Coastal Protection and Restoration Authority of Louisiana

2011 Operations, Maintenance and Monitoring Report

for

Oaks/Avery Canals Hydrologic Restoration

State Project Number T/V-13a
Priority Project List 6

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Iberia/Vermilion Parishes

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2011 Operations, Maintenance, and Monitoring Report
For
Oaks/Avery Canals Hydrologic Restoration (TV-13a)

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I. Introduction

The Oaks/Avery Canals Hydrologic Restoration project area encompasses 2,876 acres (1,164 ha) located in the southeastern portion of Vermilion Parish and southwestern portion of Iberia Parish, north of Vermilion Bay (figure 1). The Vermilion Bay shoreline makes up most of the southern boundary of the project area. The major tributaries and waterways within the project area are Oaks Canal to the west, Avery Canal on the east, and the Gulf Intracoastal Waterway (GIWW) traversing the project area east to west. Union Oil Canal makes up the eastern boundary of the hydrologic unit of the project north of the GIWW. Most soils in this area are classified as Lafitte Muck, which are very poorly drained, very fluid, organic soils in brackish marshes. The area is composed of approximately 1,936 acres (783 ha) of brackish marsh and 791 acres (320 ha) of open water, 4.8% of which is dominated by submerged aquatic vegetation (SAV), with the remainder made up of non-marsh habitats (Natural Resources Conservation Service 1998). The dominant SAV species is *Myriophyllum spicatum* (Eurasian watermilfoil). The vegetation in the area has historically been classified as brackish and intermediate marsh (O'Neil 1949, Chabreck and Linscombe 1968, 1978, 1988). Land loss rates in the project area averaged 8 acres/yr from 1956-1978. Pre-project erosion rate estimates for the Vermilion Bay shoreline and the GIWW bank in the project area were 13 ft/yr (4 m/yr) and 5-10 ft/yr (1.5-3 m/yr) respectively.

This project consists of the following unrelated restoration components designed to address different land loss problems within the project area: protection of Vermilion Bay shoreline with vegetative plantings; protection of GIWW bankline with rock dikes; stabilization of water level variability north of the GIWW and east of Oaks Canal by installation of a steel sheetpile weir in the "Cowpath" canal, a rock plug in a large breach in the north bank of an oilfield canal, spoilbank restoration along sections of the western bank of Union Oil Canal, and bank paving of the east and west banks of Oaks Canal at its convergence with Vermilion Bay. Approximately 1,200 ft of bankline protection was installed on the south bank of the GIWW adjacent to the area where Bayou Petite Anse exits Tigre Lagoon and enters Vermilion Bay. The remaining 6,300 ft of bankline stabilization was installed on the north bank of the GIWW immediately west of Oaks Canal.

During the life of the 20 year project, 160 acres (65 ha) of wetlands is projected to be protected. Approximately 34,000 *Spartina alterniflora* (smooth cordgrass) plants were planted along 5.1 miles of the Vermilion Bay shoreline in the summer of 2000. Project construction of structural components began on June 25, 2002 with the construction of approximately 7500 linear feet of rock dikes to protect the shoreline of the GIWW by contractor Luhr Brothers, Inc. of Columbia, Illinois. Subcontractors Bertucci Construction Company of Jefferson, Louisiana and Berry Brothers General Contractors, Inc. of Berwick, Louisiana completed project construction with the installation of a low sill sheetpile structure, low sill rock weir, spoilbank refurbishment, and navigation aids. Construction of the $2.8 million project was completed on October 14, 2002.

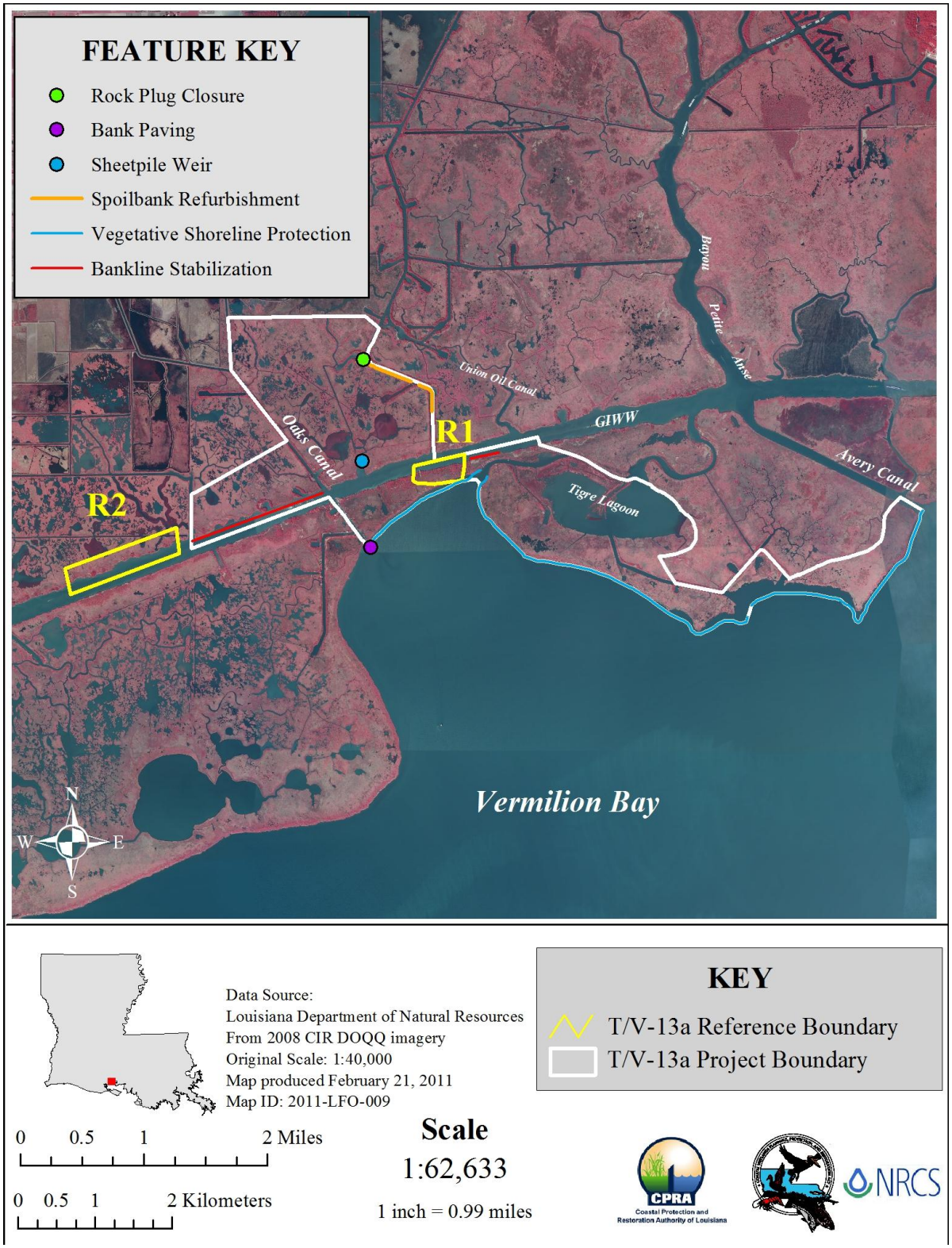


Figure 1. Locations of the TV-13a project and reference areas and project features.

II. Maintenance Activity

a. Project Feature Inspection Procedures

The purpose of the annual inspection of the Oaks/Avery Canals Hydrologic Restoration Project (TV-13a) 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, OCPR 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 which were completed since completion of constructed 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 Oaks/Avery Canals Project are outlined in Section II.d.

An inspection of the Oaks/Avery Canals Hydrologic Restoration Project (TV-13a) was held on April 12, 2011 under sunny skies and cool temperatures. In attendance were Dion Broussard, Mel Guidry and Darrell Pontiff of OCPR. NRCS was represented by Loland Broussard and Charles Slocum. Parties met at the Lafayette Field Office of NRCS and proceeded to the TV-13a project area. The annual inspection began at the west end of the rock shoreline protection on the north side of the GIWW.

The field inspection included a complete visual inspection of the entire project site. Staff gauge readings, when available, and existing temporary benchmarks were used to determine approximate elevations of water, rock dikes, earthen embankments, low sill sheet pile weir and other project features. 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—Rock dike/North bank

The dike is in excellent condition. Approximately 50 linear feet on the eastern end at a barge slip continues to settle but is in no need of any repairs. This low area is located at N 29° 49’ 58.3” and W 91° 59’ 25.9”. East and west tie-ins are stable, however there is some minor erosion occurring at the east tie-in which will be monitored on future inspections. The water level was low at the time of the inspection so the entire rock dike was visible. (Appendix A; Photo 6)

Site 2—Rock paving at Oaks Canal

No worsening in this area was evident. The bank between the bay and Bayou Hebert is still only about 6 feet wide and has not gotten any worse. Additional rock has been added to connect the end of the existing rock paving to the rock island protecting two pipelines located on the eastern side of the Oaks Canal. This work was performed by ChevronTexaco Pipeline, LLC-Erath in 2009 through CUP No. 20070581. No immediate maintenance required at this time. (Appendix A; Photos 1-3)

Site 3—Cow path Structure

Due to low water conditions, the water control structure could not be inspected. Water could be seen pouring out of structure. The levee on the east side of the structure connecting it to the north bank of the GIWW is stable, in good shape, and well vegetated. (Appendix A; Photo 4)

Site 4—Earthen closures

Spoilbank maintenance looks good and is in same condition as last inspection. (Appendix A; Photo 8)

Site 5—Rock plug

The rock plug is in need of repair. It looks as though more rock has been removed since the last inspection. (Appendix A; Photo 5)

Site 6—Rock dike/South bank

The rock dike is similar to immediate post construction condition and in no need of any repairs. (Appendix A; Photo 7)

Site 7—Vegetation plantings

The shoreline plantings were not directly inspected on this trip due to time and wave constraints. The vegetation near the mouth of Oaks Canal is in fair condition and it is expected that this condition was typical along the remainder of the bay shore.

c. Maintenance Recommendations

i. Immediate/ Emergency Repairs

None

ii. Programmatic/ Routine Repairs

Overall, the Oaks/Avery Canals Hydrologic Restoration Project is in good condition and functioning as designed. The landowners have pointed out a breach that has occurred off of the eastern embankment of Oaks Canal which is circumventing the hydrologic boundary of the project, as well as some low spots along the same embankment south of the breach. Plans and specifications are being prepared for a maintenance event for the following:

- Repair breach off of Oaks Canal.

- Construct earthen plug in lieu of repairing vandalism to the rock plug (site 5) as per landowner's preference.
- Repair low spots on the Oaks Canal where water is seeping through or over the existing levee.
- Add staff gage at Cow Path.

d. Maintenance History

General Maintenance: Below is a summary of completed maintenance projects and operation tasks performed since October 2002, the construction completion date of the Oaks/Avery Canals Hydrologic Restoration Project.

2007 Acadian Engineers – Post construction surveys were conducted to establish inlet/outlet baseline channel conditions adjacent to the Cowpath weir. These were performed by Acadian Engineers at a cost of $5,194.15.

Structure Operations: There are no active operations associated with this project.

III. Operation Activity

a. Operation Plan

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

b. Actual Operations

There are no water control structures with operational features associated with this project, therefore no required structural operations.

IV. Monitoring Activity

a. Monitoring Goals

The objectives of the Oaks/Avery Hydrologic Restoration Project are:
1. Protect the Vermilion Bay shoreline through the planting of *S. alterniflora*.
2. Protect sections of the GIWW bank from erosion through use of rock dikes.
3. Stabilize water levels in the hydrologic unit.

The following goals will contribute to the evaluation of the above objectives:
1. Reduce erosion rate on the northern shoreline of Vermilion Bay.
2. Reduce erosion rate of specific high-risk portions of the GIWW bank.
3. Attenuate rapid water level fluctuations in hydrologic unit.
4. Reduce rate of loss of emergent vegetated marsh area in the hydrologic unit.

b. Monitoring Elements

Aerial Photography:

Near-vertical color-infrared aerial photography (1:12,000 scale) was used to measure vegetated and non-vegetated areas for the project and reference areas. The photography was obtained in 2000 (pre-construction), 2002, and 2006 (post-construction) and will be acquired in 2014. The original photography was checked for flight accuracy, color correctness, and clarity and was subsequently archived. Aerial photography was scanned, mosaicked, and georectified by USGS/NWRC personnel according to standard operating procedures (Steyer et al. 1995, revised 2000).

Shoreline Change:

The shoreline position was monitored along Vermilion Bay, along sections of the GIWW bank where rock dikes were constructed, and along the reference area bankline in R1 and R2. A differentially corrected Global Positioning System (dGPS) was used to map the Vermilion Bay shoreline in 2000 (immediately following planting of vegetation), 2003, 2007 and 2010. Shoreline position will be surveyed in years 2012, 2015, and 2018. The bankline along the GIWW in the project and reference areas was mapped in 2003 immediately following construction of the rock dike, in 2006, and in 2010. Future surveys will follow the schedule listed above. The difference between bankline change in the reference areas and the project will be used to estimate the area of wetlands protected by the rock dikes along the GIWW. Because of the lack of a suitable reference area for the Vermilion Bay shoreline, the benefits of the plantings will be inferred from the survival of the plantings and temporal changes in shoreline position, from which changes in rate of loss can be calculated.

