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Department of Natural Resources
Coastal Restoration Division and
Coastal Engineering Division

2004 Operations, Maintenance, And Monitoring Report

For

Freshwater Bayou Canal Bank Stabilization

State Project Number ME-13
Priority Project List 5

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Vermilion Parish

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I. Introduction

The Freshwater Bayou Canal Bank Stabilization (ME-13) is located in the Mermentau Basin, which is included in Region 4 of the Coast 2050 Plan. The major problem in this Region is marsh erosion caused by salt water intrusion, rapid water level fluctuation, and wave action (USDA/SCS 1989). Many canals have been dug in this Region to aid in navigation, mineral extraction, hunting, and fishing. The 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, approximately 12 miles (19.3 km) east-northeast of the town of Pecan Island in Vermilion Parish, Louisiana (figure 1). The project area borders the FBC to the east and varies in width from 0.25 - 1.0 mi (0.4 - 1.6 km) to the west to several north-south oilfield access canals which form an almost continuous, north-south line of spoil banks parallel to FBC.

The main causes of wetland loss in the ME-13 project area are tidal scour and saltwater intrusion associated with the erosion of the spoil banks along the west bank of FBC. Most of this spoil bank has already eroded away, exposing fragile organic marsh soils to boat-wake induced shoreline erosion, tidal scour, and the impact of salinity spikes entering FBC from Little Vermilion Bay.

Constructed between 1965 and 1967, the FBC channel extends from the Gulf Intracoastal Waterway (GIWW) at Intracoastal City to the Gulf of Mexico and includes a lock at the Gulf of Mexico designed to reduce saltwater intrusion into the fresh water and low salinity interior wetlands along the canal. When completed in 1967, the average width of the original FBC channel was 173 ft (53 m). By 1990, the average width of the channel had more than tripled to 583 ft (178 m).

To prevent further wetland loss through bank erosion and subsequent tidal scour of shoreline marshes, approximately 23,193 linear ft (7,069 m) of free-standing rock dike was constructed in shallow water 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 of the rock dike began on March 1, 1998 and was completed on June 1, 1998.

