVD88) | +4.0 / +6.0 | +3.0 |
| Surface Area (acres) | 223 | 375 |
| Side Slopes (V:H) | 1:45 | NA |
| Required Fill Volume (mcy) | 2.03 | 1.74 |
| Cut-to-Fill Ratio | 1.3 | 1.6 |
| Required Excavation Volume (mcy) | 2.64 | 2.79 |

For Alternative 2, an 11,670-foot long containment dike will be constructed to separate the beach/dune fill area from the marsh fill area. A second containment dike, which will be 16,910 feet in length, will be constructed along the northern limits of the marsh platform to prevent sediment migration into the bay. The fill that will be used for the containment dikes will be excavated from a 20,080-foot long floatation channel located along the perimeter of Scofield Island. A summary of the design parameters for the containment dikes and the floatation channel is provided in Table 9-4.

**Table 9-4: Summary of containment dike and floatation channel parameters for Alternative 2**

| | Beach/Marsh Separation Dike | Marsh Containment Dike | Floatation Channel |
|---|---|---|---|
| Length (ft) | 11,670 | 16,910 | 20,080 |
| Required Fill Volume (cy) | 159,630 | 350,550 | NA |
| Cut-to-Fill Ratio | 2:1 | 2:1 | NA |
| Required Excavation Volume (cy) | 319,260 | 701,100 | NA |

A plan view and typical cross-section for Alternative 2 are presented in Figure 9-1.



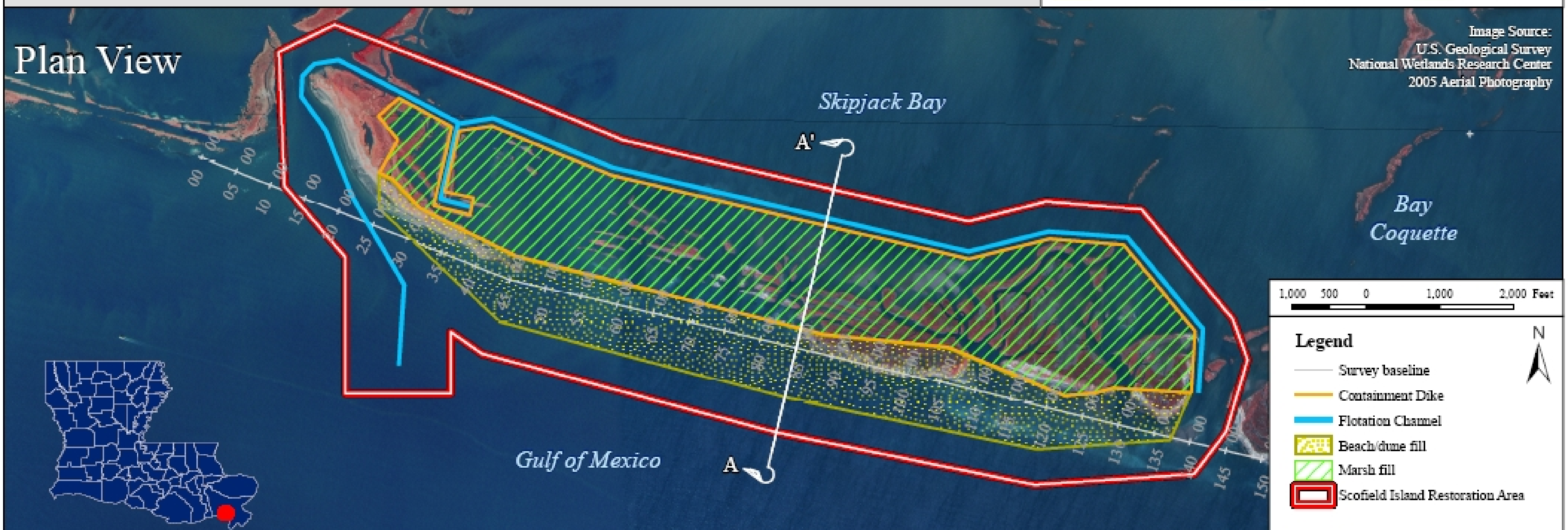




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**Figure 9-1**
**Preliminary Design:**
**Alternative 2 - Plan View and Typical Cross-section**

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### 9.5.3 Alternative 3

Similar to Alternative 2, this template is designed to provide an approximate 11,400 foot long beach and dune fill with approximately 2,100 foot and 1,800 foot tapers on west and east end, respectively, to close the breach areas and restore and protect the eroding beach. The tapers are provided to blend the sediments into the existing grades and maintain a buffer from the inlets on both ends of Scofield Island. Compared to Alternative 2, the beach and dune fill was translated northward and it covers more of the existing island framework. The dune component includes a 50 foot wide crest width at +6 feet NAVD88 with 1:45 side slopes. The beach fill template includes a 100 foot wide construction berm at +4 feet NAVD88 with 1:45 side slopes. The elevations were chosen to correspond to storm surge levels between the 5- and 10-year storm events to minimize overtopping into the marsh. The average beach fill width measured at MHW is approximately 690 feet excluding the tapers. The surface area of the proposed beach platform is approximately 221 acres measured at +4 feet NAVD88. The required fill volume is approximately 1.72 million cubic yards including the preliminary design criteria for the overfill ratio and two years of background gulf-side erosion. The required excavation volume including the preliminary design criteria for the cut to fill ratio is approximately 2.24 million cubic yards.

This alternative is also designed to provide an approximately 10,600 foot long marsh platform on the bay side of Scofield Island. Compared to Alternative 2, the marsh platform's width varies ranging from approximately 1,400 feet on the west end of the island to approximately 2,400 feet near the east end of the island to preserve an approximate 40 acre area of the existing healthy marsh. The area of the proposed marsh platform is approximately 319 acres. The target marsh platform elevation is +3.0 feet NAVD88 accounting for the preliminary design criteria on average existing marsh elevation, sea level rise, subsidence and consolidation. The required fill volume is approximately 1.76 million cubic yards accounting for two years of background overwash into the marsh cell. The required excavation volume including the preliminary design criteria for the cut to fill ratio is approximately 2.82 million cubic yards.

A summary of the design parameters is presented in Table 9-4.

**Table 9-5: Summary of beach and marsh platform parameters for Alternative 3**

| | Beach / Dune | Marsh Platform |
|---|---|---|
| Average Length (ft) | 11,400 | 10,600 |
| Average Width (ft) | 690 / 50 | 1,400 – 2,400 |
| Elevation (ft NAVD88) | +4 / +6 | +3 |
| Surface Area (acres) | 221 | 319 |
| Side Slopes (V:H) | 1:45 | NA |
| Required Fill Volume (mcy) | 1.72 | 1.76 |
| Cut-to-Fill Ratio | 1.3 | 1.6 |
| Required Excavation Volume (mcy) | 2.24 | 2.82 |

A 10,230-foot long containment dike will be constructed to separate the beach/dune fill area from the marsh fill area. A second containment dike, which will be 17,890 feet in length, will be constructed along the northern limits of the marsh platform to prevent sediment migration into the bay. The fill that will be used for the containment dikes will be excavated from a 20,920-foot long floatation channel located along the perimeter of Scofield Island. A summary of the design parameters for the containment dikes and the access channel is provided in Table 9-6.

