MONITORING PLAN

PROJECT NO. BA-15 LAKE SALVADOR SHORELINE PROTECTION DEMONSTRATION PROJECT

ORIGINAL DATE: September 20, 1996
UPDATE: September 24, 1997
REVISED DATE: July 23, 1998

Preface

The original plan was updated to include monitoring of an additional rock breakwater that was constructed under phase two of the project.

Pursuant to a CWPPRA Task Force decision on April 14, 1998, the updated monitoring plan was reduced in scope due to budgetary constraints. The goal to increase the frequency of occurrence of submerged aquatic vegetation (SAV) in the Phase 1 project area was deleted; therefore all post-construction SAV monitoring was eliminated. Additionally, the second post-construction aerial photography was omitted and shorelines will now be evaluated annually with a Global Positioning System (GPS).

Project Description

The Lake Salvador Shoreline Protection Demonstration (BA-15) project has two different locations: Phase 1 is located along 4.2 mi (6.8 km) of the north Lake Salvador shoreline and is bounded to the west by Baie du Cabanage and to the east by Couba Island (figure 1). The project area extends inland for a distance of approximately one mile into the Lake Salvador Wildlife Management Area. The area comprises 4,070 ac (1,647 ha) of fresh marsh and shallow, open-water habitat. Phase 2 is located along approximately 10,000 ft (3,050 m) of shoreline of the north Lake Salvador shoreline bounded to the west by Bayou des Allemands on the St. Charles-Lafourche Parish lines and to the east by Baie du Chactas (figure 2). The project will begin at the mouth of Bayou des Allemands and follow the lake rim north and eastward. The project affects approximately 4,070 ac (1,647 ha) of fresh marsh and shallow, open-water habitat.

Marsh vegetation in the project areas are dominated by *Polygonum spp.* (smartweed) and *Sagittaria lancifolia* (bulltongue). Submerged aquatic vegetation in the project areas are dominated by *Myriophyllum spicatum* (Eurasian watermilfoil) and *Eichornia crassipes* (water hyacinth). Other common species include *Typha* sp. (cattail), *Colocasia antiquorum* (elephant's ear), *Eichinochloa walteri* (wild millet), *Scirpus californicus* (bullwhip), *Salvinia minima* (floating fern), *Spirodela polyrhiza* (large duckweed), and *Lemna minor* (common duckweed) (Gammill 1993).

The project areas are composed of several soil types, mainly Kenner muck and including some areas of Allemands, Barbary, and Larose soils. These soils are characterized by level, poorly drained, organic soils in fresh marshes. They are ponded and flooded most of the time. Typically, the surface

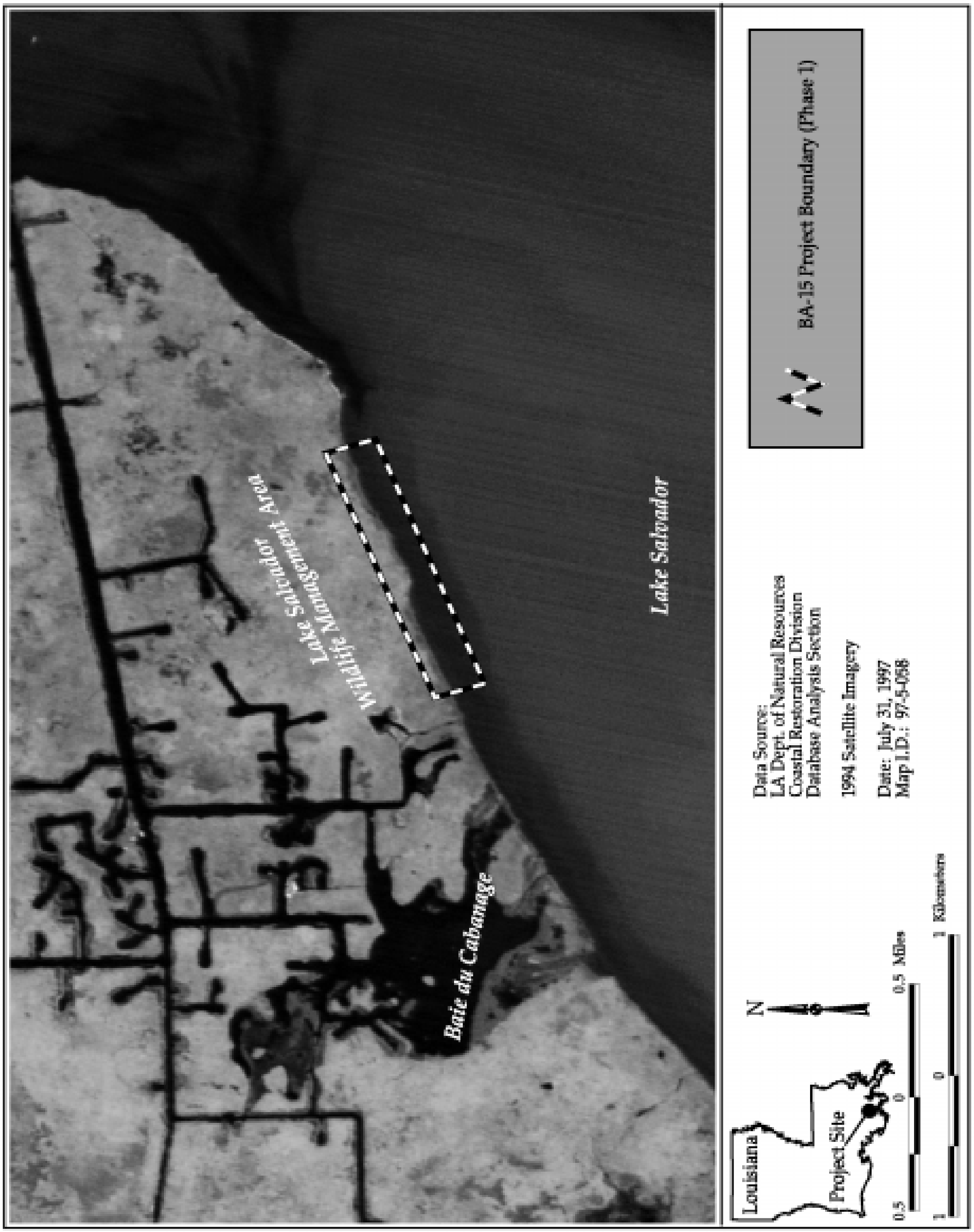

Figure 1. Lake Salvador Shoreline Protection Demonstration (BA-15) project area for Phase 1.

