Coastal Protection and Restoration Authority of Louisiana
Office of Coastal Protection and Restoration

2011 Operations, Maintenance, and Monitoring Report

for

Four-Mile Canal Terracing and Sediment Trapping

State Project Number TV-18
Priority Project List 9

October 2011
Vermilion Parish

Prepared by:

Mike Miller
and
Stan Aucoin
CPRA/Office of Coastal Protection and Restoration
Lafayette Field Office
635 Cajundome Boulevard
Lafayette, LA 70506

Suggested Citation:

Miller, M., and S. Aucoin 2011. *2011 Operations, Maintenance, and Monitoring Report for the Four-Mile Canal Terracing and Sediment Trapping (TV-18), Coastal Protection and Restoration Authority of Louisiana, Office of Coastal Protection and Restoration, Lafayette, Louisiana 37 pp.*

2011 Operations, Maintenance, and Monitoring Report
For
Four-Mile Canal Terracing and Sediment Trapping (TV-18)

Table of Contents

I. Introduction

The Four Mile Canal Terracing and Sediment Trapping (TV-18) project is from the 9th priority list of the Coastal Wetlands Planning, Protection, and Restoration Act. The project is located approximately 4 miles (6.44 km) south of Intracoastal City in Vermilion Parish, Louisiana, and includes Little White Lake and the portion of Little Vermilion Bay immediately west of Four-Mile Canal also known as the Vermilion River Cutoff (figure 1). The project consists of earthen terraces meant to protect the shorelines of Little White Lake and Four Mile Canal from further erosion.

The Flood Control Act of 18 August 1941 enacted by the United States Congress provided for improvements in the Vermilion River. Vermilion River Cutoff, an 8 ft by 80 ft (2.4 m by 24 m) channel from the -8 foot contour in Vermilion Bay to the Gulf Intracoastal Waterway (GIWW), was constructed for improving navigation from Lafayette, LA to Vermilion Bay. The materials excavated to build the canal were deposited on spoil banks along the canal which prevented river water from nourishing the adjacent marsh (USACE 1993; HNTB 2002). The main cause of marsh loss in this area is shoreline erosion. The 1978 Louisiana Department of Transportation and Development (LDOTD) inventory and assessment of shoreline erosion in coastal Louisiana documented erosion rates of 1.6 ft/yr (0.5 m/yr) and 2.6 ft/yr (0.8 m/yr) in the vicinity of Little Vermilion Bay (Adams et al. 1978). Shoreline change in the project area from 1978 to 1988 was 2.86 ft/yr (0.87 m/yr) (USGS 2003). The TV-18 project area was relatively unprotected and affected by storm events emerging from Vermilion Bay. The project should allow sub-aerial marsh development from sediments introduced to the area by the GIWW through the Vermilion River and Four-Mile Canal (LDNR 1999) by preventing shoreline erosion.

Landloss in the region mostly occurred between 1956 and 1978 and was along the edge of Four Mile Canal and the Little Vermilion Bay shoreline (USGS 2002). Within the project area, there were approximately 160 acres (65 ha) of land and 2,109 acres (854 ha) of open water in 1993 which accounted for 93 and 7% of project area respectively.

The soils surrounding the project area include Clovelly and Lafitte muck with two patches of Udifluvents. Clovelly and Lafitte series are poorly drained organic soils that formed in herbaceous plant material over clayey alluvium. Udifluvents are sandy to clayey soils that were hydraulically excavated during the construction and maintenance of navigable waterways (USDA 1996). Soil boring samples collected in Little White Lake and Little Vermilion Bay revealed two to five feet of very soft clay over two to eight feet of organic clay (HNTB 2002).

The surrounding marsh was brackish in 1949 (O'Neil 1949) and 1968 (Chabreck et al. 1968) and was intermediate in 1978, 1988, and 1997 (Chabreck and Linscombe 1978, 1988, 1997). In 2004 observed emergent vegetation on the shore around Little White Lake included *Phragmites australis* (common reed), *Zizaniopsis mileacea* (giant cutgrass), *Spartina alterniflora* (smooth cordgrass), *Hymenocallis caroliniana* (Carolina spiderlily), *Triadica sebifera* (tallowtree), and *Sesbania drummondii* (poisonbean). In 1998, area vegetation consisted of *Spartina patens* (saltmeadow cordgrass), *Cladium mariscus ssp. jamaicense* (Jamaica sawgrass), and *Schoenoplectus robustus* (sturdy bulrush) with scattered SAVs

including *Myriophyllum spicatum* (spike watermilfoil), *Ceratophyllum demersum* (coon's tail) and *Najas guadalupensis* (southern waternymph) (United States Department of Commerce National Oceanic and Atmospheric Administration National Marine Fisheries Service 2000).

The project goals include:

1. Create 70 acres (28.3 ha) of earthen terraces within the project area immediately after construction.
2. Reduce shoreline erosion rates by 50% (reduce from 8 ft/yr to 4 ft/yr) over the 20 year project life.
3. As a result of goals 1 and 2, achieve a 9% (approximately 17 acres [6.9 ha]) net increase in marsh habitat by the end of the 20 year project.
4. Increase submerged aquatic vegetation (SAV) coverage from 0% to 25% of the project area by the end of the 20 year project life.
5. Increase fisheries utilization of the project area.

The construction of terraces in Little White Lake and Little Vermilion Bay was meant to buffer existing marsh against shoreline erosion by reducing wave and wake energy and creating marsh both by the planting of *S. alterniflora* along the crowns and slopes of the constructed terraces and by allowing suspended sediments introduced from Four Mile Canal and the Vermilion River to be trapped in the shallow open water adjacent to the terraces. Terraces may indirectly reduce water-column turbidity within the project area which, in conjunction with decreased wave and wake energy, should create habitat suitable for the colonization by submerged aquatic vegetation (SAV). Fisheries habitat may also be enhanced by the marsh edge created by the terraces and the propagation of SAV.

Approximately 40,300 linear ft (12,280 m) of terraces in the eastern portion of Little Vermilion Bay area adjacent to Four Mile Canal (figure 2) and 28,150 linear ft (8,580 m) in the Little White Lake area (figure 3) were constructed to deter wave erosion and enhance sediment deposition. The terraces were arranged in either a linear or "fish-net" orientation in the open water areas. Terraces in the Little Vermilion Bay area were built to + 5.0 ft (+1.5 m) NAVD88 with a 20 ft crown and 4:1 ft side slopes. Terraces in the Little White Lake area were also built to + 5.0 ft (+1.5 m) NAVD88, but have a 15 ft (4.6 m) crown with 4:1 ft side slopes (figure 4). Post consolidation elevation of all terraces was expected to be between 2 and 3 ft NAVD88. The borrow or floatation channel is located on the land side of all terraces and was constructed to a maximum depth of 10 ft below the existing water bottom. In order to minimize erosive energies, the terrace slopes and crowns were planted with *Spartina alterniflora* (smooth cordgrass). Construction was completed in May, 2004.

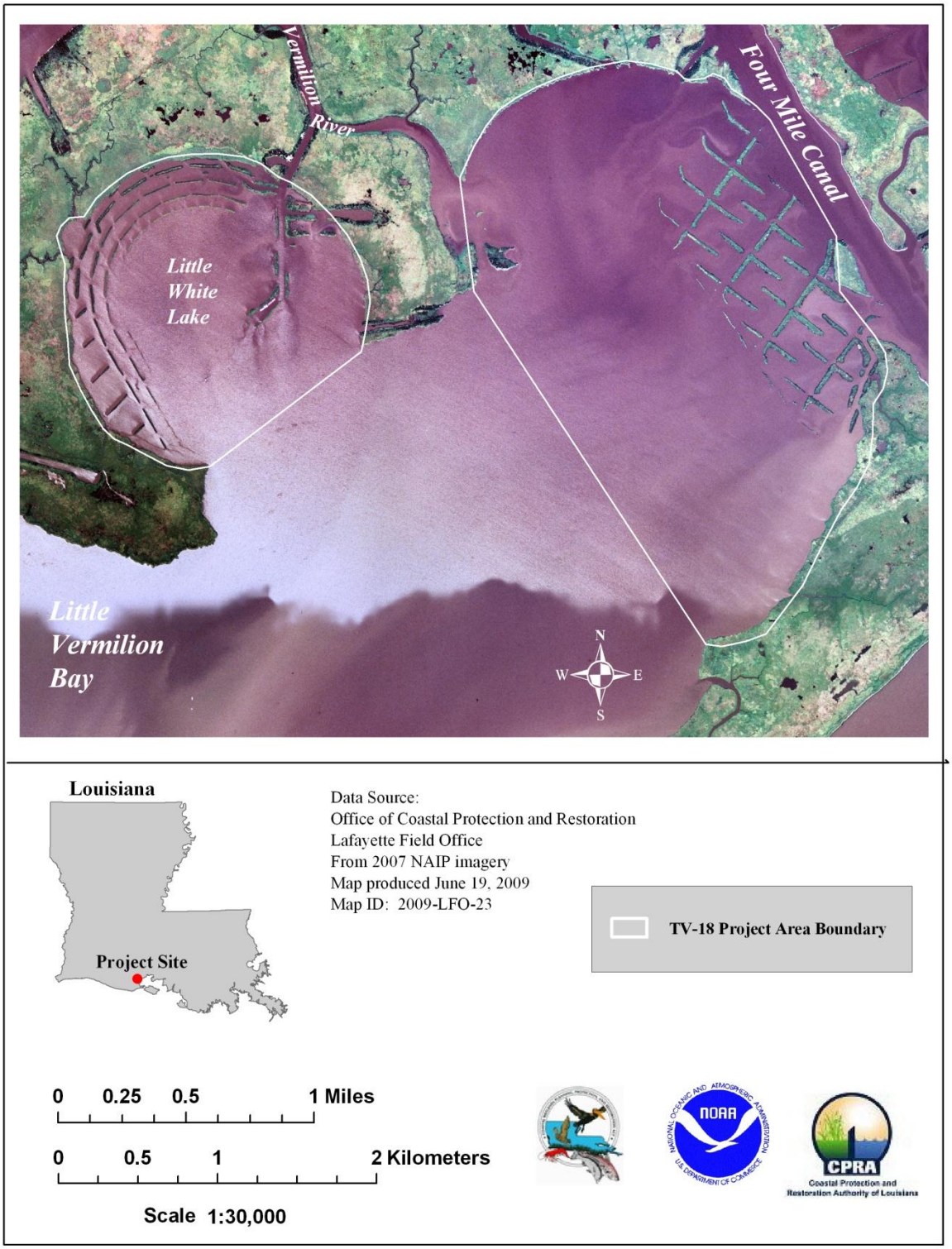

Figure 1. Four-Mile Canal Terracing and Sediment Trapping (T/V-18) project area showing boundary and terrace locations.

