

ME-13

Freshwater Bayou Bank Stabilization Summary Data and Graphics



Freshwater Bayou Bank Stabilization (ME-13)

Project Overview:

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, 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.



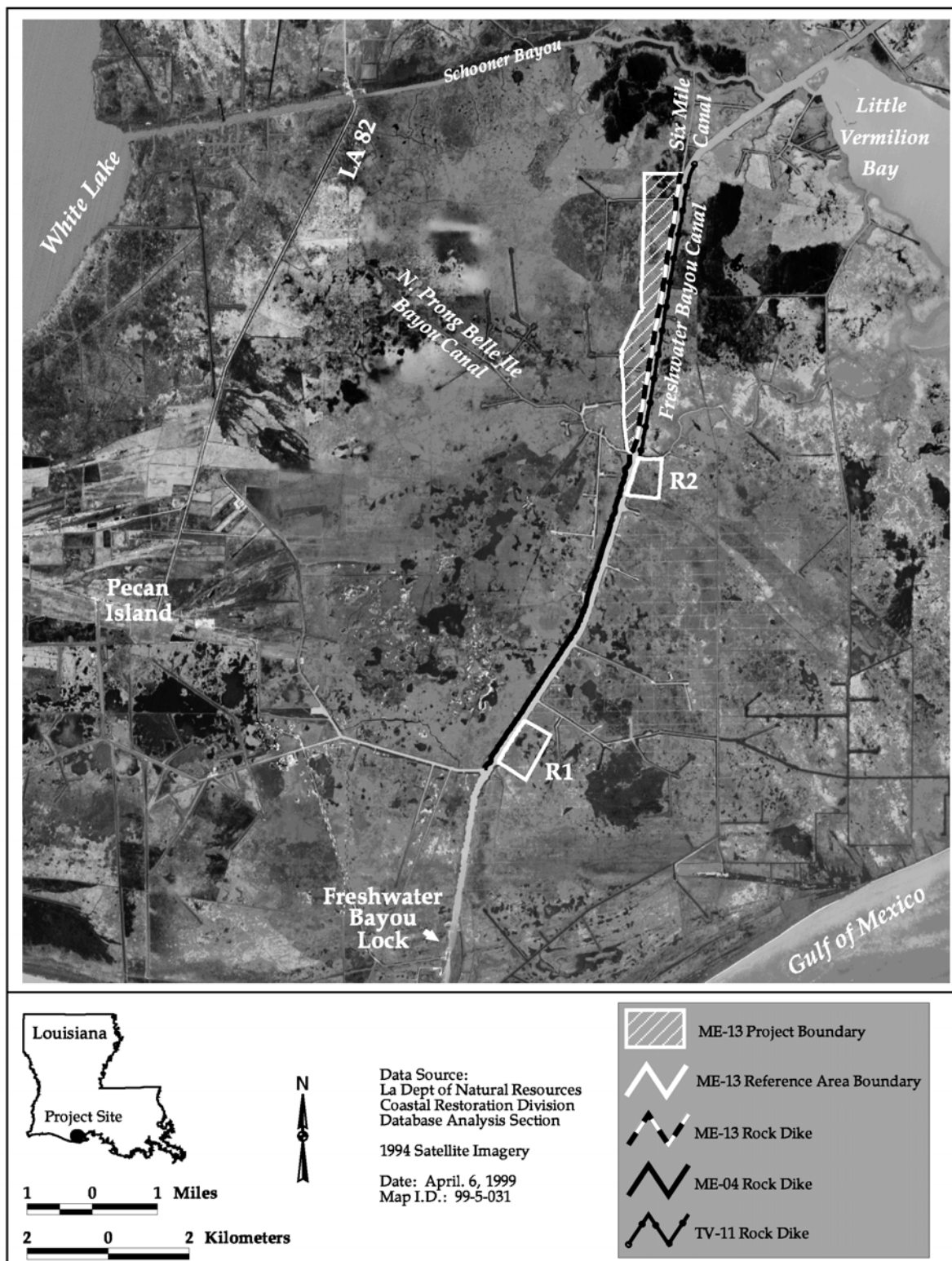


Figure 1. Freshwater Bayou Canal Bank Stabilization (ME-13) project and reference area boundaries.



Freshwater Bayou Bank Stabilization (ME-13)

Project Objectives:

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

Specific Goals:

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.



Freshwater Bayou Bank Stabilization (ME-13)

Monitoring Elements:

Aerial Photography: To document the pre-construction shoreline position, and land and water areas along Freshwater Bayou Canal 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. At the U.S. Geological Survey's National Wetlands Research Center (NWRC) in Lafayette, Louisiana, the pre-construction photography was georectified using standard operating procedures described in Steyer et al. (1995, revised 2000), and analyzed to measure land to open water ratios in the project and reference areas. 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.



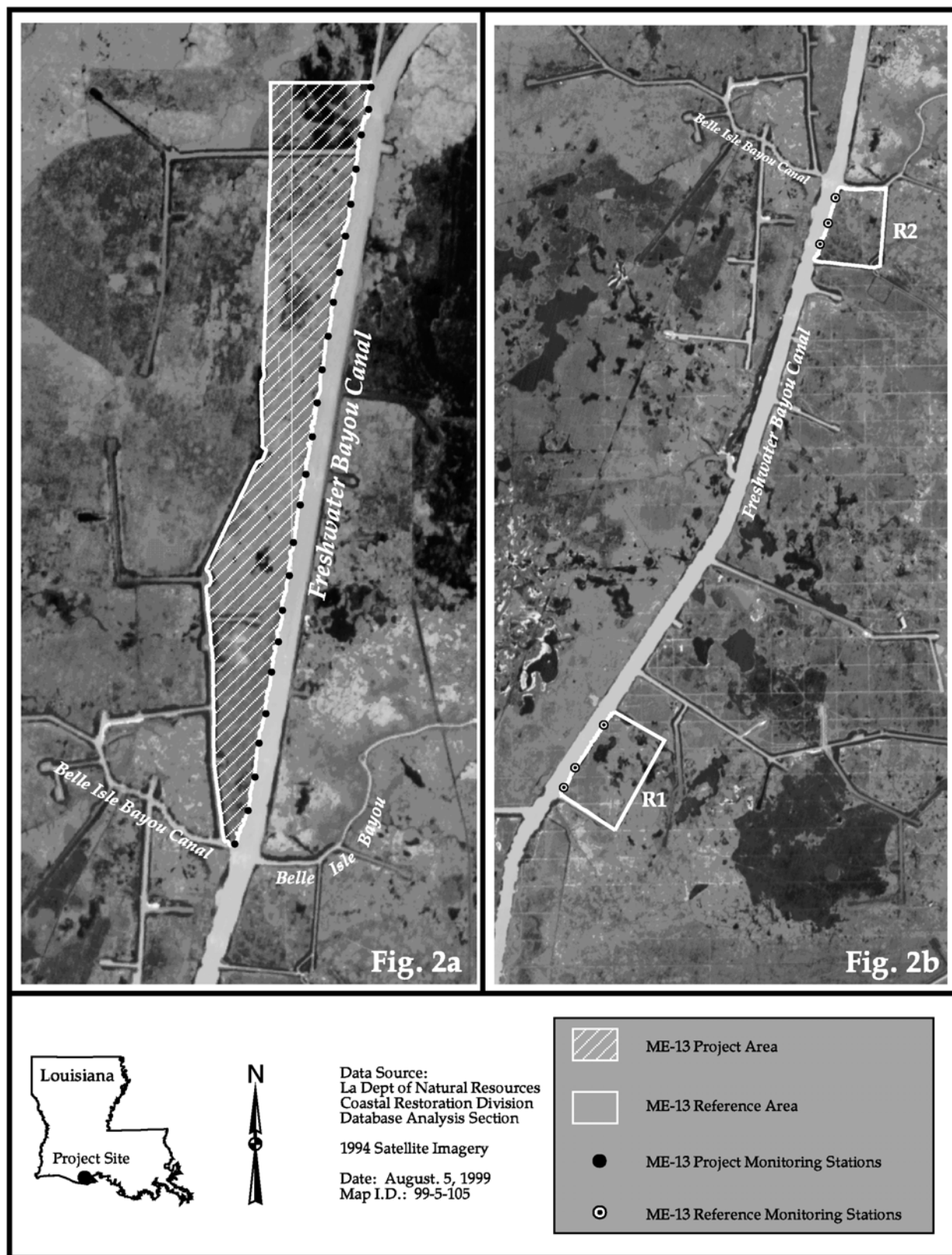


Figure 2. Approximate locations of the shoreline monitoring stations established along Freshwater Bayou Canal adjacent to the ME-13 project area (fig 2a, 24 sites) and the two reference areas (fig 2b, 6 sites)



Freshwater Bayou Bank Stabilization (ME-13)

Aerial Photography

Aerial photography obtained pre-construction on December 19, 1996 (and January 11, 1997 for reference area R2) was georectified, photomosaicked, classified according to pixel value, and analyzed to determine land to water ratios in the ME-13 project and reference areas (figure 3). All areas characterized by emergent vegetation were classified as land, while open water, aquatic beds, and mud flats were classified as water (figure 3, tables 1 and 2). Post-construction aerial photography will be obtained in 2015 and similarly processed and analyzed for comparison.

