Monitoring Series No. ME-13-MSPR-0699-1

PROGRESS REPORT NO. 1
For the period May 7, 1998 to June 1, 1999

Coast 2050 Region 4

FRESHWATER BAYOU CANAL BANK STABILIZATION ME-13 (XME-29)

Fifth Priority List Shoreline Protection Project
of the Coastal Wetlands Planning, Protection, and Restoration Act
(Public Law 101-646)

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Introduction

This is the first in a series of progress reports describing monitoring activities of the Louisiana Department of Natural Resources, Coastal Restoration Division on the Freshwater Bayou Canal Bank Stabilization project. This report, and all subsequent progress reports for this project, will identify the monitoring data being collected and will briefly discuss the preliminary results from project monitoring efforts.

The Freshwater Bayou Canal Bank Stabilization (State project no. ME-13, CWPPRA project no. XME-29) project area encompasses 1,169 ac (468 ha) of intermediate and brackish marsh along the west bank of Freshwater Bayou Canal (FBC) between its confluence with North Prong Belle Ile Bayou Canal and Sixmile Canal in Vermilion Parish, Louisiana (figure 1). The project area extends westward from FBC for 0.25–1.0 mi (0.4 - 1.6 km) to several north-south oilfield access canals, which form an almost continuous, north-south line of spoil banks parallel to FBC.

Constructed between 1965 and 1967, the FBC channel extends from the Gulf Intracoastal Waterway (GIWW) at Intracoastal City to the Gulf of Mexico (GOM), providing safe passage for deep-draft vessels of commercial interests from the GOM to the GIWW. The canal includes a lock at the GOM to reduce saltwater intrusion into the fresh water and low salinity interior wetlands along the canal. Between 1979 and 1986, approximately 300,000 tons of cargo were transported along FBC, mostly in oil and gas service and supply vessels and commercial fishing boats (U. S. Army Corps of Engineers [USACE] 1989).

The main cause of wetland loss in the ME-13 project area is boat wake-induced erosion of the canal spoil banks and the fragile organic soils of the adjacent marsh along the west bank of the canal (USACE and Louisiana Department of Natural Resources [LDNR] 1994). The subsequent impact of tidal scour and seasonal salinity spikes entering FBC, mainly from Little Vermilion Bay, exacerbates the loss of shoreline marsh in the project area. When completed in 1967, the average bank width of the original FBC channel was 173 ft (53 m). By 1990, the average bank width of the channel had more than tripled to 583 ft (178 m) (Good et al. 1995). Brown and Root (1992) estimated that between 1968 and 1992, shoreline erosion along FBC averaged 12.5 ft/yr (3.8 m/yr) on each bank. Data collected at reference sites opposite from the termini points of the rock dike component of the Freshwater Bayou Wetlands Hydrologic Restoration (ME-04) project (LDNR 1998a; figure 1) indicate that the east bank of the canal eroded at an average rate of 6.54 ft/yr (2.0 m/yr) between April 1995 and July 1996 (Vincent and Sun 1997).