Water Level:

Salinity and water level data were collected in 1999 and 2003 at four recorder stations (figure 2) to monitor hydrologic conditions (water depth, salinity) and document water levels within the hydrologic unit. One data recorder was placed inside the unit and three recorders were placed outside the project area at three locations along a semi-natural waterway at increasing distances from the GIWW (figure 2). Water level data were used to document the water level variability in the project area relative to the reference data recorders. Water level data were collected at the shortest interval possible with the recorders (every 30 seconds) for 10 days each month during a 6-month period for the year 1999 (pre-construction) and year 2003 (post-construction). Specifically, water level data have been collected at the above-mentioned stations from 02/05/1999 – 09/02/1999 and 02/24/2003 – 09/06/2003.

Vegetative Shoreline Protection:

The general condition of *S. alterniflora* plantings along Vermilion Bay (installed on the summer of 2000) was documented in July 2001 by monitoring twenty 40-ft long vegetation sampling plots (3% of entire planted area) (figure 3). Each plot consisted of 16 plantings with the sampling location determined by a random numbers table based on distance and marked with a pole. Species composition and percentage cover for the 16-plant plot was documented using the Braun-Blanquet procedure. Survival was determined as a percentage of the number of live plants to the number planted (within the plot) (Mendelssohn et al. 1991).

CRMS-*Wetlands* (CRMS) Supplemental

In addition to project specific monitoring elements, other data types are collected at CRMS sites which can be used as supporting or contextual information (figure 4). Data types collected at CRMS sites include hydrologic from continuous recorder, vegetative, physical soil characteristics, discrete pore water, surface elevation, and land:water analysis of 1 km^2 area encompassing the station. For this report, soil properties, vegetation, and hydrologic data from one site within the project area (CRMS0532) and two sites outside the project area (CRMS0527 and CRMS0531) are presented. In the future, data collected from the CRMS network over a sufficient amount of time to develop valid trends will be used to develop integrated data indices (hydrology, plant productivity, and soil surface elevation change) at different spatial scales (local, basin, coastal) to which we can compare project performance.

Soil cores were collected one time to describe soil properties (bulk density and percent organic matter). Three, 4" (10.16-cm) diameter cores were collected to a depth of 24 cm and divided into 6, 4-cm sections at each site. The Department of Agronomy and Environmental Management at Louisiana State University processed the soil. Cores were collected at the site inside the project area, and suitable cores (quality or same marsh type) were collected from one site (CRMS0527) outside the project area.

Emergent vegetation parameters are evaluated at each CRMS site using techniques described in Steyer et al (1995) to describe species composition, richness, and relative abundance; in addition, overall percent cover and height of the dominant species are monitored. Annually at each site, data are collected and averaged from ten, 4-m^2 sample plots randomly established along a 282.8 m transect that crosses diagonally through a 200-m × 200-m vegetation plot in middle of the CRMS site.

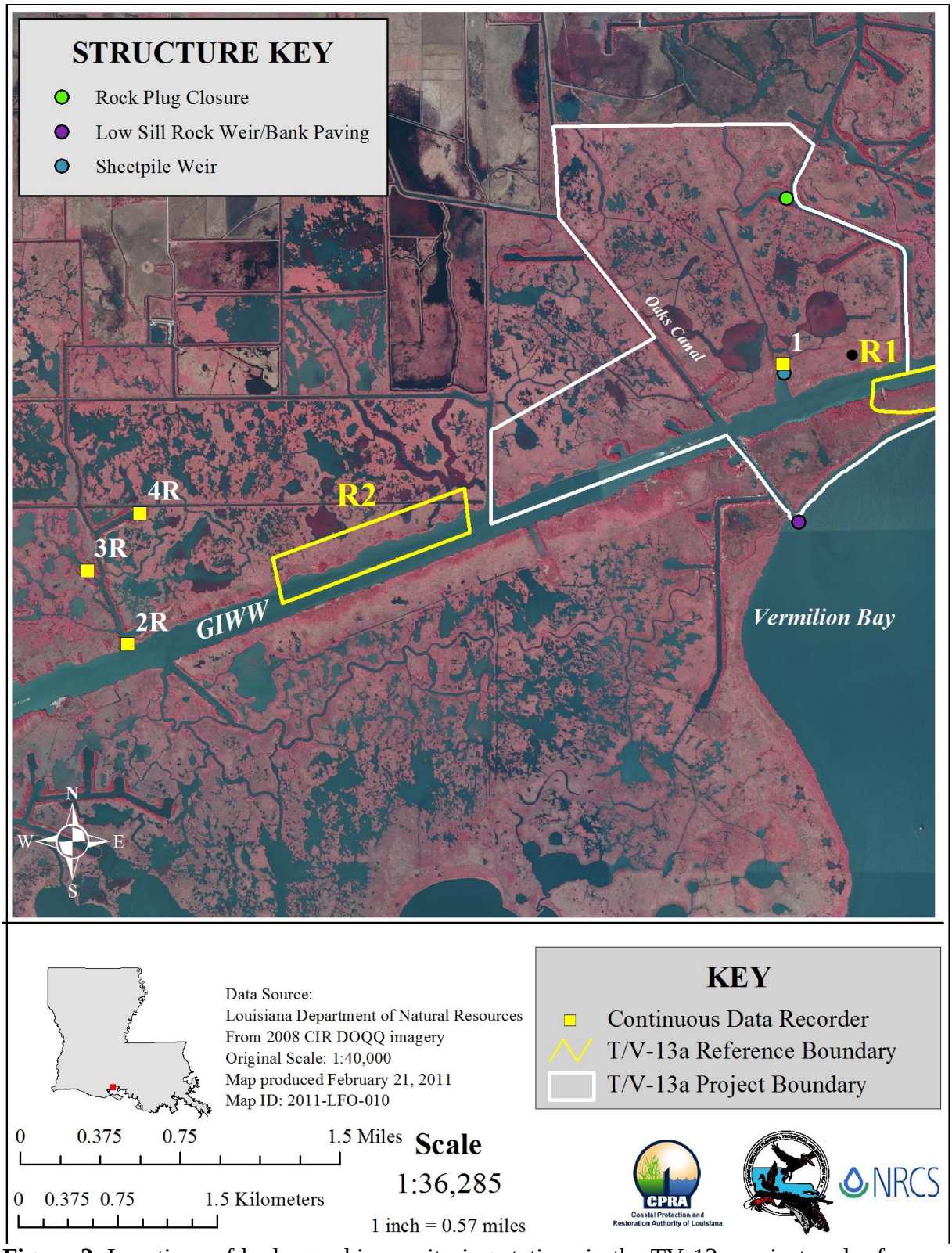


Figure 2. Locations of hydrographic monitoring stations in the TV-13a project and reference areas.

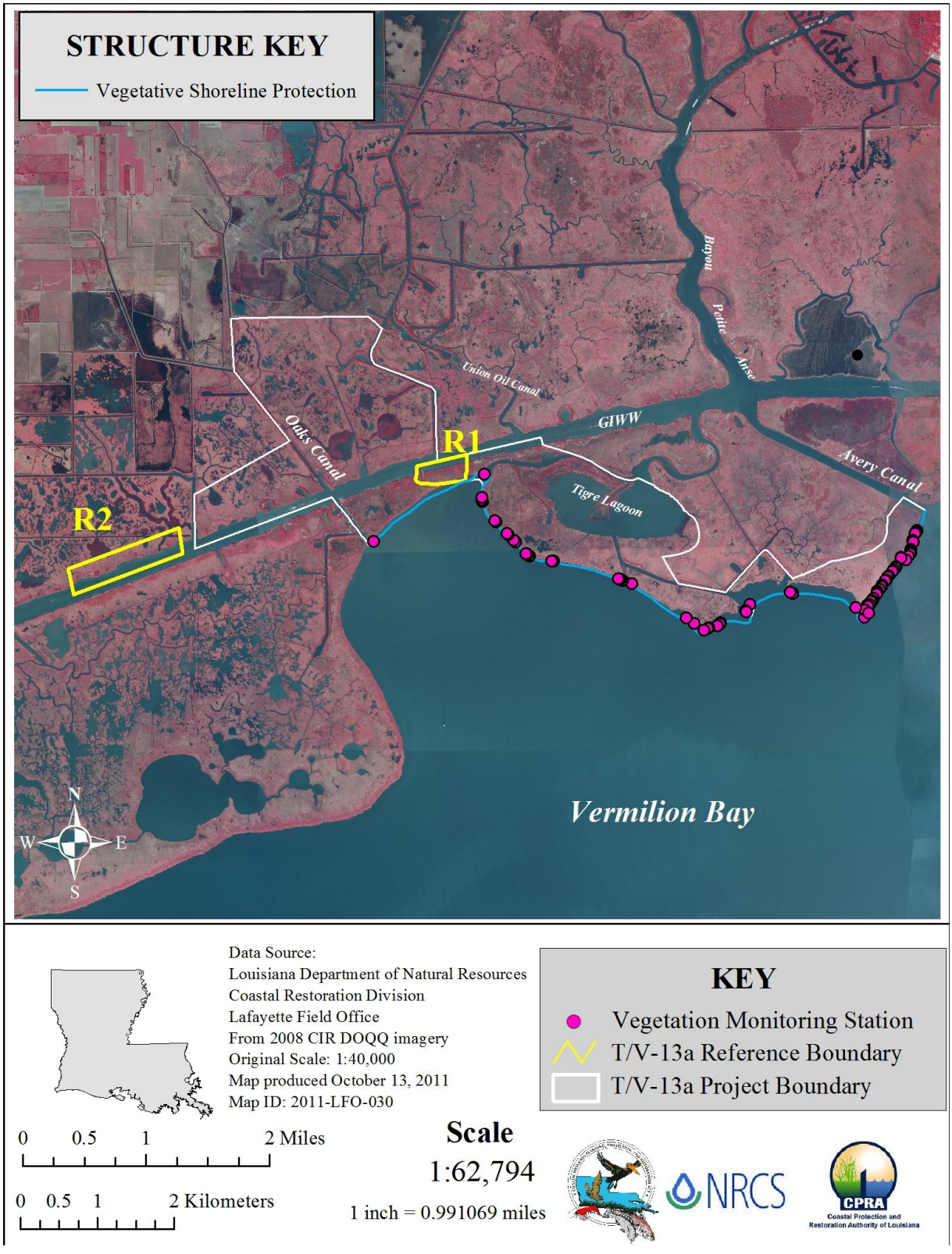


Figure 3. Locations of planted vegetative survey stations in the TV-13a project area.

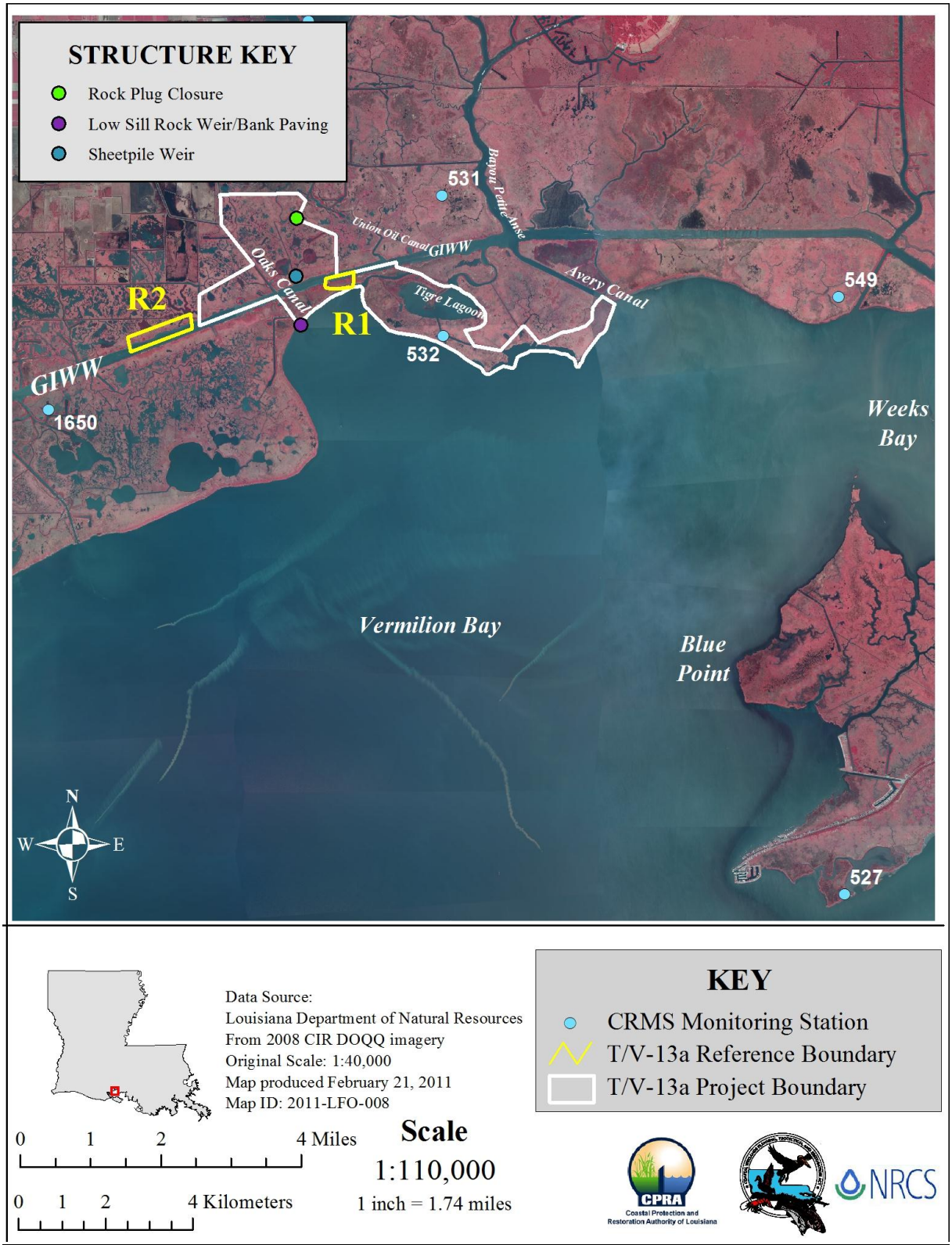


Figure 4. Location of CRMS monitoring sites within and near the TV-13a project area.