Figures:

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

Tables:

Table 1. Pre-construction land to water relationships in the Freshwater Bayou Canal Bank Stabilization (ME-13) project and reference areas (acres).

Table 2. Pre-construction land to water relationships in the Freshwater Bayou Canal Bank Stabilization (ME-13) project and reference areas (hectares).



1996 Pre-Construction Results

Project Area

Land: 875.4 acres
 Water: 131.8 acres
86.9 % land
13.1 % water

Reference Area 2

Land: 150.8 acres
 Water: 11.5 acres
92.9 % land
7.1 % water

Reference Area 1

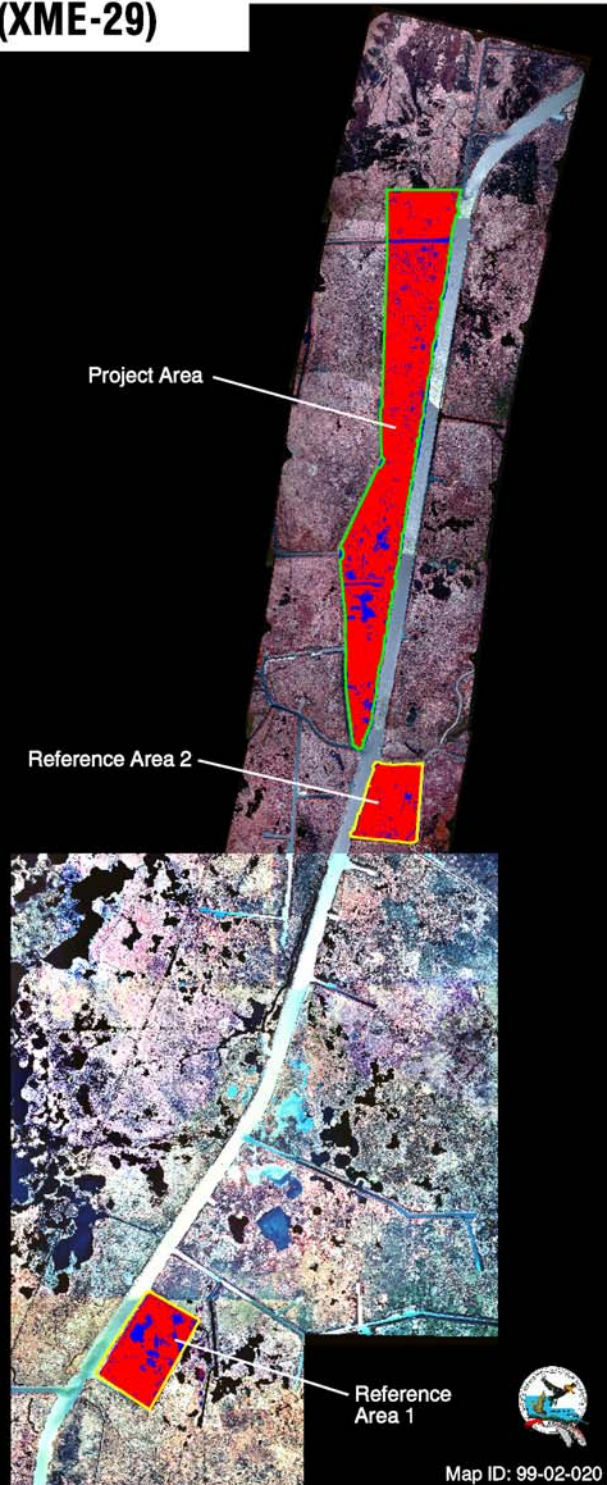
Land: 197.6 acres
 Water: 41.5 acres
82.6 % land
17.4 % water

Prepared by:
U.S. Department of the Interior
U.S. Geological Survey
National Wetlands Research Center
Lafayette, Louisiana

Louisiana Department of Natural Resources
Coastal Restoration Division
Abbeville Project Office

1:12,000 scale aerial photography
taken December 19, 1996 and January 11, 1997

1000 0 1000 2000 Meters
4000 0 4000 8000 Feet



Map ID: 99-02-020



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

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

Habitat Type	<u>Project Area</u>		<u>Reference Area R1</u>		<u>Reference Area R2</u>	
	Acres	Percent	Acres	Percent	Acres	Percent
Land	875.4	86.9	197.6	82.6	150.8	92.9
Water	131.8	13.1	41.5	17.4	11.5	7.1
Total	1007.2	100.0	239.1	100.0	162.3	100.0

Table 2. Areas and percentages of land and water in the ME-13 project and reference areas, based on GIS interpretations of aerial photography taken on December 9, 1996 (project and reference area R2) and on January 11, 1997 (reference area R1). [hectares]

Habitat Type	<u>Project Area</u>		<u>Reference Area R1</u>		<u>Reference Area R2</u>	
	Hectares	Percent	Hectares	Percent	Hectares	Percent
Land	350.2	86.9	79.0	82.6	60.3	92.9
Water	52.7	13.1	16.6	17.4	4.6	7.1
Total	402.9	100.0	95.6	100.0	64.9	100.0



Freshwater Bayou Bank Stabilization (ME-13) Shoreline Change

The pre-construction, horizontal baseline position for the ME-13 project and reference area shorelines was established on July 21-23, 1998. Pre-construction site conditions observed on these dates are described in tables 3 and 4. Post-construction shoreline positions for the ME-13 project and reference areas were documented on July 21, 2003. Shoreline change rates at each station and for each area for the July 1998 – July 2003 time period are presented in table 5 and figures 4 through 9.

The two ME-13 reference areas have been monitored by LDNR since April 1995 when the six shoreline monitoring stations were established for monitoring the ongoing Freshwater Bayou Wetlands Protection (ME-04) project. Mean shoreline change data from these reference area shorelines for June 1995 through June 2001, collected for the ME-04 project, are presented in figures 10 and 11 along with the data collected in July 2003 at these areas.

Tables:

- Table 3.** Pre-construction conditions observed on July 21-23, 1998 at the ME-13 project area monitoring stations.
- Table 4.** Pre-construction conditions observed on July 21-23, 1998 at the ME-13 reference area monitoring stations.
- Table 5.** Shoreline change rates at the ME-13 project area monitoring stations between July 21, 1998 and July 21, 2003.
- Table 6.** Shoreline change rates at the ME-13 reference area monitoring stations between July 21, 1998 and July 21, 2003.



Freshwater Bayou Bank Stabilization (ME-13) Shoreline Change

Figures:

- Figure 4.** Shoreline change rate (ft/yr) along Freshwater Bayou Canal at the ME-13 project area stations for the July 21, 1998 – July 21, 2003 time period. Error bars represent ± 1 standard error of the mean of all 24 stations.
- Figure 5.** Shoreline change rate (m/yr) along Freshwater Bayou Canal at the ME-13 project area stations for the July 21, 1998 – July 21, 2003 time period. Error bars represent ± 1 standard error of the mean of all 24 stations.
- Figure 6.** 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 stations.
- Figure 7.** Shoreline change rate (m/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 stations.
- Figure 8.** Mean shoreline change rate (ft/yr) along Freshwater Bayou Canal at the ME-13 project and reference area monitoring stations for the July 23, 1998 – July 21, 2003 time period. Error bars represent ± 1 standard error of the mean of all 24 project area and all 6 reference area stations, respectively.



Freshwater Bayou Bank Stabilization (ME-13) Shoreline Change

Figures:

Figure 9. Mean shoreline change rate (m/yr) along Freshwater Bayou Canal at the ME-13 project and reference area monitoring stations for the July 23, 1998 – July 21, 2003 time period. Error bars represent ± 1 standard error of the mean of all 24 project area and all 6 reference area stations, respectively.

Figure 10. Comparison of mean shoreline change rates (ft/yr) along Freshwater Bayou Canal adjacent to the ME-04 and ME-13 reference areas R1 and R2 shoreline segments for 5 time periods between April 27, 1995 and July 21, 2003. Error bars represent ± 1 standard error of the mean for each reference area for each time period.

Figure 11. Comparison of mean shoreline change rates (m/yr) along Freshwater Bayou Canal adjacent to the ME-04 and ME-13 reference areas R1 and R2 shoreline segments for 5 time periods between April 27, 1995 and July 21, 2003. Error bars represent ± 1 standard error of the mean for each reference area for each time period.

