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Habitat Enhancement and Protection
Shamrock Island, Corpus Christi Bay, Texas

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Shamrock Island, located in Nueces County, Texas, is experiencing severe erosion. The Island, which was acquired by the Nature Conservancy in early 1990s, contains unique bird habitat and valuable wetlands. The Conservancy, in cooperation with a consortium of state and federal agencies obtained funding for a habitat restoration and protection project. Shiner Moseley and Associates, Inc. (SMA) was engaged to provide engineering services that included planning, permitting, design, and construction observation. The remedy involved a 4,000-foot, sand-filled geotube breakwater, five acres of newly vegetated wetlands, and a 90,000-cubic yard feeder bench to ensure the continued existence of the only royal tern nesting beach in south Texas. The project was completed in early 1999 at a total cost of $750,000, and formally dedicated by Land Commissioner David Dewhurst on April 7, 1999.

Introduction

Shamrock Island is in eastern Corpus Christi Bay, about two miles west of Mustang Island, a barrier island that separates it from the Gulf of Mexico. Shamrock Island is exposed to occasional strong winds generated by winter low- pressure fronts, or "northers," and ship surges from vessels in the Corpus Christi Ship Channel. See Figure 1 for a general location map.

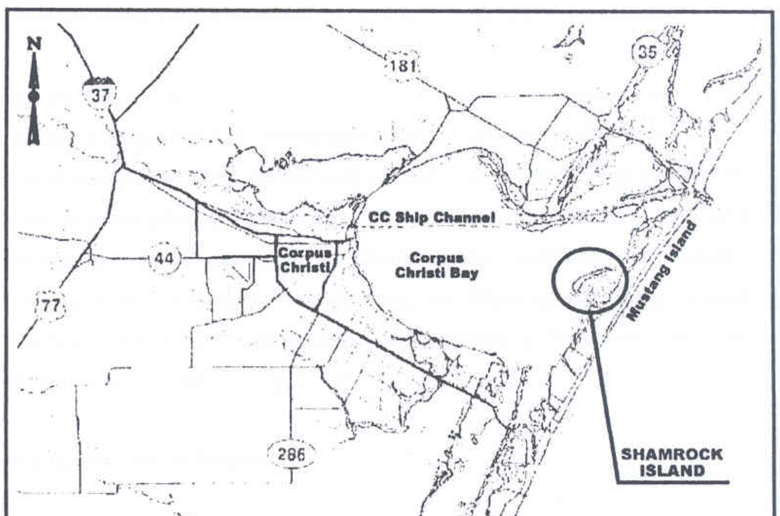

Figure 1 – Location Map
Shamrock Island, Texas

Shamrock Island is undeveloped and widely regarded as some of the best aquatic and colonial waterbird habitat in south Texas. The Island was formed as a spit and was once connected to Mustang Island by a "land bridge" at its north end. It became detached following construction of navigation channels through the Island around 1951 and erosion by Hurricane Celia in 1970. Since its detachment from Mustang Island, the north and northwest areas of Shamrock Island have experienced considerable beach erosion and loss of wetlands, losing approximately 17 acres between 1950 and 1997. Figure 2 shows the shoreline changes that have occurred between 1956 and 1995. The beach area at the southern end of the Island is the only nesting area for the royal tern in south Texas.