The percent cover of the plot and of each species is fed into a floristic quality index based on the marsh type the data was collected. Floristic Quality Indices (FQIs) have been developed for several regions to determine the quality of a wetland based on its species composition (Cohen et al., 2004; Bourbaghs et al., 2006). This FQI was developed by Jenneke Visser and an expert panel on Louisiana coastal vegetation as part of CRMS analytical working group in 2007 to develop integrated data indices (hydrology, plant productivity, and soil surface elevation change) at different spatial scales (local, basin, coastal) to which we can compare project performance. The panel provided an agreed upon score (Coefficient of Conservatism or CC Score) from 0 to 10 for each species in a list of ~500 plant species occurring in Louisiana's coastal wetlands. CC scores are weighted by percent vegetative cover and summed to determine the FQI for the CRMS site. CRMS sites inside and outside the project area were used for this report.

Continuous salinity data are collected hourly. Discrete pore-water from the soil salinity at 10 and 30 cm are collected at five of the vegetation plots during vegetation sampling. Pore water is extracted with a sipper tube assembly (rigid aquarium tubing, flexible hose, and syringe), and salinity is measured using a hand held salinity meter (YSI 30 Salinity, Conductivity, Temperature Meter).

The CRMS station located in the project area is 532. This site is in the portion of the project area affected by the shoreline restoration, but is not affected by the hydrologic management aspect of the project. Reference stations locations were chosen based on tidally influenced marsh in the Acadiana Bays complex which differs from the rest of the coast because the marsh is protected by Marsh Island and not protected by weirs so to limit other hydrologic influences. The two CRMS stations to be compared to the project area station are 527 and 531. Site 527 is similar to the project site, but without any shoreline protection measures. Reference site 531 is nearer to the project than 527. However, this site is farther inland and may not be experiencing the same conditions as the project area site. All three sites are in intermediate marsh. Data types collected at CRMS sites include hydrologic from continuous recorder, vegetative, physical soil characteristics, discrete porewater, surface elevation, and land:water analysis of 1 km^2 area encompassing the station.

c. Preliminary Monitoring Results and Discussion

Aerial Photography:

Aerial photography, collected in December 2002, was classified and indicated a slight increase of land (0.1%) in the project area and a slight decrease of land (0.5%) in the reference areas during the period 2000-2002 (table 1, figures 5-6). The 2006 classification indicated a loss of 1.5% land in the project area and a further loss of 8.6% land in the reference areas for the period 2002-2006 (table 1, figure 7). It is not known to what extent Hurricane Rita caused this increased loss of land in both the project and reference areas. However, land:water analyses for other CWPPRA projects following the hurricane exhibited similar effects. Additionally, these other projects also showed areas of marsh scoured by the storm as observed on the ground. It is believed that this hurricane induced land loss also occurred in the Oaks-Avery project and reference areas as well.

Table 1. Land area and land area change rates compiled from high resolution imagery (1:12,000) collected by the USGS-National Wetlands Research Center pre- (2000) and post-construction (2002, 2006) of TV-13a. Initial construction was completed in October 2002; Hurricane Lili occurred in October 2002 and Hurricane Rita occurred in September 2005.

	Project Area					
	2000		2002		2006	
	acres	%	acres	%	acres	%
Land	1905.2	66.1	1911.0	66.2	1865.0	64.6
Water	977.9	33.9	975.0	33.8	1021.0	35.4
Total	2883.1		2886		2886	
	Reference Area 2					
	2000		2002		2006	
	acres	%	acres	%	acres	%
Land	69.6	55.2	69.0	54.8	66.0	52.4
Water	56.6	44.8	57.0	45.2	60.0	47.6
Total	126.2		126.0		126.0	

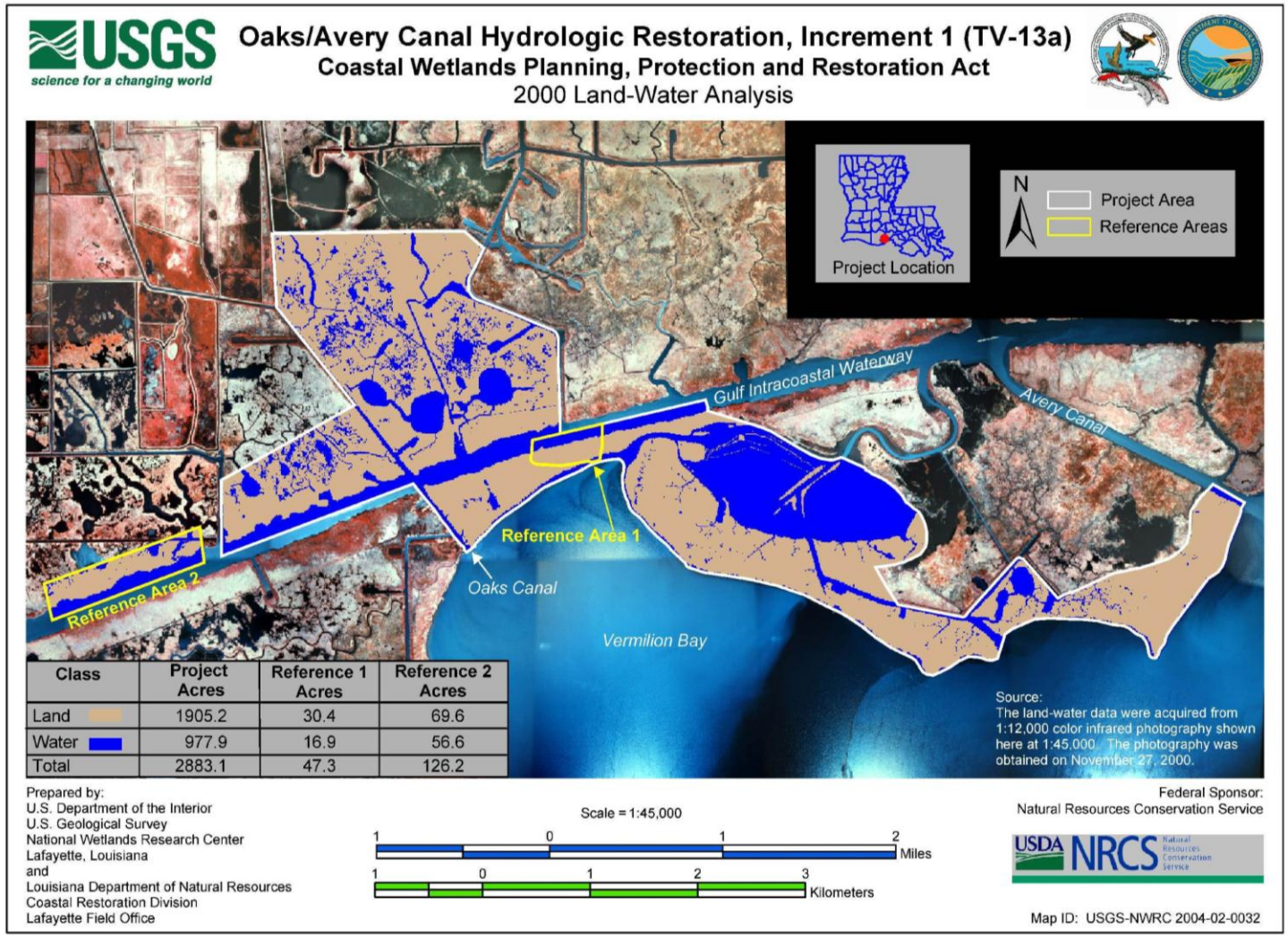


Figure 5. Results of the 2000 Land:Water GIS image classification for the TV-13a project and reference areas.

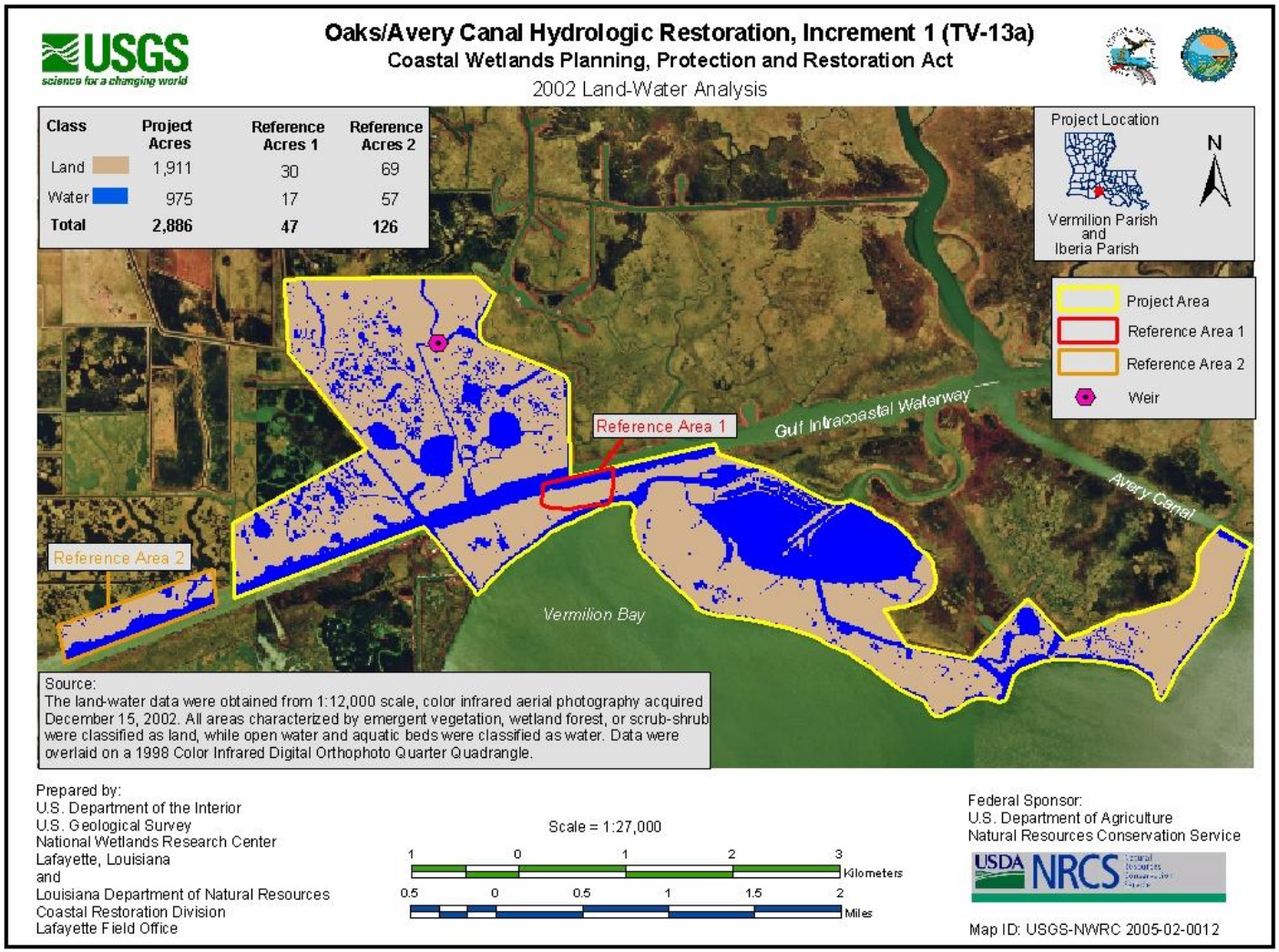


Figure 6. Results of the 2002 Land:Water GIS image classification for the TV-13a project and reference areas.