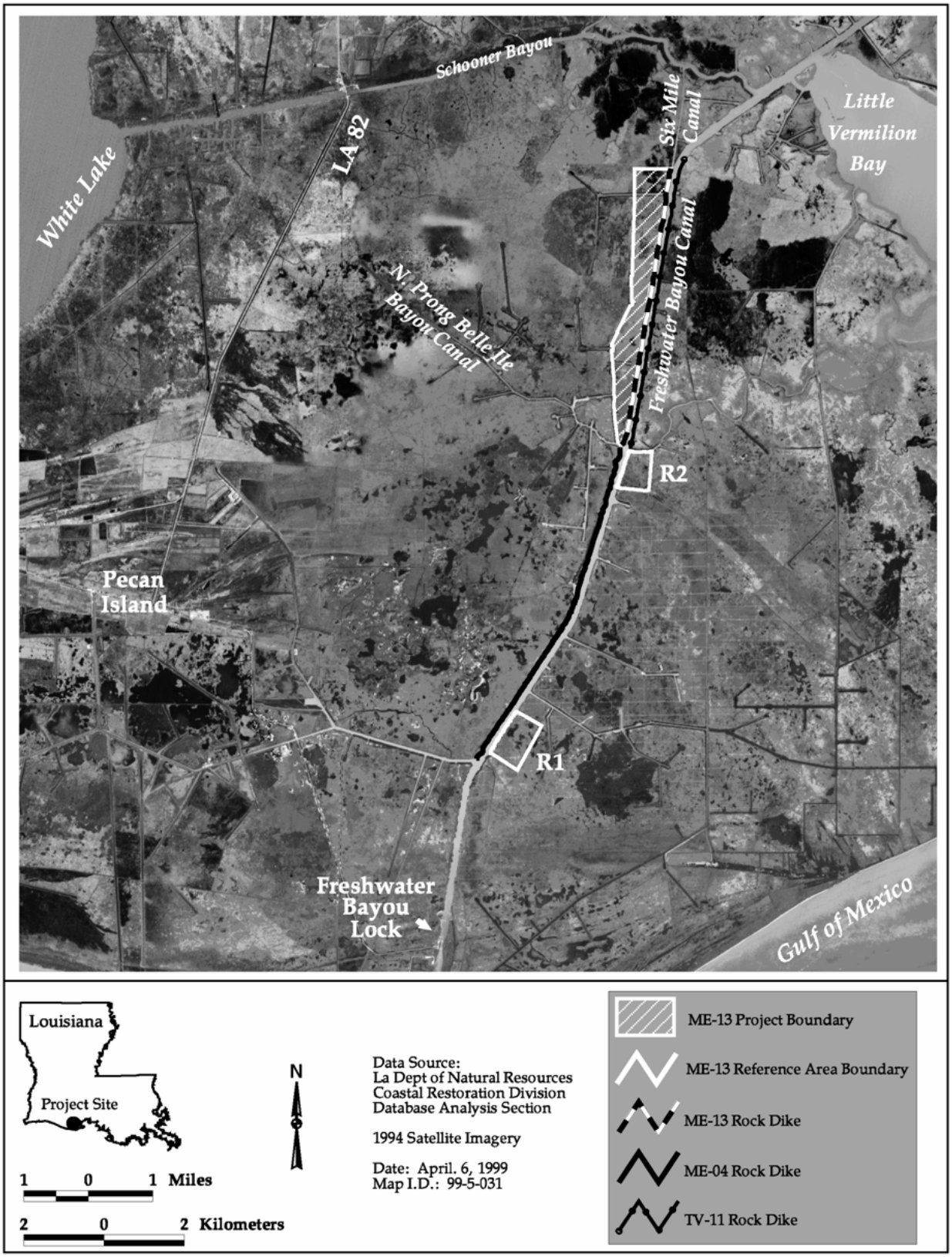

Figure 1: Freshwater Bayou Canal Bank Stabilization (ME-13) project and reference area boundaries.

II. Maintenance Activity

a. Project Feature Inspection Procedures

The purpose of the annual inspection of the Freshwater Bayou Canal Bank Stabilization Project (ME-13) is to evaluate the constructed project features to identify any deficiencies and prepare a report detailing the condition of project features and recommend any necessary corrective actions needed. Should it be determined that corrective actions are needed, LDNR shall provide, in the report, a detailed cost estimate for engineering, design, supervision, inspection, and construction contingencies, and an assessment of the urgency of such repairs (LDNR 2002).

The annual inspection included a complete visual inspection of the entire project site. Staff gauge readings were read to determine water and rock dike elevation. Photographs were taken of the project and Field Inspection Forms were completed for each project feature.

b. Inspection Results

Acadian Engineers & Environmental Consultants Inc. completed a survey of the project. The existing protection was considered to be deficient if the crown elevation falls below +2.5 ft (NAVD88) in a section of the dike. Where required, the dike shall be restored to elevation +3.5 ft (NAVD88) with a four (4) foot crown width and 1 on 2 channel side and a 1 on 1.5 marsh side slope. Based on the survey data, a total of seventeen thousand (17,000) linear feet of dike is deficient. A total of 48,000 tons of 1,100 lb stone is required with an estimated cost of $1,115,684.00.

c. Maintenance Recommendations

i. Immediate/ Emergency Repairs

None (see below).

ii. Programmatic/ Routine Repairs

A rock dike routine maintenance event is planned for July, 2005 and will restore the typical section as noted above in Inspection Results.

III. Operation Activity

a. Operation Plan

There are no active operations associated with this project.

b. Actual Operations

There are no active operations associated with this project.

IV. Monitoring Activity

a. Monitoring Goals

The first objective of the Freshwater Bayou Bank Stabilization Project is to protect the existing emergent wetlands along the west bank of Freshwater Bayou Canal and prevent their further deterioration from shoreline erosion and tidal scour. The second objective is to prevent the widening of the Freshwater Bayou Canal channel into the project area wetlands.

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

1. Decrease the rate of shoreline erosion along the west bank of Freshwater Bayou Canal adjacent to the ME-13 project area using a rock dike.

b. Monitoring Elements

Aerial Photography:
To document the pre-construction shoreline position along Freshwater Bayou Canal, and to measure land to open water ratios in the ME-13 project and reference areas, near-vertical, color-infrared aerial photography (1:12,000 scale) was obtained on December 9, 1996. Since the 1996 photography did not include reference area 2, aerial photography (1:24,000 scale) obtained on January 11, 1997 for the ME-04 project was re-sampled to 1:12,000 scale and photomosaicked with the 1996 ME-13 photography to complete the pre-construction study for ME-13. The original photography was checked for flight accuracy, color correctness, and clarity and was subsequently archived. Aerial photography was scanned, mosaicked, and georectified by USGS/NWRC personnel according to standard operating procedures (Steyer et al. 1995, revised 2000). Post-construction aerial photography will be obtained in 2015 and similarly processed and analyzed for comparison.

