STORM DRAIN REPLACEMENT USING A SALT MARSH IN BILOXI, MISSISSIPPI

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INTRODUCTION

A wetland is defined by 40 C.F.R. (Code of Federal Regulations) 230.3 as "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas." A tidal salt marsh is simply a marsh that is within the tidal range of an ocean.

This project began in the fall of 1991. A group of seniors from the Landscape Architecture Department at Mississippi State University were invited by the City of Biloxi, Mississsippi, to survey the Mississippi Gulf Coast area and offer suggestions and improvements that could be made in order to increase tourism into the coastal area. One of the suggestions was to remove from the beach storm sewers that run from the sea wall out into the Mississippi Gulf Coast Sound area. Many visitors and residents mistakenly believe that the storm sewers conduct municipal waste. The appearance of the storm sewers, and this mistaken perception as to their function, has diminished the attractiveness of the beaches. The Landscape Architecture students suggested that the storm drains be replaced by a more natural "wetland" type drainage system. This system would still allow the storm water runoff to be routed into the Gulf, while offering a more aesthetically pleasing beach area.

Design problems associated with wetland restoration are, in general, relatively uncomplicated and have been implemented successfully in other locations. Extensive literature on the establishment of *Spartina alterniflora* marshes on sand-dominated dredge spoil along the North Carolina coast is an additional resource of project information. East coast and Gulf of Mexico marshes seem to be similar in structure and function. Thus, much of the information on transplanting of *S. alterniflora* in North Carolina should be applicable to its establishment in Mississippi.

A unique feature of this particular problem is the small size of the system which was constructed. Patterns of beach use by residents and visitors mandated that the salt marsh remain a minor feature on the beach landscape. The small size (~ 1/2 acre) made the salt marsh vulnerable to substantial disruption by events that would represent minor perturbations in a larger system.

The following represents a chronicle of the first year of this project. It should be noted that this is very much a "project in progress" and has been a significant learning experience for all of the participants.

THE HISTORICAL COASTLINE

The manmade beach that stretches across the interface between the mainland of Harrison County and the Mississippi Sound replaces an original fringe that long ago would have included extensive emergent vegetation characteristic of a salt marsh. By the early 1900s, as a result of human activity, this vegetation was reduced to pockets interspersed with bare, narrow, and muddy beaches.

The seawall at Biloxi and Gulfport, Mississippi, was built between 1915 and 1928 to stabilize the shoreline. In 1951, sand was pumped onto the site to protect the seawall. The 55 to 75m artificial beach has been replenished at roughly ten year intervals by the Corps of Engineers. Littoral drift, storms, and the occasional hurricane have been responsible for most of the beach erosion. Upbeach dunes were begun in 1986. Existing dune vegetation include *Panicum amarum*, *P. repens*, and *Uniola paniculata*.

The Mississippi Sound receives drainage from an extensive system of estuarine wetlands. The Mississippi coastal estuaries are among the most productive and commercially important ecosystems in the United States. The estuaries that ring the Gulf of Mexico provide spawning grounds for 95 percent of the fishes that are caught there. The U.S. Fish and Wildlife Service and the Mississippi Department of Marine Resources has made preservation and enhancement of these habitats a high priority. Re-establishment of small salt marshes along the 26 mile manmade beach is clearly in concert with these goals.

MARSH CONSTRUCTION

The salt marsh site was selected by representatives of the Sand Beach Commission and the Biloxi Area Chamber of Commerce. The site (Figure 1) was bordered on the north by Mississippi Route 90, the sea wall, and a line of sand dunes. A 36 inch concrete drain pipe carried water from a system of storm drains north of the sea wall to the Mississippi Sound. Marsh construction occurred during late March - early April 1995.

The first event in the construction process was a human error that was to have far reaching consequences. As a result of a miscommunication, the construction crew responsible for preparing the site mistakenly removed a section of the protective dune immediately upbeach from the proposed site. The crew then, correctly, broke the drain pipe, plugged the lower portion with sand bags, installed a 10 foot long section of concrete pipe to divert stormwater to the west, and enclosed the break site in a block and cement structure (Figure 2).

Figure 1. Site of the small salt marsh constructed in Spring, 1995.