**Table 9-6: Summary of containment dike and floatation channel parameters for Alternative 3**

| | Beach/Marsh Separation Dike | Marsh Containment Dike | Floatation Channel |
|---|---|---|---|
| Length (ft) | 10,230 | 17,890 | 20,920 |
| Required Fill Volume (cy) | 139,900 | 370,820 | NA |
| Cut-to-Fill Ratio | 2:1 | 2:1 | NA |
| Required Excavation Volume (cy) | 279,800 | 741,640 | NA |

A plan view and typical cross-section for Alternative 3 are presented in Figure 9-2.

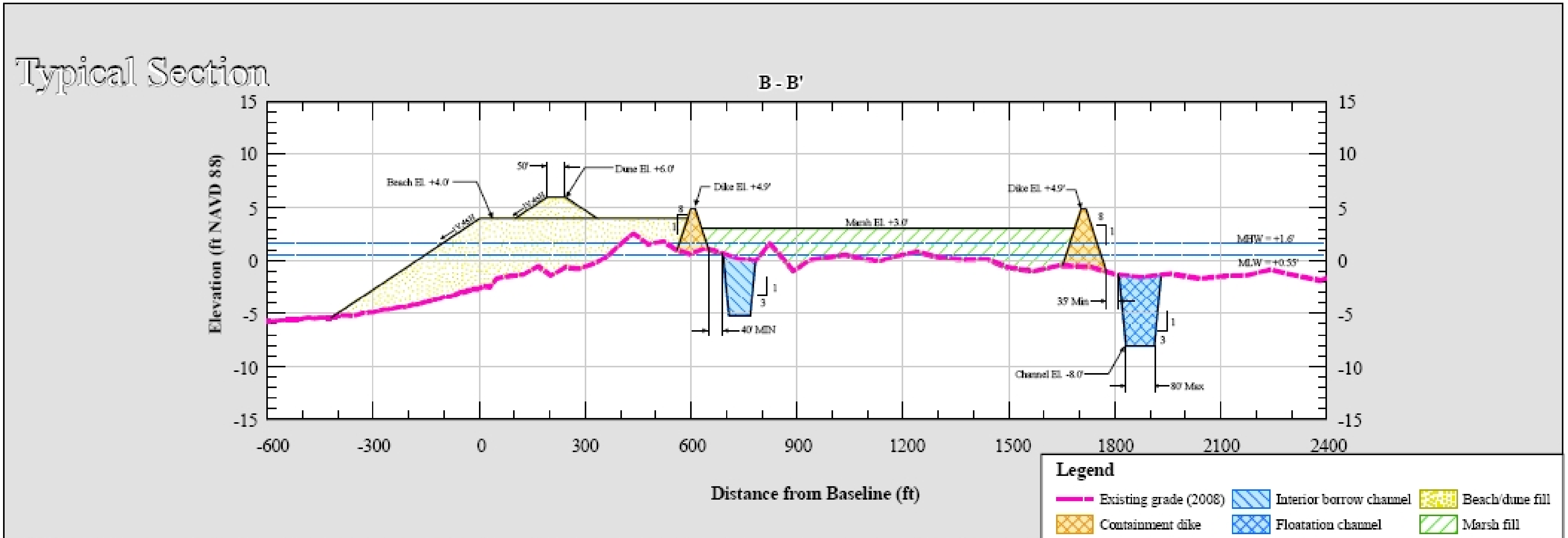



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**Figure 9-2**
**Preliminary Design:**
**Alternative 3 - Plan View and Typical Cross-section**

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### 9.5.4 Alternative 4

This alternative is designed to provide an approximate 10,600 foot long beach and dune fill. The gulfward limits of the beach fill are approximately aligned with the current shoreline position thus the majority of the existing island framework is covered by the proposed beach and dune fill. The dune component includes a 200 foot wide crest width at +6 feet NAVD88 with 1:45 side slopes. The beach fill template includes a variable width, 340 feet to 440 feet wide, construction berm that extends from the Gulf side beach fill crest to the Gulf side toe of the dune at +4 feet NAVD88 with 1:45 side slopes. The elevations were chosen to correspond to storm surge levels between the 5- and 10-year storm events to minimize overtopping into the marsh. The average beach fill width measured at MHW is approximately 950 feet. The area of the proposed beach platform is approximately 267 acres measured at +4 feet NAVD88. The required fill volume is approximately 2.03 million cubic yards including the preliminary design criteria for the overfill ratio and two years of background erosion equal to the gulf-side erosion less the overwash. The required excavation volume including the preliminary design criteria for the cut to fill ratio is approximately 2.64 million cubic yards.

This alternative is also designed to provide an approximately 12,000 foot long by 1,100 foot wide marsh platform on the bay side of Scofield Island. The marsh is also placed west of the beach fill on the west end of the island. The area of the proposed marsh platform is approximately 299 acres. The target marsh platform elevation is +3.0 feet NAVD88 accounting for the preliminary design criteria on average existing marsh elevation, sea level rise, subsidence and consolidation. The required fill volume is approximately 1.88 million cubic yards. The required excavation volume including the preliminary design criteria for the cut to fill ratio is approximately 3.01 million cubic yards.

A summary of the design parameters is presented in Table 9-7.

**Table 9-7: Summary of beach and marsh platform parameters for Alternative 4**

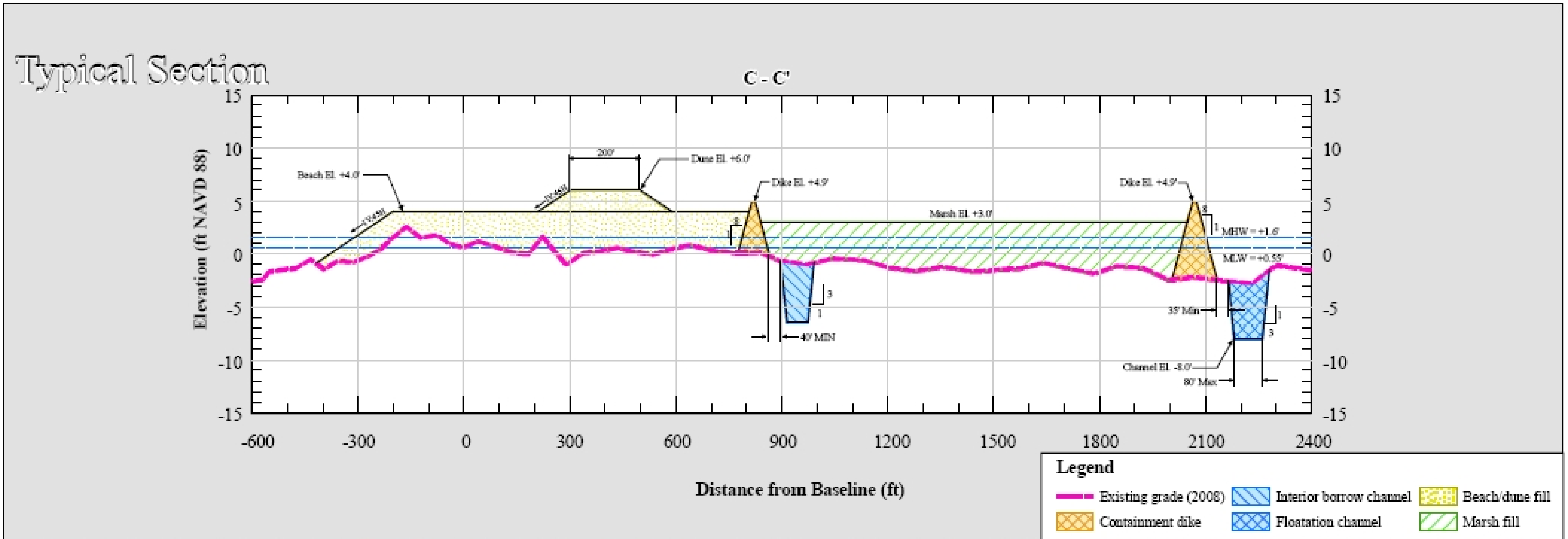
| | Beach / Dune | Marsh Platform |
|---|---|---|
| Average Length (ft) | 10,600 | 12,000 |
| Average Width (ft) | 950 / 200 | 1,100 |
| Elevation (ft NAVD88) | +4 / +6 | +3 |
| Surface Area (acres) | 267 | 299 |
| Side Slopes (V:H) | 1:45 | NA |
| Required Fill Volume (mcy) | 2.03 | 1.88 |
| Cut-to-Fill Ratio | 1.3 | 1.6 |
| Required Excavation Volume (mcy) | 2.64 | 3.01 |

