State of Louisiana
Department of Natural Resources
Coastal Engineering Division

2006/2007 Annual Inspection Report

for

BARATARIA LANDBRIDGE SHORELINE PROTECTION PROJECT – Phases 1, 2, 3 and 4

State Project Number (BA-27), (BA-27c) and (BA-27d)
Priority Project List 7, 9 and 11

June 21, 2007
Jefferson and Lafourche Parishes

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I. Introduction

The Barataria Landbridge Shoreline Protection (BA-27) Project (Phases 1, 2, 3 and 4) is located approximately 14 miles south of the town of Lafitte in Jefferson and Lafourche Parishes, Louisiana and is separated into six (6) construction units (CU). Phase 1 identified as (BA-27) consists of CU# 1, and portions of CU#2, CU#4 and CU#5. Phase 2, also identified as (BA-27), encompasses another segment of CU#4. Phase 3 is identified as (BA-27c) and includes portions of CU#3, CU#4 and CU#5. Phase 4 designated (BA-27d) includes the entire segment of CU#6 (Figure 1). Below are a brief description, location and status of all construction units associated with the Barataria Landbridge Shoreline Protection Project (BA-27), (BA-27c) and (BA-27d):

Construction Unit No. 1 (CU#1) – CU#1 is a 5 year demonstration project completed in July 2001 and consists of approximately 3,340 linear feet of shoreline protection treatments along the east bank of Bayou Rigolettes and the west bank of Bayou Perot. The shoreline treatments of CU#1 utilizes various methods of shoreline protection to reduce shoreline erosion along the existing banks of Bayou Perot and Bayou Rigolettes and assesses the constructability and economic feasibility of constructing future projects using these techniques on the Barataria Landbridge Shoreline Protection Project (BA-27) (Figure 2).

Construction Unit No. 2 (CU#2) – CU#2 was completed in October 2002 and consists of approximately 6,403 linear feet of shoreline protection (rock dike) parallel to the southeast shoreline of Bayou Rigolettes and Bayou Perot west of the Harvey Cutoff Canal (Figure 3) (O&M Plan, 2002).

Construction Unit No. 3 (CU#3) – CU#3 was completed in May 2004 and consists of approximately 10,865 linear feet of rock dike along the northeast shoreline of Little Lake and the south bank of Bayous Rigolettes (Figure 4) (O&M Plan, 2005).

Construction Unit No.4 (CU#4) – CU#4 is currently under construction and includes the construction of approximately 30,500 linear feet of concrete pile wall along the southeast shoreline of Bayou Rigolettes and the mouth of the Harey Cutoff Canal.

Construction Unit No. 5 (CU#5) – CU#5 is currently under construction and includes approximately 14,000 linear feet of concrete wall along the southwest shoreline of Bayou Perot.

Construction Unit No. 6 (CU#6) – CU#6 was completed in late 2005 and consisted of the construction of 29,500 linear feet of shoreline protection (rock revetment) along northern reach of the east bank of Bayou Rigolettes (Figure 5).

In January 2005, NRCS made a request at the CWPPRA task force meeting for funding to construct CU #5 which included rock revetment, foreshore rock dikes and concrete wall panels along the southwest bank of Bayou Perot and the northern bank of Little Lake. Consequently, approval was given for only a portion of CU#5. Due to the partial funding authorized by the CWPPRA task force, CU #5 was separated into two (2) construction units, creating CU #7 which would included the portion of CU 5 not approved for funding. CU#5, currently under construction, consists of the concrete wall component of the original request. CU#7 made up the remainder of the CU#5 project features consisting of the rock revetment and foreshore rock dikes.

> Construction Unit No.7 (CU#7) is currently on hold pending future funding for construction. As of now, the proposed features of construction unit No.7 include approximately 19,500 linear feet of rock revetment and 2,000 linear feet of foreshore rock dike along the southwestern bank of Bayou Perot and the northern bank of Little Lake.

The 2006/2007 Annual Inspection Report will cover the completed portion of the project only (CU#'s 1, 2, 3 & 6).

Construction of the Barataria Basin Landbridge Project (BA-27) was authorized by Section 303(a) of Title III Public law 101-646, the Coastal Wetlands Planning Protection and Restoration Act (CWPPRA) enacted on November 29, 1990, as amended. Phases 1 & 2 (BA-27), Phase 3 (BA-27c) and Phase 4 (BA-27d) of the Barataria Landbridge Shoreline Protection Project were approved on the 7th, 9th and 11th Priority Project List, respectively.

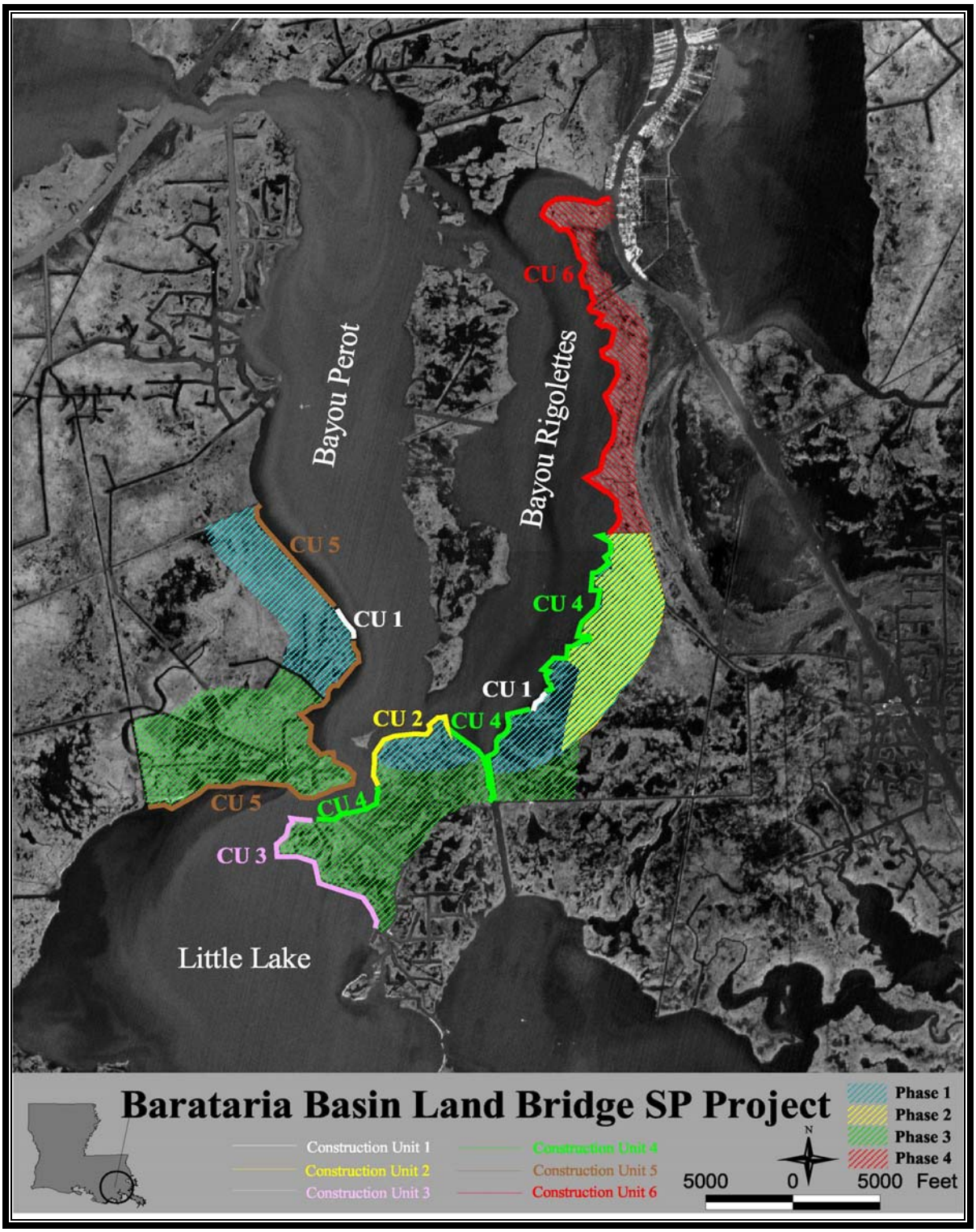

Figure 1. Overall map of the Barataria Landbridge Shoreline Protection Project (BA-27) showing all Phases and Construction Units (map source: USDA/NRCS).

II. Inspection Purpose and Procedure

The purpose of the annual inspection of the Barataria Landbridge Shoreline Protection Projects (BA-27), (BA-27c) and (BA-27d) is to evaluate the constructed project features, identify any deficiencies, prepare a report detailing the condition of such features and to recommend corrective actions needed, if any (O&M Plan, 2002 & 2005). Should it be determined that corrective actions are needed, LDNR shall provide in report form, a detailed cost estimate for engineering, design, supervision, inspection, construction contingencies, and an assessment of the urgency of such repairs (O&M Plan, 2002 & 2005). The inspection report also contains a summary of maintenance projects undertaken since the constructed features were completed and an estimated project budget for the upcoming three (3) years for operation and maintenance and rehabilitation. The three (3) year projected operation and maintenance budgets for CU#1, CU#2, CU#3 and CU#6 based on the outcome of this inspection are shown in Appendix B. A summary of past operation and maintenance projects undertaken since the completion of the Barataria Landbridge Shoreline Protection (CU#1, CU#2, CU#3 and CU#6) project are outlined in Section IV of this report.

An inspection of the Barataria Landbridge Shoreline Protection Project (CU#1, CU#2, CU#3 and CU#6) was held on February 13, 2007 under partly cloudy skies and mild temperatures. In attendance were Brian Babin, Elaine Lear and Shane Triche of LDNR and Warren Blachard and Bob Payton of NRCS. The attendees met at the Clovelly Canal Public Boat Launch at approximately 7:30 a.m. The inspection began at approximately 8:15 a.m. and ended at 10:30 a.m. The GIWW to Clovelly Hydrologic Restoration Project (BA-02) was also inspected on this day. The field investigation included a visual inspection of the constructed project features.

III. Project Description and History

The Barataria Basin Landbridge Shoreline Protection Project area is located within the Barataria Basin, which is bounded on the north and east by the Mississippi River, on the west by Bayou Lafourche, and on the south by the Gulf of Mexico. The upper portion of the Barataria Basin is largely a freshwater-dominated system of natural levee ridges, bald-cypress, water tupelo swamps, and fresh marsh habitats (Monitoring Plan, October 2003). The lower portion of the basin is dominated by marine/tidal processes, with barrier islands, saline marsh, brackish marshs, tidal channels, and large bays and lakes (Monitoring Plan, October 2003). Historically, a small meandering Bayou Perot, and the longer, narrower Bayou Dupont, Bayou Barataria and Bayou Villars channels provided limited hydrologic connection between the upper and lower basin. The hydrologic connections between the upper and lower basin are much greater today due to the Barataria Waterway, Bayou Segnette Waterway, Harvey Cutoff, and substantial erosion and interior marsh loss along and between the now-enlarged Bayou Perot and Bayou Rigolettes have increased (Monitoring Plan, October 2003). Fortunately, there still exists a landmass that extends southwest to northeast across the basin, roughly between Lake Salvador and Little Lake. This landmass can be referred to as the “Barataria Basin Landbridge.” The shoreline protection project aims to

protect the functional integrity of this critical area of the Barataria Basin (Monitoring Plan; October 2003)

Major factors contributing to the excessive marsh loss in this area included the elimination of overbank flooding of the Mississippi River; closure of Bayou Lafourche and the Mississippi River; dredging of the Gulf Intracoastal Waterway, Barataria Waterway, Harvey Cutoff Canal, and oilfield access channels; physical erosion due to wind, boat wake, and tidal energy; subsidence, and sea level rise (Monitoring Plan; October 2003).

Project Objective

The project objective for the Barataria Basin Landbridge Project as a whole is to provide 107,500 linear feet of shoreline protection to areas along the west and south banks of Bayou Perot, the east and south banks of Bayou Rigolettes, the north and northeast banks of Little Lake, and the east and west banks of the Harvey Cutoff Canal in order to reduce or eliminate shoreline/bankline erosion of the Barataria Basin Landbridge (Monitoring Plan; 2003).