Shoreline Change:
To establish a pre-construction, horizontal baseline position for the project area shoreline, monitoring stations were established on July 21-23, 1998, using the 24 settlement plates installed as reference points at 1,000 ft (305 m) intervals along the centerline of the rock dike (figure 2a). At each station, the distance from settlement plate to vegetated marsh edge of the adjacent shoreline was determined by direct measurement using a steel tape, site characteristics were recorded, and compass bearing was documented from each settlement plate to the adjacent shoreline to ensure that subsequent measurements are taken along the same line. On July 23, 1998, the pre-construction, horizontal baseline shoreline position for the two reference areas was similarly determined using six survey monuments (three in each of the two reference areas) established in the marsh along the east bank of Freshwater Bayou Canal in 1995 as reference points to the vegetated edge of the adjacent canal bank (figure 2b). Changes in distance from the settlement plates and survey monuments to the adjacent shorelines will be averaged to estimate shoreline erosion rates over time. Shoreline position relative to the 24 settlement plates and six

reference area survey monuments were documented post-construction on July 21, 2003. Additional post-construction surveys will be conducted in July of 2009 and 2015**.**

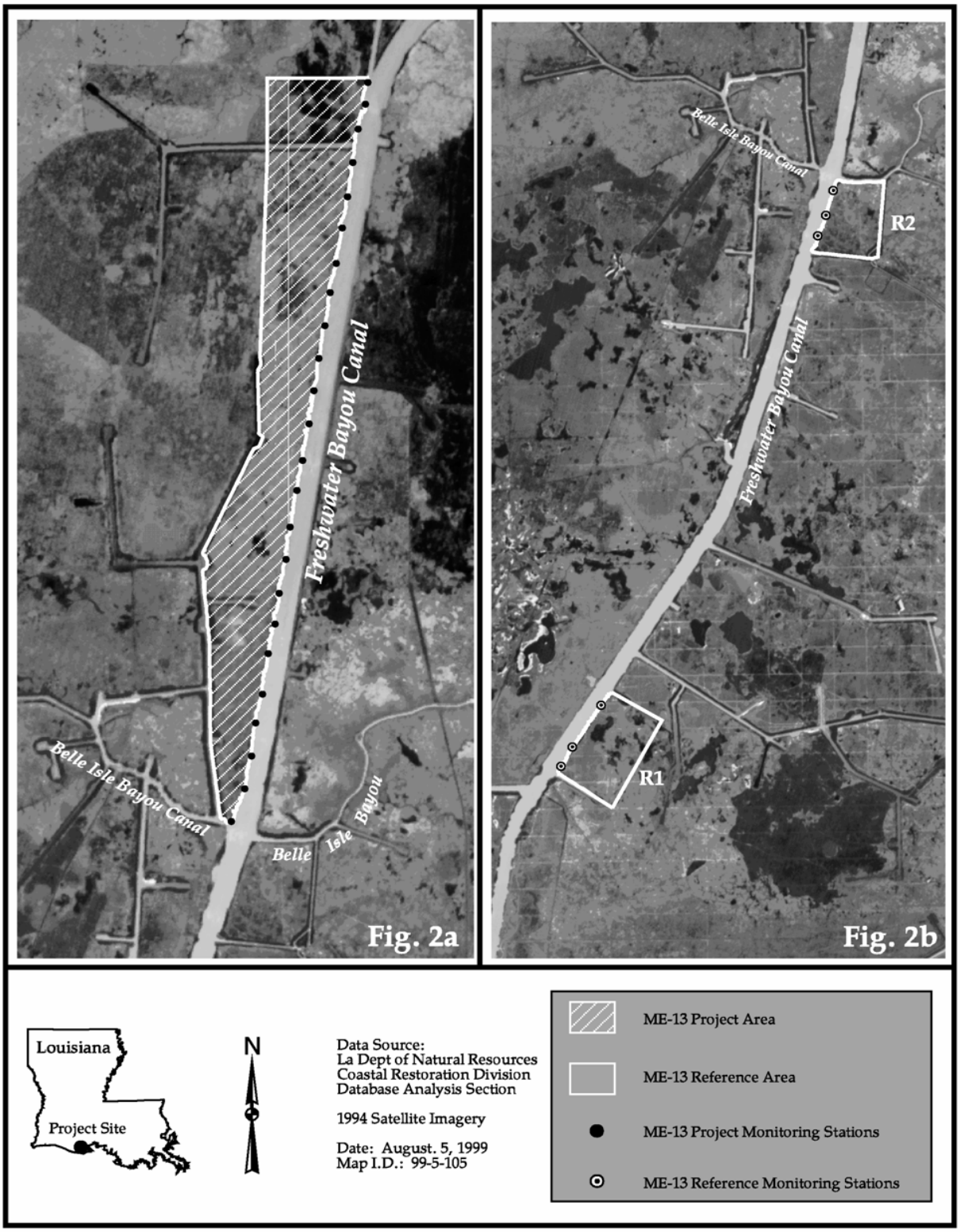

Figure 2: Approximate locations of the shoreline monitoring stations established along Freshwater Bayou Canal adjacent to the ME-13 project area (fig 2a, 24 sites) and the two reference areas (fig 2b, 6 sites).