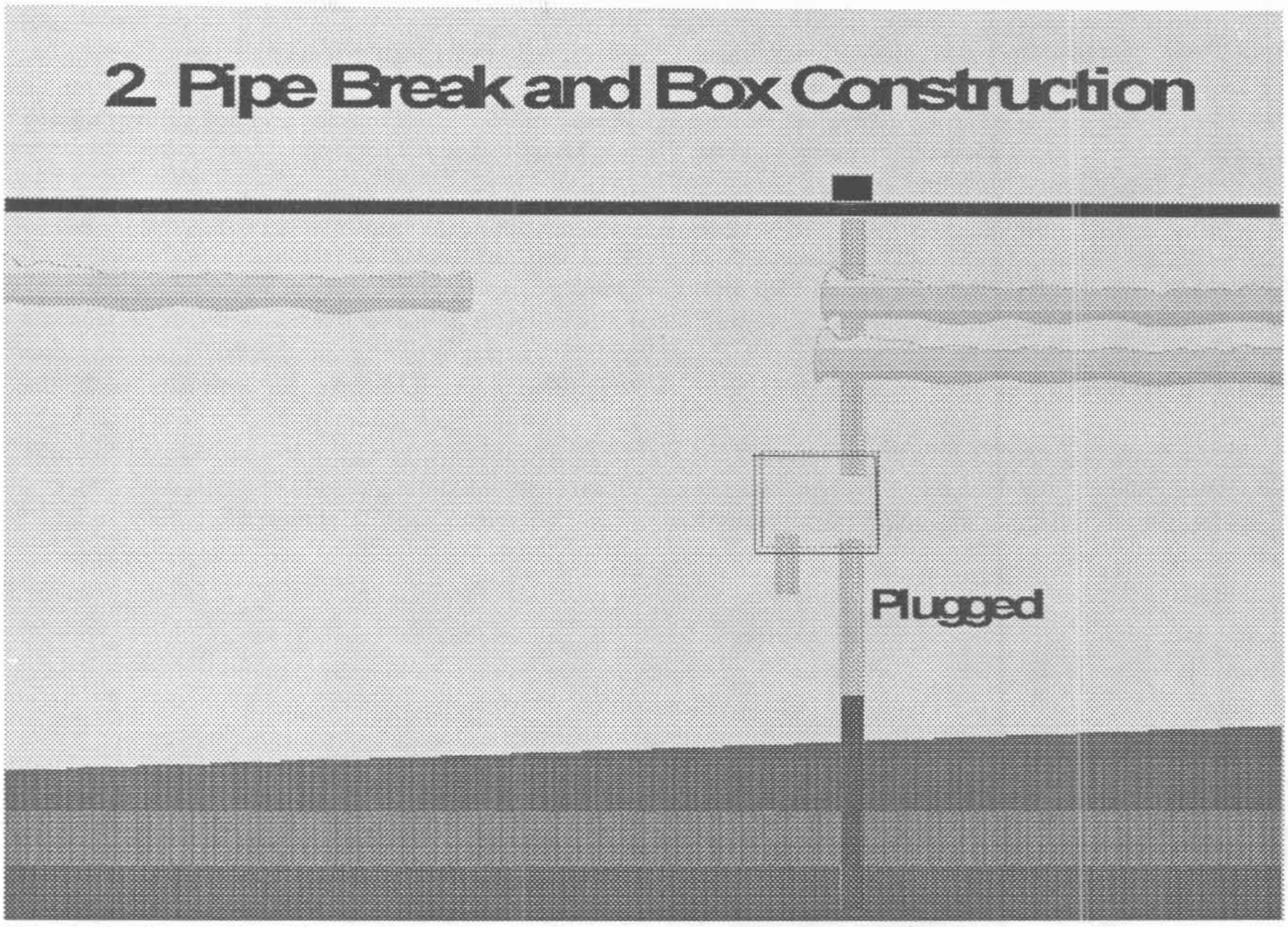

Figure 2. Marsh site under construction.

