FRESHWATER BAYOU WETLANDS (ME-04)

I. INTRODUCTION

I.1. Project Description

Freshwater Bayou Wetlands is a second year CWPPRA project (figure 1). It was implemented in two phases because of the availability of rock from an emergency authorization to dismantle Wax Lake Outlet weir. Phase 1 involved the construction of a rock dike for shoreline protection; phase 2 involves the structures on the hydrologic restoration aspect of the project. Pursuant to a Task Force decision on April 14, 1998 the original monitoring plan was reduced in scope due to budgetary constraints.

WVA on 3 August 1992 listed the boundary of the 14,381 acre area as bounded on the north by an imaginary east-west line connecting an oilfield canal system to Hwy. 82, on the west by Louisiana Highway 82, on the south by Humble Canal and on the east by Freshwater Bayou Canal.

The CUP permit issued April 1, 1996 shows a boundary of the 36,000 acre area similar to the Plan/EA. The exceptions are for the removal of Sections 34, and 35 and part of Sec. 1 along the southwestern area, and the addition of parts of Sec. 14, 15, 20, 21, 22 and 28 along the northwestern area. The SW area removed is an impounded fastland used for cattle grazing. This project area extension was at request of landowners because of structure effects.

Project Plan and Environmental Assessment of June 1996 had the boundary of the 36,928 acre area as bounded on the north by Schooner Bayou, on the west by Louisiana Highway 82, on the south by Humble Canal and on the east by Freshwater Bayou Canal.

The Monitoring Progress Report No. 5 for the period of January 31, 1995 to October 01, 1999 shows a boundary on the 33,292 acre area as bounded on the north by Schooner Bayou, on the west by Louisiana Highway 82, on the south by Humble Canal and on the east by Freshwater Bayou Canal. The removal of pump-off area - Sections 34, and 35 and part of Sec. 1 along the southwestern area - is indicated on the map.

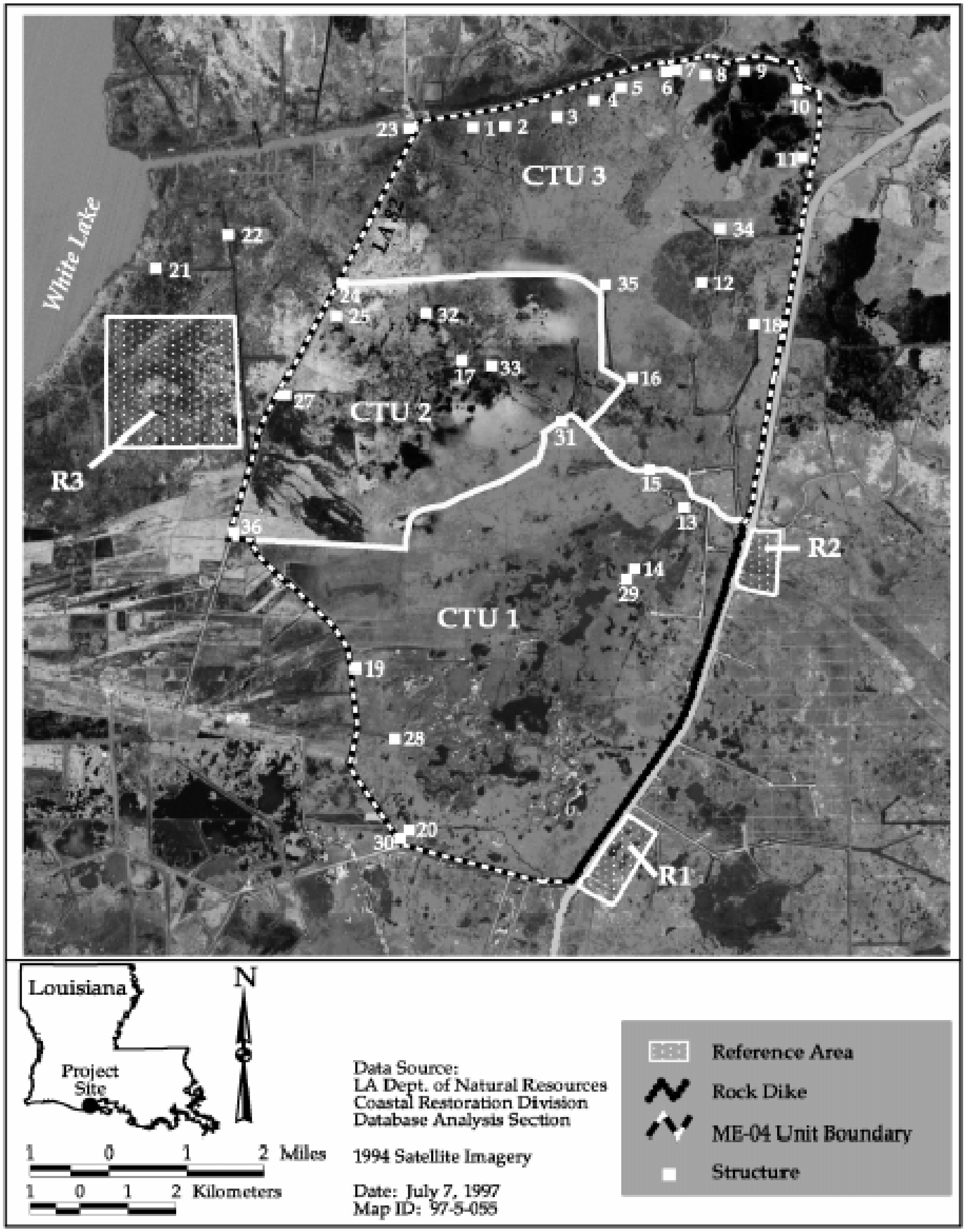

Figure 1. Project location and features.

I.2. Project Personnel

NRCS Project Manager: Joe Conti DNR Project Manager: Karl Vincent		
Planning -	W. "Judge" Edwards	Vermilion Corp.
	Donald Menard	NRCS (retired)
	Britt Paul	NRCS
	Joe Conti	NRCS
	Marty Floyd	NRCS
	George Townsley	NRCS
	CWPPRA Environmental Work Group	
Implementation -	W. "Judge" Edwards	Vermilion Corp.
	Ronnie Faulkner*	NRCS
	Wayne Melancon*	NRCS
	Garrett Broussard	LDNR
	Mel Guidry	LDNR
	Stan Aucoin	LDNR
Monitoring -	Karl Vincent	LDNR
	Ralph Libersat	LDNR
	Marty Floyd	NRCS

*NRCS provided the preliminary design, however the interior structural components were modified and built by landowner

II. PLANNING

II.1. Causes of Loss

What was assumed to be the major cause of land loss in the projected area?
Enlargement of Freshwater Bayou resulted in increased tidal exchange, wave action, and wave wash from boat traffic which increased shoreline erosion. Erosion occurred to the extent that some sections of spoil bank were lost allowing tidal scouring and breakup of interior marshes. Other areas had increased freshwater introduction from White Lake and culverts under Hwy. 82 with limited outlets resulting in impounding of interior (PL2 Project Description, p.155).