IV. **Monitoring Activity** (continued)

c. Preliminary Monitoring Results and Discussion

Aerial Photography:

Preliminary conclusions based on aerial photography will be made after the post-construction aerial photography is acquired in 2015. Preconstruction, the project area was comprised of 86.9% land to 13.1% water while Reference 1 was 92.9% land to 7.1% water and Reference 2 was 82.6% land to 17.4% water (figure 3).

Shoreline Change:

The analyses of post-construction data collected on July 21, 2003 at the shoreline monitoring stations for the five-year period beginning July 21, 1998 and ending July 21, 2003 indicate that the ME-13 project is currently meeting its specific goal of reducing shoreline erosion along the west bank of Freshwater Bayou Canal behind the project rock dike. This is supported by the following data.

- The project area shoreline prograded at an average rate of 0.84 ft/yr (0.26 m/yr) (figure 4, table 1) and the reference area shorelines eroded at an average rate of -11.94 ft/yr (-3.64 m/yr) (figure 5, table 2) indicating that the ME-13 project rock dike has significantly reduced wave erosion of the protected segment of canal bank for the past five years.

- The variability in shoreline change along the project area shoreline was significantly different than the variability along the reference area shorelines ($p < 0.0001$) for this time period.

- The highest rate of shoreline retreat occurred at the north end of reference areas R2 (north unit) at station ME13-25R, where the shoreline retreated 89.0 ft (27.1 m) between July 23, 1998 and July 21, 2003 (figure 6).

- Variation in the shoreline retreat rate along the project and reference area shorelines may be related to the erodibility of the substrate. Additionally, variability in the project area may also be related to crown height of the rock dike, which may require periodic additions of rock to be maintained. Marsh soils erode more rapidly than spoil bank soils, which erode more rapidly than shell ridges. In unprotected areas, variation in substrate erodibility produces a scalloped shoreline profile with small coves and headlands (figure 7). In protected areas, sediment accumulates along shorelines behind rock dikes, which tend to prograde towards the rock dike, and can even meet the rock dike with accumulated sediment which can revegetate naturally (figure 8).

Ancillary Data:

- Previous data from the two reference areas collected between April 27, 1995 and May 15, 2001 for the Freshwater Bayou Wetlands Protection (ME-04) project, document mean shoreline change rates of -6.69 ft/yr (-2.04 m/yr) from 1995-1996, -11.15 ft/yr (-3.40 m/yr) from 1996-1998, and -9.17 ft/yr (-2.79 m/yr) from 1998-2001. Between 1995 - 1996, the shoreline retreat rate was greater along the reference area R1 (south unit) shoreline, but from 1996-2003 the retreat rate has been greater along the reference area R2 (north unit) shoreline.

- Over this same time period, the Freshwater Bayou Canal shoreline segment behind the ME-04 rock dike (on the opposing bank of FBC) prograded +2.17 ft/yr (+0.66 m/yr) from 1995-1996, prograded +0.89 ft/yr (+0.27 m/yr) from 1996-1998, but eroded -2.89 ft/yr (-0.88 m/yr) from 1998-2001.

- Vegetation along unprotected shorelines of Freshwater Bayou Canal is subject to repeated battering from rack that accumulates along the unprotected shorelines, particularly where fallen trees are present. As a result, unprotected shoreline vegetation appears to be more stressed and in poorer health than shoreline vegetation protected by a rock dike.

