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

2004 Operations, Maintenance, and Monitoring Report

for

NAOMI OUTFALL MANAGEMENT and BARATARIA BAY WATERWAY EAST

State Project Numbers BA-03c and BA-26
Priority Project Lists 5 and 6

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Jefferson & Plaquemine Parishes

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2004 Operations, Maintenance, and Monitoring Report
For
Naomi Outfall Management (BA-03c) and Barataria Bay Waterway East (BA-26)

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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. The new report 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

In 1992, the state-funded Naomi-Lareussite Siphon Construction (BA-03) project was built to re-introduce (or divert) freshwater from the Mississippi River into the adjacent marshes through a set of eight siphons (Figure 1). The freshwater re-introduction was intended to replace some of the ecological functions supported by periodic over-bank flooding that occurred prior to the placement of the flood-control levee system. In order to manage freshwater from the diversion and to protect the area marshes from shoreline erosion and saltwater intrusion, the CWPPRA-funded Naomi Outfall Management (BA-03c) project and the Barataria Bay Waterway East Side Shoreline Protection (BA-26) project were completed in 2002 (USDA-NRCS 1999). Monitoring of the state-funded BA-03 project was expanded in 1997 to include both the BA-03c and BA-26 project areas because they were adjacent to one another. Thus, for monitoring reporting purposes, all three projects are combined into one project and will be referred to in this report as the Naomi Outfall Management project. All references to "project area" will refer to the unified area of all three projects. Note that although the three projects are combined for monitoring purposes, they are not related for maintenance budgeting purposes.

The Naomi Outfall Management project area lies within the Barataria Basin in Jefferson and Plaquemines Parishes, Louisiana. The area is bordered by the Barataria Bay Waterway (BBW) and the town of Lafitte on the west and the Mississippi River back protection levee and the community of Naomi on the east. The area extends to the south of the Pen and includes the Dupre Cut portion of the Barataria Bay Waterway (Figure 2). The project comprises an area of approximately 26,956 ac (10,782 ha) of brackish and intermediate marsh.

The objective of the Naomi Outfall Management project is to protect the project area from continued degradation by managing freshwater introduced from the Mississippi River. In doing so, the project also seeks to increase the benefit of sediment and nutrients introduced into the project area. Project objectives are (1) to manage the diverted freshwater from the Naomi siphon in the project area via the installation of two water control structures designed to reduce freshwater loss and saltwater intrusion and (2) to protect the adjacent marsh from erosion due to boat wakes and saltwater intrusion by rebuilding the east bank of the BBW.

Figure 1. Naomi siphons (BA-03) constructed in 1992 and funded by the State of Louisiana. Mississippi River water is siphoned from the river intakes, discharged into a ponding area and distributed through a single channel into the surrounding marshes.

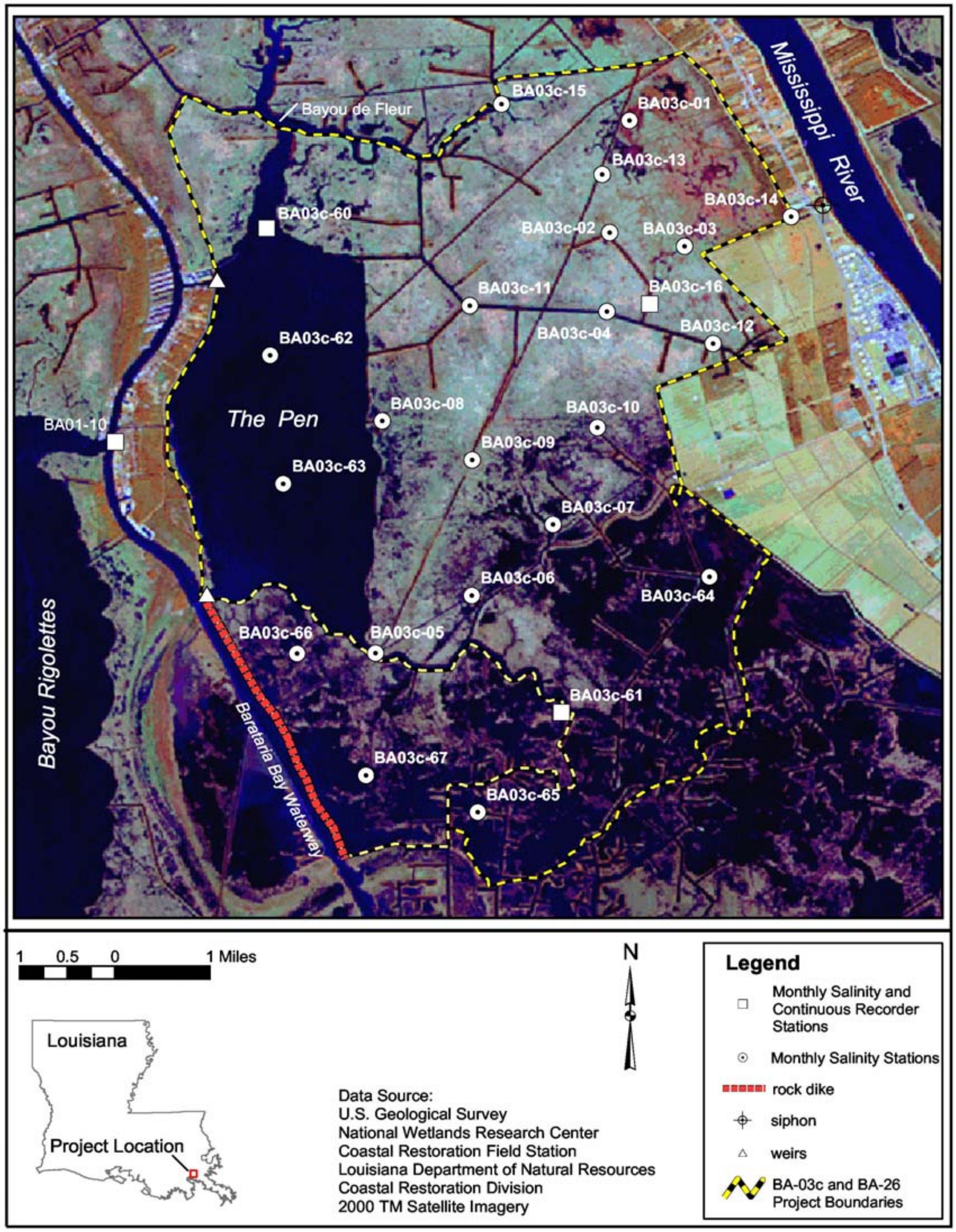


Figure 2. The Naomi (BA-03), Naomi Outfall Management (BA-03c) and Barataria Bay Waterway East (BA-26) project boundary, stations, and water control structures. Staff gauges are located at stations 1, 3, 6, 10, 11, 14, 16, 60, and 61.

The principal project features include:

- A set of 8 separate siphons, each consisting of a steel pipe 6 feet (1.8m) in diameter and 2,600 ft. in length, which cross over the west levee of the Mississippi River at Naomi, Louisiana (BA-03) (Figure 1)
- Two fixed-crest weirs with boat bays (BA-03c) (Figure 2).
- 17,054 ft (5366 m) of foreshore rock dike (BA-26) (Figure 2).

II. BA-03c Naomi Outfall Management Maintenance Activity

a. Project Feature Inspection Procedures

Project features were located on two channels – Goose Bayou Canal and Bayou Dupont – which connect the Barataria Bay Waterway to the Pen. The site was inspected on February 18, 2004 by Brian Babin, Shane Triche, and Tom Bernard from LDNR; Allen Bolotte, and Brad Sticker of NRCS. The weather was partly cloudy and the temperature was approximately 50°F. There was a brisk wind and a tide of about +0.1 foot NAVD

In February, 1993, the Naomi Siphon, located on the Mississippi River, went into operation and delivered freshwater into the marshes and streams east of the Pen. Much of the fresh water eventually exited the project area through the Pen via Goose Bayou Canal and Bayou Dupont Canal. Both streams flow into the Barataria Waterway. During periods of high tide, reverse flow occurred and high-salinity water entered the Pen from the Barataria Waterway via the two subject streams. Therefore, the two channels provided a source for the loss of fresh river water from the project area and the intrusion of high-salinity water into the project area.