II. Maintenance Activity

a. Project Feature Inspection Procedures

The purpose of the annual inspection of the Four Mile Canal Terracing and Sediment Trapping Project (TV-18) is to evaluate the constructed project features to identify any deficiencies and prepare a report detailing the condition of project features and recommended corrective actions needed. Should it be determined that corrective actions are needed, CPRA shall provide, in the report, a detailed cost estimate for engineering, design, supervision, inspection, and construction contingencies, and an assessment of the urgency of such repairs. The annual inspection report also contains a summary of maintenance projects completed since initial construction of project features and an estimated projected budget for the upcoming three (3) years for operation, maintenance and rehabilitation. The three (3) year projected operation and maintenance budget is shown in Appendix B. A summary of past operation and maintenance projects completed since completion of the Four Mile Canal Project is outlined in Section IV.

An inspection of the Four Mile Canal Terracing and Sediment Trapping Project (TV-18) was held on February 22, 2011 under partly cloudy skies and mild temperatures. In attendance were Stan Aucoin and Mel Guidry from CPRA. Representatives from NOAA Fisheries were invited but were unable to attend. The annual inspection began at the site of the terraces constructed in Little White Lake.

The field inspection included a visual inspection of the project site. Staff gauge readings were used, when available, to determine approximate elevations of water and earthen terraces. Photographs were taken at each project feature (see Appendix A) and Field Inspection notes were completed in the field to record measurements and deficiencies (see Appendix C).

b. Inspection Results

Site 1—Earthen terraces

In Little White Lake, the 4th row of terraces continues to erode, but is still somewhat visible and breaking waves. The 3rd row is in fairly decent shape. The 1st and 2nd rows are in excellent condition. The channels are beginning to silt in. Future inspections will need to be done in a tunnel boat. Ducks were abundant in the area. The eastern terraces adjacent to the Four Mile Canal continue to erode as well as the western most terraces. Consideration is being given to armoring the open water along Four Mile Canal with rock in order to protect the remaining terraces. Boat wakes are severely damaging these terraces. Channels between the terraces are silting in. (Photos: Appendix B, Photo 1-4)

Site 2—Vegetation plantings

Vegetation is stable on terraces in both areas and is doing extremely well. Emergent vegetation is becoming established. No maintenance with regard to the plantings is needed at this time.

c. Maintenance Recommendations

i. Immediate/Emergency repairs

Permitting and installing approximately 5,200 LF of foreshore rock dike

ii. Programmatic/Routine Repairs

None

d. Maintenance History

General Maintenance: Below is a summary of completed maintenance projects and operation tasks performed since May 2004, the construction completion date of the Four Mile Canal Terracing and Sediment Trapping Project.

There has been no required maintenance on this project.

III. Operation Activity

a. Operation Plan

There are no water control structures associated with this project, therefore no Structural Operation Plan is required.

b. Actual Operations

There are no water control structures associated with this project, therefore no Structural Operation Plan is required.

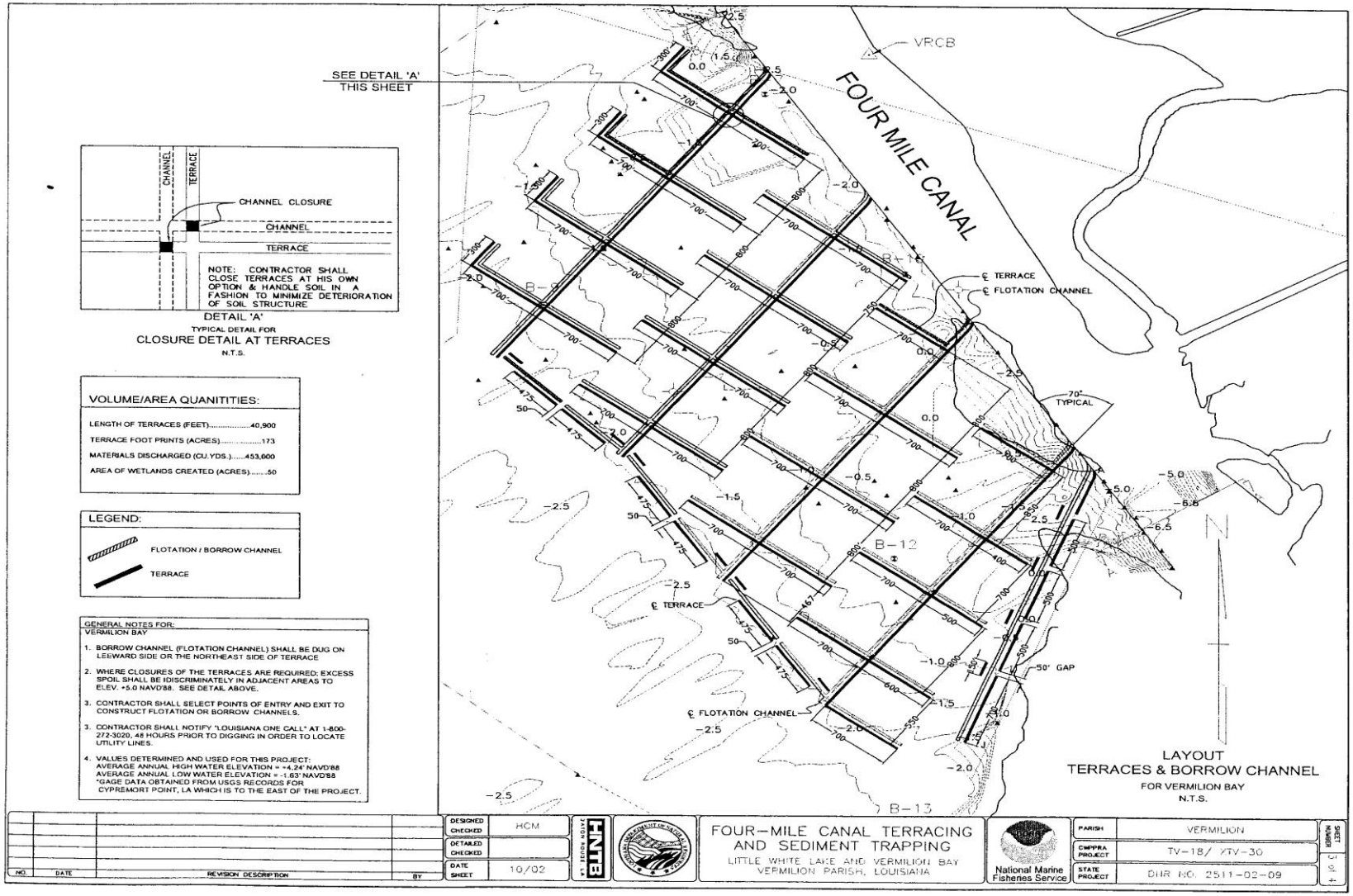

Figure 2. Proposed schematic for Four-Mile Canal Terracing and Sediment Trapping (T/V-18) for terraces in the eastern section of Little Vermilion Bay (HNTB 2002).

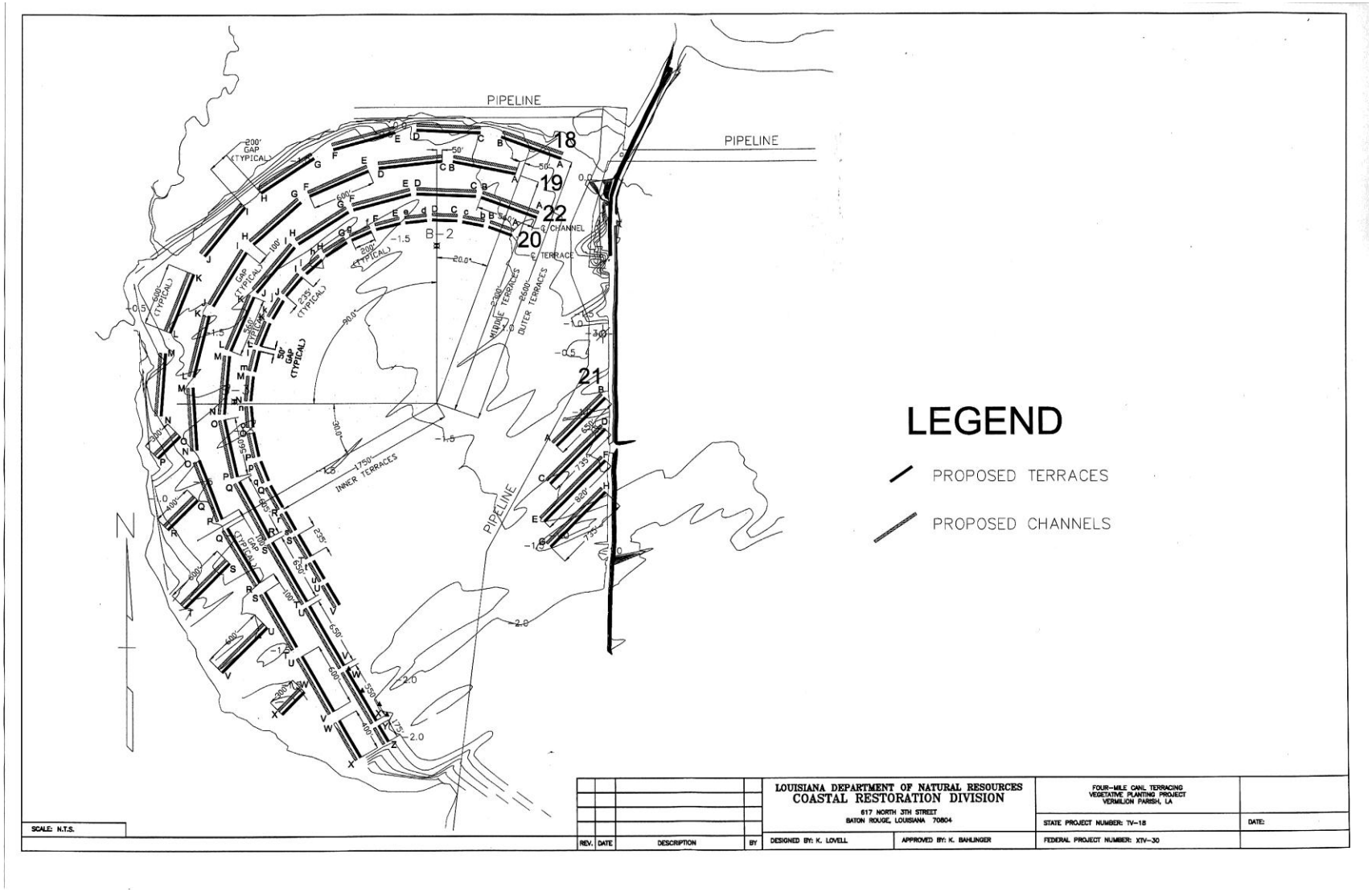

Figure 3. Schematic for Four-Mile Canal Terracing and Sediment Trapping (T/V-18) for terraces in the western section of Little White Lake (HNTB 2002).