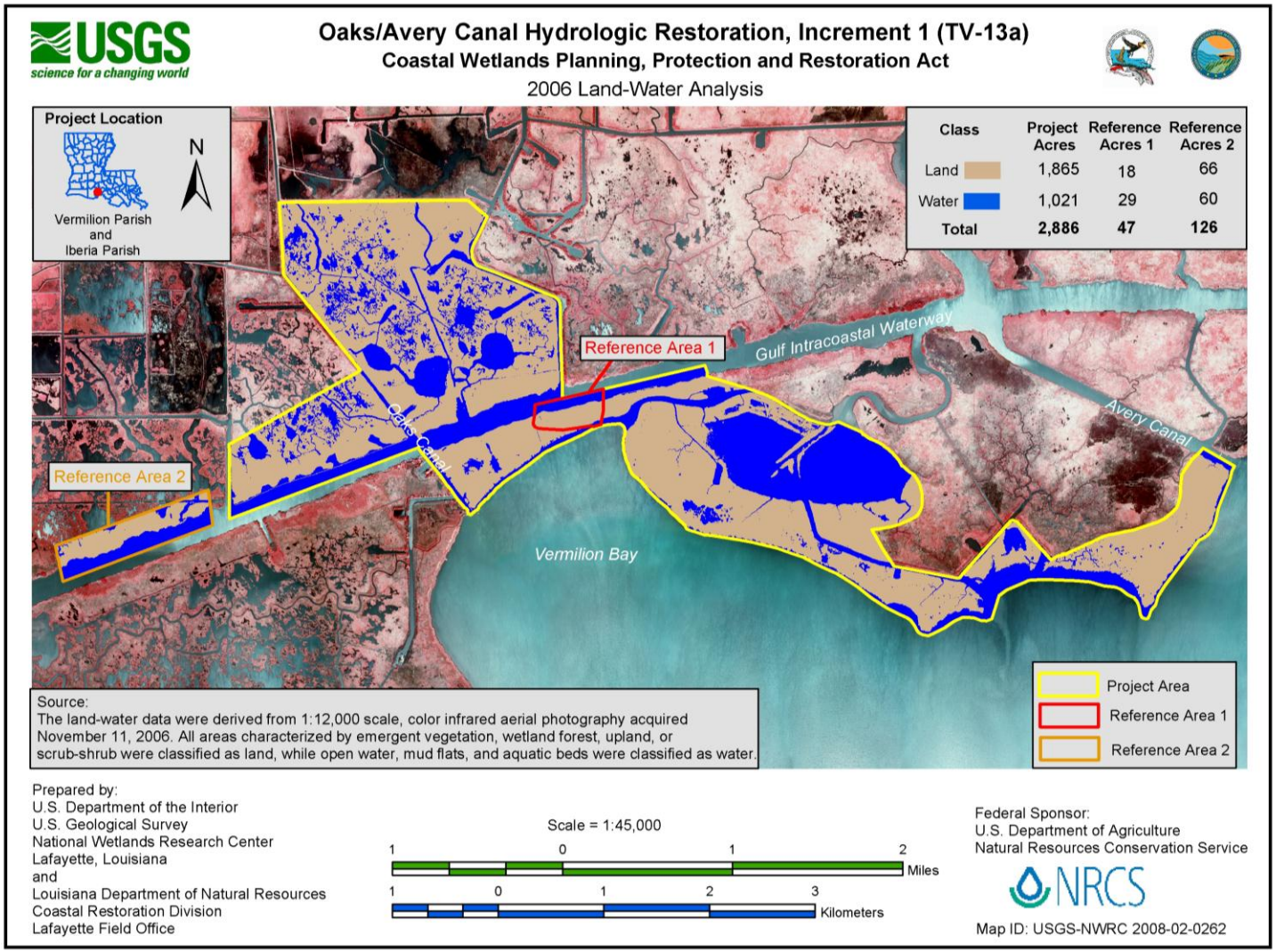


Figure 7. Results of the 2006 Land:Water GIS image classification for the TV-13a project and reference area

Shoreline Position:

As-built (immediately post-construction) bankline positions for the project and reference areas along the GIWW were collected following rock dike construction and again in 2006/7 and 2010 (table 2). Overall, between 2003 and 2010, the project bankline prograded at a mean rate of 0.7 m/yr (2.3 ft/yr) and the unprotected reference area eroded at a rate of -1.4 m/yr (-4.6 ft/yr) (figure 8). These data are consistent with shoreline change in other rock dike projects built along the GIWW. Sediment appears to be accumulating between the shore and the rock dike, resulting in the progradation of the bankline.

Data were collected in 2000 (pre-construction), 2003 (post-planting), 2007, and 2010 for the Vermilion Bay shoreline (table 2, figure 9). Shoreline loss was minimal for the majority of the project area, with the exception of a 6000-ft long section southeast of Tigre Lagoon, which exhibited marked shoreline erosion. It is possible that erosion rates from 2003-2007 increased with time as plantings were lost, or remained consistent with 2000-2003, with the additional loss attributed to Hurricane Rita, which battered the shoreline of the project with high winds and a storm surge of as much as 11-12 ft. From 2007-2010, shoreline erosion in the 6000 ft section southeast of Tigre Lagoon decreased (table 2). It is not known why this decrease occurred. There could have been a change in soil composition as marsh was exposed, which could have reduced the erodibility of the soil. During the entire monitoring period (2000-2010), the shoreline retreated at a rate of -3.8 m/yr (-12.5 ft/yr). The 6000 ft long section southeast of Tigre Lagoon eroded at a mean rate of -15.8 m/yr (-51.8 ft/yr). Loss in this area was as much as -29.4 m/yr (-96.5 ft/yr) (figure 9).

Table 2. Land area and land area change rates compiled from high resolution imagery (1:12,000) collected by the USGS-National Wetlands Research Center pre- (2000) and post-construction (2003, 2006/7) of TV-13a. Initial construction was completed in October 2002; Hurricane Lili occurred in October 2002 and Hurricane Rita occurred in September 2005.

	Shoreline Change Rate (m/yr)-Mean	SE +/-	Shoreline Change Rate (m/yr)-Max Loss	Shoreline Change Rate (m/yr)-Max Gain
Vermilion Bay				
2000-2003	-1.5	8.0	-30.7	49.2
2003-2007	-7.7	12.5	-60.6	2.4
2007-2010	-3.4	4.5	-28.5	1.7
GIWW				
2003-2006/7 Project	0.4	1.5	-9.0	3.0
2003-2006/7 Ref 2	-0.9	0.5	-3.5	0.3
2006/7-2010 Project	1.0	1.5	-1.7	9.2
2006/7-2010Ref 2	-2.1	1.0	-5.0	0.2

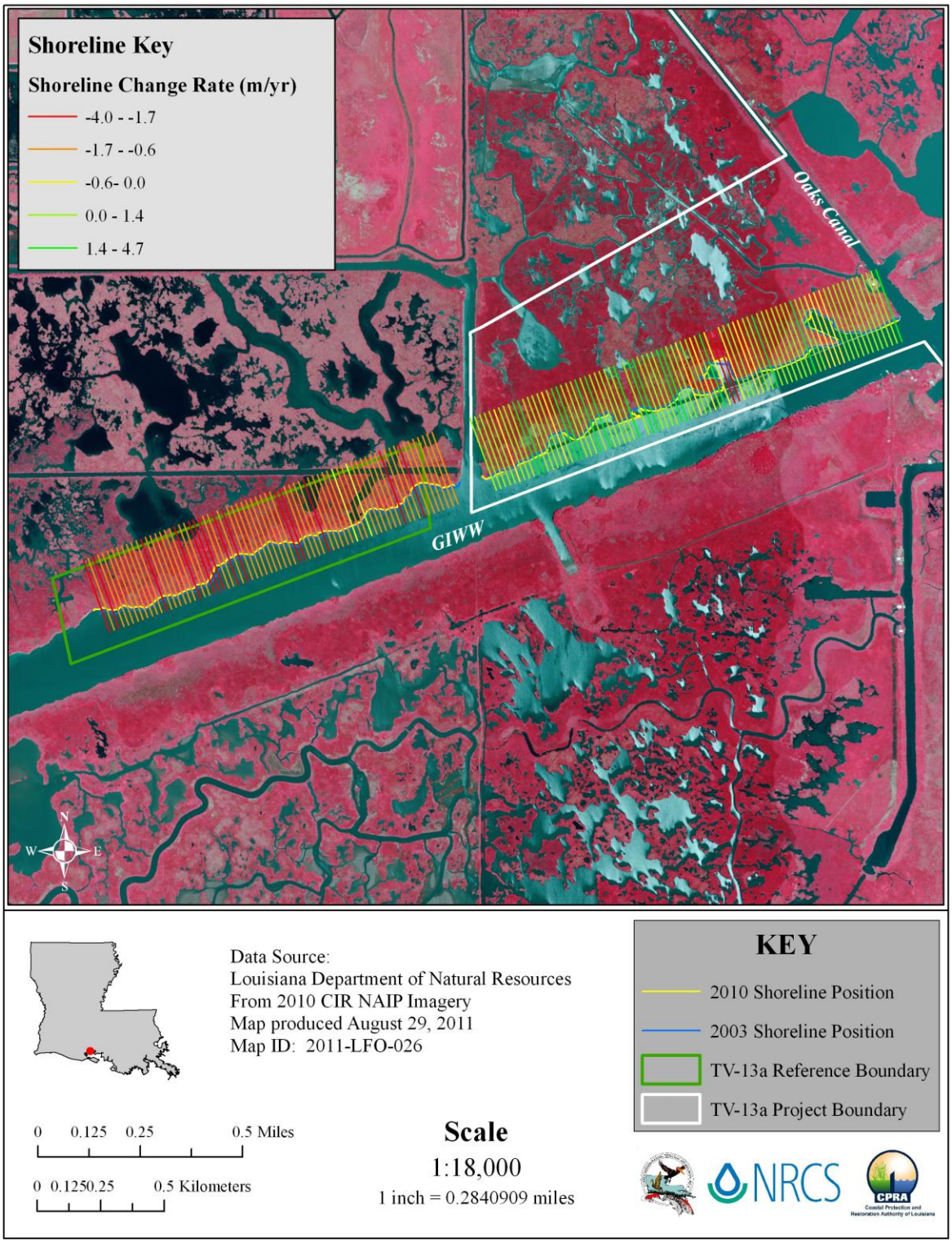


Figure 8. Shoreline change in the TV-13a project area along the GIWW for the period 2003-2010.

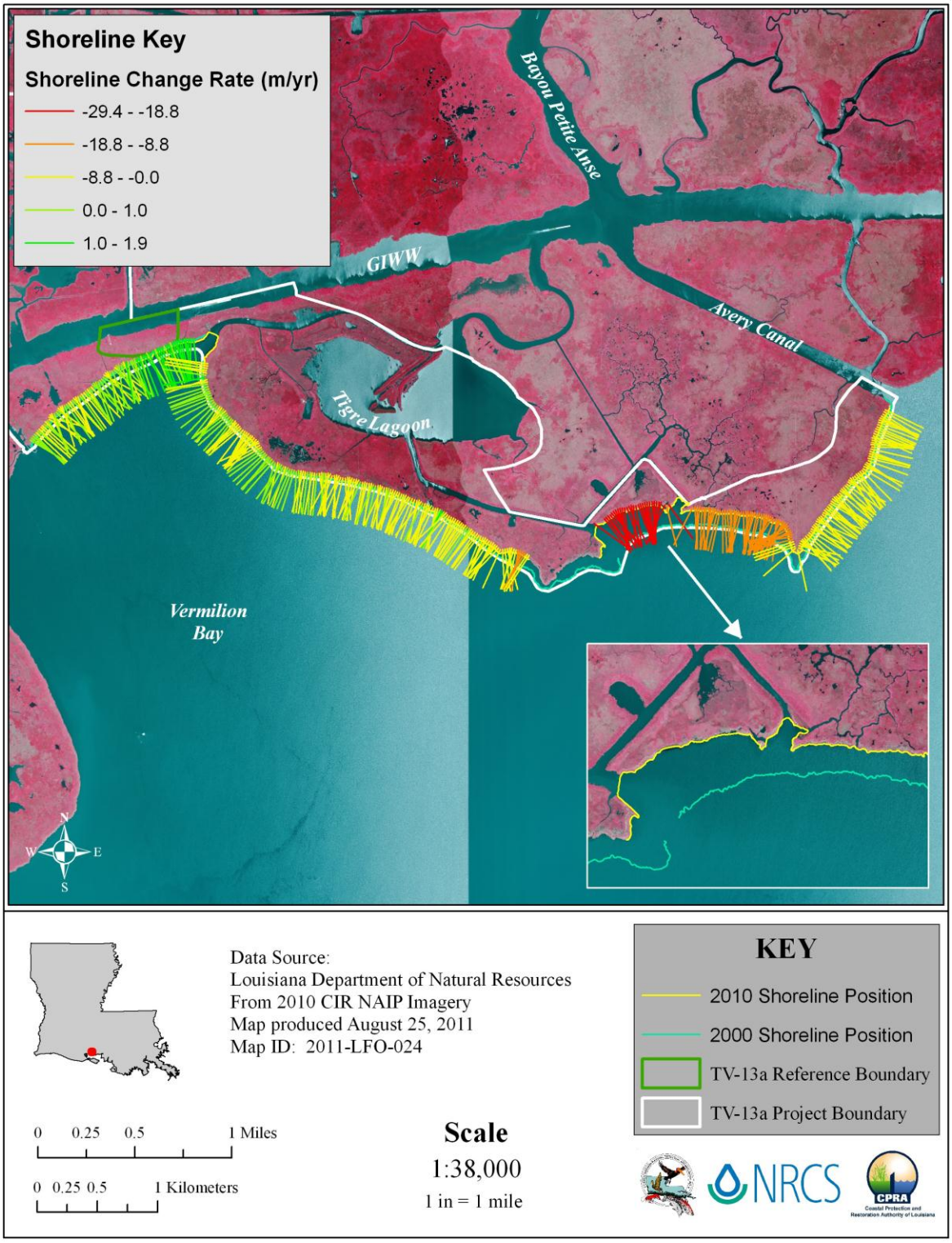


Figure 9. Shoreline change along the shore of Vermilion Bay during the period 2000-2010.

Water Level:

Pre- and post-construction data for the project area station TV13-01 and reference stations TV13-2R, TV13-3R, and TV13-4R are presented in figures 10-13. Data collected in 30 s intervals are presented for one typical day for each station. This time interval illustrates the rapid water level changes (boat wake induced) common in the project and reference areas. Short-term water level variability (<1 hr) decreased in the reference stations as a function of distance from the source of disturbance (i.e. the GIWW). Short-term water level variability was significantly lower in the project area following construction and significantly lower than the reference stations (P<0.0001) (figure 14).

Vegetative Plantings:

For the vegetation survey conducted on 7/24/2001, overall survival of *S. alterniflora* plants was 80%. Individual plants were indistinguishable from each other in all plots where plants survived. The remaining plots had no surviving vegetation. Cover estimates ranged from 3-100% with mean cover for surviving plots at 59%. Average plant height was 45.9 in (116.6 cm). Because individual plants were indistinguishable in all surviving plots in 2001, no further surveys will be conducted.