The project managed the flows of diverted water from the siphon and the intruding high-salinity water from the Barataria Waterway. A water control structure (fixed crested weir with boat bay) was used in each of the two subject channels. The weirs were intended to moderate the interchange of water into or out of the Pen through Goose Bayou Canal and Bayou Dupont Canal. Thus, retention of sediment-rich fresh siphon water in the outfall area was maximized and intrusion of high-salinity water was minimized.

Project construction began on June 1, 2002 and was completed on August 16, 2002. Project life was estimated to be 20 years, and annual project inspections were planned. The 2004 Annual Inspection Report contained photographs along with a summary of project specifics (Bernard 2004).

Specific project features include:

1. One stone weir at **Goose Bayou Canal**
    a. Total length of weir = 458 ft.
    b. Bottom width of boat bay = 30 ft.

c. Boat bay bottom elevation= -5 ft. (NAVD 88)
d. Weir crest = +1 ft. (NAVD 88)
e. Rock placed directly on geotextile
f. Rock rip rap = 3,967 tons
g. Geotextile = 2,851 yards
h. Rock conforms to Rock Type 1 of Material Specification 523 with a gradation of:

i.

Percent Lighter Than	Rock Unit Weight
100	700 lbs
50-100	300 lbs
15-50	150 lbs
0-15	45 lbs

j. Four (4) - 4-piling clusters with navigation aid lights and warning signs
k. Six (6) single pilings with warning signs
l. Thirty-two buoys and associated stainless steel cable

2. One stone weir at **Bayou Dupont Canal**
   a. Total length of weir = 302 ft.
   b. Bottom width of boat bay = 30 ft.
   c. Boat bay bottom elevation = -5 ft. (NAVD 88)
   d. Weir crest +1 ft. (NAVD 88)
   e. Rock placed directly on geotextile
   f. Rock rip rap = 8,505 tons
   g. Geotextile = 3,374 yards
   h. Rock conforms to Rock Type 1 of Material Specification 523 with a graduation of:

Percent Lighter Than	Rock Unit Weight
100	700 lbs
50 -100	300 lbs
15-50	150 lbs
0-15	45 lbs

i. Four (4) 4-pile clusters with day mark navigation signs, and three (3) of the piling clusters have navigation aid lights.

j. Five (5) single pilings with warning signs

k. Twenty-two buoys with stainless steel cable.

The field inspection included a complete visual evaluation of the entire project site from both land and water. Photographs were taken (Appendix A) and a Field Inspection form (Appendix C) was completed to record measurements and deficiencies.

b. Inspection Results

GOOSE BAYOU CANAL WEIR

Rock Riprap

Visual inspection indicated that rock riprap subsided slightly on the north side; however, the elevation was unchanged July 2002. No survey readings were made. The flow of the water through the boat bay was restricted, indicating a head drop across the weir and the weir continued to function as intended. No velocity readings were taken at the boat bay and no water level readings were taken on the opposite sides of the weir.

Pilings

All pilings appeared to be damage-free and in good condition.

Warning Signs and Day Board Navigation Signs

All signs appeared to be in satisfactory condition with no indication of significant damage.

Navigation Aid Lights

All of the 4 navigation aid lights were repaired since the 2003 inspection and were functioning as required by the U.S. Coast Guard. A maintenance contract was negotiated to allow for periodic inspections of all LDNR Navigation aids. This contract was to be in place prior to the next annual inspection.

BAYOU DUPONT CANAL WEIR

Rock Riprap

Visual inspection indicated that the rock riprap was at approximately the same elevation as when completed in July 2002. No survey readings were made. The flow of the water through the boat bay was restricted and appeared to be the same as we typically see at the boat bay. This is an indication that the weir is continuing to function as intended. No velocity readings were taken at the boat bay and no water level readings were taken on the opposite sides of the weir.

Pilings

All pilings were in good condition except for the piling on the right side (as one cross into the Pen) of the boat bay. This piling **may** have been damaged during construction; however, there was no threat of failure. It will continue to be examined during regular inspections (Photograph 1)

Warning Signs and Day Board Navigation Signs

All signs were in satisfactory condition with no indication of significant damage.

Navigation Aid Lights

All navigation aid lights were repaired and or maintained since the 2003 inspection, and are now functioning in accordance with the U.S. Coast Guard regulations.
One of the light covers had become unhitched and was open. NRCS personnel climbed the structure and closed the cover and hitched the latch (Bernard 2004).

Photograph. 1 – Bayou Dupont Canal Weir. Damaged pile at right side of boat bay as one enters the Pen from Barataria Waterway. Pile was damaged by boat collision during construction. Pile may eventually need to be replaced or reinforced.

c. Maintenance Recommendations

Overall, the Naomi Outfall Management project was functioning properly and was in good to excellent condition. The damaged piling at the Bayou Dupont weir will be closely observed during periodic inspections.

Follow up on the procurement of a contract for periodic maintenance of the navigation aid lights for both weirs. Place a lock similar to the battery box lock on the light cover. Some slight modification may have to be made to the lights to accomplish this.

i. Immediate/ Emergency Repairs

No immediate repairs are necessary at this time.

ii. Programmatic/ Routine Repairs

Based on the problem noted during the 2003 inspection, all navigation lights will be checked periodically to make sure they are functioning properly.

The damaged piling at the Bayou Dupont weir will be checked periodically and, if necessary, will be braced or replaced.

III. BA-26 Barataria Bay Waterway Protection Project (East) Maintenance Activity

No maintenance projects have been undertaken since 5/16/2001, the completion of the Barataria Bay Waterway Shoreline Project (East).

a. Project Feature Inspection Procedures

The purpose of the annual inspection of the Barataria Bay Waterway Shoreline Protection Project (East) was to evaluate the constructed project features, identify any deficiencies, and prepare a report detailing the condition of such features and to recommend corrective actions needed (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 contained a summary of maintenance projects undertaken since the constructed features were completed as well as the three (3) year budget for operation, maintenance and rehabilitation (Babin 2004).

An inspection of the Barataria Bay Waterway Shoreline Protection Project (East) 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 inspection of the Barataria Bay Waterway Shoreline Protection Project (East) began at approximately 9:50 a.m. and was the second of four (4) projects inspected on February 18, 2004.

The field inspection included a complete visual evaluation of the entire project site. Staff gauge readings located along the Barataria 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 rock structure that may require corrective action or periodic visual inspection on future site visits. Photographs were taken along the rock dike and Field Investigation Notes were completed to document and record measurements and deficiencies (Babin 2004).