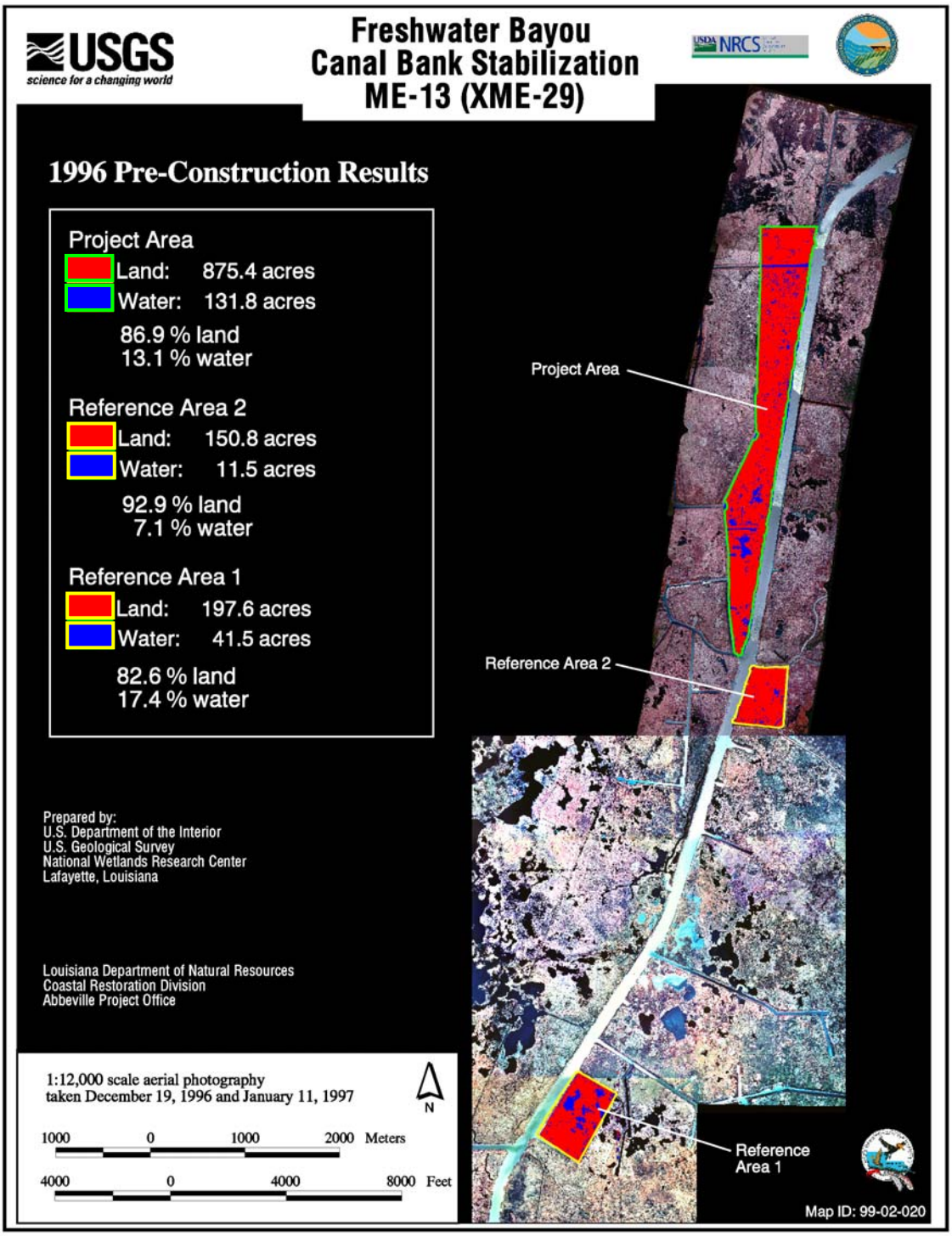

Figure 3: Preconstruction land to water relationships in the Freshwater Bayou Canal Bank Stabilization (ME-13) project and reference areas.