CRMS Supplemental

A comparison of the project area CRMS site and the two reference sites indicated several interesting trends. The soil properties data for the project and reference (CRMS0527) showed soil bulk density was lower in the project area than the reference and tended to be highest at the surface and below 20 cm (figures 15a,b and 16a,b). Overall, bulk densities for both sites were relatively low, ranging from approximately 0.3-0.5 g/cm^3. Analysis of soil organic matter content indicated that organic content was higher in the project area than the reference site. This is also reflected in the project site's lower bulk density as bulk density usually decreases as organic matter content increases. Organic matter content was lowest at the surface and increased with depth for both sites.

Analysis of the vegetation data indicated that percent cover generally increased with time for both of the reference areas (figures 17-18). FQI scores remained relatively stable in the reference site. The project area showed an increase in percent cover through 2009, with a large decline in 2010 (figure 19). For 2010, mean percent cover was higher in the reference areas than the project area (figures 17-19). FQI score increased from 2007 to 2009 in the project area but decreased greatly in 2010. This is mostly the result of a large drop in percent cover of *Schoenoplectus americanus*. This decrease does not appear to be related to Hurricanes Gustav and Ike, which affected the southwestern coast of Louisiana in 2008. In fact, these two hurricanes appear to have had no impact on percent cover and FQI at any of these CRMS sites. Mean percent cover was lower in the project area than reference CRMS sites 527 and 531 in 2010. The project site exhibited the highest FQI values prior to 2010.

Soil porewater salinity was higher in the project area than the reference sites at both the 10 and 30 cm depths during the period January-December 2010 (figure 20-22). Porewater salinity in the project area remained high, even as surface water salinity decreased in the winter and late summer. At the reference sites, porewater salinity tracked well with surface water salinity throughout the year.

Continuous salinity data revealed that CRMS sites 532 and 527 tracked well, as they both indicated similar surface water trends in salinity, due to their close proximity to Vermilion Bay (figures 20, 22). CRMS site 531 is farther inland, and thus did not exhibit the increasing salinity during the last half of the year as is seen in the other two sites (figure 21). The site did show a spike in salinity in the spring, as was observed in the nearby project site. Overall, salinity at all sites ranged between 0.3 and 12 ppt. Data collected since site installation were summarized by calculating daily means from the hourly data and then calculating monthly means of the daily means. Although climatic data were not collected at the site, it can be assumed that factors such as decreased precipitation or a decreased influx of fresh water from the Atchafalaya River contributed to the increases in surface water salinity.

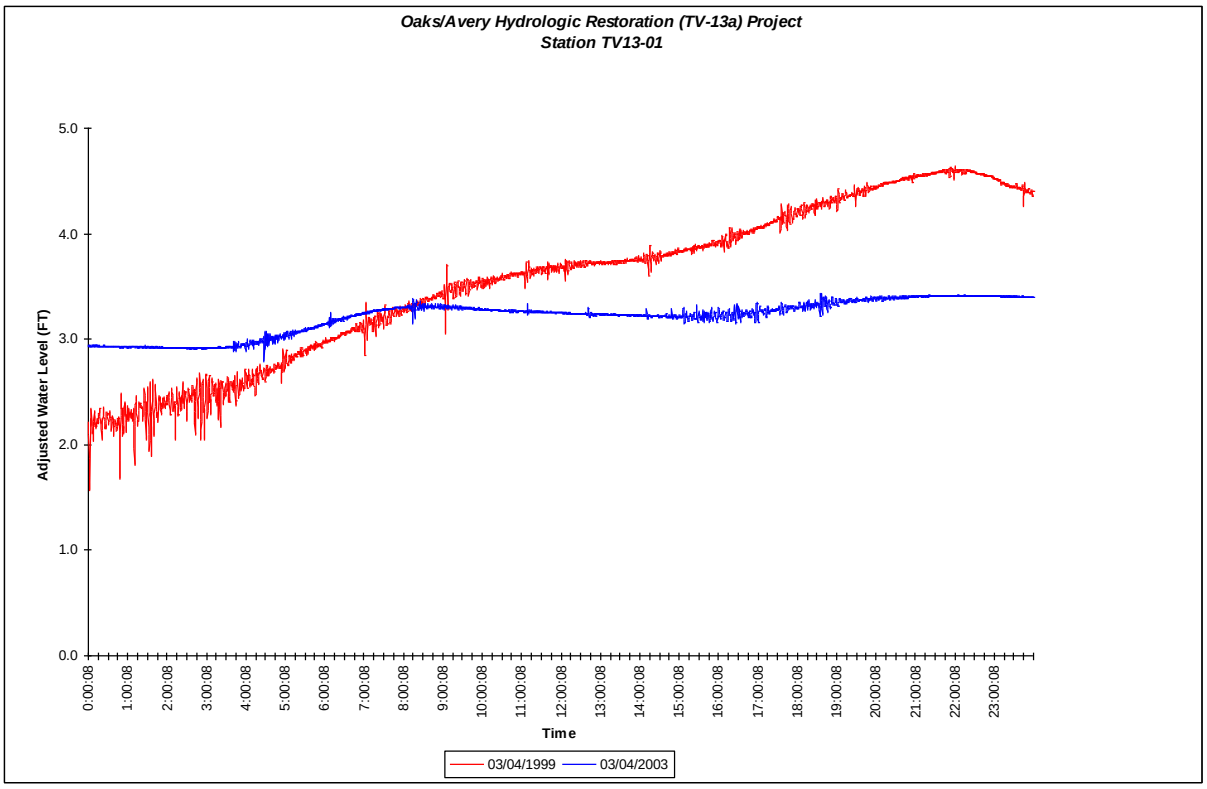


Figure 10. Relative daily water level data (feet) for 1999 and 2003 for Station TV13-01.

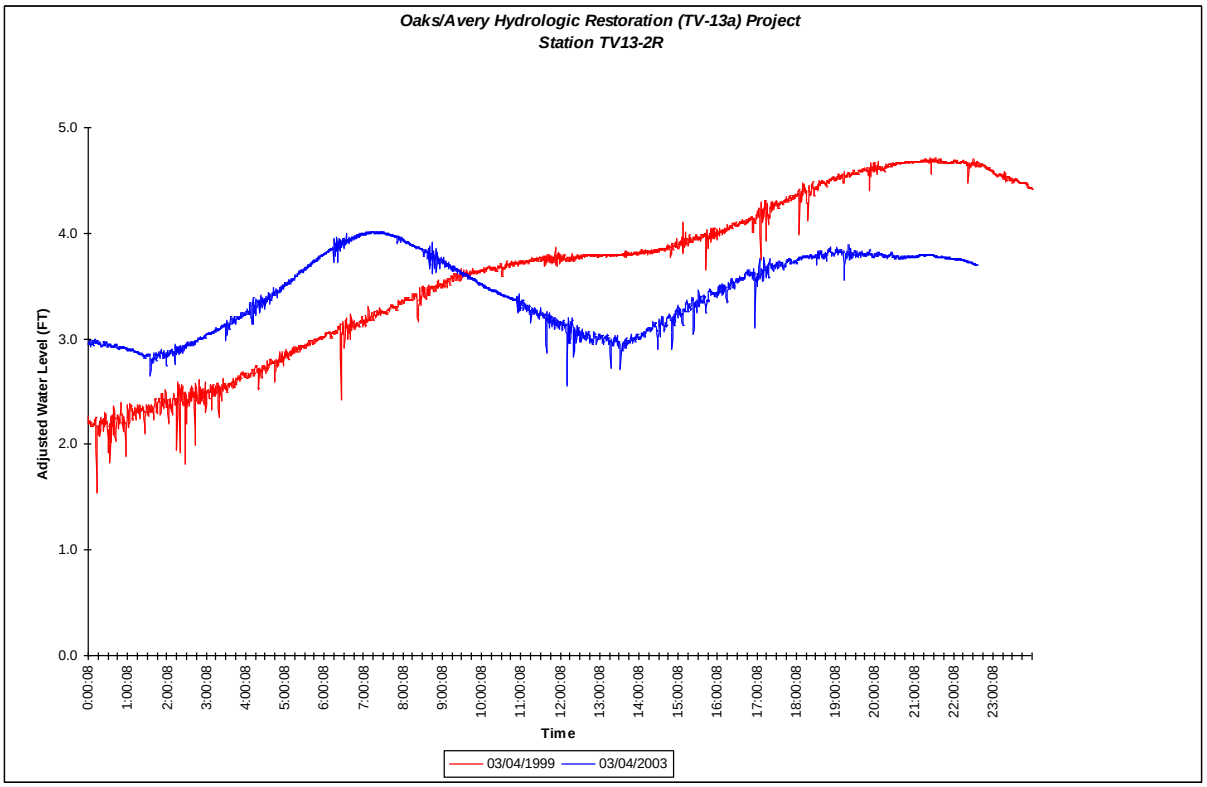


Figure 11. Relative daily water level data (feet) for 1999 and 2003 for Station TV13-2R.

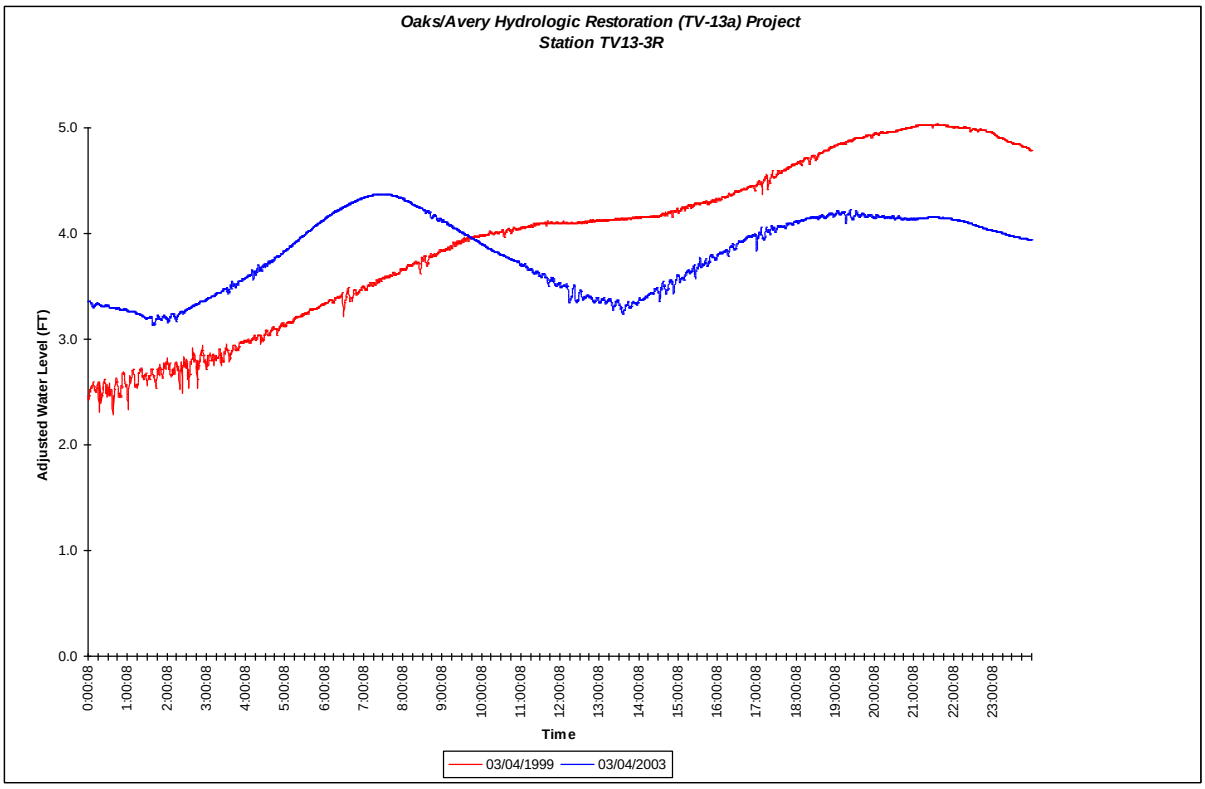


Figure 12. Relative daily water level data (feet) for 1999 and 2003 for Station TV13-3R.

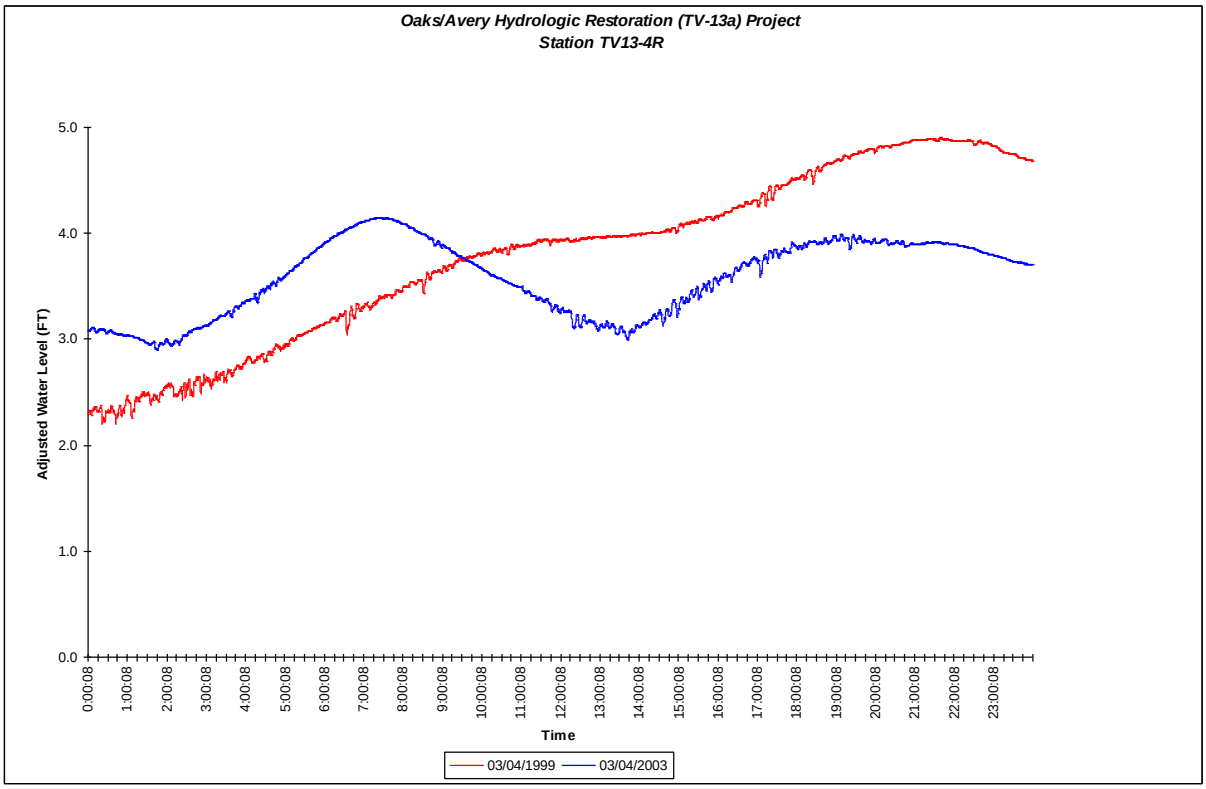


Figure 13. Relative daily water level data (feet) for 1999 and 2003 for Station TV13-4R.