The Barataria Bay Waterway (East) Project involved the installation and maintenance of approximately 17,054 linear feet (3.2 miles) of foreshore rock dike bank line protection including creation of an earthen hydrologic barrier using dredge material from the Barataria Bay Waterway Channel placed to the East along the rock dike within the project area. The bank line protection is intended to rebuild and protect a portion of the Barataria Bay Waterway, from unnatural water exchange and subsequent erosion which is exacerbated by wakes form vessel traffic on the waterway.

b. Inspection Results

Foreshore Rock Dike

We noticed significant settlement in several areas of the rock dike on the east bank of the Barataria Waterway. LDNR and NRCS agree that maintenance will be required to recap the low areas of the rock dike. To determine the actual extent of settlement, a centerline profile of the rock dike was needed to evaluate the low areas. As the federal sponsor, NRCS agreed to utilize their survey staff in obtaining the necessary survey information. Based on survey data provided by NRCS, approximately 2,200 linear feet of the rock dike required maintenance. Below are the stations along the rock dike that require maintenance this upcoming year:

Dike Lengths Requiring Capping
Sta. 1356+23 to Sta. 1362+23
Sta. 1384+43 to Sta. 1389+83
Sta. 1399+33 to Sta. 1403+33
Sta. 1407+33 to Sta. 1419+83
Sta. 1421+83 to Sta. 1424+83
Sta. 1430+33 to Sta. 1447+83
Sta. 1450+83 to Sta. 1452+83

Survey drawings prepared by NRCS identifying low areas along the rock dike were included in the 2004 Annual inspection report and are available upon request.

c. Maintenance Recommendations

Overall, the Barataria Bay Waterway Shoreline Protection Project (East) was in fair condition with significant settlement along the foreshore rock dike as noted in the above inspection results. NRCS and LDNR agreed that the rock dike between stations listed in Section III b required immediate maintenance as a result of the 2004 annual inspection. From the post-inspection survey provided by NRCS, estimated the quantity of rock needed to recap the low areas of the rock dike along the east bank of the Barataria Waterway. It is anticipated that approximately 19,000 tons of rock rip rap is needed to repair the low areas. With concurrence from NRCS, it is recommended that LDNR initiate a maintenance project to repair the low areas of the foreshore rock dike. Below is an overall estimated project budget for construction, engineering, project oversight and contingencies to complete this maintenance project. Funds for this maintenance work were provided by the overall CWPPRA-approved O&M budget approved for Barataria Bay Waterway Protection Project (East).

Construction Cost BA-26:			
Mobilization/Demobilization:	$ 20,000		
Channel Excavation: (4,000 c.y. @ $2.50/c.y.)	$ 10,000		
Rock Rip-Rap: (19,000 c.y. @ $32/c.y.)	$608,000		
Total Construction Cost:		$638,000	
Engineering and Project Oversight			
Engineering and Design: ($638,000 x 8%)	$51,040		
Surveying: (4 days @ $1,420/day)	$ 5,680		
Resident Inspection: (160 hours @ $65/hr)	$10,400		
As-built Survey: (4 days @ $1,420/day)	$ 5,680		
Construction Administration: (70 hrs @ $70/hr)	$ 4,900		
Total Engineering and Project Oversight:		$ 77,700	
Total Construction, Engineering and Oversight:			**$715,700**
Contingency: ($715,700 x 10%)		$ 71,570	
Total Estimated Project Budget:			**$787,270**

iii. Immediate/ Emergency Repairs

Recap existing foreshore rock dike along the east side of the Barataria Waterway.

iv. Programmatic/ Routine Repairs

No programmatic/routine repairs were required as a result of the 2004 annual inspection.

IV. BA-03 Operation Activity

a. Operation Plan

Siphon Operation

The revised operation plan called for the structure to have all eight pipes operating at just over 1,000 ft^3s^{-1} for all months except March and April when only two pipes are to be in operation (LDNR 1992). Daily siphon discharge from 1993-2003 was calculated from the head differential between the river, the immediate outfall area, and the number of siphons in operation. Water elevation data were obtained from the Mississippi River gauge readings at Alliance LA, and the immediate outfall area staff gauge (BA03c-14). Operation data were obtained from Plaquemines Parish Government (PPG), which contain both the date and number of siphons in operation. It should be noted that PPG is responsible for all operations of the Naomi Siphon.

b. Actual Operations

Siphon Discharge

The siphons were capable of a maximum discharge of 2,144 ft^3s^{-1} with the optimum river stage and full, faultless operations. However, for 1993 through 2003, the structure was only in operation 69% of the time and averaged 819 ft^3s^{-1} when fully operational (i.e. all eight pipes), and 519 ft^3s^{-1} over the entire period, including times of no flow (Figure 3). In addition, siphon flow varied each year, due to limited operations, seasonal low river stages, and droughts. Below 1.5 feet NAVD88 on the Mississippi River gauge in Alliance, LA, the siphons began to lose prime and are rendered inoperable. Additional obstacles to operation were: seasonal shellfish such as oysters and shrimp, tropical storms, oil spills, maintenance problems, and staffing limitations within PPG.

V. 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 objective of the project was to protect the project area from continued degradation by managing the diverted freshwater from the Naomi siphon in the project area. This was

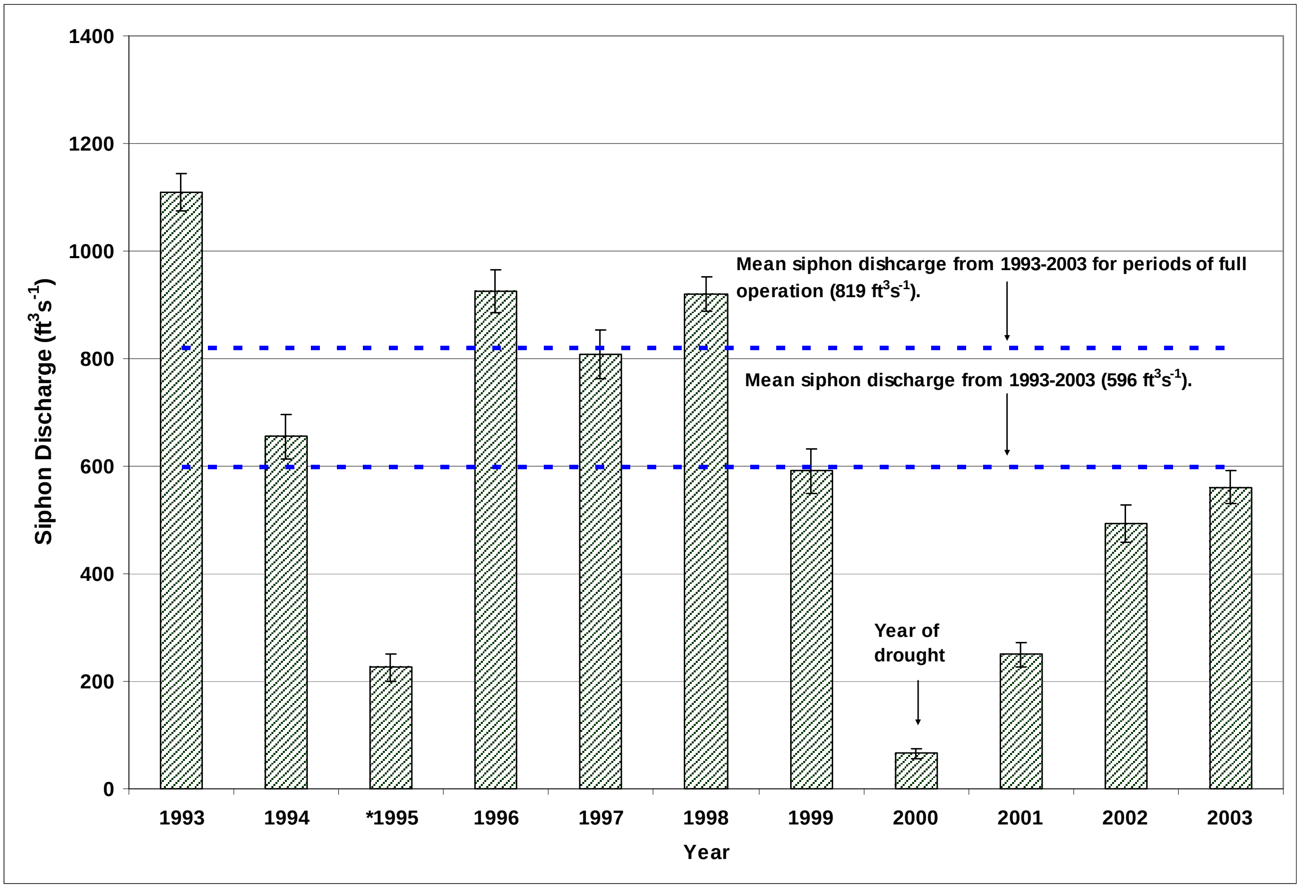


Figure 3. BA-03c yearly mean (±SE) siphon discharge from 1993 -2003. Dotted lines represent mean discharge during periods when siphons were in full operation and the overall average for 1993-2003. Daily siphon discharge was estimated from the Mississippi River gauge at Alliance LA, the immediate staff gauge in the outfall area, and the number of siphons in operation. *Siphons were not operational for 9 months during 1995.

achieved with the installation of two water control structures designed to reduce freshwater loss and saltwater intrusion. Renovation of the BBW's will protect the adjacent marsh from erosion due to boat wakes and saltwater intrusion. It will also help retain the freshwater that will enter the area from the Naomi siphon located to the north of the project area.