Specific Goal

Decrease the mean rate of shoreline/bankline erosion in subsections of the project area stratified according to historical erosion rates along Bayous Perot and Rigolettes, Little Lake, and Harvey Cutoff. This shall be accomplished through the use of one or more of the following shoreline protection techniques:

a) foreshore rock dike above spoil material
b) foreshore rock dike with lightweight core material
c) composite rock dike using furrow method
d) pre-stressed concrete pile and panel wall

Construction Unit No.1 (CU #1)

CU #1 of the Barataria Landbridge Shoreline Protection Project consists of the installation of a total of 3,340 linear ft. of shoreline protection along the west bank of Bayou Perot and southeast bank of Bayou Rigolettes (Figure 2). The shoreline features at each location included four different types of shoreline protection treatments measuring 400 feet in length, spaced 50 to 75 feet apart. Identified below are the tested techniques constructed along the shoreline at each location:

- Section A and A1 – consisted of approximately 200 linear foot of rock dike and 200 linear ft. of rock dike placed on freshly excavated spoil material.
- Section B – consisted of approximately 400 linear ft. of composite rock dike with a lightweight aggregate core encapsulated in geotextile fabric.

- Section C – consisted of approximately 400 linear ft. of composite rock dike using a furrow method to place and encapsulate the lightweight aggregate core.
- Section D – consisted of approximately 400 linear ft. of pre-stressed concrete pile and panel wall.

The purpose of the Barataria Landbridge Shoreline Protection Project (Phase I – CU #1) is to evaluate several methods of shoreline protection that would reduce or minimize shoreline/bank line erosion along Bayou Perot and Bayou Rigolettes. The performance of these test sections were monitored and assessed during the five (5) year demonstration period by the Natural Resource Conservation Service (NRCS). The evaluation of the test sections included the constructability, construction cost, short-term stability, maintenance cost, and aesthetic quality. The final report, "Evaluation of Shoreline Protection Techniques on Highly Organic Soil Foundations, Barataria Basin, Louisiana", NRCS concluded that construction costs, constructability, structural stability and maintenance costs supported the selection of the concrete sheetpile wall as the most suitable method of shoreline protection in areas of highly organic soil foundations prevalent in the Barataria Basin (Lafleur, Kinler, Garber and Sticker, N.D.)

CU# 1 of the Barataria Landbridge Project is a demonstration project with an anticipated project life of 5 years, which began in July 2001.

Construction Unit No.2 (CU #2)

CU #2 of the Barataria Landbrige Shoreline Protection Project consist of a 2,712 linear foot rock dike on the west side of an existing oil field canal opening on the southern bank of Bayou Rigolettes and 3,691 linear foot rock dike from the east bank of the existing oil field canal to the opening of the Harvey Cutoff Canal (Figure 3). The rock dike was constructed to an elevation of +3.5' NAVD with a 2.0 ft. wide crest and 2:1 side slopes (O&M Plan, 2002).

Barataria Landbridge Shoreline Protection Project (CU #.2) was constructed to reduce erosion and marsh loss along the south bank of Bayou Rigolettes and Bayou Perot west of the Harvey Cutoff Canal. Major factors contributing to erosion and marsh loss in this area is physical erosion due to wind, boat-wake, tidal energy, subsidence and sea level rise (Monitoring Plan; 2003).

CU# 2 of the Barataria Landbridge Project has a twenty (20 year) economic life, which began in October 2002.

Construction Unit No.3 (CU #3)

CU #3 consists of approximately 10,865 linear feet of rock dike along the northeast shoreline of Little Lake (Figure 4). The rock rip rap structure was constructed to an elevation of +3.5' NAVD with a 4' wide top width and 3:1 side slopes. The rock dike was constructed over a geotextile fabric. Two (2) fish dips were constructed at Sta. 43+05 and Sta. 74+79 consisting

of a 60’ wide (bottom width) opening in the rock dike to allow for marine organism access. Warning signs were installed at both fish dips and at the entrance of an existing oilfield canal plugged with rock riprap near Sta. 96+00 (O&M Plan, 2005). CU#3 also included a beneficial use of dredge material component in which spoil material resulting from flotation channel excavation was used to fill seven (7) small ponds in the marsh behind the rock dike creating a total of 30 acres of marsh.

CU #3 of the Barataria Landbridge Project has a twenty (20 year) economic life which began in May 2004.

Construction Unit No.6 (CU #6)

CU #6 consists of approximately 29,500 linear feet of rock shoreline revetment along the east bank of Bayou Rigolettes. The rock revetment was constructed to an elevation of 3.5 ft NAVD with a top width of 4 ft. and 3:1 side slopes. At seven locations along the rock revetment, organism access openings were constructed to allow continued aquatic organism ingress and egress and provide adequate discharge of surface water flow. Each opening was lined with two (2) ft of rock to a sill elevation two (2) ft below the average water elevation of -0.8 ft NAVD.

CU #6 of the Barataria Landbridge Project has a twenty (20 year) economic life which began in April 2006.

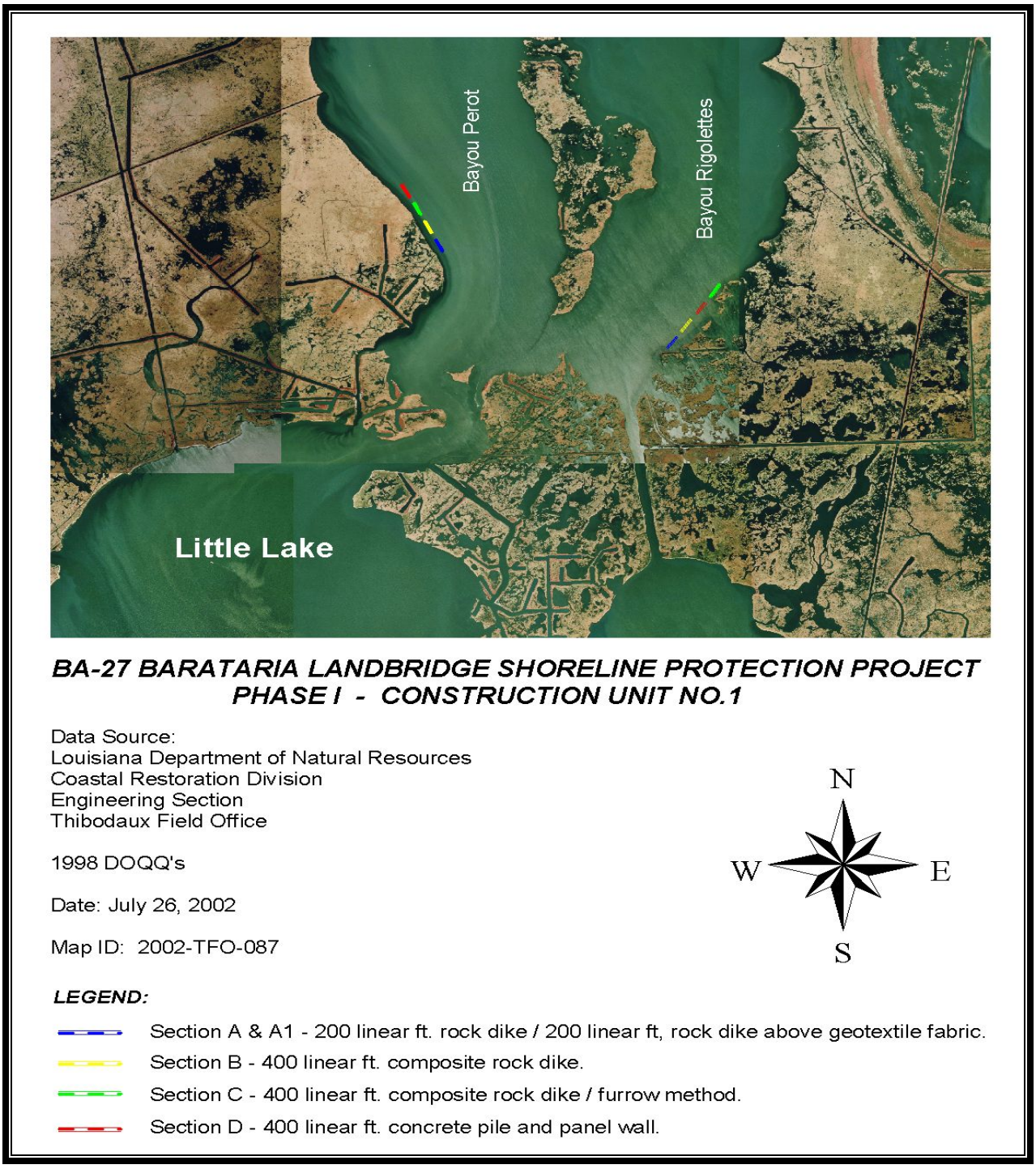

Figure 2. Project infrastructure map for the Barataria Landbridge Shoreline Protection Project (BA-27) – CU #1

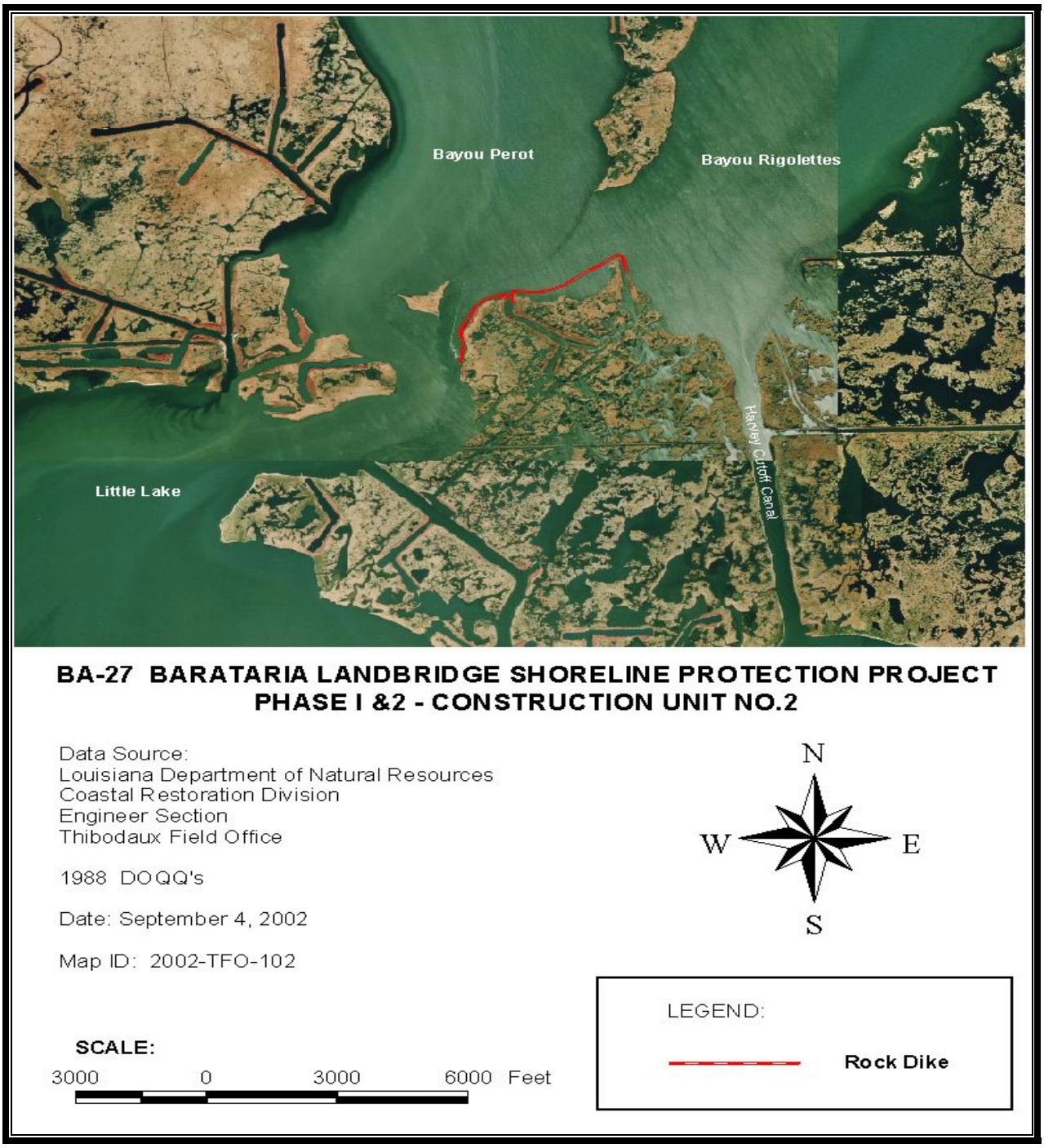

Figure 3. Project infrastructure map for the Barataria Landbridge Shoreline Protection Project (BA-27) – CU #2.

