MILE POINT TRAINING WALL CONFIGURATION

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ABSTRACT

Keywords: geotextile tubes, scour aprons, erosion control, marshland, habitat restoration

Infrastructure Alternatives, Inc. (IAI) completed a unique geotextile tube installation in the Mile Point area of the Jacksonville Intracoastal Waterway, near Jacksonville, Florida, in 2016, as a subcontractor to Manson Construction Company (Manson). The in-water geotextile tube structure was specified by the United States Army Corps of Engineers (USACE) and designed and installed by IAI as part of an effort to restore and protect Great Marsh Island, an important wetland habitat, from tidal erosion. For this project, IAI installed 1,146-m. (3,763-ft.) of geotextile tubes, both on land and in water, overcoming challenging conditions, such as high velocity cross-currents, tidal influences, and areas of unstable base material in the alignment path.

INTRODUCTION

Mile Point is located at the intersection of the St. Johns River and the Intracoastal Waterway, an area that experiences strong cross-currents at ebb tide. The USACE designed the Mile Point Training Wall project to restore and protect Great Marsh Island, and selected Manson as the General Contractor. Manson placed stone, marine mattresses and precast concrete units to create the training wall. IAI was then brought to the project as a subcontractor to Manson, to install geotextile tubes and scour aprons, along a 1,146-m. (3,763-ft.) section of the wall. Dredge spoils were later pumped behind the wall to create approximately 0.21-km^2 (52 acres) of new marshland. The containment wall retains the dredge spoils in place and prevents them from being washed away. This paper will detail the methods utilized to install the geotextile tube portion of the training wall, the challenges that were encountered along the way, and describe how those challenges were overcome.

Figure 1. USACE design of the Flow Improvement Channel

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DESIGN

IAI worked closely with the USACE to develop a custom geotextile tube layout plan to achieve the required elevations. Throughout the 1,146-m. (3,763-ft.) alignment length of the wall, water depth varied significantly. Geotextile tubes, ranging from 5.2-m. (17-ft.) circumference to 18.3-m. (60-ft.) circumference, were deployed in a single layer in the shallower areas, while in the deepest section, a pyramidal stack of three 10.4-m. (34-ft.) circumference geotextile tubes was needed to meet the design elevation.

The chart below lists the size and location of each geotextile tube installed, along with the Mean Low Low Water (MLLW) height required by the Project Specifications.

Table 1. Geotextile Dimensions/Locations

Tube Dimensions	Tube Location	Fill Height	MLLW Height
5.2-m. x 64-m. (17-ft. x 210-ft.)	Station 00+00 – 13+00 Station 31+00 – 33+63	1.2-m. (4-ft.) 1.2-m. (4-ft.)	1.5-m. (5-ft.) min. 1.5-m. (5-ft.) min.
10.4-m. x 64-m. (34-ft. x 210-ft.), stacked	Station 13+00 – 19+00	3-m. (10 ft.)	1.5 – 1.8-m. (5 – 6-ft.)
18.3-m. x 64-m. (60-ft. x 210-ft.)	Station 19+00 – 25+00	2.1-m. (7 ft.)	1.5 – 1.8-m. (5 – 6-ft.)
10.4-m. x 64-m. (34-ft. x 210-ft.), stacked 13.7-m. x 64-m. (45-ft. x 210-ft.), stacked	Station 25+00 – 27+00 Station 25+00 – 27+00	3.7-m. (12 ft.) 3.7-m. (12 ft.)	1.5 – 1.8-m. (5 – 6-ft.) 1.5 – 1.8-m. (5 – 6-ft.)
10.4-m. x 64-m. (34-ft. x 210-ft.)	Station 27+00 – 33+00	3-m. (10 ft.)	1.5 – 1.8-m. (5 – 6-ft.)
5.2-m. x 64-m. (17-ft. x 210-ft.) 5.2-m. x 50-m. (17-ft. x 163-ft.)	Station 33+00 – 35+00 Station 35+00 – 37+63	1.2-m. (4-ft.) 1.2-m. (4-ft.)	1.5-m. (5-ft.) min. 1.5-m. (5-ft.) min.