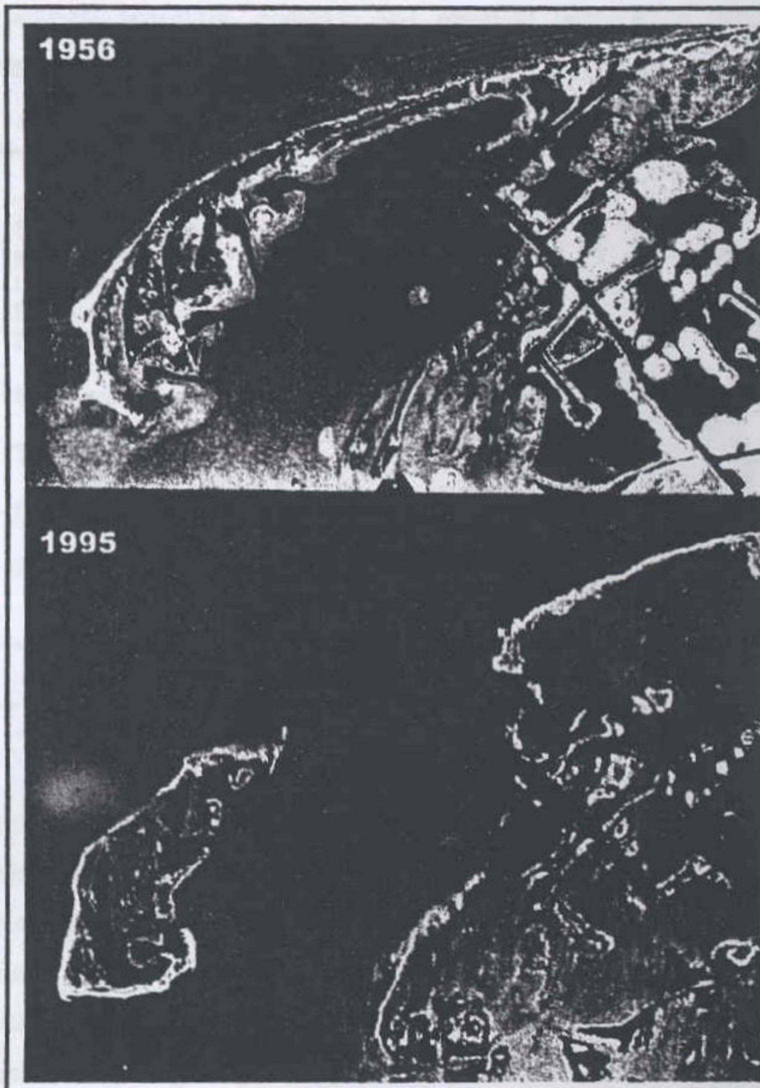

Figure 2 – 1956 and 1995 Aerials
Shamrock Island, Texas

Recognizing the unique ecological role of Shamrock Island, the Nature Conservancy acquired the Island in the early 1990s from private interests. By the mid-1990s it became apparent that erosional breaches were imminent and would significantly increase the rate of habitat loss. The Conservancy and other responsible agencies worked together to structure a financial package involving funds from a number of sources, including the U.S. Fish and Wildlife Service, the U.S. Army Corps of Engineers (via fines paid by violators who had damaged state-owned lands), the Texas Audubon Society, and the Coastal Bend Bays Foundation, to pay for the necessary protective and enhancement measures.

Using the Texas General Land Office as the primary contracting entity, the consortium engaged SMA to provide professional engineering services to execute the project, which included: (a) working with the sponsors to develop an effective erosion response plan; (b) seeking permit approvals; (c) preparing plans and specifications; and (d) providing construction phase assistance that included bidding assistance, construction observation, etc. Planning and design started during May 1998, bids for construction were obtained in November 1998, and construction was completed in March 1999.

Planning and Design Process

A project such as this that involves habitat protection/creation in a dynamic and complex coastal situation is always interesting. In this case, a major challenge was to provide a "cure that wasn't worse than the disease." For example, the initial solution seemed simple -construct some type of shore protection system such as an offshore breakwater or groins along the north and northwest sides of the Island where the erosion was occurring. BUT, the critical royal tern nesting beaches are at the south end of the island and are continually supplied by sand that erodes from the north end. Thus, the obvious remedy would have cut off the sediment supply from the north end, resulting in the destruction of the royal tern nesting area. Consequently, the challenge became to find a way to protect the north end from erosion, while maintaining a sand source for the downdrift beach. The solution was a detached breakwater and a feeder beach with some constructed wetlands.

A systematic approach was undertaken to define existing conditions, options, and formulate a preferred alternative. Figure 3 illustrates how knowledge of physical processes, ecology, and practical engineering design must be combined to devise an effective, practical, and affordable remedy.