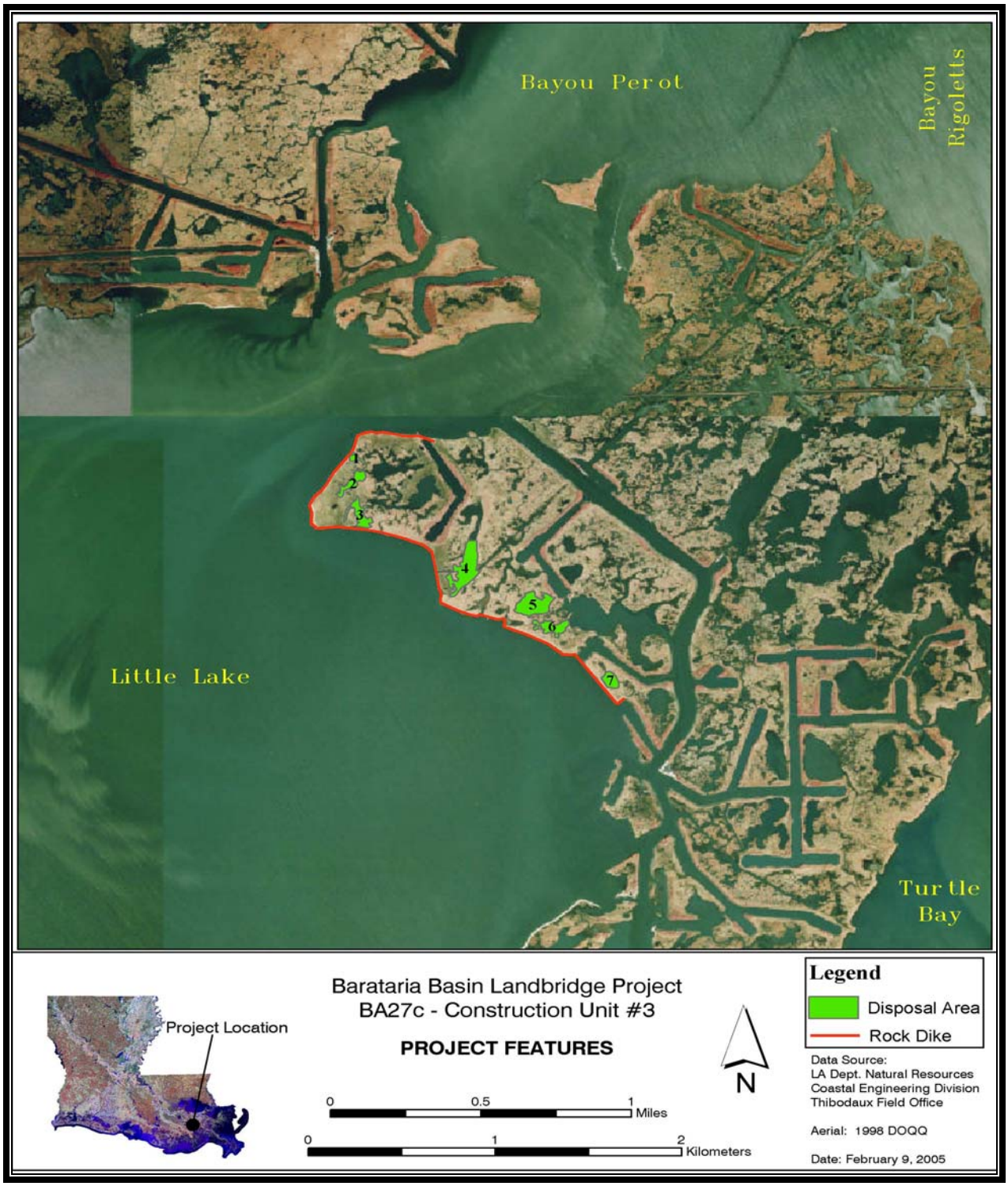

Figure 4. Project infrastructure map for the Barataria Landbridge Shoreline Protection Project (BA-27c) – CU #3.

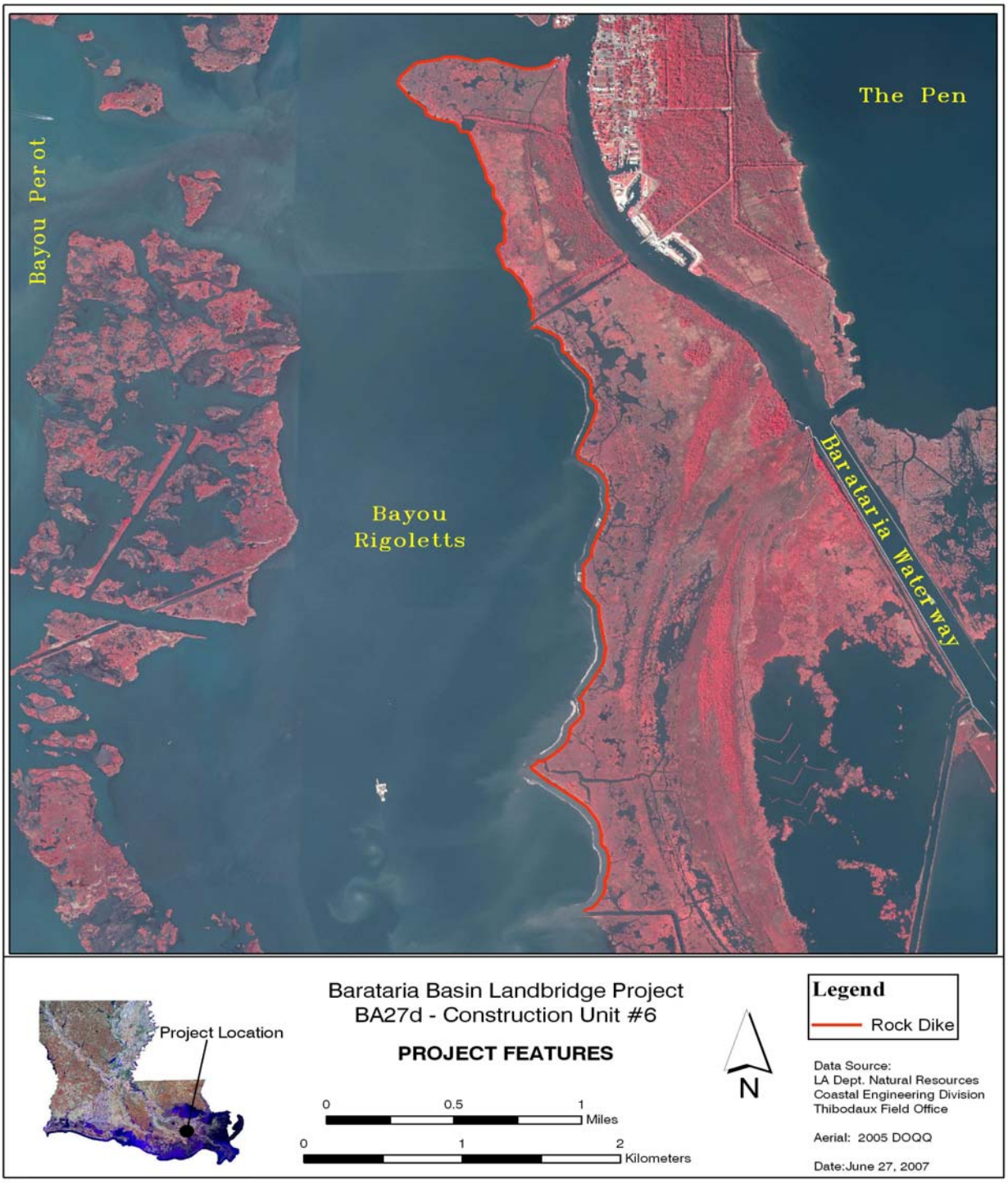

Figure 5. Project infrastructure map for the Barataria Landbridge Shoreline Protection Project (BA-27d) – CU #6

IV. Summary of Past Operation and Maintenance Projects

Construction Unit #1 is a demonstration project which does not include provisions in the cost-share agreement for operation and maintenance. However, NRCS will be utilizing the concrete wall features of CU#1 in the construction of CU#4 and CU#5. Since the completion of Construction Units #2, #3 and #6, no maintenance events have been required.

V. Inspection Results

BA-27 -Construction Unit No. 1 (CU#1)

Due to time constraints and the close proximity of ongoing construction of Construction Unit #4, the shoreline protection treatments located along Bayou Rigolettes and Bayou Perot were not included in the 2006/2007 Annual Inspection. The five (5) year demonstration period for testing each treatment ended in July 2006. The results presented by NRCS in the final report concluded that the concrete pile and wall treatment was the most suitable method of shoreline protection in the organic soils prevalent in the Barataria Basin. Detail information and analysis regarding the performance of each treatment is outlined in Appendix D, "Evaluation of Shoreline Protection Techniques on Highly Organic Soil Foundations".

Construction Units #4 and #5, currently under construction, will tie into the ends of the existing 400 ft concrete wall section constructed under Construction Unit #1 along Bayou Rigolettes (Site No.1) and Bayou Perot (Site No.2). The remaining three (3) treatments at each site will remain in place behind the newly constructed concrete wall.

BA-27 -Construction Unit No. 2 (CU#2)

The inspection of Construction Unit #2 began at the east end of the east reach near Sta. 36+83 and proceeded westward to the end of the west reach near Sta. 0+42. As reported on previous field inspections, we noted a low area from Sta. 29+50 to Sta. 31+50. It is apparent that the soils in this area are poor causing consolidation rates to increase during placement of the rock rip rap. As-built drawings indicated that the final crest elevation of the rock dike in this area after construction was +2.0 ft NAVD. From our observations and approximate water elevation at the time of the inspection, we concluded that the rock dike is currently at an elevation of +1.5 ft NAVD. The inspection team will continue to monitor this location on future site visits (Appendix B, Photos 1 & 2).

We also noted a slight dip in the rock dike above the existing Exxon/Humble pipeline right-of-way located near Sta. 12+33 of the west reach. As-built drawings indicate that the finished elevation of the rock dike after construction was +3.0 NAVD. From field measurements on the day of the inspection, we estimate that the rock dike has not settled significantly from the constructed elevation.

Signs and supports aligning the rock dike were also in good condition. All features related to Construction Unit #2 are in good condition and no maintenance is required at this time.

BA-27c -Construction Unit No. 3 (CU#3)

The inspection of Construction Unit #3 began near the mouth of Bayou Perot and northeast bank of Little Lake at Sta. 0+00 and proceeded along the northeast and east bank of Little Lake to the end of the project near Sta. 108+65. A visual inspection of the project revealed that the rock dike was in very good condition with no displacement or settlement since construction of the structure. The marsh tie-ins on both ends of the project were also in very good condition with no noticeable erosion or wash-outs. The marsh disposal areas behind the rock dike appeared to be in good condition with plenty vegetation. Overall, Construction Unit #3 was in very good condition with no noted deficiencies (Appendix B, Photos 3 through 5)

BA-27d – Construction Unit No.6 (CU#6)

The inspection of Construction Unit #6 began at Sta. 307+78 near the Barataria Waterway and proceed along the east bank of Bayou Rigolettes to Sta. 00+00 near an existing oilfield access canal. The rock dike appeared to be in very good condition with no apparent damage of settlement. All sings and supports located at the fish dip locations were also in good condition. Overall, the foreshore rock dike was in very good condition and will not require any corrective actions. (Appendix B, Photos 6 through 8)

V. Conclusions and Recommendations

Overall, the Barataria Landbridge Shoreline Protection Project (BA-27) appeared to be in very good condition with only minor deficiencies noted in the above inspection results. NRCS and DNR agree that these deficiencies noted are minor and will not require corrective actions or maintenance at this time. No immediate or programmatic maintenance required. We are recommending that a structural assessment surveys be conducted sometimes in next couple of years to evaluate settlement and determine whether maintenance is needed.

References:

Hymel, Melissa, August 2003. *Monitoring Plan*, Barataria Basin Landbridge Shoreline Protection (Phases 1, 2 & 3), Louisiana Department of Natural Resources, Coastal Restoration Division, 11 pp.

LDNR, July 2002. *Operation, Maintenance and Rehabilitation Plan, BA-27* Barataria Landbridge Shoreline Protection Phases 1 & 2 (Construction Units No. 1 & 2), Louisiana Department of Natural Resources, Coastal Engineering Division.

LDNR, February 2005. *Operation, Maintenance and Rehabilitation Plan,* BA-27c Barataria Landbridge Shoreline Protection Phase 3 (Construction Unit No. 3) , Louisiana Department of Natural Resources, Coastal Engineering Division.

Appendix A

Inspection Photos

Photo No. 1 – (BA-27 CU#2) – Beginning of rock dike near the mouth of the Cut Off Canal.

Photo No. 2 – (BA-27 CU#2) – rock dike beginning the west reach in an existing location canal.

Photo No. 3 – (BA-27 CU# 3) - beginning of rock dike located along the south bank of Bayou Perot.

Photo No. 4 – (BA-27 CU# 3) – fish dip in rock dike located along the east bank of Little Lake.

Photo No. 5 – (Ba-27 CU#3) – end of rock dike located on the east bank of Little Lake.

Photo No.6 – (BA-27 CU#6) – rock dike tie-in on the north end of the project near the Barataria Waterway.