CONSTRUCTION

Figure 2. Aerial view of construction of the training wall, including the geotextile tube alignment and installation of precast concrete units.

Customized filling techniques developed by the IAI crew were utilized to safely and effectively deploy the scour aprons and geotextile tubes from boats in areas with high velocity currents. The crew learned that tide change was the best time to deploy tubes, so work days were scheduled such that deploying, filling and the start of filling individual tubes fell within the daily tide change windows.

Scour Aprons

A scour apron is a length of geotextile material, with small diameter tubes (anchor tubes) fixed longitudinally on each side of the apron, which, after deployment, are filled with sand. The sand-filled anchor tubes sink the apron to the bottom and hold it in place. As the name suggests, the scour apron provides a stable base which prevents scouring of the geotextile tube sub-base underneath the apron. A geotextile tube is then deployed on top of the scour apron, and filled. For this project, IAI ordered scour aprons which extended a minimum of 10-ft. beyond the width of the geotextile tubes when deployed.

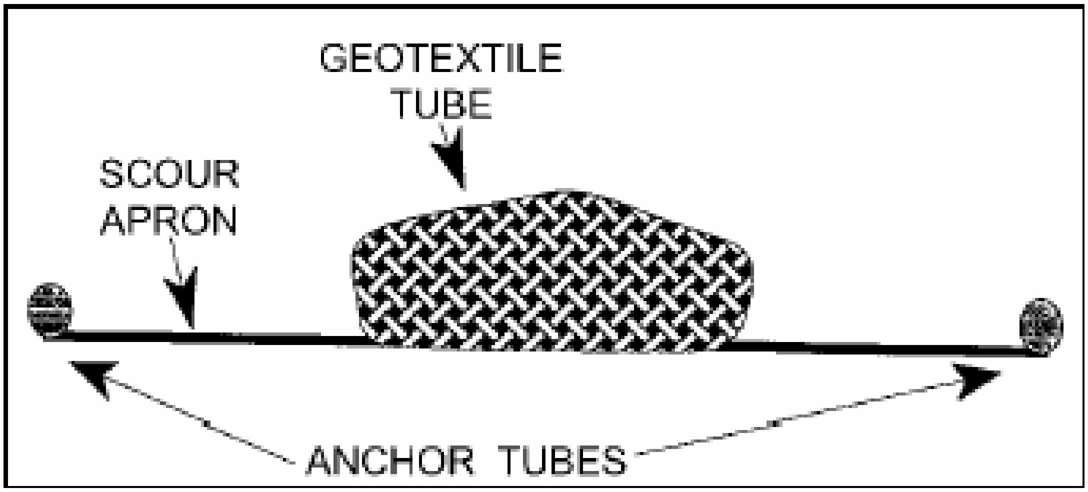

Figure 3. Scour apron, typical installation

The scour apron installation was a change from the original design, but was a key factor in the successful installation of the wall, by providing critical protection of the sand base under the geotextile tubes, and preventing the base from washing out.

Station 00+00 to Station 13+75

The first section of the geotextile tube installation was placed on land, from Station 00+00 to Station 13+75. Installation operations in this section were challenging, due to the small circumference tubes utilized in this section, as well as the instability of the marshland where the geotextile tubes were placed.

IAI began installing geotextile tubes at Station 01+00. (Station 00+00 was completed later when the contractor at that location finished their construction activities.) The first 1,300-lineal-ft. of geotextile tubes installed were 17-feet in circumference, and 210-feet long. This is significantly narrower than the 13.7-, 22.9-, and 27.4-m. (45-, 75-, and 90-ft.) circumference geotextile tubes frequently utilized by IAI. Narrower tubes are generally more susceptible to rolling, as they fill quickly and provide less frictional resistance to overturning. The faster a tube fills, the less time to build a stabilizing base of dewatered material inside the tube during the first fill cycles. IAI successfully maintained the alignment without geotextile tube roll, while filling at 4,732-L/min. (1,250 gal/min.).