Figure 12. Mean shoreline change rate (ft/yr) along Freshwater Bayou Canal behind the ME-04 project rock dike from June 12, 1995 – May 15, 2001. Error bars represent ± 1 standard error of the mean of all 24 project area stations.

Figure 13. Mean shoreline change rate (m/yr) along Freshwater Bayou Canal behind the ME-04 project rock dike from June 12, 1995 – May 15, 2001. Error bars represent ± 1 standard error of the mean of all 24 project area stations.



Freshwater Bayou Bank Stabilization (ME-13) Shoreline Change

Figures:

Figure 14. 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 15. 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 visible in the 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 16. 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.

Figure 17. View of the ME-13 rock dike looking north towards station ME13-12 at settlement plate no. 12, taken on July 21, 2003. The dip in the rock dike in front of the settlement plate post will require maintenance to bring this section of dike back up to the specified crown height.



Table 3. 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; <i>Spartina patens</i> , <i>Sesbania drummondii</i> , <i>Typha latifolia</i> , <i>Schoenoplectus americanus</i> . 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; <i>Triadica sebifera</i> , <i>Solidago sempervirens</i> var. <i>mexicana</i> . 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; <i>Phragmites australis</i> , <i>Bacopa monnieri</i> . 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; <i>P. australis</i> , <i>Eleocharis</i> 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; <i>P. australis</i> , <i>T. sebifera</i> , <i>Baccharis halimifolia</i> , <i>S. drummondii</i> . S/L bearing 280° W from settlement plate.
ME13-06	6	28.45 (8.67)	Old P/L rip rap in front of <i>P. australis</i> 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; <i>T. sebifera</i> , <i>S. drummondii</i> , <i>S. sempervirens</i> var. <i>mexicana</i> .
ME13-08	8	26.5 (8.08)	4-ft (1.22-m) high cut scarp bank along spoil bank; <i>P. australis</i> , <i>T. sebifera</i> , <i>Baccharis halimifolia</i> , <i>S. sempervirens</i> var. <i>mexicana</i> . 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; <i>T. sebifera</i> . S/L bearing 296° W from settlement plate.

(continued)



Table 3. (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; <i>P. australis</i> , <i>T. sebifera</i> ; shoreline at stand of <i>S. californicus</i> . 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; <i>P. australis</i> . S/L bearing 290° W from settlement plate.
ME13-12	12	50.4 (15.36)	Old P/L rip rap covered with <i>P. australis</i> , along scalloped shoreline; S/L at mudflat stand of <i>Spartina alterniflora</i> . S/L bearing 298° W from settlement plate.
ME13-13	13	58.2 (17.74)	Marshy bank on N side of cove; <i>P. australis</i> , <i>S. alterniflora</i> , <i>S. patens</i> , <i>S. drummondii</i> ; near small island with <i>P. australis</i> . S/L bearing 298° W from settlement plate.
ME13-14	14	103.2 (31.46)	Marshy bank with <i>P. australis</i> on large cove, with small islands of <i>P. australis</i> between dike and S/L, and with <i>S. alterniflora</i> 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 (<i>Rangia</i>) ridge along straight S/L; <i>P. australis</i> , <i>T. sebifera</i> , <i>S. drummondii</i> . S/L bearing 320° W from settlement plate.
ME13-16	16	57.6 (17.56)	Low marshy bank along straight S/L; <i>S. alterniflora</i> , <i>Eleocharis</i> 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 <i>S. drummondii</i> , <i>S. alterniflora</i> , <i>S. patens</i> , <i>S. robustus</i> , and <i>Zizaniopsis mileacea</i> . S/L bearing 310° W from settlement plate

(continued)



Table 3. (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 <i>P. australis</i> , <i>T. sebifera</i> , and <i>S. drummondii</i> , mudflat stands of <i>S. robustus</i> , <i>S. californicus</i> , <i>S. alterniflora</i> , and <i>S. patens</i> ; <i>Juncus roemerianus</i> 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; <i>P. australis</i> , <i>T. sebifera</i> , <i>S. patens</i> , <i>S. cynosuroides</i> , <i>Cladium mariscus</i> ssp. <i>jamaicense</i> . 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 <i>P. australis</i> , dead <i>T. sebifera</i> , and <i>Sesbania exaltata</i> . 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; <i>P. australis</i> , <i>S. drummondii</i> . S/L bearing 304° W from settlement plate.
ME13-22	22	30.9 (9.42)	Straight marshy S/L with <i>P. australis</i> , <i>Spartina cynosuroides</i> , <i>S. patens</i> , <i>Symphotrichum subulatum</i> , <i>S. drummondii</i> , <i>T. sebifera</i> , and <i>J. roemerianus</i> . 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; <i>S. patens</i> , <i>Iva frutescens</i> , <i>B. halimifolia</i> , <i>P. australis</i> , <i>S. drummondii</i> , <i>S. sempervirens</i> var. <i>mexicana</i> , and <i>Amaranthus australis</i> . S/L bearing 290° W from settlement plate.
ME13-24	24	26.4 (8.05)	Straight, scalloped marshy S/L; <i>S. cynosuroides</i> , <i>P. australis</i> , and <i>Panicum virgatum</i> . S/L bearing 296° W from settlement plate.



Table 4. 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 <i>Triadica sebifera</i> ; measurements taken on back brass cap (ME04-93b) and adjacent S/L.
ME13-26R	2	46.54 (14.19)	Eroding spoil bank with <i>T. sebifera</i> ; measurements taken on back brass cap (ME04-94b) and adjacent S/L.
ME13-27R	3	69.705 (21.25)	Eroding spoil bank with <i>T. sebifera</i> ; measurements taken on back brass cap (ME04-95b) and adjacent S/L.
ME13-28R	20	38.8 (11.83)	Eroding spoil bank with <i>T. sebifera</i> ; measurements taken on back brass cap (ME04-96b) and adjacent S/L.
ME13-29R	22	58.28 (17.76)	Eroding spoil bank with <i>T. sebifera</i> ; measurements taken on back brass cap (ME04-97b) and adjacent S/L.
ME13-30R	23	53.18 (16.21)	Eroding <i>Phragmites australis</i> stand; measurements taken on back brass cap (ME04-98b) and adjacent S/L; front brass cap (ME04-96a) buried near current S/L.



Table 5. Shoreline change rates at the ME-13 project area monitoring stations between July 21, 1998 and July 21, 2003. Stations and settlement plates numbered from north to south.

Station No.	ME-13 Settlement Plate No.	Shoreline Change ft (m)	Shoreline Change Rate ft/yr (m/yr)
ME13-01	1	-5.2 (-1.6)	-1.04 (-0.32)
ME13-02	2	-1.4 (-0.4)	-0.28 (-0.09)
ME13-03	3	-6.55 (-2.0)	-1.31 (-0.40)
ME13-04	4	-8.3 (-2.5)	-1.66 (-0.51)
ME13-05	5	-3.4 (-1.0)	-0.68 (-0.21)
ME13-06	6	-3.95 (-1.2)	-0.79 (-0.24)
ME13-07	7	-4.6 (-1.4)	-0.92 (-0.28)
ME13-08	8	-2.6 (-0.8)	-0.52 (-0.16)
ME13-09	9	-1.8 (-0.5)	-0.36 (-0.11)
ME13-10	10	12.4 (3.8)	2.48 (0.76)
ME13-11	11	-13.9 (-4.2)	-2.78 (-0.85)
ME13-12	12	30.1 (9.2)	6.02 (1.83)
ME13-13	13	16.7 (5.1)	3.34 (1.02)
ME13-14	14	15.6 (4.8)	3.12 (0.95)

(continued)



Table 5. (continued)

Station No.	Settlement Plate No.	Shoreline Change ft (m)	Shoreline Change Rate ft/yr (m/yr)
ME13-15	15	34.7 (10.6)	6.94 (2.11)
ME13-16	16	-5.2 (-1.6)	-1.04 (-0.32)
ME13-17	17	-1.4 (-0.4)	-0.28 (-0.09)
ME13-18	18	-6.55 (-2.0)	-1.31 (-0.40)
ME13-19	19	-8.3 (-2.5)	-1.66 (-0.51)
ME13-20	20	-3.4 (-1.0)	-0.68 (-0.21)
ME13-21	21	-3.95 (-1.2)	-0.79 (-0.24)
ME13-22	22	-4.6 (-1.4)	-0.92 (-0.28)
ME13-23	23	-2.6 (-0.8)	-0.52 (-0.16)
ME13-24	24	-1.8 (-0.5)	-0.36 (-0.11)
Average:			0.84 (0.26)
SD:			2.71 (0.83)
SE:			0.55 (0.17)



Table 6. Shoreline change rates at the ME-13 reference area monitoring stations between July 21, 1998 and July 21, 2003. Stations and settlement plates numbered from north to south.