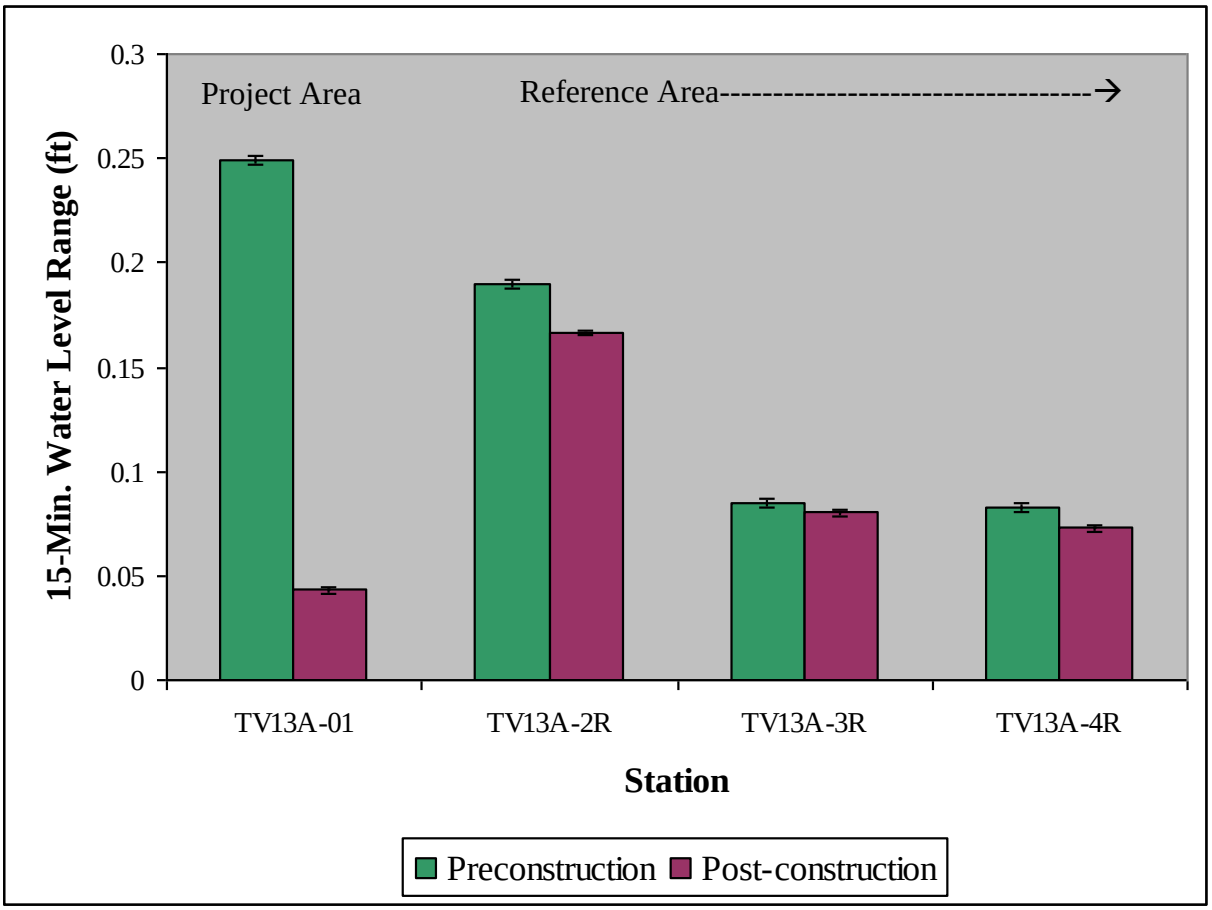
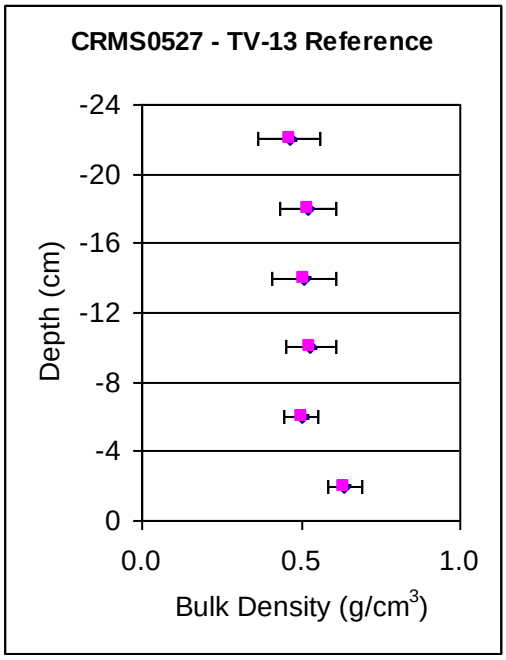
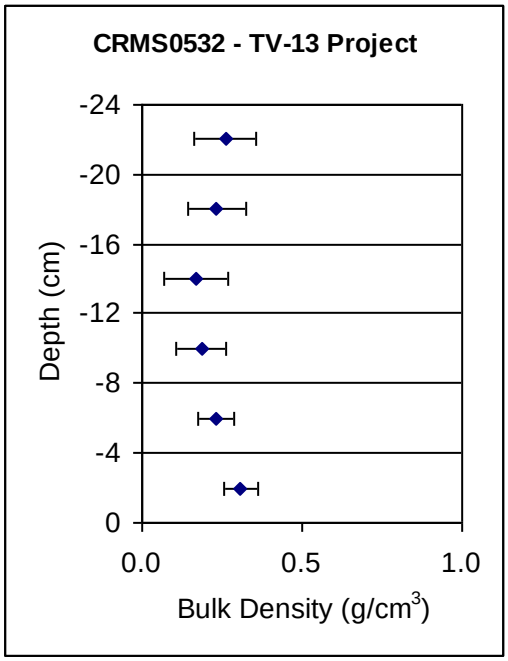
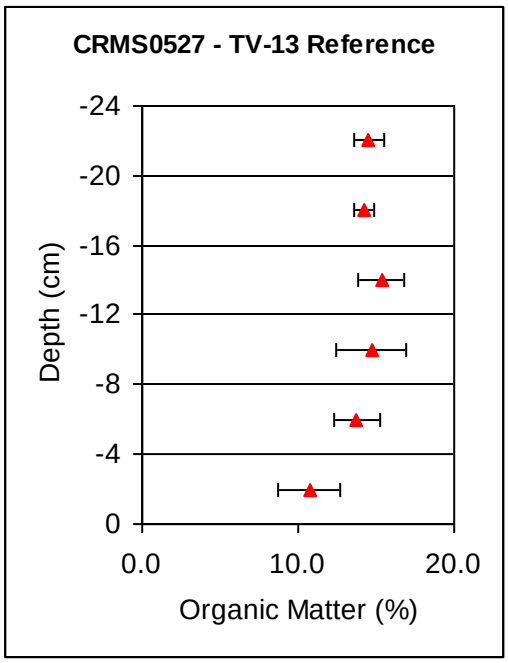


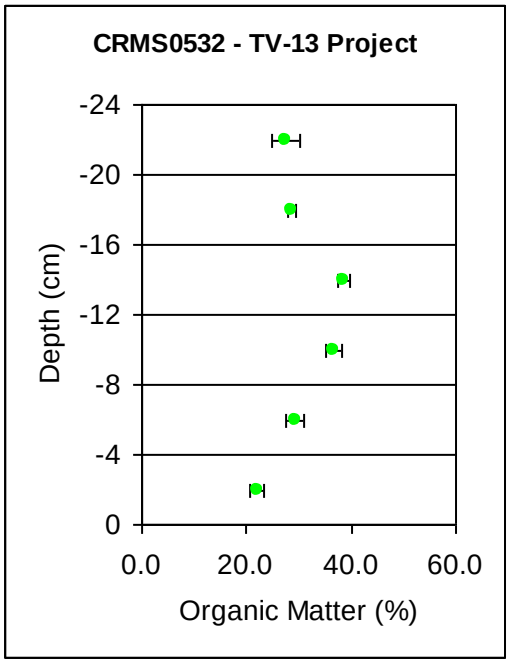
Figure 14. Relative daily water level variability (ft) both pre- and post-construction for the project and reference stations.





Figures 15a and 15b. Soil bulk density comparison of CRMS site 532 (project) and CRMS site 527 (reference).





Figures 16a and 16b. Soil organic matter content comparison of CRMS site 532 (project) and CRMS site 527 (reference).

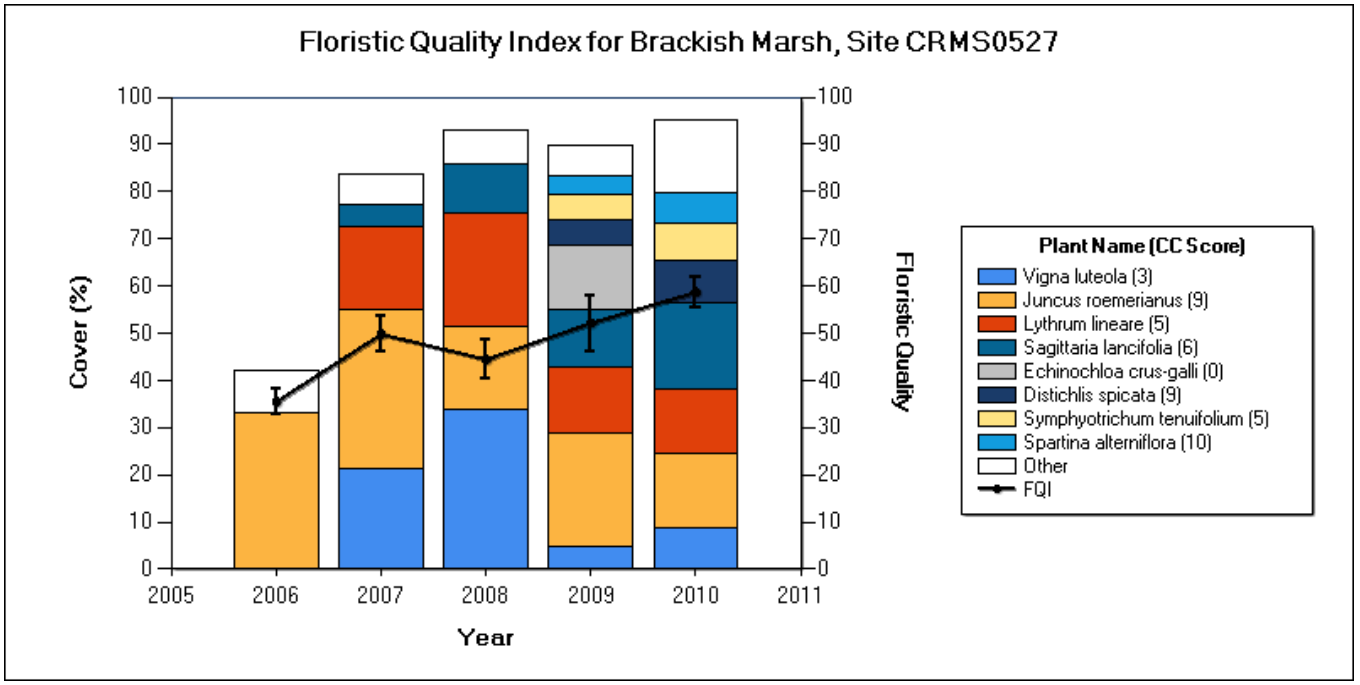


Figure 17. Vegetative composition and Floristic Quality Index for CRMS site 527 (reference site) since sampling began. Values are means of 10 stations within the site; therefore, the sum of percent coverage of individual species can be greater than 100 %.