On the first day of operations, 121.9-m. (400-lineal ft.) of geotextile tubes were filled to slightly more than the minimum height of 1.5-m. (5-ft.) MLLW, as planned. The next morning, the crew found that the geotextile tubes that had sunk into the marshland, so much that some parts of the top surface of the tube alignment was lower than ground level.



Figures 4 and 5. Filled geotextile tubes, sinking in the marshlands.

To prevent this from happening again, a process was developed to inspect the remainder of the marshland, and increase stability if needed, before installing any more geotextile tubes in the alignment. In unstable areas, the base was prepared by placing sand in the alignment path and compacting the sand as much as possible. In the least stable area, a 10.4-m. (34-ft.) circumference geotextile tube was placed in the alignment, to achieve the minimum 1.5-m. (5-ft.) MLLW height. That geotextile tube was almost complete when the weight of the tube caused the edge of the marsh to slide toward the water taking the geotextile tube with it.


Figure 6. Land side geotextile tubes installed over compacted sand.

Working with the USACE and Manson, a plan was developed to add a single 5.2-m. (17-ft.) circumference by 33.5-m. (110-ft.) geotextile tube to the alignment, which bridged the gap from Station 03+40 to 04+40, and maintained the minimum required height.

Station 13+75 to Station 25+00

The geotextile tube alignment entered the water at Station 13+75. Beginning at this station, the geotextile tubes were stacked in a 2-1 pyramid configuration of three 5.2-m. (34-ft.) circumference tubes. Scour aprons were installed, extending 15.2-m. (50-ft.) in front of the geotextile tube filling operation. This practice prevented the base from washing out from under the end of the tube as it was filled. The installation process in this section of the alignment proceeded in 121.9-m. (400-lineal ft.) increments, such that two 15.2-cm. (6-in.) diameter pipelines were utilized to fill two geotextile tubes concurrently.

Figure 7. Deploying scour apron with the marsh excavator.

The General Contractor on the project, Manson Construction, planned to maintain 213.4-m. (700-lineal ft.) of concrete structure units (CSUs) ahead of the geotextile tube alignment to reduce the velocity of flow of water in and out of the marsh land as the tides rose and fell. Due to installation challenges that plan did not happen and IAI adapted to the increased flow conditions. When the geotextile tubes reached Station 25+00, IAI demobilized from the site until Manson's dredging of the flow improvement channel was completed and IAI would be able to install the remaining 385-m. (1,263-lineal ft.) of geotextile tubes in the alignment. The sediments dredged from the Flow Improvement Channel were placed within the containment area.

