State of Louisiana
Department of Natural Resources
Coastal Restoration Division and
Coastal Engineering Division

2004 Operations, Maintenance, and Monitoring Report

For

BARATARIA BAY WATERWAY WEST BANK PROTECTION

State Project Number BA-23
Priority Project List 4

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Jefferson Parish

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Preface

The 2004 OM&M Report format is a streamlined approach which combines the Operations and Maintenance annual project inspection information with the Monitoring data and analyses on a project-specific basis. This new reporting format for 2004 includes monitoring data collected through December 2003, and annual Maintenance Inspections through June 2004. Monitoring data collected in 2004 and maintenance inspections conducted between July 2004 and June 2005 will be presented in the 2005 OM&M Report.

I. Introduction

The Barataria Bay Waterway West Bank Protection Project (BA-23) is located in Jefferson Parish, Louisiana approximately 4.5 mi (7.2 km) south of Lafitte on the west side of the Dupre Cut portion of the Barataria Bay Waterway (BBW). The project area is east of Bayou Rigolettes, north of the Lafitte Oil and Gas Field, and southwest of The Pen (Figure 1).

Project area wetlands were formed in a protective curve of the natural ridge of Bayou Barataria. The east-west orientation of the ridge, which serves as the southern boundary of the project area, protected the wetlands from the direct influence of salinities and tidal action of the Gulf of Mexico through Barataria Bay. Construction of the Dupre Cut portion of BBW established a direct conduit linking project wetlands with Barataria Bay. Initially, Dupre Cut spoil banks protected the project area from salinity and tidal fluctuations in the waterway. The combination of subsidence and wave erosion from marine traffic, however, has caused a breaching of the spoil banks which has resulted in increased water exchange and salinity fluctuations.

Land loss maps (Britsch and Dunbar 1996) of the area indicate that by the late 1950's and 1960's a majority of the project wetlands had converted to open-water. The land loss rate, used in the 1994 Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) Wetland Value Assessment analysis, was 1.89 percent per year for the years 1983 to 1994 (Louisiana Coastal Wetlands Conservation and Restoration Task Force 1994).

Conversion to open-water is but one of the processes affecting the project area. Subsidence of the ridge forming the northern, western, and southern boundaries has changed the ridge from a forested wetland to more of a shrub-scrub environment. Once solid emergent marshes have converted to broken fringe marshes. In 1949, O'Neil classified the marshes in the project area as fresh *Scirpus americanus* (three-cornered grass) marsh. Thirty years later, those remaining marsh areas were classified by Chabreck and Linscombe (1978 and 1988) as brackish.

The BA-23 project consists of approximately 9,400 linear feet (2,865 m) of rock bankline protection (foreshore rock dike) along the west bank of the BBW to protect the adjacent marsh from excessive water exchange and subsequent erosion (Figure 1). The project supplemented a dredge-and-fill operation previously completed by the U.S. Army Corps of Engineers (USACE). The Natural Resources Conservation Service (NRCS) filled in gaps in the spoilbank excluded from the USACE operation thereupon reinforcing and forming a continuous foreshore rock dike.

The USACE dedicated dredging operation in the BBW utilized sediments taken from the waterway in an attempt to create new marsh within the project area. The USACE deposited approximately 750,000 cubic yards (555,556 m^3) of cutterhead dredged material in semi-confined, shallow open-water areas adjacent to the BBW. This one-time operation is designed to create conditions conducive to the establishment of emergent marsh. As a part of the BA-23 project, marsh water levels are being managed through the use of a water control structure placed in the southern portion of the project area. The structure is required by permit conditions to remain open most of the year, allowing unimpeded ingress and egress of marine organisms. During waterfowl hunting season (November through January), however, water levels will be managed to a height not to exceed 6 in (15 cm) below marsh elevation.

Project Objective

The primary objective of this project is to re-establish a hydrologic barrier to protect approximately 2,200 ac (880 ha) of combined marsh and open-water from excessive wave energy, water level fluctuations, and saltwater intrusion from the BBW.

The project features include approximately 9,900 linear feet (2,865 m) of bankline protection combined with a water control structure consisting of two 48 in (1.22 m) corrugated pipe culverts with stop logs to allow for management of water levels and the movement of marine organisms within the project area.

Construction Dates

Start Construction:	June 1, 2000
End Construction:	November 15, 2000

Figure 1. Barataria Bay Waterway West Side Protection (BA-23).

II. Maintenance Activity

Maintenance Projects: No maintenance projects have been undertaken since the completion of the Barataria Bay Waterway Shoreline Protection Project (BA-23).

a. Project Feature Inspection Procedures

The purpose of the annual inspection of the Barataria Bay Waterway Shoreline Protection Project (West) 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. (LDNR 2002). 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 (LDNR 2002). The 2004 Annual Inspection Report contains a summary of maintenance projects undertaken since the completion of constructed features as well as the three (3) year projected budget for operation and maintenance.

An inspection of the Barataria Bay Waterway (West) Shoreline Protection Project was held on February 18, 2004, under partly cloudy skies and mild temperatures. In attendance were Brian Babin, Shane Triche and Tom Bernard with LDNR, Brad Sticker and Alan Bolotte representing NRCS. The attendees met at the C&M Marina and Fuel Dock at approximately 8:30 a.m. The Barataria Bay Waterway (West) Shoreline Protection Project inspection began at 8:45 a.m. and was the first of four (4) other projects to be inspected on February 18, 2004.

The field inspection included a complete visual inspection of the entire project site. Staff gauge readings located along the Barataria Bay Waterway were used to determine approximate elevations of water, rock dikes and other project features. A hand held GPS unit was used to mark locations of low areas along the earthen embankment and rock structures that may require corrective action or periodic visual inspection on future site visits. Photographs were taken at each project feature and Field Investigation Notes were completed in the field to document and record measurements and deficiencies. (Photographs and Field Inspection documents can be found in the 2004 Annual Inspection Report for the BA-23 Barataria Bay Waterway West Side Shoreline Protection Project).

b. Inspection Results

Site No.1 – Variable Crest Weir Structure

Due to extremely low water levels in the location canal leading to the water control structure, we were unable to perform an inspection of this feature. LDNR performed structure operations at the end of January 2004 and did not notice any deficiencies in the structure.

Foreshore Rock Dike

While inspecting the rock dike along the west bank of the Barataria Bay Waterway, we discovered several areas that appeared to have settled significantly. LDNR and NRCS agree that maintenance will be needed to repair the low areas along the rock dike. As a result of the inspection, it was determined that a centerline profile of the rock dike was needed to evaluate the extent of settlement. As the federal sponsor, NRCS agreed to perform the necessary surveys to identify these locations. Below are the stations along the rock dike which will require maintenance this upcoming year:

Sta. 1362+17 to Sta. 1367+37

Sta. 1372+37 to Sta. 1376+37

Sta. 1383+77 to Sta. 1387+17

Sta. 1395+67 to Sta. 1397+17

Sta. 1404+17 to Sta. 1416+17

Sta. 1414+33 to Sta. 1418+33

Survey drawings prepared by NRCS identifying low areas along the rock dike are included in the 2004 Annual Inspection Report (Babin 2004) and are available on request.

