

IV. SHORELINE CHANGES

A shoreline change analysis was completed to assess shoreline advance and recession along the study area. The shoreline is typically defined as a specified elevation contour. For this study, the shoreline was defined as the Mean High Water (MHW) contour, which represents the +1.2-foot NAVD elevation (CPE-NC, 2015). Shoreline change is calculated by comparing shoreline position along shore perpendicular transects. Typically, shoreline change is then annualized to describe recession and advance rates. Regardless of whether total or annual shoreline changes are described, positive shoreline change denotes seaward advance while negative shoreline change indicates landward recession.

The analysis discussed in this report evaluated the MHW positions for the following surveys: October 1996 (LiDAR), and profile surveys obtained in September 2013, May 2015, and December 2017. The MHW position for each survey was identified along shore perpendicular transects spaced at approximately 1,000-foot intervals at the profiles identified in Table 1 along the monitoring area.

The linear changes in the shoreline position represented by the MHW contour can vary considerably along the monitoring area and can sometimes differ from volume change trends along sections of a beach. This difference is often due to changes in the slope of the foreshore along the beach from one end of the monitoring area to the other. As shown in Figure 6, the position of the MHW location on the profile can vary greatly depending on the shape of the profile at the time of the survey.

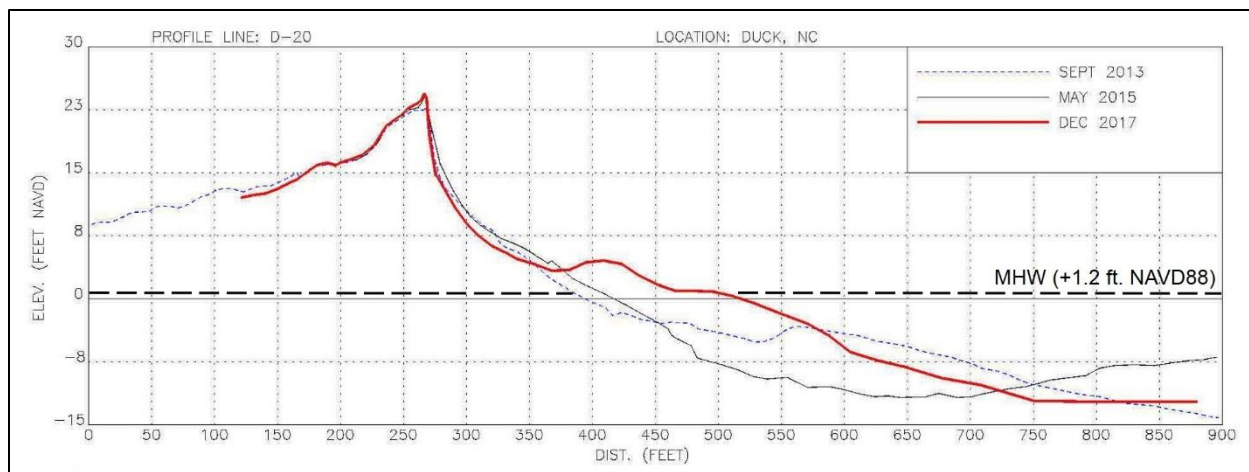


Figure 6. MHW Shoreline Change Variations

Shoreline change is provided as a rate in an annualized form by dividing the shoreline change by the time period (number of years) between survey events (i.e. feet per year). These rates are described in terms of positive (“+”) or advance (shoreline moving seaward) and negative (“-”) or recession (shoreline moving landward).

May 2015 to December 2017

The average shoreline change within the monitoring area (PI-17 to SS-02) between May 2015 and December 2017, a time period that included the Duck beach fill project, was 34.8 feet (shoreline advanced seaward) and represents an equivalent average annual shoreline change rate of +13.5 feet per year. This is a significant change in the shoreline behavior observed during the previous monitoring period (September 2013 to May 2015) which did not include the effects of the beach fill project. Prior to the construction of the 2017 beach fill project, the average shoreline change within the monitoring area was a recession rate of -2.6 ft./yr.

The average shoreline change rate was also calculated at +44.0 ft./yr. for the project area (D-10 to D-19) in which fill was placed as part of the 2017 beach nourishment project. This is a significant increase from the +2.2 ft./yr. change rate that was measured in the same area between September 2013 and May 2015. Long-term changes over the 21 year period from October 1996 to December 2017 within the monitoring area (PI-17 to SS-02) and the project area (D-10 to D-19) show average shoreline change rates of +1.2 ft./yr. and +4.4 ft./yr., respectively. Table 2 shows the measured change rates at each profile location. Figure 7 graphically displays the variability of changes along the Town’s shoreline between the short-term change rates measured from September 2013 to May 2015 and May 2015 to December 2017 and the long-term rates calculated between October 1996 and December 2017.