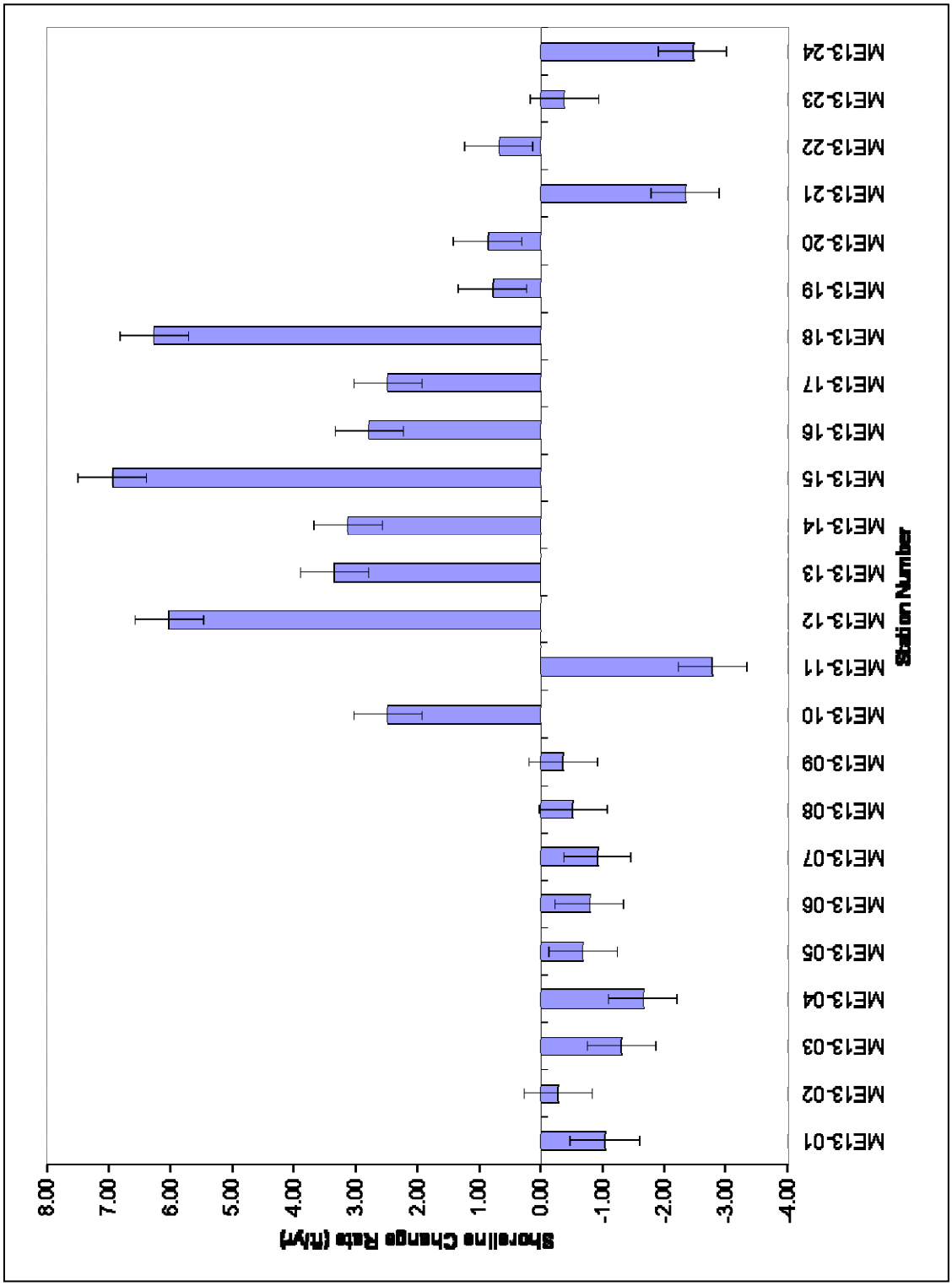

Figure 4: Shoreline change rate (ft/yr) along Freshwater Bayou Canal at the ME-13 project area stations for the July 23, 1998 – July 21, 2003 time period. Error bars represent ±1 standard error of the mean of all stations.

Table 1: Locations and site characteristics of the ME-13 project area shoreline monitoring sites established July 21-23, 1998. VEB = vegetated edge of bank; S/L = shoreline; SP = settlement plate; P/L = pipeline.

Station No. (from S to N)	Settlement Plate No.	Distance From SP 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, Schoenoplectus americanus*. S/L bearing 270°W from settlement plate.
ME13-02	2	45.6 (13.9)	10-ft (3.05-m) high cut scarp bank on straight shoreline; *Triadica sebifera, Solidago sempervirens* var. *mexicana*. S/L bearing 312° W from 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 280° W from 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; *P. australis, Eleocharis* sp., S/L bearing 300° W from 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; *P. australis, T. sebifera, Baccharis halimifolia, S. drummondii*. S/L bearing 280° W from settlement plate.
ME13-06	6	28.45 (8.67)	Old P/L rip rap in front of *P. australis* stand. S/L bearing 290° W from settlement plate.
ME13-07	7	14.5 (4.42)	Backside of old spoil bank with old P/L rip rap; *T. sebifera, S. drummondii, S. sempervirens* var. *mexicana*.
ME13-08	8	26.5 (8.08)	4-ft (1.22-m) high cut scarp bank along spoil bank; *P. australis, T. sebifera, Baccharis halimifolia, S. sempervirens* var. *mexicana*. S/L bearing 300° W from settlement plate.
ME13-09	9	18.3 (5.58)	4-ft (1.22-m) high cut scarp bank along spoil bank; *T. sebifera*. S/L bearing 296° W from settlement plate.

(continued)

Table 1 (continued)

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

(continued)

Table 1 (continued)