Station No.	Opposing ME-04 Settlement Plate No.	Shoreline Change ft (m)	Shoreline Change Rate ft/yr (m/yr)
ME13-25R	1	-133.66 (-40.74)	-26.73 (-8.15)
ME13-26R	2	-41.54 (-12.66)	-8.31 (-2.53)
ME13-27R	3	-63.51 (-19.36)	-12.70 (-3.87)
ME13-28R	20	-40.40 (-12.31)	-8.08 (-2.46)
ME13-29R	22	-38.18 (-11.64)	-7.64 (-2.33)
ME13-30R	23	-40.88 (-12.46)	-8.18 (-2.49)
		Average:	-11.94 (-3.64)
		SD:	7.49 (2.28)
		SE.	3.06 (0.93)



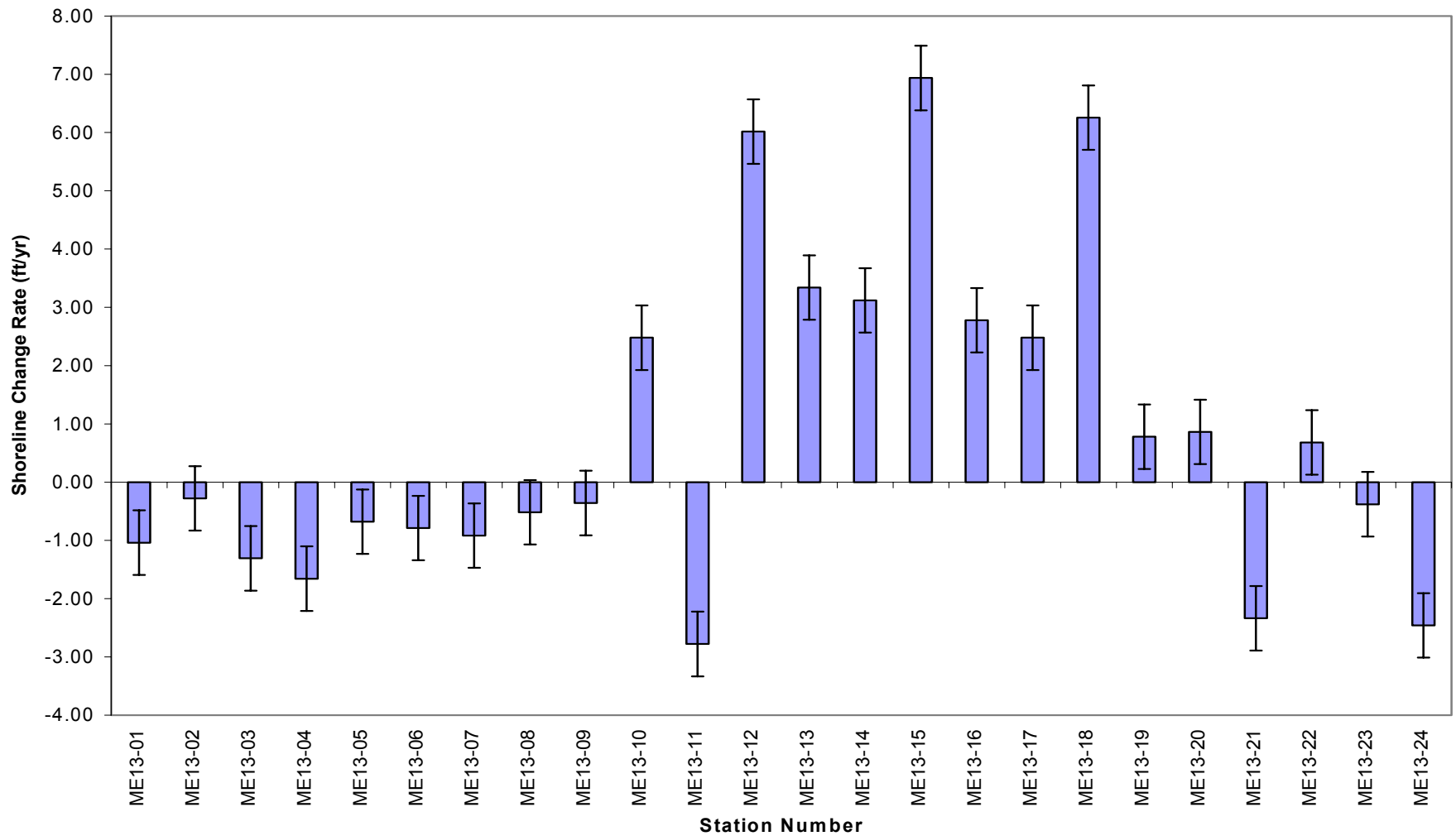


Figure 4. Shoreline change rate (ft/yr) along Freshwater Bayou Canal at the ME-13 project area stations for the July 23, 1998 – July 21, 2003 time period. Error bars represent ± 1 standard error of the mean of all stations.



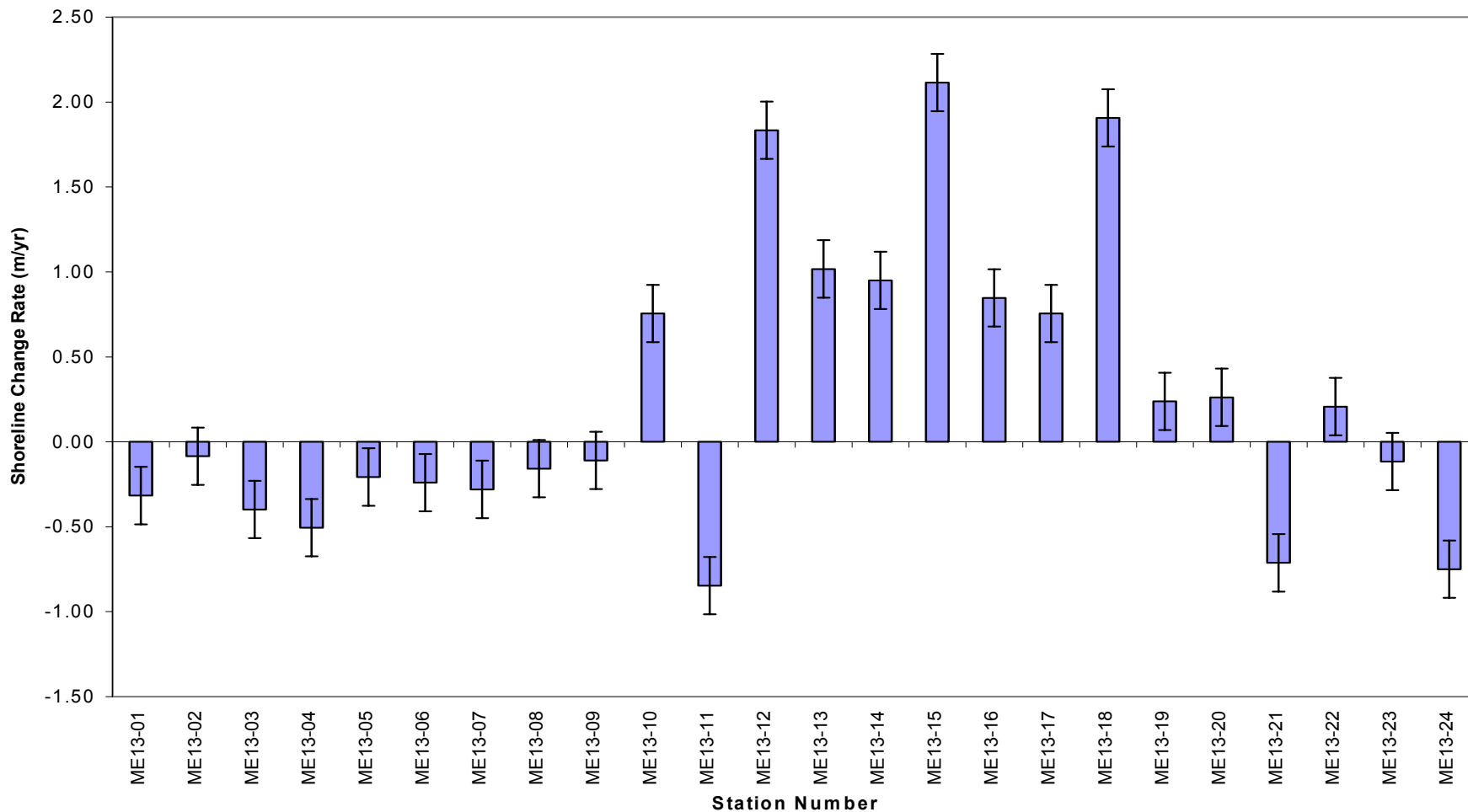


Figure 5. Shoreline change rate (m/yr) along Freshwater Bayou Canal at the ME-13 project area stations for the July 23, 1998 – July 21, 2003 time period. Error bars represent ± 1 standard error of the mean of all stations.