Photo No.7 – (BA-27 CU#6) – rock dike along east bank of Bayou Rigolettes.

Photo No.8 – (BA-27 CU#6) – end of the rock dike along the east bank of Bayou Rigolettes.

Appendix B

Three Year Budge Projections and Worksheets

BARATARIA LAND BRIDGE, PH 1 & 2 / BA27 / PPL7			
Three-Year Operations & Maintenance Budgets 07/01/2007- 06/30/10			
Project Manager	O & M Manager	Federal Sponsor	Prepared By
	Babin	*NRCS*	*Babin*
	2007/2008	**2008/2009**	**2009/2010**
Maintenance Inspection	$ 5,407.00	$ 5,569.00	$ 5,736.00
Structure Operation	$ -	$ -	$ -
Administration	$ -	$ 2,000.00	
Maintenance/Rehabilitation			
07/08 Description:			
E&D	$ -		
Construction	$ -		
Construction Oversight	$ -		
Sub Total - Maint. And Rehab.	$ -		
08/09 Description			
E&D		$ 11,520.00	
Construction		$ -	
Construction Oversight		$ -	
	Sub Total - Maint. And Rehab.	$ 11,520.00	
09/10 Description:	Structural Assessment - survey profile and cross-section of CU #2 rock dike		
E&D			
Construction			$ -
Construction Oversight			$ -
		Sub Total - Maint. And Rehab.	$ -
	2007/2008	**2008/2009**	**2009/2010**
Total O&M Budgets	**$ 5,407.00**	**$ 19,089.00**	**$ 5,736.00**
O&M Budget (3 Yr Total)			**$ 30,232.00**
Unexpended O&M Funds			**$ 1,498,506.00**
Remaining O&M Funds			**$ 1,468,274.00**

OPERATIONS & MAINTENANCE BUDGET WORKSHEET

Project: Barataria Landbridge Shoreline Protection (Phase 1 & 2 Construction Units 1&2)

FY 07/08 –

Administration		$ 0
O&M Inspection & Report		$ 5,407
Operation:		$ 0
Maintenance:		$ 0
E&D:	$ 0	
Construction:	$ 0	
Construction Oversight:	$ 0	

FY 08/09 –

Administration		$ 2,000
O&M Inspection & Report		$ 5,569
Operation:		$ 0
Maintenance:		$ 11,520
E&D:	$ 11,250	
Construction:	$ 0	
Construction Oversight:	$ 0	

Operation and Maintenance Assumptions:
Annual Inspection and Report ($5,569)
Structural Assessment Survey – rock dike CU#2
(5 days @ $1,420/day =$7,100)
(Process Data and Prepare Deliverables - $2,500)
7,100 + 2,500 = 9,600 x .20 Contingency = 11,520
DNR/NRCS Administration: $2,000

FY 09/10 –

Administration		$ 0
O&M Inspection & Report		$ 5,736
Operation:		$ 0
Maintenance:		$ 0
E&D:	$ 0	
Construction:	$ 0	
Construction Oversight:	$ 0	

BARATARIA LAND BRIDGE, PH 3-CU#3 / BA27 / PPL9

Three-Year Operations & Maintenance Budgets 07/01/2007 - 06/30/10

Project Manager	O & M Manager	Federal Sponsor	Prepared By
	Babin	*NRCS*	*Babin*

	2007/2008	2008/2009	2009/2010
Maintenance Inspection	$ 5,407.00	$ 5,569.00	$ 5,736.00
Structure Operation	$ -	$ -	$ -
Administration	$ -	$ 2,000.00	
Maintenance/Rehabilitation			
07/08 Description:			
E&D	$ -		
Construction	$ -		
Construction Oversight	$ -		
Sub Total - Maint. And Rehab.	$ -		
08/09 Description	Structural Assessment		
E&D		$ 8,616.00	
Construction		$ -	
Construction Oversight		$ -	
	Sub Total - Maint. And Rehab.	$ 8,616.00	
09/10 Description:			
E&D			
Construction			$ -
Construction Oversight			$ -
		Sub Total - Maint. And Rehab.	$ -

	2007/2008	2008/2009	2009/2010
Total O&M Budgets	**$ 5,407.00**	**$ 16,185.00**	**$ 5,736.00**

O&M Budget (3 Yr Total)	**$27,328**
Unexpended O&M Funds	**$8,778**
Remaining O&M Funds	**($36,106)**

OPERATIONS & MAINTENANCE BUDGET WORKSHEET

Project: <u>Barataria Landbridge Shoreline Protection (Ph. 3 - Construction Units 3)</u>

FY 07/08 –

Administration		$ 0
O&M Inspection & Report		$ 5,407
Operation:		$ 0
Maintenance:		$ 0
E&D:	$ 0	
Construction:	$ 0	
Construction Oversight:	$ 0	

FY 08/09 –

Administration		$ 2,000
O&M Inspection & Report		$ 5,569
Operation:		$ 0
Maintenance:		$ 8,616
E&D:	$ 8,616	
Construction:	$ 0	
Construction Oversight:	$ 0	

Operation and Maintenance Assumptions:
Annual Inspection and Report ($5,569)
Structural Assessment Survey – rock dike CU#3
(4 days @ $1,420/day = $5,680)
(Process Data and Prepare Deliverables - $1,500)
$5,680 + $1,500 = 7,180 x .20 contingency = 8,616
DNR/NRCS Administration: $2,000

FY 09/10 –

Administration		$ 0
O&M Inspection & Report		$ 5,736
Operation:		$ 0
Maintenance:		$ 0
E&D:	$ 0	
Construction:	$ 0	
Construction Oversight:	$ 0	

BARATARIA LAND BRIDGE, PH 4-CU#6 / BA27 / PPL11

Three-Year Operations & Maintenance Budgets 07/01/2007 - 06/30/10

Project Manager	O & M Manager	Federal Sponsor	Prepared By
	Babin	*NRCS*	*Babin*
	2007/2008	**2008/2009**	**2009/2010**
Maintenance Inspection	$ 5,407.00	$ 5,569.00	$ 5,736.00
Structure Operation	$ -	$ -	$ -
Administration	$ -	$ 2,000.00	
Maintenance/Rehabilitation			
07/08 Description:			
E&D	$ -		
Construction	$ -		
Construction Oversight	$ -		
Sub Total - Maint. And Rehab.	$ -		
08/09 Description	Structural Assessment		
E&D		$ 13,224.00	
Construction		$ -	
Construction Oversight		$ -	
	Sub Total - Maint. And Rehab.	$ 13,224.00	
09/10 Description:			
E&D			
Construction			$ -
Construction Oversight			$ -
		Sub Total - Maint. And Rehab.	$ -
	2007/2008	**2008/2009**	**2009/2010**
Total O&M Budgets	**$ 5,407.00**	**$ 20,793.00**	**$ 5,736.00**
O&M Budget (3 Yr Total)			**$31,936**
Unexpended O&M Funds			**$6,625,940**
Remaining O&M Funds			**$6,594,004**

OPERATIONS & MAINTENANCE BUDGET WORKSHEET

Project: <u>Barataria Landbridge Shoreline Protection (Ph. 4 - Construction Unit 6)</u>

FY 07/08 –

Administration		$ 0
O&M Inspection & Report		$ 5,407
Operation:		$ 0
Maintenance:		$ 0
E&D:	$ 0	
Construction:	$ 0	
Construction Oversight:	$ 0	

FY 08/09 –

Administration		$ 2,000
O&M Inspection & Report		$ 5,569
Operation:		$ 0
Maintenance:		$ 13,224
E&D:	$ 13,224	
Construction:	$ 0	
Construction Oversight:	$ 0	

Operation and Maintenance Assumptions:
Annual Inspection and Report ($5,569)
Structural Assessment Survey – rock dike CU#6
(6 days @ $1,420/day = $8,520)
(Process Data and Prepare Deliverables - $2,000)
$8,520 + $2,500 = 11,020 x .20 contingency = 13,224
DNR/NRCS Administration: $2,000

FY 09/10 –

Administration		$ 0
O&M Inspection & Report		$ 5,736
Operation:		$ 0
Maintenance:		$ 0
E&D:	$ 0	
Construction:	$ 0	
Construction Oversight:	$ 0	

Appendix C

Inspection Field Notes

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project Name: **BA-27 Barataria Landbridge Shorline Protection Demo CU#1** Date of Inspection: February 13, 2007

Structure No. No number assigned Inspector(s): B.Babin, S. Triche, E. Lear, W. Blanchard, B Payton

Structure Description: Shoreline Bank Stabilization Water Level :

Type of Inspection: Annual, Post Storm, other Annual Weater Conditions: Clear / Windy

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
Signage /Supports				N/A	The features of CU#1 (demo) along Bayou Rigolettes was not inspected due to close proximity of ongoing construction of CU#4. The concrete pile and wall panels of CU#1 has been incorporated into the design of CU#4.
Rock Armored Embankment					
Settlement Plates					As in the case of the CU#1 (demo) along Bayou Rigolettes, the concrete pile and wall panels constructed under CU#1 will be utilized in the construction of CU#5. CU#5 construction contract has been awarded and is currently under construction under direction of NRCS.

Construction Unit No. 1 of the Barataria Landbridge Shoreline Protection Project consists of the installation of 1,600 linear ft. of shoreline protection along the west bank of Bayou Perot and 1,600 linear feet of shoreline protection along the southeast bank of Bayou Rigolettes. Each location consists of four types of shoreline protection features. Below is a discription of the features constructed at each site.

Section A and A1 - consists of 200 linear ft. of rock dike and 200 linear ft. of rock placed on freshly excavated spoil material.
Section B - consist of 400 linerar ft. of composit rock dike with a lightweight aggregate core encapsulated in geotextile fabric.
Section C - consist of 400 linear ft. of composite rock dike using a forrow method to place and encapsulate the lightweight aggregate core.
Section D - consist of 40 linear ft. of pre-stressed concrete pile and panel wall.

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project Name: **BA-27 Barataria Landbridge Shorline Protection CU#2** Date of Inspection: February 13, 2007

Structure No. No number assigned Inspector(s): B.Babin, S. Triche, E. Lear, W. Blanchard, B. Payton

Structure Description: Shoreline Bank Stabilization Water Level :

Type of Inspection: Annual, Post Storm, other Annual Weater Conditions: Clear / Windy

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
Signage /Supports	Good				As noted on previous inspections, we observed low areas beginning at Sta. 31+00 near the mouth of the Harvey Cutoff Canal., Sta 12+33 near an existing pipeline right-of-way. It is documented that the low areas mention above were the result of settlement which occurred during construction. The final design elevation was not achieved. From observation over a period of several years since construction, we did not observe any further settlement in these locations. With the exception of low areas noted, the overall condition of the rock dike was very good. All signs and supports were also in good condition.
Rock Armored Embankment	Good				
Settlement Plates	Good				

Construction Unit No.2 - consisted of the installation of approximately 6,403 linerar feet of rock dike along the shoreline of the land mass located at the southern end of Bayou Rigolettes and Bayou Perot west of the Harvey Cutoff Canal.
The rock dike was constructed to an elevation of +3.5 ft. NAVD with a 2.0 ft. wide crest and 2:1 side slopes.

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project Name: **BA-27 Barataria Landbridge Shorline Protection CU#3**

Date of Inspection: February 13, 2007

Structure No. No number assigned

Inspector(s): B. Babin, S. Triche, E. Lear, W. Blanchard and B.Payton

Structure Description: Shoreline Bank Stabilization

Water Level :

Type of Inspection: Annual, Post Storm, other — Annual

Weater Conditions: Clear / Windy

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
Signage /Supports	Good				The rock dike appeared to be in excellent condition with no noticeable low areas or other defects. No maintenance is required at this time.
Rock Armored Embankment	Excellent				
Settlement Plates	Good				

Construction Unit No.3 - consisted of the installation of approximately 10,865 linear feet of rock dike along the northeast shoreline of Little Lake and south bank of Bayou Rigolettes and Bayou Perot. The rock rip rap structure was constructed to an elevation of +3.5 NAVD with a 4 ft. wide crest and 3:1 side slopes. Two (2) fish dips were constructed at Sta. 43+05 and Sta. 74+79 consisting of a 60 ft. wide bottom width to allow for marine organism access. Spoil material resulting from access dredging was deposited into seven (7) small open water ponds located landward of the rock dike. The total acreage of marsh created from beneficial use of dredge material was approximately 30 acres.