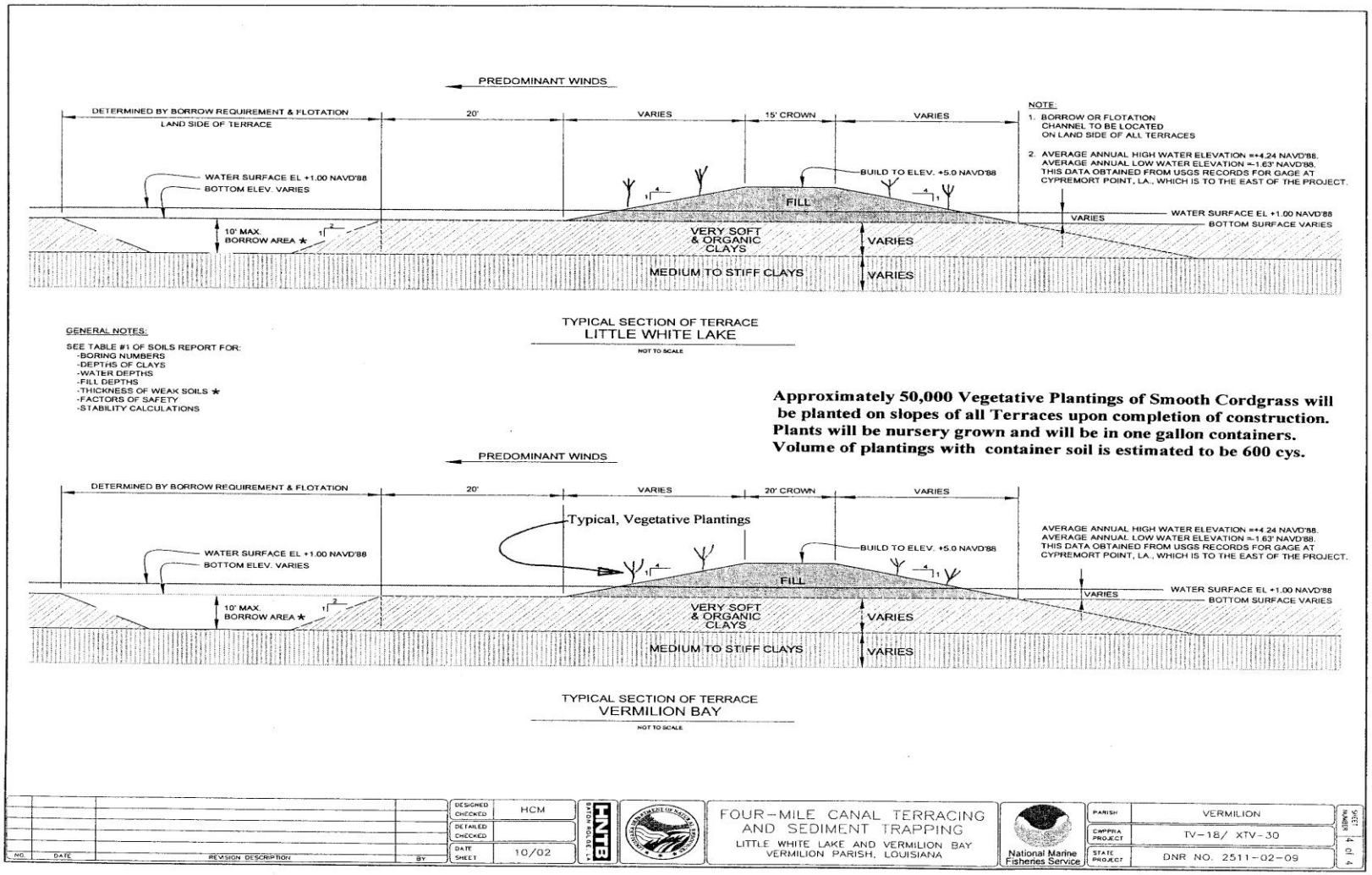

Figure 4. Typical layout and cross section of terraces constructed in Little Vermilion Bay and Little White Lake for the Four-Mile Canal Terracing and Sediment Trapping (TV-18) project (HNTB 2002).

IV. Monitoring Activity

a. Monitoring Goals

The objectives of the Four-Mile Canal Terracing and Sediment Trapping project are to reduce shoreline erosion rates and increase marsh habitat, SAV and fisheries utilization, and to increase freshwater and sediment flow from Four-Mile Canal into the project area by constructing conveyance channels adjacent to earthen terraces.

The following goals contribute to the evaluation of the above objectives:

Specific Monitoring Goals:

1 Evaluate the rate of erosion along the shoreline of the project area (Little White Lake and adjacent Little Vermilion Bay).
2 Evaluate establishment of emergent vegetation on planted terraces.
3 Evaluate sediment deposition within the project area.
4 Evaluate land/water ratios with respect to initial and secondary land gains.

b. Monitoring Elements

Shoreline Survey

To document shoreline movement, differential GPS was used to map the shoreline in Little Vermilion Bay and Little White Lake in 2004 & 2010. Differential GPS was used as described in Steyer et al. (1995). Differentially corrected GPS data sets were obtained in 2004 (as built), and post-construction in 2010. GPS data was taken during the spring of each monitoring year to minimize errors associated with taking data at different times of the year, not accounting for seasonal changes that might occur to the shoreline. Future data will be collected in 2017 if funds are made available to collect data.

Terrace Vegetation

The condition of the natural emergent and planted vegetation on the terraces over the life of the project was monitored using a stratified sampling scheme on 16 of the total planted terraces using a modified Braun-Blanquet sampling method as outlined in Steyer et al. (1995). Transect lines and plots were established across selected terraces to include both high and low energy environments. Three sampling plots were established on randomly selected transect lines which will include a plot on both slopes and 1 plot on the crown. At each station, percent cover, dominant plant height, and species composition were documented in a 4 m^2 sample area. Each plot was marked with 2 corner poles to allow for revisiting the sites over time. Vegetation was evaluated at the sampling sites in the spring of 2004 (as built), and post-construction in the spring of 2007 and 2010. Future data will be collected in 2016 provided funds are available.

Bathymetry/Topography

Sediment deposition was monitored along existing transects used in bathymetry map creation. Twenty eight (28) transects encompassing an array of terrace and channel formations were selected for development of elevation profiles. Elevation of the water bottom sediments was determined along each transect in a similar fashion to that in the initial survey. Surveys were conducted by a professional engineering firm in 2003 (immediately post-construction, funded by construction), and will be replicated in 2017 if possible. Survey years may change to gather additional information earlier in the project life based on potential effectiveness of the project.

Digital Color Infrared Video Imagery

To document land to open-water ratios and marsh loss/gain rates in the project area, color infrared video imagery (1:12,000) was obtained in the summer of 2004 (as built), and post-construction in 2005, and 2007. Imagery were delineated to classify all land in the project area as either (1) preexisting wetlands, (2) vegetated and non-vegetated terraces, and (3) non-terrace, newly developed wetlands (i.e., those that develop in open water areas between the terraces or adjacent to the preexisting perimeter levees). Aerial photography collected in 2010 has not is currently being analyzed by USGS.

CRMS Supplemental

In addition to the project specific monitoring elements listed above, a variety of other data is collected at CRMS-*Wetlands* stations which can be used as supporting or contextual information. Data types collected at CRMS sites include hydrologic from continuous recorder, vegetative, physical soil characteristics, discrete porewater salinity, surface elevation change, vertical accretion and land-water analysis of a 1 km^2 area encompassing the station (Folse et al. 2008). For this report, vegetation data from CRMS2041 was used to contrast emergent vegetation on the terraces and in existing marsh.

c. Preliminary Monitoring Results and Discussion

Shoreline Position

DGPS shoreline surveys were performed in June 2004 and June 2010 (figure 5, Table 1). On average the shoreline erosion rate in Little White Lake was 0.00 m/yr. There was more loss on the west side where the outer terraces had eroded (up to -2.41 m/yr (-7.9 ft/yr)) and more gain on the more protected north side of Little White Lake (up to 5.39 m/yr (17.7 ft/yr)). The average shoreline erosion rate for the Little Vermilion Bay area was 0.58 m/yr (1.9 ft/yr). There was more gain on the protected south side than the unprotected northern shore with up to 13.91 m/yr (45.6 ft/yr) in the south and up to -1.31 m/yr (-4.3 ft/yr) in the north. Sediments from Hurricanes Katrina, Rita and Gustav appeared to have been trapped behind the terraces. A final shoreline survey is scheduled for June 2017. If funds are not available to do so, this will serve as the last monitoring report.

Table 1. Shoreline Change Rate from 2004 to 2010.

	m/yr				ft/yr			
	Mean	**± Std Error**	**Min**	**Max**	**Mean**	**± Std Error**	**Min**	**Max**
Little White Lake	0.00	0.09	-2.41	5.39	0	0.3	-7.9	17.7
LWL-W	-0.65	0.07	-2.41	0.79	-2.1	0.2	-7.9	2.6
LWL-N	0.58	0.13	-1.96	5.39	1.9	0.4	-6.4	17.7
Little Vermilion Bay	0.58	0.16	-2.20	13.91	1.9	0.5	-7.2	45.6
LVB-N	-0.14	0.06	-1.31	3.36	-0.5	0.2	-4.3	11
LVB-S	1.73	0.37	-2.20	13.91	5.7	1.2	-7.2	45.6

Terrace Vegetation

Total percent cover of vegetation within Little White Lake increased for years 2004, 2007 and 2010 from 12.3%, 38.1% and 44.6% respectively (figure 6, photos Appendix A). Little Vermilion Bay had a slight decrease of 71.6%, 69.7% and 61.2% respectively. Little White Lake terrace cover increased significantly faster than Little Vermilion Bay terraces which started out with more cover ($F_{2, 264} = 11.7$; $p<0.0001$) (figure 6).