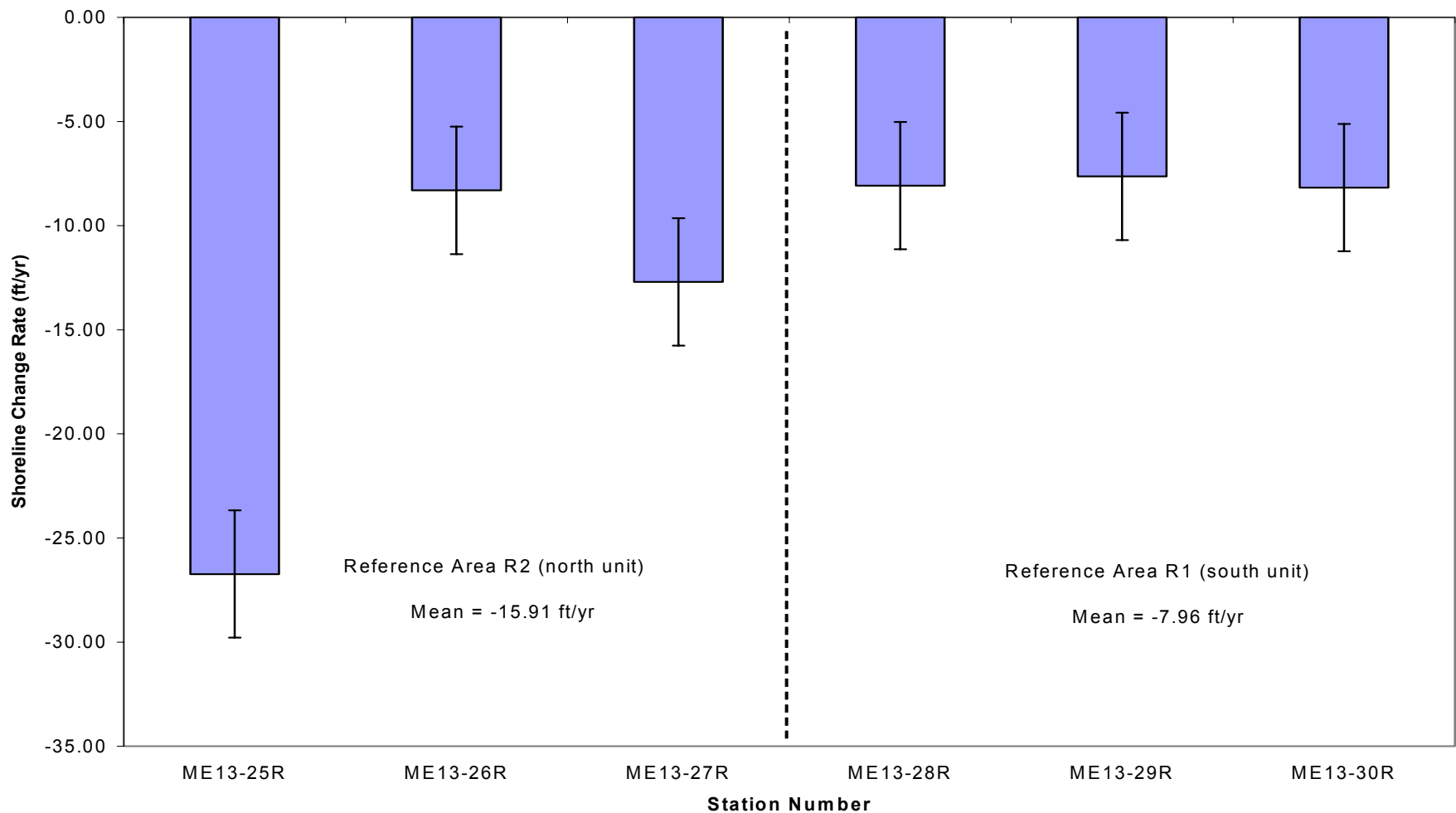


Figure 6. Shoreline change rate (ft/yr) along Freshwater Bayou Canal at the ME-13 reference area monitoring stations for the 23 July 1998 – 21 July 2003 time period. Error bars represent ± 1 standard error of the mean of all 6 stations.



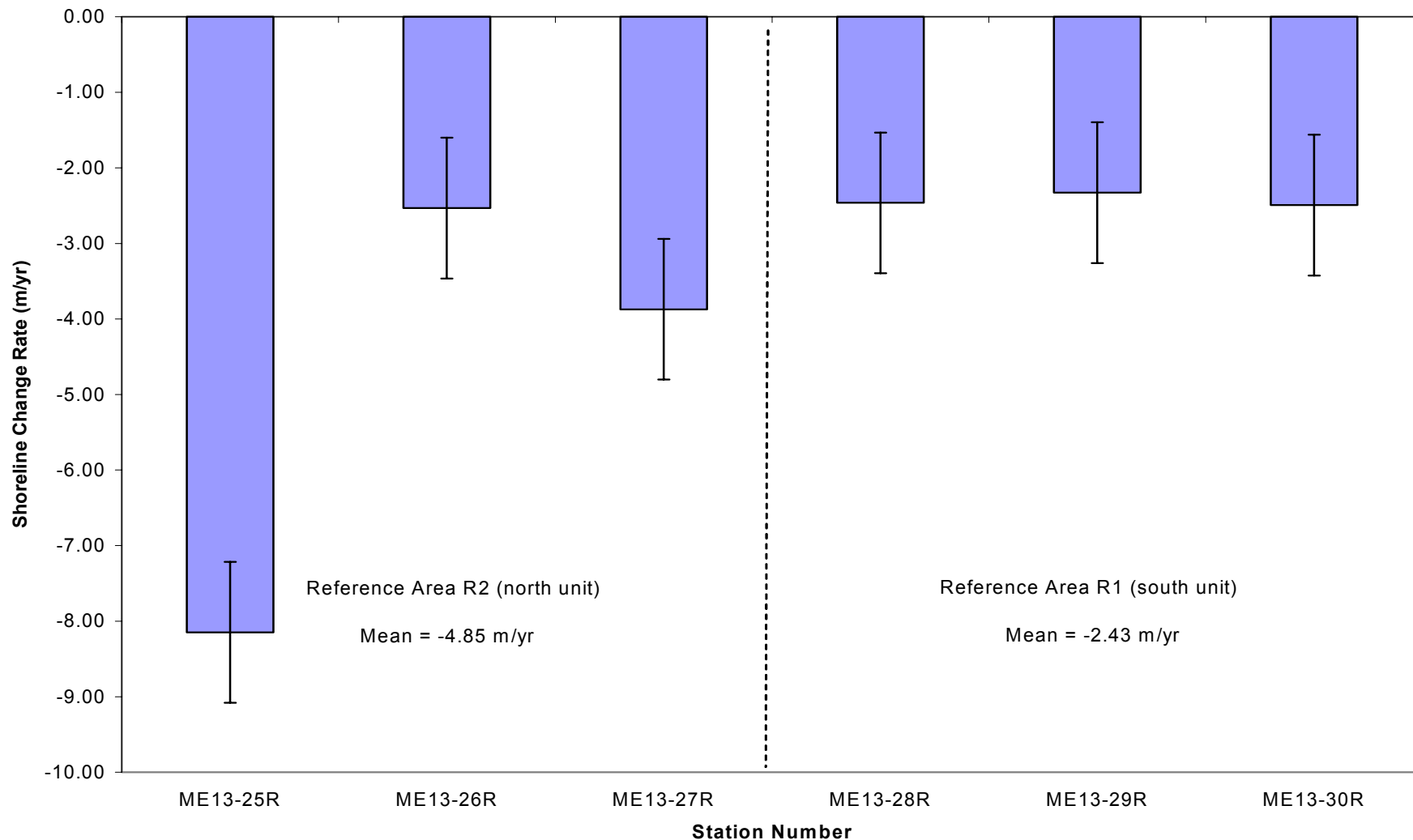


Figure 7. Shoreline change rate (m/yr) along Freshwater Bayou Canal at the ME-13 reference area monitoring stations for the 23 July 1998 – 21 July 2003 time period. Error bars represent ± 1 standard error of the mean of all 6 stations.