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project Name: **BA-27 Barataria Landbridge Shorline Protection CU#6**

Date of Inspection: February 13, 2007

Structure No. No number assigned

Inspector(s): B. Babin, S. Triche, E. Lear, W. Blanchard and B.Payton

Structure Description: Shoreline Bank Stabilization

Water Level :

Type of Inspection: Annual, Post Storm, other — Annual

Weater Conditions: Clear / Windy

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
Signage /Supports	Good				The rock dike appeared to be in excellent condition with no noticeable low areas or other defects. No maintenance is required at this time.
Rock Armored Embankment	very good				
Settlement Plates	Good				

Construction Unit No.6 - consisted of approximately 29,500 linear feet of shoreline protection (rock revetment) along the east bank of Bayou Rigolettes. The rock revetment was constructed to an elevation of +3.5 ft. NAVD with a top width of 4 ft. and 3:1 side slopes. At seven (7) locations along the rocck revetment, organism access openings were constructed to allow continued aquatic organism access and provide adequate discharge of surface water flow.

Appendix D

Construction Unit No.1 – Post Construction Evaluation Report prepared by the Natural Resources Conservation Service

"Evaluation of Shoreline Protection Techniques on Highly Organic Soil Foundations"

Evaluation of Shoreline Protection Techniques on Highly Organic Soil Foundations, Barataria Basin, Louisiana

Cherie E. LaFleur, USDA – Natural Resources Conservation Service, Alexandria, LA
Quin J. Kinler, USDA – Natural Resources Conservation Service, Baton Rouge, LA
Dale J. Garber, USDA – Natural Resources Conservation Service, Thibodaux, LA
Brad A. Sticker, USDA – Natural Resources Conservation Service, Alexandria, LA

ABSTRACT

Historic maps reveal that the hydrologic connections between upper (freshwater) and lower (brackish to marine) Barataria Basin in southeast Louisiana are much greater today due to large navigation channels and substantial erosion. The Barataria Basin Landbridge Shoreline Protection Project is an effort to protect the remaining landmass that extends southwest to northeast across the basin. The Project consists of 107,500 feet (32.8 kilometers) of shoreline protection. Geotechnical investigations revealed the presence of a highly organic soil foundation, raising serious concerns regarding the use of traditional shoreline protection techniques. To aid in selecting an appropriate design, five techniques were evaluated from April 2001 through April 2003 to determine constructibility, construction cost, short-term stability, maintenance cost, and aesthetic quality. The evaluation yielded the following estimated costs per linear foot: 1) traditional foreshore rock dike - $540, 2) foreshore rock dike with an earthen core - $540, 3) foreshore rock dike with a lightweight core material - $439, 4) foreshore rock dike with a lightweight core material furrow method - $445, 5) concrete sheetpile wall - $361. The constructibility evaluation showed the concrete sheetpile wall to be the favorable alternative because a smaller access channel was required for construction and its construction took less time than the other methods. Elevational settlement over the 24 month period serves as the primary measure for determining short term stability. The results were as follows: 1) traditional foreshore rock dike –4.3 feet (–1.3 meters), 2) foreshore rock dike with a dredged spoil base –3.2 feet (–1.0 meter), 2) foreshore rock dike with a lightweight core material –2.7 feet (–0.8 meter), 3) foreshore rock dike with a lightweight core material furrow method –3.1 feet (–1.0 meter), 4) concrete sheetpile wall –0.1 foot (0.0 meter). An evaluation of long-term maintenance costs produced 20-year estimates of $2,033,453 for all foreshore rock dike structures versus $865,363 for the concrete sheetpile wall. Aesthetics polling revealed 1) a slight preference for the appearance of a rock dike versus concrete sheetpile, 2) a unanimous preference for using a technique with low aesthetics value versus continued erosion, and 3) an indication that cost throughout the project life is a more important selection criteria than aesthetics. This evaluation supports selection of the concrete sheetpile wall as the most suitable method of shoreline protection in areas of highly organic soil foundations in the central Barataria Basin.

INTRODUCTION

The Barataria Basin is approximately 90 miles (145 kilometers) long, bounded on the north and east by the Mississippi River, on the west by Bayou Lafourche, and on the south by the Gulf of Mexico (Figure 1). The upper portion of the Barataria Basin is largely a freshwater-dominated system of natural levee ridges, baldcypress - water tupelo swamps, and fresh marsh habitats. The lower portion of the basin is dominated by marine/tidal processes, with barrier islands, saline marshes, brackish marshes, tidal

channels, and large bays and lakes. Historically, small meandering Bayous Perot and Rigolettes, and the longer, narrower Bayou Dupont-Bayou Barataria-Bayou Villars channels provided limited hydrologic connection between the upper and lower basin. The hydrologic connections between upper and lower basin are much greater today due to the Barataria Bay Waterway, Bayou Segnette Waterway, Harvey Cutoff, and the substantial erosion and interior marsh loss along and between the now-enlarged Bayou Perot and Bayou Rigolettes.

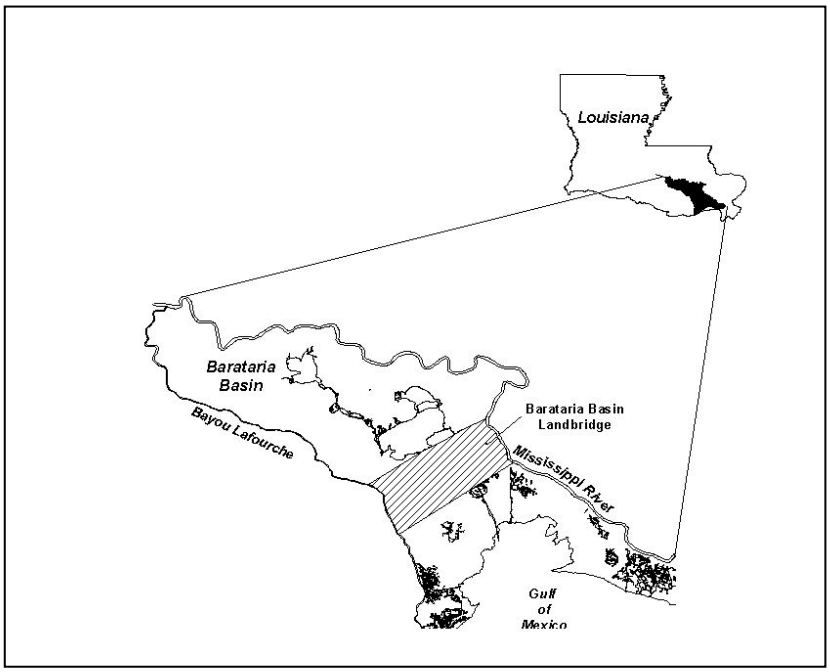

Figure 1. Barataria Basin, Louisiana

The 1892 Barataria 15 minute Quadrangle depicts Bayou Perot and Bayou Rigolettes as narrow meandering bayous (Figure 2). "By the 1940's both bayous exhibited estuarine stream configuration of oblong pools connected by narrow channels at the bends, exhibiting sinuous curves with narrow and long point bars" (Reed 1995). Presently, the two water bodies, while still referred to as "bayous", essentially exist as broad elongated lakes (Figure 2). Current aerial imagery and the Britsch and Dunbar (1996) map also illustrates that the marsh area between the two bayous has converted from a contiguous landmass to a pronounced peninsula, to a very broken and deteriorating series of islands. For the period of 1985-1990, Swenson and Kinler (1997) reported shoreline erosion rates of 114, 103, and 70 feet (35, 31, and 21 meters) per year for three locations on Bayous Perot and Rigolettes. For the period of 1990-1995, they reported rates of 76, 101, and 97 feet (23, 31, and 30 meters) per year for the same locations.

Fortunately, there still exists a landmass, albeit deteriorating, that extends southwest to northeast across the basin, roughly between Lake Salvador and Little Lake; this landmass can be referred to as the "Barataria Basin Landbridge" (Figure 1). Many wetland restoration and protection concepts and potential projects have been discussed for this general area. The Barataria Basin Landbridge Shoreline Protection Project (Project) represents the consensus of a local-state-federal-academic work group as to what measures should be implemented first in addressing this critical area of the Barataria Basin.

The Project is funded under authorization of Public Law 101-646 and Revised Statute 49:213-214. The Natural Resources Conservation Service (NRCS) is the federal sponsor of the project, and the Louisiana Department of Natural Resources (LDNR) will provide the non-federal share of the total project cost.

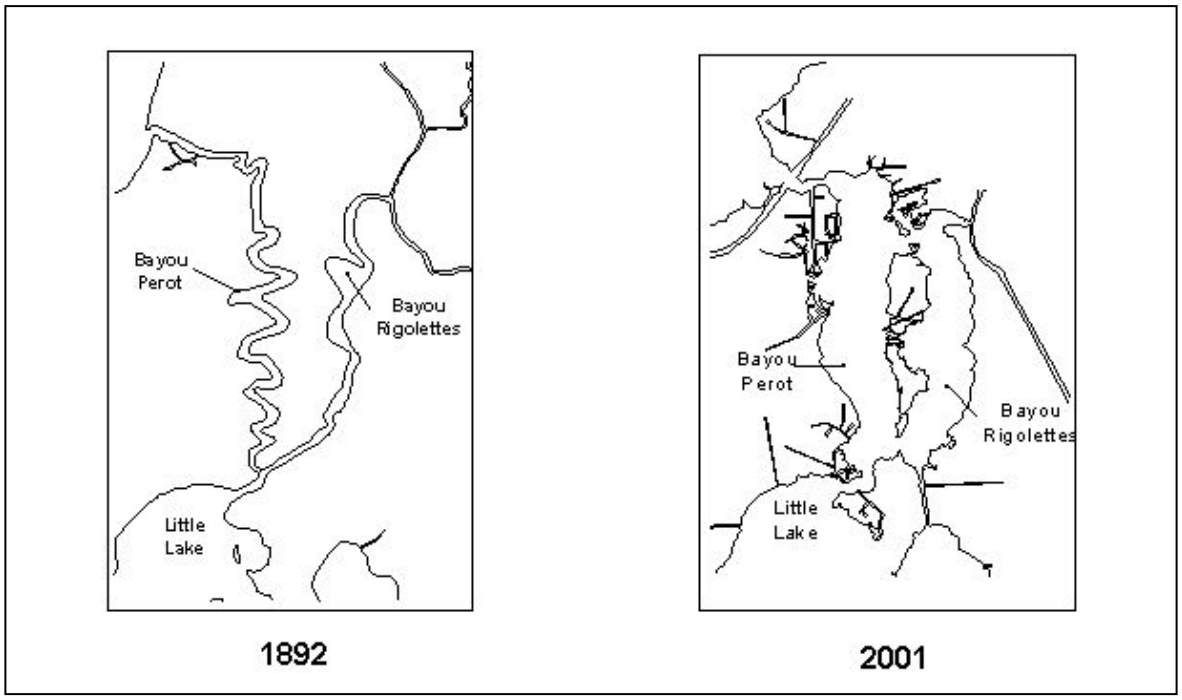

Figure 2. Comparison of Bayou Perot and Bayou Rigolettes, 1892 and 2001.

The Project is located in Jefferson and Lafourche Parishes on the east and west bank of Bayou Perot, the east bank of Bayou Rigolettes, the north and northeast shores of Little Lake, and the east and west bank of Harvey Cutoff. The Project encompasses about 107,500 feet (32.8 kilometers) of shoreline protection (Figure 3). The objective of the Project is to reduce or eliminate shoreline erosion within this critical area of the Barataria Basin.

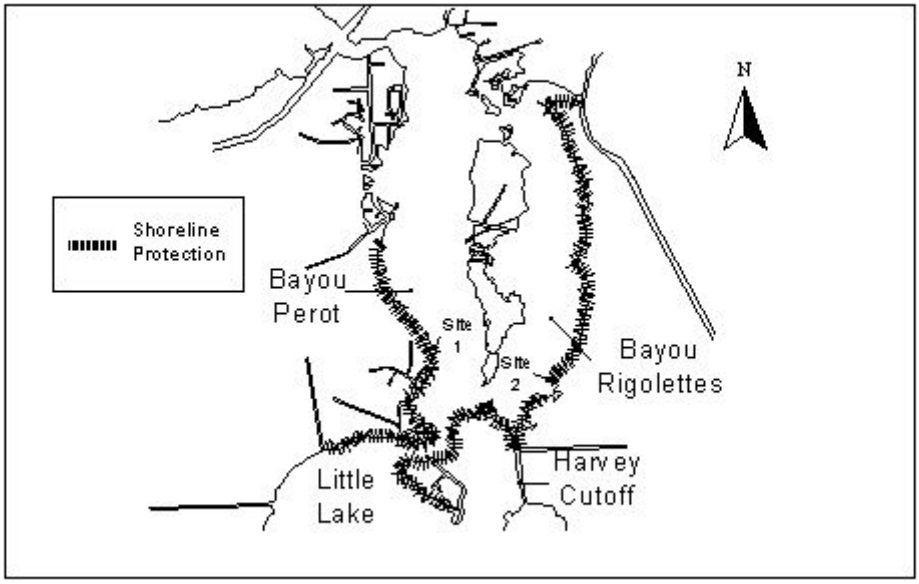

Figure 3. Extent of shoreline protection features of the Barataria Basin Landbridge Shoreline Protection Project.