Species richness showed no significant difference between stations over time ($F_{2, 264} = 2.5$; p-0.0854), although there have consistently been more species within Little Vermilion Bay than Little White Lake (figure 7). In Little White Lake, the terraces located on the northeast lake rim were protected by the terrace rows in front of them and showed a higher number of species. The outer most terrace row was subjected to more wave energies and experienced the lowest number of species and high rates of erosion. In Little Vermilion Bay, terraces located behind an existing island and in the innermost terrace field had the highest number of species while the first set of terrace rows opened to the large fetch experienced the most erosion and low species numbers.

Cover, species richness, and floristic quality (FQI) increased over time on the Little White Lake terraces (figure 8). Cover, richness, and FQI began much higher on the Little Vermilion Bay terraces and remained high over time. The dominant species in both areas in all years was the planted species, *Spartina alterniflora*. Many of the species colonizing the Little Vermilion Bay terraces receive low FQI scores indicative of a disturbed environment.

Vegetation at nearby CRMS2041 has a few species in common with the community on the Little Vermilion Bay terraces although the dominants are not the same (figure 9). The CRMS site is dominated by *Phragmites australis* and *Schoenoplectus robustus*, both of which are present on the Vermilion Bay terraces but the CRMS site has little *Spartina alterniflora.* The CRMS site also has *Spartina patens* which is absent on the Little Vermilion Bay terraces. FQI scores are about 10 points higher at CRMS2041.

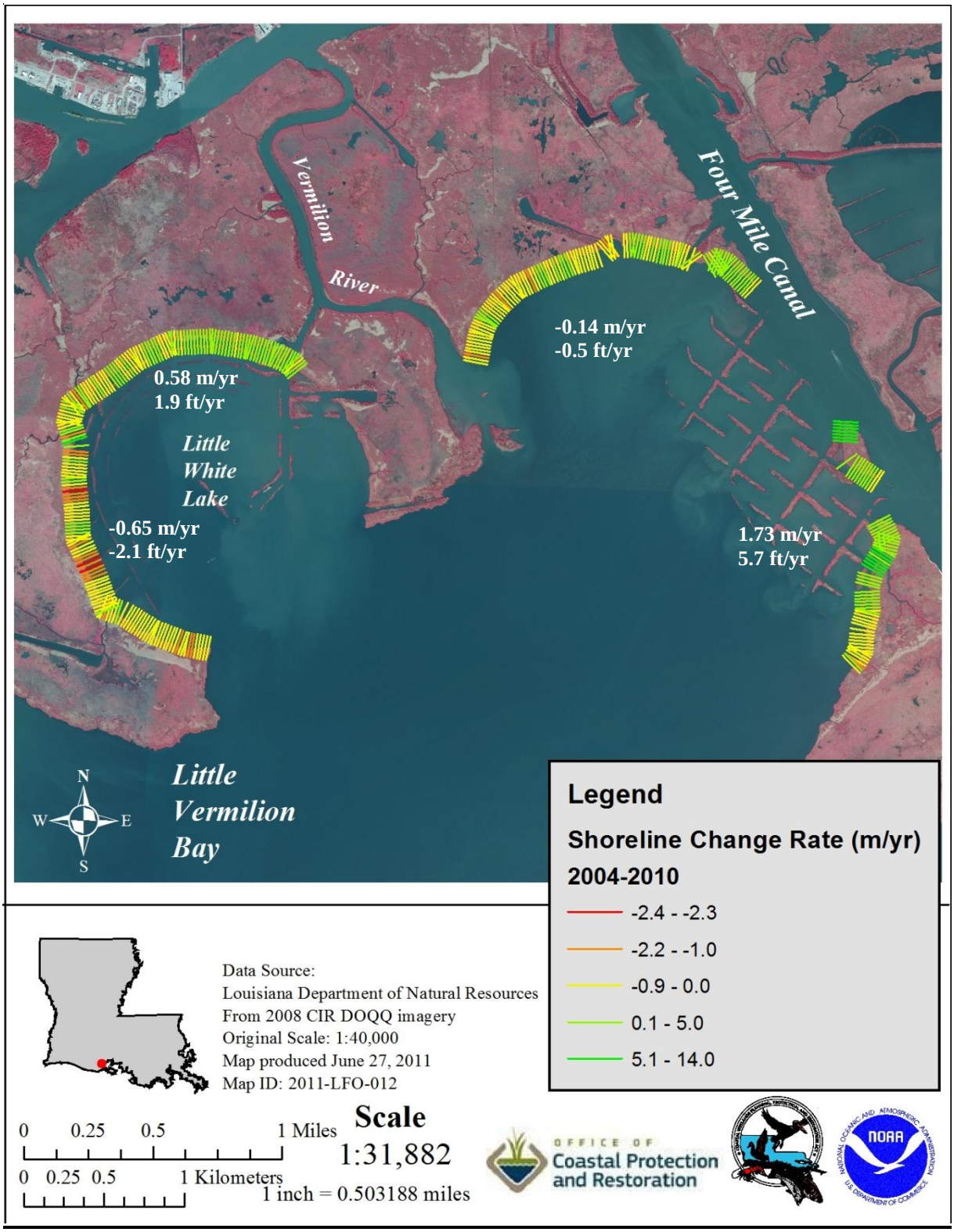

Figure 5. Four-Mile Canal Terracing and Sediment Trapping DGPS shoreline change rates (m/yr) from 2004 to 2010.

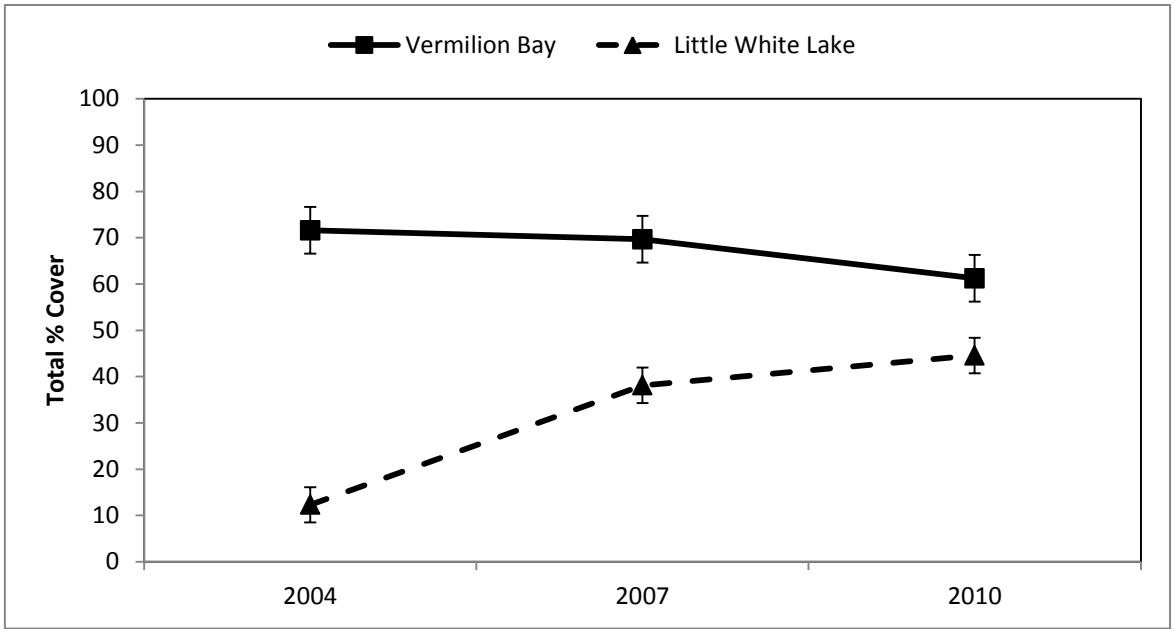

Figure 6. Little Vermilion Bay stations were significantly higher in total % cover over time than Little White Lake stations for all years (F2, 264 = 11.7; p<0.0001).

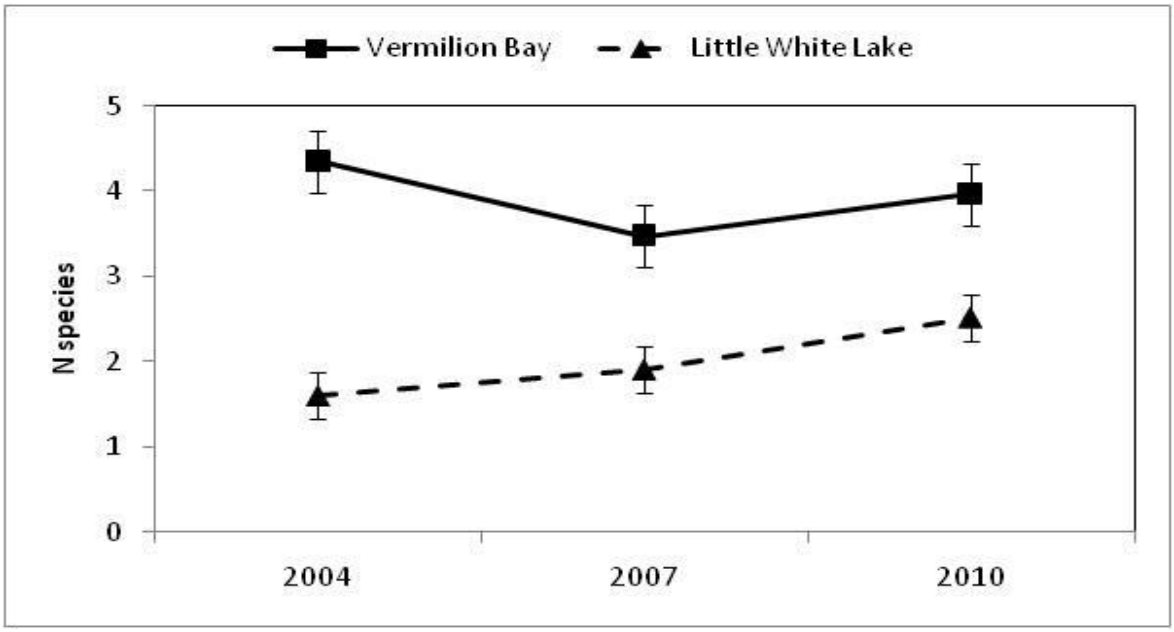

Figure 7. There was no significant difference in species richness between stations over time (F2, 264 = 2.5; p=0.0854) although there have consistently been more species at Little Vermilion Bay than Little White Lake.