Figure 2. Lake Salvador Shoreline Protection Demonstration (BA-15) project structure location for Phase 2.

layer is very dark gray, slightly acid, fluid muck about 21 in (53 cm) thick. Normally the next layer is gray, very fluid layer about 2 in (5 cm) thick. The underlying material, to a depth of approximately 8 in (0.2 m), is black, mildly alkaline, very fluid clay. Acreage of these types of soils are mainly used as habitat for wetland wildlife and for extensive forms of recreation. This Kenner soil is in capability subclass VIIIw (a soil having severe limitations that reduces the choice of crops and interferes with agricultural use by having water in or on the soil). It is not assigned a woodland suitability group (USDA 1983, U.S. Soil Conservation Service 1987, HNTB 1992).

Shoreline erosion is influenced by many environmental factors, such as wind generated waves, boat wakes, subsidence, vegetation, shoreline orientation, shoreline geometry, and sediment composition (Grosskopf and Vincent 1982; Knutson and Inskeep 1982). The Lake Salvador shoreline is susceptible to erosion because of the long fetch across Lake Salvador, the vulnerable shoreline configuration, and a sediment base of highly unconsolidated sediments. These factors are responsible for the high shoreline erosion rate in the Lake Salvador area of approximately 13 ft yr^{-1}(4 m yr^{-1}) (LDNR 1994). Shoreline erosion along Lake Salvador has resulted in breaching of the lake rim at several locations. These breaches have allowed tidal and wave energy to erode the highly organic marsh surface, resulting in large, shallow pond formation in the interior marsh.

Phase 1 of the Lake Salvador Shoreline Protection Demonstration (BA-15) project seeks to demonstrate the effectiveness of four separate types of segmented breakwaters (figure 3) in highly organic, unconsolidated sediments with poor load bearing capacities. Unconsolidated sediments, such as those found in the Lake Salvador Shoreline Protection Demonstration (BA-15) project area, make traditional shoreline stabilization techniques ineffective. Structural components of the plan include:

- Approximately 1,000 ft (300 m) of angled timber fence structures (figure 4). The angled timber fence structure is a vertically constructed, V-shaped wave dampening structure. The wave energy and pattern is dissipated by the structure preventing bottom scour, while water is allowed to pass through the grates.

- Approximately 1,000 ft (300 m) of vinyl sheet pile structures (figure 5). The vinyl sheet pile structure is intended to dissipate the wave energy and prevent bottom scour. Like the timber fence structure, the vinyl sheet pile structure is constructed vertically, but is not V-shaped.

- Approximately 1,000 ft (300 m) of grated apex structures (figure 6). The grated apex is a timber wave dampening structure which is constructed much like an A-frame structure with a timber grate which dissipates the wave energy and pattern and allows water to pass through the structure. By dissipating the wave energy and pattern, the bottom scour is eliminated.

- Approximately 1,000 ft (300 m) of geotextile tube structures (figure 7). The geotextile tube structure is a tube constructed with permeable geotextile material and