We also observed that the spoil material from the dredging operations placed on the backside of the rock dike was in excellent condition. Vegetation was thick and plentiful.

c. Maintenance Recommendations

Overall, the Barataria Bay Waterway (West) Shoreline Protection appeared to be in fair to poor condition with significant settlement noticed along the rock dike as noted in the above inspection results. NRCS and DNR agree that rock dike between the stations listed above will require immediate repairs as a result of the 2004 annual inspection. From survey profiles collected by NRCS, we estimated approximately 11,000 tons of rock rip-rap will be needed to complete the maintenance of the rock dike along the west bank of Barataria Bay Waterway. With concurrence from NRCS, it is recommended that a maintenance project be initiated to repair low areas of the rock dike. Below is an estimated project budget for construction, engineering, project oversight and contingencies to complete the project:

Construction Cost:

Mobilization/Demobilization:	$ 20,000		
Channel Excavation: (5000 c.y. @ $2.50/c.y.)	$ 12,500		
Rock Rip-Rap: (11,000 tons @ $32/ton)	$352,000		
Total Construction Cost:	$384,500		

Engineering and Project Oversight

Engineering and Design: ($384,500 x 8%)	$30,760		
Surveying: (4 days @ $1,420/day)	$ 5,680		
Resident Inspection: (150 hours @ $65/hr)	$ 9,750		
As-built Survey: (4 days @ $1,420/day)	$ 5,680		
Construction Administration: (50 hrs @ $70/hr)	$ 3,500		
Total Engineering and Project Oversight:		$ 55,370	
Total Construction, Engineering and Oversight:			**$439,870**
Contingency: ($439,870 x 20%)		$ 87,974	
Total Estimated Project Budget:			**$527,844**

III. Operation Activity

a. Operation Plan

Structure Operations: In accordance with the operation schedule outlined in the Operation and Maintenance Plan, operations of the water control structure located at the southern end of the project area began in May 2, 2001. Since May 2001, this water control structure has been operated twice annually, in November and January. Shaw Coastal, Inc. of Houma, La. operated this structure twice in 2003 at a cost of $4,182.51.

Permit Issues: To address low water conditions during the winter months in the impoundment area, LDNR applied for a permit modification on behalf of Jefferson Parish to modify the position of stop logs in the water control structure to retain higher water levels in the project area. The permit modification request was based on the following analysis from the LDNR – New Orleans Monitoring Section:

The Barataria Bay Waterway Shoreline Protection Project (BA-23) has been actively monitored by the New Orleans Monitoring Section of the Louisiana Department of Natural Resources since January 1999. Three subjects of biological importance in the BA-23 project are fishes, vegetation (submerged and emergent), and waterfowl. These goals are of great importance to National Marine Fisheries Service (NMFS), the LDNR and the land owners (Webb-Milling), respectively. Fishes often need secure off-waterway areas for spawning grounds, feeding locations and refuge. Submerged and emergent vegetation are a vital part to the health and longevity of marsh and wetlands. Waterfowl hunting is one of the main uses of this land by its owners and their lessees. These goals are synergistic in the respect that both the fishes and the waterfowl need SAV (submerged aquatic vegetation) and emergent vegetation to make the wetlands useful and increase site fidelity. Under the original operation schedule of the water control structure, these goals can not be met.

Modifying the operation of the water control structure to retain additional water earlier in the year will markedly increase winter-time levels. Currently there are many days during the winter months when water levels in some parts of the project area drop to 0.0 ft. creating large mud flats throughout the project area. This total loss of water will have a lethal and permanent affect on the fish populations contained within. Those fishes that can make it to the few remaining low areas will suffer severe competition for all life sustaining resources such as food, refuge, etc. SAV growth that may occur during the summer months will be lost with excessive dewatering. Next year, the populations must be restarted from the seed bank only and not from existing stock. Many emergent plants can not survive dry land conditions and must have some level of inundation all year. Without sufficient water levels, plant mortality will be high. Waterfowl use wetlands for nesting, feeding, mate locations, breeding, and protection. Without the available water, there will be little or no site fidelity. Increasing these winter-time water levels should eliminate all of these problems and create a healthier and more sustainable wetland that is usable by wildlife as well as the land owner. The proposed operation schedule to achieve the goals outlined above is as follows:

From January 31 to November 1, stop log bays shall remain fully open to allow unimpeded migration of marine organisms.

From November 1 to January 31, stop log bays shall be placed at a crest elevation not to exceed marsh elevation in all bays.

The memorandum requesting the modification of the COE permit was sent on July 24, 2003. The temporary permit modification was issued by the COE on December 9, 2003 with the following special conditions added:

1. As proposed, the stop logs shall only be placed at marsh elevation between the times of November 15, 2003 and January 31, 2004.

2. The permittee shall install a continuous recorder within the project area to monitor water levels for the remainder of the winter and to determine if the proposed modification achieves the desired water levels. The results of the monitoring shall be provided to the USFWS, the COE and NMFS prior to March 1, 2004, to determine if the modification was successful and or requires any permit changes.

3. The permittee shall regularly monitor the water flow exchange across the Bayou Barataria Ridge as to determine if the modification is inducing increased marsh erosion within the natural channel of the ridge. If it is determined that erosion has increased to an extent that the proposed water management plan has been contradicted, the permittee shall contact this office and other pertinent resources agencies for our review and possible permit modification.

On April, 29, 2004, LDNR submitted a letter presenting monitoring data collected over the period of December 15, 2003 thru January 31, 2004. In the letter, LDNR requested an extension of the permit modification to collect additional monitoring data during the period of November 2004 thru January 2005 to further evaluate the water levels in the project area. Along with the collection of additional monitoring data, LDNR will have a marsh elevation survey conducted throughout the project area to acquire an accurate representation of average marsh elevation. The additional survey and monitoring data shall be used to bolster the argument that the permitted operation schedule should be modified to meet the goals of the project. LDNR is presently awaiting a response from the COE to the requested extension to the permit modification.

IV. Monitoring Activity

This is a comprehensive report and includes all data collected from the pre-construction period and the post-construction period through December 2003.

a. Monitoring Goals

The following goal contributed to the evaluation of the above objective:

1. Maintain or increase marsh to open-water ratio in the project area.

b. Monitoring Elements

Aerial Photography

To evaluate land to water ratios in the project area, near vertical, color infrared aerial photography (1:12,000 scale, with ground controls) was obtained in 1997 (pre-construction) and in 2003, and will be obtained in 2009 (more frequent photography will be available via CRMS-*Wetlands*).