0.157%/yr interior loss rate between 1983-1990 (Britsch, USACE) with 0.38%/yr loss rate between 1983-1990 (Dunbar, Britsch & Kemp, 1992) ~ consensus of WVA used 0.2%/yr (WVA Information Sheet, rev. 8/4/92, p.2-5).

5.8 ft/yr shoreline erosion along west bank using DNR GIS data (Coastal Environments, Inc.) ~ assumed a tripling of this rate to 17.4 ft/yr (WVA Information Sheet, rev. 8/4/92, p.8).

In the marsh conservation plan (USDA-SCS 1994, p.13), it is stated that wetlands within the project area are adversely affected by high water levels in the Grand/White lakes system, which is maintained at an artificially high level. This is resulting in physiological stress on the vegetation, causing wetland loss and shifts in plant species composition to communities having reduced primary productivity and reduced fish and wildlife habitat value.

The major cause was assumed to be the cumulative changes in hydrology (EA, 1996, pp10 and 21). Maintaining above average water levels in the Grand/White lakes system is believed to cause prolonged periods of elevated water levels and flooding of the adjacent marshes. This has resulted in ponding, or the creation of ponds as the marsh vegetation dies off from physiological stresses brought on by the prolonged inundation. This is further complicated by the loss of perimeter spoil banks which has allowed for increased salt water intrusion and increased tidal exchange.

What were assumed to be the additional causes of land loss in the projected area?
Canalization and subsequent rapid erosion of canal spoil banks, especially along FWB Canal and Humble Canal, is allowing saltwater intrusion into and tidal scour of interior marshes (USDA-SCS 1994, p13). Subsidence has also been mentioned (USDA-NRCS 1996, p17.).

II.2. Background

The restoration technique chosen was based on consensus of members of CWPPRA Environmental Work Group regarding positive results from similar management in areas having comparable soils, vegetation and hydrologic conditions in the Mermentau and Calcasieu-Sabine Basins, including peer-reviewed publications regarding such approaches.

The landowner requested spoil bank repairs and rip rap to cover/protect exposed sections of pipeline along FWB Canal, and additional water control structures to increase discharge capacity in the adjacent managed marsh. The original project plan that was evaluated through the WVA called for 10,000 linear feet of spoil bank repairs and the installation of 12 water control structures along the southern perimeter of the project area. During the WVA, the project area was truncated across the top, omitting the northern third since that area would not benefit from the restoration features proposed for the southern end of the project area.

In 1994, NRCS personnel worked with the landowner to produce a marsh management plan for the entire FWB wetlands area, including the northernmost third of the project area that was removed during the WVA. This plan included 13 existing water control structures and proposed to install 9 additional structures and 5 canal plugs, and to perform spoil bank maintenance in two areas.

The landowner and NRCS personnel selected 8 of the proposed water control structures to serve, along with the rock dike, as the restoration features for the ME-04 project. However, Vermilion Corp. did not want CWPPRA structures on the interior of their property out of concern that this could eventually lead to public access. Vermilion Corp. offered to put in 8 water control structures at its own expense in exchange for the installation of a rock dike along FWB Canal.

Later in 1994, NRCS, LDNR, and USACE agreed to construct 28,000 linear feet of continuous foreshore rock dike along the west bank of FWB Canal using rock obtained from the removal of the Wax Lake Outlet weir. The low-cost used material allowed for the construction of a dike almost 3 times the length of what could have been built from new material.

The added shoreline protection provided by the dike and the increased water management capability provided by the 8 new water control structures were supposed to assist the landowner in reducing “ponding” in the southern half of the ME-04 project area.

II.3. Project Goals and Objectives

Primary objectives are: 1) stabilize the rapidly eroding west bank shoreline of the Freshwater Bayou Canal and 2) to reduce ponding and marsh loss in the adjacent wetlands. (PL2 Project Description, p155)

The Plan/EA for Phase II gives the purpose as “to relieve the physiological stresses on wetland vegetation caused by prolonged high water levels”.

Final monitoring plan lists objectives as 1) reduce ponding and marsh loss, 2) maintain target salinity levels, and 3) increase vegetative cover in shallow open water areas. [Note: WVA predicted reduction in EM loss, salinity change with and without project, and decrease in SAV without project, but no increase with project in SAV].

How were the goals and objectives for the project determined?
NRCS (and LDNR) staff worked up the goals and objectives, based on discussions with the landowner and field observations. The WVA group through consensus made any modifications to these both at time of WVA and during comment period on the draft plan/EA.

Are the goals and objectives clearly stated and unambiguous?
Yes

Are the goals and objectives attainable?
Yes, with appropriate repair and maintenance.

Do the goals and objectives reflect the causes of land loss in the project area?
Yes

III. ENGINEERING

III.1. Design Feature(s)

What construction features were used to address the major cause of land loss in the project area?
Installation of 10,000 linear feet of rock breakwater (rip rap) along the west shoreline of Freshwater Bayou Canal, where needed, to protect from further erosion; and gated water control structures on Acadiana Marina Canal to reduce ponding in area known as Freshwater Bayou Wetlands (PL2 Project Description, p156).

The construction features actually used on the ME-04 project were the installation of 28,000 linear feet of continuous foreshore rock dike along the west bank of Freshwater Bayou Canal from Belle Isle Bayou to Acadiana Marina Canal (using CWPPRA funds) for shoreline protection, and the installation of eight additional water control structures at eight separate locations in the project area (by the landowner at his expense) to increase water management capability in the project area.

The eight additional water control structures installed by the landowner to increase water management capability are supposed to allow the landowner more opportunity to discharge water so he could attempt to reduce the frequency and duration of marsh flooding (Plan/EA, 1996, p 21).

