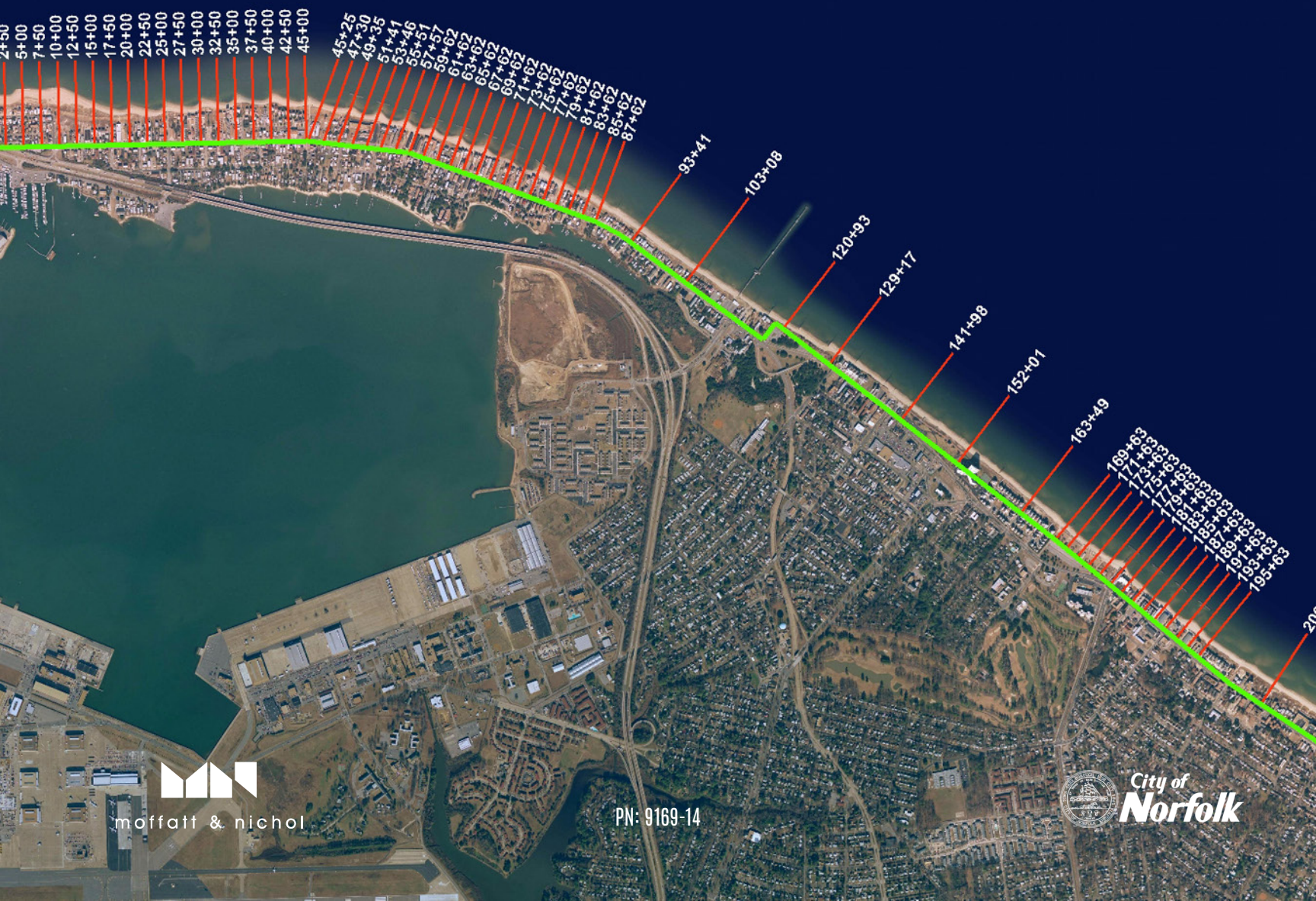


PERIODIC SURVEY EVALUATION: OCEAN VIEW BEACH



City of Norfolk, Virginia | Fall 2016



Periodic Survey Evaluation: Ocean View Beach Fall 2016

Presented to:

City of Norfolk

January 2017

Prepared by:



moffatt & nichol

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1. Executive Summary

The twenty-third consecutive twice-yearly survey of the Ocean View shoreline was conducted on October 17 - 18, 2016. The study area extends from the western end of Willoughby Spit to the western edge of Little Creek Inlet in East Ocean View. The periodic surveys are collected bi-annually in March/April and September/October to monitor the condition of the shoreline and the state of existing shore protection projects. A baseline and transect locations were established with the first survey in September 2005 and have been used for each subsequent survey. Shoreline changes at Mean High Water (MHW) and volumetric changes above 0 feet NAVD88 and -15 feet NAVD88 are calculated at each transect. Differences in the region above 0 feet NAVD88 are indicative of changes to the dune and subaerial beach berm, while the differences above -15 feet NAVD88 indicate changes in the nearshore zone. Comparison of seasonal surveys (i.e. October 2015 to October 2016) eliminates seasonal variation of profiles in volumetric change analyses. Consecutive survey comparisons are useful to assess the direct impact of extreme events which have occurred during the six month period between surveys. This report documents the data sources, methods, and results of a periodic surveying evaluation performed to compare the October 2016 survey data with previous surveys taken in October 2015 (fall to fall comparison) and May 2016 (most recent periodic survey comparison) in the Ocean View Beach area between Willoughby Spit and Little Creek Inlet.

Comparison	Parameter	Quantity
October 2015 vs. October 2016	Average Shoreline Change Rate at MHW (+0.98 ft NAVD88)	-1.28 ft/yr
	Cumulative Volume Change Rate Above 0 ft NAVD88	32,165 cy/yr
	Cumulative Volume Change Rate Above -15 ft NAVD88	-39,747 cy/yr
May 2016 vs. October 2016	Average Shoreline Change at MHW (+0.98 ft NAVD88)	0.59 ft
	Cumulative Volume Change Above 0 ft NAVD88	-43,747 cy
	Cumulative Volume Change Above -15 ft NAVD88	-58,912 cy

The Ocean View region experienced an overall gain in material above 0 feet NAVD88 and overall loss above -15 feet NAVD88 over the past year (October 2015 to October 2016). The average MHW shoreline change over the past year shows an erosional trend. Over the most recent survey period (May 2016 to October 2016), there was overall slight accretion of the average MHW shoreline. The Ocean View shoreline experienced a loss in material above 0 feet NAVD88 and above -15 feet NAVD88 during this period. The surveyed shoreline reaches were affected by several storms and experienced dune and subaerial beach erosion. It is important to note that the October 2015 survey was obtained two days after the October 2-6 storm dissipated, so that the survey reflects the conditions of the subaerial beach with little or no post-storm recovery. The October 2016 survey occurred approximately 10 days following the passage of Hurricane Matthew offshore of the northern Outer Banks; while the hurricane did not enter Chesapeake Bay, it did produce significant wave action and sediment transport along the Ocean View shoreline.

While the Ocean View system showed overall volume loss for the past year, there was variability within the defined shoreline regions. The Willoughby Spit region overall experienced erosion of the MHW shoreline and volumetric gains above 0 feet NAVD88 and volumetric loss above -15 feet NAVD88 over the past year. An emergency nourishment project in January 2016 placed sand in the dune and berm system in the vicinity of 11th View Street and Toler Place to help with the erosion that is occurring in this specific location.

In the 800 Block region, there has been erosion of the MHW shoreline, with slight volumetric gain above 0 feet NAVD88 and volumetric loss above -15 feet NAVD88 over the year. Between May 2016 and October 2016 there has been erosion of the MHW shoreline and volumetric losses above 0 feet NAVD88 and above -15 feet NAVD88.

The reconstructed groin in West Ocean View has performed well over the past year. The yearly analysis shows overall slight volumetric loss above both 0 feet NAVD88 and -15 feet NAVD88 as well as erosion of the MHW shoreline.

The Central Ocean View Breakwaters region has remained fairly stable over the past year. This region experienced slight erosion of the MHW shoreline, with a small volumetric gain above 0 feet NAVD88 and volumetric loss above -15 feet NAVD88 over the past year.

Typically a very stable region, Central Ocean View has experienced accretion of the MHW shoreline over the past year. There has been volume gain above 0 feet NAVD88 and slight volume loss above -15 feet NAVD88 in the past year. Over the current survey period, this region experienced volume losses above 0 feet NAVD88 and above -15 feet NAVD88.

There has been erosion of the MHW shoreline along with volumetric losses above both 0 feet NAVD88 and -15 feet NAVD88 in the East Ocean View region over the past year. Over the current survey period, there was erosion of the MHW shoreline and volumetric loss above 0 feet NAVD88 and -15 feet NAVD88. The Bay Oaks breakwaters are continuing to perform well, trapping sediment and eliminating the hotspot at this location.

In addition to regional assessments, comparison of the October 2016 survey was made against post-fill surveys from the East Ocean View beach nourishment, Willoughby Spit to Central Ocean View dune restoration, and the West Ocean View Shoreline Improvement Project which took place in March 2009, January-March 2005, and October 2013 respectively.

Comparison	Average Shoreline Change	Average Volume Change Above 0 ft NAVD88	Cumulative Volume Change Above 0 ft NAVD88	Average Volume Change Above -15 ft NAVD88	Cumulative Volume Change Above -15 ft NAVD88
East Ocean View Nourishment vs. October 2016 Comparison	-109.07 ft	-22.18 cy/ft	-115,862 cy	-38.57 cy/ft	-201,167 cy
Central Ocean View Nourishment vs. October 2016 Comparison	-35.52 ft	-11.39 cy/ft	-210,600 cy	-8.69 cy/ft	-155,902 cy
West Ocean View Pre-Nourishment vs October 2016 Comparison	-1.00 ft	0.76 cy/ft	3,724 cy	2.89 cy/ft	14,164 cy

Since the East Ocean View Nourishment project in 2009, all of the placed material above 0 feet NAVD88 has been lost. Since the Central Ocean View Nourishment project in 2005, 66% of the placed material above 0 feet NAVD88 has been lost. The Willoughby Spit Shoreline Improvement Project has alleviated a majority of the areas of concern in that reach; however, the eastern end of the reach has been experiencing higher rates of erosion. This will continue to be monitored and studied in the near future. The West Ocean View Shoreline Improvement Project completed in 2013 has mitigated erosion in the hotspot between the 200 Block and Sarah Constant Shrine Park. The remaining volume

for the 2013 West Ocean View project is approximately 14,200 cy out of the 73,600 cy placed, so that 19% of the original fill volume remained at the time of the October 2016 survey.

It is expected that the upcoming federal coastal storm damage reduction project will provide all of the Ocean View reaches (directly, or indirectly in the case of the Cottage Line area of Central Ocean View) with significant additional beach profile volume over the next year. It is also expected that this bi-annual monitoring program will continue post-construction of the federal project, allowing the City and the federal agencies involved to track the evolution of the federal project over time and to respond to future storm impacts.

2. Objective

The City of Norfolk, Virginia has maintained a program of periodic surveying of the Ocean View shoreline since 2005. The periodic surveying data collection dates are shown in Table 2-1. This report documents the data sources, methods, and results of a periodic surveying evaluation performed to compare the October 2016 survey data with previous surveys taken in October 2015 (fall to fall comparison) and May 2016 (most recent periodic survey comparison) in the Ocean View Beach area between Willoughby Spit and Little Creek Inlet. In addition, comparison of the most recent survey (October 2016) was made to: post-fill surveys from a Central Ocean View beach nourishment project that took place in January-March 2005; an East Ocean View beach nourishment project which took place in March 2009; and the post-fill conditions of the 2013 West Ocean View nourishment project.

Table 2-1: Surveyors and Collection Dates

Data Collection Date	Surveyor
September 2005	McKim & Creed
March 2006	McKim & Creed
October 2006	McKim & Creed
March 2007	McKim & Creed
October 2007	McKim & Creed
March 2008	McKim & Creed
October 2008	McKim & Creed
April 2009	McKim & Creed
October 2009	Geodynamics, LLC
March 2010	Geodynamics, LLC
October 2010	Geodynamics, LLC
April 2011	Geodynamics, LLC
October 2011	Geodynamics, LLC
March 2012	Geodynamics, LLC
September 2012	Geodynamics, LLC
April 2013	Geodynamics, LLC
October 2013	Geodynamics, LLC
March 2014	Geodynamics, LLC
October 2014	Geodynamics, LLC
April 2015	Geodynamics, LLC
October 2015	Geodynamics, LLC
May 2016	Geodynamics, LLC
October 2016	Geodynamics, LLC

3. Data Sources

Geodynamics, LLC, conducted the most recent survey of Ocean View Beach on October 18, 2016. The baseline and transects established for the September 2005 survey were used for the most recent survey. Figure 3-1 shows the location of the baseline, transects and the stationing applied by Geodynamics for the surveying. As shown in Figure 3-1, transects were stationed from west to east along the Ocean View shoreline. The survey data were provided in xyz and shapefile formats allowing for compatibility with multiple programs.

Geodynamics noted that typical vertical survey accuracy along the hydrographic portions of the profiles is approximately ± 1 cm. This 'margin of error', if applied over the entire length of the hydrographic profiles can potentially result in significant volumetric differences, in particular on the shallow-sloped and long profiles near Willoughby Spit. Therefore, volumetric changes discussed herein are analyzed with regard to potential volumetric margins of error.

In late November 2016, the Virginia Institute of Marine Science (VIMS) flew aerial photography of the Ocean View shoreline, georectified the images, and digitized the apparent MHW shoreline position from the images. The November 2016 aerial photos with the digitized shoreline positions from November 2016, May 2016, and October 2015 are presented in Appendix A. Since these photos cover a limited portion of area landward and seaward of the shoreline, a previous image (2009) is underlain for presentation purposes.

Post-fill survey data from the East Ocean View beach nourishment, collected in March 2009, were used as baseline data for assessing the current state of that nourishment project. Similarly, post-fill survey data from the Willoughby Spit dune restoration (February 2005), Central Ocean View dune restoration project (March 2005), and West Ocean View nourishment project (sand fill completed in November 2013) were utilized to assess the present state of those project areas. Post-fill data were available in xyz format from previous studies of these projects by Moffatt & Nichol.



Figure 3-1: Survey Baseline and Transects

4. Methods

Survey comparisons and respective analysis were performed using a combination of Microsoft Excel, Golden Software Surfer, ESRI ArcGIS, and the USACE's Beach Morphology Analysis Package (BMAP). Surfer is a contouring and 3D surface mapping program utilized to create 3D surfaces for analysis. BMAP is a program developed by the USACE to analyze morphologic and dynamic properties of beach profiles.

The horizontal coordinate system used was Virginia South State Plane NAD 1983 (HARN), US Survey feet with a vertical datum of NAVD88. Individual profile plates showing the survey profile at each transect for each date are presented in Appendix B. From the profiles, shoreline changes and volumetric changes were then calculated at each transect for the following time periods:

1. October 2015 to October 2016 (Entire Shoreline)
2. May 2016 to October 2016 (Entire Shoreline)
3. March 2009 (East Ocean View post-fill) to October 2016 (Sta 329+63 through Sta 383+58)
4. March 2005 (Central Ocean View post-fill) to October 2016 (Sta 15+00 through Sta 195+63)
5. December 2004-February 2005 (Central Ocean View pre-fill) to October 2016 (Sta 15+00 through Sta 195+63)
6. June 2003 (East Ocean View pre-fill) to October 2016 (Sta 329+63 through Sta 383+58)
7. October 2013 (West Ocean View pre-fill) to October 2016 (Sta 103+08 through Sta 152+01)

First, the change in shoreline based on the survey profiles at mean high water (MHW) was calculated at each transect for each time period mentioned. MHW along Ocean View beaches is defined as +0.98 feet NAVD88 based on NOAA tidal benchmark at Sewells Point. The resulting value represents the shoreline change (feet) over the time period between surveys. The shoreline change rate (ft/yr) was then calculated by dividing by the amount of time between survey dates.

Representative volume changes were also calculated at each transect for all time periods. Volume changes were calculated for two different extents in order to better understand the processes occurring onshore and offshore of the Ocean View beach area. Calculations included volume changes above -15 feet NAVD88 and volume changes above 0 feet NAVD88. The results represent volume change per linear foot of shoreline (cy/ft) over the period of time between surveys. The volume change rate (cy/ft/yr) was then calculated by dividing by the amount of time between survey dates. In addition, the volume changes were converted to cumulative changes over the entire shoreline. This was done by applying the average end area method to the unit volume changes (cy/ft) and unit volume change rates (cy/ft/yr) computed at each transect and summing the total volume changes over the entire shoreline. The resulting value indicated the total loss or gain of material (cy) between surveys based on the applicable profile extents.

Volume changes calculated for portions of the profiles above 0 feet NAVD88 are representative of changes in the amount of material in the dune system and on the subaerial beach. These areas are highly influenced by the performance of coastal structures and the impact of storm activity. Volume changes calculated for portions of the profiles above -15 feet NAVD88 allow for the tracking of sand movement in the submerged active profile; removing profile data deeper than the -15 feet NAVD88 contour from the analysis reduces uncertainty that would be associated with hydrographic data beyond this depth.

5. Discussion of Periodic Surveying Evaluation

This section discusses differences observed between the noted surveys, overall shoreline trends, regional shoreline trends and the 2009 East Ocean View, 2005 Central Ocean View, and 2013 West Ocean View nourishment projects. The computed shoreline changes and volume changes at each individual transect for the time periods covered are tabulated in Appendix C.

5.1. Differences in Survey Coverage

Variation in profile positions between surveys taken as part of the ongoing program of periodic surveying of the Ocean View shoreline (October 2015, May 2016, and October 2016) were minimal in the topographic portion of the survey due to use of the same baseline and transects put in place for the initial survey in September 2005. Profile extents and alignment were virtually the same when comparing the survey data.

The pre-fill and post-fill surveys taken for the East Ocean View and Central Ocean View nourishment projects did not use the same baseline and transects or cover the same extents as the periodic surveys. Profiles were extracted from DTMs created in Civil 3D at the periodic surveying transects; these are interpolations between the actual pre- and post-fill data points. In addition, the pre- and post-construction surveys for the historical nourishment projects did not extend as far offshore as the regular periodic surveys, and this limits the extent of the computations and the ability to track the offshore movement of sand.

5.2. Key Events During the Reporting Period

Beach processes are greatly influenced by natural and engineering processes. This section describes key events that happened during the present reporting period which likely had an impact on shoreline position changes and profile volume gains and losses.

5.2.1. Storm Wave Events

Understanding of the wave climate immediately offshore of the Norfolk shoreline is vital for the design, monitoring, and understanding of projects along the shoreline and the behavior of the beach. The data used were collected from the City's AWAC (Acoustic Wave and Current) gage, which was deployed in 2006 directly offshore of the Norfolk Shoreline in approximately 23 feet of water. Wave data were collected throughout this survey period up to October 19, 2016.

A summary of the observed conditions during this deployment period yields the following general observations:

- The average significant wave height and peak period over the measurement period (July 14, 2016 to October 19, 2016) was approximately 1.3 feet and 5.2 seconds.
- The largest significant wave height observed during this deployment was approximately 7.6 feet with a corresponding peak period of approximately 6.0 seconds and mean direction of 35 degrees (October 9, 2016).