Vegetation

Plant species composition and relative abundance of wetland vegetation was documented in the project area in 1997 (pre-construction) and in 2003, further data will be collected as a part of CRMS-*Wetlands*. Utilizing random stratified sampling with two strata of ten stations each (20 stations total), a modification of the Braun-Blanquet technique (Mueller-Dombois and Ellenberg 1974) was used for emergent vegetation and the "rake" method used for submergent vegetation (Nyman and Chabreck 1996). Strata are defined as a northern and southern section divided by an oil field canal that essentially bisects the project area. Expected changes in land to open-water ratios require flexibility in vegetative sampling. Current open-water stations were sampled for submergent vegetation. If these stations subsequently converted to emergent marsh, they were sampled accordingly. The converse also occurred. All procedures followed methods outlined in Steyer et al. (1995). Vegetation surveys were conducted in early fall, prior to the first frost.

Water Level

To monitor water level variability, one continuous recorder was located within the project area and one recorder located in the Barataria Bay Waterway. Hourly water level data was collected continuously prior to construction in 1998-2000, and after construction in 2001-2003.

Salinity

To monitor salinity variability, one continuous recorder was located within the project area and one recorder located in the Barataria Bay Waterway. Hourly salinity data was collected continuously prior to construction in 1998-2000, and after construction in 2001-2003.

c. Preliminary Monitoring Results and Discussion

Aerial Photography

Color infrared aerial photography was obtained in 1997 (pre-construction) and 2003, and is currently being analyzed. Photography will be obtained again in 2009 (post-construction).

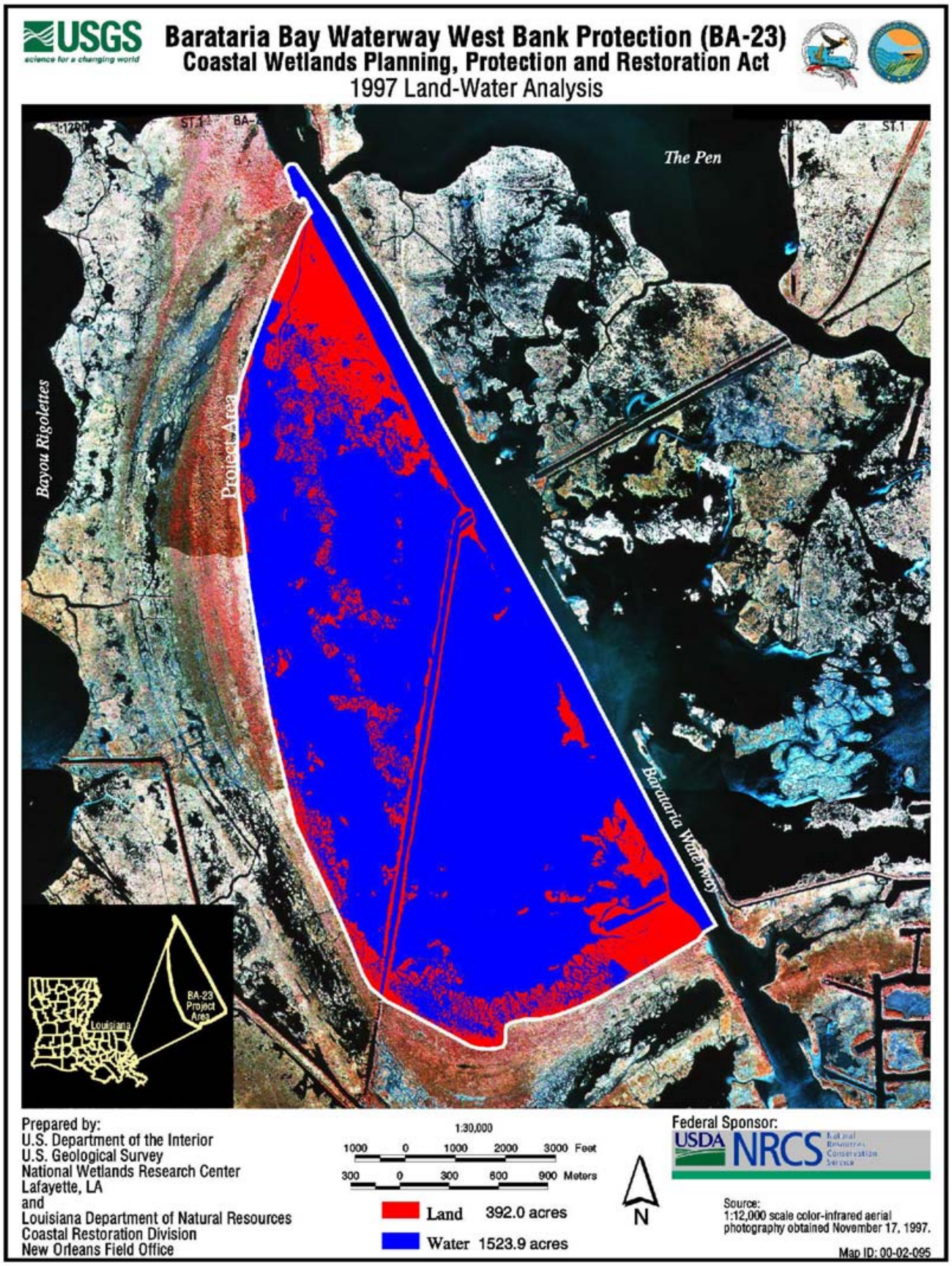

Figure 2. Land-Water analysis of BA-23 Barataria bay Waterway West Side Shoreline Protection.

Vegetation

Vegetation surveys were conducted in November 1997 (N=20 plots) pre-construction and September 2003 (N=20 plots) post-construction. *Spartina patens* (marshhay cordgrass) was the dominant species of vegetation in both 1997 and 2003, however the diversity of species observed in 2003 was quite different than that recorded in 1997 (Figure 3). The abundance of fresh marsh species was lower in 2003 than it was in 1997. This is probably due to the combined effects of the 2000 drought and the dredge overspill. After construction of the Barataria Bay rock wall, an earthen containment levee was build inside the project area. The space between the levee and the rock wall was to be filled in with dredge material. A large amount of this high salinity dredge material was leaked into the project area and settled in the northern end of the southern half. This created a higher marsh elevation that will become exposed during winter months and also a constant supply of high saline soil. These two factors combine to create an environment that supports those plant species that are better competitors in saline environments. Therefore, those species classified as freshwater species would not be able to survive in the highly saline environment.