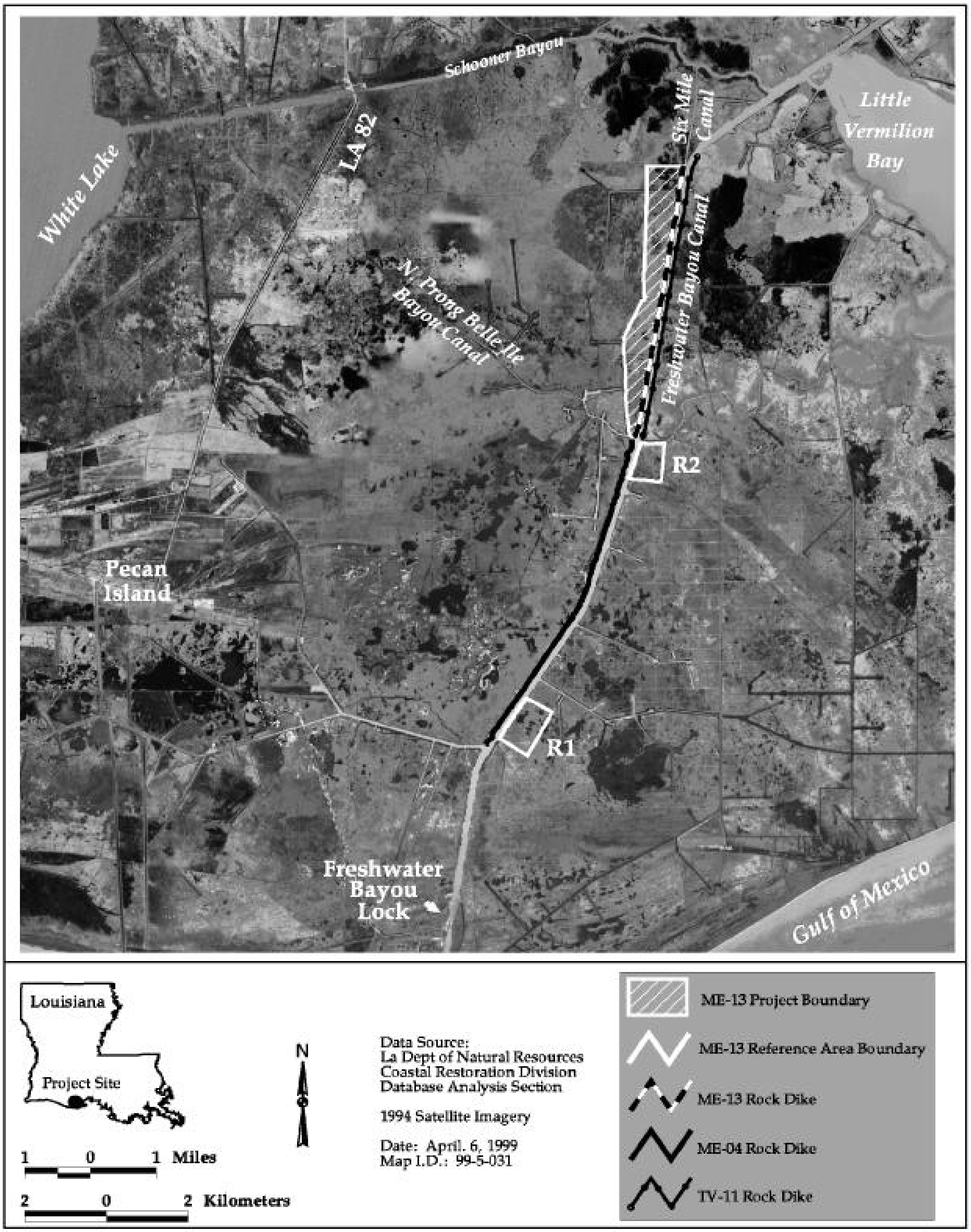

Figure 1. Freshwater Bayou Canal Bank Stabilization (ME-13) project area map showing project and reference area boundaries and rock dike locations.

The objective of the ME-13 project is to prevent further widening of the FBC channel into the project area to protect the existing emergent wetlands along the west bank of the canal from further erosion and deterioration. The specific goal of the project is to decrease the rate of erosion and wetland loss along the west bank of Freshwater Bayou Canal with a rock dike. To achieve this objective and goal, a free-standing, continuous rock dike with an approximate length of 23,193 linear ft (7,069 m) was installed in shallow water on the -1.0 ft (NAVD) contour line along the west bank of FBC between its confluence with Sixmile Canal on its north end and North Prong Belle Ile Bayou Canal on its south end (figure 1). Construction began in March 1998 and was completed in May 1998.

Methods

A detailed description of the monitoring design to be used over the entire project life can be found in the revised project monitoring plan (LDNR 1998b). A general overview of the LDNR's standard monitoring procedures is provided in Steyer et al. (1995).

At the U.S. Geological Survey's National Wetlands Research Center (NWRC), 1:12,000 scale color infrared aerial photography was classified to measure land to open water ratios in the project and reference areas. Preconstruction photography was obtained on December 19, 1996. However, the initial ME-13 boundary did not include photography encompassing the southern-most reference area (reference area 2). Subsequently, 1:24,000 photography (flown Jan 11, 1997) of reference area 2, taken from the neighboring ME-04 project, was resampled to 1:12,000 and mosaicked with ME-13 to complete the study site.