The marsh planting was conducted by students from Mississippi State University, a local high school, representatives of the Chamber of Commerce, and the authors (Figure 3). Low marsh plants, primarily *Spartina alterniflora*, were placed at the lowest elevation. Upper marsh plants, primarily *S. Patens*, were placed at the periphery. Upper beach plants, consisting of *Panicum spp.*, were placed to the northwest to begin a series of protective dunes (Figure 4). Fiber mats were used to help stabilize the low marsh plantings. The actual planting was completed in 6 hours.

Figure 3. Marsh construction, Spring, 1995.

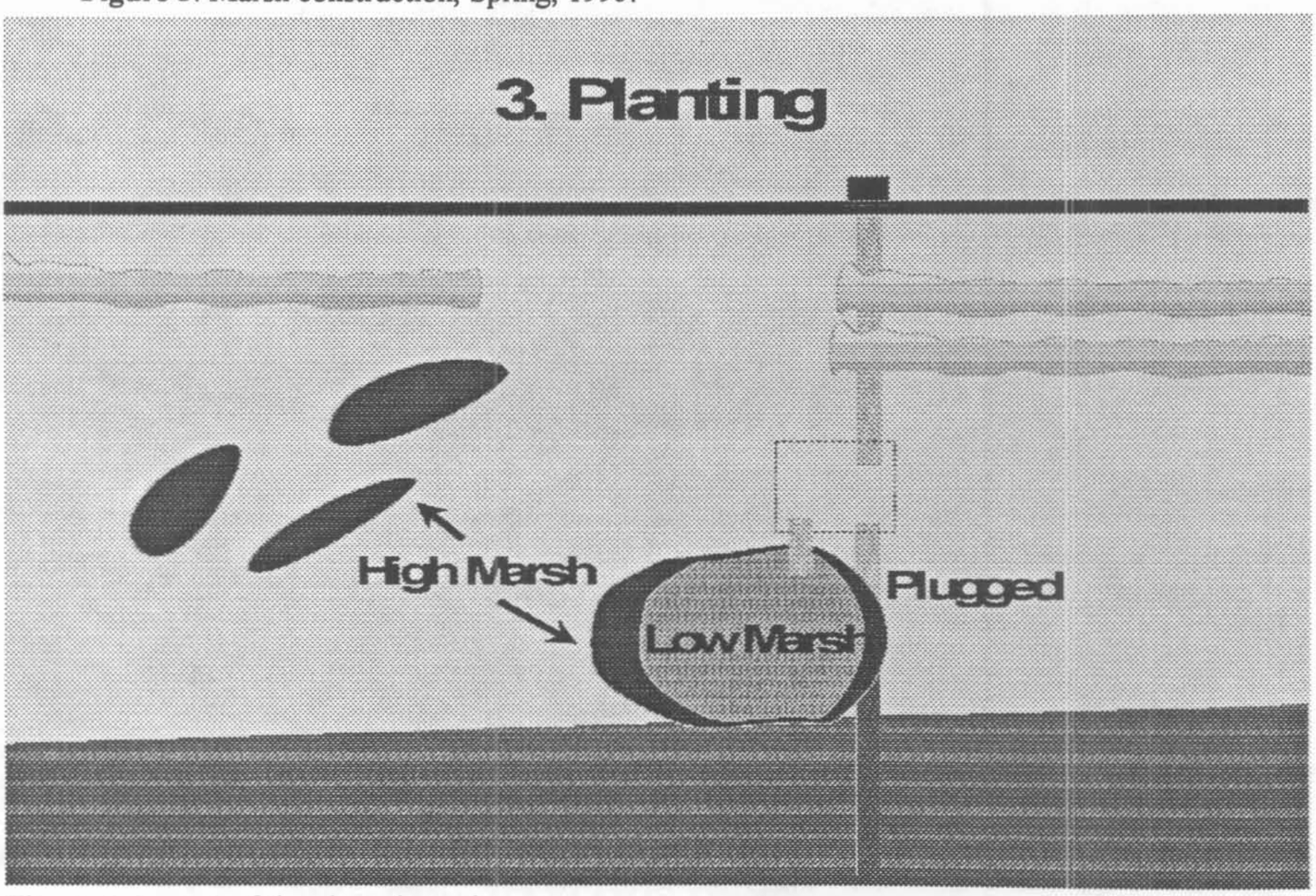

Figure 4. Layout of the planted marsh.