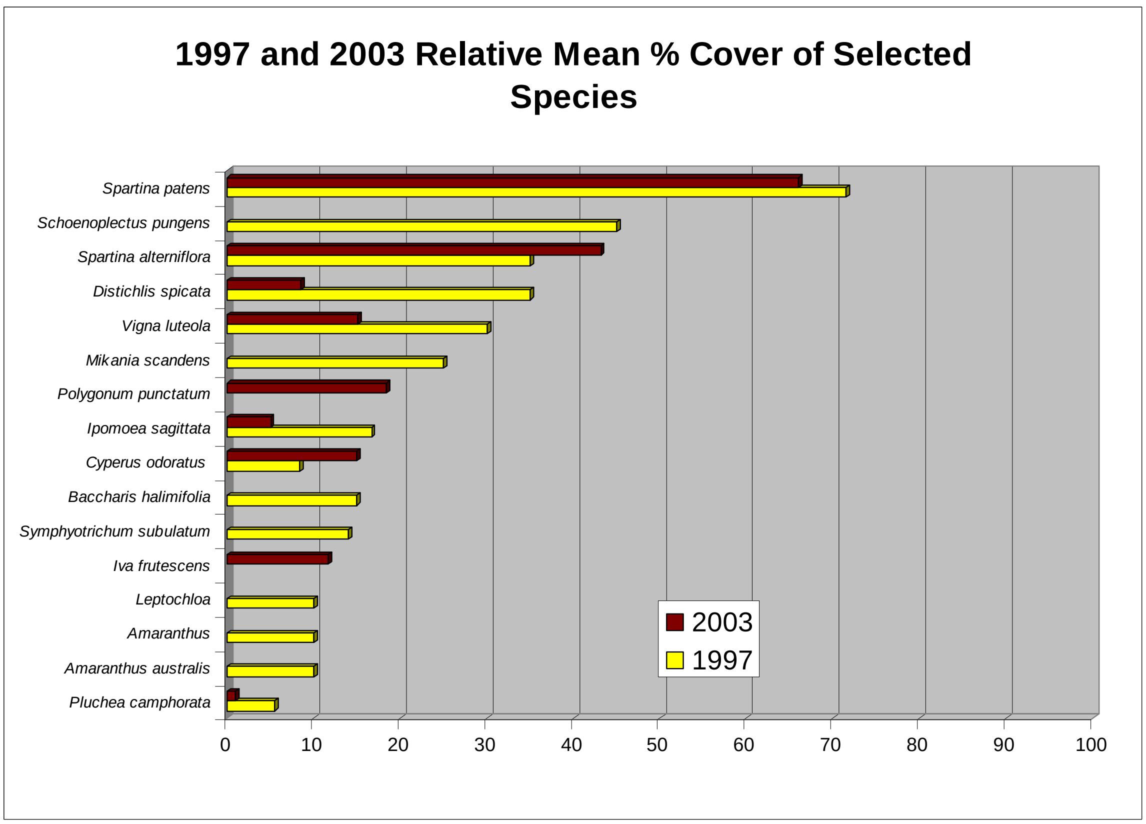

Figure 3. Mean % cover of selected species across all 4-m^2 plots with that species present within the BA-23 project area during November 1997 (N=20 plots) and September 2003 (N=20 plots). Vegetation was sampled using the modified Braun-Blanquet method.

Salinity and Water Level

Hourly salinity and water level data have been collected at the following continuous recorder stations:

Station	**Data collection period**
BA23-01	9/9/1998 – 9/24/2003
BA23-02	8/13/1998 – 7/17/2003

The severe drought of 2000 caused large spikes in salinity levels throughout the region, thus affecting all data collection during that period. Consequently, with construction occurring in late 2000, much of the decrease in salinity over time was due to drought relief and not the immediate impact of the project, as salinity of the project and reference areas both decreased over time (Figure 4 and Figure 5).

A multivariate analysis of variance (MANOVA) was run for the entire project comparing the changes in water level and salinity from two locations across three time periods. Monitoring station BA23-01 was inside the project area (Impact) and station BA23-02 was outside the project area (Control). The three time periods are Pre-construction (Sep 1998-Nov 2000), Post-Construction (Nov 2000-Mar 2002), and Post-Weir (Mar 2002–Jul 2003). Pre-construction time is defined as the time period before any construction took place on the project. It is characterized by complete unimpeded exchange of water on the project's east side (the side bordering the Barataria Bay Waterway). Post-construction time is defined as the time period after the rock wall was built on the eastern edge of the project. It is characterized by a separation of the main body of the project and the Barataria Bay Waterway. At this time, there is no water control structure. Post-weir time is defined as the time period after the construction of the rock wall and after the construction and operation of the water control structure on the project's southeastern side. It is characterized by limited flow of water through the control structure during a three month period (November through January) and a free flowing water control structure during the remainder of the year.

A BACI design (see Appendix A) was constructed to analyze the salinity data using BA23-01 as the Impact site, BA23-02 as the Control site, and Before-After was broken into the three previously stated periods (Pre-construction, Post-construction, and Post-weir). Prior to analysis, Salinity data for the project was heavily skewed as natural salinity data tends to. A Box-Cox Y transformation on the salinity data was necessary to normalize it. Water level data was sufficiently normal to allow analysis without transformation.

A BACI design tests for the interaction of both elements (location and time), therefore any significance found between Control-Impact or Pre-Post-Weir will not be analyzed. The only significant result will be the interaction of those factors (Underwood 1992). A difference between Control and Impact could be explained by natural difference in the two environments. Any difference between Pre-construction, Post-construction, and Post-weir could be explained by regional environmental factors such as weather and water table fluctuations. A significant interaction between these two factors will demonstrate that the change over time is not equal between the two locations. This “difference in change” should be the result of a third factor, the project.

Using Wilk’s lambda, the MANOVA was significant, showing a project effect ($p<.001$, $F=96.1128$ $df=10$) with a significant interaction ($p<.0001$, $F=36.9737$, $df=4$). Individual Univariate tests (salinity and water level) derived from this analysis continued to show significant project effects (see below). Analysis and interpretation of individual project effects will be presented on the Univariate tests.

The BACI (2x3 ANOVA) of salinity revealed a significant project effect across period ($p<.0001$, $F=32.4317$ $df=2$), location ($p<.0001$, $F=432.5441$ $df=1$), and a significant interaction effect ($p<.0001$, $F=9.1179$ $df=2$). While it may appear that this result supports the goal of reducing salinity inside the project area, it does not. From an engineering standpoint, the project successfully controlled and lowered project area salinity in comparison to the reference area. Upon inspection of the actual salinity means derived from the data, it can be seen that during each of the three time periods the difference in average salinity is not ecologically significant (Figure 3). Therefore, while the statistics showed a marked decrease, it is not enough of a difference to impact the environment in a positive way as compared to the reference area. The greatest difference is during the Post-Construction period (11/1/00 – 3/1/02) and is only 1.02 ppt. The remaining two time periods have differences of less than .2 ppt.

Monthly variance in hourly salinity readings were compared to help evaluate whether the project helped decrease fluctuations. Monthly variance was used to help reduce time lag artifacts in the data without loss of statistical power. While fluctuations are less frequent and of lower intensity in the project area than in the reference area, these differences seemed to exist prior to construction of the project (Figure 6). Thus, the data again does not support a conclusion of project effectiveness on salinity reduction.