What construction features were used to address the additional causes of land loss in the project area?
The FWB Wetlands Conservation Plan (NRCS 1994, p14) recommended that rip-rap bank protection be used to stabilize critical areas along the west bank of FWB Canal and the north bank of Humble canal. The structure permitted and installed in 1995, as Phase 1 of this project, is a 28,000-ft long continuous rock dike constructed along the west bank of FWB Canal [LDNR CUP P910081/USACE 404 permit SW (Freshwater Bayou) 25]. The dike was supposed to halt shoreline erosion along the canal. <u>Note</u>: The 1996 EA pertains only to Phase 2 of the project, hydrologic restoration. It does not even mention the rock dike. No EA was done on Phase 1 of the project since a permit already existed (which satisfies most of NEPA requirements) and this was a rush job only involving rock work.

What kind of data was gathered to engineer the features?
Data collected during field investigations included soil types, vegetation types, water depth (ponds and marsh), locations and dimensions of drainage openings, and potential structure sites. A comparison of aerial photography was made to determine changes in hydrology and land loss. Additional research was conducted to determine historical changes in vegetation, salinity regimes, and modifications to the basin's hydrology (Plan/EA, 1996, p17)

Design and performance of several rock projects were used as a basis for the design of this project. Two of the reference projects are located on Freshwater Bayou. The gradation of the rock for this project was selected based on the evaluation of those projects and rock gradations at other project locations.

Geotechnical data from the T/V-11 State project may have been considered during planning and designing the ME-04 rock dike component. No geologic investigation was performed where the dike was constructed. The bottom of Freshwater Bayou was probed and found to be substantially firm.

Prior to construction, elevation was “carried” from the staff gage at the Vermilion Corp. camp near the project site to the 8 new structure sites by the contractor and NRCS personnel, by reading water levels. Contractors for LDNR have more recently installed a TBM on each of the structures to establish elevation relative to the NAVD datum.

No structural design was performed on the dike. However, from the evaluation of several other rock projects in the vicinity and other similar rock projects, a typical section for the dike was used that has performed well under Freshwater Bayou wave conditions.

No geotextile was used in the construction of this project. The basis for this is that the bottom of Freshwater Bayou is very firm. Also, discussion with Garrett Broussard of LDNR revealed that LDNR has evaluated test sections in the general area with and without geotextile which indicates that the performance is basically the same. Settlement plates were placed at 1,000 foot intervals and are monitored periodically.

What engineering targets were the features trying to achieve?
The rock dike was engineered to have a settled crown height of 4 feet NAVD. The standard crown height for such structures is approximately 2 feet above water level and is based on the ability to break the impact of waves.

The structures are installed at a certain elevation to provide maximum stability and discharge capacity. The 8 new structures were sized to provide the landowner with enough discharge capacity to lower excessive water levels, to the extent possible. The structures are permitted to have the weirs set at 6 inches below marsh elevation under normal conditions, and 12 inches below marsh elevation during a spring draw down, which may be attempted every 3 years after a successful one is achieved.

Each structure is supposed to have two 4-inch wide vertical slots in the weir section and one 4-inch slot in the flap gate, to enhance marine organism access to the project area. None of the slots were installed. The flap gates are set to leave a 2-inch wide horizontal opening along the bottom edge of the flap gate when it is fully closed. This only allows some marine organisms to enter into the weir section, and only those that can get over the weirs ever make it into the project area.

III.2. Implementation of Design Feature(s)

Were construction features built as designed? If not, which features were altered and why?

The rock dike was built in accordance with a USACE design plan. However, the low-cost rock used for initial construction was substandard in that it included mud and rock of a smaller grade than required for the ME-04 rock dike. By 1997, the rock dike was already in need of maintenance. The first O & M work on the dike has been delayed until the spring of 2002, over four years after the need became apparent.

The permitted water control structure is a culvert through an embankment, with a slotted flapgate mounted on the "outside" end and a variable crest weir with a 4-inch vertical slot mounted on the "inside" end of the culvert, OR a double-flapgated, variable-crested weir box with vertical slots [LDNR CUP P950086/USACE 404 permit SW(Vermilion Parish Wetlands) 321]. NRCS provided the landowner with several designs for the slotted, variable-crest weired, flapgated water control structures. The landowner's consultant used these plans to come up with a modified wooden box design that eliminated the vertical slots in the weir section and on the flapgate that were supposed to enhance fisheries access. Instead, each structure was constructed to allow for a two-inch wide horizontal gap at the base of the fully closed wooden flapgate so estuarine organisms can enter the weir section under the flap gate. But this only allows organisms to enter the marsh if the outside water level is higher than the weirs are set, allowing them to swim over the weirs. Organisms can exit the marsh by the same means, but the lack of a vertical slot in each weir box greatly reduces the opportunity for fisheries ingress and egress through the structures.

This little "flounder gate" feature also negates the landowner's ability to operate the structures in accordance with the project plan's salinity safety provision "C" (EA, 1996, p22). Provision C allows the landowner to operate the flapgate when salinity is above 6 ppt at structures 1 and 8, or above 4 ppt at structures 2-7. But because of the way they are set, the flapgates can never fully close so saline water can seep in under the flapgate when this situation arises.

The structures are all supposed to be installed at a certain elevation to provide maximum stability and discharge capacity. Some of the structures are set too low, allowing water to flow in over the structures on a high tide. Some structures need maintenance on the wingwalls that are now exposed due to bank erosion. The stop logs are not locked into the stop log bays, so they tend to float up in the bays, allowing water to seep between the stop logs. Unauthorized persons can also remove stoplogs at will to increase flows for shrimping/fishing at the structure. On any given field trip, it is not uncommon to find one of the structures with the stop logs set improperly, presumably by someone fishing or crabbing on the structure.

III.3. Operation and Maintenance

The operational scheme for Phase 2 of the project is included on page 21-22 of the Plan/EA, in Exhibit “D” of the Coastal Use Permit No. P950086 LMNOD-SW (Vermilion Parish Wetlands) 321, and on page 5-6 of Monitoring Report No. 5. Phase 2 was completed in July 1998 and the operations began in October 1998.

Were structures operated as planned? If not, why not?
Yes (Progress Report No. 5).

Phase 1 (rock dike) construction began 10 October 1994 and was completed on 31 January 1995. There is no operation involved on the rock dike, just lots of maintenance.

Phase 2 (installation of the 8 CWPPRA structures) construction began in January 1998, was completed in July 1998, and structure operation began in October 1998 when all structures were opened to remove floodwaters from Tropical Storm Francis. The structures have been more or less operated in accordance with the CUP and 404 permits.

Are the structures still functioning as designed? If not, why not?
Although the ME-04 rock dike has met its specific goal of reducing shoreline erosion along the west bank of Freshwater Bayou Canal behind the dike from 1995-2001, monitoring data indicate that its effectiveness steadily decreased over this time period (see section IV.2.5). This was in large part due to the substandard nature of the original construction material used, and the logistics of implementing a cost-effective maintenance lift to the structure, as explained below.