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

1. Reduce mean project area salinity.
2. Improve growing conditions and increase relative abundance of fresh-to-intermediate marsh species.
3. Reduce the rate of conversion of marsh to open water in project area.

b. Monitoring Elements

Salinity
Salinity was monitored hourly at 3 continuous recorder stations from June 1999 – December 2003 (see Figure 2). Discrete salinity was monitored monthly at 16 stations from 1992 – 1999 and at 24 stations from 1999 – 2003. Data were used to characterize the spatial and temporal variation in salinity throughout the project area. Salinity data will continue to be collected through 2012.

Water elevation
Hourly water level data were taken with the three continuous recorder stations from 1999 - 2003, and discrete water level measurements were recorded monthly at seven staff gauges from 1992-2003 and at nine gauges from 1999 – 2003 (see Figure 2). Data were used to characterize the spatial and temporal variation in water level throughout the project area. Water level data collection will continue through 2012.

Vegetation
Species composition and relative abundance of emergent vegetation were quantified using techniques described in Steyer et al. (1995). Twenty-one stations were visually monitored in 1992 (pre-construction) and in 1995 (post-construction). Forty plots ($4m^2$) were surveyed in years 1997, 2000, 2003, and will continue in 2006, 2009, and 2012.

Habitat Mapping
In order to document vegetated and non-vegetated areas, color-infrared aerial photography (1:12,000 scale with ground controls) was obtained following procedures outlined in Steyer et al. (1995). Photography was obtained in 1993 (pre-construction) and 2000 (post-construction) and will be collected in 2009 and 2017.

c. Preliminary Monitoring Results and Discussion

Salinity

Mean daily salinity measured at the continuous recorders was lower during periods when all siphons were in either major or minor operation vs. no-flow, indicating that the siphons are capable of reducing salinity in the project area (Figure 4). However, salinity during these periods was influenced by factors other than siphon operation, particularly normal seasonal variability within the Barataria Basin (Swenson and Swarzenski 1995; Wiseman et. al. 1990; Conner and Day 1987). For example, salinity levels in the project area were highest in the spring and fall (Figure 5). During a drought from September 1999 through December 2000 mean yearly salinity levels in the project area increased greatly while siphon operation decreased substantially due to low river stage (Figure 6). Siphon operation is a function of river stage; thus, ability to control salinity during drought or normal low river stages (e.g. late summer and fall) was limited. The drought had a confounding effect on the results of the analysis of pre- and post-construction salinity data for the outfall management project. Pre-construction salinity levels were higher than post-construction levels at continuous recorder stations both within and just outside the project area (Figure 7). The drought effect was eliminated by using salinity data from the Barataria Bay Waterway (Station BA01-10, Figure 2) as a reference. The difference in salinity was calculated from the project and reference stations for the entire data set [i.e., (project - reference)], thereby creating a new variable called "difference". The difference in mean monthly salinity was compared between the pre- and post-construction periods using a paired T-test based on the BACIP (Before-After Control-Impact Paired) model (Underwood 1994 and Smith 2002; Table 1a and Figure 1d, respectively).

Stations 16 and 60 had consistently lower salinity than the reference station (Figure 7). It was assumed that if the water control structures were reducing salinity intrusions from BBW, and at the same time increasing the residence time of (diverted) fresh water from the siphons in the project area (i.e., a project impact), then the salinity difference would be greater after the installation of the structures. In contrast station 61 had a consistently higher salinity than the reference station. Thus, we assumed that if there was a project impact (i.e., fresher in project) then the salinity difference would be smaller during the post-construction time period. Results of these analyses indicated that the salinity "difference" was not significantly different between pre- and post-construction periods for station 16 (P=0.0575) and station 60 (P=0.3893). However, at station 61 the salinity "difference" was significantly smaller (P=0.0137), during the post construction period (Figure 8). This suggests that the project structures may have benefited the project area by increasing the freshwater retention and reducing saltwater intrusion in the area (as designed). However, it should be noted that the differences observed between periods were very small (< 1.5 ppt) and likely did not have an ecological effect on the project area (e.g., vegetation community). In addition, siphon flow was greater during the post-construction period and likely affected salinity in the area and interpretation of the tests.

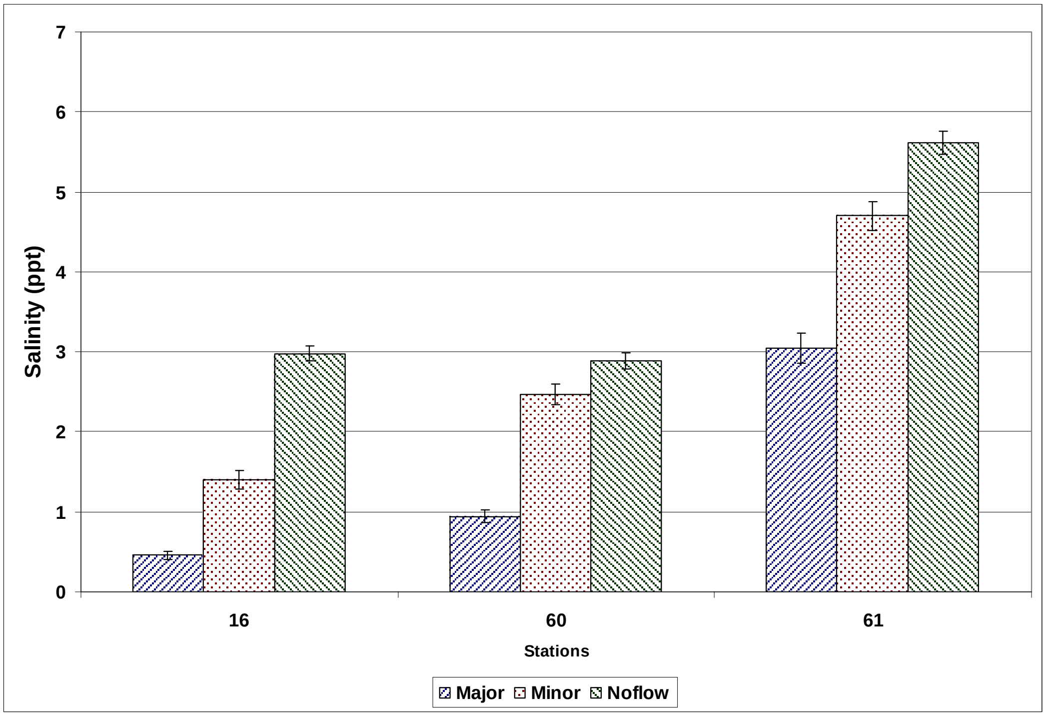


Figure 4. BA-03c mean (±SE) salinity for the period 1999-2003 for 3 operational categories at YSI continuous recorder stations (major discharge >1,072 ft^3s^{-1}; minor discharge >0, <1,072 ft^3s^{-1}; no flow = 0 ft^3s^{-1}).