Although the average shoreline change rates calculated between May 2015 and December 2017 were positive for the monitoring and project areas, a profile-by-profile comparison shows a wide range in the rate of change along the shoreline outside of the project area. The shoreline changes within the monitoring area ranged from an advance of 12.8 ft./yr. between Stations D-05 and D-

08 (south end of Station Bay Dr. to Waxwing Ct.) to a recession of -19.6 ft./yr. between Stations D-23 and D-24 (the southern portion of the USACE Field Research Facility and Ship Watch Dr.). The highest recession rates were measured at Stations D-09 (-17.0 ft./yr.), D-23 (-27.7 ft./yr.) and D-30 (-20.2 ft./yr.).

The 2015 monitoring report (CPE-NC, 2016), identified two (2) main areas of erosion based on the shoreline changes that occurred between the September 2013 and May 2015 monitoring surveys. The first area was located in the northern portion of the monitoring area between PI-17 and D-11 (Pine Island to Ocean Pines Dr.) which experienced an erosion rate of -6.4 ft./yr. The second area was along the southern portion of the monitoring area between D-25 and SS-01 (Sea Colony Dr. to Southern Shores) which was eroding at a rate of -4.7 ft./yr. The recent changes from May 2015 to December 2017 show the shoreline along the northern area advanced an average of 26.2 ft. seaward while the second or southern area advanced at an average rate of 1.0 ft./yr. There was one exception in the southern area located in the vicinity of D-30 (Lala Ct.) where the shoreline migrated landward a distance of 52.1 ft., or a rate of -20.1 ft./yr., when annualized from May 2015 to December 2017. A discussion of the changes observed at D-30 is provided later in this report.

The previous Town-wide monitoring report (CPE-NC, 2016) also updated the SBEACH storm vulnerability analysis which was initially presented in the May 2013 feasibility report (CPE-NC, May 2013). The updated analysis, which was based on the May 2015 beach profile survey data, identified the beach areas between Stations D-09 to D-11 (Pelican Way to Ocean Pines Dr.) and D-25 to D-29 (Sea Colony Dr. to Ocean Front Dr.) as having experienced an increase in the number of vulnerable structures relative to those identified in the feasibility report (CPE-NC, 2013). However, the recent changes measured between May 2015 and December 2017 show the shoreline between D-09 to D-11 advanced seaward an average distance of 48 ft. This reversal is attributed primarily to the construction of the beach fill project, completed in June 2017. The average shoreline change for the area between Station D-25 to D-29 advanced seaward 3.7 ft. between May 2015 and December 2017. These changes are not likely related to the beach fill project. Given the recent shoreline changes, some of the structures identified as being vulnerable in the SBEACH analysis (CPE-NC, 2016) may now be outside the storm impact area.

In general, the average shoreline change rates within both the monitoring area and project area experienced shoreline advance during the short-term period from May 2015 to December 2017. Furthermore, due to the shoreline advance that occurred as a result of the 2017 beach nourishment project between Stations D-10 and D-19, the long-term shoreline change between October 1996 and December 2017 measured an advance of the shoreline at a rate of 1.2 feet per year within the monitoring area. This rate is a reversal from the previous long-term rates measured by comparing the long-term rates from 1996 to 2011, 2012, 2013, and 2015, which were -0.6 ft./yr., -1.4 ft./yr., -0.3 ft./yr., and -0.5 ft./yr., respectively.

Over the long-term period from 1996 to 2017, the rates of change within specific segments of the monitoring area ranged from an advance of 3.5 ft./yr. between Stations D-07 and D-20 (Waxwing Ln. to the USACE Field Research Facility) to a recession of -1.7 ft./yr. between Stations D-25 and D-27 (Sea Colony Dr. to Wampum Dr.).

Table 2. MHW Shoreline Changes

PROFILE	EFFECTIVE DISTANCE (FT)	MHW SHORELINE CHANGES (FT/YR)		
		SEPT. 2013 TO MAY 2015	MAY 2015 TO DEC. 2017	OCT. 1996 TO DEC. 2017
PI-17	497	-3.2	20.9	2.8
PI-18	985	-21.9	-5.9	0.3
D-01	963	-4.3	6.2	1.5
D-02	986	4.5	-3.0	0.7
D-03	1,012	-25.0	13.4	1.1
D-04	988	13.7	-6.6	-1.7
D-05	975	-32.3	20.3	-1.2
D-06	975	-9.9	7.7	-0.6
D-07	975	-2.3	10.3	0.9
D-08	976	-0.3	12.7	2.1
D-09	993	21.8	-17.0	1.2
D-10	1,012	-19.4	28.2	4.0
D-11	897	-5.1	44.3	7.1
D-12	900	21.3	33.4	7.5
D-13	997	20.1	41.8	6.4
D-14	975	-4.1	66.3	6.3
D-15	975	14.5	47.7	5.3
D-16	973	-15.0	63.0	2.7
D-17	1,010	-1.5	44.9	0.6
D-18	823	0.5	39.7	2.2
D-19	601	10.3	30.9	1.9
D-20	737	12.4	23.3	0.8
D-21	825	-27.6	15.8	-1.3
D-22	767	-23.2	1.8	-1.0
D-23	787	10.8	-27.6	-0.1
D-24	899	14.5	-11.6	0.5
D-25	976	-6.5	2.2	-1.3
D-26	977	-23.7	12.3	-2.2
D-27	975	-23.3	0.8	-1.7
D-28	975	-3.2	-4.2	0.3
D-29	975	0.4	-4.0	1.2
D-30	975	39.0	-20.1	1.7
D-31	1,013	-17.0	8.9	0.5
D-32	975	-6.3	4.0	-1.4
D-33	959	-4.9	1.7	-1.0
D-34	1,007	-12.6	12.2	0.8
SS-01	998	6.6	-2.6	-0.8
SS-02	500	1.9	-0.9	0.0
PROJECT AREA (D-10 TO D-19)	8,358	2.2	44.0	4.4
MONITORING AREA (PI-17 TO SS-02)	34,808	-2.6	13.5	1.2