There was no control on the gradation of the rock used for initial construction of the ME-04 rock dike, which was obtained from the U.S. Army Corps of Engineers when they removed and salvaged the rock weir in Wax Lake Outlet north of Morgan City, Louisiana in 1995. The material obtained included a mix of very large stones, some debris of mud and wood, and many stones much smaller in size than the gradation required for a suitable rock dike on Freshwater Bayou Canal. Over time, the rock dike deteriorated as dissipating wave energy from boat-wakes striking the rock dike dislodged the debris of mud and wood, as well as smaller stones from the structure, leaving numerous dips in the crown height along the entire length of the structure.

This type of rock would never be part of a design recommendation for construction of a normal rock dike due to the uncontrolled gradation, however, this was a terrific opportunity to build a rock dike for less than $6.00 a ton as opposed to the normal $20.00 a ton for rock from the quarry. It is very doubtful that this situation will ever present itself again in the future.

A Monitoring/O&M Survey was completed in April 1998. A profile of the entire dike was performed in conjunction with the O & M inspection conducted by LDNR and the Federal Sponsor, NRCS, in late 1998. The profiles showed that the top elevation of the rock dike had deteriorated to (+) 3.0' N.A.V.D. in various reaches due to the smaller stones and debris being washed away by the large vessel wakes. The consensus by LDNR and NRCS was that although the top elevation of the dike had deteriorated, the dike was still functioning and no maintenance was to be performed. A subsequent O & M inspection was conducted in late 1999 and these same reaches as well as others had deteriorated to (+) 2.5' N.A.V.D. To perform maintenance on the project with the type of graded stone necessary (1,100 lb min. top end) would have put the dike out of compliance with the permitted crown height of (+) 4.0 NGVD. To use any smaller gradation of stone would have not held up to the wakes and would have been a waste of money. During the O & M inspection of late 2000, it was obvious to LDNR and NRCS that the dike was continuing to deteriorate and maintenance would need to be performed. Acadian Engineers and Environmental Consultants was contracted to perform the Engineering and Design for the proposed maintenance work. The work consisted of performing all necessary surveys, design reports, plans/specifications and contract documents. After various reviews by the NRCS, the final Plans and Specifications were approved in October 2001 and the contracting process was initiated with The Division of Administration. Bids were opened on February 20, 2002 and the work was completed on April 22, 2002, bringing the crown height of the rock dike back up to (+) 4.0 ft N.A.V.D. for its entire length.

On the structures, the stop logs are not locked into the stop log bays. This allows the stop logs to float up in the bays when water levels are high, allowing water to seep between the stop logs. Also, on any given month, it is not uncommon to find one or two of the eight structures with the stop logs set improperly, presumably by someone fishing or crabbing on the structure. Locking mechanisms would minimize these occurrences.

The structures have not been tied to the NAVD yet, so it is difficult to relate water levels at these structures to water levels at our continuous recorder stations. LDNR had a TBM set to NAVD installed on each structure in September 2001 and is currently preparing to have staff gages set to NAVD installed on the inside and outside of each structure in April or May 2002.

The large wooden flapgate on each structure is very heavy, and it does not budge when water if flowing out of the marsh unless there is a very large head difference at the structure. The flaps would work better if constructed out of lighter materials or if a counterweight was added to the existing flapgate to make it easier to open.

Structure 1 seems to be installed at a lower elevation than the other structures. It is regularly overtopped by high tides and there is a lot of erosion on top of the earthen embankment it is installed in. There is also some bank erosion along the wingwalls of this structure and several others.

Was maintenance performed?
The first O & M work on the rock dike will be done in the spring of 2002.

It is the landowner's responsibility to maintain the structures. No maintenance has been performed yet.

IV. PHYSICAL RESPONSE

IV.1. Project Goals

Do monitoring goals and objectives match the project goals and objectives?
Yes, but the monitoring goals and objectives attempt to be more specific and quantifiable than those of the project plan. This is typical since the Breaux Act was initiated in order to "get projects on the ground" as expressed by the public's concern that marsh loss was being studied but nothing done. As the process has evolved more emphasis has been placed on measurable goals and objectives.

The project goals and strategies stated in the marsh conservation plan (USDA-SCS 1994, p14) are as follows.

Objectives:
1. Increase emergent vegetative growth by restoring the area's natural hydrologic regime.
2. Control shoreline erosion along Humble and Freshwater Bayou Canals.

Strategies:
1. Developing additional outlets to outside channels to more rapidly discharge excess water.
2. Managing water levels to mimic natural conditions.
3. Regulating the inflow of water from the White Lake system.
4. Installation of bank stabilization structures on the western shoreline of FWB Canal and the north shoreline of Humble Canal.

The Plan/EA (USDA-NRCS 1996) does not include a list of the project goals and strategies. In the Project Action section (p13), it is stated that, "Implementation of the proposed project would provide opportunities to develop additional outlets to more rapidly discharge excess water and manage water levels to mimic historic conditions. This in turn will reduce plant physiological stresses and increase primary productivity, thus improving fish and wildlife habitat value."

In the Formulation Process section (p17), it is stated that, "The landowner's objective for the project area is to reduce the stress on emergent vegetation caused by high water levels. This will be accomplished by manipulating water levels to the extent possible."

In the Description of Alternative Plans section, under Alternative 2 –Hydrologic Restoration (p17), it is stated that "… installing 8 variable crest flapgated structures at selected locations in the project area … should have sufficient weir length to adequately lower excess water levels …This alternative will reduce vegetative physiological stress associated with prolonged high water levels, thus increasing emergent vegetative growth. Seventy percent of the open water will remain dominated by aquatic plants. Lower water levels will provide an opportunity for seasonal drying which will improve conditions for the production of summer annuals favored by wildlife. Project implementation will result in the continued maintenance of existing marsh types with little change in dominant plant species. Land loss rates will be significantly reduced … Marine organism access … will be greatly enhanced …"

The monitoring plan for phase 1 (LDNR 1995, p3) includes the following objectives and goals.

Objectives:
1. Protect the existing emergent wetlands along the west bank of FWB Canal and prevent their further deterioration from shoreline erosion and tidal scour.
2. Prevent the widening of the FWB Canal channel into the project area.

Specific Goal:
1. Decrease the rate of spoil bank erosion along the west bank of FWB Canal using a rock breakwater.

The revised monitoring plan for phase 2 (LDNR 1998, p8) includes the following objectives and goals.