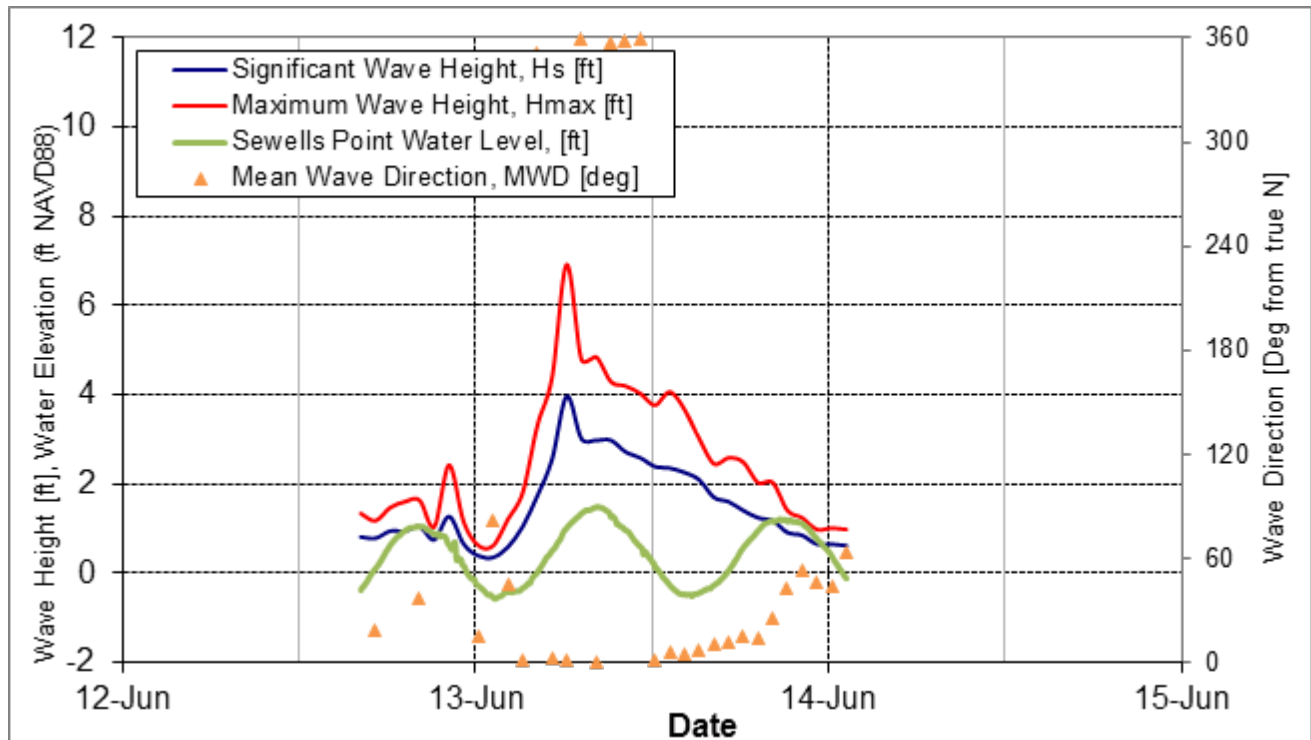
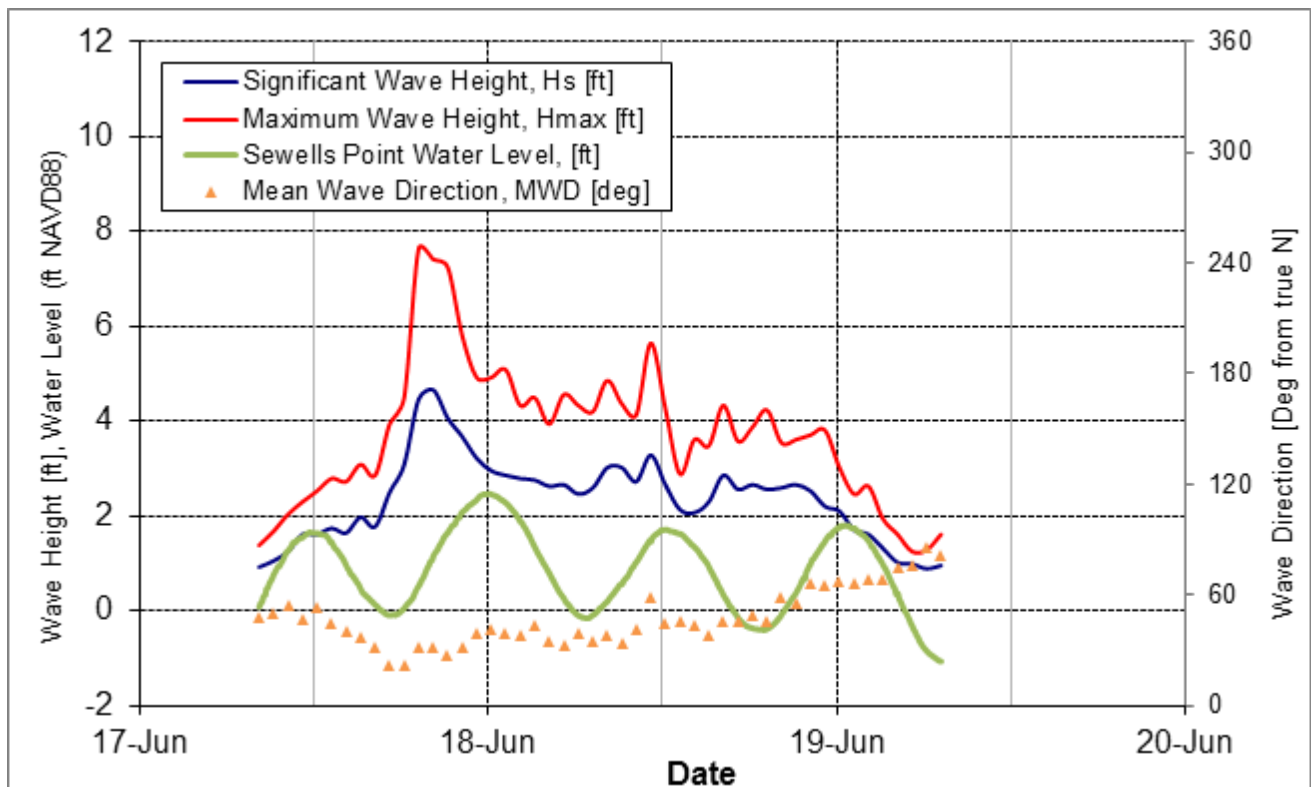
- Waves approach from the northwest to southeast, with more than 96.9% approaching from 0 to 120 degrees North.

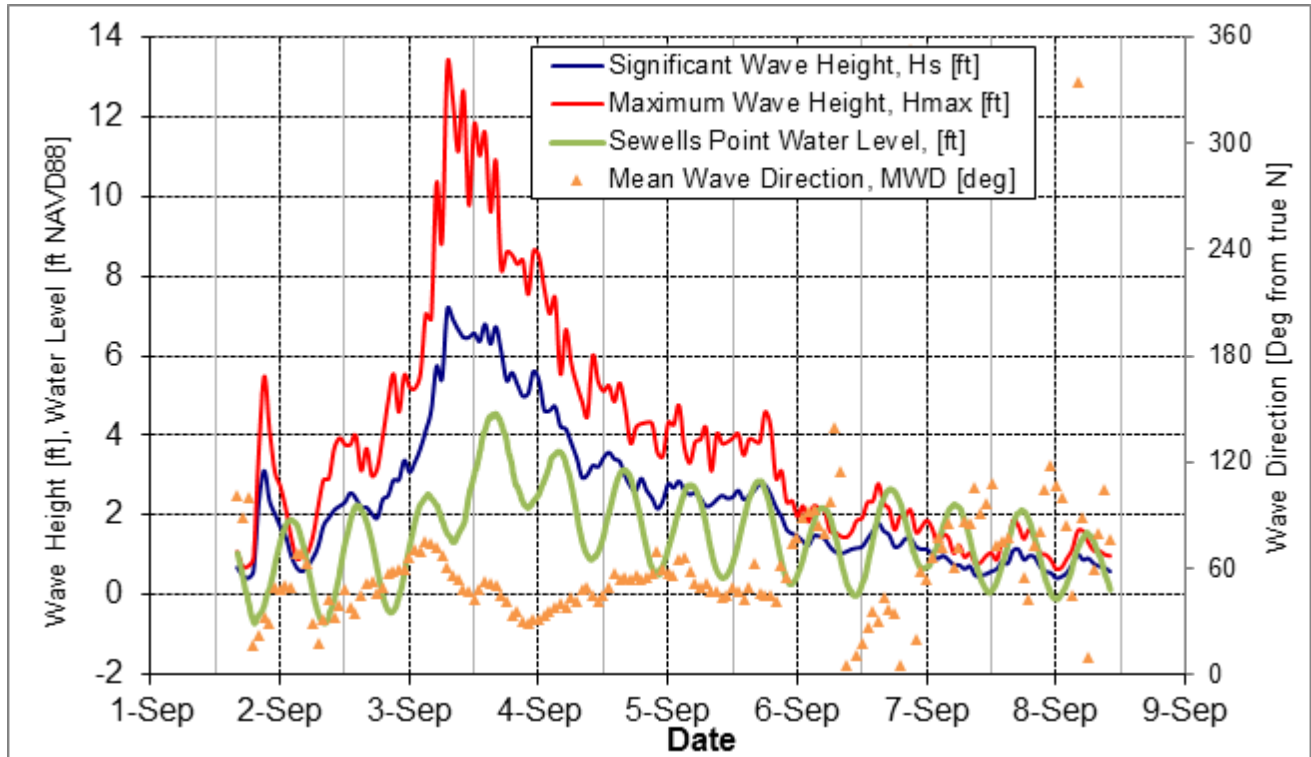
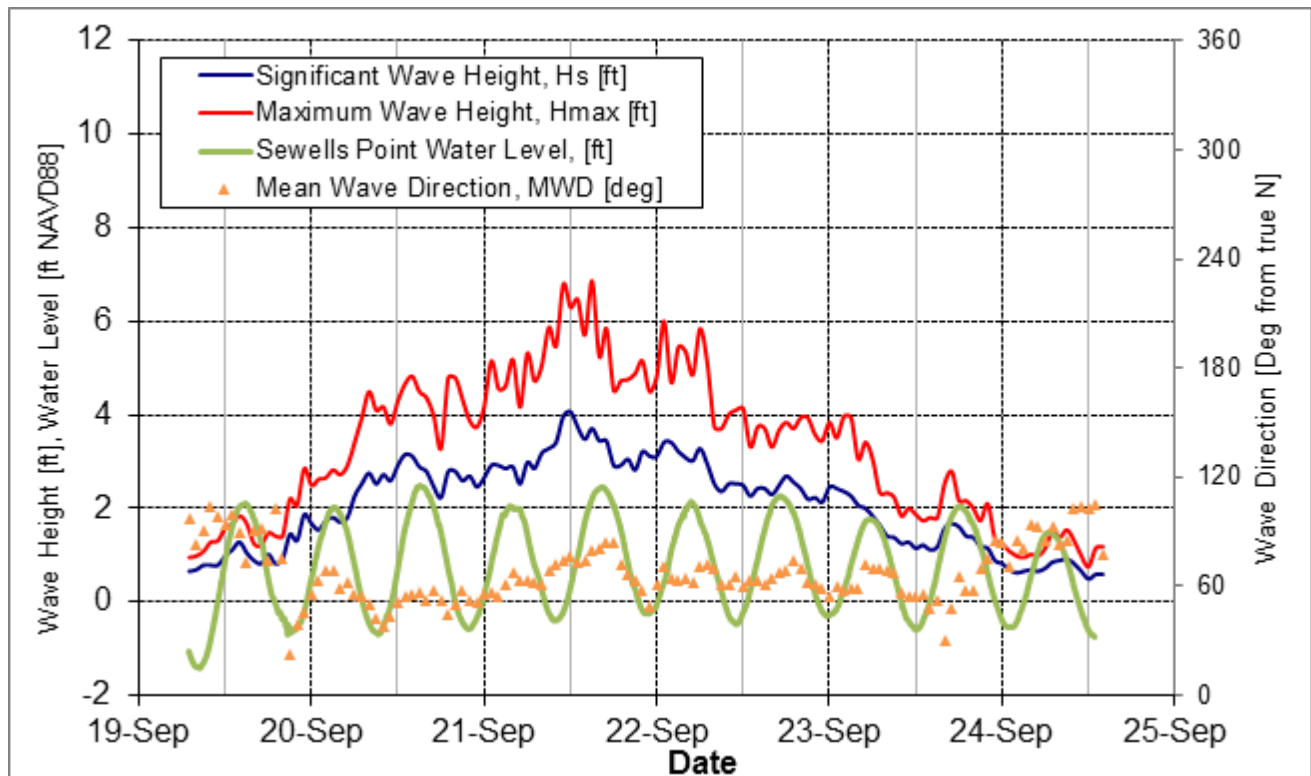
The overall wave climate during this period was typical for this location. Six storm events that occurred during the survey period for which the significant wave height at the wave gauge exceeded 3.3 feet (1.0 meter). These events are shown in Figure 5-3 through Figure 5-6.

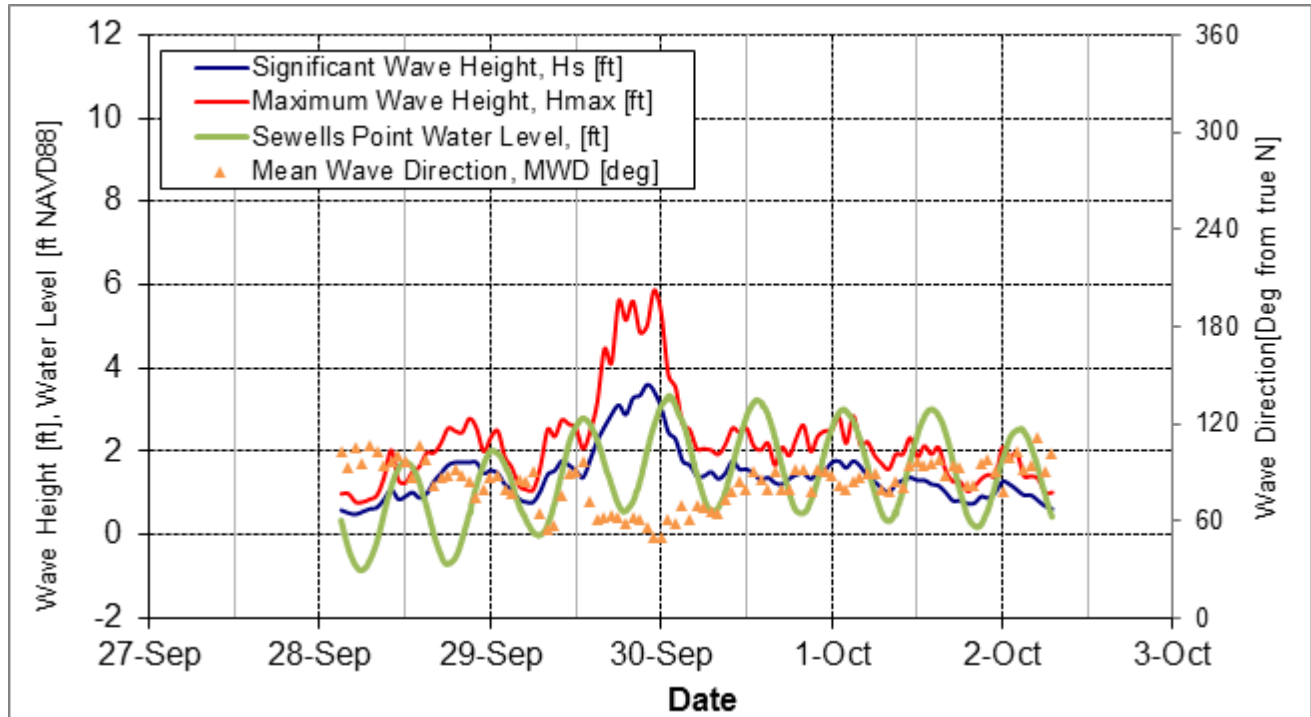
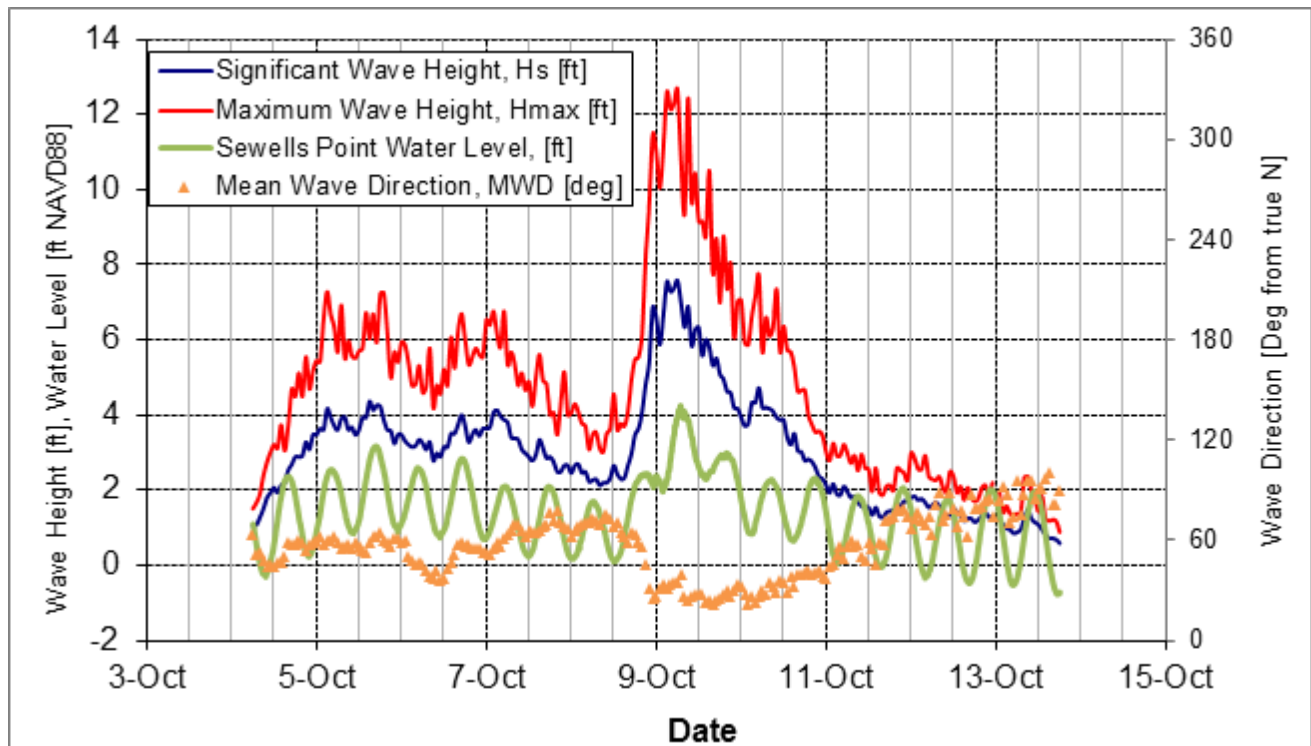
The overall trends remained consistent with prior measurement periods with waves during calm periods being predominantly swell traveling into the bay from the ocean and having longer wave periods and lower wave heights. Typically, the larger wave height events are driven by northerly and northeasterly storm winds within the bay and tend to have shorter wave periods. There were four storm events identified during this period, and, as observed in the prior measurement periods, the wind data indicate that for large and sustained wind events there is a corresponding increase in significant wave height. A summary of wave statistics by month during this deployment is given in Table 5-1.