To determine land to open water ratios, the aerial photographs were scanned at 300 pixels per inch and georectified using ground control data collected with a global positioning system (GPS) capable of sub-meter accuracy. These individually georectified frames were then mosaicked to produce a single image of the project and reference areas. Using geographic information systems (GIS) technology, the photomosaic was classified according to pixel value and analyzed to determine land to water ratios in the project and reference areas. All areas characterized by emergent vegetation were classified as land, while open water, aquatic beds, and mud flats were classified as water.

Project area shoreline monitoring stations were established on July 21-23, 1998. Twenty-four settlement plates installed at 1,000-ft intervals in the rock dike during construction were used as reference points to establish a horizontal baseline position for the project area shoreline (figure 2). Direct measurements from the 24 settlement plates to the vegetated edge of the adjacent west canal bank were taken with a steel tape, and site characteristics were recorded at each monitoring station, including the compass bearing from each settlement plate to the adjacent shoreline. On July 23, 1999, the horizontal baseline shoreline position along the two reference areas was similarly determined using as reference points to the vegetated edge of the adjacent canal bank six survey monuments (three in each of the two reference areas) established in the marsh along the east bank of FBC in 1995. As explained in the ME-13 monitoring plan (LDNR 1998b), the two reference areas and six monitoring stations used to monitor this project are identical to those being used to monitor the ME-04 project (LDNR 1998a, Vincent and Sun 1997; figures 1 and 2).