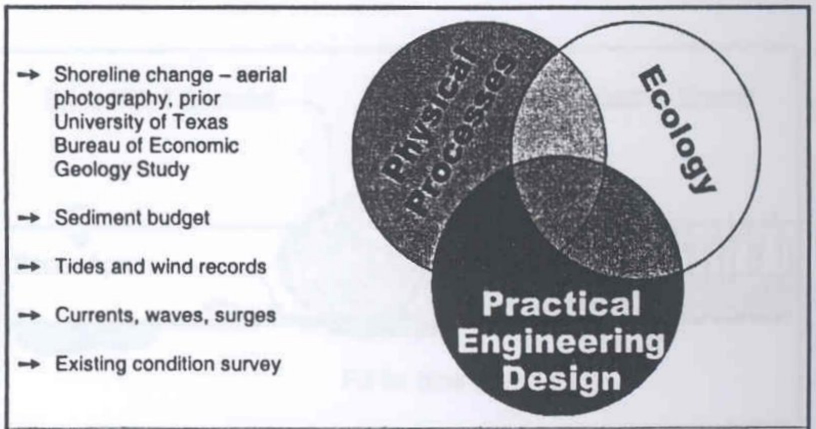

Figure 3 –Data Requirements, Analyses

The multidisciplinary team approach is absolutely critical in developing the best solution. Besides the agencies previously mentioned and SMA staff that included coastal engineers and biologists, the University of Texas Bureau of Economic Geology provided input on physical processes. Such diverse often makes for some interesting meetings; however, it ensures that all view expressed and all options are considered, resulting in a favorable outcome.

The Remedy, "Preferred Alternative"

Figure 4 is an oblique aerial illustrating the design that was adopted with the features of the completed project. The offshore breakwater was constructed of 4,000 linear feet of 30-foot circumference geotube. It was filled with approximately 8,000 cubic yards of sand from the remnants of the land bridge. The sand was pumped from a source that was about 4,000 feet away using a l0-inch hydraulic dredge. The typical fill rate was 200 linear feet per day or about 500 cubic yards per day.

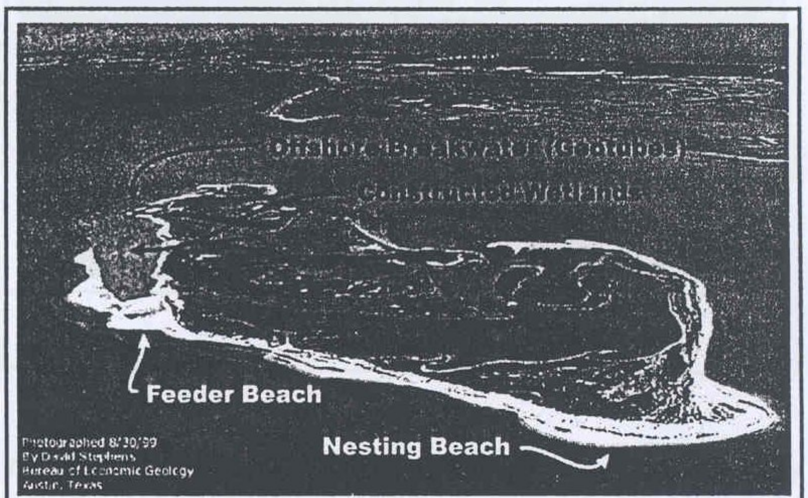

Figure 4 – Aerial with Project Features
Shamrock Island, Texas

Geotubes are sometimes referred to as "sand socks," implying that design and installation is simply a matter of pumping sand into a tube until it is full. As is often the case with such deceptively simple concepts, the "devil is in the details." Geotubes are no exception.

A schematic section through the geotube breakwater is shown in Figure 5 and illustrates the major components. The scour apron, which is held in place by smaller geotubes, is needed to prevent undermining of the main tube. The primary tube is constructed of a woven geotextile fabric and is filled with sand that is pumped into the tube with a hydraulic dredge. The shroud is a non-woven fabric designed to protect the exposed portion of the geotube above the waterline from ultraviolet rays. If the shroud deteriorates, it can be replaced much easier than the geotextile tube.

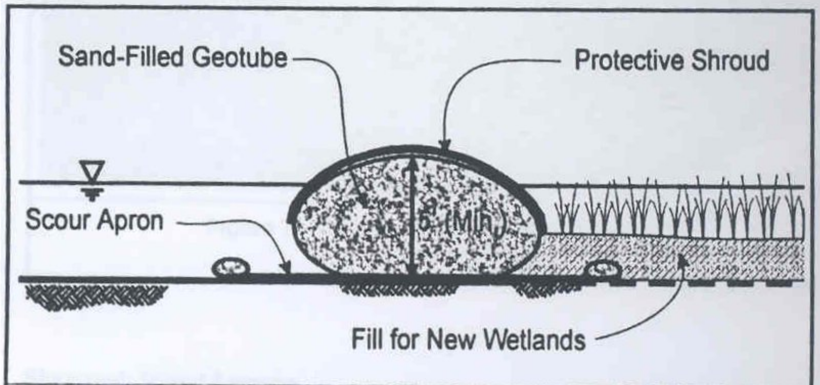

Figure 5 – Typical Geotube Section for Breakwater Application
Shamrock Island, Texas