Table 5-1: Monthly Wave Statistics Summary

Wave Statistic	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16
Average Significant Wave Height, H_s (ft)	1.48	1.26	1.56	1.14	1.18	0.64	0.95	1.68
Average Wave Period, T_m (s)	2.66	2.60	2.70	2.54	2.44	2.28	2.42	2.78
Average Peak Wave Period, T_p (s)	4.88	4.95	4.73	4.90	4.59	5.06	4.90	5.16
Maximum Observed Significant Wave Height, H_s (ft)	4.49	5.22	5.28	3.25	4.66	2.26	2.53	7.19
Maximum Observed Wave Height, H_{max} (ft)	7.22	7.84	9.84	5.97	7.64	3.25	4.53	13.32

**Figure 5-1: June 13, 2016 Storm****Figure 5-2: June 17, 2016 Storm**

**Figure 5-3: September 3, 2016 Storm****Figure 5-4: September 21, 2016 Storm**

**Figure 5-5: September 29, 2016 Storm****Figure 5-6: October 9, 2016 Storm**

5.2.2. Engineering Activities

Two emergency placement activities took place along the Ocean View Shoreline over the past year between October 2015 and October 2016. The first occurred between stations 35+00 and 49+35 in the Willoughby Spit and 800 Block Breakwaters reaches. Material was taken from the berm between stations 10+00 and 17+50. The second placement occurred in the East Ocean View reach between stations 380+18 and 383+58. Material for this placement was truck-hauled from an upland source outside of Norfolk. The effects of these events are discussed in Section 5.4.

5.3. General Shoreline Trends

Key statistics were calculated to describe the shoreline and volume change trends over the entire shoreline as well as for each region of the shoreline as defined in Figure 3-1. The computed statistics include average shoreline change, average volume change, and cumulative volume change (e.g. total volume of material lost or gained along a section of shoreline). A summary of the resulting statistics for the October 2015 to October 2016 comparison are presented in Table 5-2. A summary of the resulting statistics for the May 2016 to October 2016 comparison are presented in Table 5-3.

As illustrated in Table 5-2, the Ocean View shoreline has experienced overall erosion at MHW during October 2015 and October 2016 with a length-weighted average change rate of -1.28 ft/yr. The beach and dune above 0 feet NAVD88 gained sediment at a rate of 32,165 cy/yr from October 2015 to October 2016. The beach and dune above -15 feet NAVD88 lost sediment at a rate of -39,747 cy/yr from October 2015 to October 2016.

From May 2016 to October 2016, the MHW shoreline gained on average by 0.59 feet, as shown in Table 5-3. The volumetric change over the same period showed lost above 0 feet NAVD88 and above -15 feet NAVD88 of -43,747 cy and -58,912 cy, respectively.

The Ocean View shoreline overall lost -58,912 cy above -15 feet NAVD88 between May 2016 and October 2016, and it had a net -39,747 cy loss of sand volume above -15 feet NAVD88 over the year between October 2015 and October 2016. These overall trends and the behavior of the system are better understood by looking at patterns of change on a reach-by-reach basis, as discussed in more detail in the following section.

Table 5-2: Regional Shoreline and Volume Change Statistics (October 2015 to October 2016)

Region	Average Shoreline Change	Average Volume Change Rate Above 0 ft NAVD88	Cumulative Volume Change Rate Above 0 ft NAVD88	Average Volume Change Rate Above -15 ft NAVD88	Cumulative Volume Change Rate Above -15 ft NAVD88
	(ft/yr)	(cy/ft/yr)	(cy/yr)	(cy/ft/yr)	(cy/yr)
Willoughby Spit (0+00 to 45+00)	-7.50	1.91	8,641	-2.90	-13,078
800 Block Breakwaters (45+25 to 87+62)	-4.22	0.07	337	-2.36	-10,727
West Ocean View (93+41 to 163+49)	-1.13	-0.16	-645	-0.44	-1,128
Central Ocean View Breakwaters (169+63 to 195+63)	-0.87	0.44	1,526	-0.46	-1,599
Central Ocean View (206+86 to 323+09)	6.97	1.95	24,433	-0.12	-1,493
East Ocean View (329+63 to 383+58)	-12.52	-0.37	-2,128	-2.05	-11,723
OVERALL	Weighted Avg (ft/yr)	Weighted Avg (cy/ft/yr)	Total (cy/yr)	Weighted Avg (cy/ft/yr)	Total (cy/yr)
	-1.28	0.82	32,165	-1.09	-39,747

Table 5-3: Regional Shoreline and Volume Change Statistics (May 2016 to October 2016)

Region	Average Shoreline Change	Average Volume Change Above 0 ft NAVD88	Cumulative Volume Change Above 0 ft NAVD88	Average Volume Change Above -15 ft NAVD88	Cumulative Volume Change Above -15 ft NAVD88
	(ft)	(cy/ft)	(cy)	(cy/ft)	(cy)
Willoughby Spit (0+00 to 45+00)	-3.91	-0.07	-300	-4.60	-20,759
800 Block Breakwaters (45+25 to 87+62)	-6.41	-1.18	-5,346	-3.29	-14,918
West Ocean View (93+41 to 163+49)	-4.26	-1.06	-8,084	0.76	5,811
Central Ocean View Breakwaters (169+63 to 195+63)	-7.14	-1.50	-5,192	-1.98	-6,854
Central Ocean View (206+86 to 323+09)	11.33	-0.89	-11,197	-0.60	-7,555
East Ocean View (329+63 to 383+58)	-2.67	-2.38	-13,627	-2.56	-14,637
OVERALL	Weighted Avg (ft)	Weighted Avg (cy/ft)	Total (cy)	Weighted Avg (cy/ft)	Total (cy)
	0.59	-1.14	-43,747	-1.54	-58,912

5.4. Regional Shoreline Trends

Regional shoreline trends are discussed below for the defined regions between Willoughby Spit and Little Creek Inlet (see Figure 3-1). A summary of the information in Table 5-2 and

Table 5-3 has been created for each region of study. Figure 5-7 through Figure 5-10, following the discussion of regional shoreline trends, present the shoreline and volume change at each transect within the defined regions.

5.4.1. Willoughby Spit

The western end of the Willoughby Spit region has, since regular monitoring started in 2005, been a relatively stable and accreting region. The eastern end of this region contained an erosional hot spot that was studied in 2010, and that study recommended improvements to manage erosion rates. Prior to December 2012, coastal structures in this region included two offshore breakwaters, a rock terminal groin, and several timber groins. Construction of the Willoughby Spit Shoreline Improvement Project was completed by December 2013, and it included sand nourishment, the removal of the existing timber groin field, relocation of a prior existing breakwater in the 800 Block breakwater field, and addition of seven new detached breakwaters connecting the 800 Block breakwaters with the two prior existing Willoughby Spit breakwaters. A summary of average shoreline and volume change rates for the Willoughby Spit region between October 2015 and October 2016 and between May 2016 and October 2016 are presented in Table 5-4.

Table 5-4: Average Shoreline and Volume Change Rates for Willoughby Spit

Region	Average Shoreline Change	Average Volume Change Above 0 ft NAVD88	Cumulative Volume Change Above 0 ft NAVD88	Average Volume Change Above -15 ft NAVD88	Cumulative Volume Change Above -15 ft NAVD88
October 2015 vs. October 2016 Comparison					
	(ft/yr)	(cy/ft/yr)	(cy/yr)	(cy/ft/yr)	(cy/yr)
Willoughby Spit (0+00 to 45+00)	-7.50	1.91	8,641	-2.90	-13,078
May 2016 vs. October 2016 Comparison					
	(ft)	(cy/ft)	(cy)	(cy/ft)	(cy)
Willoughby Spit (0+00 to 45+00)	-3.91	-0.07	-300	-4.60	-20,759

On average, this region lost slight volume in the beach and dune above 0 feet NAVD88 over the seasonal comparison (May 2016 - October 2016). Willoughby Spit gained volume in the dune above 0 feet NAVD88 over the yearly comparison (October 2015 - October 2016). This region lost volume in the subaerial beach and in the submerged profile over the seasonal comparison (May 2016 - October 2016) and the yearly comparison (October 2015 - October 2016). For the yearly comparison, the MHW shoreline retreated at a rate of -7.50 ft/yr while gaining volume above 0 feet and losing volume above -15 feet NAVD88 at a rate of 8,641 cy/yr and -13,078 cy/yr, respectively. The seasonal comparison showed erosion of the MHW shoreline of -3.91 feet on average and a cumulative sediment lost above 0 feet and -15 feet NAVD88 of -300 cy and -20,759 cy, respectively. The observed yearly volume change includes volume redistributed in January and February 2016 as the City constructed an emergency beach nourishment project to restore a buffer against storms. The localized gain in sediment experienced in this reach was primarily due to this project in the vicinity of Toler Place (between 11th View and 12th View Streets). The total amount of sediment placed in this reach was 16,400 cy, and it

was obtained from the beach berm along the western end of Willoughby Spit. The negative volume changes within the western end of this reach shown in Figure 5-8 indicate the location of the borrow area. The breakwaters that were part of the 2013 shoreline improvement project that connected to the previously existing 800 Block breakwaters have continued to provide stability to the majority of the Willoughby Spit reach as shown in Figure 5-8 and Figure 5-10.

5.4.2. 800 Block Breakwaters

The 800 Block Breakwaters region (Sta 45+25 to Sta 87+62) is characterized by a field of eight breakwaters. The easternmost breakwater was relocated in February 2006 along with removal of a pre-existing groin spur and toe extension. This relocated breakwater was placed further offshore to mitigate an excessive salient / tombolo formation, caused by the prior structural configuration that had impaired natural sediment transport to the west. In conjunction with the 2013 Willoughby Spit shoreline improvement project, the second easternmost breakwater in the 800 Block set was also relocated further offshore to enhance natural sediment transport in the region. A summary of average shoreline and volume change rates for the 800 Block Breakwaters region between October 2015 and October 2016 and between May 2016 and October 2016 are presented in Table 5-5.

Table 5-5: Average Shoreline and Volume Change Rates for 800 Block Breakwaters

Region	Average Shoreline Change	Average Volume Change Above 0 ft NAVD88	Cumulative Volume Change Above 0 ft NAVD88	Average Volume Change Above -15 ft NAVD88	Cumulative Volume Change Above -15 ft NAVD88
October 2015 vs. October 2016 Comparison					
	(ft/yr)	(cy/ft/yr)	(cy/yr)	(cy/ft/yr)	(cy/yr)
800 Block Breakwaters (45+25 to 87+62)	-4.22	0.07	337	-2.36	-10,727
May 2016 vs. October 2016 Comparison					
	(ft)	(cy/ft)	(cy)	(cy/ft)	(cy)
800 Block Breakwaters (45+25 to 87+62)	-6.41	-1.18	-5,346	-3.29	-14,918

The 800 Block region lost volume over the seasonal comparison (May 2016 - October 2016) and over the yearly comparison (October 2015 - October 2016). Over the past year, there has been erosion of the MHW shoreline of -4.22 ft/yr as well as an overall slight volume gain above 0 feet NAVD88 and overall volume loss above -15 ft NAVD88 of 337 cy/yr and -10,727 cy/yr, respectively. The seasonal comparison showed there was erosion of the MHW shoreline of -6.41 feet and a loss of sediment volume above 0 feet NAVD88 and -15 feet NAVD88 of -5,346 cy and -14,918 cy, respectively. The gain over the previous survey period above 0 feet NAVD88 along the western end of the reach were due in part to the emergency nourishment project described above. The remainder of the reach remained fairly consistent with slight gains in sediment behind the breakwaters and slight losses between the gaps (Appendix B) as seen in Figure 5-8 - Figure 5-10.

5.4.3. West Ocean View

The West Ocean View area (Sta 93+41 to Sta 163+49), between the 800 Block and Central Ocean View breakwaters, was historically characterized by a series of timber groins. The 2013 West Ocean View Shoreline Improvement Project included the removal of all timber groins located between the Ocean View Fishing Pier and Station 141+98, the reconstruction of a rock groin at station 129+17, and

73,600 cy of sand nourishment placed in front of Sarah Constant Beach Park. A summary of average shoreline and volume change rates for the West Ocean View region between October 2015 and October 2016 and between May 2016 and October 2016 are presented in Table 5-6.

Table 5-6: Average Shoreline and Volume Change Rates for West Ocean View

Region	Average Shoreline Change	Average Volume Change Above 0 ft NAVD88	Cumulative Volume Change Above 0 ft NAVD88	Average Volume Change Above -15 ft NAVD88	Cumulative Volume Change Above -15 ft NAVD88
October 2015 vs. October 2016 Comparison					
	(ft/yr)	(cy/ft/yr)	(cy/yr)	(cy/ft/yr)	(cy/yr)
West Ocean View (93+41 to 163+49)	-1.13	-0.16	-645	-0.44	-1,128
May 2016 vs. October 2016 Comparison					
	(ft)	(cy/ft)	(cy)	(cy/ft)	(cy)
West Ocean View (93+41 to 163+49)	-4.26	-1.06	-8,084	0.76	5,811

This region had slight erosion over the yearly comparison (October 2015 - October 2016) with erosion of the MHW shoreline at a rate of -1.13 ft/yr, and a volume loss above 0 feet NAVD88 and -15 feet NAVD88 at a rate of -645 cy/yr and -1,128 cy/yr respectively. The seasonal comparison (May 2016 - October 2016) showed an erosion of the MHW shoreline of -4.26 feet, a loss of material above 0 feet NAVD88 of -8,084 cy and a gain of material above -15 feet NAVD88 of 5,811 cy. As expected, the rock groin added in 2013 has continued to perform well. The area updrift of the rock groin at station 129+17 has remained fairly stable over the past year as shown in Figure 5-8 and Figure 5-10. The area downdrift of the terminal groin has experienced some erosion since May 2016 as shown in Figure 5-9 and Figure 5-10.

5.4.4. Central Ocean View Breakwaters

The Central Ocean View Breakwaters region covers the four offshore breakwaters at Central Ocean View and approximately 800 feet westward (Sta 169+63 to Sta 195+63). A summary of average shoreline and volume change rates for the Central Ocean View Breakwaters region between October 2015 and October 2016 and between May 2016 and October 2016 are presented in Table 5-7.

Table 5-7: Average Shoreline and Volume Change Rates for Central Ocean View Breakwaters

Region	Average Shoreline Change	Average Volume Change Above 0 ft NAVD88	Cumulative Volume Change Above 0 ft NAVD88	Average Volume Change Above -15 ft NAVD88	Cumulative Volume Change Above -15 ft NAVD88
October 2015 vs. October 2016 Comparison					
	(ft/yr)	(cy/ft/yr)	(cy/yr)	(cy/ft/yr)	(cy/yr)
Central Ocean View Breakwaters (169+63 to 195+63)	-0.87	0.44	1,526	-0.46	-1,599
May 2016 vs. October 2016 Comparison					
	(ft)	(cy/ft)	(cy)	(cy/ft)	(cy)
Central Ocean View Breakwaters (169+63 to 195+63)	-7.14	-1.50	-5,192	-1.98	-6,854

This region was on average erosional over the yearly comparison (October 2015 - October 2016) and seasonal comparison (May 2016 – October 2016) above -15 feet NAVD88. The yearly comparison showed slight overall erosion of the MHW shoreline at a rate of -0.87 ft/yr and an overall volume gain above 0 feet NAVD88 and an overall volume loss above -15 feet NAVD88 at a rate of 1,526 cy/yr and -1,599 cy/yr. The seasonal comparison showed erosion of the MHW shoreline of -7.14 feet and a loss of material above 0 feet NAVD88 and -15 feet NAVD88 of -5,192 cy and -6,854 cy respectively. The end effects of the breakwaters in this region continue to be evident in this reach (see Figure 5-8 and Figure 5-10). Overall, this reach has continued to fare well over the past few monitoring periods.

5.4.5. Central Ocean View

Central Ocean View (Sta 206+86 to Sta 323+09) is historically a stable region with slight accretion despite the absence of engineering interventions (e.g. beach fill or structures). A summary of average shoreline and volume change rates for the Central Ocean View region between October 2015 and October 2016 and between May 2016 and October 2016 are presented in Table 5-8.

Table 5-8: Average Shoreline and Volume Change Rates for Central Ocean View

Region	Average Shoreline Change	Average Volume Change Above 0 ft NAVD88	Cumulative Volume Change Above 0 ft NAVD88	Average Volume Change Above -15 ft NAVD88	Cumulative Volume Change Above -15 ft NAVD88
October 2015 vs. October 2016 Comparison					
	(ft/yr)	(cy/ft/yr)	(cy/yr)	(cy/ft/yr)	(cy/yr)
Central Ocean View (206+86 to 323+09)	6.97	1.95	24,433	-0.12	-1,493
May 2016 vs. October 2016 Comparison					
	(ft)	(cy/ft)	(cy)	(cy/ft)	(cy)
Central Ocean View (206+86 to 323+09)	11.33	-0.89	-11,197	-0.60	-7,555

As shown in Table 5-8, the yearly comparison (October 2015 - October 2016) for the Central Ocean View region showed volume gain above 0 feet NAVD88. The seasonal comparison (May 2016 - October 2016) indicated volume loss with the majority of this loss occurring above 0 feet NAVD88. The volume loss over the current survey above 0 feet NAVD88 and -15 feet NAVD88 was -11,197 cy and -7,555 cy respectively. The average yearly shoreline accretion rate was 6.97 ft/yr with an average of 11.33 ft of accretion occurring over the reach during the current survey period.

5.4.6. East Ocean View

The East Ocean View region (Sta 329+63 to Sta 383+58) is characterized by 15 breakwaters of which the 5 westernmost were built in August of 2009. Prior to the breakwater construction, a beach renourishment project took place in March 2009, adding approximately 196,000 cy of material to the beach. Table 5-9 summarizes average shoreline and volume change rates for the East Ocean View region between October 2015 and October 2016 and between May 2016 and October 2016.

Table 5-9: Average Shoreline and Volume Change Rates for East Ocean View

Region	Average Shoreline Change	Average Volume Change Above 0 ft NAVD88	Cumulative Volume Change Above 0 ft NAVD88	Average Volume Change Above -15 ft NAVD88	Cumulative Volume Change Above -15 ft NAVD88
October 2015 vs. October 2016 Comparison					

	(ft/yr)	(cy/ft/yr)	(cy/yr)	(cy/ft/yr)	(cy/yr)
East Ocean View (329+63 to 383+58)	-12.52	-0.37	-2,128	-2.05	-11,723
May 2016 vs. October 2016 Comparison					
	(ft)	(cy/ft)	(cy)	(cy/ft)	(cy)
East Ocean View (329+63 to 383+58)	-2.67	-2.38	-13,627	-2.56	-14,637

This region is normally characterized by a consistent erosional pattern due to sediment movement along the shoreline from east to west with no external sand source due to the terminal groin at Little Creek Inlet. East Ocean View experienced volume loss over the yearly (October 2015 - October 2016) comparison and over the seasonal (May 2016 – October 2016) comparison. The MHW shoreline yearly comparison showed an overall erosion of the MHW shoreline at a rate of -12.52 ft/yr and an overall volume loss above 0 feet NAVD88 and -15 feet NAVD88 at a rate of -2,128 cy/yr and -11,723 cy/yr respectively. The seasonal comparison showed an erosion of the MHW shoreline of -2.67 feet and a loss of material above 0 feet NAVD88 and -15 feet NAVD88 of -13,627 cy and -14,637 cy respectively. The Bay Oaks breakwaters have continued to be very successful at retaining sand that may be eroding from the beach and eliminating the previous hotspot. Typically, the east end of the region, adjacent to the jetty, is more erosive than most areas west in this region due to the lack of a sediment source and the littoral sediment movement in this region going from east to west. Usually, this region has a fairly steady pattern of accretion on the profiles behind the breakwaters and erosion on the profiles between the breakwaters. This indicates the influence of the breakwaters on decreasing the wave heights and retaining sediment along the shore.