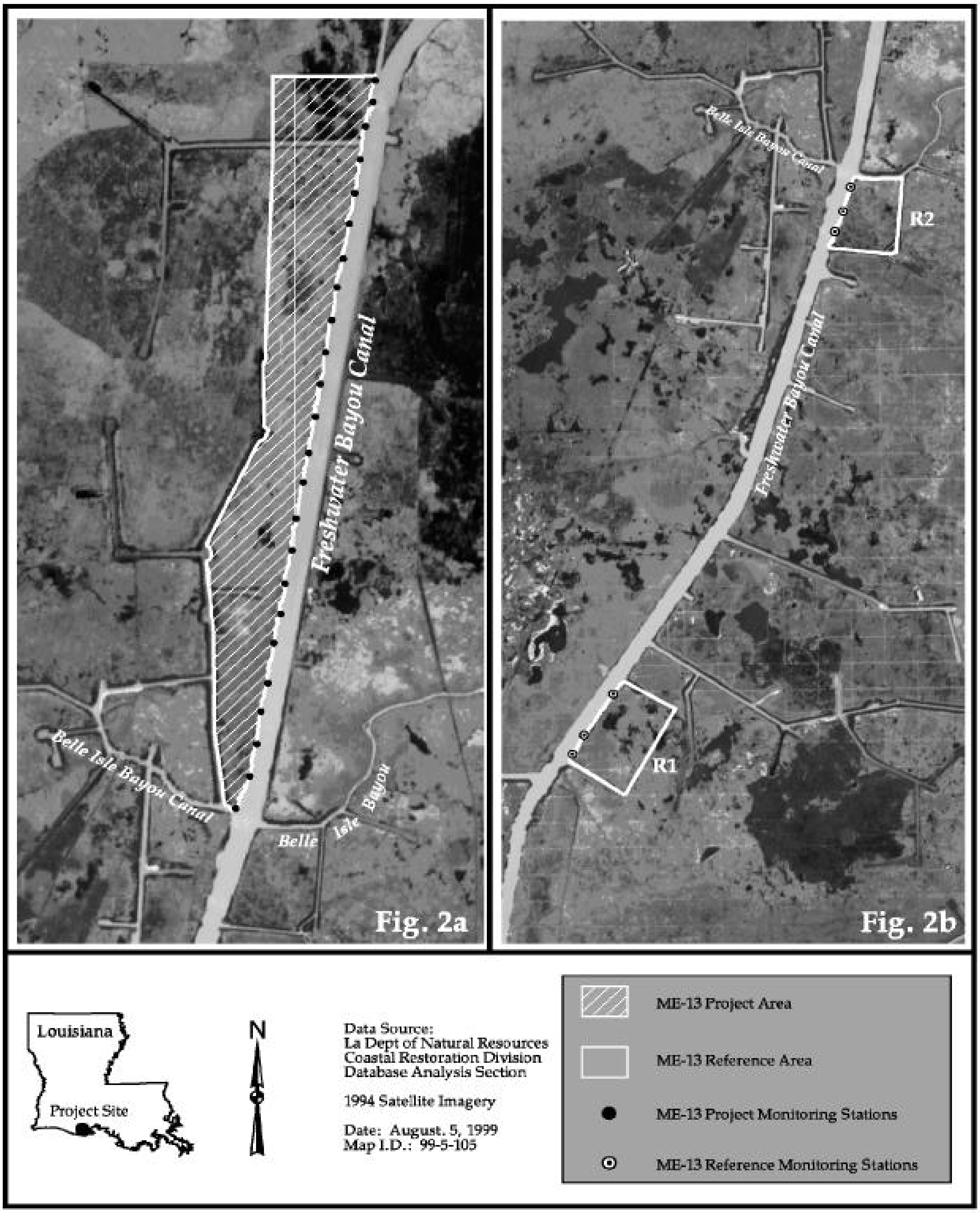

Figure 2. Approximate locations of the shoreline monitoring stations established along Freshwater Bayou Canal adjacent to the ME-13 project area (fig 2a, 24 sites) and the two reference areas (fig 2b, 6 sites).

Results

Preconstruction land and water areas in the project and reference areas are summarized in table 1 and illustrated in figure 3.

Table 1. Ratios and percentages of land to water in the ME-13 project and reference areas, based on GIS interpretations of infrared aerial photography taken on December 9, 1996 (project and reference area R2) and on January 11, 1997 (reference area R1).

Habitat Type	Project Area		Reference Area R1		Reference Area R2	
	Area ac (ha)	%	Area ac (ha)	%	Area ac (ha)	%
Land	875.4 (350.2)	86.9	197.6 (79.04)	82.6	150.8 (60.3)	92.9
Water	131.8 (52.7)	13.1	41.5 (16.6)	17.4	11.5 (4.6)	7.1
Total	1007.2 (402.9)	100.0	239.1 (95.6)	100.0	162.3 (64.9)	100.0