GEOTECHNICAL INFORMATION

The shallow subsurface in the region consists of mostly Holocene deposits underlain by Pleistocene deposits. The Holocene deposits are composed of natural levee clays and silts, point bar clays and sands, swamp and marsh clays, and organic material. These deposits range in thickness from 50 feet (15 meters) to over 200 feet (61 meters) towards the Gulf of Mexico. The Pleistocene deposits, which were formed in a fluvial/deltaic environment, consist of oxidized clays and silty clays with some sand lenses. These deposits were formed during Quaternary times, under the influence of a series of sea-level fluctuations.

The subsurface geology in the area is composed of marsh and swamp deposits overlying Holocene-age inter-distributary sediments, which in turn overlie Pleistocene age deposits. Generally, the thickness of the marsh and swamp deposits and the Holocene inter-distributary sediments varies from about 85 to 120 feet (26 to 37 meters). The upper Pleistocene surface varies from elevation –85 to –120 feet (–26 to –37 meters) National Geodetic Vertical Datum.

Subsurface soil and geologic conditions were explored by means of several soil borings drilled to depths of 30 and 60 feet (9 and 18 meters) below the mud-line. Generally, the depositional environments encountered throughout the project area were marsh deposits underlain by inter-distributary deposits that may include isolated swamp deposits at varying depths. Figure 4 presents example soil boring logs from the Project area that illustrate the presence of extremely poor and unstable substrate conditions. These conditions raise serious concerns regarding the use of traditional shoreline protection techniques for this project.

TEST SECTIONS, SITE SELECTION, AND DESIGN CRITERIA

Because of the extremely poor and unstable substrate conditions, a traditional shoreline protection technique and a number of non-traditional techniques were tested to determine constructability, construction cost, short-term stability, maintenance cost, and aesthetic quality. The techniques were tested at one location along the west bank of Bayou Perot (Site #1) and at one location along the east bank of Bayou Rigolettes (Site #2) (Figure 3) in areas where foundation conditions are the least stable.

Design criteria included a non-breaking wave height of 2.3 feet (0.7 meter) generated by boat traffic and maximum fetch lengths of approximately 28,000 feet (8.5 kilometers). Additionally, because water levels in the area are influenced by tide and wind, the normal tide ranges from one to two feet (0.3 to 0.6 meter). Therefore, a hydrostatic differential of two feet (0.6 meter) of water from a top of water elevation of 2.0 feet (0.6 meter) North American Vertical Datum 1988 (NAVD88) was also considered.

The tested techniques are identified below and illustrated in Figures 5 and 6:

- Typical Section A: 426 feet (130 meters) of traditional foreshore rock dike
- Typical Section A-1: 421 feet (128 meters) of foreshore rock dike with an earthen (access channel spoil) core
- Typical Section B: 849 feet (259 meters) of foreshore rock dike with a lightweight aggregate (LWA) core
- Typical Section C: 846 feet (258 meters) of foreshore rock dike with a LWA core -- furrow method
- Typical Section D: 800 feet (244 meters) of concrete sheetpile wall.

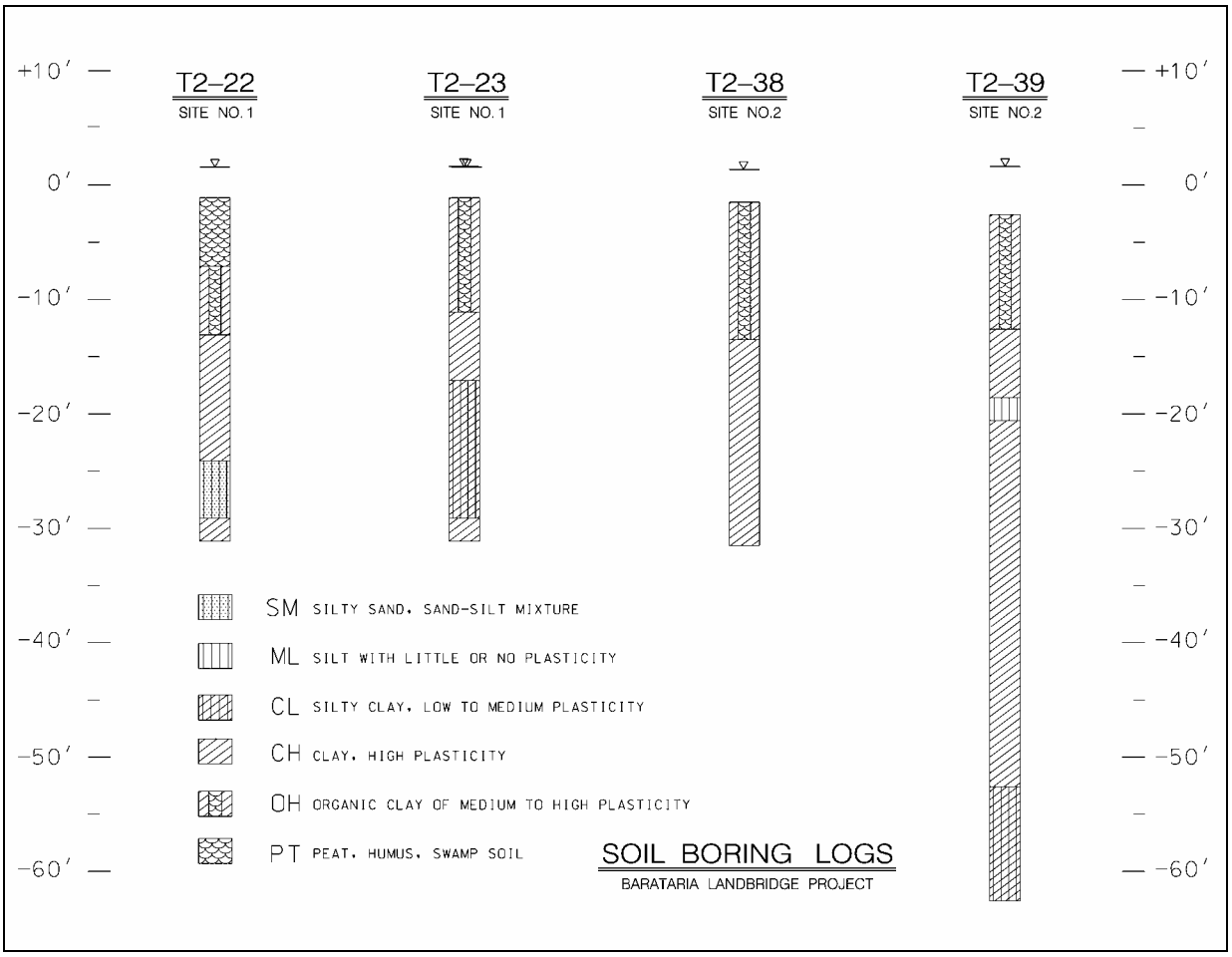

Figure 4. Example of soil boring logs from the Project area..

CONSTRUCTABILITY

Traditional Foreshore Rock Dike

Construction of the traditional foreshore rock dike consisted of placement of a single layer of geotextile that was secured in place with rock. The contractor then placed rock rap in lifts of 1.5 feet (0.5 meter) in thickness over the entire footprint of the structure. Subsequent lifts of rock were placed over the entire cross-section working from one side of the structure to the other side, and continuing for the entire length. This technique was relatively easy to construct, but the contractor was unable to attain the specified grade prior to the start of excessive settlement. This portion of the work was "terminated for convenience" at both Sites 1 and 2 due to the excessive settlement during construction.

Foreshore Rock Dike with Earthen Core

The foreshore rock dike with an earthen (access channel spoil) core required placement of the spoil excavated from the access channel to an elevation of 1.0 foot (0.3 meter) NAVD88 and shaped to achieve a uniform foundation. A single layer of geotextile was then placed and secured with rock. Placement of the rock proceeded in a manner similar to the traditional foreshore rock dike. Construction of this technique was slightly more difficult due to problems in placing the geotextile over the shaped spoil and

this resulted in an increase in construction time. This portion of the work was also "terminated for convenience" due to excessive settlement during construction.

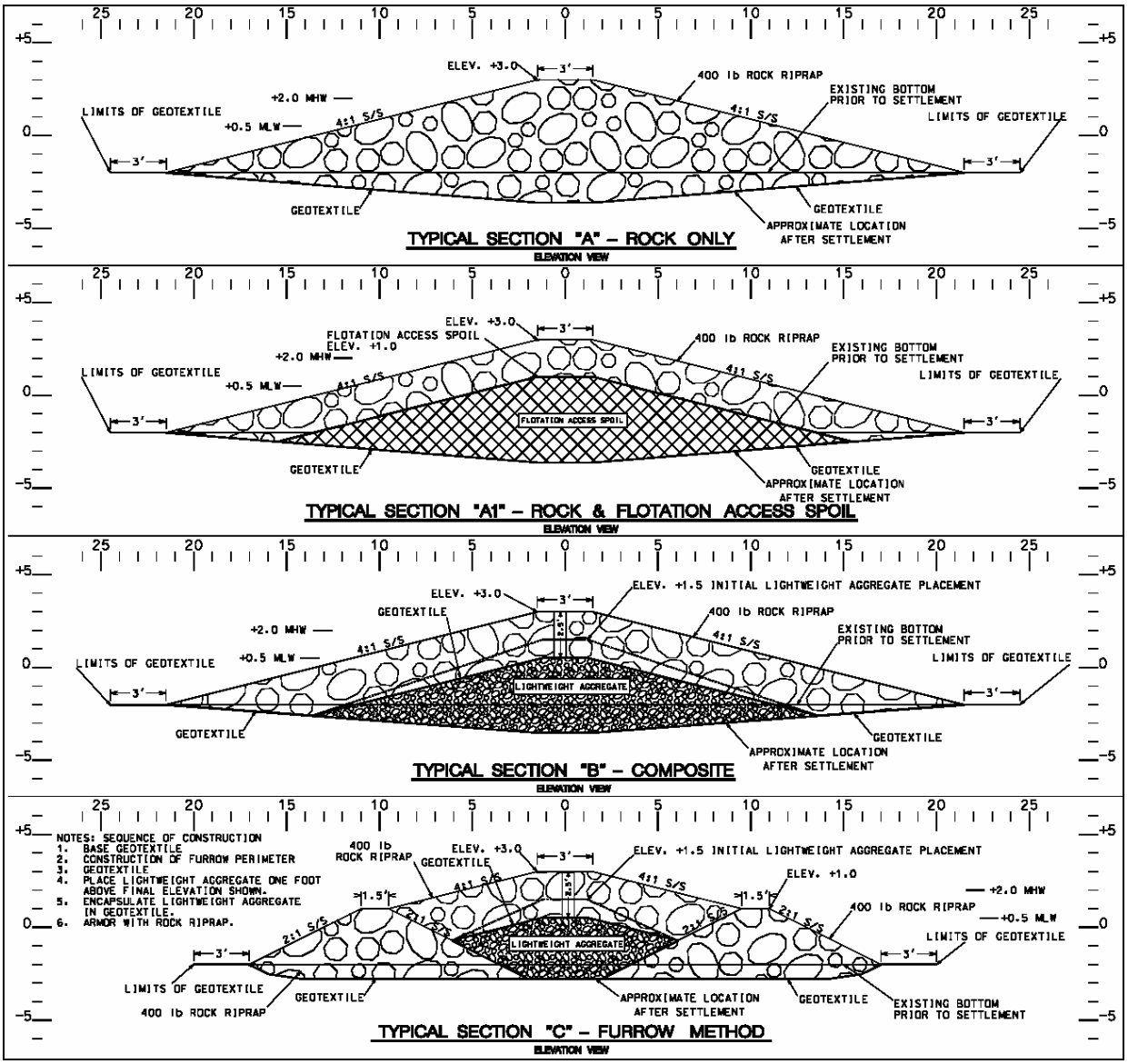

Figure 5. Typical Sections A, A-1, B, and C.

Foreshore Rock Dike with a LWA Core

The foreshore rock dike with a LWA core required placement of two layers of geotextile over the entire footprint of the structure. The first layer was secured to the water bottom and held in place while the second layer was placed over the first and secured in place. The LWA was then placed to the lines and grades specified for the entire length of the structure. The top geotextile layer was folded over the LWA and lapped to encapsulate the LWA. The rock was placed to lines and grades and shaped to complete the section. Construction of this technique was rather labor intensive, and multiple passes were required over the same section of dike to complete construction. Placement of the top layer of geotextile over the bottom layer was more difficult because it would not move freely into position. The LWA was difficult to

control, and prior to being encapsulated it sloughed to flatter slopes in the water. The contractor was able to construct this technique to grade and complete it as planned.