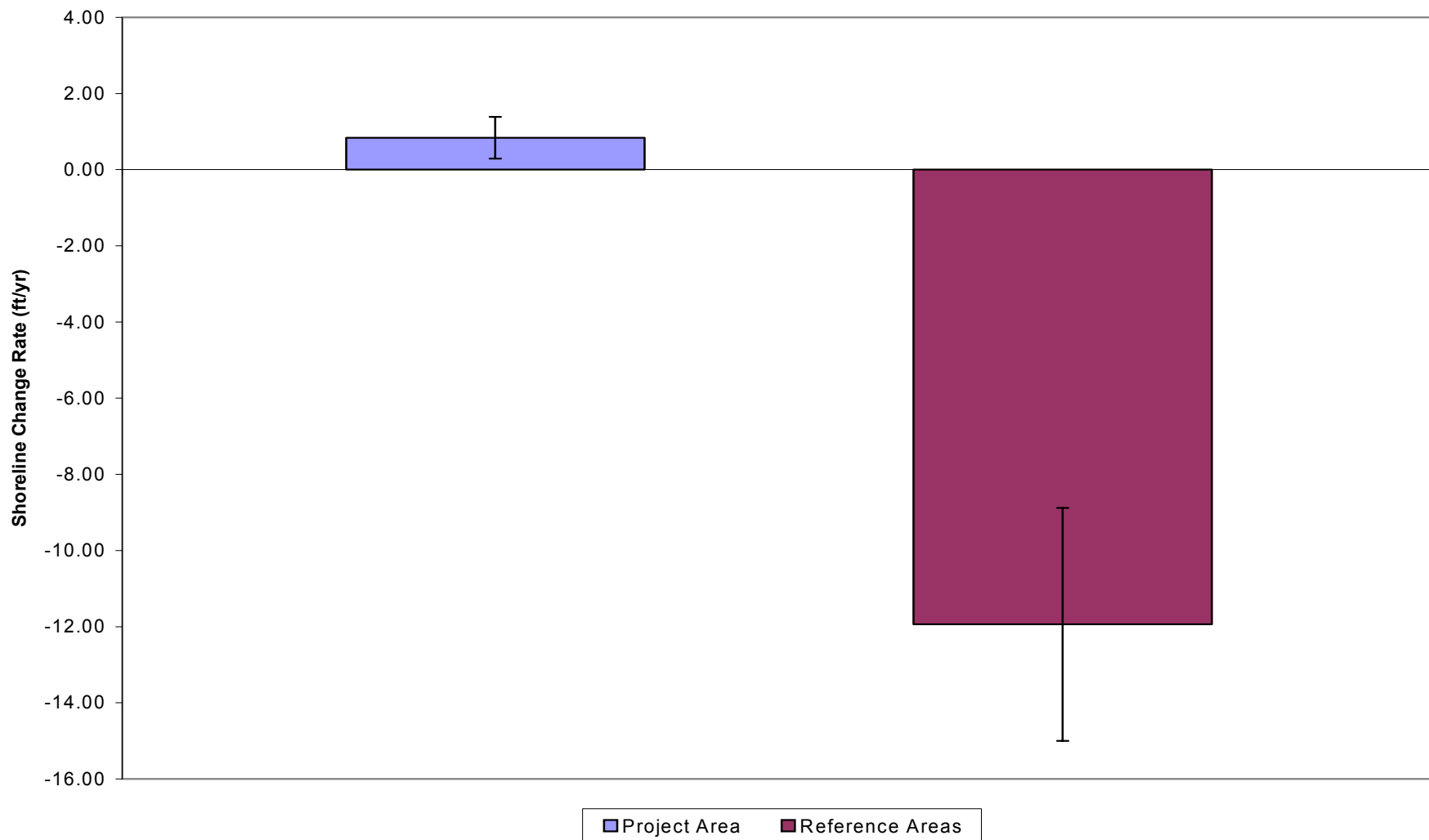


Figure 8. Mean shoreline change rate (ft/yr) along Freshwater Bayou Canal at the ME-13 project and reference area monitoring stations for the July 23, 1998 – July 21, 2003 time period. Error bars represent ± 1 standard error of the mean of all 24 project area and all 6 reference area stations, respectively.



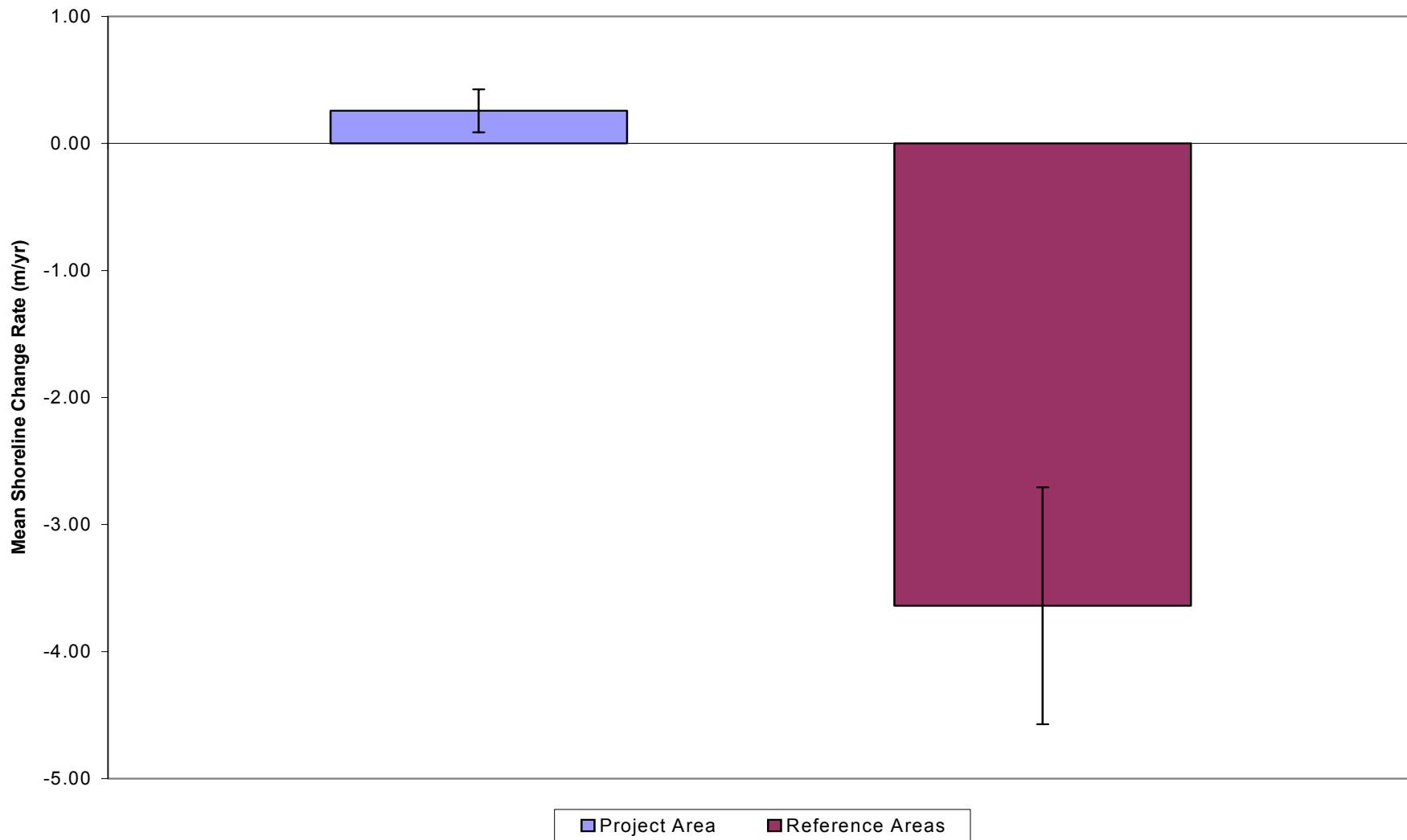


Figure 9. Mean shoreline change rate (m/yr) along Freshwater Bayou Canal at the ME-13 project and reference area monitoring stations for the July 23, 1998 – July 21, 2003 time period. Error bars represent ± 1 standard error of the mean of all 24 project area and all 6 reference area stations, respectively.