An 11,820-foot long containment dike will be constructed to separate the beach/dune fill area from the marsh fill area. A second containment dike, which will be 20,270 feet in length, will be constructed along the northern limits of the marsh platform to prevent sediment migration into the bay. The fill that will be used for the containment dikes will be excavated from a 21,020-foot long floatation channel located along the perimeter of Scofield Island. A summary of the design parameters for the containment dikes and the access channel is provided in Table 9-8.

**Table 9-8: Summary of containment dike and floatation channel parameters for Alternative 4**

| | Beach/Marsh Separation Dike | Marsh Containment Dike | Floatation Channel |
|---|---|---|---|
| Length (ft) | 11,820 | 20,270 | 21,020 |
| Required Fill Volume (cy) | 161,700 | 420,200 | NA |
| Cut-to-Fill Ratio | 2:1 | 2:1 | NA |
| Required Excavation Volume (cy) | 323,400 | 840,400 | NA |

A plan view and typical cross-section for Alternative 4 are presented in Figure 9-3.



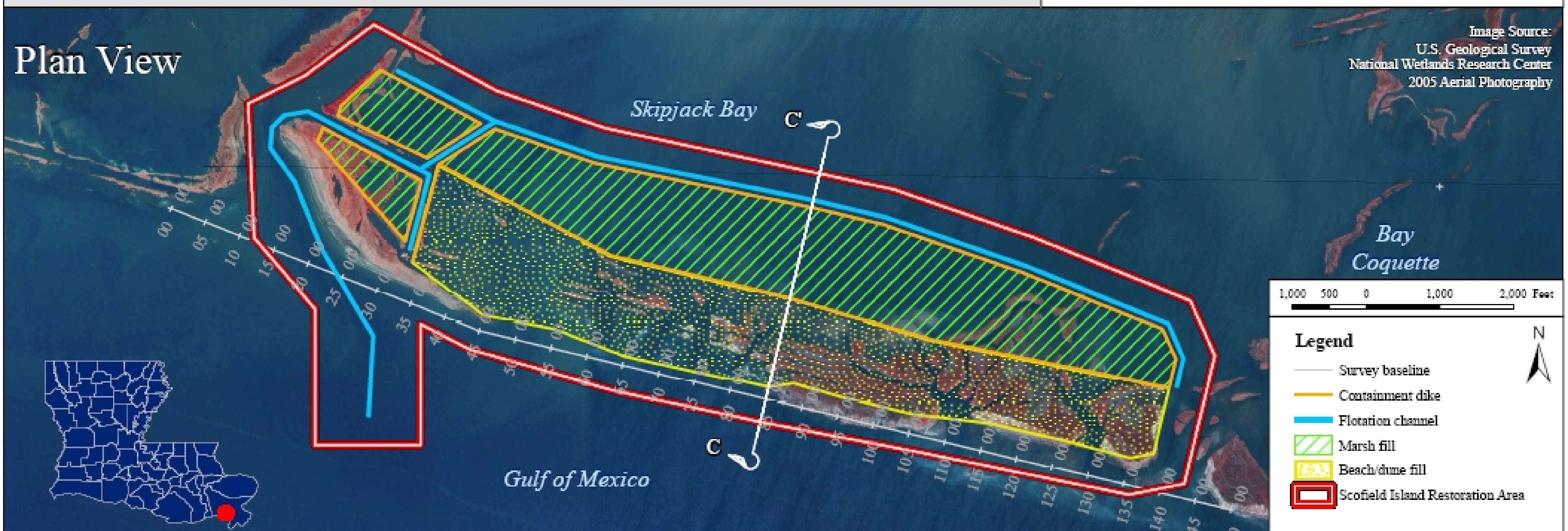




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**Figure 9-3**
**Preliminary Design:**
**Alternative 4 - Plan View and Typical Cross-section**

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## 9.6 Alternatives Analysis

The SJB Team conducted an alternatives analysis to identify the optimal preliminary design plan for Scofield Island. The following criteria were assessed:

- Storm Protection Benefits
- Habitat Creation and Sustainability
- Fiscal Considerations

Since Alternative 1 did not meet any of the Project objectives, it was excluded from the alternatives analysis. The following sections discuss Alternatives 2, 3, and 4 for each criterion.

### 9.6.1 Storm Protection Benefits

When designing beach and marsh platform templates, it is critical to assess the erodability of the fill material under various storm scenarios. In order to evaluate this aspect of the alternative designs, cross-shore sediment transport modeling was conducted using Storm-induced Beach Change Model (SBEACH) (Rosati, et al., 1993).

SBEACH is a two-dimensional model that simulates cross-shore transport of sediment caused primarily by breaking waves and changing water levels. Water level changes were quantified using wind, storm surge, and tide data. Two-grain sizes, 0.13 mm and 0.24 mm, where used in the model to represent the range of grain sizes found within the MR-B-09 and MR-E-09, respectively.

Each alternative was evaluated under two storm scenarios. The storm scenarios included Hurricanes Katrina (2005), Rita (2005), Gustav (2008), and Ike (2008). Because Katrina and Rita occurred within 25 days of each other, they were combined into a single event. Hurricanes Gustav and Ike were also combined into a single event since they occurred within 11 days of each other. For each of the two storm scenario, a time step of 0.5 minutes was used.

The model was run for the each of the four alternatives, including the “no action” alternative (Alternative 1). Based on the post-storm performance analysis, beach profiles for Alternative 1 will recede and flatten to such a degree that the entire profile will be near or below MHW. These results reinforce the argument that “no action” will result in significant land loss and the eventual disintegration of Scofield Island.

Although Alternatives 2 and 3 yielded comparable results, Alternative 3 resulted in slightly less recession at MHW and a slightly higher post-storm dune elevation. The coarser grain size (0.24 mm) resulted in less erosion when compared to model results for the finer grain size (0.13 mm). Alternative 4, which included a larger dune than Alternatives 2 and 3, resulted in the smallest shoreline recession and highest post-storm dune elevation.

Based on the results of the SBEACH modeling, Alternative 4 will provide better protection against the storms that have recently impacted Scofield Island (i.e., Katrina and Rita in 2005, and Gustav and Ike in 2008). Although Alternatives 2 and 3 will provide less protection than Alternative 4, the beach/dune system for all three alternatives should remain intact and should provide sufficient protection to prevent severe damage and breaching.