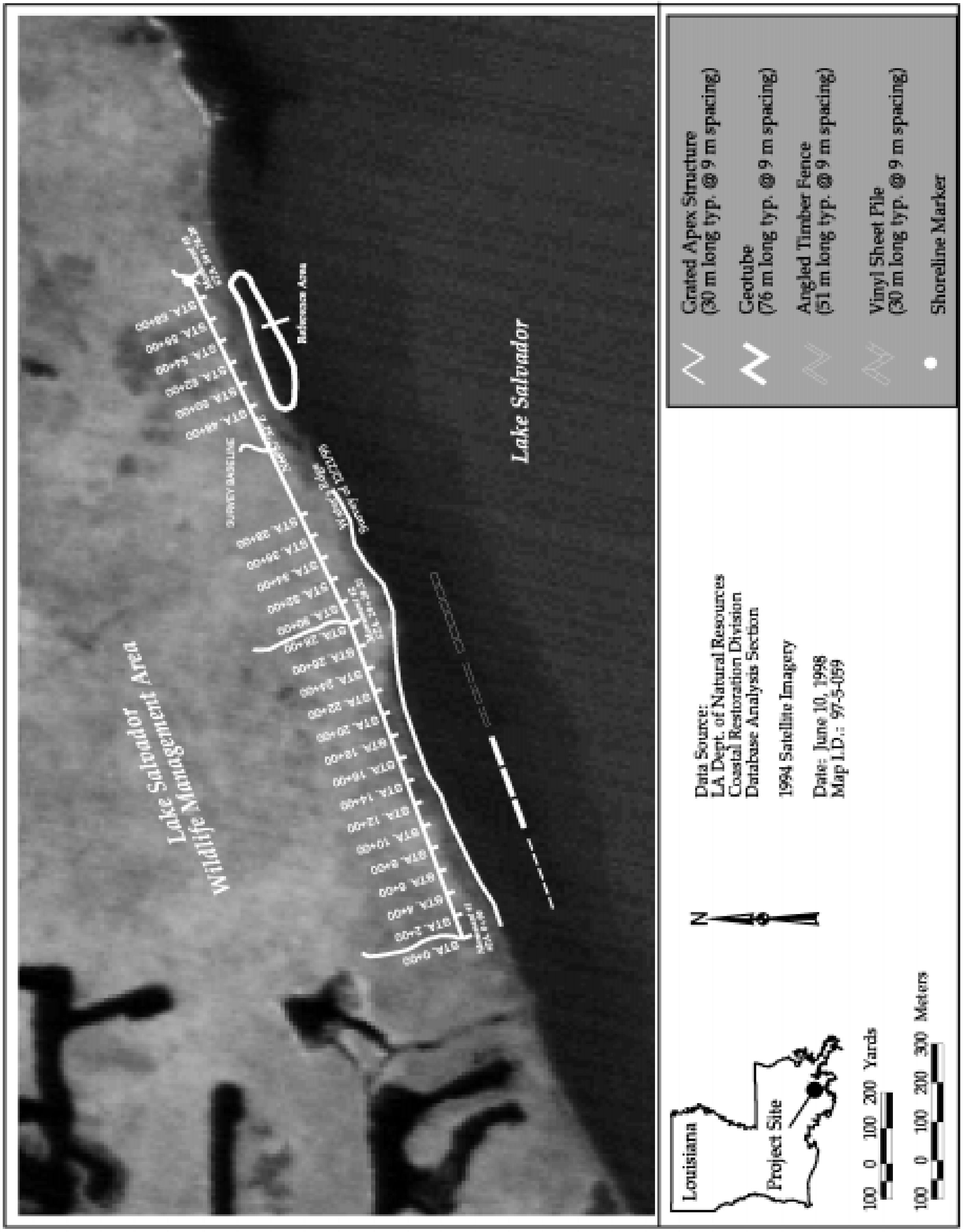

Figure 3. Lake Salvador Shoreline Protection Demonstration (BA-15) project area, reference area and structure type locations for Phase 1.

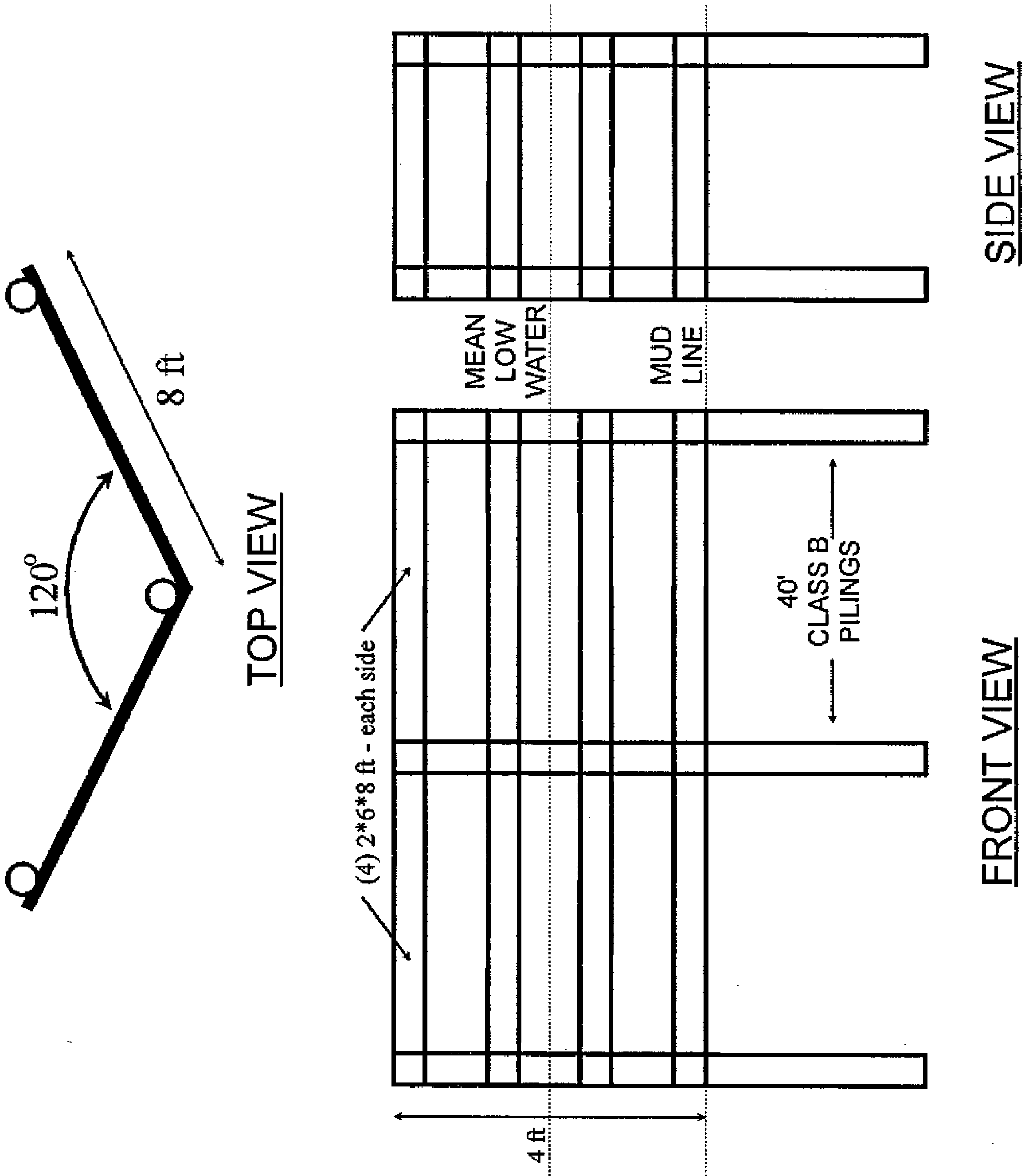

Figure 4. Lake Salvador Shoreline Protection Demonstration project - angled timber fence structure locations for Phase 1.

