

VI. SUMMARY

This monitoring report evaluated shoreline and volume changes along the 5.9 mile shoreline of the Town of Duck and 2,000 feet of shoreline on the southern end of Pine Island. Data collected in June 2018 was used to update shoreline and volume change analyses presented in the previous monitoring report (APTIM, 2018A) as well as the feasibility study (CPE-NC, 2013) and the design analysis associated with the beach nourishment project (CPE-NC, 2015). Both the shoreline and volume change results were influenced by the beach fill project constructed in June 2017, which placed 1,263,181 cy of material along the beach between station D-10 and D-19.

The monitoring area extends south from profile station PI-17, located on the south end of Pine Island, to profile station D-34, located near the Town of Duck town limits with the Town of Southern Shores. With the construction of the beach nourishment project in June 2017, the monitoring area was divided into three sections, namely; the Project Area (D-10 to D-19), the Area North of the Project (PI-17 to D-10), and the Area South of the Project (D-19 to D-34).

Shoreline Change Analysis:

Project Area. Within the Project Area, the beach fill project moved the MHW shoreline an average of 111 feet seaward between the April 2017 pre-construction survey and the December 2017 monitoring survey. During the ensuing 6-months from December 2017 to June 2018, the MHW shoreline retreated 55 feet as the constructed beach profile adjusted to tide and wave conditions. Most of the retreat of the MHW shoreline was due to movement of sediment from the upper portions of the profile, where it was initially placed during construction, to deeper portions of the active beach profile in response to tide and wave conditions. Such adjustments in the shape of the nourished profile are normal for beach nourishment projects. Over time, the movement of the MHW shoreline is expected to moderate as the profile moves toward an equilibrium configuration.

In terms of shoreline changes, the beach fill project has performed as expected and has added a layer of protection to upland development against damage associated with long-term erosion and has reduced the damage potential due to coastal storms.

Area North of the Project. Long-term changes in the position of the MHW shoreline in the area north of the Project Area were not significantly changed by the placement of the beach fill. The long-term shoreline change rate in the area prior to the beach nourishment project, as measured between October 1996 and May 2015, was 0 ft/yr. indicating, on average, the shoreline was stable. For the updated long-term period from October 1996 to June 2018, which included the beach fill project, the average rate of change in the MHW shoreline was -0.2 ft/yr. which is also considered to represent a stable condition. One area located between the Sanderling Resort (station D-04) and Martin Lane (station D-06) did appear to experience an increase in the rate of recession of the MHW shoreline.

South of the Project Area. Long-term shoreline change rates computed between October 1996 and May 2015 prior to the construction of the beach nourishment project averaged -0.6 ft/yr. For the updated long-term period that includes the beach fill project (October 1996 to June 2018), the shoreline change rate remained about the same, averaging -0.2 ft/yr. One section of the shoreline south of the project located between profile stations D-25 and D-27 (Sea Colony to Wampum Dr.) eroded at an average rate of -1.5 ft./yr. for the October 1996 to June 2018 period as did another section between D-32 and D-33 (Seahawk Dr. to Tides Dr.). Even though the recession rates in these two sections was considerably greater than the overall average, the rates are considered to be moderate. These two areas will need to be closely monitored to see if threat levels increase.

Volume Change Analysis:

Project Area. During the 6-month period from December 2017 to June 2018, the project area lost 98,500 cubic yards or about 9.5% of the fill measured in the Project Area in December 2017. Some of the volume loss from the project area appeared to be due to material being transported to the north and south out of the Project Area. For example, the 4,000-foot section of shoreline just north of the Project Area (between stations D-10 and D-06) gained approximately 17,000 cubic yards between December 2017 and June 2018. However, the 2,000-foot section of shoreline immediately south of the Project Area (stations D-20 to D-23), lost 38,300 cubic yards. This negative volume change was driven by changes in the profile measured at station D-21 which exhibited an anomalous wide and deep trough just offshore. A similarly sized trough was not observed on the profiles immediately north and south of D-21. With profile D-21 immediately north and adjacent to the FRF pier, the configuration of the project could have been influenced by wave interacting with the pier's piles. Changes in the profile at D-21 will be closely examined following the next monitoring survey to determine if the abnormal trough is still present or if it was just an ephemeral feature associated with antecedent wave conditions.

North of Project Area.

The updated long-term volume changes in the area north of the project, measured between September 2013 and June 2018, averaged -4.2 cy/ft./yr. The extreme northern sections of the area between profile stations D-07 and PI-17 continued to experience higher erosion rates compared to the southern end between profile stations D-07 and D-10. Between profile stations D-06 and PI-17, the long-term average rate of volume change was -6.1 cy/ft./yr. while the southern end of the area only lost an average of -1.0 cy/ft./yr. The performance of the southern end of the area is an indication of the positive impacts the beach nourishment project is having in this area.

South of Project Area. As previously reported in the May 2018 monitoring report (APTIM, 2018A), the average long-term volume change between profile station D-19 to D-34, measured between September 2013 and December 2017, was a gain of 2.9 cy/ft./yr. The updated long-term trend for this area, based on the September 2013 and June 2018 surveys, indicates an average loss of -0.6 cy/ft./yr. The major difference in the shoreline response for these two periods occurred between profile stations D-24 and D-30 (Shipwatch to Four Seasons Lane). For the previous long-term period between September 2013 and December 2017, this section of the shoreline lost an average of -0.7 cy/ft./yr. whereas the updated long-term rate in this section measured between

September 2013 and June 2018 was a loss of -4.4 cy/ft./yr. This area should be closely monitored to see if the risk of damage to development in the area increases.

VII. RECOMMENDATIONS

APTIM recommends the Town continue to monitor the entire Town oceanfront shoreline in order to assess if the trends measured in the volume change analysis persist in those regions identified. Based on the most recent analysis and observations made during the monitoring of the beach nourishment projects in Kitty Hawk and Kill Devil Hills, APTIM is recommending that future monitoring surveys also include tighter bathymetric survey grid spacing in the nearshore portion of the profile. We recommend that 200-foot spaced, shore-parallel lines be surveyed at the same time the beach profile surveys are conducted. These shore-parallel surveys should lead to a better understanding of how features in the nearshore may be influencing volume change calculations conducted using 1000-foot beach profile surveys alone. Furthermore, APTIM recommends that the 2019 annual monitoring survey include an updated analysis of the vulnerability of structures located outside the project area.

Future monitoring will be instrumental for the Town to evaluate future areas of concerns and to develop successful shoreline management strategies to deal with issues as they arise. The monitoring program will continue to provide valuable information on the performance of the 2017 beach fill project and aid in the determination as to when additional nourishment is needed in the project area. The measured performance of the beach fill will also serve as a valuable tool to aid in the development and design of future beach nourishment projects the Town may consider. Along those lines, the monitoring of the beach fill project is necessary for the Town to be eligible for federal Public Assistance funds should the project be impacted by a storm.