Station No. (from S to N)	Settlement Plate No.	Distance From SP To VEB ft (m)	Shoreline Condition
ME13-18	18	58.9 (17.95)	Marshy, curved S/L covered with *P. australis, T. sebifera,* and *S. drummondii*, mudflat stands of *S. robustus, S. californicus, S. alterniflora,* and *S. patens*; *Juncus roemerianus* on islands along dike. S/L bearing 286° W from settlement plate.
ME13-19	19	26.9 (8.2)	Old P/L rip rap forming rock bank along straight S/L; *P. australis, T. sebifera, S. patens, S. cynosuroides, Cladium mariscus* ssp. *jamaicense*. S/L bearing 314° W from settlement plate.
ME13-20	20	38.4 (11.7)	Backside of old spoil bank on scalloped S/L with *P. australis,* dead *T. sebifera,* and *Sesbania exaltata*. S/L bearing 298° W from settlement plate.
ME13-21	21	64.7 (19.7)	Backside of old spoil bank on cove with several headlands; *P. australis, S. drummondii*. S/L bearing 304° W from settlement plate.
ME13-22	22	30.9 (9.42)	Straight marshy S/L with *P. australis, Spartina cynosuroides, S. patens, Symphyotrichum subulatum, S. drummondii, T. sebifera, and J. roemerianus*. S/L bearing 296° W from settlement plate.
ME13-23	23	24.5 (7.47)	Backside of old spoil bank behind old P/L rip rap; *S. patens, Iva frutescens, B. halimifolia, P. australis, S. drummondii, S. sempervirens var. mexicana*, and *Amaranthus australis*. S/L bearing 290° W from settlement plate.
ME13-24	24	26.4 (8.05)	Straight, scalloped marshy S/L; *S. cynosuroides, P. australis*, and *Panicum virgatum*. S/L bearing 296° W from settlement plate.

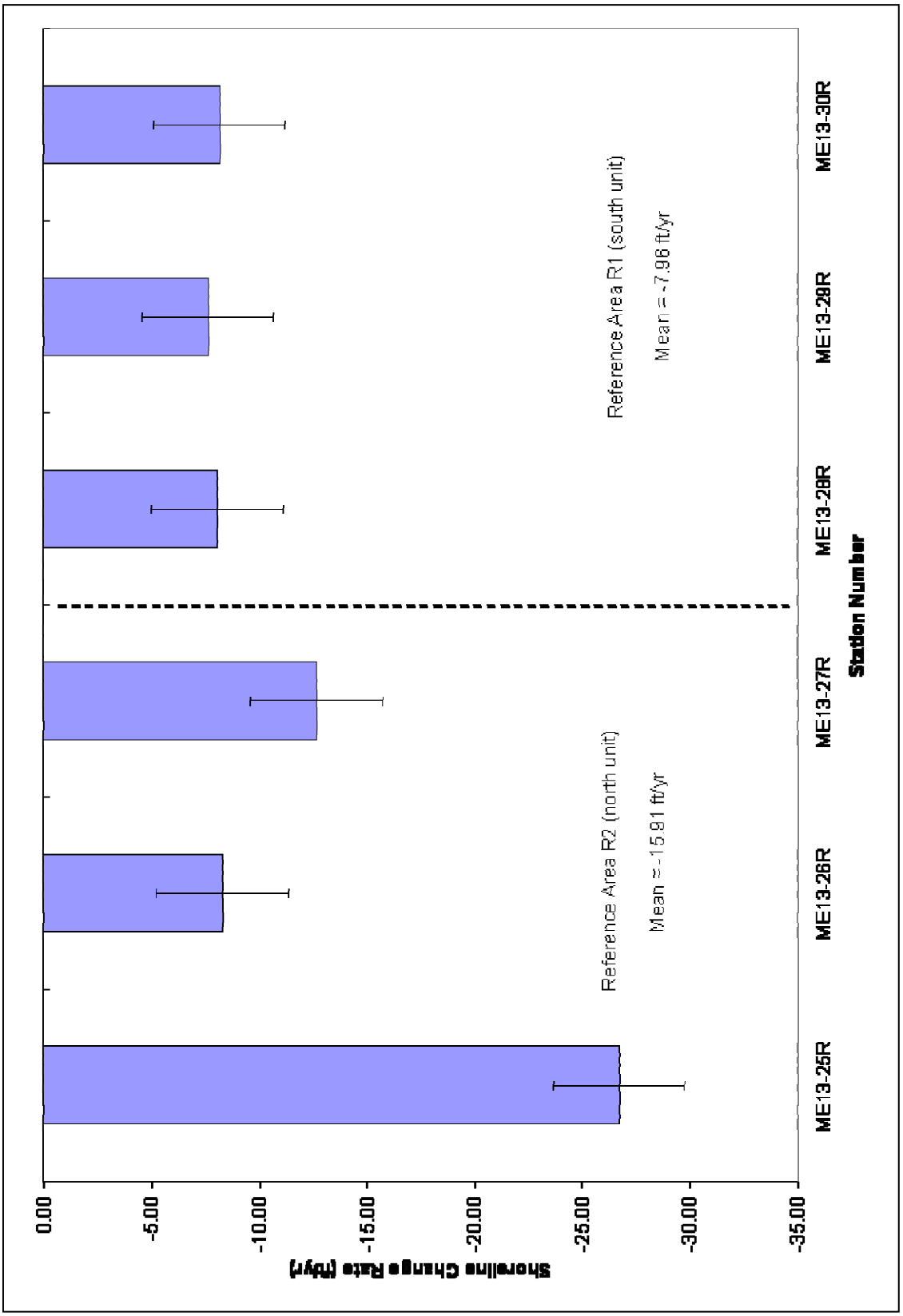

Figure 5: Shoreline change rate (ft/yr) along Freshwater Bayou Canal at the ME-13 reference area monitoring stations for the 23 July 1998 – 21 July 2003 time period. Error bars represent ±1 standard error of the mean of all 6.