### 9.6.2 Habitat Creation and Sustainability: Modeling Approach

Each of the alternatives (excluding Alternative 1) was assessed to determine the number of habitat acres that will be created and sustained by the preliminary designs. Habitat acreages were computed using the Barrier Island Community Wetland Value Assessment Model (CWPPRA Task Force, 2003). Specific habitat types were defined as follows:

- Dune: > +5.0 feet NAVD88
- Supratidal: +2 to +5 feet NAVD88
- Intertidal: 0 to +2 feet NAVD88
- Subtidal: -1.5 to 0 feet NAVD88

The acreages that were computed by the model were then compared to the CWPPRA conceptual restoration goals that included construction of 429 acres of beach/dune habitat (above-tide) and marsh habitat at Year 1 and to sustain intertidal habitats throughout the Project life to yield 278 acres at Year 20. Table 9-9 presents the habitat acres created at Year 1. The total acreages provided in the table were then adjusted by subtracting the subtidal (bay) and intertidal (gulf) acreages so that the values could be compared to the CWPPRA goal of 429 acres.

As seen in Table 9-9, the habitat acreages created by each alternative will exceed the CWPPRA conceptual restoration goal of 429.0 acres.

**Table 9-9: Habitat acreages for Year 1**

| Habitat | Alternative 2 (acres) | Alternative 3** (acres) | Alternative 4 (acres) |
|---|---|---|---|
| Subtidal (Bay) | 11.0 | 23.6 | 10.8 |
| Intertidal (Bay) | 32.3 | 102.7* | 21.0 |
| Supratidal | 499.4 | 436.4 | 524.0 |
| Dune | 30.0 | 29.8 | 55.5 |
| Intertidal (Gulf) | 23.4 | 23.3 | 27.2 |
| Total | 596.0 | 615.8 | 638.5 |
| Adjusted Total* | 561.6 | 568.9 | 600.6 |
| CWPPRA Goal | 429.0 | 429.0 | 429.0 |

* Adjusted total was calculated by subtracting subtidal (Bay) and intertidal (Gulf) from the Total
** Alternative 3 preserves approximately 40.4 acres of existing marsh, which are included in the calculation

Longshore transport, overwash, and subsidence rates were then applied to each of the alternatives to predict the island's evolution throughout the life of the Project. Table 9-10 presents the habitat acres at Year 20 for each alternative. The total acreages provided in the table were then adjusted by subtracting the subtidal (bay) and intertidal (gulf) acreages so that the values could be compared to the CWPPRA goal of yielding 278 acres of back-barrier habitat at Year 20.

**Table 9-10: Habitat acreages for Year 20**

| Habitat | Alternative 2 (acres) | Alternative 3** (acres) | Alternative 4 (acres) |
|---|---|---|---|
| Subtidal (Bay) | 46.4 | 51.0 | 95.5 |
| Intertidal (Bay) | 407.4 | 364.3 | 310.1 |
| Supratidal | 29.8 | 39.7 | 166.0 |
| Dune | 0.0 | 0.0 | 0.0 |
| Intertidal (Gulf) | 19.5 | 19.7 | 29.6 |
| Total | 503.1 | 474.7 | 601.2 |
| Adjusted Total* | 437.2 | 404.0 | 476.1 |
| CWPPRA Goal | 278.0 | 278.0 | 278.0 |

*Adjusted total was calculated by subtracting subtidal (Bay) and intertidal (Gulf) from the Total
**Alternative 3 preserves approximately 40.4 acres of existing marsh, which are included in the calculation

As seen in Table 9-10, the habitat acreages maintained by each alternative will exceed the CWPPRA conceptual restoration goal of 278 acres. Based on the modeling results, Alternative 4 is the preferred alternative in terms of both the habitat acres created and those sustained through the Project life and yielded at Year 20.

### 9.6.3 Fiscal Considerations

A preliminary opinion of construction cost for the three alternatives was determined by computing the costs based on equipment types and estimates of production rates, historical bids, professional experience, and consultation with construction contractors. The estimates included costs associated with mobilization and demobilization, levee corridor pipeline crossing, surveying, access channels, marsh fill, containment dikes, beach and dune fill, inspection, construction administration, and a 15% contingency. Construction duration was based on excavation equipment methods, equipment capacity, weather days, and mobilization and demobilization durations. Pumping duration was based on the required volume divided by the dredging capacity per day. Based on the costs analysis, Alternative 3 is the least costly alternative ($47,579,000) primarily because it preserves existing marsh areas on Scofield Island and thus requires less fill volume. Alternative 4 is the most expensive alternative ($50,582,000) followed by Alternative 2 ($49,415,000).

## 9.7 Recommended Design Alternative for Scofield Island

Alternatives 2, 3, and 4 were evaluated based on the following criteria:

- Achieving design objective for creating and sustaining target habitat acres
- Providing storm protection
- Project cost

### 9.7.1 Habitat Creation and Sustainability

Tables 9-11 and 9-12 summarize the analysis of habitat acres created and sustained by the preliminary designs. Each alternative was scored by dividing the total habitat acreage by the CWPPRA goal.

**Table 9-11: Habitat acreages and CWPPRA goal for Year 1**

| | Alternative 2 | Alternative 3 | Alternative 4 |
|---|---|---|---|
| Total Habitat Created (acres) | 561.6 | 568.9 | 600.6 |
| CWPPRA Habitat Creation Goal (acres) | 429.0 | 429.0 | 429.0 |
| Score | 1.31 | 1.33 | 1.40 |

**Table 9-12: Habitat acreages and CWPPRA goals for Year 20**

| | Alternative 2 | Alternative 3 | Alternative 4 |
|---|---|---|---|
| Habitat Acres Yielded at Year 20 (acres) | 437.2 | 404.0 | 476.1 |
| CWPPRA Restoration Goal at Year 20 (acres) | 278 | 278 | 278 |
| Score | 1.57 | 1.45 | 1.71 |

### 9.7.2 Storm Protection Evaluation

Based upon the storm protection benefit analysis, Alternative 4 provides a higher level of storm protection than Alternatives 2 and 3. However, the beach/dune fill is predicted to remain intact and should provide sufficient protection from severe damage and breaching throughout the life of the Project. Thus all three alternatives were given a score of 1.0.

### 9.7.3 Project Costs

Two methods were employed to score the fiscal parameter. For the first method, each alternative was scored by dividing CWPPRA's conceptual restoration plan budget of $40,000,000 by the preliminary opinion of cost (Table 9-13).

**Table 9-13: Comparisons of cost estimates provided by CWPPRA and the SJB Team**

| | Alternative 2 | Alternative 3 | Alternative 4 |
|---|---|---|---|
| CWPPRA Conceptual Budget | $40,000,000 | $40,000,000 | $40,000,000 |
| Preliminary Opinion of Construction | $49,415,000 | $47,579,000 | $50,582,000 |
| Score | 0.76 | 0.81 | 0.74 |

The second method included comparing CWPPRA's original "cost/benefit-acre" to "cost/benefit-acre" values derived by dividing the cost by the number of acres at Year 20. Table 9-14 present the calculations for computing the values and the "cost/benefit-acre" values are then compared in Table 9-15.