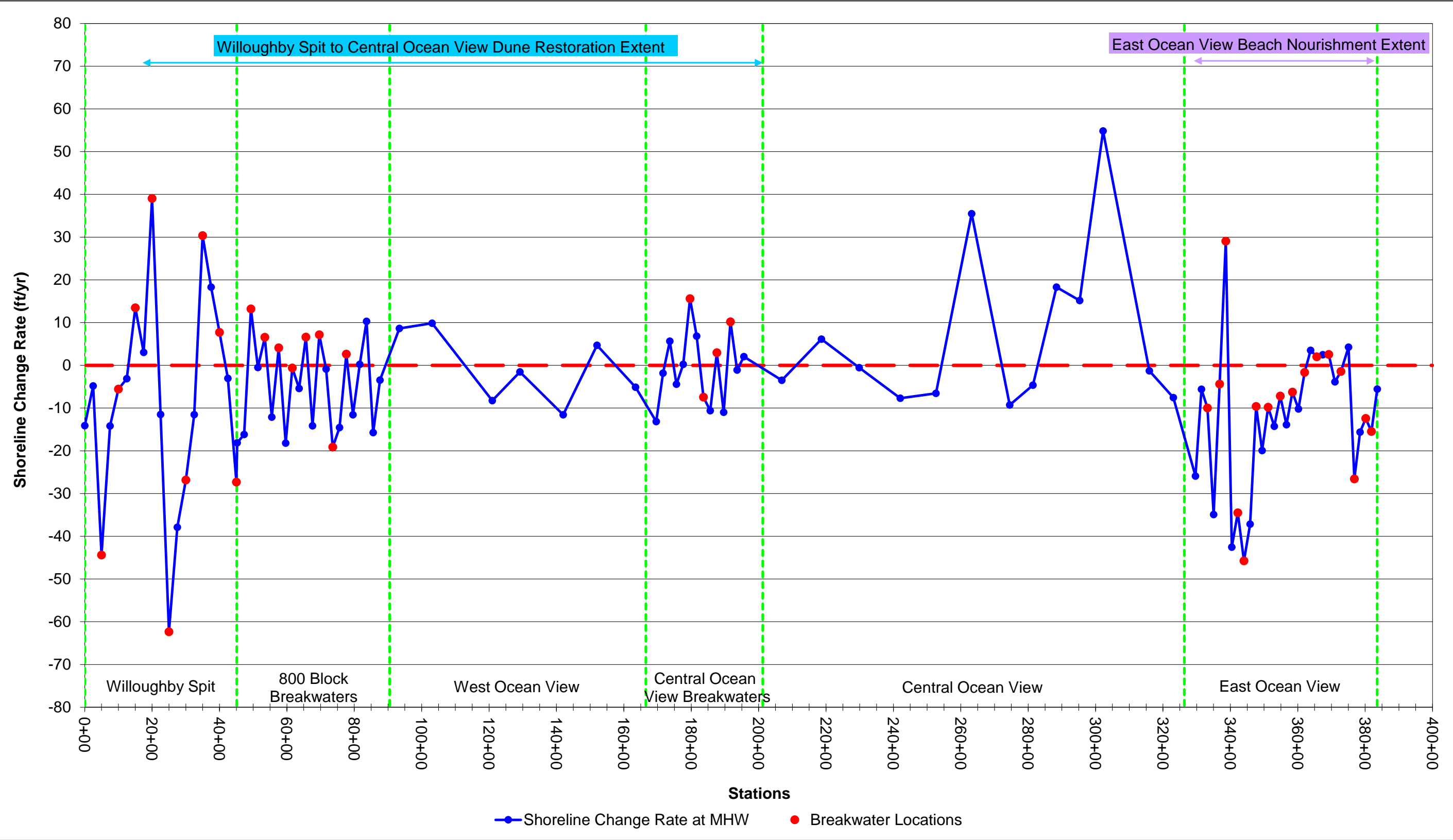


Figure 5-7: Shoreline Change Rate (ft/yr) at Mean High Water (+0.98 ft NAVD88) for October 2015 to October 2016 (Note: Positive = Accretion, Negative = Erosion)

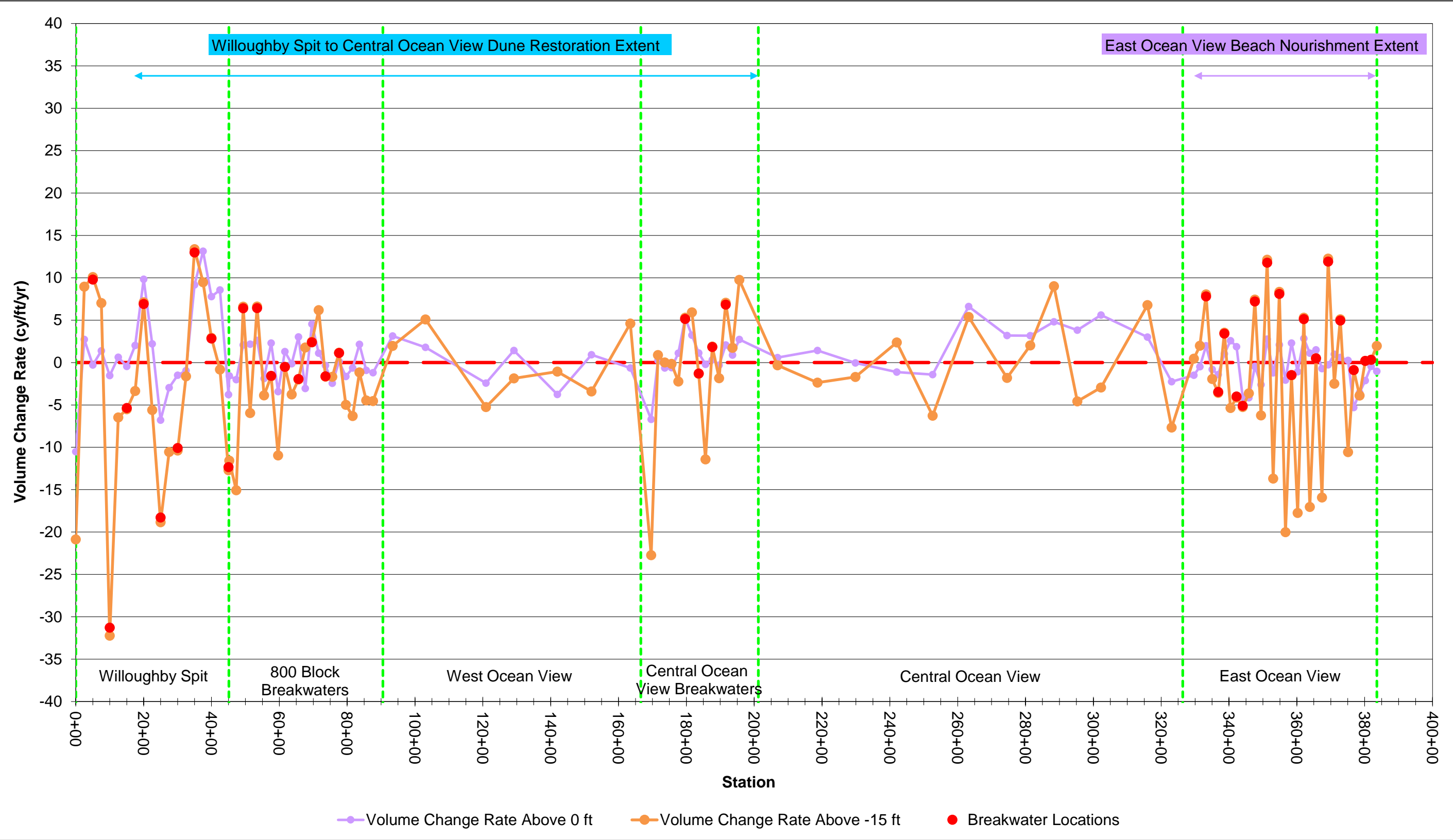


Figure 5-8: Volume Change Rate Above 0 ft NAVD88 and -15 ft NAVD88 (cy/ft/yr) for October 2015 to October 2016 (Note: Positive = Accretion, Negative = Erosion)

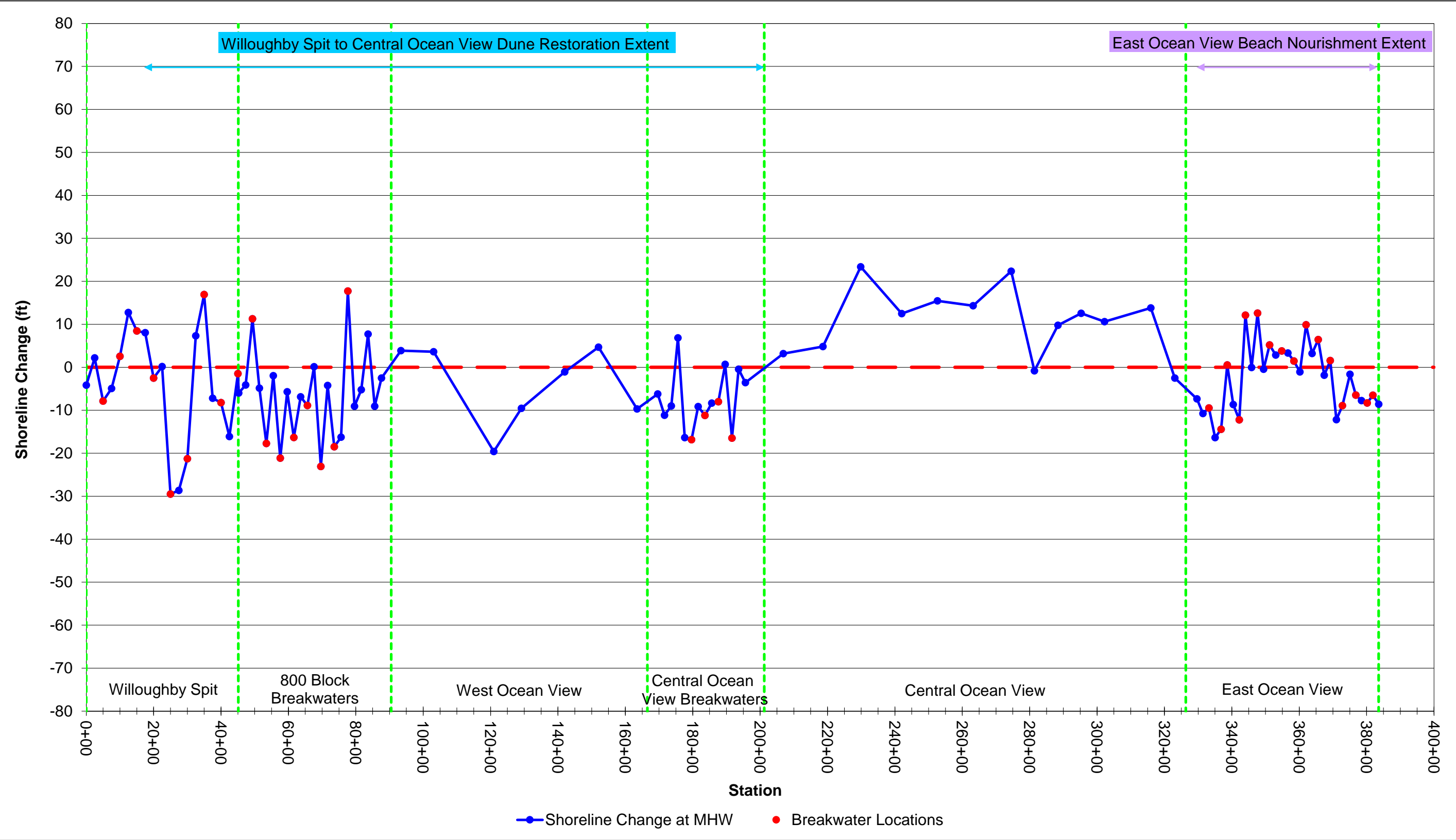


Figure 5-9: Shoreline Change (ft) at Mean High Water (+0.98 ft NAVD88) for May 2016 to October 2016 (Note: Positive = Accretion, Negative = Erosion)

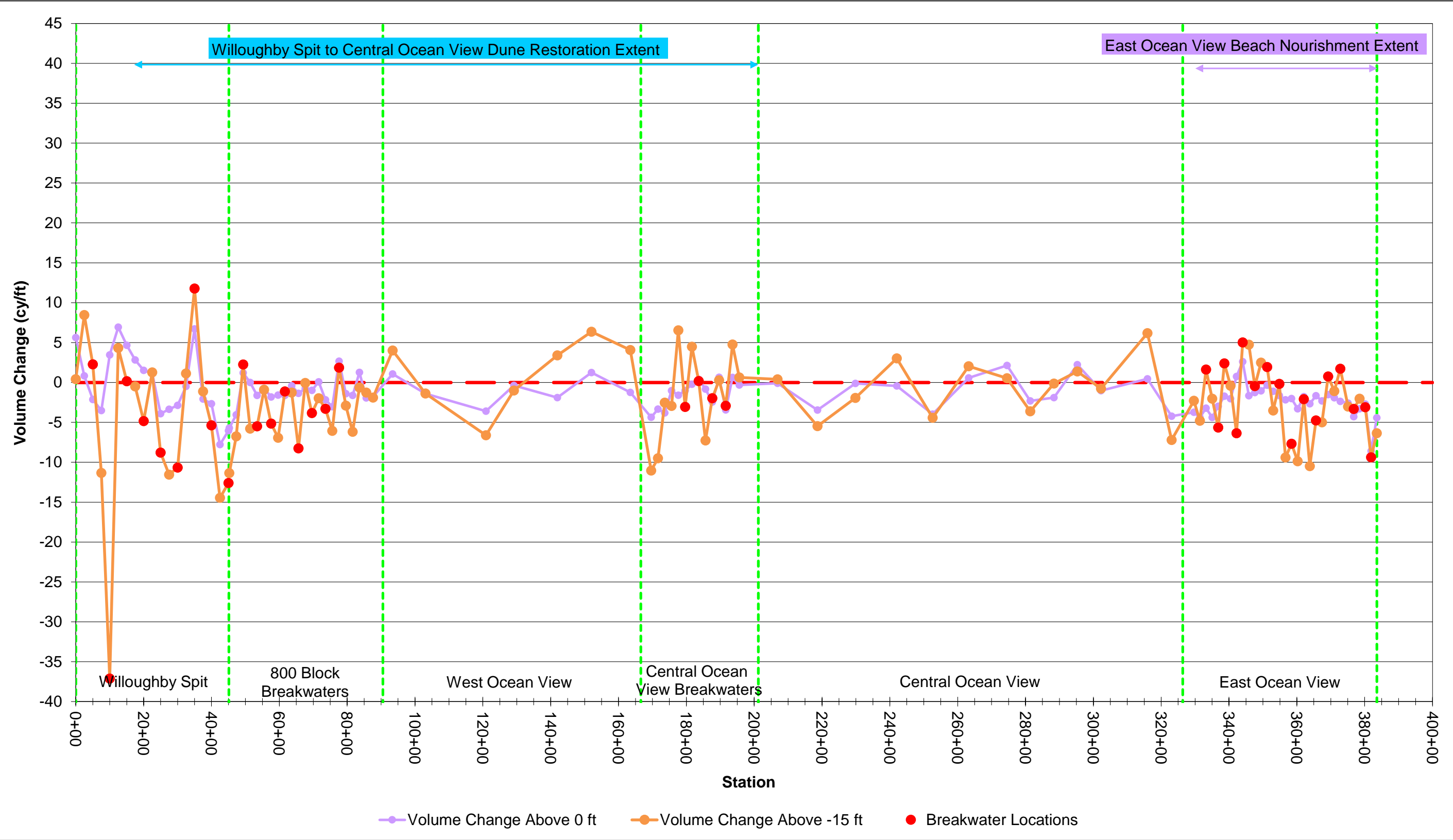


Figure 5-10: Volume Change Above 0 ft NAVD88 and -15 ft NAVD88 (cy/ft) for May 2016 to October 2016 (Note: Positive = Accretion, Negative = Erosion)

5.5. East Ocean View Beach Nourishment Project (2009)

An initial beach nourishment project took place along the East Ocean View shoreline in November 2003. Approximately 359,000 cy of material was placed on the beach between Station 329+63 and Station 383+58. More recently, the East Ocean View shoreline was renourished with approximately 196,000 cy of material in March 2009. The most recent periodic survey, taken in October 2016, was compared to the post-fill survey taken in March 2009. Table 5-10 presents the shoreline and volume change statistics comparing the two surveys.

Table 5-10: Overall Shoreline and Volume Change Statistics – East Ocean View Nourishment Project (March 2009 Post-Fill – October 2016 Comparison)

Region		Average Shoreline Change (ft)	Average Volume Change Above 0 ft NAVD88 (cy/ft)	Cumulative Volume Change Above 0 ft NAVD88 (cy)	Average Volume Change Above -15 ft NAVD88 (cy/ft)	Cumulative Volume Change Above -15 ft NAVD88 (cy)
East Ocean View (329+63 to 383+58)	Rate per Year	-14.38	-2.92	-15,273	-5.08	-26,517
	Total	-109.07	-22.18	-115,862	-38.57	-201,167

Results indicate that the East Ocean View MHW shoreline has continued to erode and that all of the 113,000 cy originally placed above 0 feet NAVD88 has been lost from the East Ocean View reach. The East Ocean View nourishment project is past the end of its effective performance life. Previous experience from the 2003 nourishment project indicates that the design life of projects in this area is limited to 4-5 years due to storm impact and lack of sediment source to the east, and from this perspective the 2009 East Ocean View nourishment project has performed well. The need for renourishment is indicated, and this is expected to be provided by the upcoming federal coastal storm damage reduction project.

Figure 5-11 shows areas of elevation change between the post-fill survey and the October 2016 survey. As depicted in the figure, there has been erosion of the beach face and nearshore, with more erosion in-between the breakwaters than in the areas directly behind the breakwaters. Some of the sediment eroded from the beach face and nearshore in the East Ocean View breakwater field appears to have accreted within the Bay Oaks breakwaters. These breakwaters have continued to be successful in addressing the previous hotspot and providing a transition into the Central Ocean View region.