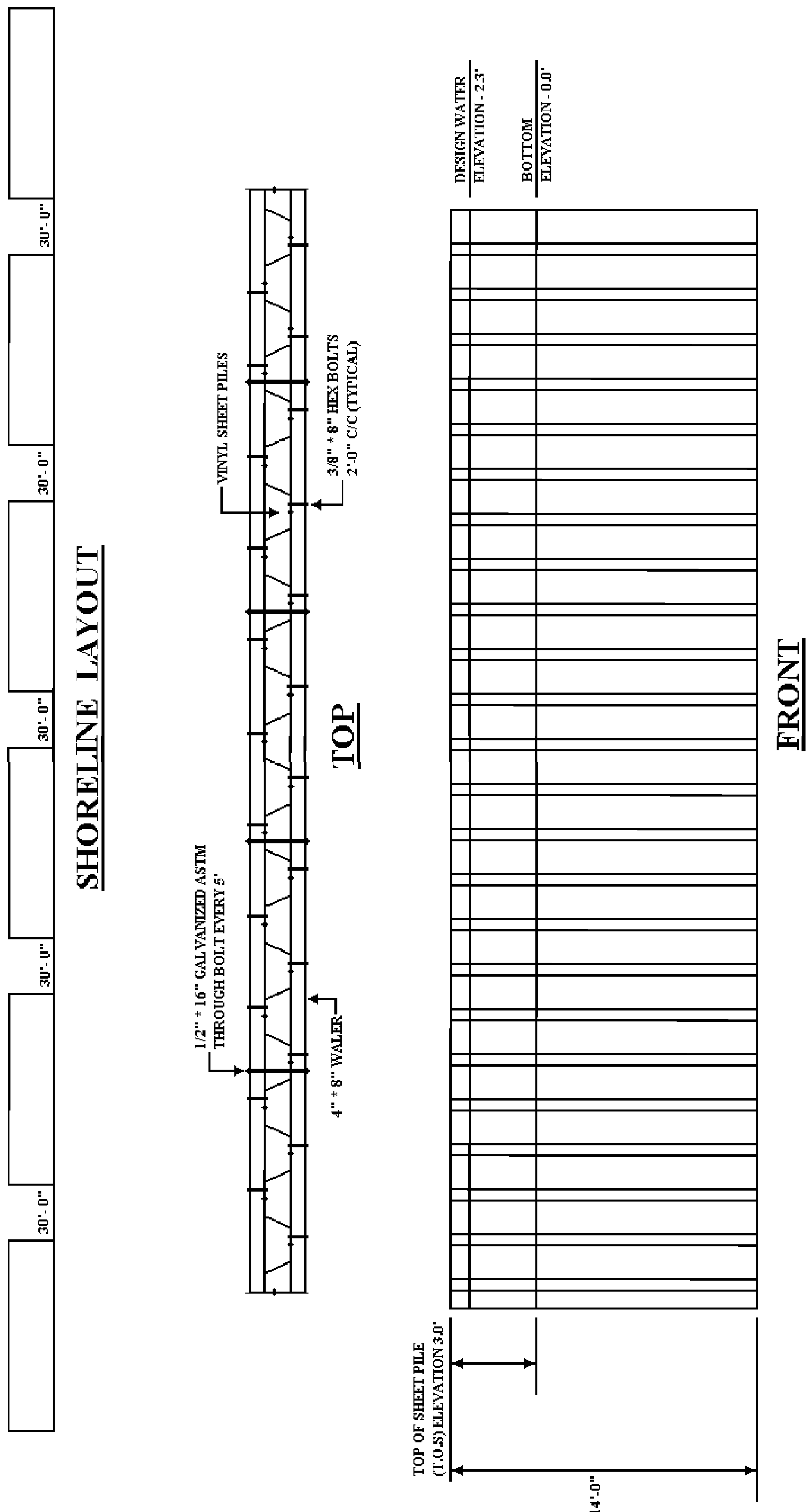

Figure 5. Lake Salvador Shoreline Protection Demonstration (BA-15) project - vinyl sheet piling structure locations for Phase 1.