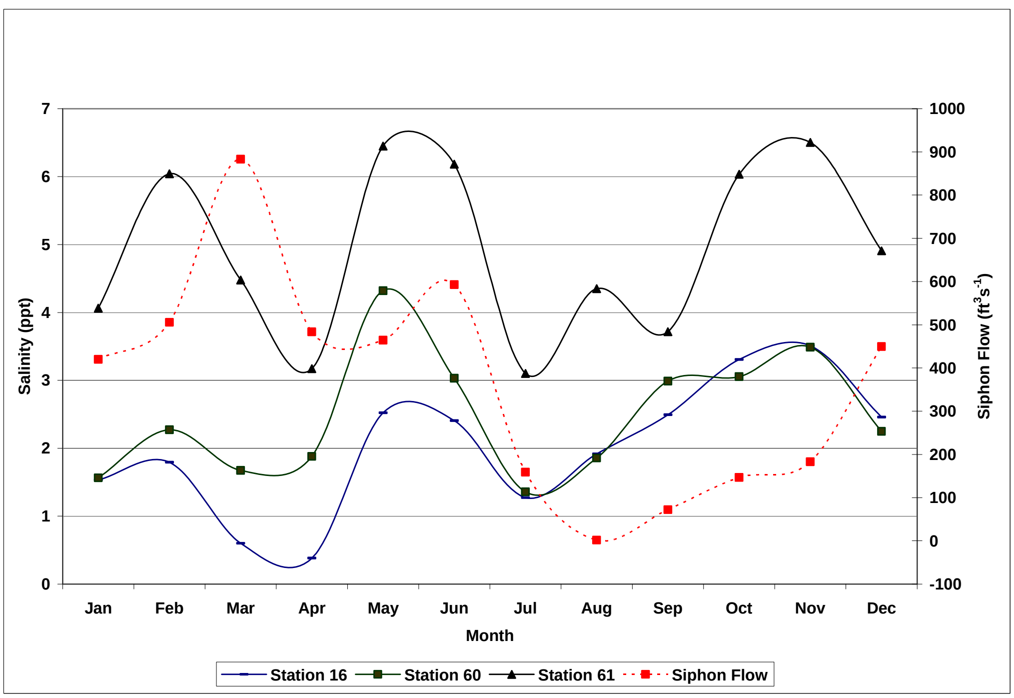


Figure 5. BA-03c mean monthly salinity and siphon flow for the period 1999-2003 for continuous recorder stations 16, 60, and 61.

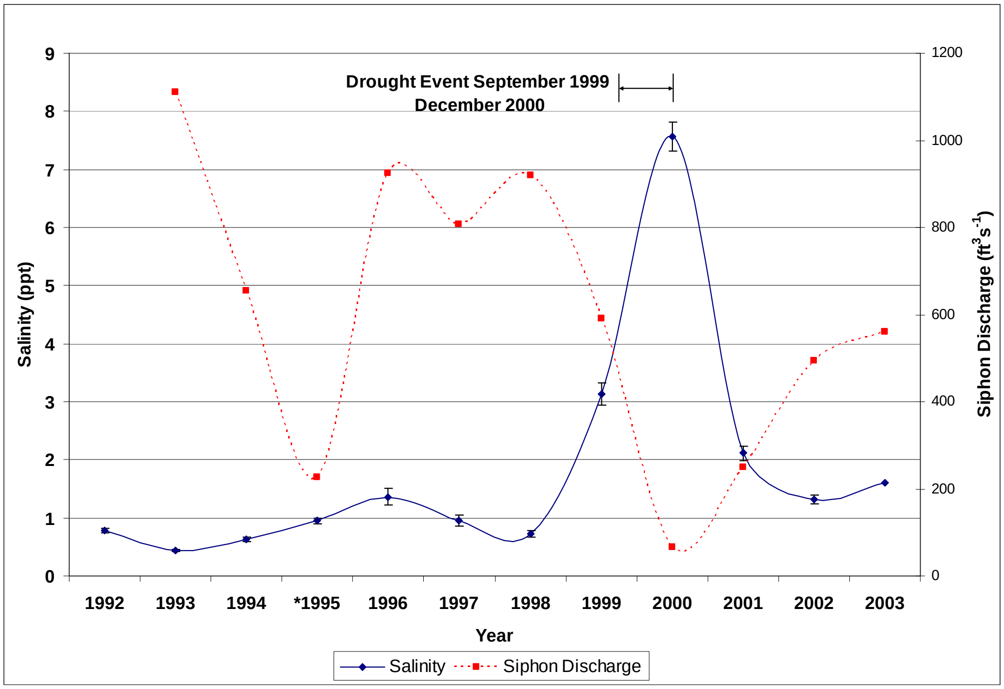


Figure 6. BA-03c Naomi Outfall Management project yearly mean (±SE) salinity and siphon discharge. Salinity was measured at 16 discrete monthly hydrologic stations for the period 1992-2003 and at 24 stations from 1999 – 2003. *Siphons were not operational for 9 months during 1995.

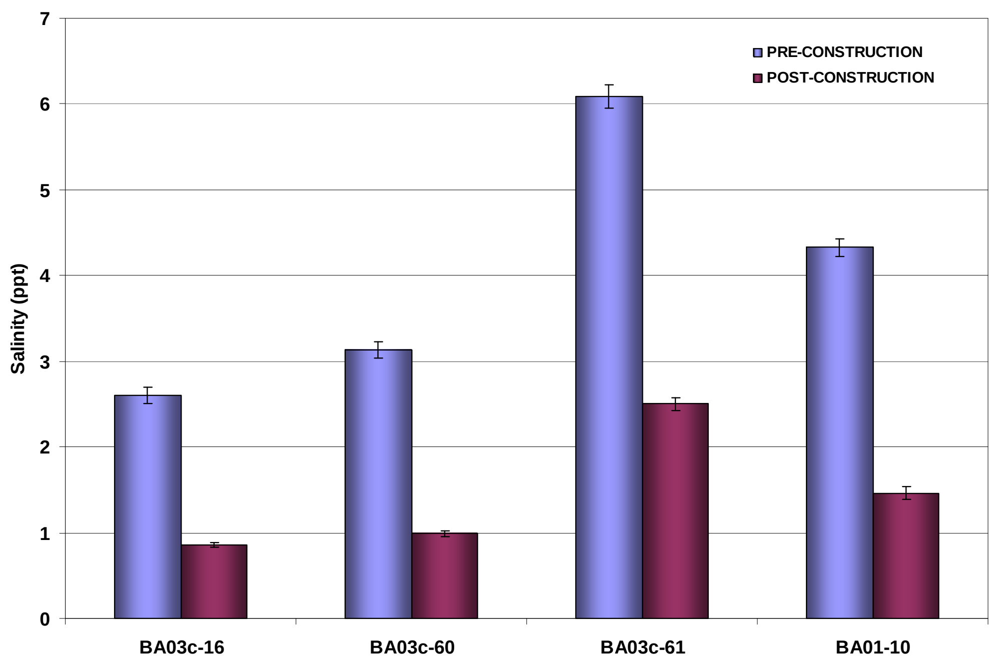


Figure 7. Mean monthly salinity during pre-construction (05/01/1999 – 08/15/2002) and post-construction (08/15/2002 – 12/31/2003) for project and reference (BA01-10) stations.