The 2x3 ANOVA of water level revealed a significant project effect across period ($p<.0001$, $F=31.5261$ $df=2$), location ($p<.0001$, $F=18.1784$ $df=1$), and a significant interaction effect ($p<.0001$, $F=49.3094$ $df=2$). These results must be compared to the actual water level values seen (Figure 7). The water levels of the project area did not change significantly across time periods (Figure 7). However, the water levels of the reference area did change significantly across time periods, increasing during construction, and then finally decreasing to higher than pre-construction levels (Figure6). There is no implication that the project created this effect. Combined with the significant interaction, the data lead us to the conclusion that the project had a significant effect on stabilizing the water level inside the project area.

There were a few isolated events, occurring after project construction, which resulted in abnormal spikes of water depth in the reference area that did not occur in the project area (Figure 8). There is a strong possibility that this buffering effect is a result of the project itself. More of these data points would be needed to perform any statistical analysis of the effect, but empirical evidence does support the theory.

Unlike the salinity data, the effects seen on water level appear to be ecologically significant. Differences in water level between the project area means and the reference area means range as high as .3 ft. This alone could be enough water to enhance growth of fresh marsh in a restoration area. The most striking result seen in Figure 6 is the stabilization of the project area means across time, while the reference area means fluctuate greatly. Monthly variance in hourly water depth readings (adjusted to datum NAVD 88) of the project area and reference area were also compared and similar effects were observed (Figure 9).

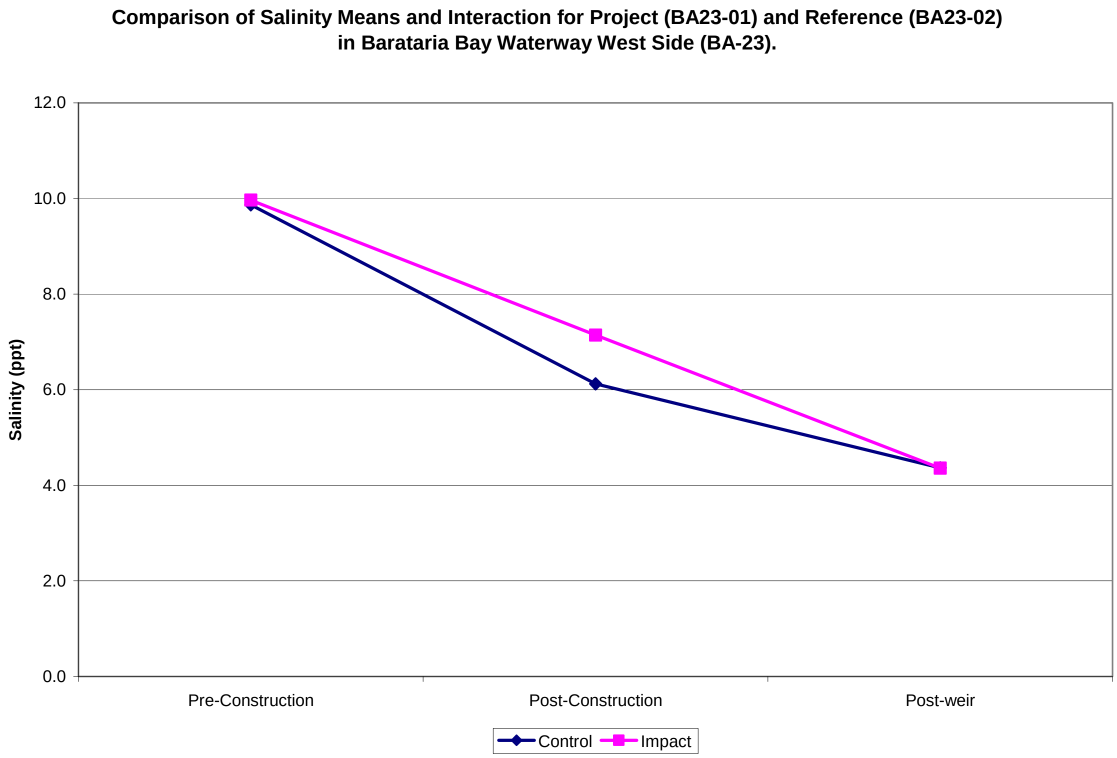

Figure 4. Mean hourly salinity at two YSI continuous recorder stations located in the Barataria Bay Waterway West Side Protection (BA-23) project and reference area during pre-construction (8/98 – 11/00), post-construction (12/00 – 2/02), and post weir opening (3/02 – 9/03) periods.

Monthly Average Salinity Measured at Barataria Waterway Shoreline Protection Project (BA-23) from Sept 1998 - Nov 2002

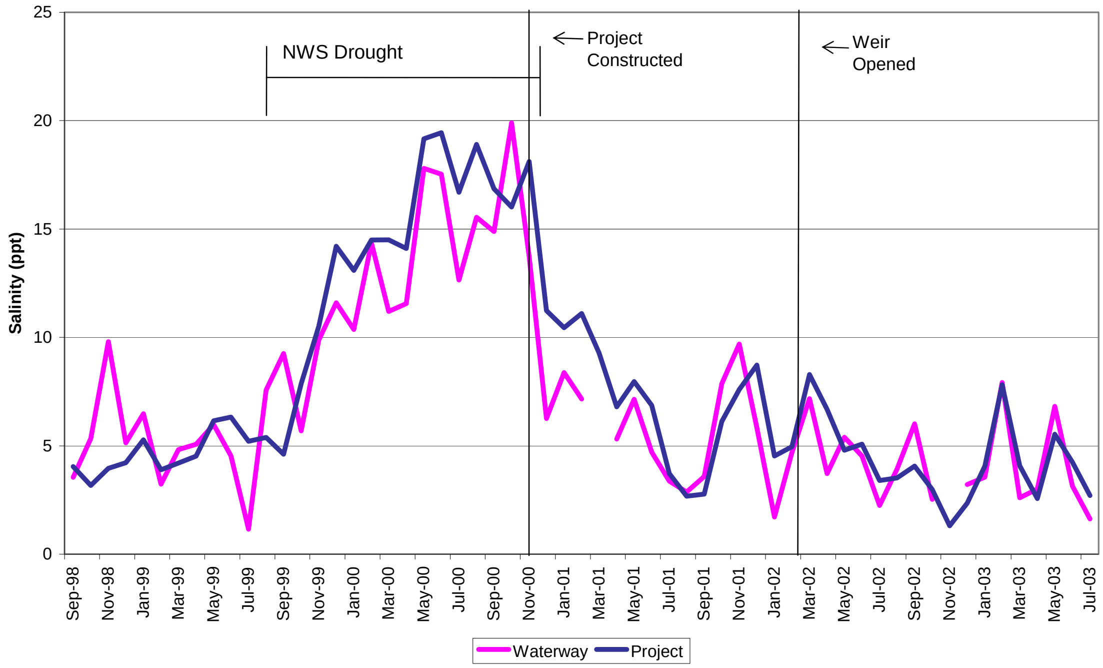

Figure 5. Mean salinity at two YSI continuous recorder stations located in the Barataria Bay Waterway West Side Protection (BA-23) project and reference area during pre-construction (8/98 – 11/00), post-construction (12/00 – 2/02), and post weir opening (3/02 – 9/03) periods.