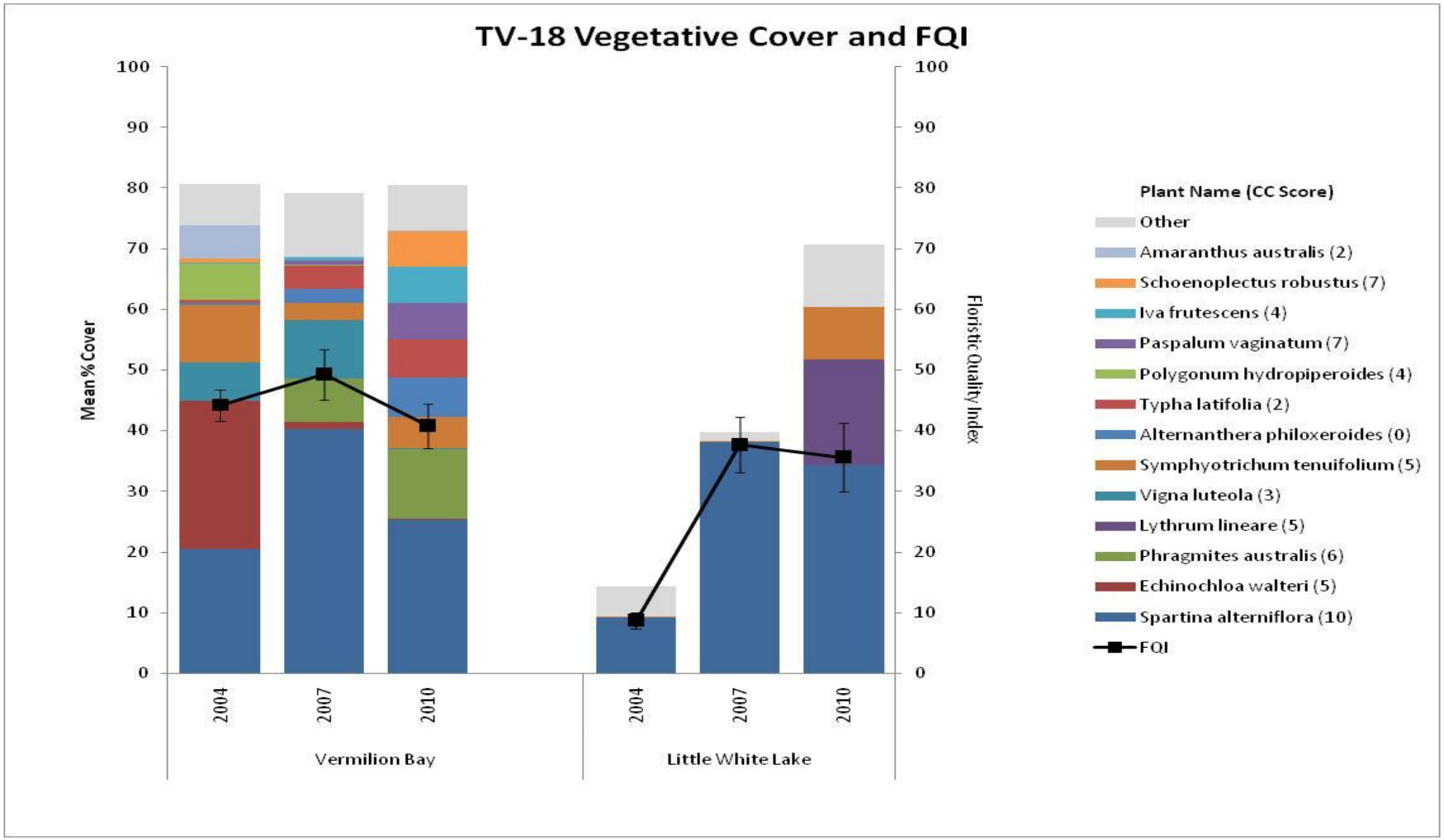

Figure 8. Percent coverage of species and floristic quality index of vegetation data collected on the Little Vermilion Bay and Little White Lake terraces. Values are means of 57 stations within the Little Vermilion Bay site and 33 stations within the Little White Lake site; therefore, the sum of % coverage of individual species can be greater than 100 %.

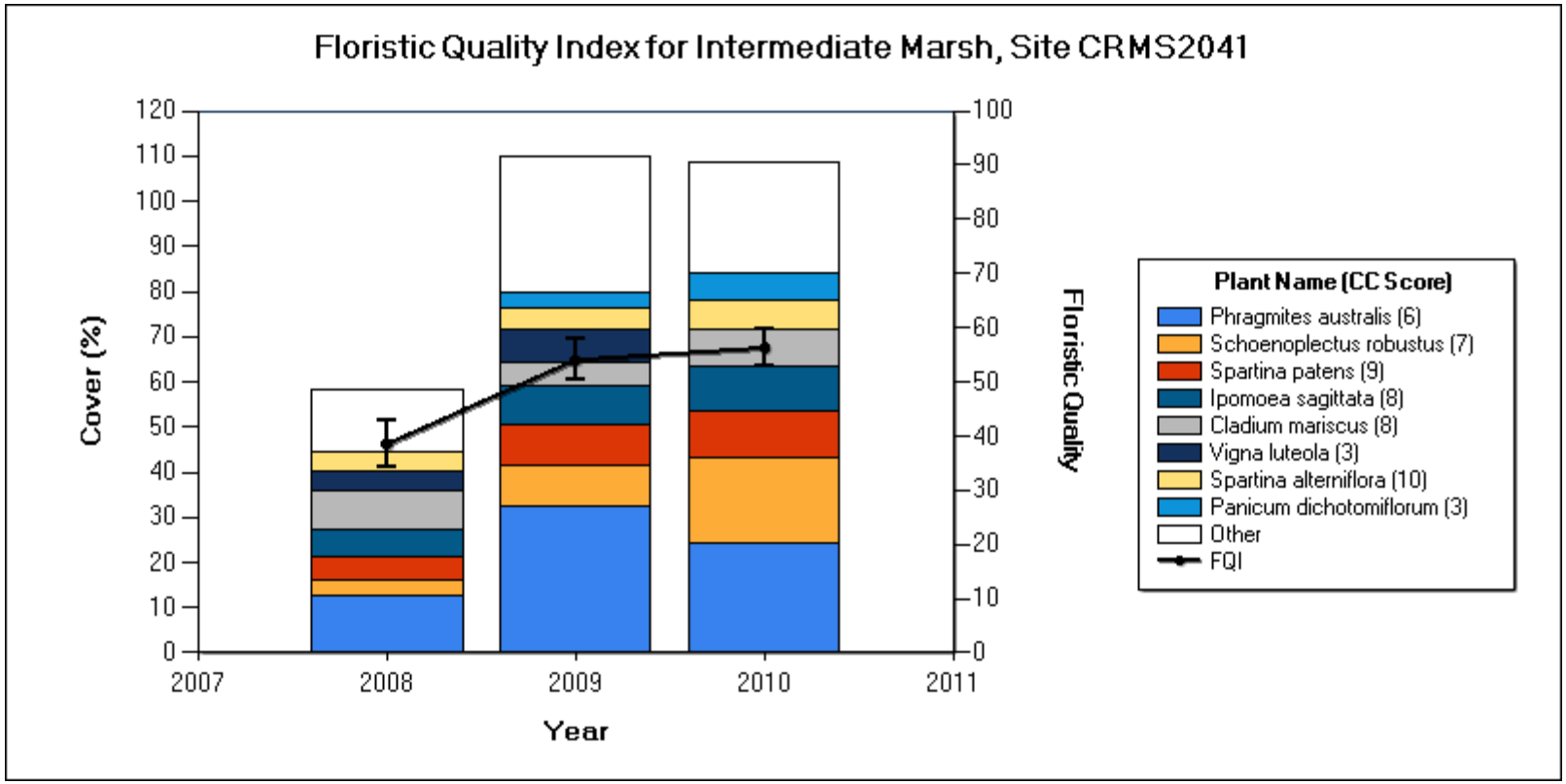

Figure 9. Percent coverage of species and floristic quality index of vegetation data collected on at CRMS station 2041 approximately a quarter mile north of Little White Lake .

Bathymetry/Topography

Preliminary bathymetry surveys were completed in 2003 (figure 10) and differences will be calculated after the second survey scheduled for June 2017 if possible.

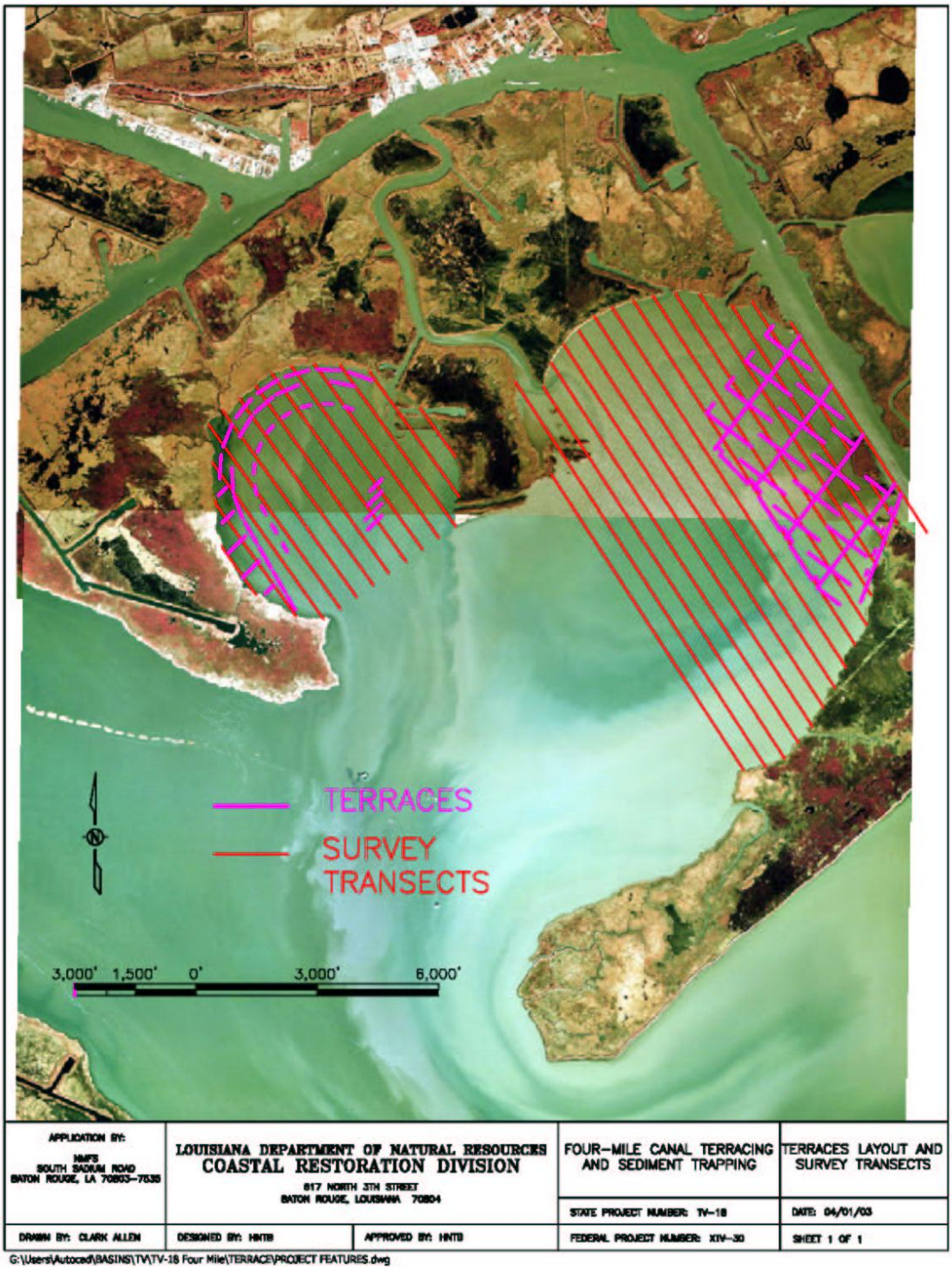

Figure 10. Bathymetry layout for survey transects within the Four-Mile Canal Terracing and Sediment Trapping (T/V-18).