Because of the numerous critical construction considerations, installation of a geotube requires an experienced marine contractor. Dredge pumping rates are limited and at times must suddenly be suspended, a situation very difficult in dredging operations. The remedy is to have a way to quickly divert part or all of the pumped material to another location. In the Shamrock Island case, the solution was simple: put a Y-valve in the line and route the material to the area being filled for wetlands and feeder beach construction. Other concerns may include anchoring the scour apron adequately, filling of the tube uniformly, preventing rolling of the tube during filling, coping with ship surges, working in a remote and exposed area, etc. Figure 6 shows the hydraulic filling of a geotube at Shamrock Island.

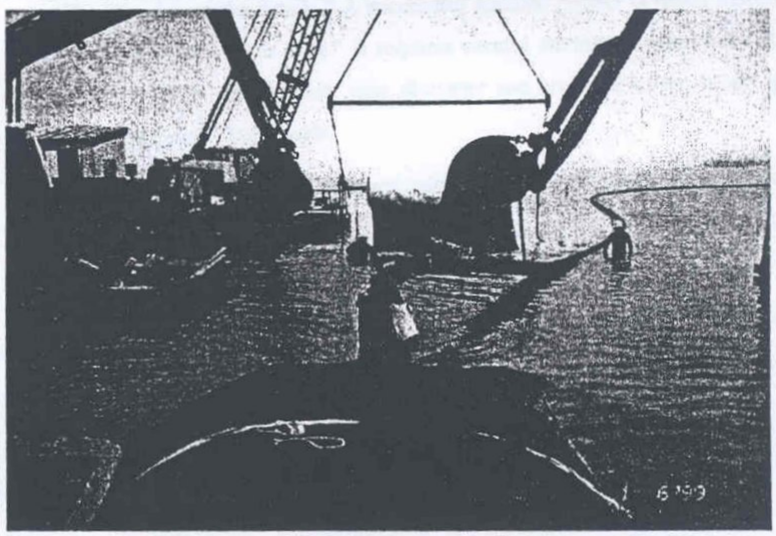

Figure 6 – Hydraulic Filling of Geotube
Shamrock Island, Texas

The feeder beach was constructed by placing 90,000 cubic yards of sand outside the breakwater along the northwest side of the island. The source of the feeder beach sand was the former land bridge, similar to the sand that was pumped into the geotubes and placed in the wetlands creation area. The beach will be monitored to determine when renourishment is needed. Based on past erosion rates, it is expected that future dredging will be required to replenish the beach in about three to six years.

The new wetlands total approximately five acres and were created by placing approximately 10,000 cubic yards of sand behind the geotube. The area was filled to intertidal depth and planted with mixed vegetation. Figure 7 shows sand placement for the wetlands.

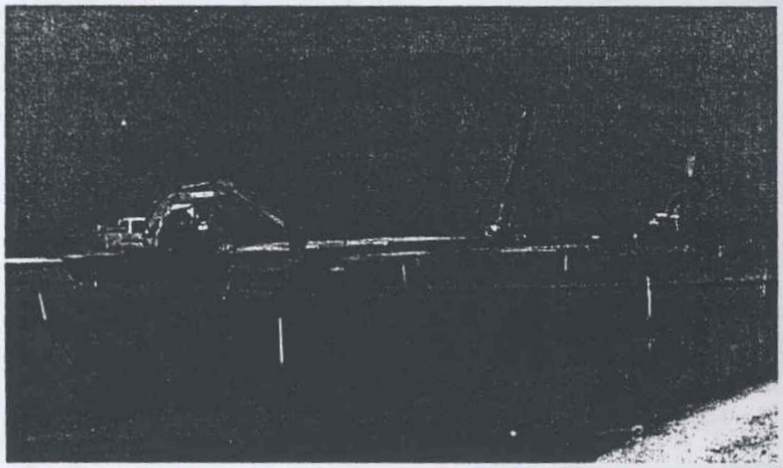

Figure 7 – Placement of Sand for Wetlands
Shamrock Island, Texas

Shamrock Island Lessons

Several guidelines for habitat design and construction were reinforced:

- A team approach involving multiple disciplines is critical in planning, designing, and executing a complex habitat creation project. The team should remain intact throughout the construction phase to resolve unforeseen problems.
- A thorough understanding of the underlying physical processes is critical to avoid a cure that is worse than the disease.
- Quantitative evaluation of the physical processes is needed that includes an analysis of the effects of the different proposed remedies. Without such an evaluation, the design process can degenerate into a debate of opinions, which is not likely to result in the best solution.