MARSH DEVELOPMENT

During the first year, there has been substantial progress toward the development of a naturally functioning salt marsh (Figure 5).The planted vegetation withstood several severe storm tides, took root, and began the natural process of accumulating detritus. The accumulated detritus provides mineral nutrients and organic matter and retains fresh water for further community development. The invading plant species thus far have primarily consisted of annuals that naturally invade bare littoral habitats. Even at the earliest stages, the habitat diversity provided by the planted vegetation was attractive to birds. As the process of succession continues, the new salt marsh will grow in significance as a natural filter for materials flowing into the Mississippi Sound and as habitat for an increasing variety of vertebrate and invertebrate organisms. With further development, the site may become productive as a nursery for aquatic animals.

As mentioned above, the inadvertent removal of the sand dunes to the north of the site had serious and unforeseen consequences. It became apparent afterward that the section of beach immediately to the north of the removed section represented a topographical low spot along the seawall. Rainwater flowed to the site of the gap from the east and west. The gap, once created, acted as an efficient conduit for transporting the accumulated rainwater through the dunes and directly onto the marsh site. The transport of the rainwater alone may not, of itself, have been very damaging, as the fiber mesh appeared to do an excellent job stabilizing the sand. The primary source of damage was the sand transported with the rainwater which was largely deposited on the western half of the marsh. This section was almost completely buried by up to 12 inches of sand. Virtually all of the plant mortality experienced in the salt marsh during the first year was directly attributable to erosion of the upbeach sand and subsequent deposition on the site.

The occurrence of record rainfall during May 1995 (over 16 inches) provided a graphic illustration of the seriousness of the above problem. Plans to reconstruct the dunes were made the following month, but it