Digital Color Infrared Video Imagery:

Analysis of digital color infrared video taken in 2004, Z-1 imaging for 2005 and color infrared aerial photography for 2007 for the entire project area are presented in figures 11, 12, and 13. The total project area is 2,270 acres. The Little White Lake project area consists of 708 acres and the Little Vermilion Bay project area consists of 1,562 acres. The Little White Lake area decreased by 4 acres from 2004 to 2005 but had an increase of 11 acres from 2005 to 2007. The Little Vermilion Bay area had an increase in land of 15 acres from 2004 to 2005 and another 3 acres from 2005 to 2007 (Table 2). The losses within the Little White Lake area were attributed to the erosion of the outer terraces on the western shore as a result of wave action and fetch from across Little Vermilion Bay. The gains within both areas were attributed to the deposition of sediment behind the terraces where sediment was trapped and became vegetated. Hurricanes Katrina, Rita and Gustav could be a contributing factor to the gradual increase in land behind the terraces. Sediments appeared to have been trapped behind the terraces after the storms.

There were 10 acres of newly developed wetlands in the Little Vermilion Bay terrace area and 11 acres in the Little White Lake terrace area in 2007 (figure 13). Most gains were made on the edge of the terraces with small pockets in protected existing wetlands. Total land gain from 2004-2007 was 25 acres, seven in Little White Lake and 18 in Little Vermilion Bay.

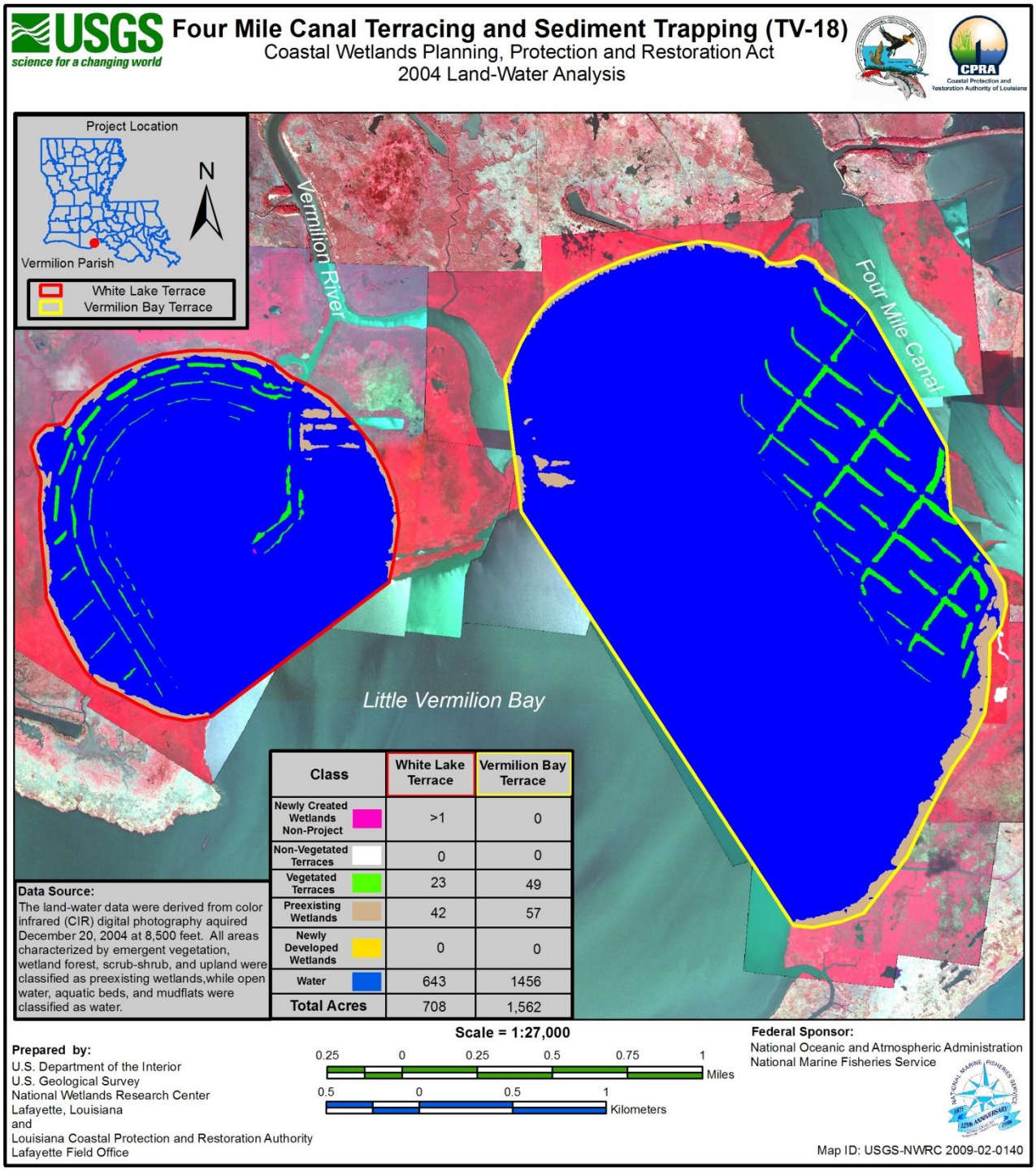

Figure 11. Four-Mile Canal Terracing and Sediment Trapping (TV-18) 2004 land water analysis.

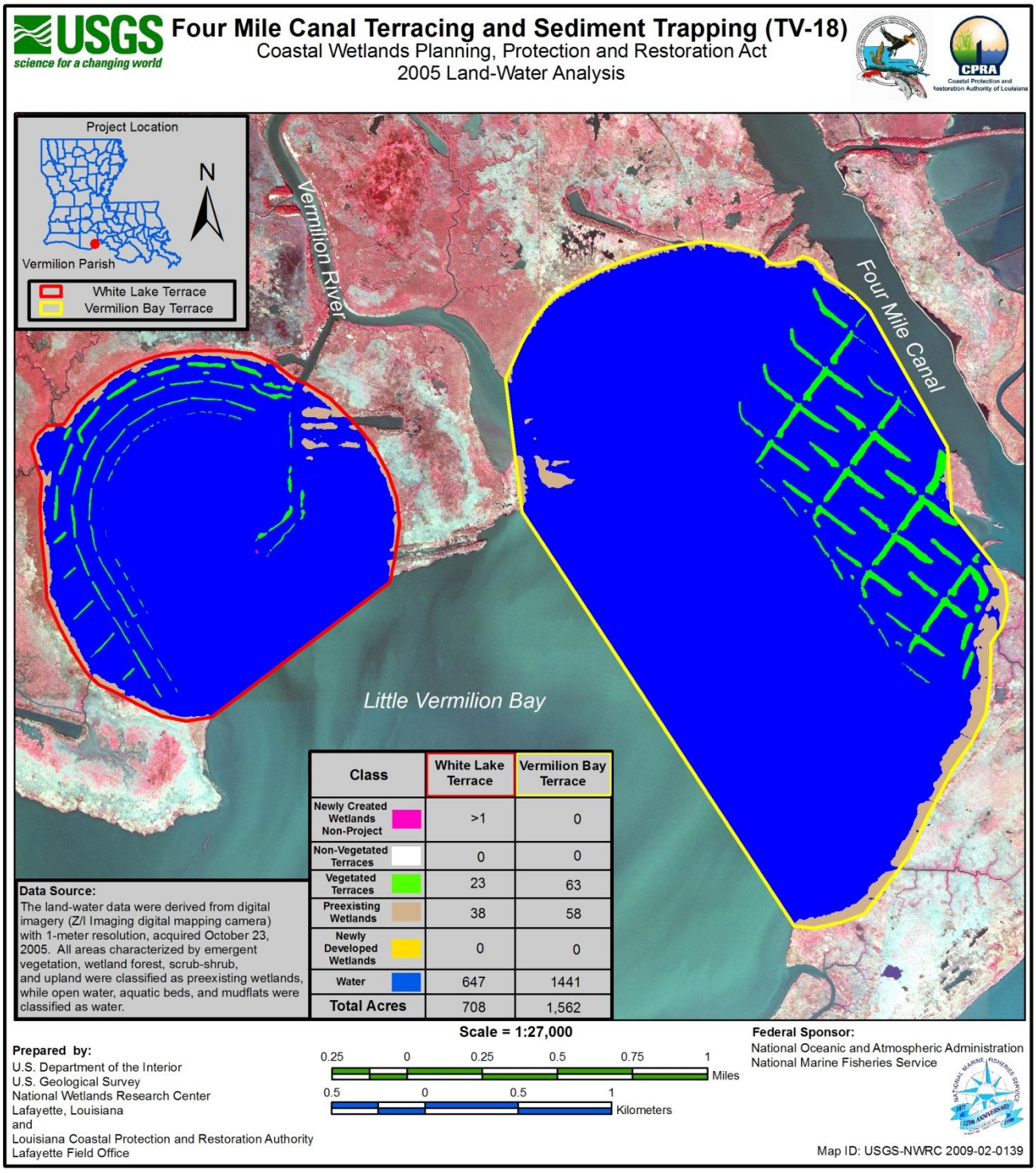

Figure 12. Four-Mile Canal Terracing and Sediment Trapping (TV-18) 2005 land water analysis.