Successfully working with geotubes also requires adherence to several basic principals:

- The "devil is in the details," A successful geotube project is much more than "pumping sand into a sock." It requires careful attention to numerous items such as fabric specification, tube diameter and crest elevation, scour apron anchoring, and other details.
- Geotubes can provide a well-functioning and relatively inexpensive option for many habitat creation and shoreline protection problems, but they are not a universal remedy and do have their limitations.
- Geotube installation requires an experienced marine contractor. This is especially true when the project is located in a relatively remote area exposed to waves and ship surge.

Diverse Geotube Applications

Shiner Moseley and Associates and its professionals have been involved in applying geotubes to a wide range of applications, each of which has provided its own array of lessons. Several examples are listed below.

- Over eight miles of geotubes have been installed as sand dune cores on Galveston Island and Bolivar Peninsula, Texas. These tubes are located landward of the public beach and are intended to provide storm protection for public infrastructure and adjacent property. Figure 8 shows a dune core geotube before it is covered with sand and vegetated. When these are placed in an eroding area, it is absolutely critical that beach nourishment also be provided to protect against undermining, thereby providing a useable public beach. Geotubes may be filled mechanically as well as hydraulically; Figure 9 shows one method of mechanical filling.

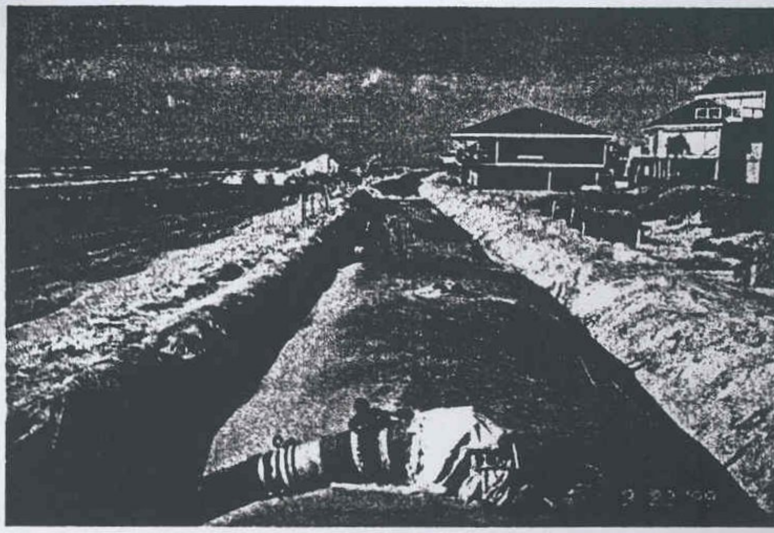

Figure 8 –Geotube Dune Core Prior to Planting and Covering
Galveston Island, Texas

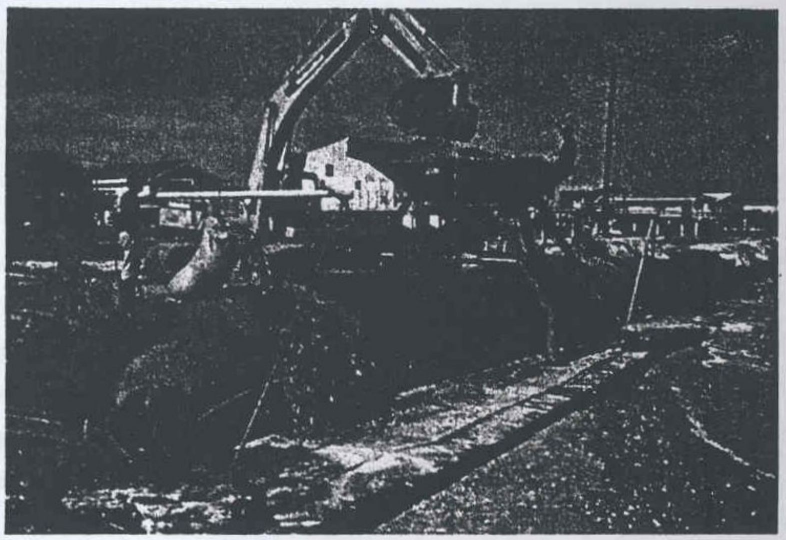

Figure 9 – Mechanical Filling of Geotube
San Luis Pass / Treasure Island, Texas

- Geotubes can also be used as groins. One such project designed by SMA incorporated geotubes filled with grout and has been in place for over a decade serving as a terminal groin on a bay recreational beach.
- Geotubes can serve as jetties on navigation channels. One such application was designed by an SMA professional in order to protect the entrance of a small boat channel into a major ship channel (Figure 10).