The October 2016 MHW shoreline was compared to the MHW shoreline from June 2003, before the first nourishment project in November 2003, as another way to measure the amount of protection being supplied by the March 2009 nourishment project. Areas where the current shoreline is within 20 feet of the June 2003 shoreline need to be targeted for nourishment. Figure 5-12 shows the MHW shoreline position difference between the June 2003 pre-fill and October 2016 shorelines. The Bay Oaks Breakwaters have experienced a recession at a majority of the stations. Currently 50% of the Bay Oaks stations are within the 20 foot buffer zone, which is a slight decrease from 60% in the previous monitoring period. The percentage of stations that have receded beyond the buffer increased from 20% previously to 40% currently. Only one station (344+05) within the Bay Oaks Breakwaters has remained outside of the 20 foot buffer for the pre-fill shoreline. The MHW shoreline at all stations along the East Ocean View Breakwaters have receded within 20 feet of the pre-fill shoreline with some receding beyond the pre-fill shoreline position. Currently 70% of the East Ocean View Breakwater

stations have receded beyond the pre-fill shoreline. As stated previously, the upcoming Federal Project is expected to alleviate the concern within this reach.

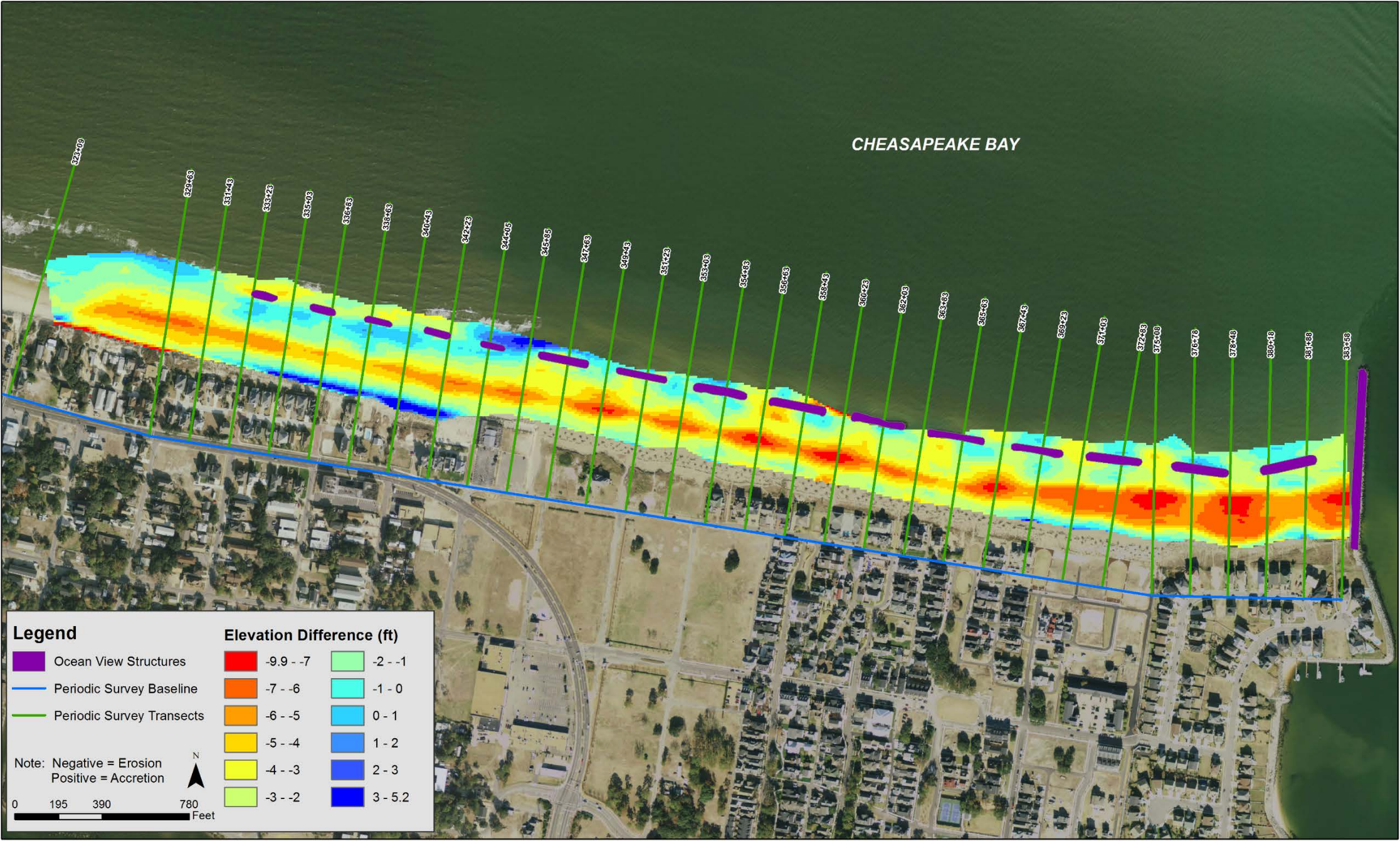


Figure 5-11: Net Volume Change Since the East Ocean View Nourishment Project (March 2009)

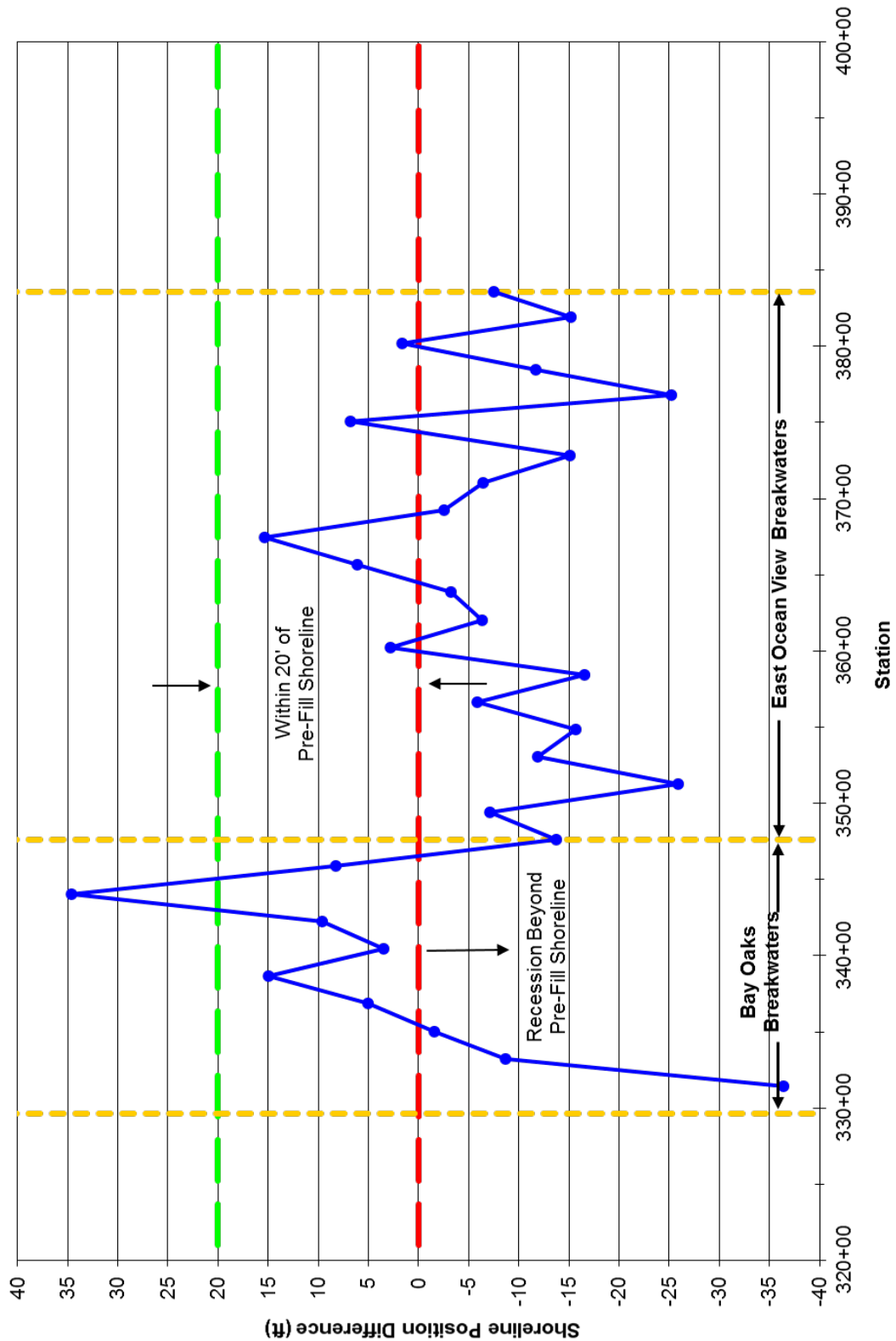


Figure 5-12: Shoreline Position Difference (ft) at MHW Between 2003 Pre-Fill and October 2016 Shorelines for East Ocean View

5.6. Central Ocean View Dune Restoration Project (2005)

The most recent periodic survey, taken in October 2016, was also compared to the post-fill survey taken in March 2005 after completion of the Willoughby Spit to Central Ocean View Dune Restoration project. A total of 504,300 cy of sand was placed in 2005 from Station 15+00 to Station 195+63. Table 5-11 presents the shoreline and volume change statistics comparing the two surveys.

Table 5-11: Regional and Overall Shoreline and Volume Change Statistics for Central Ocean View Nourishment Project (March 2005 Post-Fill – October 2016 Comparison)

Region		Average Shoreline Change (ft)	Average Volume Change Above 0 ft NAVD88 (cy/ft)	Cumulative Volume Change Above 0 ft NAVD88 (cy)	Average Volume Change Above -15 ft NAVD88 (cy/ft)	Cumulative Volume Change Above -15 ft NAVD88 (cy)
Willoughby Spit (0+00 to 45+00)	Rate per Year	-0.32	-0.44	-1,114	-0.50	-1,166
	Total	-3.70	-5.06	-12,924	-5.78	-13,528
800 Block Breakwaters (45+25 to 87+62)	Rate per Year	-5.85	-1.28	-5,605	-2.03	-8,855
	Total	-67.91	-14.84	-65,037	-23.58	-102,740
West Ocean View (93+41 to 163+49)	Rate per Year	-3.40	-1.44	-11,237	-0.85	-6,346
	Total	-39.47	-16.70	-130,384	-9.91	-73,636
Central Ocean View Breakwaters (169+63 to 195+63)	Rate per Year	-1.14	-0.08	-194	0.93	2,931
	Total	-13.26	-0.95	-2,255	10.83	34,003
OVERALL		Weighted Average	Total	Weighted Average	Total	Weighted Average
Rate per Year		-3.06	-0.98	-18,151	-0.75	-13,437
Total		-35.52	-11.39	-210,600	-8.69	-155,902

It is important to consider changes above the 0 feet contour since the project was primarily a dune restoration, placing the majority of sand above the intertidal zone. Table 5-11 shows that there has been significant loss of material in the dune system and subaerial beach above 0 feet NAVD88 since the project was completed. Approximately 210,600 cy of the 320,700 cy originally placed above 0 feet NAVD88 (for approximately 66% loss) has been lost from this reach. The previous monitoring period (May 2016) report indicated that the percentage loss at that time was 59%, which indicates there was a loss of additional sediment over the most recent survey period.

Figure 5-13 shows areas of elevation change between the March 2005 post-fill survey and the October 2016 survey. The beach has eroded more quickly between the easternmost Willoughby Spit breakwaters and the western end of the 800 Block Breakwaters, and along the shorelines adjacent to Ocean View Beach park. Losses have been less in the Central Ocean View Breakwaters than in the 800 Block Breakwaters and Willoughby Spit breakwaters. It is noted that the Willoughby Spit breakwaters were constructed in 2013, while this figure shows cumulative changes since 2005; much of the erosion of the 2005 nourishment project in the vicinity of these breakwaters occurred before the breakwaters were constructed.

The losses in dune volume seen immediately west of the 800 Block Breakwaters (between Stations 42+50 and 47+30, in the 11th View and 12th View Street vicinity) persist even after the construction of

the seven Willoughby Spit breakwaters in 2013 served to slow erosion of the shoreline and subaerial beach. At this location near 11th View Street, and in West Ocean View between Stations 129+17 and 141+98, the eroded condition means that there is a narrow beach and little dune volume fronting several residential and commercial buildings. The emergency nourishment project in January – February 2016 helped to alleviate the immediate concern between 11th View and 12th View Streets, and most of that fill has now eroded; both areas will be closely monitored going forward. Additional localized nourishments may be needed in these areas, if significant winter and spring storms occur prior to the upcoming Federal Project which is now planned to begin in early 2017.

In addition, the October 2016 MHW shoreline was compared to the pre-fill MHW shoreline as another way to measure the amount of protection still being supplied by the January-March 2005 nourishment (dune restoration) project. The design life of the nourishment project was outlined in the M&N Willoughby Spit to Central Ocean View Dune Restoration Project Performance Analysis from October 2004. The study anticipated a project design life of 5 to 6 years with no major storm activity and 2 to 3 years at hot spot areas if there were impacts to this reach of shoreline from storms. The nourishment project is in its eleventh year and has been impacted by several storms since its construction, e.g. October 2006 and November 2009 nor'easters, Hurricane Irene in August 2011, and Hurricane Sandy in October 2012. Areas where the current shoreline is within 20 feet of the pre-fill shoreline need to be targeted for nourishment. Figure 5-14 shows the MHW shoreline position difference between the pre-fill and October 2016 shorelines. The October 2016 Willoughby Spit to Central Ocean View MHW shoreline comes within 20 feet of the pre-fill shoreline in several locations, and long segments of the shoreline have receded landward of the pre-fill shoreline. The shoreline has accreted bayward of the buffer zone at the western end of Willoughby Spit between stations 0+00 and 40+00 and within the Central Ocean View breakwaters. Specific areas of concern remain the shoreline to the west of the 800 Block breakwater field (as discussed above) and within the breakwater field itself at Stations 42+50 through 67+62. A short segment of the eastern end of the 800 Block Breakwaters (Stations 69+62 through 77+62) is bayward of the buffer, and the remainder of the breakwater field is now landward of the pre-fill shoreline. The majority of the western and central section of the West Ocean View shoreline (Stations 79+62 through 152+01) have receded landward of the pre-fill shoreline.

The upcoming federal coastal storm damage reduction project is expected to provide this reach with significant additional beach berm widths and associated beach profile volume between +3.5 feet and depth of closure in the submerged profile. However, the Federal Project is now expected to start in early 2017, so that the beach system will experience several additional months of wave action prior to receiving this large-scale renourishment.

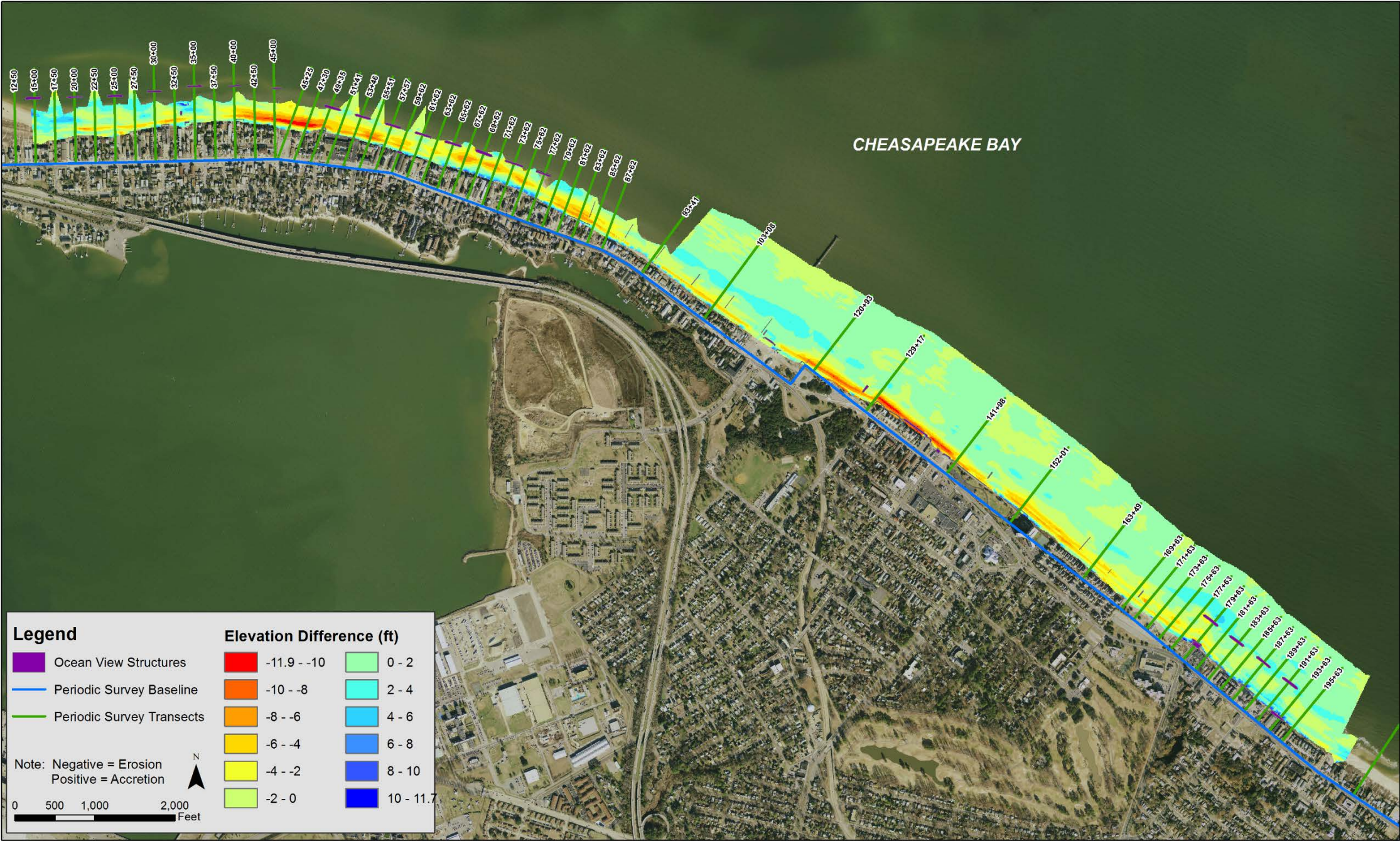


Figure 5-13: Net Volume Change Since the Willoughby Spit to Central Ocean View Dune Restoration Project (March 2005)

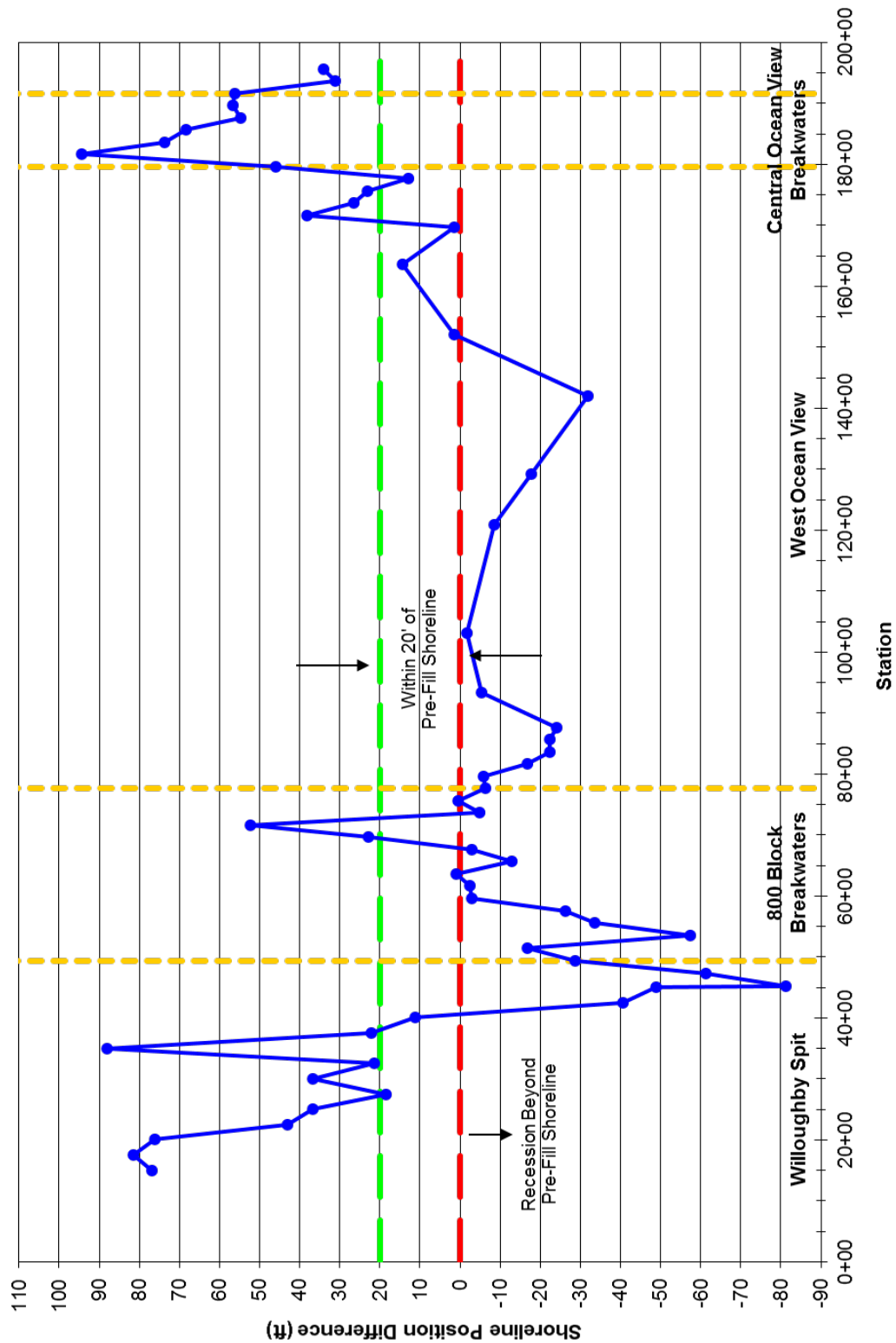


Figure 5-14: Shoreline Position Difference (ft) at MHW Between 2003 Pre-Fill and October 2016 Shorelines for Central Ocean View

5.7. West Ocean View Shoreline Improvement Project (2013)

The most recent periodic survey from October 2016 was compared to the October 2013 survey of the West Ocean View Shoreline Improvement Project area, where a total of 73,600 cy of sand was placed from Station 103+08 to Station 152+01 in November 2013.