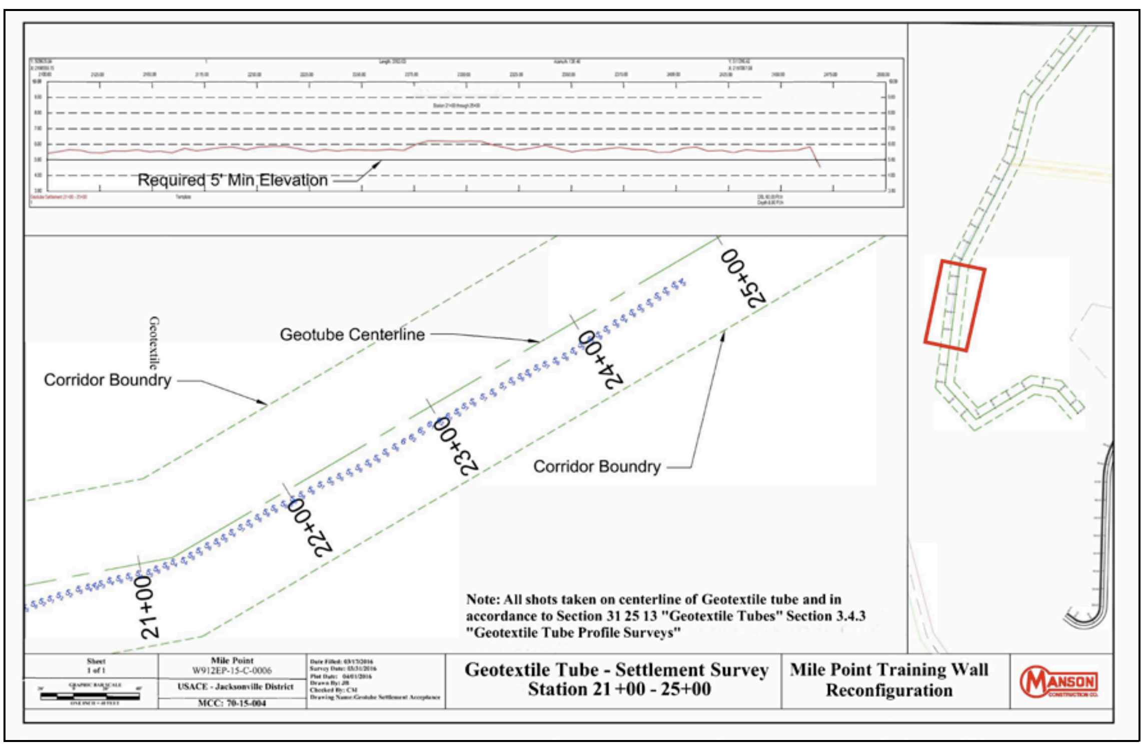

Figure 8. This figure, showing the elevations of the top surface of the geotextile tubes from Station 21+00 – 25+00, is a typical example of the elevations after installation and settling

Station 25+00 to Station 33+00

When Flow Improvement Channel dredging was complete, geotextile tube installation operations resumed. In this section, geotextile tubes were stacked in a pyramid configuration of two 10.4-m. (34-ft.) circumference tubes placed on the bottom, and one 13.7-m. (45-ft.) circumference tube placed on top center of the 10.4-m. (34-ft.) circumference tubes.

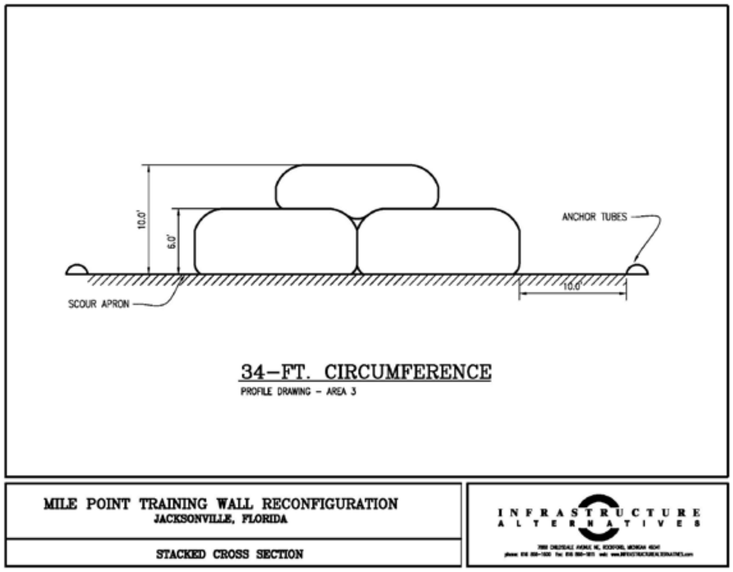

Figure 9. Example of a stacked geotextile tube configuration

In this area, all the bottom layer tubes had to be deployed by boat. Floats tied to the scour aprons were used to mark the position of the scour aprons and tubes as they were deployed, and to keep the tubes secure in the desired position until they were filled with material.

Our crew was restricted to working during daylight hours. Work schedules were adjusted as much as possible to fit within the tide cycles so that they could stand on the tubes or the ocean bottom in chest waders.

Figure 10. Working around the tides.