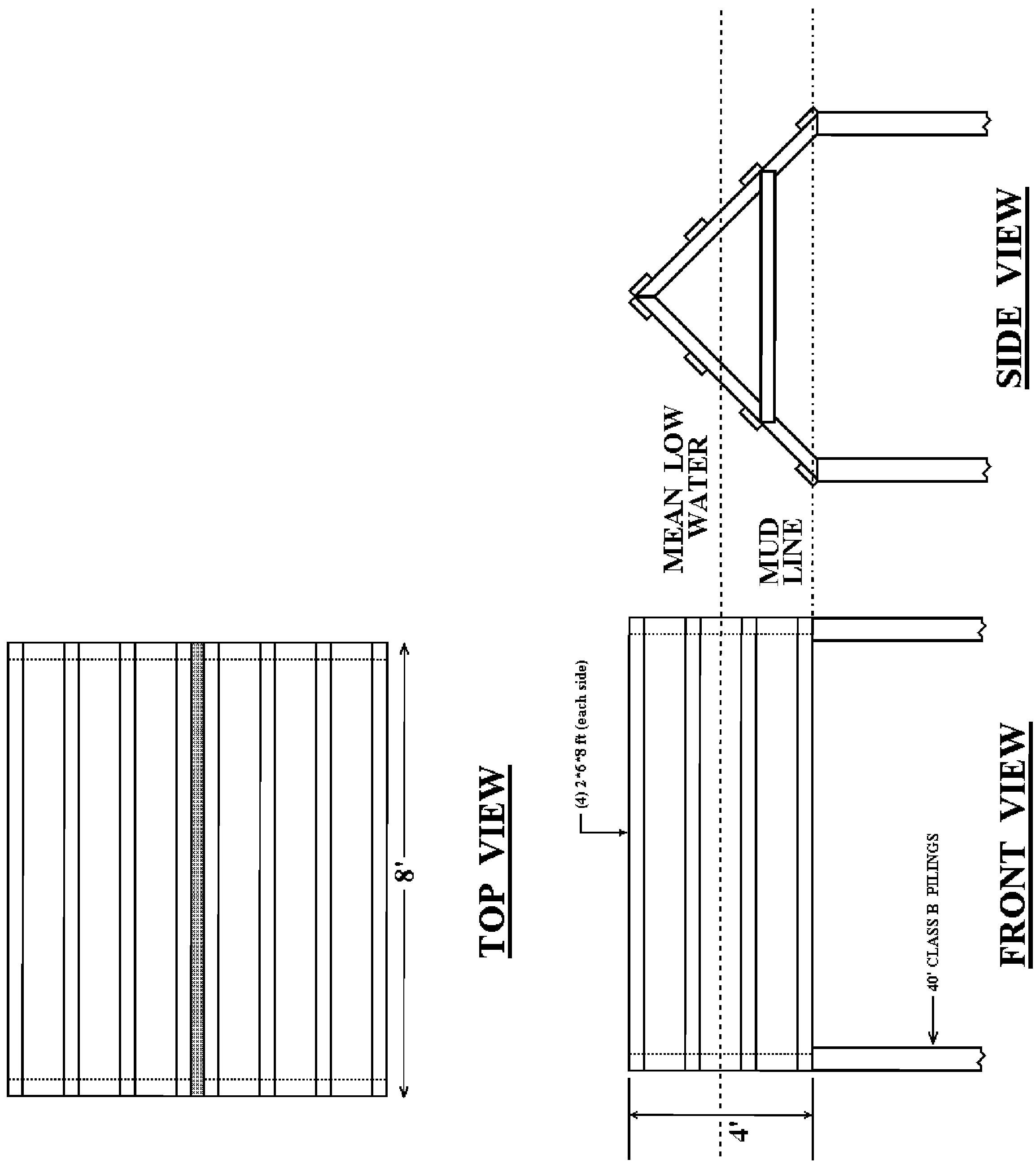

Figure 6. Lake Salvador Shoreline Protection Demonstration (BA-15) project - grated apex structure locations for Phase 1.

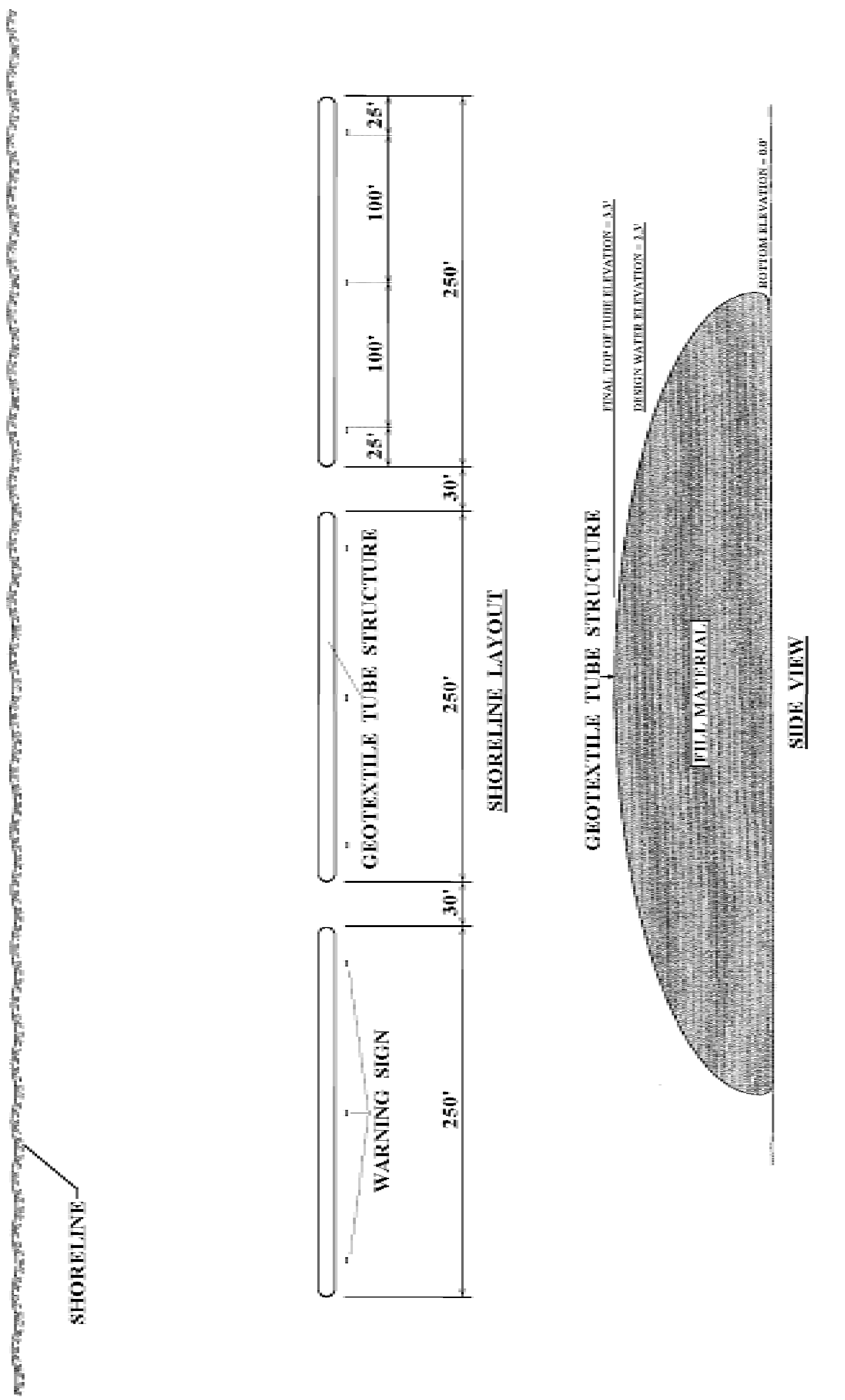

Figure 7. Lake Salvador Shoreline Protection Demonstration (BA-15) project - geotextile tube structure locations for Phase 1.

filled with a sand soil. The geotextile tubes combine together to form a structure similar to an earthen dike which dissipates the wave energy and prevents bottom scour by the waves.