Table 5-12: Overall Shoreline and Volume Change Statistics for West Ocean View shoreline Improvement Project (October 2013 – October 2016 Comparison)

Region		Average Shoreline Change	Average Volume Change Above 0 ft NAVD88	Cumulative Volume Change Above 0 ft NAVD88	Average Volume Change Above -15 ft NAVD88	Cumulative Volume Change Above -15 ft NAVD88
West Ocean View (103+08 to 152+01)	Total	-1.00 ft	0.76 cy/ft	3,724 cy	2.89 cy/ft	14,164 cy

Construction of the West Ocean View Shoreline Improvement Project was substantially complete prior to the March 2014 monitoring period. This project included the removal of the existing groin field east of the pier, reconstruction of a groin in between the 200 Block and Sarah Constant Shrine Park, and a 73,600 cy nourishment project, as shown in Figure 5-15. The new groin was designed to be shorter and more sand-tightened than the previous groins, helping to maintain adequate beach width in front of the 200 Block for vehicle access. The 73,600 cy nourishment project added 30 feet of berm width in front of Sarah Constant Beach Park, on the downdrift side of the groin.



Figure 5-15: West Ocean View Shoreline Improvement Project Area

A majority of the material was placed above -3 ft NAVD88; therefore, the volume change above -15 ft NAVD88 was evaluated to capture as much of the remaining material as possible. Approximately 14,200 cy of material remains above -15 feet NAVD88, which is 19% of the 73,600 cy originally placed.

In addition, the October 2016 MHW shoreline was compared to the MHW shoreline from October 2013, before the shoreline improvement project was completed in November 2013, as another way to measure the amount of protection being supplied by this nourishment project. Areas where the current shoreline is within 10 feet of the October 2013 shoreline need to be targeted for nourishment. Figure 5-16 shows the MHW shoreline position difference between the October 2013 and October 2016 shorelines. The groin at station 129+17 has been performing well and trapping sand as designed. However, the MHW shoreline at transect 103+08 updrift of the groin is now at the 10 foot buffer zone. The remaining transects show the MHW shoreline having receded to the position of the prefill shoreline with one transect receding significantly landward of the pre-fill shoreline. On average over the project area, the MHW shoreline has eroded -1.00 feet relative to the pre-fill shoreline, compared to the cumulative accretion of 5.26 feet average shoreline change observed in the previous monitoring period.

The upcoming federal coastal storm damage reduction project is expected to provide this reach with significant additional beach berm widths and associated beach profile volume between +3.5 feet and depth of closure in the submerged profile.

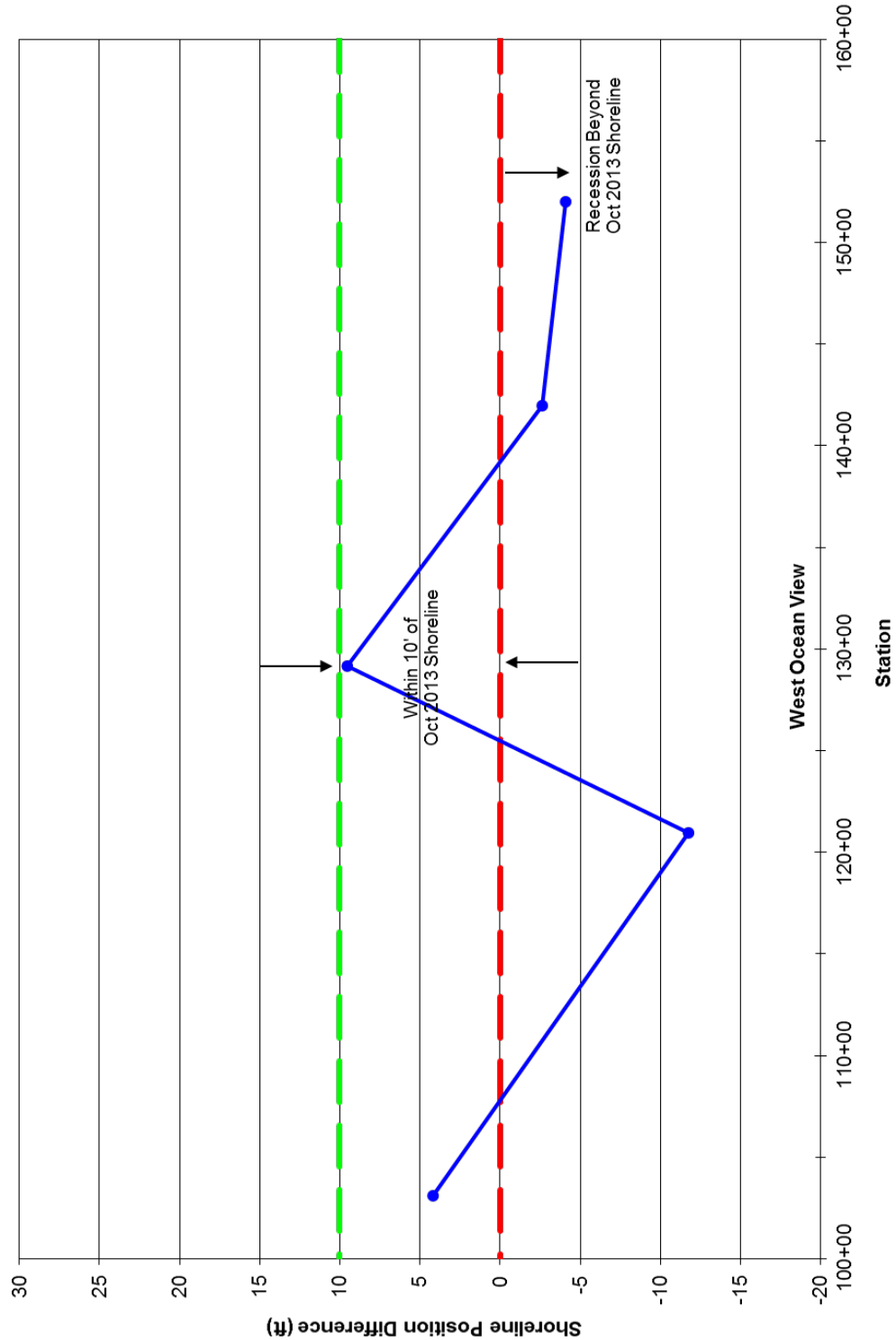


Figure 5-16: Shoreline Position Difference (ft) at MHW Between October 2013 and October 2016 Shorelines for West Ocean View

6. Summary

Comprehensive periodic surveying of the entire Ocean View shoreline began with an initial survey in September 2005. The most recent survey was completed in October 2016. The beach and bathymetric surveys performed by Geodynamics utilized baseline and transect positions established in September 2005 which are used for all periodic surveys. For this periodic evaluation, the October 2016 survey was compared with both the October 2015 and May 2016 surveys. The surveys were used to compute shoreline change at MHW and volume change above 0 feet NAVD88 and above -15 feet NAVD88.

In addition, the most recent survey in October 2016 was compared to pre- and post-fill surveys taken after the East Ocean View beach nourishment (March 2009), Willoughby Spit to Central Ocean View dune restoration (January-March 2005) projects, and West Ocean View shoreline improvement project (2013). This was done to quantify the amount of material loss since the projects were completed and condition of the shoreline with respect to pre-fill conditions.

Key statistics were computed for defined regions along Ocean View and the entire shoreline for the time period between the October 2015 and October 2016 surveys and between the May 2016 and October 2016 surveys.

Comparison	Parameter	Quantity
October 2015 vs. October 2016	Average Shoreline Change Rate at MHW (+0.98 ft NAVD88)	-1.28 ft/yr
	Cumulative Volume Change Rate Above 0 ft NAVD88	32,165 cy/yr
	Cumulative Volume Change Rate Above -15 ft NAVD88	-39,747 cy/yr
May 2016 vs. October 2016	Average Shoreline Change at MHW (+0.98 ft NAVD88)	0.59 ft
	Cumulative Volume Change Above 0 ft NAVD88	-43,747 cy
	Cumulative Volume Change Above -15 ft NAVD88	-58,912 cy

The average shoreline change rate for the entire shoreline at MHW between the October 2015 and October 2016 surveys was -1.28 ft/yr, and the cumulative volume changes above 0 feet NAVD88 and -15 feet NAVD88 were approximately 32,165 cy/yr and -39,747 cy/yr, respectively. The overall volumetric loss in the dune and subaerial beach and the system as a whole was largely due to the effects of the notable storms in late September, and early October 2015 and in January 2016. The large difference between the yearly accretion of 32,165 cy above 0 feet NAVD88, and the erosion of -43,747 cy since May 2016, would indicate that there was very significant erosion on the subaerial beach and dune in the past six months. Preliminary calculations of volume change from separate measurements by helicopter-based LiDAR elevation surfaces – captured in October 2015, May 2016, September 2016, and October 2016 – indicate significantly greater accretion above 0 feet NAVD88 than is shown by the profile surveys. Those calculations are being finalized at the time of writing of this report, and they will be presented in a technical memorandum under separate cover with commentary about the differences seen between the profile-based monitoring and the LiDAR-based volume change calculations.

The most recent six-month period of comparison (May 2016 - October 2016) depicts a slight accretion of the MHW line of 0.59 feet. The cumulative volume change above 0 feet NAVD88 indicates a sediment loss to the subaerial beach of -43,747 cy, with a loss of sediment in the nearshore system above -15 feet NAVD88 of -58,912 cy.

Willoughby Spit

The Willoughby Spit region overall experienced erosion of the MHW shoreline with volumetric gains above 0 feet NAVD88 and volumetric loss above -15 feet NAVD88 over the past year. The trend over the past six months has been erosional above 0 feet NAVD88 and above -15 feet NAVD88.

800 Block Breakwaters

In the 800 Block region, there has been erosion of the MHW shoreline, with slight volumetric gain above 0 feet NAVD88 and volumetric loss above -15 feet NAVD88 over the year. In the current six months monitoring period there has been erosion of the MHW shoreline and volumetric losses above 0 feet NAVD88 and above -15 feet NAVD88.

West Ocean View

The reconstructed groin in West Ocean View has performed well over the past year. The yearly analysis shows overall slight volumetric loss above both 0 feet NAVD88 and -15 feet NAVD88 as well as erosion of the MHW shoreline.

Central Ocean View Breakwaters

The Central Ocean View Breakwaters has remained fairly stable over the past year. This region experienced slight erosion of the MHW shoreline over the past year, with volumetric gain above 0 feet NAVD88 and volumetric loss above -15 feet NAVD88 over the past year.

Central Ocean View

Typically a very stable region, Central Ocean View has experienced accretion of the MHW shoreline over the past year. There has been volumetric gain above 0 feet NAVD88 and slight volumetric loss above -15 feet NAVD88 over the past year. Over the current survey period, this region experienced volume losses above 0 feet NAVD88 and -15 feet NAVD88 with an advance in shoreline position.

East Ocean View

There has been erosion of the MHW shoreline along with volumetric losses above both 0 feet NAVD88 and -15 feet NAVD88 in the East Ocean View region over the past year. Over the current survey period, there was erosion of the MHW shoreline and volumetric gains above 0 feet NAVD88 and -15 feet NAVD88. The Bay Oaks breakwaters are continuing to perform well, trapping sediment and eliminating the hotspot at this location.

In addition to regional assessments, comparison of the October 2016 survey was made against post-fill surveys from the East Ocean View beach nourishment, Willoughby Spit to Central Ocean View dune restoration, and the West Ocean View Shoreline Improvement Project which took place in March 2009, January-March 2005, and November 2013 respectively.

Comparison	Average Shoreline Change	Average Volume Change Above 0 ft NAVD88	Cumulative Volume Change Above 0 ft NAVD88	Average Volume Change Above -15 ft NAVD88	Cumulative Volume Change Above -15 ft NAVD88
East Ocean View Nourishment vs. October 2016 Comparison	-109.07 ft	-22.18 cy/ft	-115,862 cy	-38.57 cy/ft	-201,167 cy
Central Ocean View Nourishment vs. October 2016 Comparison	-35.52 ft	-11.39 cy/ft	-210,600 cy	-8.69 cy/ft	-155,902 cy
West Ocean View Pre-Nourishment vs October 2016 Comparison	-1.00 ft	0.76 cy/ft	3,724 cy	2.89 cy/ft	14,164 cy

The 115,900 cy volumetric loss above 0 feet NAVD88 within the East Ocean View project (since construction in 2009) covers all of the original amount placed in this dune and subaerial beach area. The 210,600 cy loss above 0 feet NAVD88 in the Central Ocean View project area (since 2005) is roughly 66% of the original amount placed above 0 feet NAVD88. The remaining volume for the West Ocean View project is approximately 14,200 cy out of the 73,600 cy placed in 2013, which is 19% of the original fill volume remaining. Due to storm impacts and background erosion that has occurred, as anticipated, over the projects' design lives, areas in the Central Ocean View region and all of the East Ocean View region needs that should be targeted for nourishment. The completed Willoughby Spit (2013) project and the West Ocean View (2013) projects have alleviated the concerns with these hot spots and have provided additional protection in vulnerable areas; however, this area as well as others may require additional nourishment to provide adequate storm protection. It is expected that the upcoming federal coastal storm damage reduction project will provide all of these reaches (directly, or indirectly in the case of the Cottage Line area of Central Ocean View) with significant additional beach profile volume over the next year.

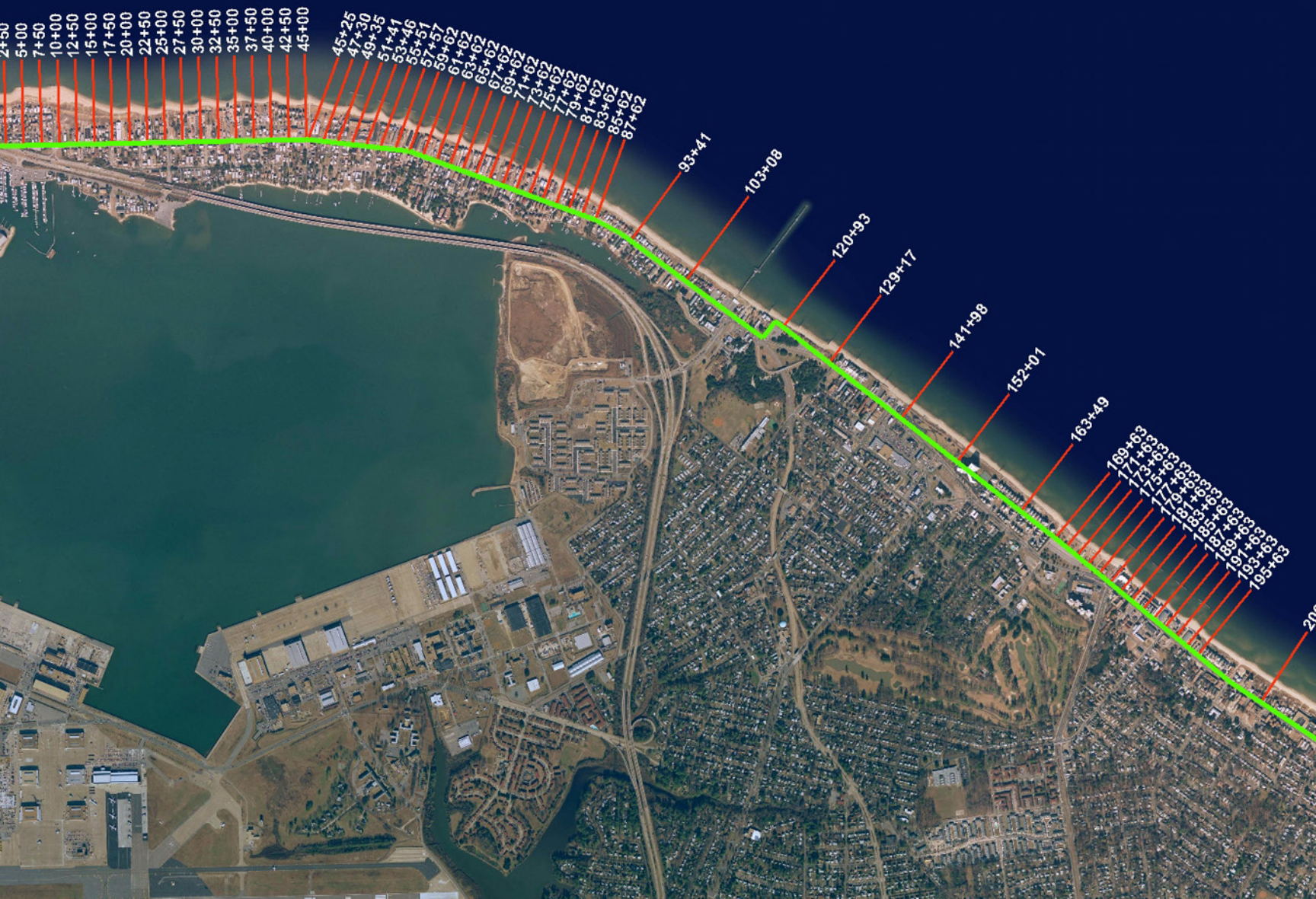
This is the twenty-third periodic survey report completed to date, and the twenty-third evaluation of a consistent survey period utilizing beach and bathymetric surveys. As noted, there are inevitable margins of error associated with the survey data that may reduce the accuracy of volumetric change analyses. Therefore, it is essential to thoroughly review the beach and bathymetric profiles using various analytical techniques and general engineering judgment to assure that results are not falsely interpreted. Comparison of surveys taken at the same season of the year (i.e. October 2015 to October 2016) mitigates seasonal variation of profiles in volumetric change analyses. Consecutive spring-fall or fall-spring survey comparisons are useful to assess the direct impact of extreme events which may occur during the six month period between surveys. Future periodic survey evaluations will continue to improve on analysis techniques so that the rich survey data sets are best utilized.