Geotextile tubes were deployed from work boats. When a geotextile tube is placed in water it will float. After the tube was placed in the water, crews had to move the work boat over top of the tube, then insert fill pipes into each fill port, and finally, lay out and attach hoses from the fill pipes to the sand slurry pipeline. If the tide was moving in or out during this operation, it made it increasingly difficult to keep the tube in place long enough to secure the pipelines. The tide could catch the tube and spread it out like a sail; the force needed to bring a fill port to the surface, as the tide rushing against it, it was significant.

Figure 11. Filling geotextile tubes in the water.

When the bottom layer geotextile tubes in the alignment reached Station 29+00, IAI went back to deploy the top layer tubes from Station 25+00 to Station 29+00. This is how the alignment progressed; in each individual area, first, a scour apron was installed, extending approximately 50-ft. ahead of geotextile tube filling operation; trailing the scour apron installation was the deployment and filling of the bottom layer geotextile tube; and following that, lastly, was the installation of the top layer geotextile tube.

The water from Station 25+00 to Station 29+00 was very deep and the flow of water was very fast, since the tube alignment was now blocking 1,500 lineal-ft., creating a bottleneck where all the tidal flow passed through this ever-narrowing section. The velocity of water going over the top of the bottom layer of tubes as the tide went out was substantial. The first top layer tube at Station 25+00 was deployed and the crew began pumping sand slurry into it, monitoring progress from work boats and a barge. After about 45 minutes of filling, the current overcame the straps that were holding the tube in place, causing the straps to fail.

Luckily, there was enough material already contained in one end of the tube, that it did not float away. The crew decided to special order geotextile tubes for this section that had extra straps, sewn into the seams every five feet. With additional places to tie off, the tube would be much more secure. The geotextile tube manufacturer could accommodate our order and we received delivery of the special-order tubes in two days. Upon receipt, the special-order tubes were successfully deployed and filled to height.

Station 31+00 to Station 33+00

From Station 31+00 to Station 33+00 the water was only a few feet deep at low tide. There, the crew could drive 10.2-cm. (4-in.) diameter poles into the ocean bottom. These poles served as anchors. The crew tied the geotextile tube straps to the poles to secure them in position until they were filled.

Station 33+00 to Station 37+63

This section was filled out of sequence, as we waited for special order tubes with additional straps sewn in to complete the top layer of tubes from Station 25+00 to Station 29+00.

Changes in the current due to the geotextile tube installation caused erosion in this area, as it was one of the last to be completed. The location of the centerline of the tube alignment had to be adjusted to accommodate the lost material, but once this change was made, the geotextile tubes were filled and maintained at the required height, without issue.

TEMPORARY AREAS

The geotextile tubes installed from Station 00+00 to Station 13+00 and Station 33+00 to 37+63 were designed to be temporary. In the temporary areas, the geotextile tubes were filled with sand to a height of six (6)-ft. MLLW. When dredged material placement behind the geotextile tube wall was complete, the geotextile tubes in the temporary areas were cut open and leveled. This allowed water to flow in and out of the marshland during tide cycles. The remainder of the geotextile tubes and scour aprons were left in place under the surface of the water, to provide the island with continued erosion protection.

CONCLUSIONS

In-water geotextile tube installations must be designed carefully. Sub-surface foundation conditions must be evaluated, to determine the stability of the bottom. Core samples should be collected, and tested for geotechnical characteristics, and this data must be utilized to develop work plans. If the area where the geotextile tubes are to be installed is not stable, the tubes may sink or shift.

When working in an uncontrolled natural environment, crews must be able to recognize changes in conditions and have the resources necessary to adapt work plans as needed. Flexibility and contingency planning are critical factors for success. For example, crews must be able to flex their work schedules, to arrange work around the time of the tide changes. Flexibility of work schedule and activity was critical on this project. Our crews, to their credit, had to be able to change plans in mid-stride to accommodate weather, equipment failure, and other factors beyond our control. Strong currents were always a factor, and in some areas, made it necessary for us to change our installation plans to accommodate the strength and velocity of the current.

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CITATIONS

None.