Objectives:
1. Protect the existing emergent wetlands along the west bank of FWB Canal and prevent their further deterioration from shoreline erosion and tidal scour.
2. Prevent the widening of the FWB Canal channel into the project area.
3. Reduce ponding and marsh loss in the project area.
4. Maintain target salinity levels in the project area wetlands.
5. Increase vegetation cover in shallow open water areas within the project area wetlands.

Specific Goals:
1. Decrease the rate of spoil bank erosion along the west bank of FWB Canal using a rock breakwater.

2. Reduce water levels to within the target range for fresh to intermediate marsh vegetation, which is 6 inches (15 cm) below to 2 inches (5 cm) above marsh level.
3. Maintain salinity levels within the target range for fresh to intermediate marsh vegetation, which is 0-5 ppt.
4. Decrease the frequency and duration of flooding over the marsh.
5. Decrease the rate of marsh loss.
6. Increase the coverage of emergent vegetation in shallow open water areas within the project area.

IV.2. Comparison to adjacent and/or healthy marshes

IV.2.1. Elevation

What is the range of elevations that support healthy marshes in the different marsh types?
Marshes in the Mermentau Basin occur at elevations of approximately 0.73 ft to 1.52 ft NAVD-88 (Gammill et al. in press). This encompasses the known elevation range in the *Sagittaria lancifolia* (bulltongue) and *Spartina patens* (wiregrass) marshes along the south side of Schooner Bayou in CTU 3 of the ME-04 project area.

John Foret's dissertation (1997) in the eastern, non-managed marshes of Rockefeller estimated the average vertical accretion (using Cs-137 techniques) to be 0.48-0.52 cm/yr. He attributed this accretion rate to organic matter production supprted by large depositions of mineral sediments (such as that associated with Hurricane Audrey) that occur or the order of 60-80 years.

Does the project elevation fall within the range for its marsh type
Yes. According to the marsh conservation plan (USDA/SCS 1994, p 9), marsh elevation along the western boundary of the project area is approximately 1.5 ft NGVD.

Recent survey data collected for LDNR's hydrologic study of the Chenier Plain (Gammil et al. in press) provides three elevations for the marshes along the south side of Schooner Bayou in CTU 3 of the project area. The fresh bull-tongue arrowhead (*Sagittaria lancifolia*) marsh near discrete WQ station ME04-02 has a mean root mass/organic mat elevation of 0.73 ft NAVD-88. The saltmeadow cordgrass-California bullwhip (*Spartina patens-Schoenoplectus californicus*) marsh near discrete WQ station ME04-03 has a mean root mass/organic mat elevation of 1.14 ft NAVD-88. The saltmeadow cordgrass-switchgrass (*Spartina patens-Panicum virgatum*) marsh near continuous recorder WQ station ME04-06 has a mean root mass/organic mat elevation of 1.52 ft NAVD-88. This range of 0.73 to 1.52 ft NAVD-88 encompasses the known elevation range for marshes within the Mermentau Basin.

Did the project meet its target elevation?
Not Applicable.

What is the subsidence rate and how long will the project remain in the correct elevation range?
Coast 2050 Appendix F – Region 4 Supplemental Information estimates the subsidence rate for the South Pecan Island mapping unit as 0-1 ft/century.

Coastal Environments, Inc. using estimates from DNR placed subsidence at 0.145 inch per year (Plan/EA, June 1996), while 0.15 inch per year were based on the average of five stations in project area according to Penland et al 1989 (WVA 1992).

Subsidence rate in the ME-04 area is estimated to be approximately 0.15 inches/yr (0.38 cm/yr) or 3.0 inches (7.69 cm) in 20 years, based on the average of five stations in the project area, according to Penland et al 1989 (WVA 1992).

The project area should remain within the elevation range for intermediate marsh for 20 to 40 years, depending on the initial base elevation, which varies from approximately 0.73 – 1.52 ft NAVD.

IV.2.2. Hydrology

What is the hydrology that supports healthy marshes in the different marsh types?
Hydrologic changes were listed as a major cause of landloss in the project area and the project was designed to return the area to a healthy system. The restoration components were designed to allow manipulation in order to facilitate removal during the growing season and reduce the threat of saltwater into the area at other times. All of the factors affecting hydrology were examined by the Environmental Work Group during WVA analysis and a consensus formed as to features to address these issues as directed by the Breaux Act.

Recent studies indicate that when certain species of fresh and intermediate marsh vegetation are subjected to continuous flooding treatments for as little as 35 days, they experienced physiological stresses such as reduced stem elongation, inhibited root growth, decreased stomatal conductance, and decreased net photosynthesis (McKee and Mendessohn 1989; Pezeshki et al. 1987, 1991). Studies that simulated extended periods of flooding ranging from one to three growing seasons, documented decreases in species density, stem density, aboveground biomass, and root biomass (Gough & Grace 1998; Grace & Ford 1996; Howard & Mendelssohn 1995; Lesserman, et al. 1997; McKee & Mendelsohn 1989; Webb & Mendelssohn 1996). Other experiments found no change in net photosynthesis, leaf conductance, and stem elongation when the same plant species were subjected to relatively short flooding treatments of 33-35 days (Banyopadhyay et al. 1993). Several experiments showed an increase in aboveground biomass or detected no change in aboveground and belowground biomass or stem density when subjecting plants to longer flooding treatments, ranging from 5-15 months in duration (Grace & Ford 1996; Howard & Mendelssohn 1995; McKee & Mendelsohn 1989). The effect of prolonged inundation is generally negative, but a better understanding of the effect of inundation on fresh and intermediate marsh vegetation is needed.

Does the project have the correct hydrology for its marsh type?
The project was designed to correct the modified hydrology of the project area, which is and has been predominantly fresh and intermediate marsh for at least the past 50 years (vegetative type maps of coastal Louisiana, prepared by LDWF for 1949, 1968, 1978, 1988, 1997).

This project would be working pretty well if all of the perimeter embankments were intact and at proper elevation to prevent overtopping on normal high tides.

What were the hydrology targets for the project and were they met?
The hydrology targets are: 1) the maintenance of water levels at 6 inches below the marsh surface year-round, with 2) the option to attempt a spring drawdown between January 15 and June 1, at a frequency no greater than once every 3 years after a successful drawdown is achieved. During a drawdown, water levels may be dropped to 12 inches below marsh elevation. (Source: EA, 1996, p22)

Water levels have more or less been maintained at or below marsh elevation for much of the period or record (1997-2001). However, because of survey problems, we have not yet confirmed what the marsh elevation is relative to the NAVD datum that was surveyed onto the project area in 2001. This is delaying a thorough analysis of inundation using our continuous recorder data and marsh elevations from the project and reference areas.