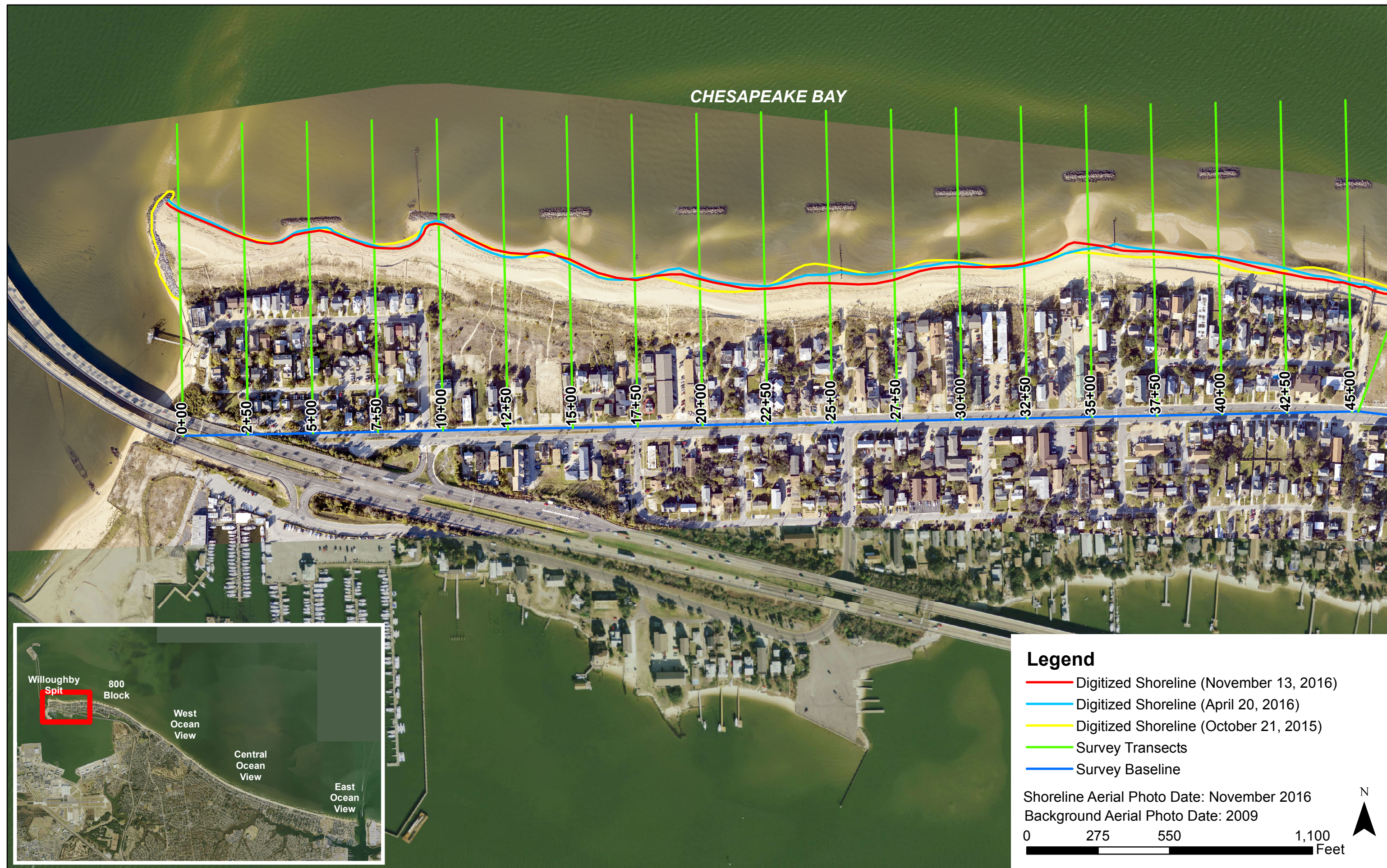


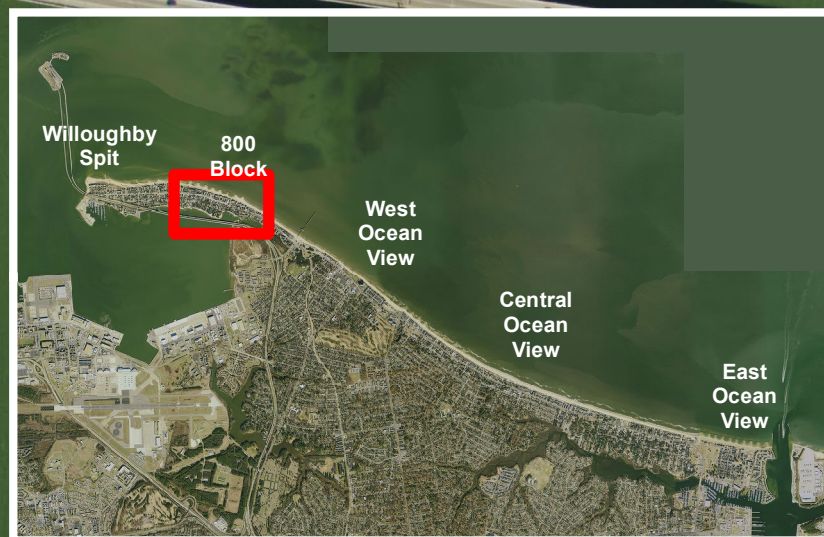
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Tel 757.628.8222