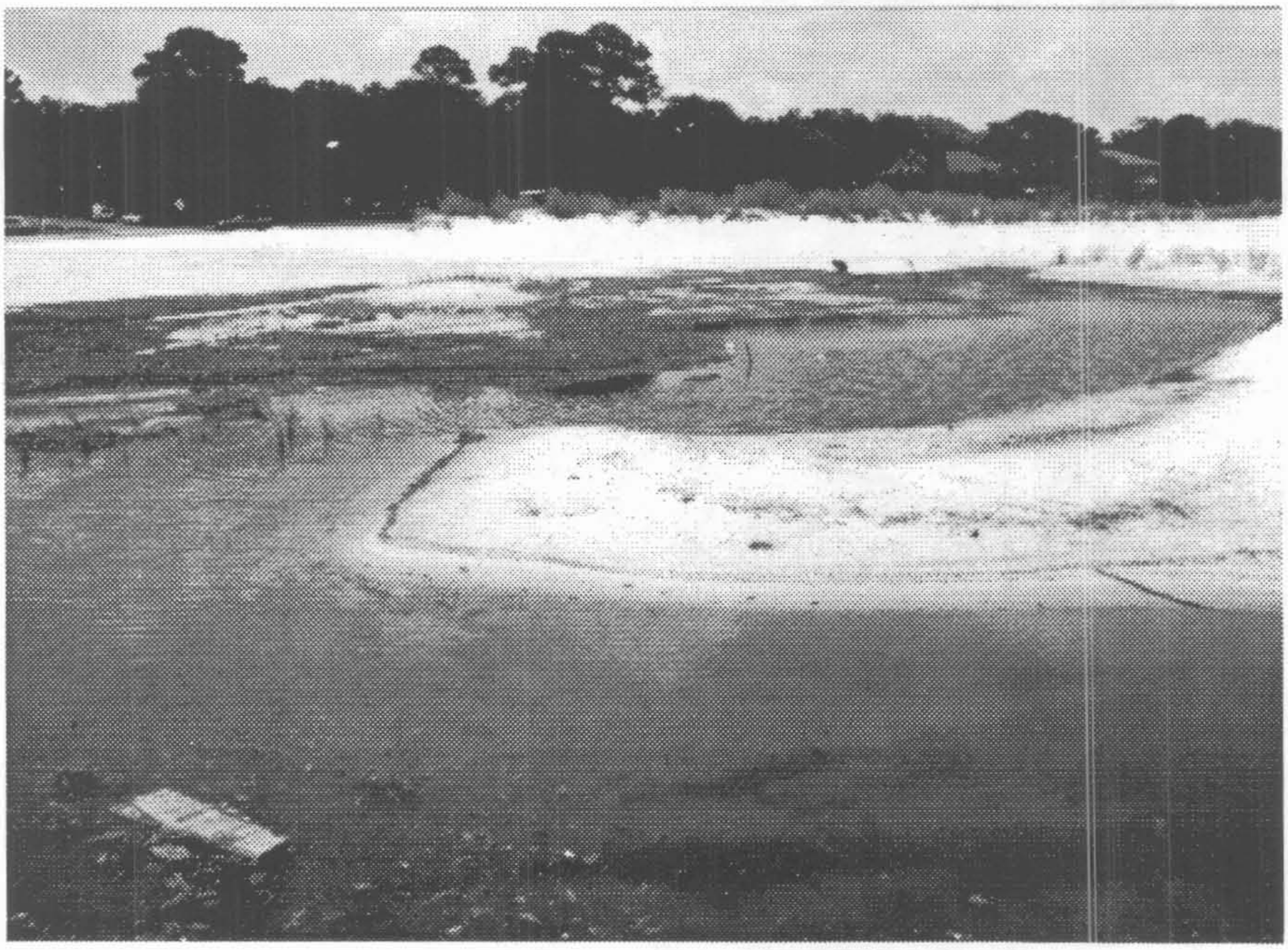

Figure 5. The constructed salt marsh after several months exposure to weather and tides.

was not until October that the plans could be put into effect. At that time, additional matting and plants were used to largely close the gap in the dunes. An "S" shaped path was left through the dunes in order to decrease the velocity and thus the sand transporting capacity of rainwater draining from the north of the dunes. To date, it looks as though the dune repair has succeeded; dune growth appears to be underway and upbeach erosion appears greatly diminished.

Once the dunes were rebuilt and proven to be effective in controlling the runoff and sand deposition problem, the salt marsh began to stabilize. It has assumed the same physiographic condition for the last six months. Despite the physical damage caused by the channeling, a pattern had become apparent by July. The marsh pool at the end of the conduit developed into a bayou meandering west approximately 75 feet along the berm of the beach (Figure 5). During dry periods, the berm acts as a levee to the bayou, creating a pool of standing water. Following heavy rains, the "levee" is breached and outflow occurs. Diurnal tidal ranges of approximately 1.5 feet do not appear to routinely flush the marsh. They do, apparently, result in seepage through the berm sufficient to maintain existing salt marsh plants.

DISCUSSION

When this project began, there was general agreement that 30 to 40 percent survival of the plants during the first year would be considered quite good. The smallness of the marsh made it vulnerable to large scale damage by small scale events. The inherent instability of the beach environment and potential erosion at the conduit outfall site both appeared likely sources of damage. It came as a big surprise, then, that the principal source of damage to the marsh was human error. The expected calamities simply did not occur. The marsh has proven remarkably resilient in the face of record rainfall and a long and hot summer.

As mentioned, the project participants have learned much about beachfront marsh design criteria from work on this prototype salt marsh. It is likely that second generation constructed marshes would differ substantially from the prototype, both with respect to morphology and placement on the beach.

It is too early to predict whether the constructed salt marsh will provide a practical alternative to the storm drains. The prototype marsh has not, as yet, demonstrated that it will persist, much less flourish, as a beachfront entity. The resilience of the marsh in the face of expected and unexpected stressors is encouraging. If this approach can be shown to be viable, then the potential exists for small constructed salt marshes to provide a number of direct and indirect benefits to the man made beach. Direct benefits would include removal of unsightly drain pipes, increased visual diversity, improved aesthetics, and a more natural appearance. Potential indirect benefits might include treatment of stormwater runoff via naturally occurring wetland processes, increased wildlife abundance and diversity, and possibly some enhancement of local fisheries. If all 200 drains were replaced with marshes that were 100 feet wide, then almost 4 miles of salt marsh would be added to the 26 mile beach. This would still leave approximately 600 feet between successive marshes for recreational activities.