**Table 9-14: Cost /benefit-acre at Year 20 (original values)**

| | Alternative 2 | Alternative 3 | Alternative 4 |
|---|---|---|---|
| CWPPRA Conceptual Budget | $40,000,000 | $40,000,000 | $40,000,000 |
| CWPPRA Restoration Goal at Year 20 (acres) | 278.0 | 278.0 | 278.0 |
| Original Cost/Benefit Acre at Year 20 ($/acre) | $143,885 | $143,885 | $143,885 |
| | | | |
| Preliminary Opinion of Construction | $49,415,000 | $47,579,000 | $50,582,000 |
| Habitat Acres Yielded at Year 20 (acres) | 437.2 | 404.0 | 476.1 |
| Updated Cost/Benefit Acre at Year 20 ($/acre) | $113,026 | $117,770 | $106,242 |

**Table 9-15: Comparisons of cost/benefit-acres at Year 20 (original vs. updated values)**

| | Alternative 2 | Alternative 3 | Alternative 4 |
|---|---|---|---|
| Original Cost/Benefit-Acre at Year 20 | $143,885 | $143,885 | $143,885 |
| Updated Cost/Benefit-Acre at Year 20 | $113,026 | $117,770 | $106,242 |
| Score | 1.27 | 1.22 | 1.35 |

### 9.7.4 Preferred Alternative

The scores assigned to each of the criteria discussed above were summed for each alternative to identify the alternative that is expected to provide the best balance of environmental benefit and economic feasibility. The scores are summarized in Table 9-16.

**Table 9-16: Summary of scores for each criterion**

| Criteria | Alternative 2 | Alternative 3 | Alternative 4 |
|---|---|---|---|
| Habitat Acres Created | 1.31 | 1.33 | 1.40 |
| Habitat Acres Sustained | 1.57 | 1.45 | 1.71 |
| Storm Projection | 1.00 | 1.00 | 1.00 |
| Project Costs | 0.76 | 0.81 | 0.74 |
| Cost/Benefit-Acres | 1.27 | 1.22 | 1.35 |
| Total | 5.91 | 5.81 | 6.20 |

Based on the findings of the alternatives analysis, the SJB Team recommended Alternative 4 as the preferred alternative. As seen in Table 9-16, Alternative 4 scored the highest among the three alternatives. While it is the most expensive alternative, its cost/benefit-acre is the lowest. Alternative 4 also yielded the highest benefit acreage at Year 20.

## 9.8 Optimization of Preferred Alternative

As part of the Preliminary Design process, a value engineering analysis was completed of Alternative 4 (the preferred alternative). The design was optimized to maximize the environmental benefit and economic feasibility while still meeting or exceeding the CWPPRA conceptual restoration goal. The optimized alternative is hereafter referred to as "Alternative 4–Opt". In order to be more cost effective, the following modifications were assessed:

- Reduced beach fill template width by 25 feet (950 feet to 925 feet)
- Reduced marsh platform width by 100 feet (1,100 feet to 1,000 feet)
- Reduced dune crest width by 150 feet (200 feet to 50 feet)

The optimized alternative is designed to provide an approximate 10,600 foot long beach and dune fill. The gulfward limits of the beach fill are approximately aligned with the current shoreline position thus the majority of the existing island framework is covered by the proposed beach and dune fill. The dune component includes a 50 foot wide crest width at +6 feet NAVD88 with 1:45 side slopes. The beach fill template includes a variable width, 315 feet to 415 feet wide, construction berm that extends from the Gulf side beach fill crest to the Gulf side toe of the dune at +4 feet NAVD88 with 1:45 side slopes. The average beach fill width measured at MHW is approximately 925 feet. The area of the proposed beach platform is approximately 261 acres measured at +4 feet

NAVD88. The optimized required fill volume is approximately 1.88 million cubic yards including the preliminary design criteria for the overfill ratio and two years of background erosion equal to the gulf-side erosion less the overwash. The optimized required excavation volume including the preliminary design criteria for the cut to fill ratio is approximately 2.44 million cubic yards.

This alternative is also designed to provide an approximately 12,000 foot long by 1,000 foot wide marsh platform on the bay side of Scofield Island. The marsh is also placed west of the beach fill on the west end of the island. The optimized area of the proposed marsh platform is approximately 273 acres. The target marsh platform elevation is +3.0 feet NAVD88 accounting for the preliminary design criteria on average existing marsh elevation, sea level rise, subsidence and consolidation. The optimized required fill volume is approximately 1.69 million cubic yards. The optimized required excavation volume including the preliminary design criteria for the cut to fill ratio is approximately 2.70 million cubic yards.

A summary of the design parameters is presented in Table 9-17.

**Table 9-17: Summary of optimized beach, dune and marsh parameters for Alternative 4-Opt**

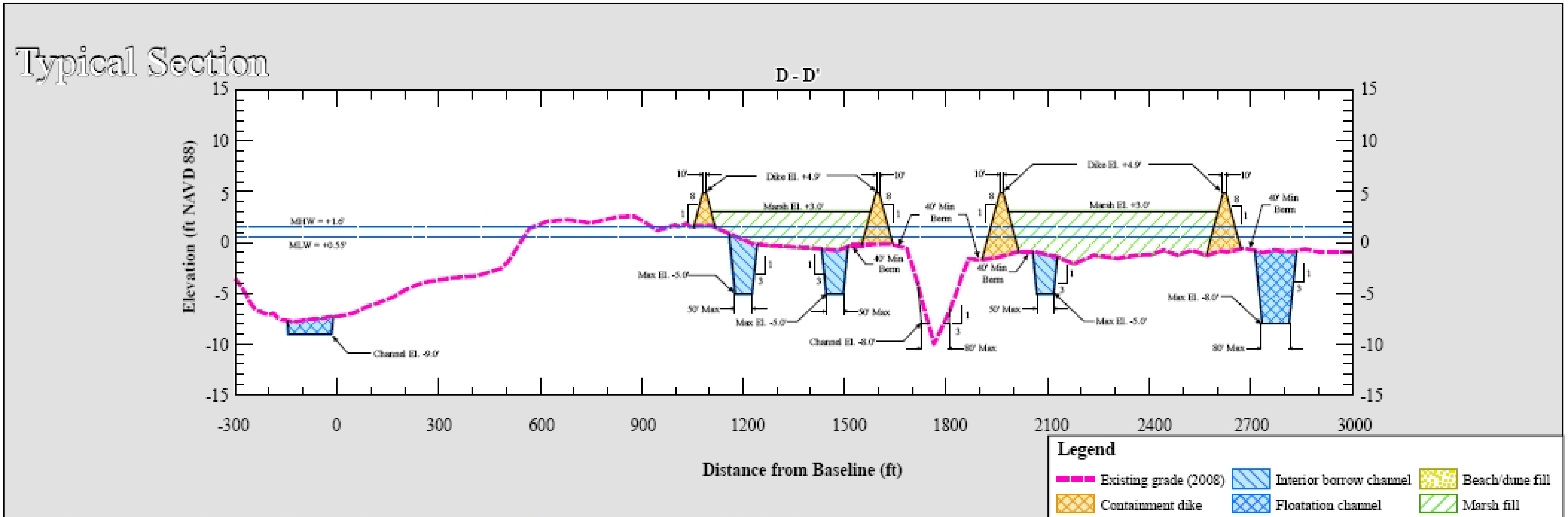
| | Beach / Dune | Marsh Platform |
|---|---|---|
| Average Length (ft) | 10,600 | 12,000 |
| Optimized Average Width (ft) | 925 / 50 | 1,000 |
| Elevation (ft NAVD88) | +4 / +6 | +3 |
| Surface Area (acres) | 261 | 273 |
| Side Slopes (V:H) | 1:45 | NA |
| Optimized Required Fill Volume (mcy) | 1.88 | 1.69 |
| Cut-to-Fill Ratio | 1.3 | 1.6 |
| Optimized Required Excavation Volume (mcy) | 2.44 | 2.70 |

An 11,800-foot long containment dike will be constructed to separate the beach/dune fill area from the marsh fill area. A second containment dike, which will be approximately 20,000 feet in length, will be constructed along the northern limits of the marsh platform to prevent sediment migration into the bay. The fill that will be used for the containment dikes will be excavated from a 21,020-foot long floatation channel located along the northern and western perimeter of Scofield Island. A summary of the design parameters for the containment dikes and the floatation channel is provided in Table 9-18.