Nonetheless, the weirs on the structures are all set at about 6 inches below marsh elevation, so the marsh has not been allowed to dry out since the 1996 drawdown. The main problem seems to be that breaches in the spoil bank system behind the rock dike along FWB Canal and Acadiana Marina Canal allow uncontrolled water flow into and out of the project area when tides are high, especially when the tides are driven by strong southerly winds, which prevents water from adequately draining from the project area for prolonged periods. There is also a tendency for water levels to be managed at or above marsh elevation for much of the waterfowl-hunting season.

A successful drawdown was achieved in the spring of 1996, in large part because drought conditions prevailed over southwest Louisiana that year.

IV.2.3. Salinity

What is the salinity regime that supports healthy marshes in the different marsh types?
Current WVA models list mean high salinity during the growing season (March through November) for intermediate marsh as 4.0 ppt or less. The project was designed to be within this range.

Does the project have the correct salinity for its marsh type?
The project is classified as intermediate marsh, which matches the salinity goals.

What were the salinity targets for the project and were they met?
WVA projections (August 1992) with project had salinity readings at 3 ppt during the growing season. Citations in the WVA Information Sheet are as follows:

- 4.2 ppt in Vermilion Bay (Coastal Environments, Inc.) with spring listed as 0.0-3.0 ppt and fall at 2.0-5.0 ppt.
- Field observation in June 1992: 2.6-3.0 ppt in open water canals, 0.7-2.6 in interior marshes
- Vermilion Corporation readings 1985-1987: 0.25-4.0 ppt in open water canals, and 0.25-4.0 ppt in marsh (usually 2.0 ppt)

The salinity target is the maintenance of salinity at 4.0 ppt or less throughout the year. Safety provisions allow that when salinity exceeds 4.0 ppt at structures 2, 3, 4, 5, 6, and 7, or 6.0 ppt at structures 1 and 8, the flapgates on the structures can be set to operate (flap) and the weirs set at 6 inches below marsh elevation.

Weekly mean water salinity (ppt) calculated using hourly data from 7 continuous recorders shows that from April 1996 through September 1999 water salinity in the project area generally fell within the target range for fresh to intermediate marsh, which is 0 to 5 ppt. Deviations from this pattern appear to be associated with either periods of drought, when reduced inflow of freshwater from White Lake and rainfall allows salinity to increase, or during periods of tropical storm activity, when extremely high tides and storm surges cause an inflow of higher salinity water into the project area through breeches in the perimeter embankments and over the tops of some structures. During these time periods weekly mean water salinity can range from 5 to 11 ppt (Vincent et al 2000).

IV.2.4. Soils

What is the soil type that supports healthy marshes in the different marsh types?
Allemands mucky peat, Bancker muck, Clovelly muck, Larose muck and Mermentau clay are the soil types (Plan/EA, June 1996).

The following information is from the Soil Survey of Vermilion Parish, Louisiana, USDA-NRCS, issued May 1996.

<u>Moist Bulk Density</u> (g/cc):

Allemands mucky peat

0-12” – 0.05-0.25
12-48” – 0.05-0.25
48-60” – 0.15-1.00
60-95” – 0.25-1.00

Bancker muck

0-10” – 0.10-0.40
10-72” – 0.20-1.00

Clovelly muck

0-40” – 0.05-0.25
40-80” – 0.15-1.00

Larose mucky clay

0-6” – 0.15-1.00
6-30” – 0.15-1.00
30-60” - 0.15-1.00

Mermentau clay

0-21” – 1.25-1.70
21-56” – 1.25-1.70
56-60” – 1.00-1.50

Grain Size (refer to Table 20 in Soil Survey)

Percent Organic Matter:

Allemands mucky peat

0-12” – not available

Bancker muck

0-10” – 22-70

Clovelly muck

0-40” – 30-60

Larose mucky clay

0-6” – 4-14

Mermentau clay

0-21” – 4-14

Soil Salinity (mmhos/cm):

Allemands mucky peat

0-12” – <4
12-48” – <4
48-60” – <4
60-95” - <4

Bancker muck

0-10” – 4-8
10-72” – 4-8

Clovelly muck

0-40” – 4-8

40-80” - 4-8

Larose mucky clay

0-6” – <4

6-30” – <4

30-60” - <4

Mermentau clay

0-21” – 4-16

21-56” – 4-16

56-60” - 4-16

<u>Soil Nutrients</u> (Refer to Table 19 in Soil Survey):

These soil types, and their characteristics, support healthy marsh.

Actual structure placement is done in spoil banks so any design would require site specific investigation.

Does the project have the correct soil for its marsh type?
The project will maintain the existing soil and marsh type.

IV.2.5. Shoreline Erosion

How have shoreline erosion rates changed in the project area compared to nearby reference areas?
Shoreline change along Freshwater Bayou Canal from 1995-2001 was estimated by measuring the distance from the vegetated edge of the west canal bank behind the rock dike to survey hubs established further inland at approximately 1000-ft intervals (n=27), and along two reference areas (n=6) established on the east canal bank across from the rock dike termini points (figure 1). Measurements were made in 1995, 1996, 1998, and 2001.

The project area shoreline prograded an average of 2.17 ft/yr (0.66 m/yr) between June 1995 and July 1996, and an average of 0.89 ft/yr (0.27 m/yr) between August 1996 and February 1998, but eroded an average of -2.62 ft/yr (-0.80 m/yr) between March 1998 and May 2001 (figure 2). Overall, the average shoreline change rate on the west canal bank behind the rock dike was -0.83 ft/yr (-0.25 m/yr) between June 1995 and May 2001 (figure 2).

Conversely, erosion was documented at all six reference area monitoring stations on each survey conducted, averaging -6.69 ft/yr (-2.04 m/yr) between April 1995 and July 1996, -11.15 ft/yr (-3.40 m/yr) between August 1996 and February 1998, and -9.99 ft/yr (-3.05 m/yr) between March 1998 and May 2001 (figure 2). Overall, the average shoreline change rate along the two reference areas on the east canal bank was -9.95 ft/yr (-3.03 m/yr) between June 1995 and May 2001(figure 2).