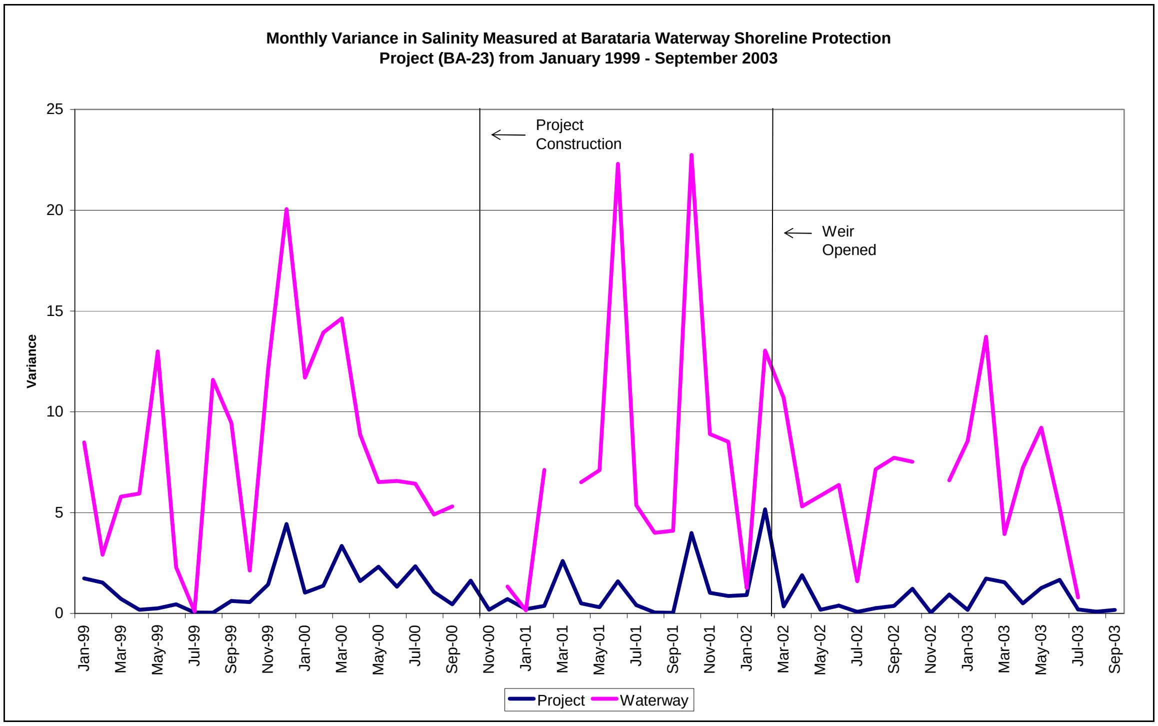

Figure 6. Comparison of variance (to represent variation) in salinity during the entire monitoring period of the project (1999-2003) between the project area (BA23-01) and the reference area (BA23-02).

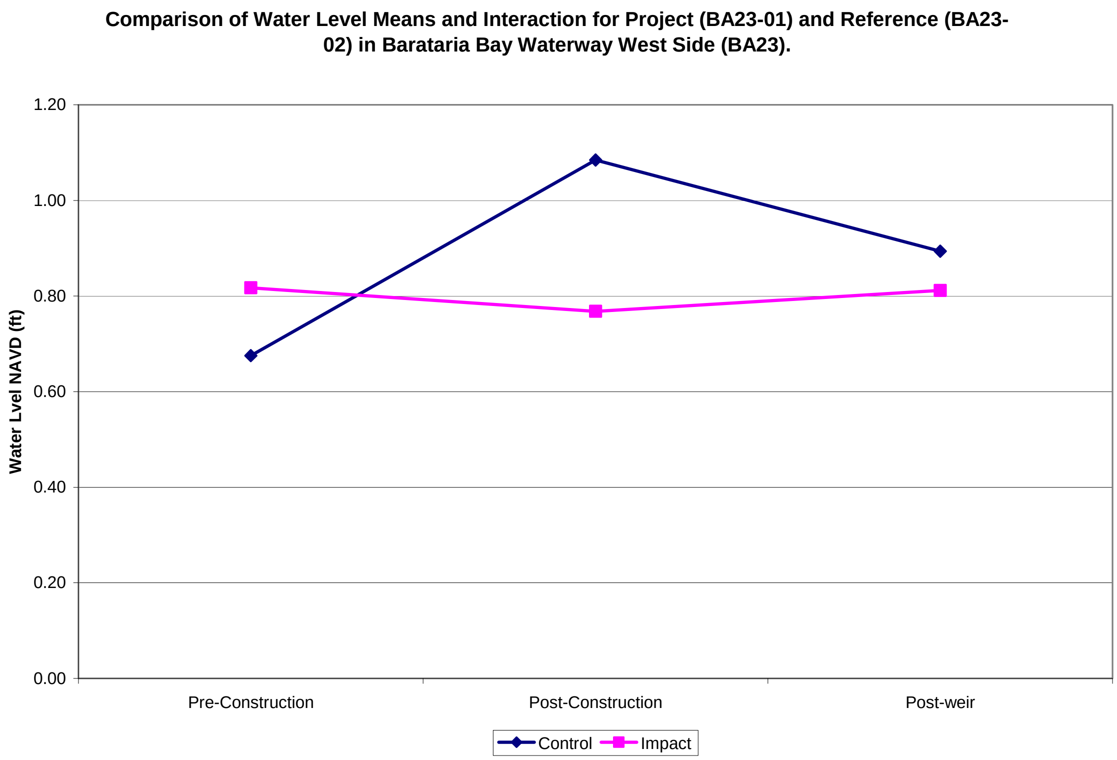

Figure 7. Mean hourly water level at two YSI continuous recorder stations located in the Barataria Bay Waterway West Side Protection (BA-23) project and reference area during pre-construction (8/98 – 11/00), post-construction (12/00 – 2/02), and post weir opening (3/02 – 9/03) periods.