**Table 9-18: Summary of optimized containment dike and floatation channel parameters for Alternative 4-Opt**

| | Beach/Marsh Separation Dike | Marsh Containment Dike | Floatation Channel |
|---|---|---|---|
| Length (ft) | 11,800 | 20,000 | 21,020 |
| Required Fill Volume (cy) | 161,700 | 415,000 | NA |
| Cut-to-Fill Ratio | 2:1 | 2:1 | NA |
| Required Excavation Volume (cy) | 323,400 | 830,000 | NA |

A plan view and typical cross-section for Alternative 4-Opt are presented in Figures 9-4 and 9-5.



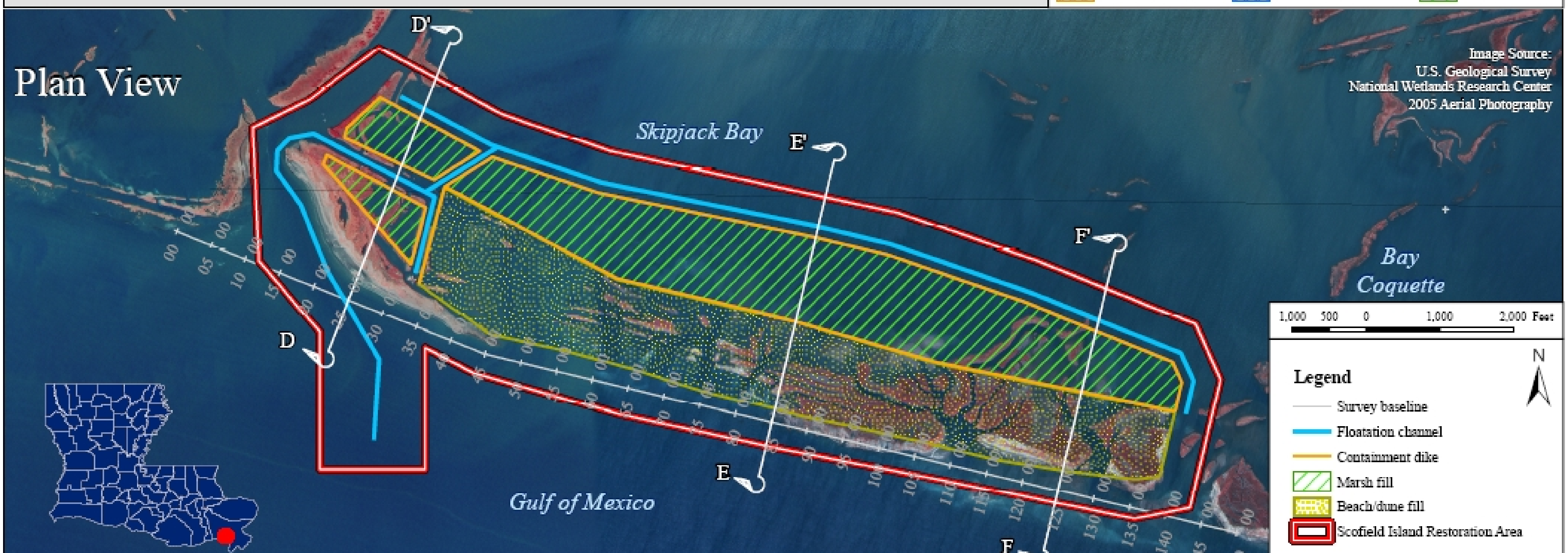




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**Figure 9-4**
**Preliminary Design:**
**Alternative 4-Optimized - Plan View and Typical Cross-section**

January 2010 | Project Number: BA-40

SJB GROUP, LLC
QUALITY BY DESIGN
P.O. BOX 1751 PHONE: (225) 769-3400
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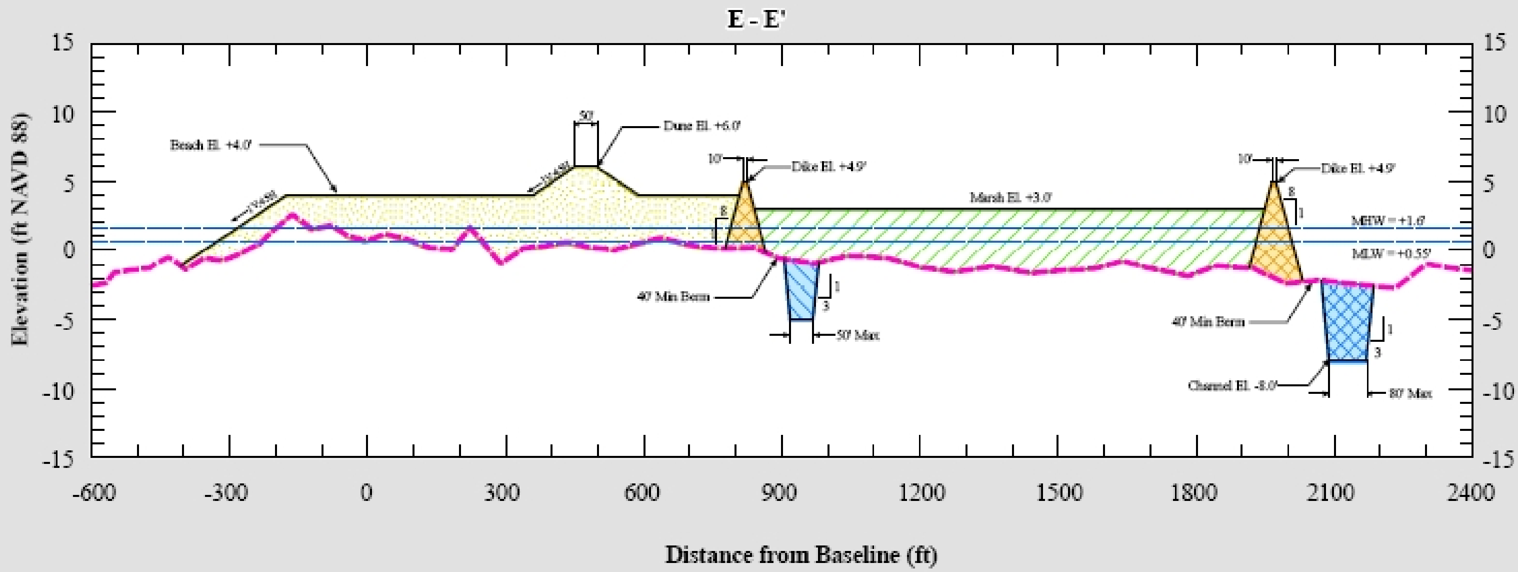
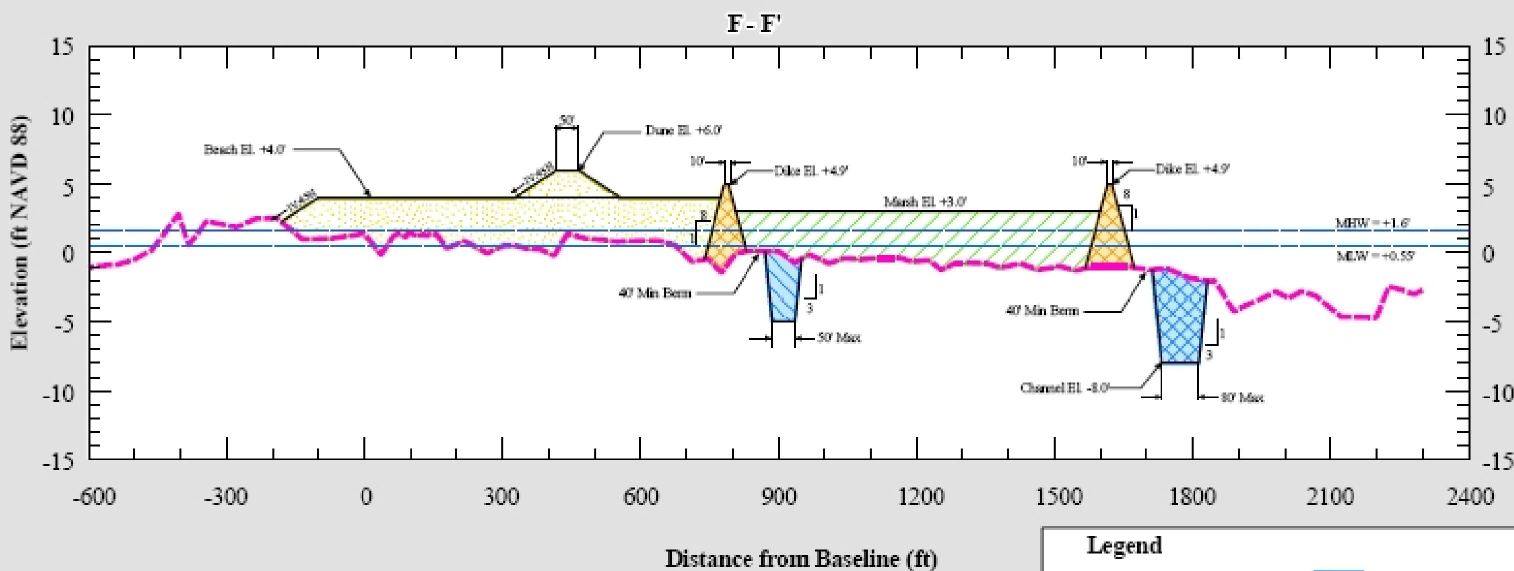
# Typical Sections