Table 2: Locations and site characteristics of the ME-13 reference area shoreline monitoring sites established July 21-23, 1998. VEB = vegetated edge of bank; S/L = shoreline; SP = settlement plate; P/L = pipeline.

Station No. (from S to N)	**Opposing ME-04 Rock Dike SP No.**	**Distance From Survey Hub To VEB ft (m)**	**Shoreline Condition**
ME13-25R	1	44.66 (13.61)	Eroding spoil bank with *Triadica sebifera*; measurements taken on back brass cap (ME04-93b) and adjacent S/L.
ME13-26R	2	46.54 (14.19)	Eroding spoil bank with *T. sebifera*; measurements taken on back brass cap (ME04-94b) and adjacent S/L.
ME13-27R	3	69.705 (21.25)	Eroding spoil bank with *T. sebifera*; measurements taken on back brass cap (ME04-95b) and adjacent S/L.
ME13-28R	20	38.8 (11.83)	Eroding spoil bank with *T. sebifera*; measurements taken on back brass cap (ME04-96b) and adjacent S/L.
ME13-29R	22	58.28 (17.76)	Eroding spoil bank with *T. sebifera*; 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.

Figure 6: View of the Freshwater Bayou Canal shoreline at reference area R2 (north unit) monitoring station ME13-25R taken on July 21, 2003. Note the current shoreline position which is 89.0 ft (27.1 m) inland from the survey hub in open water in the foreground. The hub was placed 44.7 feet (13.6 m) inland from the shoreline when it was installed in 1998.

Figure 7: View of the Freshwater Bayou Canal shoreline along reference area R1 (south unit) taken on July 21, 2003. Note the scalloped shoreline profile characterized by small coves and headlands. Fallen trees in this area are repeatedly rammed against the remaining live trees along the shoreline by boat wake-induced wave action.

Figure 8: View of the Freshwater Bayou Canal shoreline behind the ME-13 rock dike, looking south from monitoring station ME13-01, as observed on July 21, 2003. Note the healthy condition of the native vegetation along the shoreline and colonizing the shelf of sediment accumulating between the shoreline and rock dike.

V. Conclusions

a. Project Effectiveness

The project appears to be functioning as designed. The typical section for the rock dike was a 4 ft crown width constructed to elevation 4.0 ft NAVD88 with 2:1 side slopes. The gradation for the rock was 1300 lbs. The rock dike seems to be experiencing settlement in certain reaches, but the integrity of the rock dike seems to be holding up to the dynamic forces of the type of marine vessels that travel Freshwater Bayou Canal.

The shoreline is prograding as a result of accretion behind the protection of the rock dike and the unprotected reference areas are eroding. Similar responses have been documented in other shoreline protection projects throughout the state, particular in the western portions.

b. Recommended Improvements

Maintenance is needed at several locations to bring the ME-13 rock dike structure up to a crown height of 3.5 ft NAVD 88. The proposed maintenance is in the final engineering and design phase and is scheduled for the summer of 2005. The engineering and design surveys identified and will address sections of the rock dike at a crown height lower than 2.5 ft NAVD88.

c. Lessons Learned

Variation in the shoreline retreat rate along the project and reference area shorelines may be related to the erodibility of the substrate. Marsh soils erode more rapidly than spoil bank soils, which erode more rapidly than shell ridges. Additionally, variability in the project area may also be related to crown height of the rock dike, which may require periodic additions of rock to be maintained, as evidenced by shoreline erosion at several sites in the project area located behind the rock dike where crown height settled to less than 2.5 ft NAVD 88.

The ME-13 Project was a cooperative effort between the Federal Sponsor (NRCS), DNR and Cypress Gas Pipeline Company. Cypress owns a pipeline which runs parallel to the ME-13 Project. As per agreement, Cypress agreed to provide a $634,450.00 payment representing DNR's contribution to the project as the local sponsor. This type cooperative effort proved very successful for this project and is recommended for future projects of this type.

The typical section for the rock dike was a 4 ft. crown width constructed to elevation 3.5 ft. NAVD88 with 2:1 side slopes. The gradation for the rock was 1300 lbs. The rock dike seems to be experiencing settlement in certain reaches but the integrity of the rock dike seems to be holding up to the dynamic forces of the type of marine vessels that travel Freshwater Bayou Canal. This typical section appears to work well for this type environment.

VI. Literature Cited

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