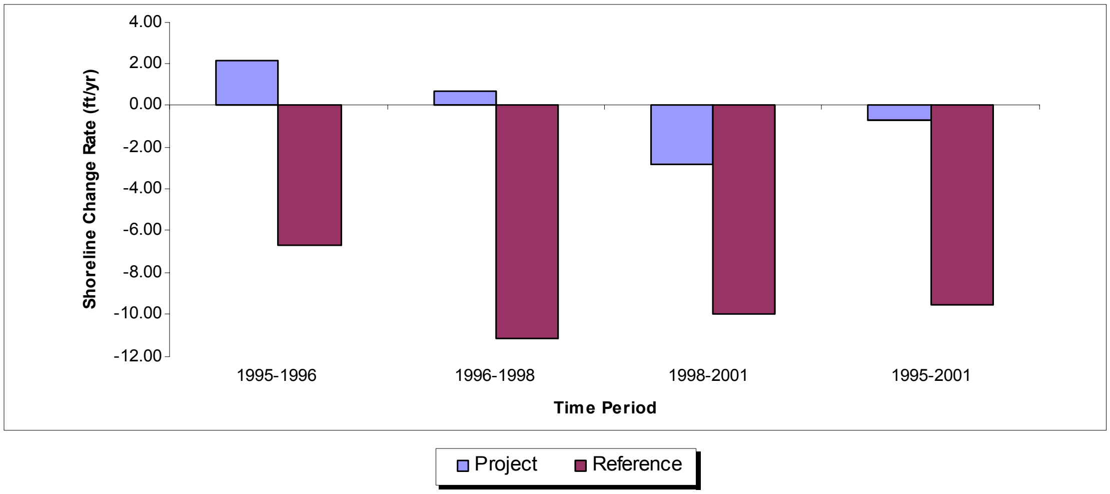

Figure 2. Shoreline erosion rates along Freshwater Bayou Canal in project and reference areas.

These data indicate that the ME-04 project rock dike has successfully prevented or significantly reduced wave erosion of the protected segment of canal bank for the entire period of record, as compared to the unprotected reference area shoreline segments, particularly between April 1995 and February 1998 (figure 2). These data support the conclusion that the ME-04 project has met its specific goal of reducing shoreline erosion along the west bank of Freshwater Bayou Canal behind the ME-04 project rock dike. However, although the ME-04 rock dike has met its specific goal of reducing shoreline erosion along the west bank of Freshwater Bayou Canal behind the dike, monitoring data indicate that its effectiveness steadily decreased over this time period. This was in large part due to the substandard nature of the original construction material used, and the logistics of implementing a cost-effective maintenance lift to the structure, as explained elsewhere (see section III.3).

IV.2.6. Other

The close proximity of Schooner Bayou Lock and Freshwater Bayou Lock may be impacting the ME-04 project area. Both locks protect the project area from high salinity. But it is also possible that operation of the locks may be holding water levels in FWB Canal between Schooner Bayou and FWB Lock at higher levels than desirable, thus impacting the rock dike, the spoil banks behind the dike, and marshes along the channel, which are readily flooding when the channel is high, due to the deteriorated spoil banks along the canal. Water level management in FWB Canal should be considered if at all feasible.

IV.3. Suggestions for physical response monitoring

Are there other variables that could be monitored to substantially increase the ability to understand the results of the project?
Some of the marsh surrounding the ponded areas on the south end of the project area appears to be floating. Installation of a mat recorder in this area to confirm or refute this contention would be useful, and could have a bearing on how water levels are managed in this section of the project area.

V. BIOLOGICAL RESPONSE

V.1. Project Goals

See answer to item IV.1 above.

V.2. Comparison to adjacent and/or healthy marshes

V.2.1. Vegetation

What is the range in species composition and cover for healthy marshes in each type?
Marsh types range from freshwater marsh dominated by *Sagittaria lancifolia*, *Panicum hemitomon, Sacciolepis striata, and Leersia hexandra*, to intermediate marshes dominated by *Spartina patens, Schoenoplectus americanus, Schoenoplectus californicus, Phragmites australis, Typha* spp., and brackish marsh dominated by *Spartina patens, Schoenoplectus americanus, and S. maritimus.*

Does the project have the correct species composition and cover for its type?
See above statement. Species composition is correct. Cover in some of the intermediate and brackish marsh areas is less than desired.

What were the vegetation targets for this project and were they met? If not, what is the most likely reason?
The vegetation target for this project was to maintain fresh to intermediate marsh species. This has been accomplished for the interior and the west side of the project area and reference area R3. Reference area R2, and the southern edge and the eastern edge of the project area are transitioning to brackish marsh due to increased tidal exchange and higher salinity in the marshes along FWB Canal associated with the loss of the spoil banks along the channel, which served as perimeter levees for these managed marshes.

V.2.2. Landscape

What is the range in landscapes that supports healthy marshes in different marsh types?
Management goals for intermediate marshes have historically been 70:30 land to water. Typical early conditions (ca. 1930s) have had much greater land percentages, while more recent losses have resulted in greater water percentages. This project has not had the necessary time under management to obtain the targeted ratio for land/water ratio, interspersion or habitat composition.

As pointed out elsewhere, perimeter embankment maintenance is essential to achieving the targeted land:water ratio of 70:30 during the life of the project.

Is the project changing in the direction of the optimal landscape? If not, what is the most likely reason?
The land:water ratio for the project was monitored in 1997 pre-construction and will be obtained in 2001, 2007 and 2016 post-construction. The 2001 photography is scheduled to be complete by May 1, 2002. The land:water ratio was 83.3% land and 16.7% water in 1997. This compares with the WVA baseline of 79% land.

There are several indicators in the southern part of the project area (CTU 1) that the project is not changing in the direction of the optimal landscape, which would be healthy fresh to intermediate marshes with a greater land:open water ratio than existed when the pre-constructed aerial photography was taken in 1996.

Since that time, 1) approximately 10% (educated guess) of this unit has converted to open water and broken marsh; 2) huge colonies of *Sesbania drummondii* and *Phragmites australis* growing along a major pipeline ditch and around the marsh ponds in the center of this unit have all but disappeared; 3) extensive muflats formerly vegetated with *Hydrocotyle ranunculoides* are now either vegetated with *Bacopa monnieri* or have converted to open water; and 4) between 1996 and 2001, some emergent vegetation plots in this unit have converted from intermediate to brackish marsh.

Operation of CWPPRA structures 3 and 5 appears to be increasing salinity in the fresh marshes just north of the Sheriff's camp in northern CTU 2, resulting in the die-out of emergent and submergent freshwater vegetation and an increase in open water. It is suspected that the horizontal gap at the base of the closed flapgate on the structures is allowing too much saline water to seep into the project area at times when the flaps should be fully closed, as per the structure operation plan.