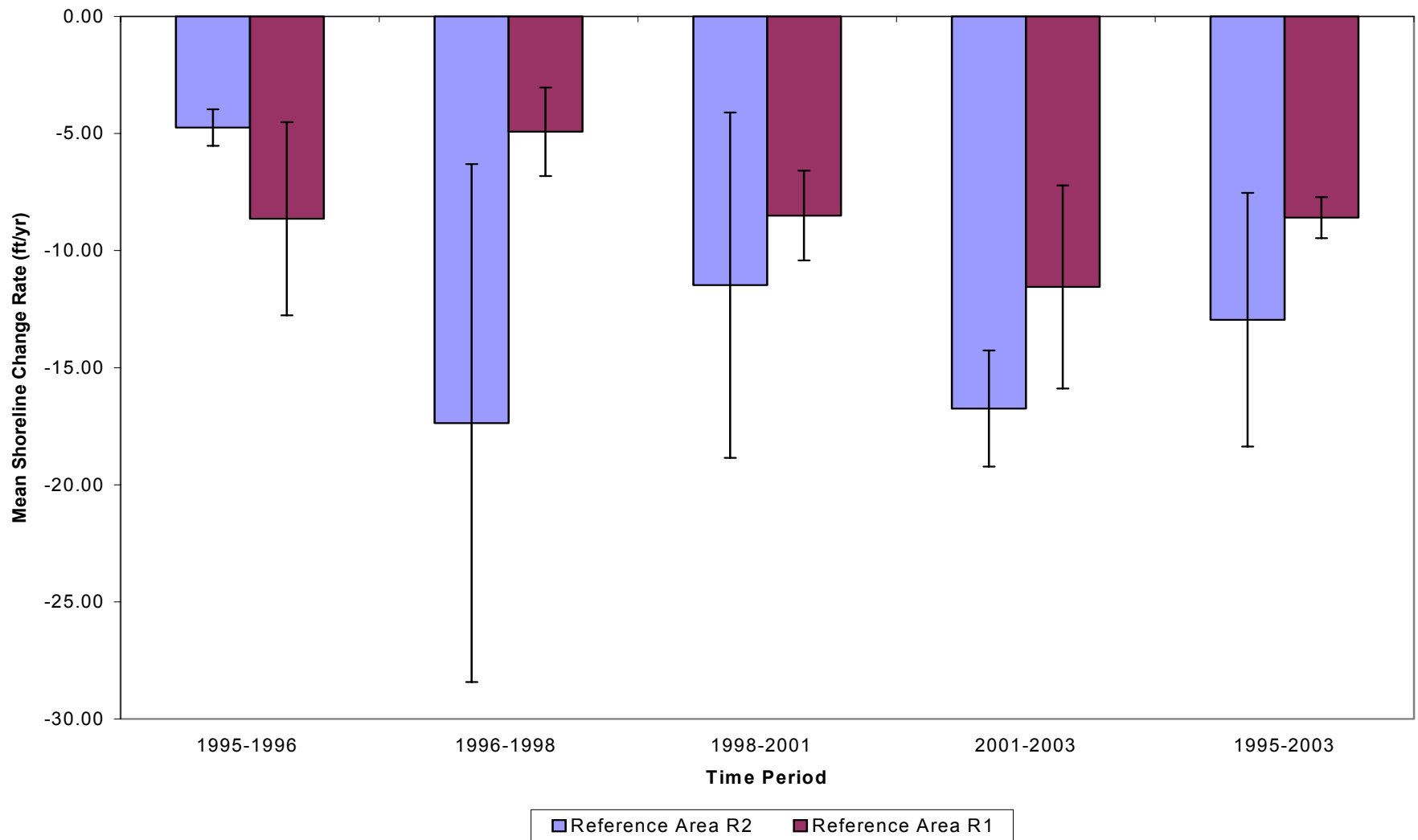


Figure 10. Comparison of mean shoreline change rates (ft/yr) along Freshwater Bayou Canal adjacent to the ME-04 and ME-13 reference areas R1 and R2 shoreline segments for 5 time periods between April 27, 1995 and July 21, 2003. Error bars represent ± 1 standard error of the mean for each reference area for each time period.



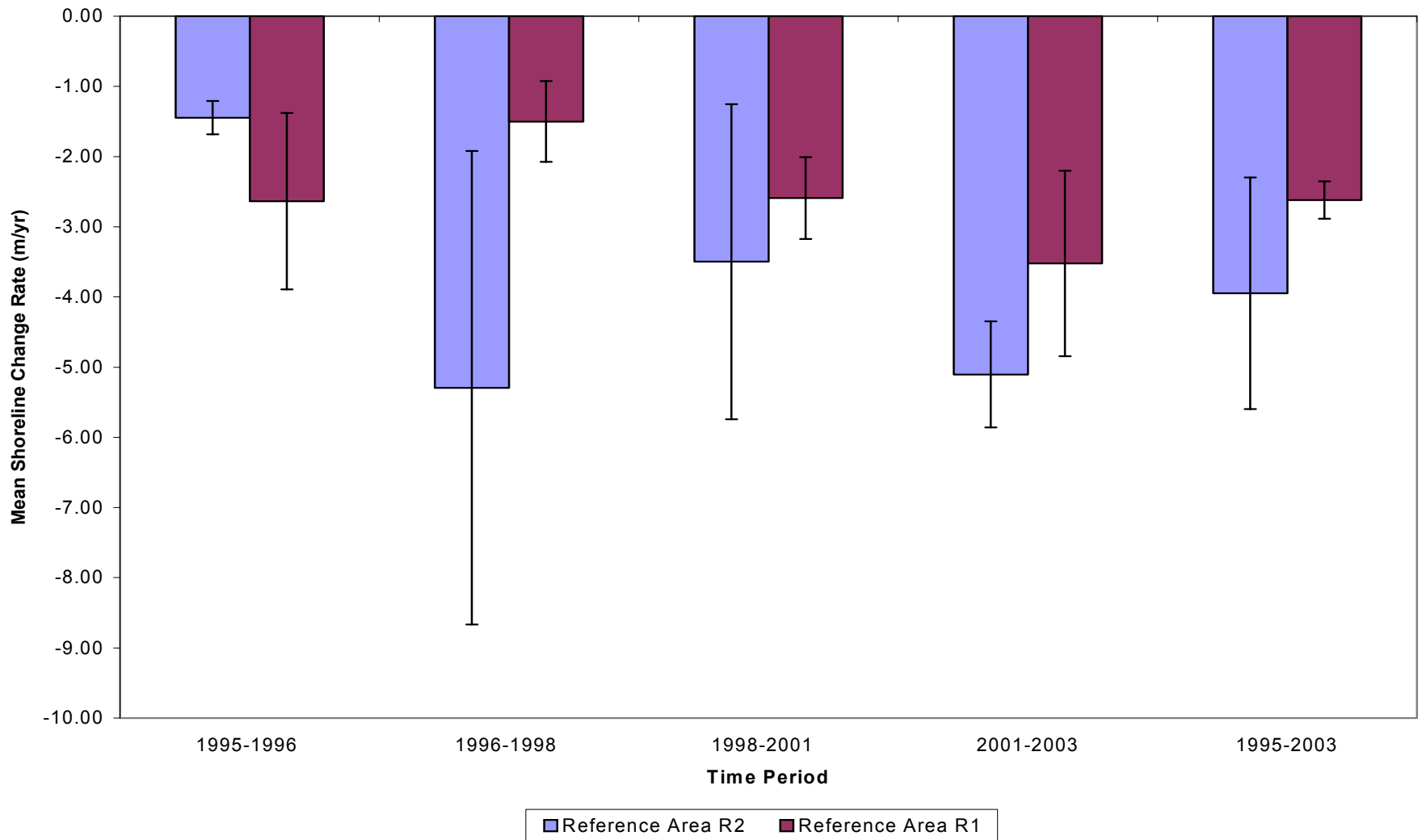


Figure 11. Comparison of mean shoreline change rates (m/yr) along Freshwater Bayou Canal adjacent to the ME-04 and ME-13 reference areas R1 and R2 shoreline segments for 5 time periods between April 27, 1995 and July 21, 2003. Error bars represent ± 1 standard error of the mean for each reference area for each time period.