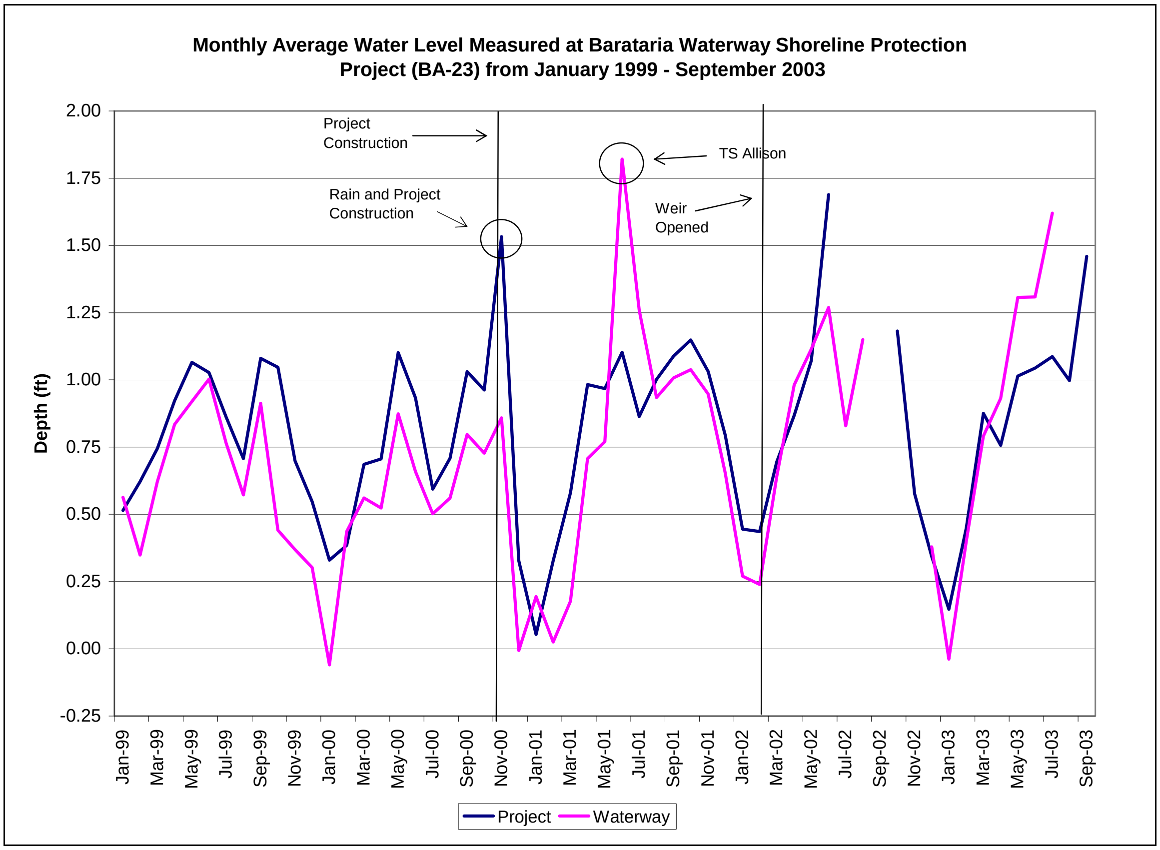

Figure 8. Comparison of means water level adjusted to datum (NAVD 88) during the entire monitoring period of the project (1999-2003) between the project area (BA23-01) and the reference area (BA23-02).

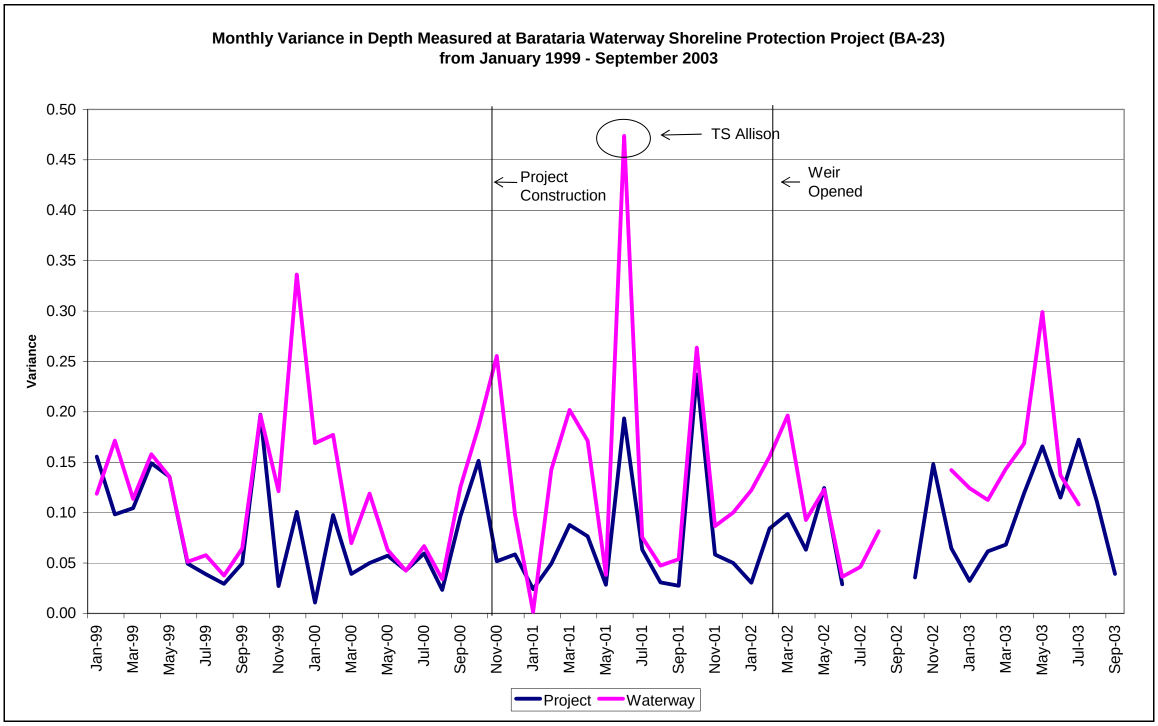

Figure 9. Comparison of variance (to represent variation) in water level adjusted to datum (NAVD 88) during the entire monitoring period of the project (1999-2003) between the project area (BA23-01) and the reference area (BA23-02).

V. Conclusions

a. Project Effectiveness

Monitoring

Post-construction aerial photography has been collected, but not yet analyzed so no determination can be made yet on whether the project has begun achieving its main goal of increasing or maintaining land to water ratio.

These results for both salinity and water level indicate that there was a project effect, yet the magnitude and ecological importance of the effect are much lower for salinity. The greatest difference in salinity between the project and reference (across the three time periods) was 1.02 ppt, which occurred during the post-construction period, and there was virtually no difference between the two areas before construction and after the weir was in place. Thus, even though project features appear to have worked as designed, the changes in salinity were ecologically insignificant. The project did stabilize water levels, and during the post-construction period, differences in mean water level between the project and reference area ranged as high as 0.3 ft. This result could be ecologically significant. With a project goal of increasing fresh marsh to open water ration, we need to stabilize the water level to allow for steady growth of pioneer species. Great fluctuation, including mud flat dryness and deep submerged pools, will not allow a strong seed bank to become established. It is also the goal of most restoration projects to meet the goals set forth by the Landowner. In this case, the landowner uses this land for winter time duck hunting and leasing. This use is aided by stable, positive (greater than zero) water levels. The project also showed some effect of buffering the water levels during severe storm events (hurricanes and tropical storms). Much more data would be needed for a worthwhile analysis of this effect, but empirically it seems to work.