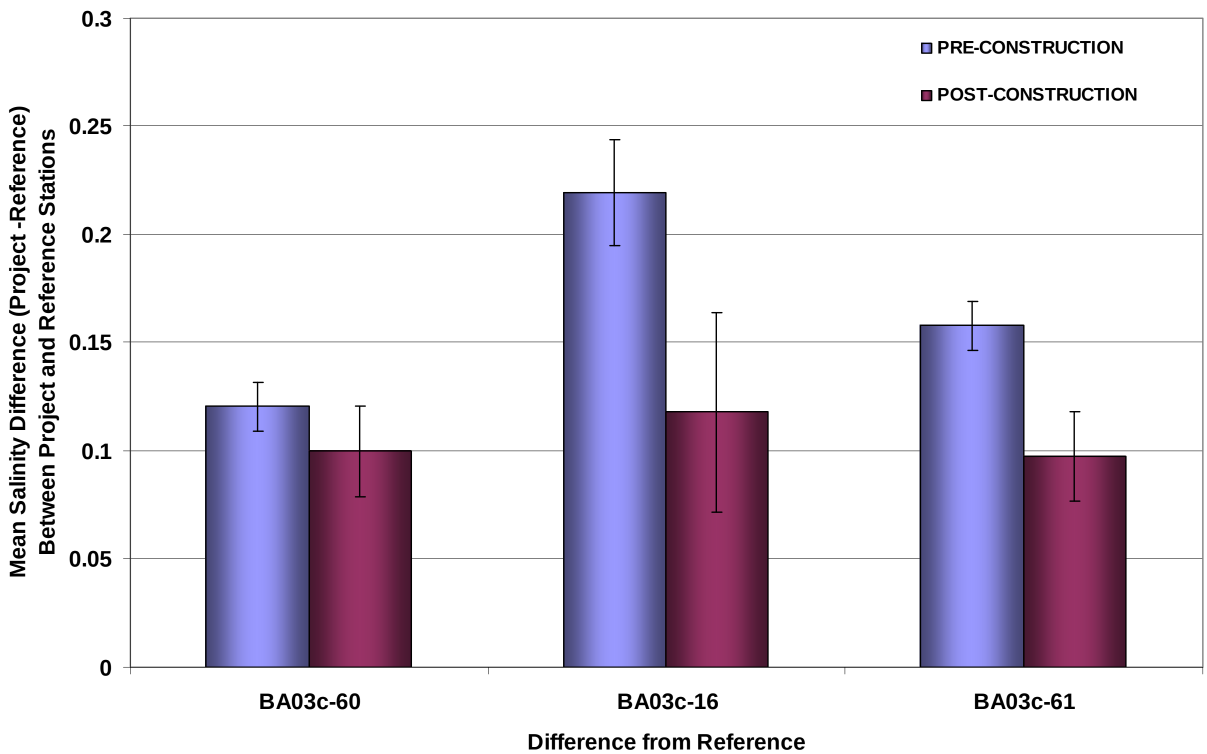


Figure 8. Least square means of the salinity difference between project and reference stations for pre and post construction periods. To calculate difference, hourly salinity readings at stations 60, 16, and 61 located within the project were subtracted from the salinity data at the reference station (BA01-10)

Water Elevation

Water level from monthly staff gauge readings collected during siphon operations were significantly higher ($P<.0001$) at the monitoring station nearest the outfall structure (station 14) than the remaining stations. During major flow conditions (>1,072 ft^3s^{-1}) mean water level at station 14 was 27.2 inches above mean water level measured than during no-flow conditions. Nonetheless, data from the remainder of the stations indicated water surface elevations dissipated quickly with distance from the discharge area, and few differences in water level were noted among flow categories for other stations outside of the immediate outfall area (Boshart 2003).

Pre and post-construction water levels for the outfall management project indicated that water levels had changed very little. Differences between pre-construction and post-construction water levels at station 16, 60, and 10 were ≤ 1 inch, but a difference of 6 inches was noted for station 61 (Figure 9).

Vegetation

The 1992 and 1995 vegetation surveys indicated that the northeast portion of the project area was comprised of fresh to intermediate marsh with *Sagittaria lancifolia* as the dominant species. The southern portion of the project area was comprised of brackish marsh with *Spartina patens* as the dominant species. Vegetation data from the 1992 and 1995 surveys can not be directly compared with the 1997, 2000, and 2003 surveys due to different methodologies, times of year, and sampling sites used in the latter years. *Spartina patens*, which is the key plant species (USDA SCS 1991), had the highest percent cover and frequency of occurrence during the 1997, 2000, and 2003 surveys (Table 1 and Figure 10). In the southern part of the project area, *S. patens* had a frequency of 100% for all stations during all three surveys, whereas frequencies in the northern area were 17%, 26%, and 23% for the three surveys, respectively. Other species that were high in abundance during the three surveys were *Eleocharis* spp., *S. lancifolia*, and *Schoenoplectus* spp., which are all typically associated with less saline environments. *Eleocharis* spp. and *Schoenoplectus* spp. were located in both the northern and southern portions of the project area during the three surveys, while *S. lancifolia*, did not occur at any stations within the southern area. In 1997 and 2003, species richness was consistent in the north and south with both areas containing nearly equal numbers of species. In 2000, however, there was a 65% decrease in the number of species observed in the southern area. This decrease may have been due to drought conditions which prevailed from January 1999 through April 2001. In 2003, species richness increased dramatically in the southern stations indicating a recovery of the vegetation community from the drought. These changes were not likely due to the construction of the outfall management structures because results from pre and post construction salinity data analysis indicated that the water control structures had little effect on the salinity in the project area.

Habitat Mapping

Aerial photography from 1993 and 2000 was currently being analyzed and will be presented in future reports.

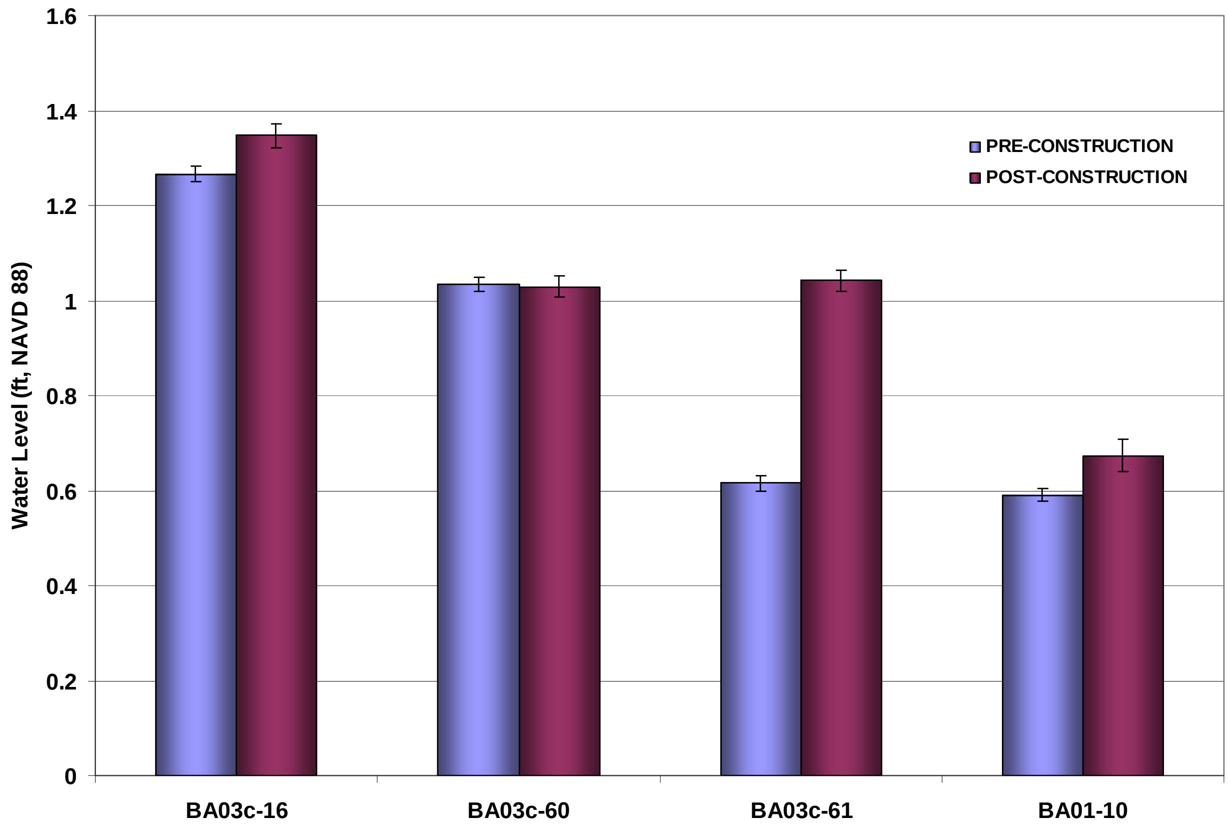
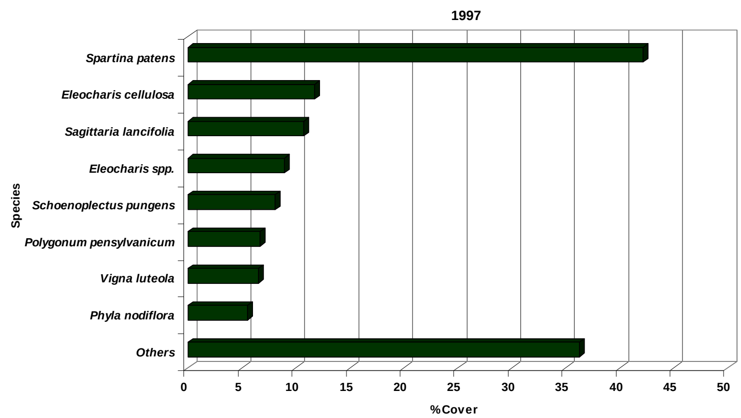
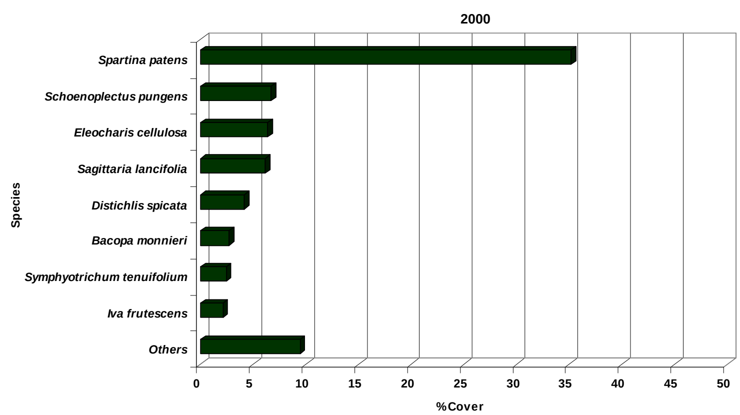