**Legend**

- Existing grade (2008)
- Containment dike
- Interior borrow channel
- Floatation channel
- Beach/dune fill
- Marsh fill


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**Figure 9-5**
**Preliminary Design:**
**Alternative 4-Optimized - Typical Cross-sections**

January 2010 | Project Number: BA-40


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QUALITY BY DESIGN
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Habitat acreage modeling using the Barrier Island Community Wetland Value Assessment Model was performed to compare the acreages created and sustained by Alternative 4-Opt to the CWPPRA conceptual restoration goal. Based on the modeling results, the total habitat acreages created for Year 1 and yielded at Year 20 exceeds the CWPPRA goals of 429 acres and 278 acres, respectively (see Tables 9-19 and 9-20).

**Table 9-19: Habitat acreages for Year 1**

| Habitat | Alternative 2 (acres) | Alternative 3 (acres) | Alternative 4-Opt (acres) |
|---|---|---|---|
| Subtidal (Bay) | 11.0 | 23.6 | 10.8 |
| Intertidal (Bay) | 32.3 | 102.7* | 21.0 |
| Supratidal | 499.4 | 436.4 | 507.7 |
| Dune | 30.0 | 29.8 | 29.9 |
| Intertidal (Gulf) | 23.4 | 23.3 | 27.2 |
| Total | 596.0 | 615.8 | 596.6 |
| Adjusted Total* | 561.6 | 568.9 | 558.7 |
| CWPPRA Goal | 429.0 | 429.0 | 429.0 |

*Adjusted total was calculated by subtracting subtidal (Bay) and intertidal (Gulf) from the Total

**Table 9-20: Habitat acreages for Year 20**

| Habitat | Alternative 2 (acres) | Alternative 3 (acres) | Alternative 4-Opt (acres) |
|---|---|---|---|
| Subtidal (Bay) | 46.4 | 51.0 | 95.5 |
| Intertidal (Bay) | 407.4 | 364.3 | 284.5 |
| Supratidal | 29.8 | 39.7 | 149.7 |
| Dune | 0.0 | 0.0 | 0.0 |
| Intertidal (Gulf) | 19.5 | 19.7 | 29.6 |
| Total | 503.1 | 474.7 | 559.3 |
| Adjusted Total* | 437.2 | 404.0 | 434.2 |
| CWPPRA Goal | 278.0 | 278.0 | 278.0 |

*Adjusted total was calculated by subtracting subtidal (Bay) and intertidal (Gulf) from the Total

Alternative 4-Opt was also evaluated using SBEACH to assess storm protection benefits. Based on the results of the modeling efforts, Alternative 4-Opt resulted in the smallest shoreline recession and highest post-storm dune elevation. Therefore, Alternative 4-Opt outperformed Alternatives 2 and 3.

One of the primary differences between Alternative 4 and Alternative 4-Opt is the amount of fill needed for construction. By decreasing the size of the beach and dune template and the marsh platform, the opinion of construction cost was reduced from $50,582,000 for Alternative 4 to $46,016,000 for Alternative 4-Optimized.

# 10.0 PRELIMINARY DESIGN: SUMMARY

The preceding sections detailed the data collection and analyses that were conducted in support of the preliminary design for the Project. This information was used to develop design plans and details for each of the four primary components of the Project:

- Mississippi River Borrow Areas
- Conveyance Corridor
- Scofield Offshore Borrow Area
- Scofield Island Restoration Area

In order to meet the Project goals of restoring and preserving the structural integrity of Scofield Island and creating and sustaining intertidal habitats, Riverine sand will be excavated from the borrow area(s) located in the Mississippi River. The sand will be transported through a sediment pipeline over the Mississippi River and Hurricane Protection Levees and down the Empire Waterway to the Gulf of Mexico located within the Conveyance Corridor. The sand will be placed on Scofield Island to restore the beach and dune system. Sediment from the SOBA will be excavated and transported to Scofield Island to create the marsh platform.

Based on the evaluation presented in the previous sections, the preliminary design will meet or exceed the goals of the Project. The following sections summarize the primary components of the preliminary design. The associated design plans are provided at the end of the report.

## 10.1 Mississippi River Borrow Areas

Two Riverine borrow areas, MR-B-09 and MR-E-09, were identified as containing significant quantities of beach compatible sand for restoring the beach and dune system on Scofield Island. The selection of MR-B-09 and MR-E-09 was based on the review of an extensive amount of prior survey data and geologic analyses. Further detailed geophysical and geotechnical surveys were subsequently conducted to assist in the development of the borrow area preliminary design plans.

In order to provide the maximum amount of flexibility to the contractor, MR-B-09 and MR-E-09 can both be used to supply the Riverine sand for the restoration efforts. This will allow contractors to use one or both borrow areas throughout construction, thus reducing potential downtime due to navigational operations on the Mississippi River. The contractors will also be able to choose between hydraulic cutterhead and hopper dredge equipment for excavation. This will be very beneficial in the bidding process because it will allow contractors with different types of equipment to compete for the Project.

The MR-B-09 design plan is linear and narrow, extending around the river bend. It is approximately 14,700 feet long, with a width ranging from 360 to 800 feet and a thickness up to 24 feet. The MR-E-09 design plan is rectangular in form and is approximately 9,500 feet long, 1,100 feet wide and 25 feet thick.