Phase 2 of the Lake Salvador Shoreline Protection Demonstration (BA-15) project seeks to demonstrate the effectiveness of a large rock berm (figure 8) in highly organic, unconsolidated sediments with poor load bearing capacities. Unconsolidated sediments, such as those found in the Lake Salvador Shoreline Protection Demonstration (BA-15) project area, make traditional shoreline stabilization techniques ineffective. Structural components of the plan include:

- Approximately 10,000 ft (3,050 m) of rip rap shoreline protection structure (figure 9). The rip rap structure is a typical rock berm used as a wave dampening structure. The wave energy and pattern is dissipated by the structure.

Project Objective

1. Compare the effectiveness and ability to reduce erosion from tidal and wave energy of 4 different wave dampening devices and 1 shoreline protection device during a 5 year evaluation period.

Specific Goals

The following goals will contribute to the evaluation of the above objective.

1. Reduce wave height behind (shoreline side) the Phase 1 project wave dampening devices.

2. Reduce marsh edge erosion rate along the project shoreline for Phase 1 and Phase 2.

Reference Shoreline

The importance of using appropriate reference areas cannot be overemphasized. Monitoring on both project and reference areas provides a means to achieve statistically valid comparisons, and is therefore the most effective means of assessing project effectiveness. Various locations in the vicinity of the project shoreline were evaluated for their potential use as a reference shoreline. The evaluation of sites was based on the criteria that both project and reference shorelines have similar vegetative, soil, hydrology, shoreline configuration, and salinity characteristics (HNTB 1992). Approximately 1,000 ft (300 m) of shoreline located 1,000 ft (300 m) from the eastern end of the project areas for Phase 1 (see figure 2) and Phase 2 (1,000 ft [300 m] of the northeastern end of the project area) was chosen as the reference shorelines. Both the project shorelines and the proposed reference shorelines share the same hydrologic aspects, have similar vegetation, and are located along Lake Salvador where extensive shoreline erosion is occurring.

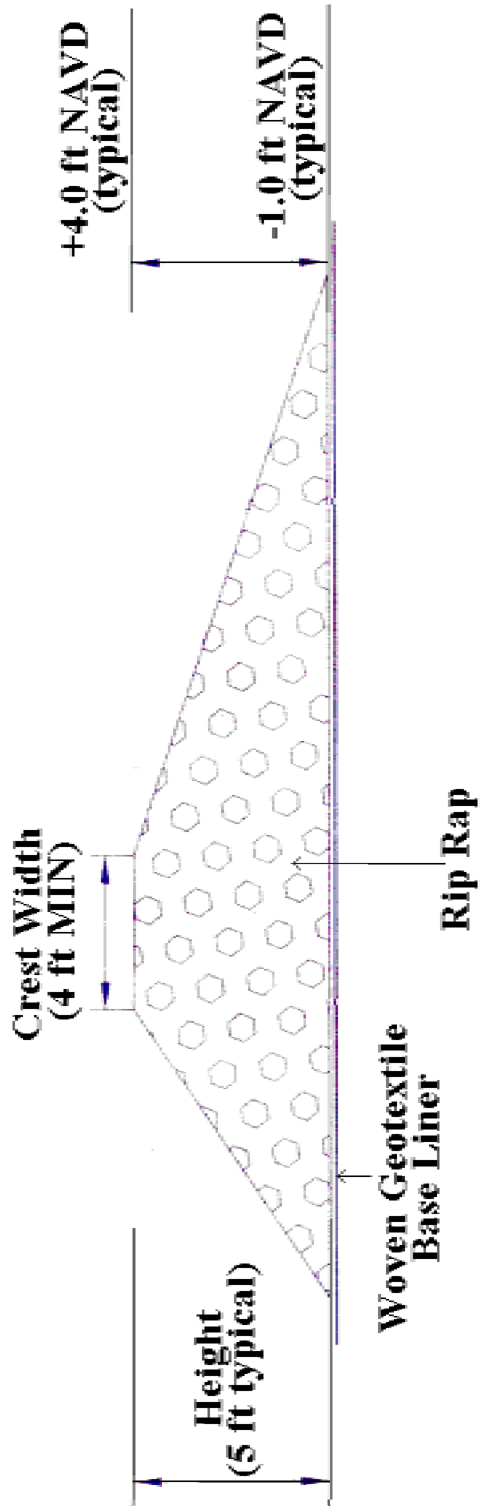

Figure 8. Lake Salvador Shoreline Protection Demonstration (BA-15) project - rip rap structure diagram for Phase 2.