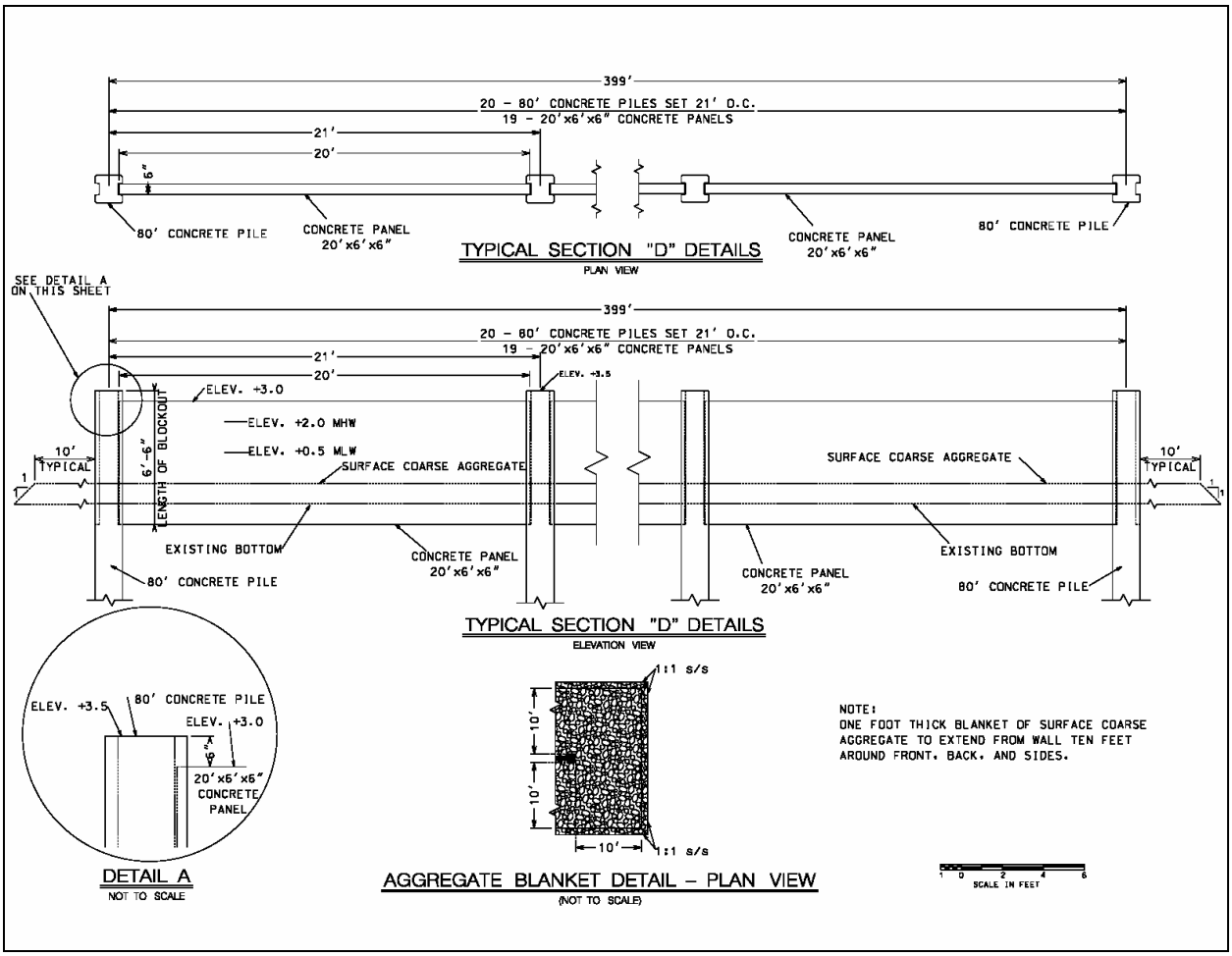

Figure 6. Typical Section D.

Foreshore Rock Dike with LWA Core – Furrow Method

The foreshore rock dike with a LWA core – furrow method required placement of an initial layer of geotextile to cover the footprint of the structure. Once the initial layer was secured in place, rock was placed in two rows to form a "furrow" to the lines and grades specified. A second layer of geotextile was placed in the furrow and secured in place. The LWA was then placed to the lines and grades and shaped in the furrow. The geotextile panel was folded over the LWA and lapped to encapsulate the LWA. Finally, the remaining rock was placed to the lines and grades and shaped to cap the structure. Although this technique required the most construction time, primarily because of the additional pass to construct the furrow, the furrow provided a benefit by containing the LWA to the area within the furrow. The contractor was able to construct this technique to grade and complete it as planned.

Concrete Sheetpile Wall

Construction of the concrete sheetpile wall consisted of driving 80-foot-long (24-meter-long) concrete piles at a spacing of 20 feet (6.1 meters). The concrete panels were then set in place between the piles and grouted on one end to secure them to the piles. The wall was completed as the contractor progressed along the alignment and construction did not require multiple passes. After all panels were set in place, a 12-inch-thick (31-centimeter-thick) layer of crushed limestone was placed on each side of the wall to reduce scour at the base of the wall. The concrete sheetpile wall required less time to construct than any other method. Additionally, less dredging for the access channel was needed due to equipment size and draft. Based on the above results, this technique is the preferable method of construction.

CONSTRUCTION COST EVALUATION

For comparison purposes and to ultimately make an informed decision regarding the selection of the most feasible shoreline protection technique, estimated costs for each technique have been calculated for a length of 5,000 feet (1,524 meters). Costs for each technique are based on contractor bid information, contract modification information, recent bid prices on other projects and discussions with the test sections contractor, as well as other contractors. Actual and estimated per linear foot costs of each technique are shown in Table 1. The actual quantities of LWA and rock used for each individual test section have been used to determine the estimated quantities for a 5,000-foot-long (1,524-meter-long) structure. Tables 2, 3, 4, and 5 include the actual and estimated quantities and costs for each item of work for each structure type. The increase in the cost of rock that is reflected in the unit price for this item in Tables 2, 3, 4, and 5 represents quotes from rock suppliers as of July 2002. For Typical Section D, the per-panel cost has remained unchanged while the costs of the concrete piles have decreased. An "economy of scale" is evident here. One-time costs, such as a pile spacing jig, incurred by the contractor to create an efficient pile installation operation can be spread among a larger quantity of piles thereby decreasing the cost per pile.

Table 1. Summary of structure costs per linear foot (LF).

Structure Type	Actual Project Cost per LF	Estimated Cost per LF for 5,000 LF Structure
A – Foreshore Rock Dike & A-1 – Foreshore Rock Dike with Earthen Core	$474.23	$539.66
B – Foreshore Rock Dike with LWA Core	$412.07	$439.10
C – Foreshore Rock Dike with LWA Core – Furrow Method	$404.05	$444.64
D – Concrete Sheetpile Wall	$490.51	$361.20

It should be noted that the actual cost of constructing section types A, A-1, B and C will be highly variable and highly dependent on the ability of the foundation soils to support the structure and the height of fill. As the fill height increases, the volumes and resulting costs of rock and LWA will increase at a rate greater than the concrete sheetpile wall.

Table 2. Actual project cost for 847 linear feet (LF) and extrapolated cost for 5,000 LF of Typical Sections A (Foreshore Rock Dike) and A-1 (Foreshore Rock Dike with Earthen Core).

	Actual Project Cost (847 LF)				Estimated Cost For 5,000 LF			
Item of Work	Quantity	Unit	Unit Price	Total	Quantity	Unit	Unit Price	Total
Mobilization and Demobilization	1	Job	LS[1]	$16,250	1	Job	LS	$90,000
Pollution Control	1	Job	LS	$500	1	Job	LS	$10,000
Surveying	1	Job	LS	$3,000	1	Job	LS	$20,000
Quality Control	1	Job	LS	$2,500	1	Job	LS	$20,000
Warning Signs	1	Job	LS	$4,000	12	EA	$1,500	$18,000
400# Rock[2]	9,458	Tons	$36	$340,488	55,850	Tons	$42	$2,345,700
Settlement Plates	4	Each	$1,000	$4,000	12	Each	$1,000	$12,000
Geotextile	5,625	SY[3]	$5.50	$30,938	33,200	SY	$5.50	$182,600
Total				$401,676				$2,698,300
Cost per L.F.				$474				$540

[1] LS = Lump Sum; [2] Rock cost includes access dredging cost and rock placement; [3] SY = Square Yard.

Table 3. Actual project cost for 849 linear feet (LF) and extrapolated cost for 5,000 LF of Typical Section B (Foreshore Rock Dike with Lightweight Aggregate Core).

	Actual Project Cost (849 LF)				Estimated Cost For 5,000 LF			
Item of Work	Quantity	Unit	Unit Price	Total	Quantity	Unit	Unit Price	Total
Mobilization and Demobilization	1	Job	LS[1]	$16,250	1	Job	LS	$90,000
Pollution Control	1	Job	LS	$500	1	Job	LS	$10,000
Surveying	1	Job	LS	$3,000	1	Job	LS	$20,000
Quality Control	1	Job	LS	$2,500	1	Job	LS	$20,000
Warning Signs	1	Job	LS	$4,000	12	Each	$1,500	$18,000
LWA, Encapsulated	2,434	CY[2]	$60	$146,040	14,370	CY	$60	$862,200
400# rock[3]	3,956	Tons	$36	$142,416	23,350	Tons	$42	$980,700
Settlement Plates	4	Each	$1,000	$4,000	12	Each	$1,000	$12,000
Geotextile	5,625	SY[4]	$5.50	$30,938	33,200	SY	$5.50	$182,600
Total				$349,644				$2,195,500
Cost per LF				$412				$439

[1] LS = Lump Sum; [2] CY = Cubic Yard; [3] Rock cost includes access dredging cost and rock placement; [4] SY = Square Yard.

SHORT TERM STABILITY EVALUATION

A primary concern for this Project is whether any of the identified shoreline protection techniques will be stable and long lasting, given the presence of extremely poor and unstable foundation conditions. In conditions such as those present at the project site, it has been observed that considerable settlement and/or signs of structural failure manifest during construction or very shortly thereafter. Measurements regarding the stability of the structural measures have been taken on a regular interval since completion of each test section.

Table 4. Actual project cost for 846 linear feet (LF) and extrapolated cost data for 5,000 LF of Typical Section C (Foreshore Rock Dike with Lightweight Aggregate Core - Furrow Method).

	Actual Project Cost (846 LF)				Estimated Cost For 5000 LF			
Item of Work	Quantity	Unit	Unit Price	Total	Quantity	Unit	Unit Price	Total
Mobilization and Demobilization	1	Job	LS[1]	$16,250	1	Job	LS	$90,000
Pollution Control	1	Job	LS	$500	1	Job	LS	$10,000
Surveying	1	Job	LS	$3,000	1	Job	LS	$20,000
Quality Control	1	Job	LS	$2,500	1	Job	LS	$20,000
Warning Signs	1	Job	LS	$4,000	12	EA	$1,500	$18,000
LWA, Encapsulated	1,417	CY[2]	$60	$85,020	8,375	CY	$60	$502,500
400# rock[3]	5,668	Tons	$36	$204,048	33,500	Tons	$42	$1,407,000
Settlement Plates	4	Each	$1,000	$2,000	12	Each	$1,000	$12,000
Geotextile	4,420	SY[4]	$6	$24,310	26,130	SY	$6	$143,715
Total				$341,628				$2,223,215
Cost per LF				$404				$445

[1] LS = Lump Sum; [2] CY = Cubic Yard; [3] Rock cost includes access dredging cost and rock placement; [4] SY = Square Yard.

Table 5. Actual project cost for 800 linear feet (LF) and extrapolated cost for 5,000 LF of Typical Section D (Concrete Sheetpile Wall).

	Actual Project (800 LF)				Estimated Cost For 5000 LF			
Item of Work	Quantity	Unit	Unit Price	Total	Quantity	Unit	Unit Price	Total
Mobilization and Demobilization	1	Job	LS[1]	$16,250	1	Job	LS	90,000
Pollution Control	1	Job	LS	$500	1	Job	LS	$10,000
Surveying	1	Job	LS	$3,000	1	Job	LS	$20,000
Quality Control	1	Job	LS	$2,500	1	Job	LS	$20,000
Warning Signs	1	Job	LS	$4,000	12	Each	$1,500	$18,000
Surface Coarse Aggregate	904	Tons	$40	$36,160	5,650	Tons	$40	$226,000
80 ft Concrete Piles	40	Each	$5,400	$216,000	250	Each	$2,700	$675,000
Concrete Panels	38	Each	$3,000	$114,000	249	Each	$3,000	$747,000
Total Cost				$392,410				$1,806,000
Cost per LF				$491				$361

[1] LS = Lump Sum.