Figure 9. Mean monthly water levels during pre-construction (05/01/1999 – 08/15/2002) and post-construction (08/15/2002 – 12/31/2003) for project and reference area.





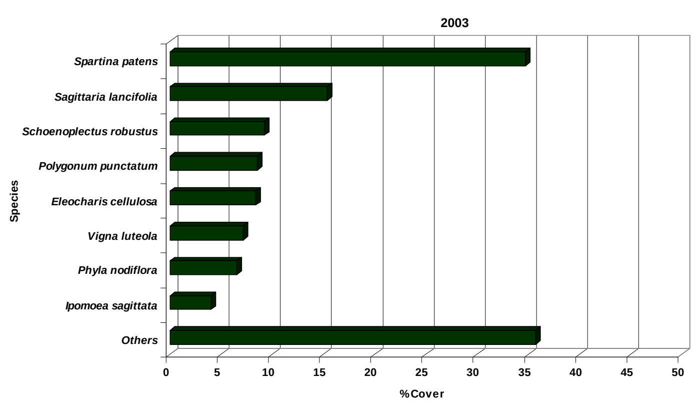


Figure 10. Mean percent cover of dominant vegetative species across all $4m^2$ plots during 1997, 2000 (pre-outfall structure construction) and 2003 (post-outfall structure construction) vegetation surveys in the BA-03c Naomi Outfall Management Project Area.

Table 1. The frequency at which each species occurs and number in the Naomi Outfall Management Project (BA-03c).

Scientific Name	Common Name	Occurrence (%)		
		1997	2000	2003
Alternanthera philoxeroides	Aligatorweed	10.00	15.00	7.50
Amaranthus australis	Southern amaranth	2.50	.	15.00
Ammannia coccinea	Valley redstem	.	2.50	.
Ammannia sp.	Redstem	2.50	.	.
Ammannia latifolia	Pink redstem	.	.	10.00
Andropogon glomeratus	Bushy bluestem	17.50	7.50	.
Baccharis halimifolia	Eastern baccharis	15.00	10.00	5.00
Baccharis sp.	Baccharis	2.50	.	.
Bacopa monnieri	Coastal waterhyssop	10.00	17.50	22.50
Cuscuta indecora	Bigseed dodder	.	.	2.50
Cyperus compressus	Poorland flatsedge	.	.	15.00
Cyperus sp.	Flatsedge	12.50	15.00	.
Cyperus odoratus	Fragrant flatsedge	12.50	10.00	20.00
Distichlis spicata	Seashore saltgrass	2.50	25.00	10.00
Echinochloa crus-galli	Barnyardgrass	2.50	.	.
Echinochloa walteri	Coast cockspur	.	2.50	10.00
Eichhornia crassipes	Water hyacinth	2.50	.	.
Eleocharis sp.	Spikerush	27.50	.	5.00
Eleocharis cellulosa	Gulf Coast spikerush	40.00	27.50	45.00
Eleocharis parvula	Dwarf spikesedge	2.50	2.50	20.00
Fuirena squarrosa	Dwarf spikesedge	.	.	2.50
Galium tinctorium	Spikerush	.	.	7.50
Hibiscus sp.	Hairy umbrella-sedge	12.50	.	.
Hibiscus moscheutos	Crimsoneyed rosemallow	5.00	.	.
Hydrocotyle sp.	Hydrocotyle	35.00	10.00	32.50
Ipomoea sagittata	Saltmarsh morninglory	30.00	37.50	42.50
Iva frutescens	Bigleaf sumpweed	2.50	10.00	5.00
Juncus effusus	Common rush	5.00	.	.
Juncus roemerianus	Needlegrass rush	2.50	2.50	2.50
Kosteletzkya virginica	Virginia saltmarsh mallow	.	2.50	2.50
Lemna minor	Common duckweed	.	5.00	.
Ludwigia sp.	Primrose-willow	2.50	.	.
Ludwigia microcarpa	Smallfruit primrose-willow	2.50	.	.
Lythrum lineare	Wand lythrum	.	.	37.50
Mikania scandens	Climbing hempvine	7.50	.	.
Panicum repens	Torpedograss	.	2.50	7.50
Paspalum distichum	Knotgrass	.	.	2.50
Phyla nodiflora	Turkey tangle fogfruit	45.00	25.00	40.00
Pluchea camphorata	Camphor pluchea	17.50	5.00	20.00
Pluchea foetida	Stinking camphorweed	2.50	.	.
Polygonum sp.	Knotweed	20.00	.	.
Polygonum pensylvanicum	Pennsylvania smartweed	37.50	.	.
Polygonum punctatum	Dotted smartweed	2.50	5.00	57.50
Sacciolepis striata	American cupscale	5.00	17.50	.
Sagittaria lancifolia	Bulltongue	45.00	47.50	50.00
Sagittaria platyphylla	Delta arrowhead	5.00	.	.
Salvinia minima	Water spangles	2.50	2.50	.
Schoenoplectus americanus	Olney bulrush	.	.	5.00
Schoenoplectus pungens	Common threesquare	35.00	25.00	.
Schoenoplectus robustus	Sturdy bulrush	.	.	37.50
Setaria sp.	Bristlegrass	17.50	.	.
Setaria magna	Giant bristlegrass	2.50	.	2.50
Setaria parviflora	Knotroot bristlegrass	5.00	2.50	5.00
Solidago sempervirens	Seaside goldenrod	17.50	15.00	5.00
Spartina alterniflora	Smooth cordgrass	2.50	10.00	7.50
Spartina patens	Marshay cordgrass	65.00	75.00	70.00
Sphenoclea zeylanica Gaertn.	Chickenspike	2.50	.	.
Sporobolus	Dropseed	7.50	.	.
Symphyotrichum subulatum	Coastal Waterhyssop	27.50	.	17.50
Symphyotrichum tenuifolium	Perennial saltmarsh aster	35.00	40.00	.
Thelypteris palustris	Eastern marsh fern	10.00	2.50	7.50
Typha latifolia	Broadleaf cattail	.	2.50	.
Typha sp.	Cattail	.	.	2.50
Vigna luteola	Hairypod cowpea	45.00	.	37.50
Zizaniopsis miliacea	Giant cutgrass	.	.	2.50
Number of species		48	32	39