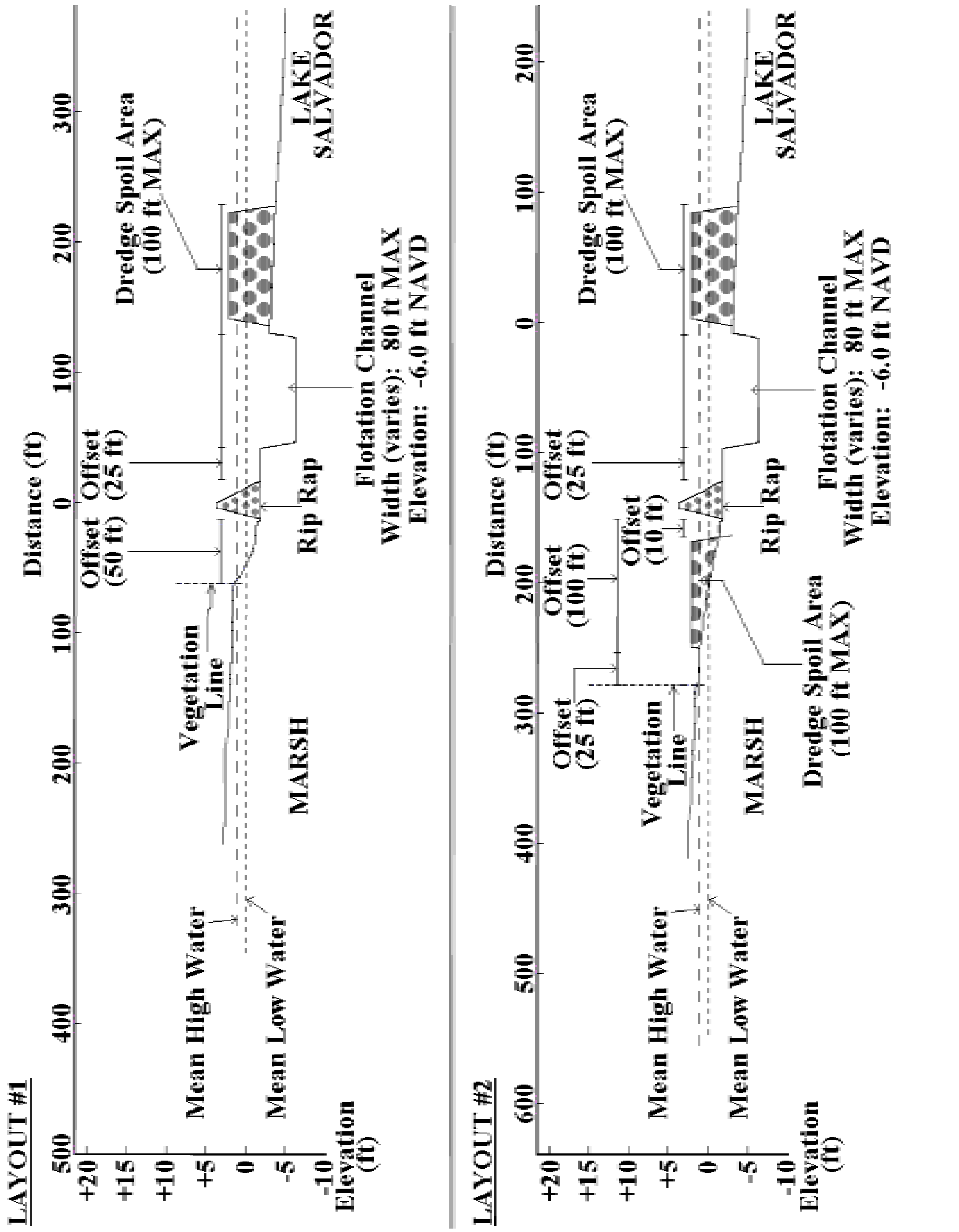

Figure 9. Lake Salvador Shoreline Protection Demonstration (BA-15) project - rip rap structure layouts for Phase 2.

Monitoring Elements

The following monitoring elements will provide the information necessary to evaluate the specific goals listed above:

1. Aerial Photography — To document vegetated and non-vegetated areas and marsh loss rates, color-infrared aerial photography (1:24,000 scale, with ground control markers) will be obtained by the Natural Wetlands Research Center (NWRC) for the project area. The photography will be georectified by National Wetlands Research Center (NWRC) personnel using standard operating procedures described in Steyer et al. (1995). Detailed photo-interpretation, mapping, and GIS interpretations will not be conducted. The photography will be obtained once prior to construction in 1994 and once after construction in 1997.

2. Wave Height — To evaluate the effectiveness and ability of the different Phase 1 project structures to reduce wave energy, wave height will be measured using continuous water level recorders. Stations will be established by placing replicate water level recorders in front (lake side) of each of the project structure types, along the project shoreline behind (shore side) each of the structure types, and along the reference shoreline. The wave height at the reference shoreline will be compared with the wave height at the project shoreline for each structure type. Additionally, the wave height in front (lake side) of each structure type will be compared to the wave height in back (shore side) of each structure type. Wave height data will be collected by measuring water level every 0.25 seconds for a 1-2 hour period. This data will be obtained every three months (seasonally) for post-construction years 1998 and 1999.

3. Shoreline Change — To evaluate marsh edge movement in the project and reference areas, differential GPS will be used to document marsh edge position using methodologies described in Steyer et al. (1995). GPS measurements will be taken once pre-construction in 1997, and in post-construction years 1998, 1999, 2000, and 2001 for Phase 1 and Phase 2. In addition, historical rates (as m/yr loss) of erosion will be obtained (e.g. Dunbar et al. 1992) and compared to erosion rates after project implementation.

Anticipated Statistical Tests and Hypotheses

The following hypotheses correspond with the monitoring elements and will be used to evaluate the accomplishment of the project goals where:

proj-1 = Phase 1 project area with grated apex structure (structure 1)
proj-2 = Phase 1 project area with geotextile tube structure (structure 2)
proj-3 = Phase 1 project area with angled timber fence structure (structure 3)
proj-4 = Phase 1 project area with vinyl sheet pile structure (structure 4)
ref-1 = Reference area for Phase 1.

1. Descriptive and summary statistics on historical data (1956, 1978, 1988) and data from aerial photography and GIS interpretation collected during post-project implementation will be used to evaluate marsh to open water ratios and marsh loss rates. If sufficient historical information is available, regression analyses will be done to examine changes in slope between pre- and post-construction conditions. These analyses will allow for the evaluation of goal 2 (above).

   Goal: Reduce marsh edge erosion rate along the project shoreline for Phase 1 and Phase 2.

2. The primary method of analysis for evaluating structure type effectiveness as a wave damping device will be to determine differences in mean wave height (DWH) (i.e., mean reduction in wave height) as evaluated by an analysis of variance (ANOVA) that will consider both spatial and temporal variation and interaction. Multiple comparisons will be used to compare individual means across different treatment levels. All original data will be analyzed and transformed (if necessary) to meet the assumption of ANOVA (e.g. normality, equality of variances). When the H_0 is rejected, the possibility of negative effects will be examined.

   Goal: Reduce wave height behind (shoreline side) the Phase 1 project wave damping devices.