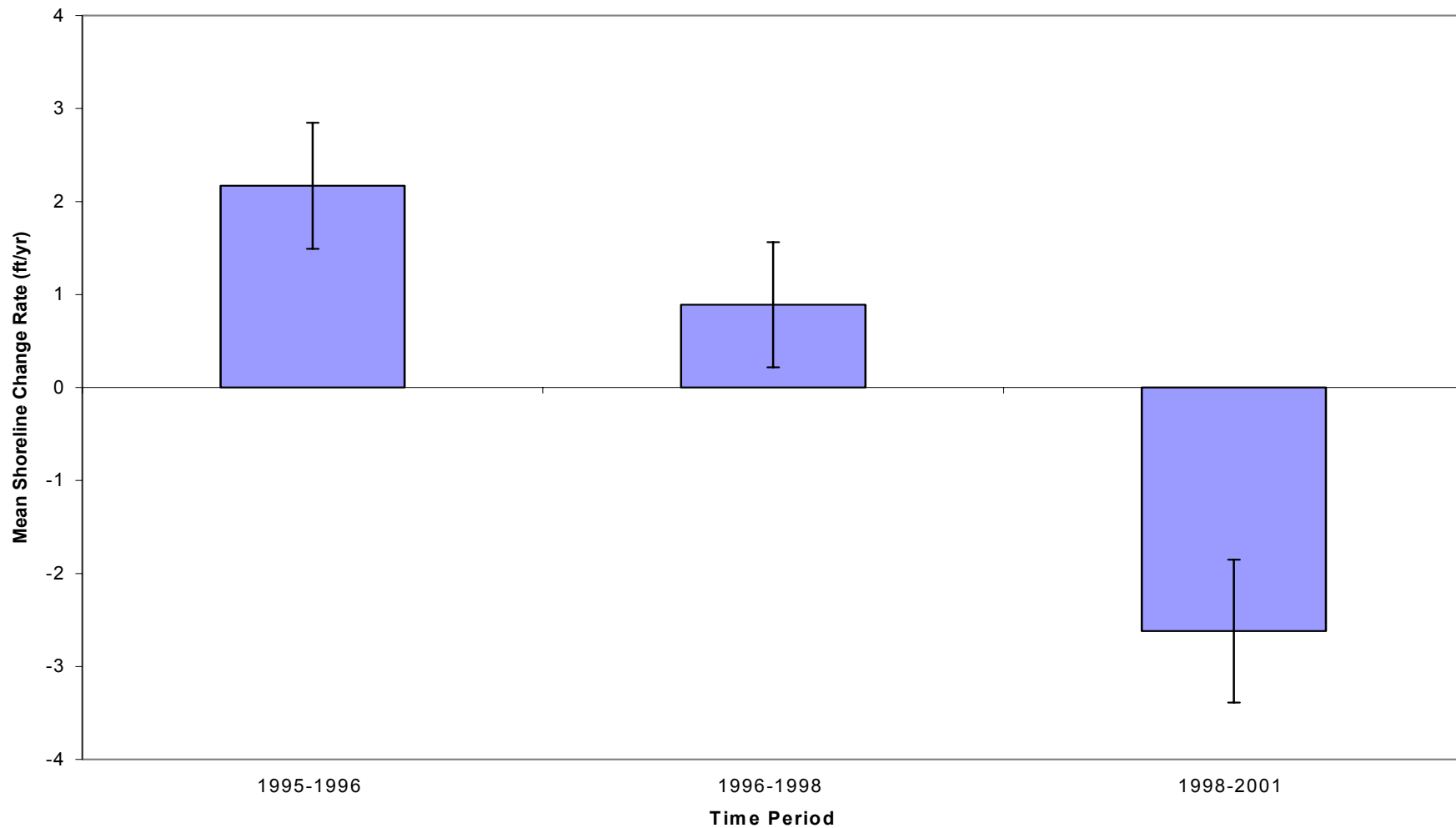


Figure 12. Mean shoreline change rate (ft/yr) along Freshwater Bayou Canal behind the ME-04 project rock dike from June 12, 1995 – May 15, 2001. Error bars represent ± 1 standard error of the mean of all 24 project area stations.



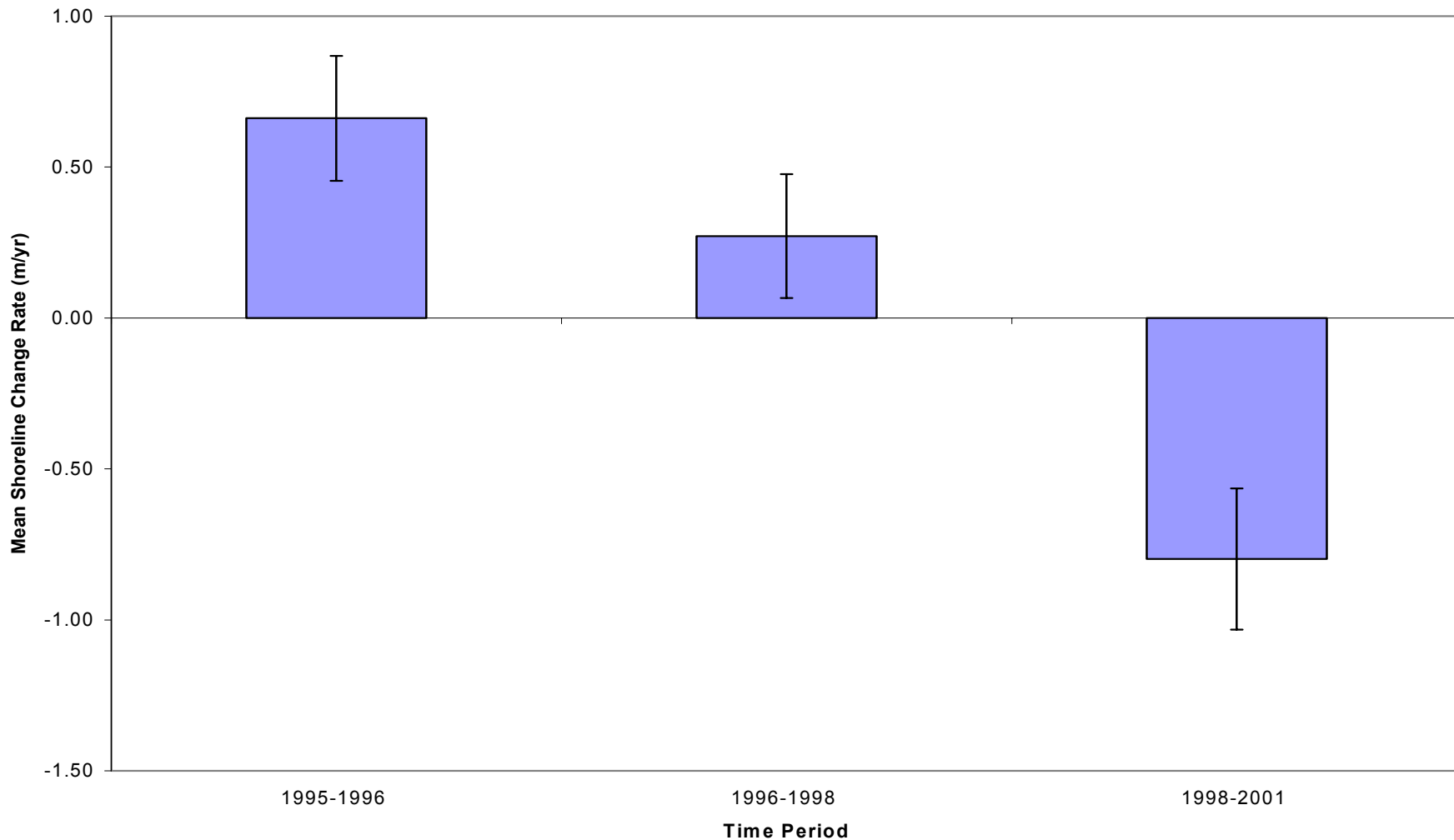


Figure 13. Mean shoreline change rate (m/yr) along Freshwater Bayou Canal behind the ME-04 project rock dike from June 12, 1995 – May 15, 2001. Error bars represent ± 1 standard error of the mean of all 24 project area stations.



Freshwater Bayou Bank Stabilization (ME-13)



Figure 14. 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.



Freshwater Bayou Bank Stabilization (ME-13)



Figure 15. 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.



Freshwater Bayou Bank Stabilization (ME-13)



Figure 16. 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.



Freshwater Bayou Bank Stabilization (ME-13)



Figure 17. View of the ME-13 rock dike looking north towards station ME13-12 at settlement plate no. 12, taken on July 21, 2003. The dip in the rock dike in front of the settlement plate post will require maintenance to bring this section of dike back up to the specified crown height.



Freshwater Bayou Bank Stabilization (ME-13) Preliminary Findings

Aerial Photography: Preliminary conclusions based on aerial photography will be made after the post-construction aerial photography is acquired in 2015.

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) (figures 4 and 5, table 3) and the reference area shorelines eroded at an average rate of -11.94 ft/yr (-3.64 m/yr) (figures 6 and 7, table 4) 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 highly significantly different than the variability along the reference area shorelines ($p < 0.0001$) for this time period.
- The highest rate of shoreline retreat has 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 15).



Freshwater Bayou Bank Stabilization (ME-13) Preliminary Findings

Shoreline Change (continued):

- 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 14). 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 16).



Freshwater Bayou Bank Stabilization (ME-13) Preliminary Findings

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 (figures 10 and 11). 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 (figures 10 and 11).
- 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 (-2.79 m/yr) from 1998-2001 (figures 12 and 13).



Freshwater Bayou Bank Stabilization (ME-13) Preliminary Findings

Ancillary Data (continued):

- Vegetation along unprotected shorelines of Freshwater Bayou Canal is subject to repeated battery from rack that accumulates along the unprotected shorelines, particularly where fallen trees are present (see figure 14). As a result, unprotected shoreline vegetation appears to be more stressed and in poorer health than shoreline vegetation protected by a rock dike (compare figures 14 and 16).

Maintenance Needs:

- Maintenance is needed at several locations to bring the ME-13 rock dike structure up to the specified crown height, including a low spot near station ME13-08 at settlement plate 8, and just south of station ME13-12 and settlement plate 12 (see figure 17).