Preliminary design isopach studies conducted for the design cut depth of –66 feet NAVD88 indicate that Borrow Areas MR-B-09 and MR-E-09 contain approximately 2.36 and 3.86 million cubic yards of sediment, respectively. During periods of low water levels, the maximum depth of excavation is –73 feet NAVD88, which includes an allowable overdredge of 3 feet. The estimated sand volume at this depth is 3.77 and 5.86 million cubic yards for MR-B-09 and MR-E-09, respectively.

Based on the design analysis, both MR-B-09 and MR-E-09 contain sufficient volumes of suitable sand to meet the excavation volume requirements (2.44 million cubic yards) for beach and dune restoration on Scofield Island. A summary of the design parameters is presented in Table 10-1.

**Table 10-1: Summary of design parameters for MR-B-09 and MR-E-09**

| Parameter | MR-B-09 | MR-E-09 |
|---|---|---|
| Average Grain Size (mm) | 0.16 | 0.19 |
| Borrow Area Length (ft) | 14,700 | 9,500 |
| Borrow Area Width (ft) | 360 to 800 | 1,100 |
| Borrow Area Thickness (ft) | 24 | 25 |
| Borrow Area Volume (mcy) | 3.77 | 5.86 |

## 10.2 Conveyance Corridor

The Conveyance Corridor begins at approximate MM 28.9 AHP. The sediment pipeline will then cross the riverbank of the Mississippi River at this location determined primarily on the basis of land ownership. From this point the Conveyance Corridor extends in a general southwesterly direction for just under one mile to the Empire Waterway. In order to reach the Empire Waterway, the sediment pipeline will cross the Mississippi River Levee as an above ground pipeline. Once over the levee, the sediment pipeline will be routed beneath Highway 11 (which is a two-lane highway) and Highway 23 (which is a four-lane highway) by jack-and-bore. The sediment pipeline will then surface and cross the Hurricane Protection Levee as an above ground pipe. The property along this route consists of a closed hurricane debris landfill operated by the PPG, the Empire Boat Harbor and the adjacent canal, a small area of saltwater marsh, and the rock breakwater at the Empire Locks

The sediment pipeline will then parallel the Empire Waterway to the coastline of the Gulf of Mexico. The sediment conveyance pipeline is expected to cross 28 pipelines and 6 navigation crossings. However, the 26-inch TGP was the only pipeline that was considered to be a potential hazard since it crossed the Empire Waterway near the intersection of the waterway and a navigation crossing. Based on discussions with the pipeline owner, the TGP will be protected with an 18-inch buffer. The sediment pipeline shall be placed in a manner to provide for navigation at the six crossings along the Empire Waterway.

From the mouth of the Empire Waterway, the sediment pipeline will then extend into the Gulf of Mexico at a water depth that will not hinder to vessel navigation. From this point the sediment pipeline will proceed eastward to Scofield Island.

The total pumping distance will be from 19 to 24 miles, depending on which borrow area is utilized. Two booster pump sites will likely be required in the Empire Waterway and one in the Mississippi River near MM 28.9 AHP if MR-E-09 is utilized. If a hopper dredge is utilized, a pump-out site will be required in the river.

### 10.3 Scofield Offshore Borrow Area

The SOBA lies approximately three miles south of Scofield Island, at depths ranging from -18 to -20 feet NAVD88. Geotechnical analysis of the area revealed that the sediment will be suitable to restore the marsh on Scofield Island. Furthermore, both the distance and depth indicate that a hydraulic cutterhead dredge can excavate and directly pump the sediment to Scofield Island to create the back-barrier marsh platform.

The SOBA was delineated to include the interdigitated strata of sandy, silty, and clayey sediment. The design plan is approximately 2,800 feet long and 1,900 feet wide at the top of cut, with a thickness ranging from 20 to 22 feet. Based on this delineation, the total estimated volume in the SOBA is approximately 3.3 million cubic yards. Based on the design analysis, the SOBA contains sufficient volume of suitable mixed sediment to meet the excavation volume requirements (2.70 million cubic yards) for marsh creation on Scofield Island. A summary of the design parameters for the SOBA is provided in Table 10.2.

**Table 10-2: Summary of design parameters for SOBA**

| Parameter | Value |
|---|---|
| Average Grain Size | 0.10 mm |
| Borrow Area Length | 2,800 ft |
| Borrow Area Width | 1,900 ft |
| Borrow Area Thickness | 20 to 22 ft |
| Borrow Area Volume | 3.3 mcy |

### 10.4 Scofield Island Restoration Area

The preliminary design for Scofield Island consists of three primary elements: 1) marsh platform, 2) beach, and 3) dune. Secondary elements include containment dikes and floatation channels that will also serve as borrow areas for dike fill. Additional “interior” containment dikes will be constructed within the marsh platform to contain the sediment-laden water and to control return water.

The design alternative that was selected for the restoration of Scofield Island (Alternative 4-Opt) will consist of a 10,600-foot long beach and dune fill with an average width of 925 feet measured at MHW aligned with the existing shoreline of Scofield Island which covers the existing island framework. The design dune crest width is 50 feet. The design elevations for the beach and dune are +4 ft NAVD88 and +6 ft NAVD88, respectively. At an elevation of +4 feet NAVD88, the area of the platform is approximately 261 acres. The required fill volume is approximately 1.88 million cubic yards corresponding to the required excavation volume of approximately 2.44 million cubic yards.

The marsh platform is approximately 12,000-feet long by 1,000-feet wide. The marsh extends beyond the beach and dune fill on the west end of the island. The total area of the marsh platform is approximately 273 acres. The target marsh platform elevation is +3.0 feet NAVD88. The required fill volume is approximately 1.69 million cubic yards corresponding to the required excavation volume of approximately 2.70 million cubic yards.

A summary of the design parameters is presented in Table 10-3.

**Table 10-3: Summary of beach, dune and marsh parameters for Scofield Island**

| | Beach / Dune | Marsh Platform |
|---|---|---|
| Average Length (ft) | 10,600 | 12,000 |
| Average Width (ft) | 925 / 50 | 1,000 |
| Elevation (ft NAVD88) | +4 / +6 | +3 |
| Surface Area (acres) | 261 | 273 |
| Side Slopes (V:H) | 1:45 | NA |
| Required Fill Volume (mcy) | 1.88 | 1.69 |
| Cut-to-Fill Ratio | 1.3 | 1.6 |
| Required Excavation Volume (mcy) | 2.44 | 2.70 |

An 11,800-foot long containment dike will be constructed to separate the beach/dune fill area from the marsh fill area. A second containment dike, which will be approximately 20,000 feet in length, will be constructed along the northern limits of the marsh platform to prevent sediment migration into the bay. The fill that will be used for the containment dikes will be excavated from a 21,020-foot long floatation channel located along the northern and western perimeter of Scofield Island. A summary of the design parameters for the containment dikes and the floatation channel is provided in Table 10-4.

**Table 10-4: Summary of containment dike and floatation channel parameters for Scofield Island**

| | Beach/Marsh Separation Dike | Marsh Containment Dike | Floatation Channel |
|---|---|---|---|
| Length (ft) | 11,800 | 20,000 | 21,020 |
| Required Fill Volume (cy) | 161,700 | 415,000 | NA |
| Cut-to-Fill Ratio | 2:1 | 2:1 | NA |
| Required Excavation Volume (cy) | 323,400 | 830,000 | NA |

## 11.0 REFERENCES

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