Observed differences in salinities between years may have been affected by drought conditions during the pre-construction period in 2000, and may not entirely indicate project effects. Therefore, the BACI design was used to eliminate these factors and effectively evaluate the data. Upon inspection of actual means, we note that the detected project effect is not ecologically significant. Regrettably, the levels of salinity tended to be higher in the project area than in the control area. The greatest difference is during the "post-construction" period from November 2000 to March 2002. This is very likely due to the dredge overspill mentioned earlier (see Vegetation, pg 15). This dredge material has a very high salt content. Empirical observations and data analysis support the claim that in long periods of low water conditions, salinity is increased in the project area due to salts leaching out of the soil substrate. During the post-construction period, most of the water was held inside the project area and allowed to absorb the saline soils. A geochemical analysis would be needed to quantify this amount and predict its persistence in the environment. The current alteration of the structure operation (allowing more water in the project for longer periods of time) will help ameliorate this.

Vegetation data seem to support the conclusion of an overall loss of plant species diversity and cover. This problem is being addressed with the changes in the water control structure operation schedule. Continued monitoring of the plant abundance and diversity will aid in our assessment of the project's success.

Field Engineering

Based on LDNR's review of water control structure operations and monitoring data collected within the project area, there are concerns that water levels, during the winter months, are lower than required to support the biological needs of the project. Currently during the winter months, water levels sometimes drop below 0.0 ft. creating large mud flats throughout the project. These conditions often have negative effects on fish populations, vegetation growth (submerged and emergent) and waterfowl nesting. To address these concerns, LDNR is pursuing a permit modification of the water control structure schedule to adjust water levels upward during these critical winter months. LDNR is currently collecting the necessary water level data and marsh elevation surveys to determine whether the existing structure operation schedule should be modified to meet the biological goals of the project.

From a structural assessment stand point, isolated areas of the rock dike appeared to have settled significantly since completion of the project. To confirm this, profile and cross sectional surveys were performed to identify locations that will require maintenance. LDNR and NRCS are currently preparing the necessary bid documents for the replenishment of the rock dike to the original design elevation. Construction of this maintenance project was completed in January 2006 (Shread-Kuyrkendall & Associates, Inc. 2006).

b. Recommended Improvements

The project was originally classified as a "shoreline protection", yet the main focus of the monitoring was to determine if a hydrologic barrier was established. This causes issues with the budget, as shoreline protection projects receive the least monitoring funds. This made it very difficult to collect enough monitoring data to accurately determine whether the project was successful as a hydrologic barrier.

Should the analysis of survey and monitoring data, currently being collected by LDNR, support the claim that water levels are lower than required to support the biological goals of the project, it is recommended that the water control structure operations schedule be re-evaluated and modified.

In order to evaluate dike settlement, stability of the rock structure, toe scour, and any vertical accretion on the land side of the rock structure, 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 is to be agreed upon by the state and federal sponsor at the annual maintenance inspection.

The original construction contract for this project included dredging of an existing oilfield location canal at the southern end of the project area to install a water control structure consisting of 2-48" corrugated culverts with four (4) stop log bays. Since completion of the project, silt and sediment has accumulated at the entrance of the location canal severely hampering access to the water control structure. It is recommended that this location canal be monitored closely during annual inspections and corrective action taken should it be determined that dredging is needed.

c. Lessons Learned

Monitoring activities that are compared across a time series, such as pre-construction vs post-construction, can suffer devastating effects from isolated events (hurricanes, floods, droughts, etc.). Immediately preceding construction in 2000 a severe drought struck the southern United States. In most areas of southeast Louisiana, salinities rose to unprecedented levels. There is very little that can be done to prepare for or resolve these problems in the future.

In the past, O&M inspections of this project have focused on the physical integrity of the constructed project features only and not on the project as a whole. While this project is classified as a shoreline protection project, there is also a hydrologic component, the water control structure at the southern end of the project, which also relies on the integrity of the entire hydrologic boundary to function correctly. The breaching of the existing hydrologic boundary may affect the overall goals and objectives of the project and should be included in the annual inspections.

Much more care should be taken in the classification of projects to ensure they get sufficient funding for the required monitoring. A sufficient number of continuous recorder stations need to be used to accurately distinguish project effects from the environmental effects of events such as droughts (CRMS-*Wetlands* will help ameliorate this). More care needs to be taken when writing monitoring plans to clearly decide what are achievable and measurable project goals within time and budget constraints.

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Appendix A

Rationale for Nonparametric BACI Analysis for Coastal Projects

Fundamentals:

First, think of a BACI model as comprising a two-dimensional factor space. Time (Before-After) is one dimension, and space (Control-Impact) is the other.

Control Before	**Control After**
Impact Before	**Impact After**

The 2X2 "textbook" arrangement shown here is the simplest form it can take, a form that builds the BACI acronym: "Before-After" in time and "Control-Impact" in space. (Substitute "Pre-Post" and "Project-Reference" when applying this discussion to DNR coastal projects.) Nothing limits these factors to only two levels; the above table could measure 2X3 with time broken into "Before-During-After", or it could measure 8X2 with eight sampling locations in space.

Replication is achieved within each cell by making repeated observations over time during the before and after periods.

What sets a BACI analysis apart from any common factorial model is this: evidence that the project had an impact comes only in the form of a statistically significant *interaction* between the main effects. Statistical significance in either of the main effects (the BA factor or the CI factor) means little with regard to impact except inasmuch as it may assist in interpreting the BA*CI interaction.

One way to define an interaction is as *an inconsistency of one main effect across levels of another*. Stated differently, if a prior difference between the control and impact sites does not persist after construction, then there is an interaction between BA and CI.

Simultaneous observations at the two stations makes them temporally *paired*. Subtracting these paired observations (Difference = Control – Impact) collapses the above table into a one-dimensional model:

Difference Before	**Difference After**

This is the situation described in Smith (2002) and Underwood (1992) as a BACI paired series (BACIP). A t-test comparing the means of these two cells is equivalent to the anova f-test for an interaction in the two-dimensional model.

Reducing a 2X2 anova to a 2-sample t-test has these benefits. First, it is easy to give computer software the wrong anova instructions when data are temporally paired; a parallel t-test supplies a welcome confirmation. Second, a 2-sample t-test has several non-parametric analogues, notably the Wilcoxon-Mann-Whitney and the sign test.

When the BA factor is extended to three levels, “Before-During-After”, a one-way anova f-test on the three differences is equivalent to an f-test for

The BACI paired series (BACIP) design is discussed at some length in the Underwood (1992) and the Smith (2002) articles.