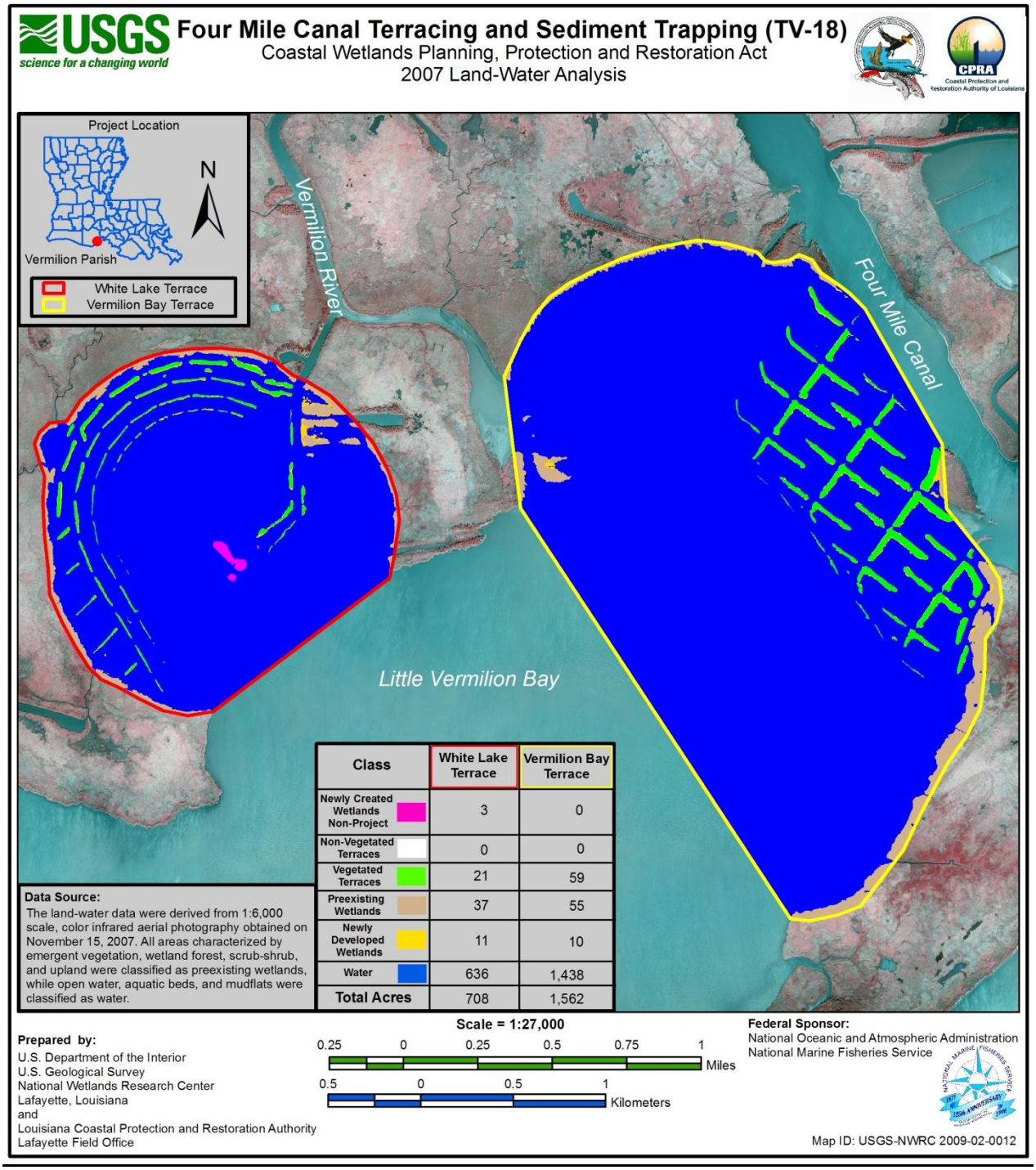

Figure 13. 2007 Land Water analysis for Four Mile Canal Terracing and Sediment Trapping (TV-18).

Table 2. Percent land and water for the for the Little White Lake and Little Vermilion Bay terrace areas for 2004, 2005 and 2007

	Little White Lake						Vermilion Bay					
	2004		2005		2007		2004		2005		2007	
	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%
Land	65	9.2	61	8.6	72	10.2	106	6.8	121	7.7	124	7.9
Water	643	90.8	647	91.4	636	89.8	1456	93.2	1441	92.3	1438	92.1
Total	708		708		708		1562		1562		1562	

V. Conclusions

a. Project Effectiveness

The Four Mile Canal Terracing and Sediment Trapping Project is in good condition and functioning as intended. The outer row of terraces have eroded in the highest energy environments but the shorelines have been protected for the most part.

The terraces effectively protected the shoreline in Little Vermilion Bay where the protected southern shoreline gained land behind the terraces and the unprotected northern shoreline continued to erode. Parts of the western shore of Little White Lake continued to erode despite being protected while the northern shoreline gained land. The new land became vegetated by *Spartina alterniflora*.

The planted vegetation has colonized most of the terraces in Little Vermilion Bay and a lower percentage of the terraces in Little White Lake. Percent cover and FQI scores have increased from 2004 to 2010 within Little White Lake but remain lower than the cover and FQI within the Little Vermilion Bay area.
Land to water ratios has increased over time in both areas.

Overall, the project has created functional marshland and is expected to maintain the integrity of the marsh it has been protecting. Unless a funding request is made to collect more shoreline, vegetation, and survey data, this will serve as the last OM&M report.

b. Recommended Improvements

In order to evaluate earthen terrace settlement and any vertical accretion between the terraces, a structural assessment survey performed by a licensed engineering/ land surveying firm is recommended within the first 5 years of construction. The date of assessment survey should be agreed upon by the state and federal sponsor at the annual maintenance inspection. If funding is continued, a topo-bathy survey of terraces and channel formations will be needed.

c. Lessons Learned

Terraces created in high energy environments such as the ones located adjacent to the Four-Mile Canal may benefit from a hard structure, fence, or breakwater to minimize the erosive effects from boat wake traffic.

VI. Literature Cited

Adams, R. D., P. J. Banas, R. H. Baumann, J. H. Blackmon, and W. G. McIntire. 1978. Shoreline erosion in coastal Louisiana: inventory and assessment. Baton Rouge: Louisiana Department of Transportation and Development, Coastal Resources Program. 139 pp.

Chabreck, R. H., and G. Linscombe 1997. Vegetation type map of the Louisiana coastal marshes. Louisiana Department of Wildlife and Fisheries, New Orleans. Scale: 1:62,500.

——— 1988. Vegetation type map of the Louisiana coastal marshes. Louisiana Department of Wildlife and Fisheries, New Orleans. Scale: 1:62,500.

——— 1978. Vegetation type map of the Louisiana coastal marshes. Louisiana Department of Wildlife and Fisheries, New Orleans. Scale: 1:62,500.

Chabreck, R. H., T. Joanen, and A. W. Palmisano 1968. Vegetation type map of the Louisiana coastal marshes. Louisiana Department of Wildlife and Fisheries, New Orleans. Scale: 1:62,500.

HNTB Corporation 2002. Four-Mile Canal Terracing and Sediment Trapping Engineering and Design Services. Data Collection and Analysis Feasibility Report. DNR Contract No. 2511-02-09. Baton Rouge, LA.

Louisiana Department of Natural Resources 1999. Four-Mile Canal Terracing and Sediment Trapping Wetland Value Assessment. Baton Rouge: Louisiana Department of Natural Resources, Coastal Restoration Division.

O'Neil, T. 1949. Map of the southern part of Louisiana showing vegetation types of the Louisiana marshes. Louisiana Department of Wildlife and Fisheries New Orleans.

Steyer, G. D., R. C. Raynie, D. L. Steller, D. Fuller, and E Swenson. 1995. Quality management plan for Coastal Wetlands Planning, Protection, and Restoration Act monitoring plan. Open-file series 95-01. Baton Rouge: Louisiana Department of Natural Resources, Coastal Restoration Division.

U. S. Army Corps of Engineers 1993. Rivers And Harbors Flood Control Projects Flood Control M. R. & T. Project Maps. New Orleans District, New Orleans, LA.

U. S. Department of Agriculture, Soil Conservation Service 1996. Soil Survey of Vermilion Parish, Louisiana. Publication No. 1996-405-693/20014/SCS. Washington, D.C.: U.S. Government Printing Office. 183 pp, 98 maps. Scale 1:20,000.

U. S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service 2000. Draft Environmental Assessment of Four-Mile Canal Terracing and Sediment Trapping Project. CWPPRA Project XTV-30. Silver Spring, Maryland. 42 pp.

U. S. Geological Survey, National Wetlands Research Center, National Biological Survey 2002. Four Mile Canal Terracing and Sediment Trapping Project TV-18 Habitat Analysis. Map ID: 2003-04-109. USGS/NWRC, Coastal Restoration Field Station, Baton Rouge, La. Unpublished data.

U. S. Geological Survey, National Wetlands Research Center, National Biological Survey 2003. Four Mile Canal Project (TV-18) Shoreline Change Analysis. Map ID: 2003-11-1781. USGS/NWRC, Coastal Restoration Field Station, Baton Rouge, La. Unpublished data.