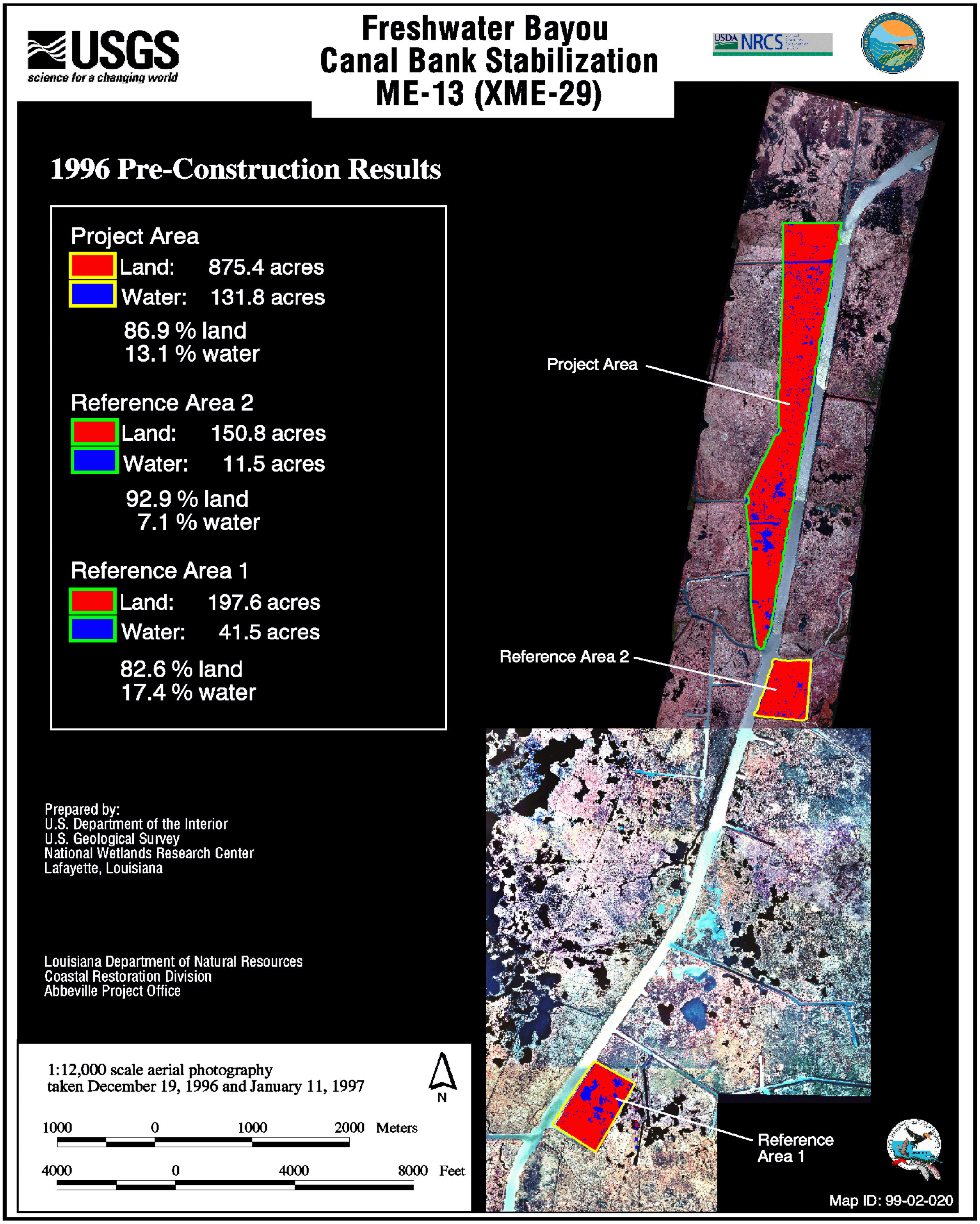

Figure 3. Preconstruction land to water relationships in the Freshwater Bayou Canal Bank Stabilization (ME-13) project and reference areas.

Approximate locations of the 30 monitoring stations are shown in figure 2. Data collected from project area stations are summarized in table 2.

Table 2. Locations and site characteristics of the project area shoreline monitoring sites established July 21-23, 1998. VEB = vegetated edge of bank; S/L = shoreline; P/L = pipeline.

Monitoring Station No. (from S to N)	Correspondin g Settlement Plate No.	Distance From Settlement Plate To VEB ft (m)	Shoreline Condition
ME13-01	1	51.5 (15.7)	Low marshy cut scarp bank on scalloped shoreline; *Spartina patens*, *Sesbania drummondii*, *Typha latifolia*, *Scirpus americanus*. S/L bearing 270E W of settlement plate.
ME13-02	2	45.6 (13.9)	10-ft (3.05-m) high cut scarp bank on straight shoreline; *Sapium sebiferum*, *Solidago sempervirens* var. *mexicana*. S/L bearing 312E W of settlement plate.
ME13-03	3	33.35 (10.17)	1.5-ft (0.46-m) high cut scarp bank on backside of old spoil bank; *Phragmites australis*, *Bacopa monnieri*. S/L bearing 280E W of settlement plate.
ME13-04	4	47.8 (14.57	1.0-ft (0.31-m) high cut scarp bank with old P/L rip rap; *Phragmites australis*, *Eleocharis* sp., S/L bearing 300E W of settlement plate.
ME13-05	5	32.0 (9.75)	2.0-ft (0.61-m) high cut scarp bank on backside of old spoil bank; *Phragmites australis*, *Sapium sebiferum*, *Baccharis halimifolia*, *Sesbania drummondii*. S/L/ bearing 280E W of settlement plate.
ME13-06	6	28.45 (8.67)	Old P/L rip rap in front of *Phragmites australis* stand. S/L bearing 290E W of settlement plate.
ME13-07	7	14.5 (4.42)	Backside of old spoil bank with old P/L rip rap; *Sapium sebiferum*, *Sesbania drummondii*, *Solidago sempervirens* var. *mexicana*.
ME13-08	8	26.5 (8.08)	4-ft (1.22-m) high cut scarp bank along spoil bank; *Phragmites australis*, *Sapium sebiferum*, *Baccharis halimifolia*, *Solidago sempervirens* var. *mexicana*. S/L bearing 300E W of settlement plate.
ME13-09	9	18.3 (5.58)	4-ft (1.22-m) high cut scarp bank along spoil bank; *Sapium sebiferum*. S/L bearing 296E W of settlement plate.