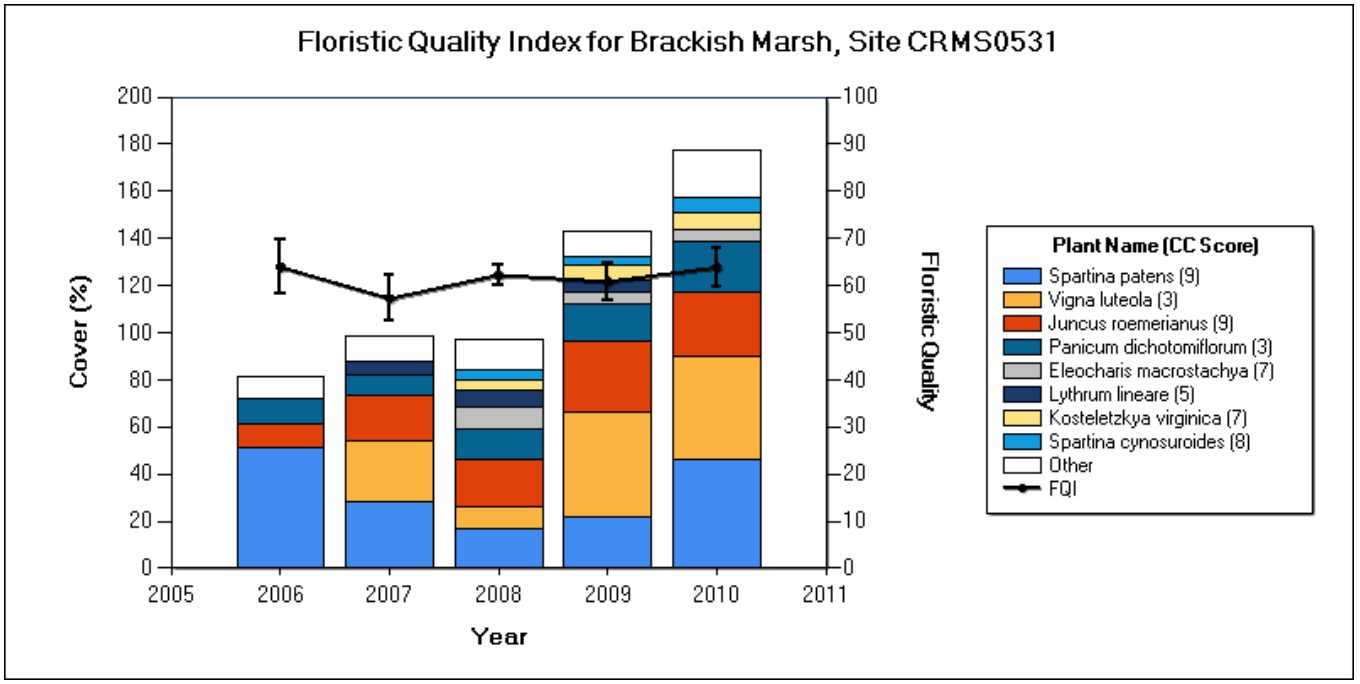


Figure 18. Vegetative composition and Floristic Quality Index for CRMS site 531 (reference site) since sampling began. Values are means of 10 stations within the site; therefore, the sum of percent coverage of individual species can be greater than 100 %.

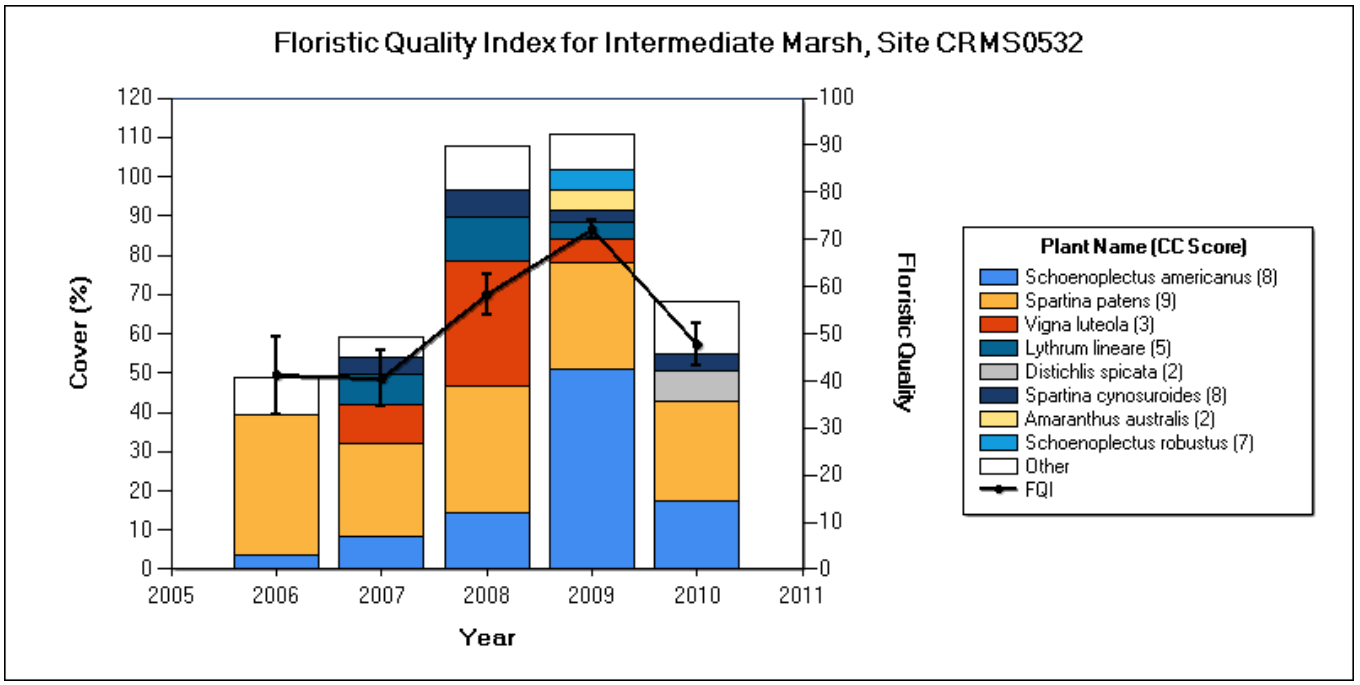


Figure 19. Vegetative composition and Floristic Quality Index for CRMS site 532 (project) since sampling began. Values are means of 10 stations within the site; therefore, the sum of percent coverage of individual species can be greater than 100 %.

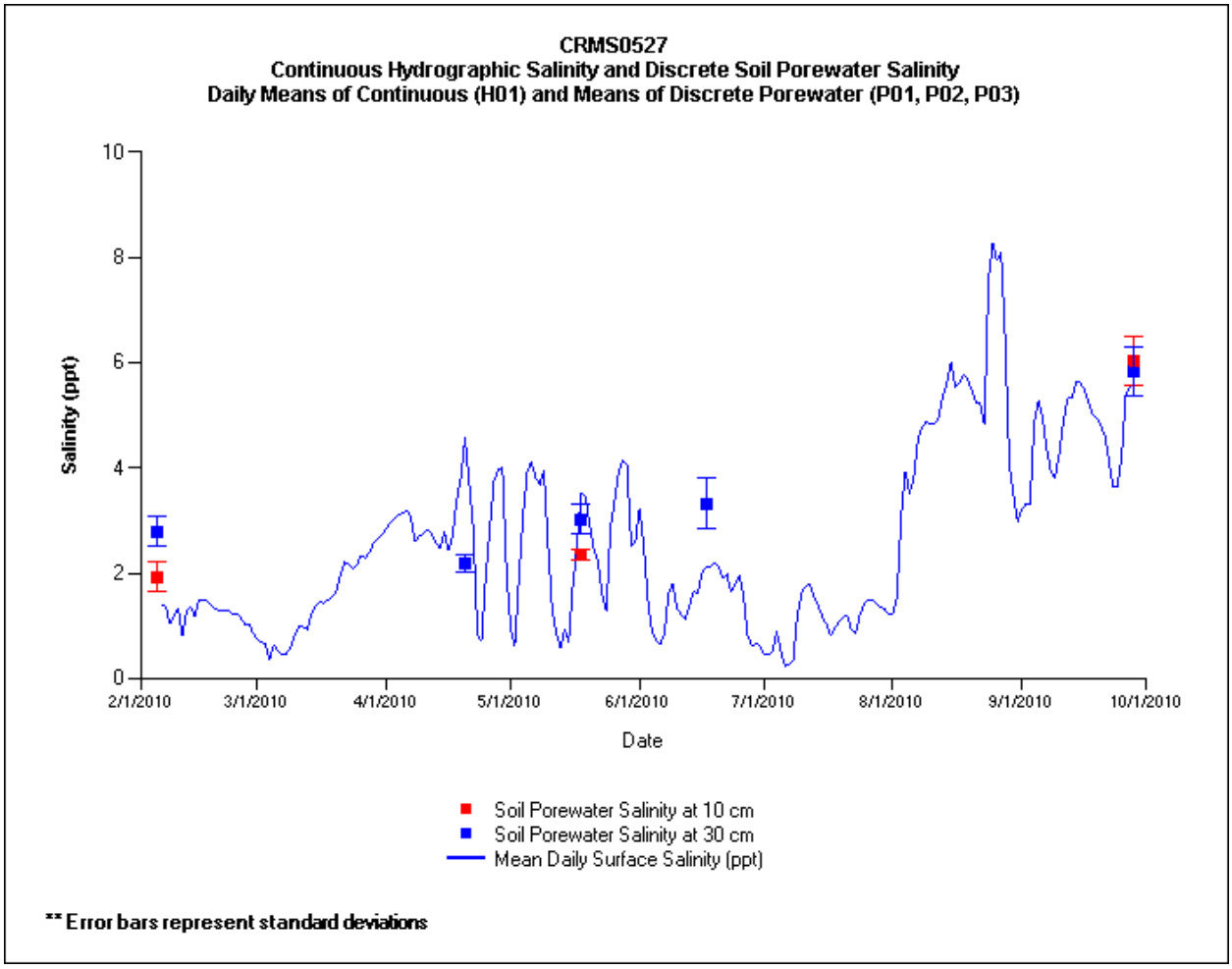


Figure 20. Surface water and soil porewater salinities (10 and 30 cm depths) for the CRMS supplemental reference site 527 for the period 2010.

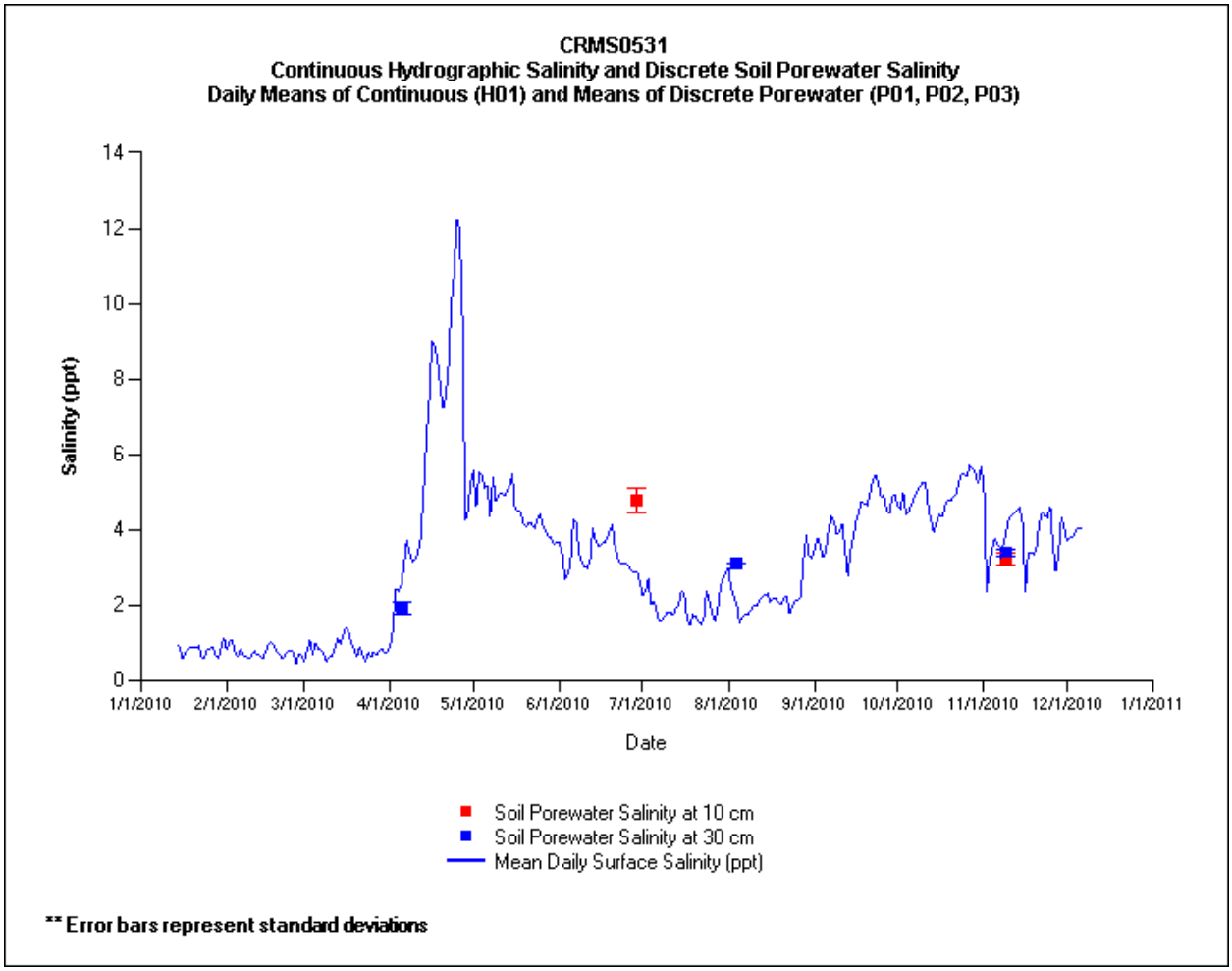


Figure 21. Surface water and soil porewater salinities (10 and 30 cm depths) for the CRMS supplemental reference site 531 for the period 2010.