Project Area

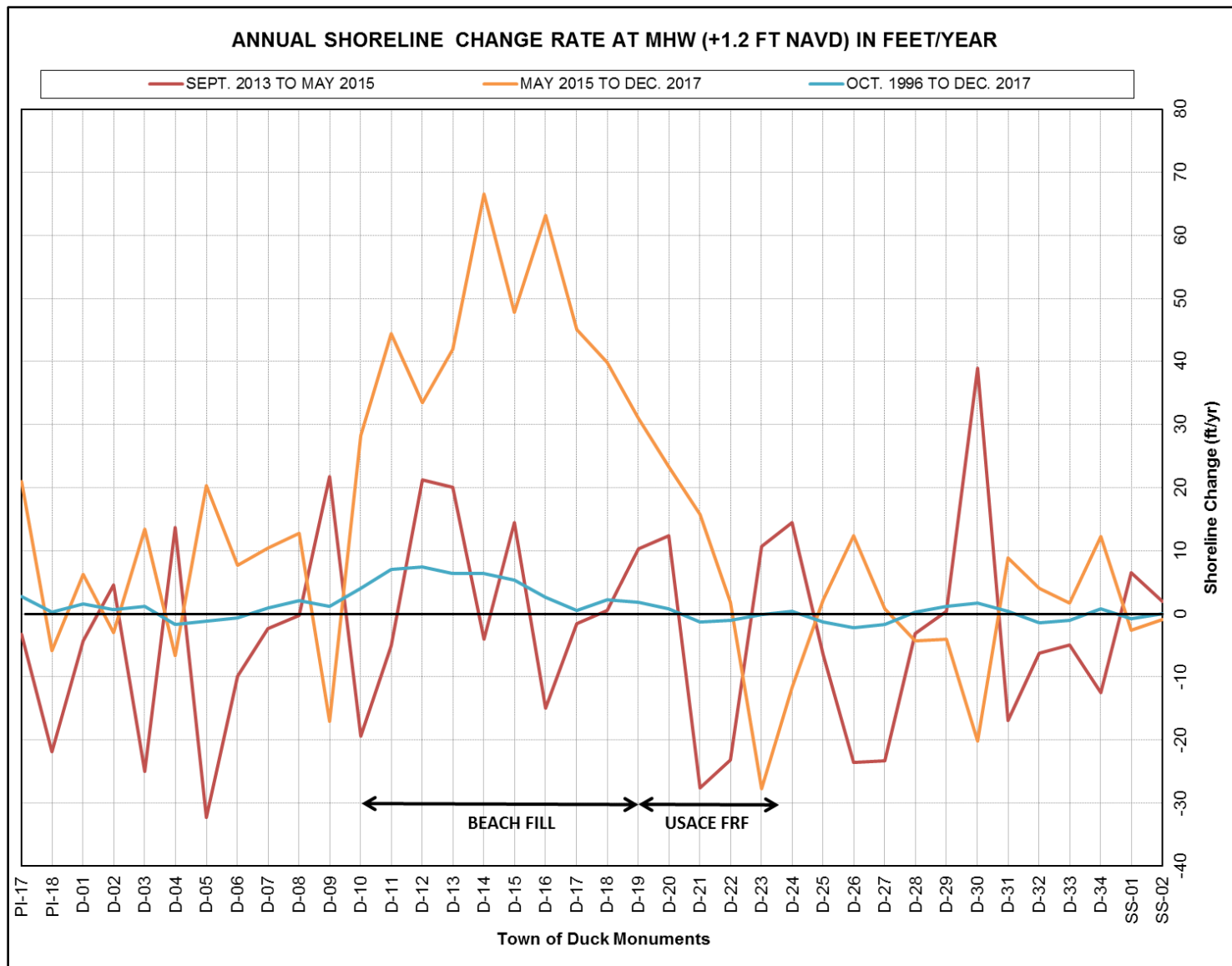


Figure 7. Comparative graph of historical MHW (+1.2 FT NAVD) shoreline change rates in Feet/Year.