(continued)

Table 2. (continued)

Monitoring Station No. (from S to N)	Corresponding Settlement Plate No.	Distance From Settlement Plate To VEB ft (m)	Shoreline Conditions
ME13-10	10	25.8 (7.86)	Backside of old spoil bank; *Phragmites australis, Sapium sebiferum;* shoreline at stand of *Scirpus californicus*. S/L bearing 298E W of settlement plate.
ME13-11	11	47.1 (14.36)	1.0-ft (0.31-m) high cut scarp bank with old P/L rip rap along scalloped shoreline; *Phragmites australis*. S/L bearing 290E W of settlement plate.
ME13-12	12	50.4 (15.36)	Old P/L rip rap covered with *Phragmites australis*, along scalloped shoreline; S/L at mudflat stand of *Spartina alterniflora*. S/L bearing 298E W of settlement plate.
ME-13	13	58.2 (17.74)	Marshy bank on N side of cove; *Phragmites australis*, *Spartina alterniflora*, *Spartina patens*, *Sesbania drummondii*; near small island with *P. australis*. S/L bearing 298E W of settlement plate.
ME-14	14	103.2 (31.46)	Marshy bank with *Phragmites australis* on large cove, with small islands of *P. australis* between dike and S/L, and with *Spartina alterniflora* on mudflat north of station. S/L bearing 298E W of settlement plate.
ME13-15	15	49.6 (15.12)	4-ft (1.22-m) high shell (*Rangia*) ridge along straight S/L; *Phragmites australis*, *Sapium sebiferum*, *Sesbania drummondii*. S/L bearing 320E W of settlement plate.
ME13-16	16	57.6 (17.56)	Low marshy bank along straight S/L; *Spartina alterniflora*, *Eleocharis* sp. S/L bearing 300E W of settlement plate.
ME13-17	17	57.6 (17.56)	Old P/L rip rap along marshy, meandering S/L covered with *Sesbania drummondii*, *Spartina alterniflora*, *S. patens*, *Scirpus maritimus, and Zizaniopsis mileacea*. S/L bearing 310E W of settlement plate.

(continued)

Table 2. (continued)

Monitoring Station No. (from S to N)	Corresponding Settlement Plate No.	Distance From Settlement Plate To VEB ft (m)	Shoreline Conditions
ME13-18	18	58.9 (17.95)	Marshy, curved S/L covered with *Phragmites australis*, *Sapium sebiferum*, and *Sesbania drummondii*, mudflat stands of *Scirpus maritimus*, *S. californicus*, *Spartina alterniflora*, and *S. patens*; *Juncus roemerianus* on islands along dike. S/L bearing 286E W of settlement plate.
ME13-19	19	26.9 (8.2)	Old P/L rip rap forming rock bank along straight S/L; *Phragmites australis*, *Sapium sebiferum*, *Spartina patens*, *Spartina cynosuroides*, *Cladium jamaicense*. S/L bearing 314E W of settlement plate.
ME13-20	20	38.4 (11.7)	Backside of old spoil bank on scalloped S/L with *Phragmites australis*, dead *Sapium sebiferum*, and *Sesbania macrocarpa*. S/L bearing 298EW of settlement plate.
ME13-21	21	64.7 (19.7)	Backside of old spoil bank on cove with several headlands; *Phragmites australis*, *Sesbania drummondii*. S/L bearing 304EW of settlement plate.
ME13-22	22	30.9 (9.42)	Straight marshy S/L; *Phragmites australis*, *Spartina cynosuroides*, *S. patens*, *Aster subulatus*, *Sesbania drummondii*, *Sapium sebiferum*, *Juncus roemerianus*. S/L bearing 296EW of settlement plate.
ME13-23	23	24.5 (7.47)	Backside of old spoil bank behind old P/L rip rap; *Spartina patens*, *Iva frutescens*, *Baccharis halimifolia*, *Phragmites australis*, *Sesbania drummondii*, *Solidago sempervirens var. mexicana*, and *Amaranthus australis*. S/L bearing 290E W of settlement plate.
ME13-24	24	26.4 (8.05)	Straight, scalloped marshy S/L; *Spartina cynosuroides*, *Phragmites australis*, and *Panicum virgatum*. S/L bearing 296E W of settlement plate.