   Hypothesis A:

   H_0: Mean difference in wave height at the Phase 1 project *k* or the reference shoreline at time *I* will not be significantly lower than the mean difference in wave height at any other shoreline at time *I*.

   H_a: Mean difference in wave height at the Phase 1 project *k* or the reference shoreline at time *I* will be significantly lower than the mean difference in wave height at any other shoreline at time *I*.

   If we accept the above null hypothesis, this indicates that none of the structures are effective. If we reject the null hypothesis, then we will test Hypothesis B.

   Hypothesis B:

   H_0: Mean difference in wave height for structure *k* on the Phase 1 project shoreline at time *I* will not be significantly lower than the mean difference in wave height at the reference shoreline at time *I*.

H_a: Mean difference in wave height for structure *k* on the Phase 1 project shoreline at time *I* will be significantly lower than the mean difference in wave height at the reference shoreline at time *I*.

If we accept the above null hypothesis for all four structures, then we will test Hypothesis C.

Hypothesis C:

H_0: Mean difference in wave height at the Phase 1 project *k* shoreline at time *I* will not be significantly lower than the mean difference in wave height at any other Phase 1 project shoreline at time *I*.

H_a: Mean difference in wave height at the Phase 1 project *k* shoreline at time *I* will be significantly lower than the mean difference in wave height for at least one other Phase 1 project shoreline at time *I*.

Pairwise comparisons will be performed among the sub-project areas to determine which structure is most effective at time *I* in reducing wave heights (WH). This will be accomplished through the testing of Hypothesis D.

Hypothesis D:

H_0: Mean wave height in back of the Phase 1 project *k* structure type at time *I* will not be significantly lower than the mean wave height in front of the Phase 1 project *k* structure type at time *I.*

H_a: Mean wave height in back of the Phase 1 project *k* structure type at time *I* will be significantly lower than the mean wave height in back of the Phase 1 project *k* structure type at time *I*.

3. The primary method of analysis for shoreline erosion (SE) will be to determine differences in mean erosion rates as evaluated by an analysis of variance (ANOVA) that will consider both spatial and temporal variation and interaction. Multiple comparisons will be used to compare individual means across different treatment levels. All original data will be analyzed and transformed (if necessary) to meet the assumption of ANOVA (e.g. normality, equality of variances). When the H_0 is rejected, the possibility of negative effects will be examined.

   Goal: Reduce marsh edge erosion rate along the project shoreline for Phase 1 and Phase 2.

Hypothesis A:

H_0: Mean shoreline erosion rate at the Phase 1 project *k* or the reference shoreline at time *I* will not be significantly lower than the mean shoreline erosion rate at any other shoreline at time *I*.

H_a: Mean shoreline erosion rate at the Phase 1 project *k* or the reference shoreline at time *I* will be significantly lower than the mean shoreline erosion rate at any other shoreline at time *I*.

If we accept the above null hypothesis, this indicates that none of the structures are effective. If we reject the null hypothesis, then we will test Hypothesis B.

Hypothesis B1:

H_0: Mean shoreline erosion rate at the Phase 1 project *k* shoreline at time *I* will not be significantly lower than the mean shoreline erosion rate at the reference shoreline at time *I*.

H_a: Mean shoreline erosion rate at the Phase 1 project *k* shoreline at time *I* will be significantly lower than the mean shoreline erosion rate at the reference shoreline at time *I*.

Hypothesis B2:

H_0: Mean shoreline erosion rate at the Phase 2 project shoreline at time *I* will not be significantly lower than the mean shoreline erosion rate at the Phase 2 reference shoreline at time *I*.

H_o: Mean shoreline erosion rate at the Phase 2 project shoreline at time *I* will be significantly lower than the mean shoreline erosion rate at the Phase 2 reference shoreline at time *I*.

If we accept the above null hypothesis, any negative aspects will be investigated.

Hypothesis C:

H_0: Mean shoreline erosion rate at the Phase 1 project *k* shoreline at time *I* will not be significantly lower than the mean shoreline erosion rate at any other Phase 1 project shoreline at time *I*.

H_a: Mean shoreline erosion rate at the Phase 1 project *k* shoreline at time *I* will be significantly lower than the mean shoreline erosion rate for at least one other Phase 1 project shoreline at time *I*.

Pairwise comparisons will be performed among the four sub-project areas to determine which structure is most effective at time *I* in reducing shoreline erosion rates. This will be accomplished through the testing of Hypothesis D.

Hypothesis D:

H_0: Mean shoreline erosion rate at the Phase 1 project *k* structure type at time *I* will not be significantly lower than the mean shoreline erosion rate at the Phase 1 project *j* structure type at time *I*.

H_a: Mean shoreline erosion rate at the Phase 1 project *k* structure type at time *I* will be significantly lower than the mean shoreline erosion rate at the Phase 1 project *j* structure type at time *I*.

Notes

1.	Implementation:	Start Construction:	June 30, 1997
		End Construction:	October 1, 1997
2.	NMFS Point of Contact:	Peggy Jones	(504) 389-0508
		Terri McTigue	(318) 482-5915
3.	DNR Project Manager:	Kenneth Bahlinger	(504) 342-7362
	DNR Monitoring Manager:	Dan Smith	(504) 447-0974
	DNR DAS Assistant:	Chris Cretini	(504) 342-0277

4. The twenty year monitoring plan development and implementation budget for this project is $88,809. Progress reports will be available in October 1998, October 1999, October 2000, and October 2001, and a comprehensive report will be available in October 2002. These reports will describe the status and effectiveness of the project.

5. Available ecological data, both descriptive and quantitative, will be evaluated in concert with all of the above data and with statistical analysis to aid in determination of the overall structure effectiveness.

6. Any additional sources of data (i.e., LDWF, Corps of Engineers, LDHH, NRCS, etc.) will be used to better develop monitoring protocol and in evaluation of structure effectiveness.

7. References:

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