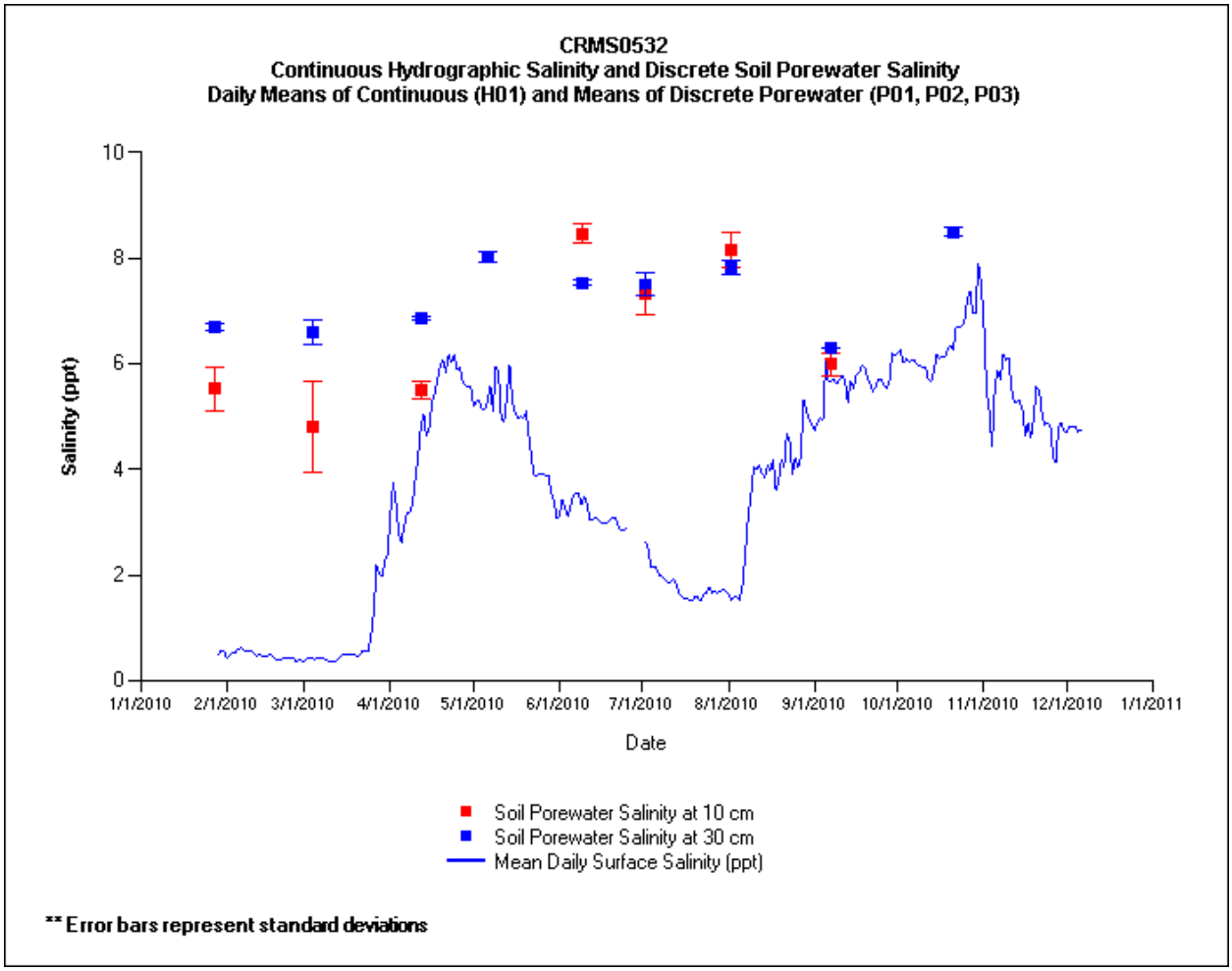


Figure 22. Surface water and soil porewater salinities (10 and 30 cm depths) for the CRMS supplemental project site 532 for the period 2010.

V. Conclusions

a. Project Effectiveness

The project appears to be meeting its goals of reducing rapid water level variability and protecting the shorelines of Vermilion Bay and the GIWW in the project area. The project and reference area exhibited increased land loss during the period 2002-2006, most likely due to the effects of Hurricane Rita. At this time, the vegetative planting shoreline protection component of the project appears to be effective along the majority of the project shoreline with the major exception of 6000 ft of rapidly eroding shoreline. Water level variability was reduced by approximately 80% in the project area.

The CRMS supplemental data showed an increase in mean vegetative cover for all sites during in the years following Hurricane Rita in 2005, most likely the result of continued recovery from the impacts of the storm. Soils were more organic in the project area than the reference, possibly contributing to accelerated erosion rates along portions of the Vermilion Bay shoreline.

From an engineering standpoint, the Oaks/Avery Canals Hydrologic Restoration Project is in good condition. The situations discussed in the vegetative planting shoreline stabilization section regarding the bay shoreline breaches will be monitored but it is unlikely to be addressed with a maintenance project.

b. Recommended Improvements

Replanting vegetation or another suitable shoreline protection measure is strongly recommended for those portions of the Vermilion Bay shoreline exhibiting erosion rates in excess of 100 ft/yr. In addition, it is imperative to have a better understanding of the factors causing the observed shoreline loss in this area of the project.

c. Lessons Learned

VI. Literature Cited

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APPENDIX A
(Inspection Photographs)

Photo No.1, Rock dike at Oaks Canal, west side

Photo No. 2, Rock dike at Oaks Canal, east side

Photo No. 3, Additional rock dike built by ChevronTexaco to protect existing pipelines, located and connected to rock dike on east side of Oaks Canal

Photo No. 4, Cow Path Structure

Photo No. 5, The difference in head between the adjacent water bodies forcing water through the breach in the rock plug.

Photo No. 6, Rock along north bank of GIWW showing low area

Photo No. 7, Rock dike along south bank of GIWW

Photo No. 8, Spoilbank Maintenance

APPENDIX B
(Three Year Budget Projection)

OAKS-AVERY HYDROLOGIC RESTORATION/ TV13a / PPL 6
Three-Year Operations & Maintenance Budgets 07/01/2011 - 06/30/2014

Project Manager	O & M Manager	Federal Sponsor	Prepared By
Darrell Pontiff	*Darrell Pontiff*	*NRCS*	*Darrell Pontiff*

	2011/2012 (-9)	2012/2013 (-10)	2013/2014 (-11)
Maintenance Inspection	$ 6,086.00	$ 6,269.00	$ 6,457.00
Structure Operation		$ -	$ -
Administration	$5,000.00	$ -	$ -
Maintenance/Rehabilitation			

11/12 Description: Add staff gage at Cow Path Structure, Oaks Canal repairs, Earthen Plug Construction

Note: E&D includes $5,000 for staff gage installation

E&D	$10,000.00
Construction	$130,625.00
Construction Oversight	$10,000
Sub Total - Maint. And Rehab.	$ 150,625.00

09/10 Description

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

10/11 Description:

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

	2011/2012 (-9)	2012/2013 (-10)	2013/2014 (-11)
Total O&M Budgets	**$ 161,711.00**	**$ 6,269.00**	**$ 6,457.00**

O &M Budget (3 yr Total)	**$ 174,437.00**
Unexpended O & M Budget	**$ 196,641.00**
Remaining O & M Budget (Projected)	**$ 22,204.00**

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

OAKS/AVERY HR/TV-13a/PPL6

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	$5,000.00	**$5,000.00**
Operations Contract	LUMP	1	$0.00	**$0.00**
Construction Oversight	LUMP	1	$10,000.00	**$10,000.00**

ADMINISTRATION

CPRA Administration	LUMP	1	$4,000.00	$4,000.00
FEDERAL SPONSER Admin.	LUMP	1	$1,000.00	$1,000.00
SURVEY Admin.	LUMP	0	$0.00	$0.00
OTHER				$0.00
			TOTAL ADMINISTRATION COSTS:	**$5,000.00**

MAINTENANCE / CONSTRUCTION

SURVEY

SURVEY DESCRIPTION:	Add staff gage at Cow Path Structure				
	Secondary Monument	EACH	0	$0.00	$0.00
	Staff Gauge / Recorders	EACH	1	$5,000.00	$5,000.00
	Marsh Elevation / Topography	LUMP	0	$0.00	$0.00
	TBM Installation	EACH	0	$0.00	$0.00
	OTHER				$0.00
				TOTAL SURVEY COSTS:	**$5,000.00**

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	1,725	$10.00	$17,250.00
	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	400	$45.00	$18,000.00
	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	$30,000.00	$30,000.00
	Contingency		LUMP	1	$22,625.00	$22,625.00
	General Structure Maintenance		LUMP	1	$0.00	$0.00
	Dredge for Earthen Plug		CU YD	950	$45.00	$42,750.00
	OTHER				$0.00	$0.00
	OTHER				$0.00	$0.00
					TOTAL CONSTRUCTION COSTS:	**$130,625.00**

TOTAL OPERATIONS AND MAINTENANCE BUDGET: **$161,711.00**

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

OAKS/AVERY HR/TV-13a/PPL6

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

OAKS/AVERY HR/TV-13a/PPL6

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-13a Oaks/Avery Canal Hydrologic Restoration

Date of Inspection: April 12, 2011 Time: 11:10 am

Structure No. N/A

Inspector(s): Dion Broussard, Mel Guidry, Darrell Pontiff (CPRA)
Charles Slocum, Loland Broussard (NRCS)

Structure Description: rock dike along northern bank of GIWW

Water Level

Type of Inspection: Annual

Weater Conditions: sunny and cool

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	N/A				
Signage /Supports	N/A				
Rip Rap/dike	Excellent			6	Dike is excellent post construction condition. Approx. 50 LF on eastern end hit by barge continues to settle.
Eathern Embankment	N/A				

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?

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: TV-13a Oaks/Avery Canal Hydrologic Restoration

Date of Inspection: April 12, 2011 Time: 10:45 am

Structure No. N/A

Inspector(s): Dion Broussard, Mel Guidry, Darrell Pontiff (CPRA)
Charles Slocum, Loland Broussard (NRCS)

Structure Description: rock paving at Oaks Canal

Water Level

Type of Inspection: Annual

Weater Conditions: sunny and cool

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	N/A				
Signage /Supports	N/A				
Rip Rap (fill)	Excellent			1,2,3	Rock in excellent condition
Eathern Embankment	N/A				

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?

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: TV-13a Oaks/Avery Canal Hydrologic Restoration

Date of Inspection: April 12, 2011 Time: 10:09 am

Structure No. Cowpath Structure

Inspector(s): Dion Broussard, Mel Guidry, Darrell Pontiff (CPRA)
Charles Slocum, Loland Broussard (NRCS)

Structure Description: Fixed crest weir

Water Level

Type of Inspection: Annual

Weater Conditions: sunny and cool

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
Steel Bulkhead / Caps	Excellent			4	Could not inspect due to low water.
Steel Grating	N/A				
Stop Logs	N/A				
Hardware	Good			4	Could not inspect due to low water.
Timber Piles	N/A				
Timber Wales	N/A				
Galv. Pile Caps	Excellent				
Vegetation	N/A				
Signage /Supports	Excellent			4	
Rip Rap (fill)	N/A				
Eathern Embankment	Excellent				

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?

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: TV-13a Oaks/Avery Canal Hydrologic Restoration

Date of Inspection: April 12, 2011 Time: 10:30 am

Structure No. N/A

Inspector(s): Dion Broussard, Mel Guidry, Darrell Pontiff (CPRA)
Charles Slocum, Loland Broussard (NRCS)

Structure Description: Spoilbank Maintenance

Water Level

Type of Inspection: Annual

Weater Conditions: sunny and cool

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	N/A				
Signage /Supports	N/A				
Rip Rap (fill)	N/A				
Eathern Embankment	Excellent			8	Earthen plugs look good.

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?

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: TV-13a Oaks/Avery Canal Hydrologic Restoration

Date of Inspection: April 12, 2011 Time: 10:30 am

Structure No. N/A

Inspector(s): Dion Broussard, Mel Guidry, Darrell Pontiff (CPRA)
Charles Slocum, Loland Broussard (NRCS)

Structure Description: Rock plug

Water Level

Type of Inspection: Annual

Weater Conditions: sunny and cool

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	N/A				
Signage /Supports	N/A				
Rip Rap (fill)	Excellent			5	It looks like more rock has been removed and water was rushing out of the compromised area of the plug.
Eathern Embankment	N/A				

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?

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: TV-13a Oaks/Avery Canal Hydrologic Restoration

Date of Inspection: April 12, 2011 Time: 9:55 am

Structure No. N/A

Inspector(s): Dion Broussard, Mel Guidry, Darrell Pontiff (CPRA)
Charles Slocum, Loland Broussard (NRCS)

Structure Description: Rock breakwater along southern bank of GIWW

Water Level

Type of Inspection: Annual

Weater Conditions: sunny and cool

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	N/A				
Signage /Supports	N/A				
Rip Rap (fill)	Excellent			7	Rock dike is in good condition.
Eathern Embankment	N/A				

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?

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: TV-13a Oaks/Avery Canal Hydrologic Restoration

Date of Inspection: April 12, 2011 Time: 10:45 am

Structure No. N/A

Inspector(s): Dion Broussard, Mel Guidry, Darrell Pontiff (CPRA)
Charles Slocum, Loland Broussard (NRCS)

Structure Description: Shoreline vegetation

Water Level

Type of Inspection: Annual

Weater Conditions: sunny and cool

Item	Condition	Physical 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				Only vegetation inspected was along either side of the mouth of the Oaks Canal.
Signage /Supports	N/A				
Rip Rap (fill)	N/A				
Earthen Embankment	N/A				

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