In July 1998, most of the project area shoreline was a low cut scarp bank vegetated with brackish marsh vegetation consisting primarily of *Phragmites australis* (common reed), *Spartina patens* (saltmeadow cordgrass), *S. alterniflora* (saltmarsh cordgrass), *Scirpus californicus* (giant bullwhip), and *S. maritimus* (saltmarsh bulrush). Old spoil bank remnants, identified by their higher elevation and the presence of *Sapium sebiferum* (Chinese tallow tree) and *Baccharis halimifolia* (saltbush), were scattered along the shoreline. There were several segments of limestone rock along the shoreline where Monterey Pipeline Co. attempted to cover sections of their pipeline (currently owned by Cypress Gas Pipeline Co.) that were exposed by bank erosion. Underlying shell ridges were also exposed at several locations.

The geometry of most of the project area shoreline was straight to slightly meandering, with a scattering of coves and headlands (figure 2). The rock dike ties into the shoreline at several locations where headlands are present. Fetch between the rock dike and shoreline ranged from 0 ft (0 m) along headlands to approximately 150 ft (45.7 m) adjacent to the larger coves. Tape measurements of 14.5 ft to 103.2 ft (4.42 m to 31.46 m) were recorded at the monitoring stations adjacent to the settlement plates (figure 2). Very little sediment has accumulated along most of the shoreline behind the rock dike, especially where rock and underlying shell ridges are exposed. Along the shorelines of the coves, where the lack of spoil banks allows erosion of the surrounding marsh soils to occur more readily, unconsolidated sediment up to 2 ft (0.61 m) deep has been observed.

Data collected at shoreline stations in the two reference areas are summarized in table 3.

Table 3. Locations and site characteristics of the reference area shoreline monitoring sites established July 21-23, 1998. VEB = vegetated edge of bank; S/L = shoreline.

ME-13 Monitoring Station No. (from N to S)	Opposing ME-04 Settlement Plate No.	Distance From Survey Hub to VEB/Shoreline ft (m)	Site Conditions
ME13-25R	1	44.66 (13.61)	Eroding spoil bank with *Sapium sebiferum*; measurements taken on back brass cap (ME04-93b) and adjacent S/L.
ME13-26R	2	46.54 (14.19)	Eroding spoil bank with *Sapium sebiferum*; measurements taken on back brass cap (ME04-94b) and adjacent S/L.
ME13-27R	3	69.705 (21.25)	Eroding spoil bank with *Sapium sebiferum*; measurements taken on back brass cap (ME04-95b) and adjacent S/L.
ME13-28R	20	38.8 (11.83)	Eroding spoil bank with *Sapium sebiferum*; measurements taken on back brass cap (ME04-96b) and adjacent S/L.
ME13-29R	22	58.28 (17.76)	Eroding spoil bank with *Sapium sebiferum*; measurements taken on back brass cap (ME04-97b) and adjacent S/L.
ME13-30R	23	53.18 (16.21)	Eroding *Phragmites australis* stand; measurements taken on back brass cap (ME04-98b) and adjacent S/L; front brass cap (ME04-96a) buried near current S/L.

In July 1998, most of the shoreline along the two reference areas was formed by the vertical face of a cut scarp bank along the remnants of the old canal spoil bank, and was vegetated primarily with *Sapium sebiferum, Baccharis halimifolia, Rubus trivialis* (dewberry), and *Rubus* sp. (blackberry). These low ridges intergraded with the adjacent brackish marsh vegetation, which consisted primarily of *Phragmites australis, Spartina patens, Scirpus americanus*, and *S. maritimus*. Where the spoil banks have been completely eroded away, the shoreline was a low cut scarp bank with brackish marsh vegetation that at some locations was covered with a rack line of dead trees, mud, and shells washed up on the bank. Underlying shell ridges were also exposed at several locations along these shorelines.

The geometry of the reference area shorelines was straight to slightly meandering, with no significant coves or headlands present. There was no accumulation of soft, unconsolidated sediment visible along these wave-washed shorelines.