Temporary benchmarks were established in the marsh adjacent to each set of test sections. The benchmarks were set based on North American Datum 1983 (NAD83) and NAVD88 and have provided the horizontal and vertical control for the Project. Two settlement plates for each test section were surveyed by Global Positioning System (GPS) prior to construction, immediately upon completion of each test section, and at post construction intervals of approximately 2, 3, 6, 9, 12, 15/16, and 23/24 months. The horizontal and vertical positions of selected concrete piles were surveyed by GPS upon placement of the concrete pile and at the stated post construction intervals. Post-construction elevations have been analyzed to determine the actual settlement of each test section versus the estimated

settlements. Figures 7, 8, and 9 illustrate the settlement of the rock (Typical Section A), rock and earth (Typical Section A-1), and rock and LWA (Typical Sections B and C) test sections for the post construction time intervals stated above. Settlement data for Section A and A1 at Site #1 are not presented due to the excessive settlement and bearing capacity failure of these sections. Measured settlement of the concrete sheetpile wall is not illustrated because the surveys have shown no horizontal movement of the concrete sheetpile wall and only minimal vertical movement.

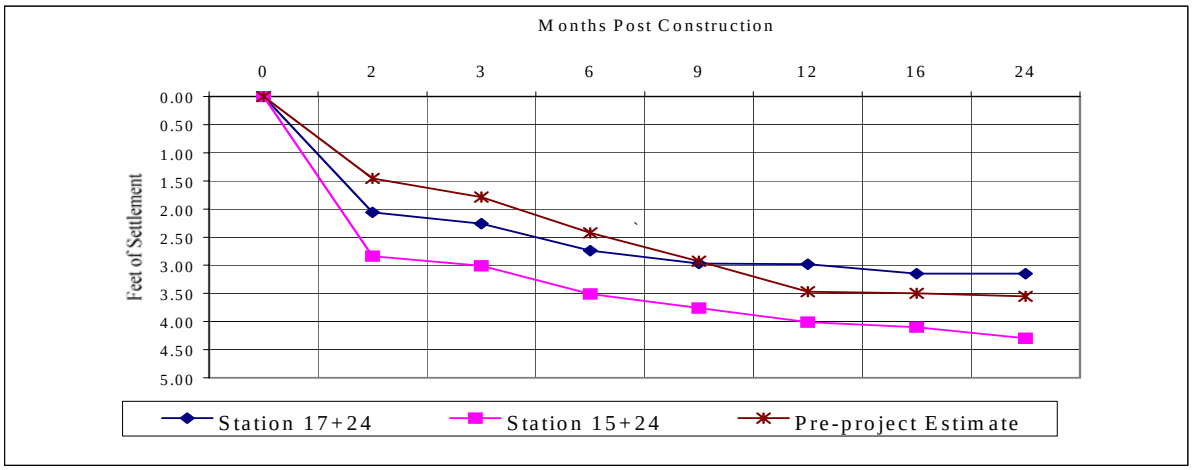

Figure 7. Settlement of Typical Section A (rock breakwater – Station 15+24) and Typical Section A-1 (rock breakwater with earthen core – Station 17+24) versus estimated pre-project settlement at Site 2.

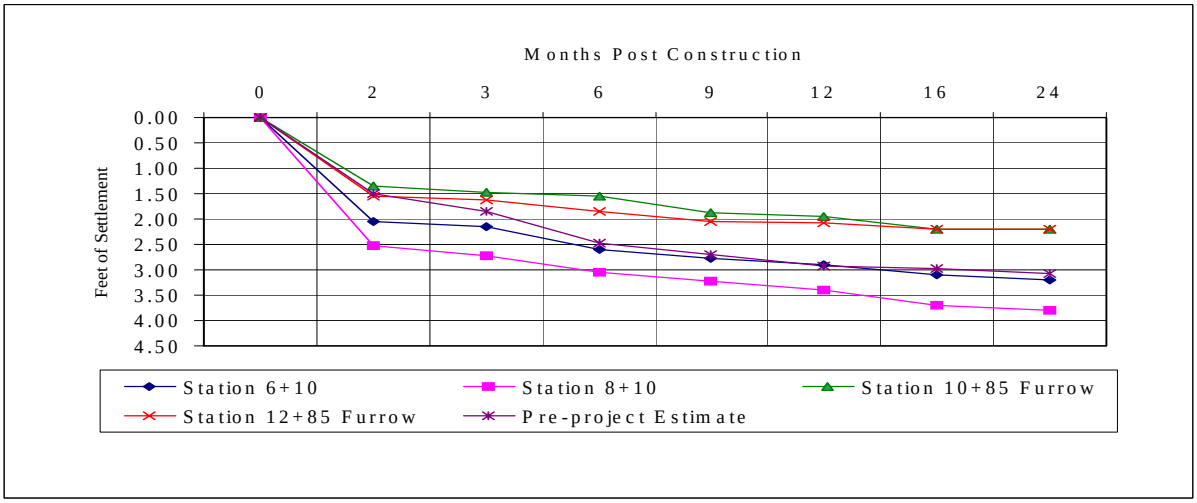

Figure 8. Settlement of Typical Section B (rock dike with a LWA core – Stations 6+10 and 8+10) and Typical Section C (rock dike with a LWA core -- furrow method – Stations 10+85 and 12+85) versus estimated pre-project settlement at Site 1.

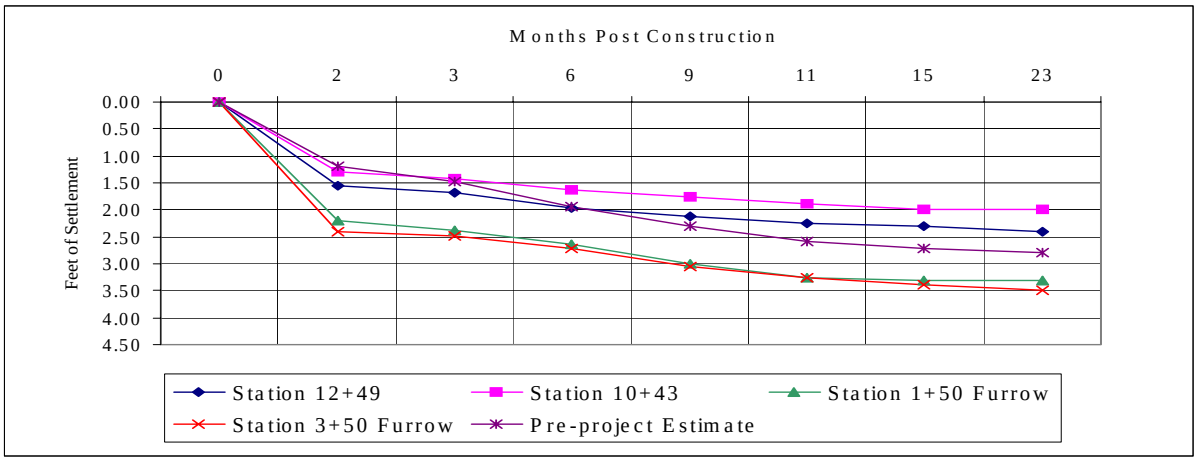

Figure 9. Settlement of Typical Section B (rock dike with a LWA core – Stations 10+43 and 12+49) and Typical Section C (rock dike with a LWA core -- furrow method – Stations 1+50 and 3+50) versus estimated pre-project settlement at Site 2.

Foundation bearing capacity, slope stability, fill height, historical geophysical features (i.e. old channels and canals), and rate of construction are additional considerations that will affect the constructibility and subsequent stability of any rock type structures. When considering concrete sheetpile wall structures in areas of increased structure height, soil cohesion, pile lengths, panel sizes and additional steel reinforcement are items that will require re-evaluation.

MAINTENANCE COSTS

Long-term maintenance costs were also considered in the evaluation process. Rock and composite structure maintenance will require subsequent lifts of rock to return the structure crest to the design elevation. Additionally, the possibility of foundation failure beneath the rock and composite structures will remain a factor that could result in increases of rock quantities or an inability to meet the target structure elevation. Maintenance of the concrete sheetpile wall may entail repair of damaged concrete, grouting of the pile to panel joints, repair of exposed steel or replacement of piles or panels. A projected maintenance schedule and associated costs for a 5,000-foot-long (1,524-meter-long) structure are presented in Table 7 for the rock and composite structures and Table 8 for the concrete sheetpile wall. Tables 7 and 8 show that the fully funded maintenance costs of a rock type foreshore dike is estimated at $2,033,453 versus $865,363 for a concrete sheetpile wall.

AESTHETIC QUALITY

Due to concerns that the concrete sheetpile would detract from the “area’s natural aesthetics”, landowners, leaseholders, recreational interests, and Project participants, including parish officials, were polled regarding their views toward the aesthetics of foreshore dikes, concrete sheetpile walls, and continued erosion. Sixteen individuals responded to the aesthetics poll, including seven federal government employees, four local residents/recreational users, one local resident/commercial user, one area landowner, one local government employee, one state government employee, and one academic. At the time of their response, thirteen of the respondents had observed the test sections, three had not.

Table 7. Fully-funded estimate of inspection and maintenance for 5,000 LF of rock dike with or without LWA.

Cost Item	Years			20-year Total
	2005	2010	2003-2022	
Annual Inspections			$121,633	$121,633
Mobilization and Demobilization	$107,237	$123,233		$230,471
Structure Repair				
Rock Replenishment	$771,603	$886,699		$1,658,302
Signs	$10,724	$12,323		$23,047
Total	$782,327	$899,022	$121,633	$2,033,453

Table 8. Fully-funded estimate of inspection and maintenance for 5,000 LF of concrete sheetpile wall.

Cost Item	Years			20-year Total
	2009	2016	2003-2022	
Annual Inspections			$121,633	$121,633
Mobilization and Demobilization	$119,297	$149,737		$269,034
Structure Repair	$48,779	$61,226		$110,005
Rock Replenishment	$149,784	$188,004		$337,787
Signs	$11,930	$14,974		$26,903
Total	$329,789	$413,941		$865,363

When asked to rank the importance (on a scale of 1 to 10, with 10 being most important) of certain criteria in selecting the shoreline protection technique (assuming the techniques were equally effective at preventing erosion), the average of responses were as follows: 1) Cost throughout the project life: 8.8; 2) Initial cost: 7.5; 3) Aesthetics: 5.9.

When asked to rank the aesthetics quality (on a scale of 1 to 10, with 10 being highest quality) of the outward appearance of tested shoreline protection techniques, the average of the responses were as follows: 1) Rock dike away from the shoreline: 8.0; 2) Concrete sheetpile: 6.1.

When given the choice of allowing erosion to continue at 50 to 100 feet (15 to 30 meters) per year versus using the technique with the lowest aesthetics rating, all respondents indicated that they would choose the technique with the lowest aesthetics rating.

The respondents were instructed to assume that the technique with lowest aesthetics score also had the lowest cost; then they were asked, “what percent increase in total cost is justifiable to allow use of the technique for which you gave the highest score?” Five respondents indicated that a “0 to 10%” increase, and five respondents indicated that a “10 to 25%” increase, in total cost is justifiable to allow use of the more aesthetically pleasing technique.

SUMMARY AND CONCLUSIONS

Because of 1) only a slight preference for the appearance of a rock dike versus concrete sheetpile, 2) a unanimous preference for using a technique with low aesthetics value versus allowing the erosion to continue, and 3) an indication that cost throughout the project life is the more important technique selection criteria, it is concluded that selection of a shoreline protection technique should be based on

evaluation of technical issues (constructability, construction costs, stability, maintenance costs) rather than on aesthetics.

The concrete sheetpile wall took less time to construct than any other method and less dredging for the access channel was needed due to equipment size and draft.

While costs to construct the rock and composite structure test sections were less than the concrete sheetpile wall test sections, an “Economy of Scale” can be achieved in the construction of a 5,000-foot-long (1,524-meter-long)section of the concrete sheetpile wall. This “Economy of Scale” can be realized through lower pile and panel fabrication costs due to the initial start up costs of forming and jig materials being absorbed by the larger quantity of materials produced. With this “Economy of Scale”, it is estimated that the concrete sheetpile wall is the least expensive technique.

The concrete sheetpile wall sections have shown very little movement in the vertical and none in the horizontal directions while the rock sections have experienced significant amounts of settlement.

Maintenance costs of the concrete sheetpile wall are expected to be significantly less than that of the rock structures.

In conclusion, construction costs, constructability, structural stability and maintenance costs support the selection of the concrete sheetpile wall as the most suitable method of shoreline protection in areas of highly organic soil foundations in Barataria Basin, Louisiana.

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