Habitat classification of the project area in 1997 pre-construction identified 15,946 acres of fresh marsh, 10,688 acres of intermediate marsh, and 795 acres of floating aquatics as the predominant classes. Habitat classification post-construction will be completed by May 1, 2002. Chabreck-Linscombe habitat classifications conducted in 1988, 1997 and 2001 covered the project area. The 1988 classification identified the area as 39% fresh, 59% intermediate, and 2% brackish. The 1997 classification identified the area as 68% fresh and 32% intermediate. Visser and Sasser (1998) further classified the 1997 Chabreck-Linscombe data into the following subclasses within the project area (fresh bulltongue, fresh maidencane, oligohaline wiregrass, oligohaline mixture and mesohaline wiregrass). The 2001 classification showed that only 15% of the project area was fresh marsh, primarily the northwest corner, with 85% classified as intermediate. Salinity data do not confirm nor refute the change in classification; however, salinities in 1999 and 2000 were higher on average than previous years. The large area change from fresh to intermediate along the eastern project boundary suggest the introduction of higher salinities from Freshwater Bayou.

The project appears to be struggling to maintain the optimal landscape of fresh to intermediate marsh since construction. The unrectified 2000 color-infrared photography suggests the landscape is maintaining its integrity and that submerged aquatic vegetation is abundant in larger waterbodies. The fall 2001 data is needed before further interpretation can be completed.

V.2.3. Other

There is some nutria herbivory on the west side of the project area and in Reference area R3 near White Lake.

V.3. Suggestions for biological response monitoring

Like many other projects, monitoring of fisheries and SAV was initially recommended, but these elements were not included in the final monitoring plant, primarily as a result of cost, resulting in concentration of effort on the primary goals.

VI. ADAPTIVE MANAGEMENT

VI.1. Existing improvements

What has already been done to improve the project?
LDNR has established elevation benchmarks set to NAVD across the Chenier Plain that can be used to survey in the elevations of structures and marshes in the project area.

LDNR is in the process of installing staff gages set to NAVD on the inside and outside of each CWPPRA structure. This will assist in properly setting the weirs on the structures in relation to marsh elevation.

The landowner has been trying to build up some low berms across the breaches in the spoil banks along FWB Canal and Acadiana Marina Canal to prevent uncontrolled entry of water from the canal into the project area on high tides.

VI.2. Project effectiveness

Are we able to determine if the project has performed as planned? If not, why?
At this time, it can not be determined whether or not the project is working as expected. The main reason is the deterioration of the spoil bank along Freshwater Bayou (FWB) Canal. This spoilbank has deteriorated to the point where it no longer functions adequately as a perimeter levee around this management unit. On high tides, more water from FWB Canal enters the project area through breaches in the canal spoil bank than the water control structures can adequately remove on low tides, so ponding continues to occur.

Other possibilities which may have led to the inability to determine project effectiveness may be the weight of flapgates and the change in southern portion to more of a flotant marsh.

What should be the success criteria for this project?
The main criterion for success on this project is the maintenance of freshwater and intermediate marshes in the project area through bank protection and water management. Rebuilding the spoil bank along FWB Canal and Acadiana Marina Canal to an elevation of 4.0 to 5.0 ft NAVD appears to be essential for achieving success with this project.

VI.3. Recommended improvements

What can be done to improve the project?
Rebuilding the spoil bank along FWB Canal and Acadiana Marina Canal to an elevation of 4.0 to 5.0 ft NAVD appears to be essential for achieving success with this project.

Lighten the flapgates on the structures so that they will operate even with low head differentials, and modify the structure operation plan to encourage a northwest to southwest flow pattern, in an effort to bring fresh, sediment laden water from White Lake and Schooner Bayou into the project area marshes.

VI.4. Lessons learned

Rock dikes break waves but they do not always stop water exchange between canal and marsh. Shoreline protection/stabilization projects along canal and marsh interfaces where salinity is a concern need to include building or rebuilding a perimeter embankment as a component along with some form of protection from wave energy (rock dike, rip rap, etc.)

The landowner intended to have the spoil banks along the west side of FWB Canal and along the north side of Humble/Acadiana Marina Canal repaired through a combination of mitigation for oil/gas projects on Vermilion Corp properties, possible maintenance dredging activity on these channels, and efforts of Vermilion Corp. This piecemeal approach has not worked. As essential as these embankments are to managing water level and salinity in the project area, there is no mechanism in the Engineering & Design or the Operations & Maintenance plans to address this matter. Current embankment conditions are reducing the level of benefits the rock dike and additional structures could provide. Therefore, CWPPRA needs to have oversight of O & M.

VII. SUPPORTING DOCUMENTATION

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VIII. PROJECT REVIEW TEAM

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APPENDIX A: INFORMATION CHECK SHEET

Project Name and Number: ME-04 Freshwater Bayou- Shoreline
Date: March 11, 2002

INFORMATION TYPE	YES	NO	N/A	SOURCE
Fact Sheet	X			Cindy Steyer (NRCS), PPL 3 RTC
Project Description	X			Cindy Steyer (NRCS), Pre-selection plan
Project Information Sheet	X			Cindy Steyer (NRCS)
Wetland Value Assessment	X			Cindy Steyer (NRCS), (DNR)
Environmental Assessment	X			John Jurgensen (NRCS); Karl Vincent (DNR)
Project Boundary	X			John Jurgensen (NRCS)
Planning Data	X			John Jurgensen (NRCS)
Permits	X			John Jurgensen (NRCS); 2 permits issued
Landrights		X		pipeline issues
Cultural Resources	X			John Jurgensen (NRCS)
Preliminary Engineering Design	X			John Jurgensen (NRCS) ; USACE did design
Geotechnical	?			John Jurgensen (NRCS)
Engineering Design	X			John Jurgensen (NRCS)
As-built Drawings	X			John Jurgensen (NRCS)
Modeling Output			X	
Construction Completion Report	X			John Jurgensen (NRCS), Mel Guidry (DNR)
Engineering Data	X			Mel Guidry (DNR), survey 1998, 2001
Monitoring Plan	X			(DNR), www.saveLAwetlands.org
Monitoring Reports	X			(DNR), www.saveLAwetlands.org
Supporting Literature	?			FW Bayou reports (other projects)
Monitoring Data	X			FW Bayou Lock data (DNR), BUMP ?
Operations Plan			X	
Operations Data			X	
Maintenance Plan: O&M Plan	X			DNR
Maintenance Data	X			Survey data 1998 (sed. Accr. and rock), 2001 (rock only); ongoing maint. to cap rock; DNR tied in settlement plates to network in 2001. Mel Guidry, Garrett Broussard (DNR)
O&M Reports: Annual inspection rpts	X			DNR
Other:				
Cost Share Agreement	X			DNR
Data Needs:				
Re-survey elevation of sediment/accretion behind breakwater (after rock maintenance work is completed)				