As previously documented, erosion occurred at all six reference area shoreline stations between April 1995 and July 1996 (Vincent and Sun 1997). The data presented here document that erosion also occurred at all six stations between July 1996 and July 1998. This was clearly evident on site from the closer proximity of the July 1998 shoreline to the survey monuments established in the adjacent marsh in 1995 (Vincent 1996), as compared to the shoreline position in July 1996 (Vincent and Sun 1997). In addition, the six reference area shoreline markers reestablished in July 1996 and November 1997 were no longer present when these shorelines were revisited in July 1998.

<u>Discussion</u>

Turner and Cahoon (1987) estimated that 1,423 ac (569 ha) of wetlands were lost through construction (i.e., channel excavation and spoil bank construction) of the FBC channel to its original depth of 12 ft (3.7 m) and bottom width of 125 ft (38 m). Over the past thirty years, wave erosion of the banks along FBC by wakes from the large, deep-draft vessels that use this channel has resulted in the breaching and loss of the shoreline spoil banks in numerous places. Once spoil banks are breached, upper layers of highly-erodible soils of the adjacent marsh are subjected to tidal scour, which leads to the conversion of emergent marsh to shallow open water. This process may have been exacerbated by the impact of seasonal salinity spikes on the salt-intolerant vegetation, which at some locations has facilitated the establishment of more salt-tolerant plant species, such as *Juncus roemerianus* (black needle rush) and *Spartina alterniflora*. Because the organic marsh soils behind the spoil banks are more erodible than the soils comprising the spoil banks, erosion rates can be expected to double or triple along shorelines where the spoil banks are no longer present (USACE-LDNR 1994; Good et al. 1995). This process of canal widening and subsequent degradation of adjacent wetlands is widespread, and it is a major contributor to wetland loss in coastal Louisiana (Good et al. 1995).

Canal widening due to boat wake-induced bank erosion at rates of 14.7 to 19.6 ft/yr (4.5 to 6.0 m/yr) was documented over 40 years ago (Nichols 1958) in the Mermentau River Basin along sections of Superior Canal that traverse wetlands with highly erodible, organic marsh soils similar to those along FBC (U. S. Department of Agriculture, Natural Resources Conservation Service [USDA-NRCS]

1996). Bovay (1959) expressed concern that bank erosion at rates up to 7 ft/yr (2.1 m/yr) could be expected along FBC in his review of the proposed FBC channel prepared by the U.S. Army Corps of Engineers (1958).

Data previously collected at the ME-13 reference areas in conjunction with monitoring efforts on the ME-04 project (LDNR 1998a) indicate that these two sections of the east bank of the canal eroded at an average rate of 6.54 ft/yr (2.0 m/yr) between April 1995 and July 1996 (Vincent and Sun 1997). In contrast, the shoreline behind the ME-04 rock dike prograded at an average rate of 2.34 ft/yr (0.71 m/yr) between June 1995 and July 1996 (Vincent and Sun 1997).

Soft, unconsolidated sediment is also expected to accumulate between the ME-13 and ME-04 rock dikes and the adjacent sections of shoreline as it has behind the rock dike components of the Blind Lake Shoreline Protection project (Holbrook 1996), the Boston Canal/Vermilion Bay Shoreline Protection (T/V-09) project (Thibodeaux 1997, Weifenbach 1997) and the Freshwater Bayou Shoreline Protection (T/V-11) project (Miller 1996). Sediment accumulating behind sections of the T/V-11 rock dike, which was constructed in 1993 on the -2.0-ft (NAVD) contour line, had accreted to approximately 0.7 ft (NAVD), based on a staff gage installed at the north end of the ME-04 rock dike on the opposite bank of FBC. Natural colonization by *Spartina alterniflora* (smooth cordgrass) is occurring on these open mudflats behind the northern 2,000 ft (610 m) of the T/V-11 rock dike (Vincent, personal observations on July 16, 1998).

Conclusion

Because only one data set is available for each monitoring element examined, no conclusions can be drawn at this time. Data from post-construction aerial photography to be taken in the year 2015, and from shoreline surveys to be conducted in the spring of years 2003, 2009, and 2015 will be used to estimate shoreline erosion rates over each 5-year period. Those estimated rates will determine if the project goal of decreasing shoreline erosion along FBC adjacent to the project area is being accomplished. Comprehensive reports in June of years 2004, 2010 and 2018 will further describe and document the status and effectiveness of this project.

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