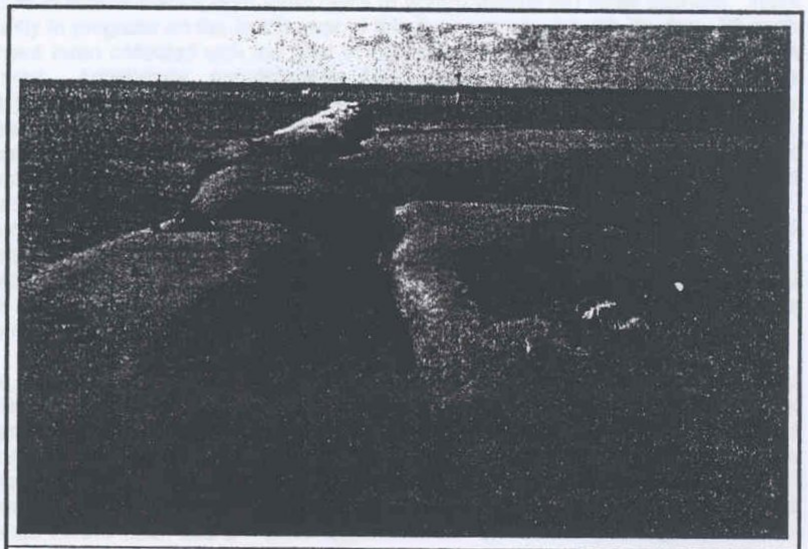

Figure 10 – Geotube Protecting Small Boat Channel
Mustang Island, Texas

- Complex habitat configurations can be obtained relatively economically using geotubes. On the bay side of Galveston Island, SMA designed a system that included approximately two miles of offshore breakwater to protect existing wetlands and a lattice of terraces to support diverse estuarine habitats. The system immediately reduced energy and, even before its completion, the Texas Parks and Wildlife Department found seagrass species that had not been seen in this area for over two decades. See Figure 11.

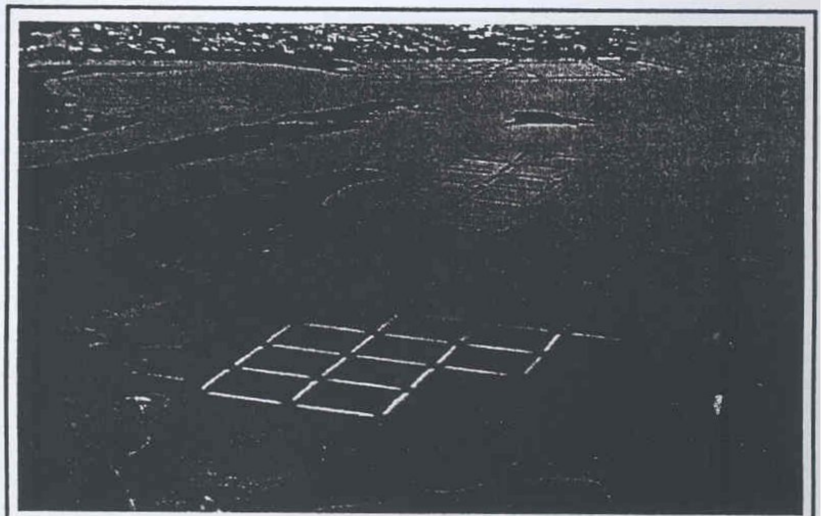

Figure 11 – Earthen Terraces for Estuarine Habitat
Galveston Island State Park, Texas

Conclusion

Geotubes often provide relatively low-cost options for shoreline protection and habitat construction. However, they do have their limitations and in many applications, when exposed to high-energy conditions or probable vandalism, are not permanent solutions. The informed and effective application of geotubes requires knowledge of the applicable physical processes. a thorough engineering design, and a candid recognition of their limitations.

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