VI. Conclusions

a. Project Effectiveness

Freshwater introduced by the siphons as a part of the state/PPG funded BA-03 project reduced salinity when the siphons were operated. However, operations were limited due to a number of factors, and thus the full potential benefits of the siphons were not realized. Moreover, some evidence has been found to suggest that the outfall management structures installed as a part of the BA-03c Naomi Outfall Management project had some effect on reducing the mean project salinity. Evidence of this was found at only one of the three continuous recorder stations (station 61). It must be noted that station 61, which is located furthest south had the greatest difference in water level between pre-construction and post-construction periods. Water levels in the project area before and after construction of the outfall management project experienced little change.

From 1992 to 1999, prior to the construction of the outfall management structures vegetation communities within the project area increased in fresher species, which was likely a result of the diversion. However, the vegetation community was affected by the drought in 2000, with some stations reverting from fresher to more saline species (Evers and Sasser 2002). Since construction of the outfall management structures, vegetation reverted back towards a fresher community; however, there is no evidence to suggest that this was a result of the project features. Similar trends in salinity were seen outside of the project area and the reversion back to fresher vegetation communities followed the trend that began prior to the installation of the outfall management structures. *S. patens*, an intermediate marsh species, remained dominant in both cover and distribution. One of the goals of this project was to increase relative abundance of intermediate to fresh marsh plant species. Therefore, that goal is being met, but only in areas closest to the diversion (Boshart 2003), which suggests that this may be more of an effect from the diversion structure than of the outfall management structures.

From a structural standpoint, isolated areas of the rock dike constructed under the BA-26 Barataria Bay Waterway East Shoreline Protection Project settled significantly since the project was completed. Profile and cross sectional surveys were conducted to identify locations that required maintenance. In a joint effort between LDNR and NRCS, bid documents are presently being prepared 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**

Naomi Outfall Management Project (BA-3C)

1. **Improve siphon operation.**

Although the following recommendations involving Naomi Siphon operation were needed, PPG owned, operated, and maintained the siphon which was not part of the BA-03C Project. There were no budgeted funds available in the CWPPRA-approved O&M budget for BA-03C for Siphon operation. The recommendations were included here because the improvements in siphon operation would have a corresponding improvement on the effectiveness of the BA-03C project.

When the Naomi Siphon was most needed, during the drought of 1999-2000, very little water was discharged by the siphon (Figures 4 and 5) due to the low river stage and siphon valve problems. The valve problems were taken care of in 2000 by a DNR-PPG cooperative maintenance effort. It was recommended that a similar cooperative effort be made to decrease the down time of the siphon during low river stages. This can be accomplished by modifying the siphon system to provide a "semi-automatic" means of placing individual siphon pipes back in service when the pipes lose prime due to low river stage or other reason. The pipes can be placed back in service by PPG personnel only. However, they must tow a large vacuum pump from the Parish lab near Caernarvon, across the Mississippi River on the ferry, and up Highway 23 to the siphon site. This action takes considerable time and can only be accomplished when the PPG is available. As a result, the out-of-service siphon pipes often remain out of service for considerable lengths of time.

DNR recently retained the engineering firm of Perrin & Carter, Inc to analyze the siphon problem. They submitted a report (Perrin and Carter 2003) itemizing improvements that can be made to the Naomi (and West Pointe a la Hache) siphon. These improvements would eliminate the need for PPG to tow the cumbersome vacuum pump to the siphon site to restart a siphon pipe. It was recommended, by the Louisiana Department of Natural Resources, that one of the several options presented in the Perrin & Carter report be implemented through a cooperative DNR-PPG endeavor.

Additional recommendations to improve siphon operation included: (1) The installation of flow meters to accurately measure and record siphon discharge (2) Operation of the siphons have been totally controlled by PPG with little input from LDNR. We recommend a more cooperative venture with the PPG and LDNR collaborating in determining siphon operation, and (3) siphon discharge should be maximized and operation plans should be closely followed.

The following two recommendations, Nos. 2 & 3,, fell within the purview of the Naomi Outfall Management Project (BA-3C) and were not associated with the BA-26 project or the PPG-controlled BA-03 project.

2. **Volumetric Water Budget Analysis.** The BA03c project was classified as a Hydrologic Restoration (HR) project. Limited reduction in salinity levels was observed once the project was implemented. Net water inflows/outflows to The Pen were determined using the volumetric water budget analysis developed during design.

3. **Navigation Lights.** It was recommended that a firm specializing in the maintenance of navigation lights be retained to monitor the lights at this project. The navigation lights continuously caused problems.

Barataria Bay Waterway East Shoreline Protection Project (BA-26)

1. **Rock Dike.** The foreshore dike at this project was in need of repair. Plans and specifications were being developed for the work. The expense for this work came from the CWPPRA-approved O&M budget for (BA-26). See Section III-b, & III-c for details.

   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 was recommended within the first 5 years of construction. The date of assessment survey was to be agreed upon by the state and federal sponsor at the annual maintenance inspection.

c. **Lessons learned**

Naomi Outfall Management Project (BA-3C)

The lessons learned while monitoring of this project increased the learning curve for wetland projects of this type. Lessons learned included: (1) project goals should have been quantified as much as possible to aid evaluation of project effectiveness, (2) considered outfall management from the beginning planning stage, (3) alternative to more expensive modeling would have been to re-visit volumetric water budget analysis using pre- and post- construction data to test assumptions and revise the analysis, (4) reference areas were not included during the project planning or developmental stages but could be addressed in the future with the Coastwide Reference Monitoring System-*Wetlands* (CRMS-*Wetlands*).

The BA-03c project was classified as a Hydrologic Restoration (HR) project and was implemented within the first few years of the CWPPRA program. Under current design criteria, this type of project would have been designed with the aide of a hydrodynamic model. Considering the above, and if Engineering/Biological monitoring results indicated that the project was not producing the predicted or desired results, further investigations of the water flow patterns would be warranted. Hydrologic assessment would be conducted to determine if there are specific structures or existing topographic features that have been compromising the goals of the project. Additional surveys, calculations, and flow measurements may be required to properly evaluate flow patterns within the project boundary. In the event that such a targeted analysis does not identify specific problems associated with the system's functionality, a more detailed hydrodynamic model may be warranted. Care should be taken in selecting the model to ensure that information developed was compatible with other modeling efforts that have been, or will be, conducted in the project basin.

Barataria Bay Waterway East Shoreline Protection Project (BA-26)

O & M inspections documented settlement at 7 segments of the rock dike. These segments settled beyond acceptable tolerance levels and were re-capped with additional material to raise their elevation. Final elevation of the repaired segments was between 3.7 and 4.1ft NAVD88 (Shread-Kuyrkendall & Associates, Inc. 2006). Maintenance was coordinated and performed in conjunction with similar maintenance on the BA-23 Barataria Bay Waterway West Side Shoreline Protection project on the opposing side of the Barataria Bay Waterway. Combining O & M activities such as this saves costs resulting from mobilization and demobilization, and materials; excess materials from the BA-23 project were used on the BA-26 project.

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