Appendix A
(Inspection Photographs)

Photo No. 1—Little White Lake terraces

Photo No. 2—Little White Lake terraces

Photo 3—Four Mile Canal terraces

Photo 4—emergent vegetation within Four Mile Canal terraces

Appendix B
(Three Year Budget Projection)

FOUR MILE CANAL/ TV18 / PPL 9

Three-Year Operations & Maintenance Budgets 07/01/2011 - 06/30/2014

Project Manager	O & M Manager	Federal Sponsor	Prepared By
Darrell Pontiff	*Stan Aucoin*	*NMFS*	*Stan Aucoin*

	2011/2012 (-8)	2012/2013 (-9)	2013/2014 (-10)
Maintenance Inspection	$ 5,086.00	$ 5,269.00	$ 5,457.00
Structure Operation			
Administration	$1,000.00	$ 1,000.00	$ 1,000.00
Maintenance/Rehabilitation			

12/13 Description:

E&D	
Construction	
Construction Oversight	
Sub Total - Maint. And Rehab.	$ -

13/14 Description

E&D	$ -
Construction	$ -
Construction Oversight	$ -
Sub Total - Maint. And Rehab.	$ -

12/13 Description:

E&D	$ -
Construction	$ -
Construction Oversight	$ -
Sub Total - Maint. And Rehab.	$ -

	2011/2012 (-8)	2012/2013 (-9)	2013/2014 (-10)
Total O&M Budgets	**$ 6,086.00**	**$ 6,269.00**	**$ 6,457.00**

O &M Budget (3 yr Total)	**$ 18,812.00**
Unexpended O & M Budget	**$ 21,789.00**
Remaining O & M Budget (Projected)	**$ 2,977.00**

OPERATION AND MAINTENANCE BUDGET 07/01/2011-06/30/2012

FOUR MILE CANAL TERRACING AND SEDIMENT TRAPPING/TV-18/PPL9

DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	ESTIMATED TOTAL
O&M Inspection and Report	EACH	1	$6,086.00	**$6,086.00**
General Structure Maintenance	LUMP	1	$0.00	**$0.00**
Engineering and Design	LUMP	1	$0.00	**$0.00**
Operations Contract	LUMP	1	$0.00	**$0.00**
Construction Oversight	LUMP	1	$0.00	**$0.00**

ADMINISTRATION

LDNR / CRD Admin.	LUMP	0	$0.00	$0.00
FEDERAL SPONSER Admin.	LUMP	0	$0.00	$0.00
SURVEY Admin.	LUMP	0	$0.00	$0.00
OTHER				$0.00
			TOTAL ADMINISTRATION COSTS:	**$0.00**

MAINTENANCE / CONSTRUCTION

SURVEY

SURVEY DESCRIPTION:	Add staff gage.				
	Secondary Monument	EACH	0	$0.00	$0.00
	Staff Gauge / Recorders	EACH	1	$0.00	$0.00
	Marsh Elevation / Topography	LUMP	0	$0.00	$0.00
	TBM Installation	EACH	0	$0.00	$0.00
	OTHER				$0.00
				TOTAL SURVEY COSTS:	**$0.00**

GEOTECHNICAL

GEOTECH DESCRIPTION:					
	Borings	EACH	0	$0.00	$0.00
	OTHER				$0.00
				TOTAL GEOTECHNICAL COSTS:	**$0.00**

CONSTRUCTION

CONSTRUCTION DESCRIPTION:					
Rip Rap	LIN FT	TON / FT	TONS	UNIT PRICE	
	0	0.0	0	$0.00	$0.00
	0	0.0	0	$0.00	$0.00
	0	0.0	0	$0.00	$0.00
Filter Cloth / Geogrid Fabric		SQ YD	0	$0.00	$0.00
Navagation Aid		EACH	0	$0.00	$0.00
Signage		EACH	0	$0.00	$0.00
General Excavation / Fill		CU YD	0	$0.00	$0.00
Dredging		CU YD	0	$0.00	$0.00
Sheet Piles (Lin Ft or Sq Yds)			0	$0.00	$0.00
Timber Piles (each or lump sum)			0	$0.00	$0.00
Timber Members (each or lump sum)			0	$0.00	$0.00
Hardware		LUMP	1	$0.00	$0.00
Materials		LUMP	1	$0.00	$0.00
Mob / Demob		LUMP	1	$0.00	$0.00
Contingency		LUMP	1	$0.00	$0.00
General Structure Maintenance		LUMP	1	$0.00	$0.00
OTHER				$0.00	$0.00
OTHER				$0.00	$0.00
OTHER				$0.00	$0.00
				TOTAL CONSTRUCTION COSTS:	**$0.00**

TOTAL OPERATIONS AND MAINTENANCE BUDGET: **$6,086.00**

OPERATION AND MAINTENANCE BUDGET 07/01/2012-06/30/2013

FOUR MILE CANAL TERRACING AND SEDIMENT TRAPPING/TV-18/PPL9

DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	ESTIMATED TOTAL
O&M Inspection and Report	EACH	1	$6,269.00	**$6,269.00**
General Structure Maintenance	LUMP	1	$0.00	**$0.00**
Engineering and Design	LUMP	1	$0.00	**$0.00**
Operations Contract	LUMP	1	$0.00	**$0.00**
Construction Oversight	LUMP	1	$0.00	**$0.00**

ADMINISTRATION

LDNR / CRD Admin.	LUMP	0	$0.00	$0.00
FEDERAL SPONSER Admin.	LUMP	0	$0.00	$0.00
SURVEY Admin.	LUMP	0	$0.00	$0.00
OTHER				$0.00
			TOTAL ADMINISTRATION COSTS:	**$0.00**

MAINTENANCE / CONSTRUCTION

SURVEY

SURVEY DESCRIPTION:					
Secondary Monument		EACH	0	$0.00	$0.00
Staff Gauge / Recorders		EACH	0	$0.00	$0.00
Marsh Elevation / Topography		LUMP	0	$0.00	$0.00
TBM Installation		EACH	0	$0.00	$0.00
OTHER					$0.00
				TOTAL SURVEY COSTS:	**$0.00**

GEOTECHNICAL

GEOTECH DESCRIPTION:					
Borings		EACH	0	$0.00	$0.00
OTHER					$0.00
				TOTAL GEOTECHNICAL COSTS:	**$0.00**

CONSTRUCTION

CONSTRUCTION DESCRIPTION:					
Rip Rap	LIN FT	TON / FT	TONS	UNIT PRICE	
	0	0.0	0	$0.00	$0.00
	0	0.0	0	$0.00	$0.00
	0	0.0	0	$0.00	$0.00
Filter Cloth / Geogrid Fabric		SQ YD	0	$0.00	$0.00
Navagation Aid		EACH	0	$0.00	$0.00
Signage		EACH	0	$0.00	$0.00
General Excavation / Fill		CU YD	0	$0.00	$0.00
Dredging		CU YD	0	$0.00	$0.00
Sheet Piles (Lin Ft or Sq Yds)			0	$0.00	$0.00
Timber Piles (each or lump sum)			0	$0.00	$0.00
Timber Members (each or lump sum)			0	$0.00	$0.00
Hardware		LUMP	1	$0.00	$0.00
Materials		LUMP	1	$0.00	$0.00
Mob / Demob		LUMP	1	$0.00	$0.00
Contingency		LUMP	1	$0.00	$0.00
General Structure Maintenance		LUMP	1	$0.00	$0.00
OTHER				$0.00	$0.00
OTHER				$0.00	$0.00
OTHER				$0.00	$0.00
				TOTAL CONSTRUCTION COSTS:	**$0.00**

TOTAL OPERATIONS AND MAINTENANCE BUDGET: **$6,269.00**

OPERATION AND MAINTENANCE BUDGET 07/01/2013-06/30/2014

FOUR MILE CANAL TERRACING AND SEDIMENT TRAPPING/TV-18/PPL9

DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	ESTIMATED TOTAL
O&M Inspection and Report	EACH	1	$6,457.00	**$6,457.00**
General Structure Maintenance	LUMP	1	$0.00	**$0.00**
Engineering and Design	LUMP	1	$0.00	**$0.00**
Operations Contract	LUMP	1	$0.00	**$0.00**
Construction Oversight	LUMP	1	$0.00	**$0.00**

ADMINISTRATION

LDNR / CRD Admin.	LUMP	1	$0.00	$0.00
FEDERAL SPONSER Admin.	LUMP	1	$0.00	$0.00
SURVEY Admin.	LUMP	1	$0.00	$0.00
OTHER				$0.00
			TOTAL ADMINISTRATION COSTS:	**$0.00**

MAINTENANCE / CONSTRUCTION

SURVEY

SURVEY DESCRIPTION:					
Secondary Monument		EACH	0	$0.00	$0.00
Staff Gauge / Recorders		EACH	0	$0.00	$0.00
Marsh Elevation / Topography		LUMP	0	$0.00	$0.00
TBM Installation		EACH	0	$0.00	$0.00
OTHER					$0.00
				TOTAL SURVEY COSTS:	**$0.00**

GEOTECHNICAL

GEOTECH DESCRIPTION:					
Borings		EACH	0	$0.00	$0.00
OTHER					$0.00
				TOTAL GEOTECHNICAL COSTS:	**$0.00**

CONSTRUCTION

CONSTRUCTION DESCRIPTION:					
Rip Rap	LIN FT	TON / FT	TONS	UNIT PRICE	
	0	0.0	0	$0.00	$0.00
	0	0.0	0	$0.00	$0.00
	0	0.0	0	$0.00	$0.00
Filter Cloth / Geogrid Fabric		SQ YD	0	$0.00	$0.00
Navagation Aid		EACH	0	$0.00	$0.00
Signage		EACH	0	$0.00	$0.00
General Excavation / Fill		CU YD	0	$0.00	$0.00
Dredging		CU YD	0	$0.00	$0.00
Sheet Piles (Lin Ft or Sq Yds)			0	$0.00	$0.00
Timber Piles (each or lump sum)			0	$0.00	$0.00
Timber Members (each or lump sum)			0	$0.00	$0.00
Hardware		LUMP	1	$0.00	$0.00
Materials		LUMP	1	$0.00	$0.00
Mob / Demob		LUMP	1	$0.00	$0.00
Contingency		LUMP	1	$0.00	$0.00
General Structure Maintenance		LUMP	1	$0.00	$0.00
OTHER				$0.00	$0.00
OTHER				$0.00	$0.00
OTHER				$0.00	$0.00
				TOTAL CONSTRUCTION COSTS:	**$0.00**

TOTAL OPERATIONS AND MAINTENANCE BUDGET: **$6,457.00**

Appendix C
(Field Inspection Notes)

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: TV-18 Four Mile Canal

Date of Inspection: February 22, 2011 Time:

Structure No. N/A

Inspector(s): Stan Aucoin, Mel Guidry (CPRA)

Structure Description: Terracing and Sediment Trapping

Water Level + 0.9 NAVD

Type of Inspection: Annual

Weater Conditions: Partly cloudy and mild

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
Steel Bulkhead / Caps	N/A				
Steel Grating	N/A				
Stop Logs	N/A				
Hardware	N/A				
Timber Piles	N/A				
Timber Wales	N/A				
Galv. Pile Caps	N/A				
Vegetation	Good				Vegetation on existing terraces in excellent condition. Emergent vegetation between terraces is becoming established.
Signage /Supports	N/A				
Rip Rap (fill)	N/A				
Eathern Embankment Terraces	Good			1,2, 3 & 4	Erosion of sacrificial terraces in Little White Lake continues as expected. Erosion of terraces adjacent to Four Mile Canal continues to worsen and should be addressed with the construction of a rock dike.

What are the conditions of the existing levees?
Are there any noticable breaches?
Settlement of rock plugs and rock weirs?
Position of stoplogs at the time of the inspection?
Are there any signs of vandalism?