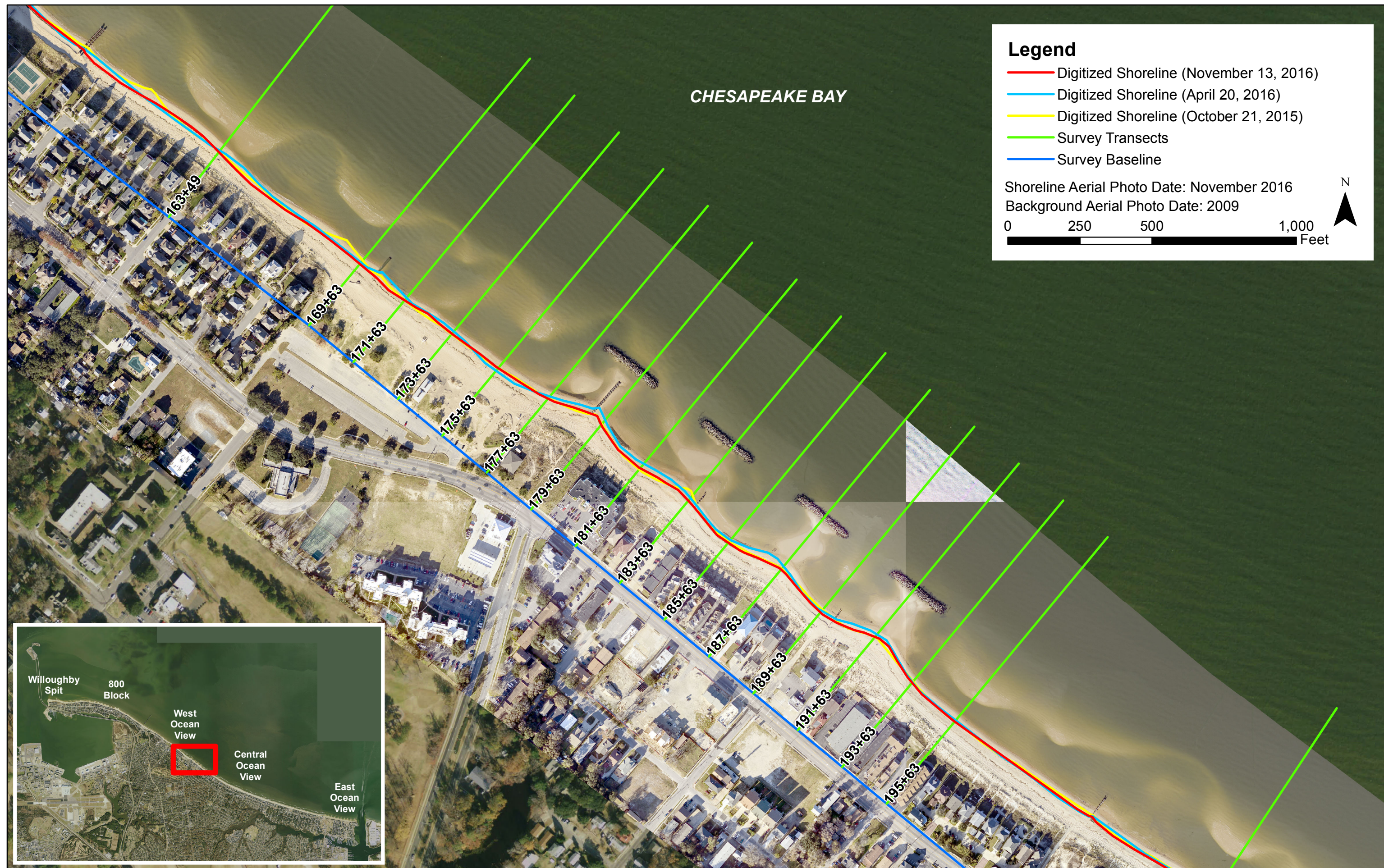
www.moffattnichol.com

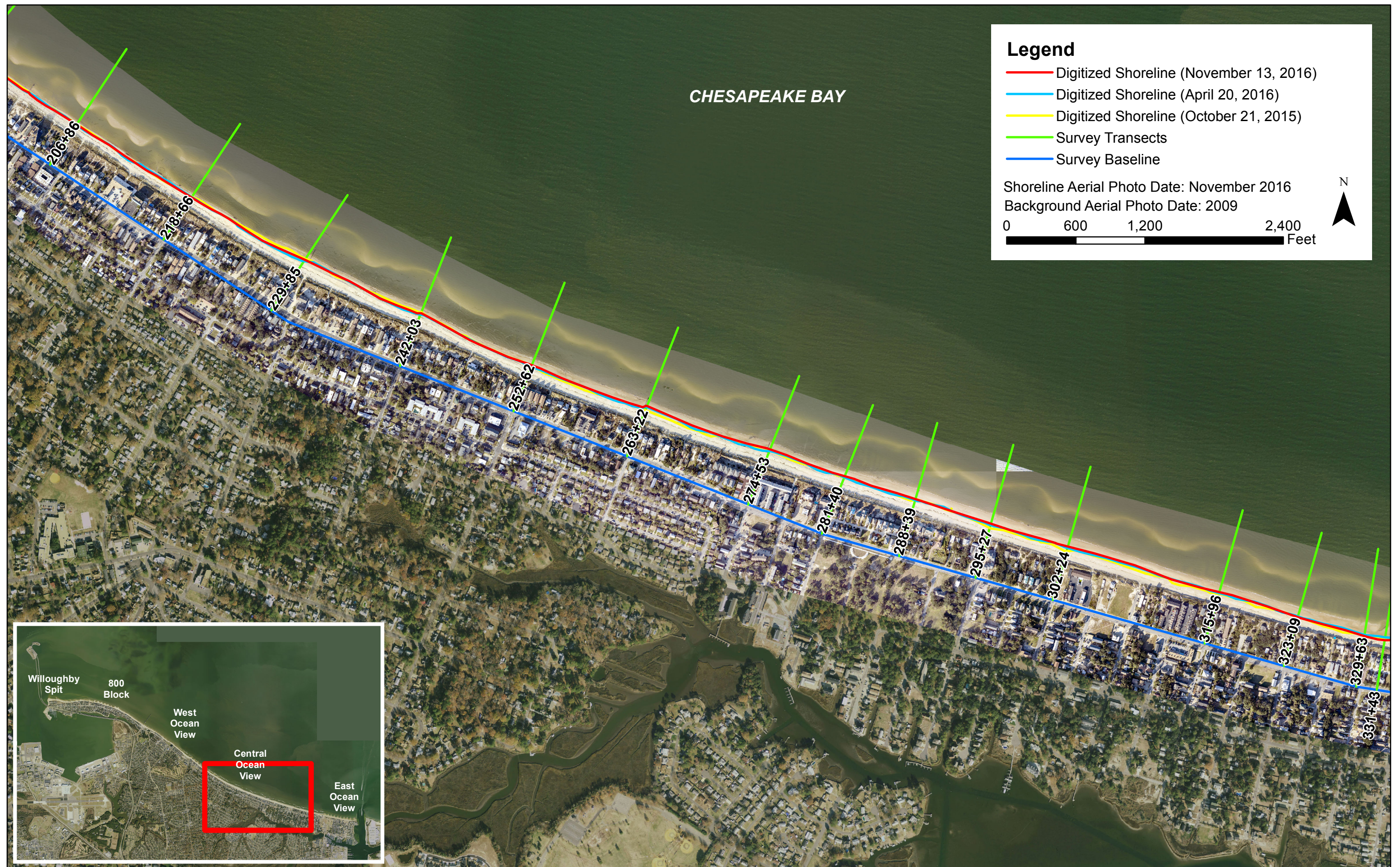










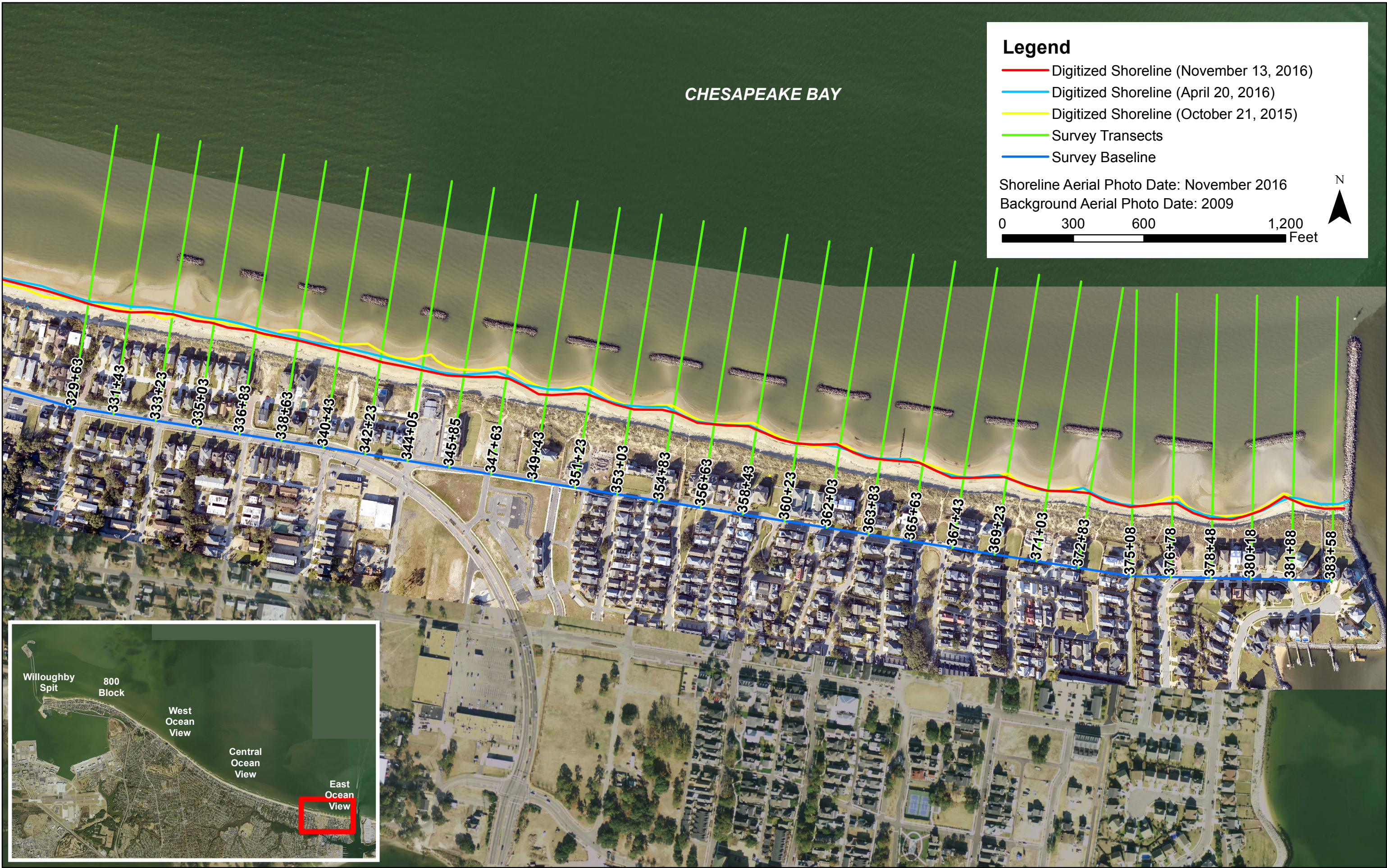


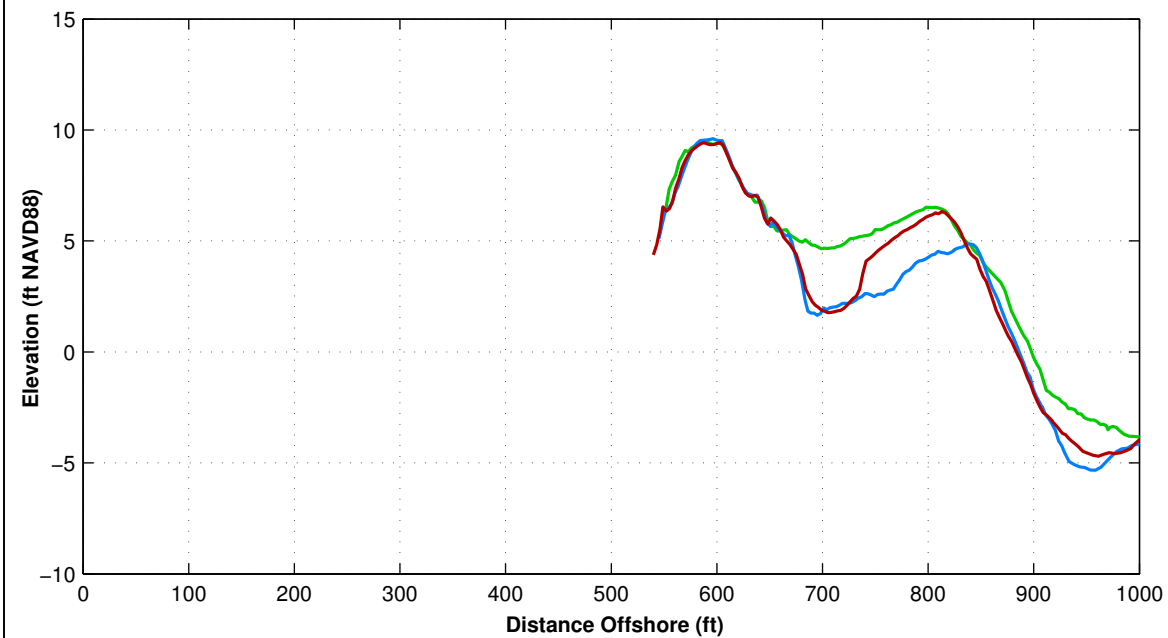
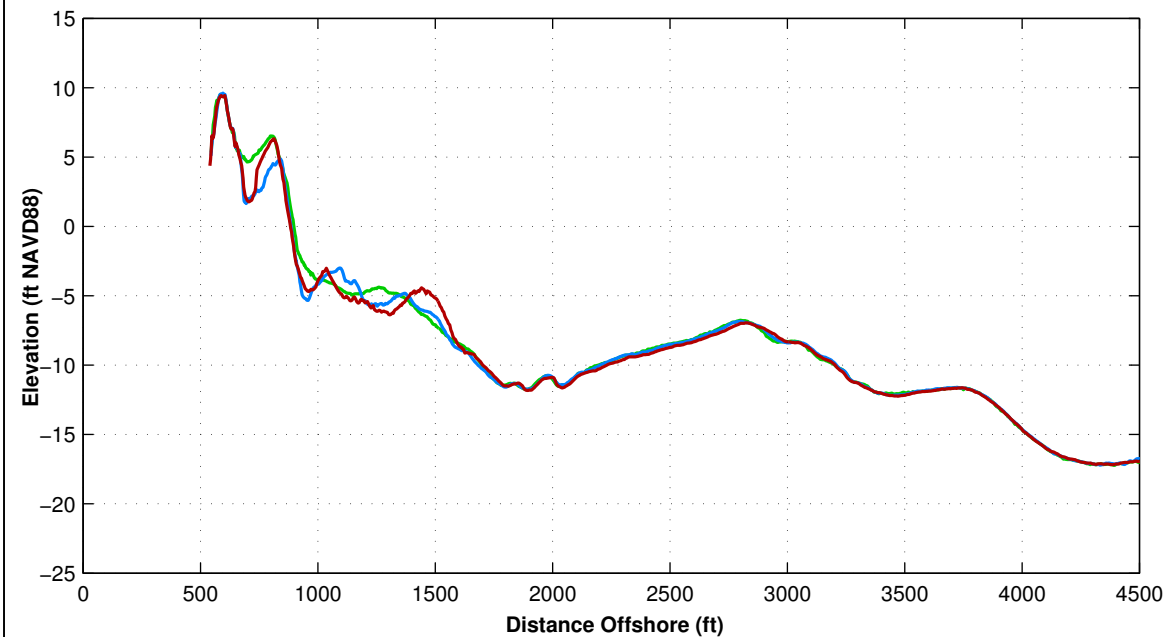
CHESAPEAKE BAY

Legend

- Digitized Shoreline (November 13, 2016)
- Digitized Shoreline (April 20, 2016)
- Digitized Shoreline (October 21, 2015)
- Survey Transects
- Survey Baseline

Shoreline Aerial Photo Date: November 2016
Background Aerial Photo Date: 2009





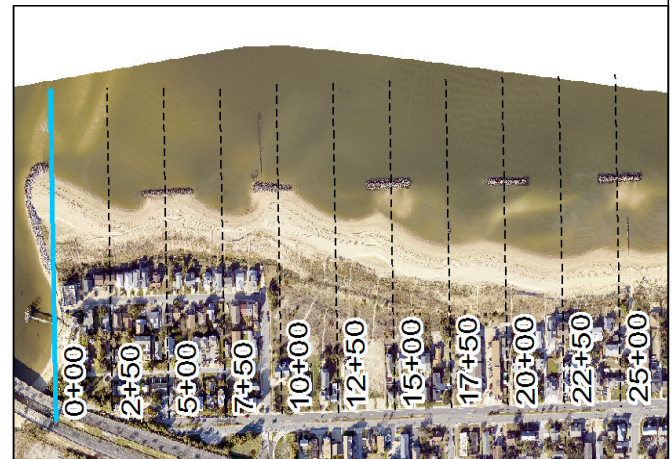
Survey Transect 0+00	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-14.10 ft/yr	-4.17 ft
Volume Change Above -15 ft NAVD88	-20.26 cy/ft/yr	0.42 cy/ft
Volume Change Above 0 ft NAVD88	-10.20 cy/ft/yr	5.63 cy/ft

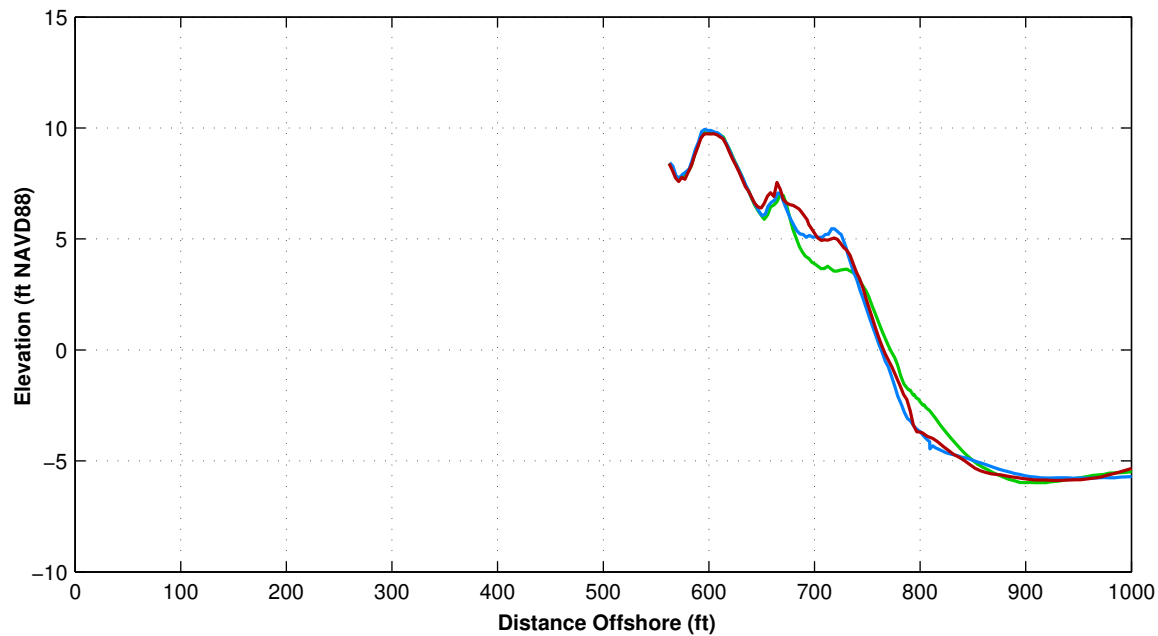
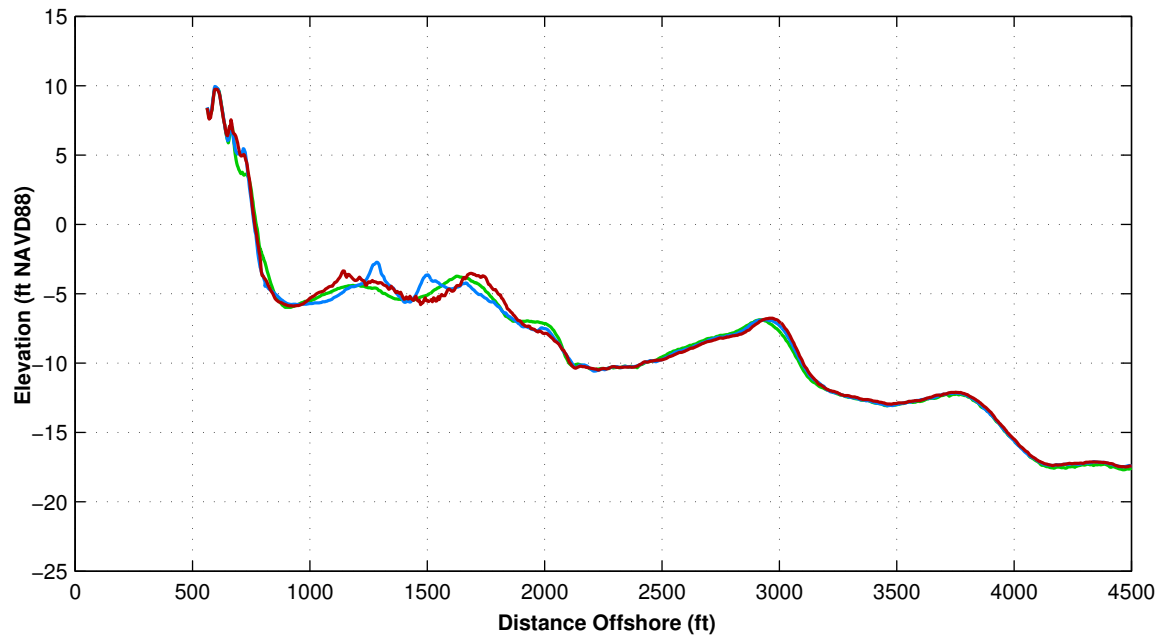
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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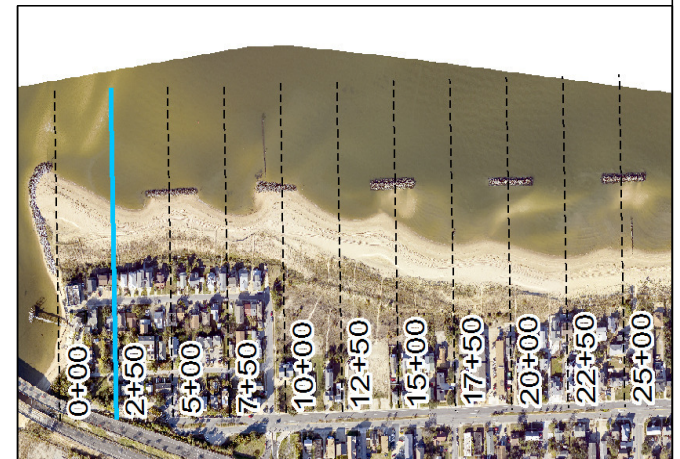
Survey Transect 2+50	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-4.83 ft/yr	2.19 ft
Volume Change Above -15 ft NAVD88	8.69 cy/ft/yr	8.45 cy/ft
Volume Change Above 0 ft NAVD88	2.65 cy/ft/yr	0.84 cy/ft

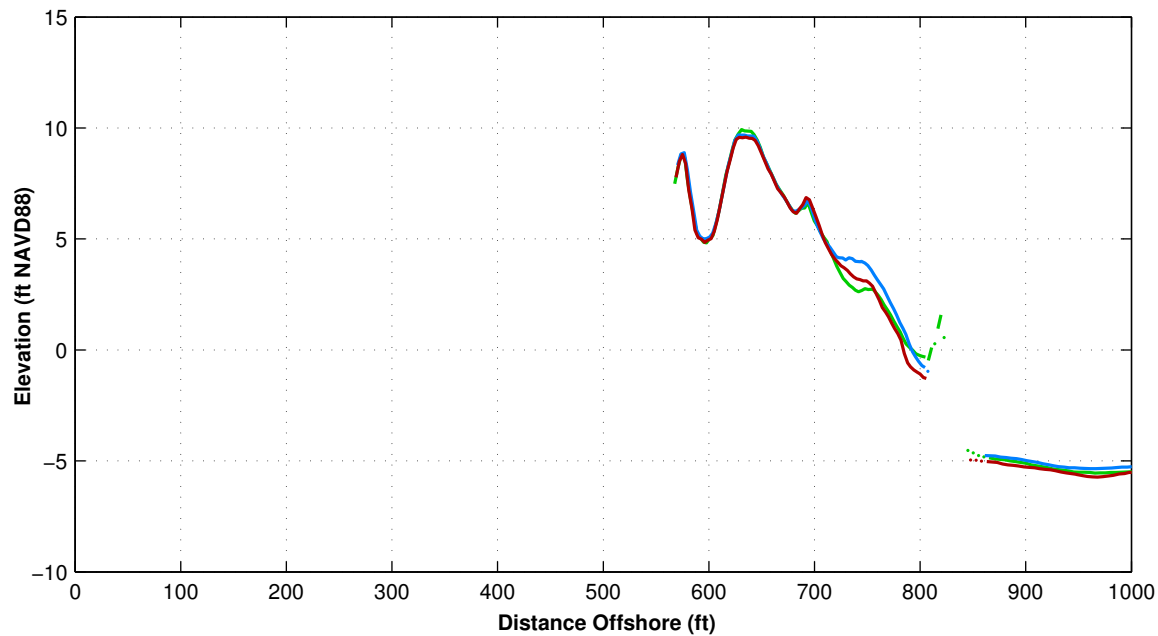
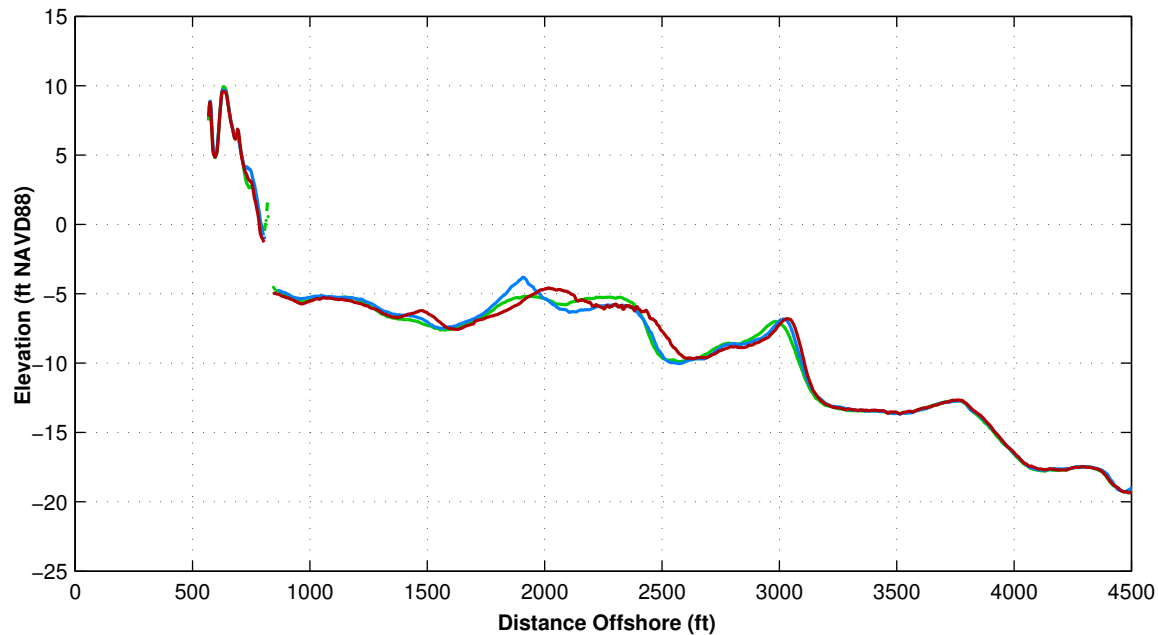
LEGEND:

OCT 2016 — (red line)
MAY 2016 — (blue line)
OCT 2015 — (green line)

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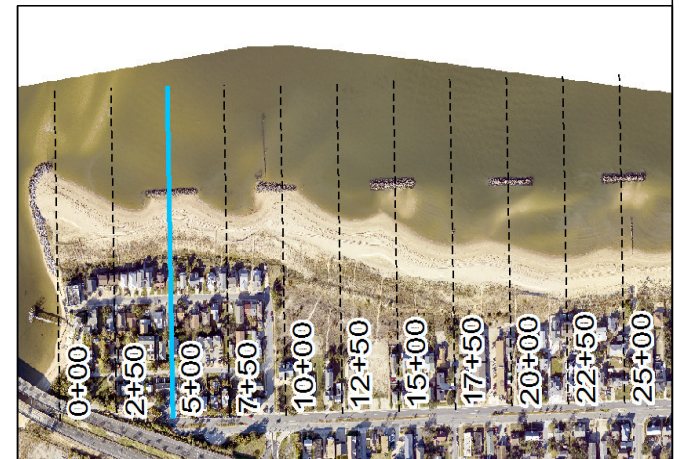
Survey Transect 5+00	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-44.37 ft/yr	-7.84 ft
Volume Change Above -15 ft NAVD88	9.78 cy/ft/yr	2.27 cy/ft
Volume Change Above 0 ft NAVD88	-0.27 cy/ft/yr	-2.14 cy/ft

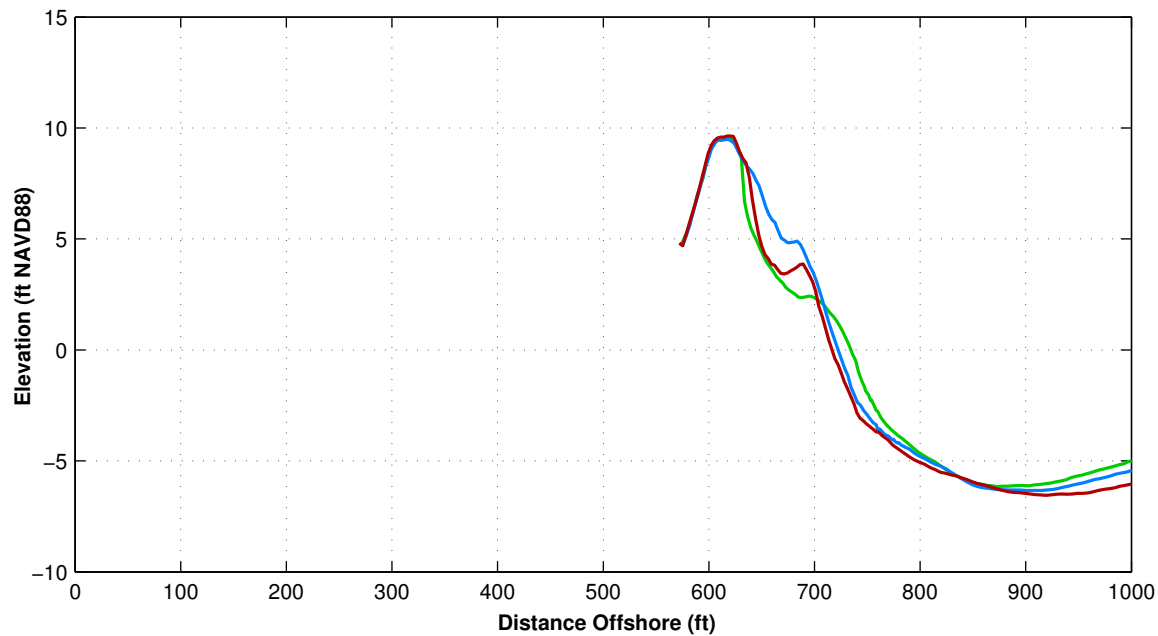
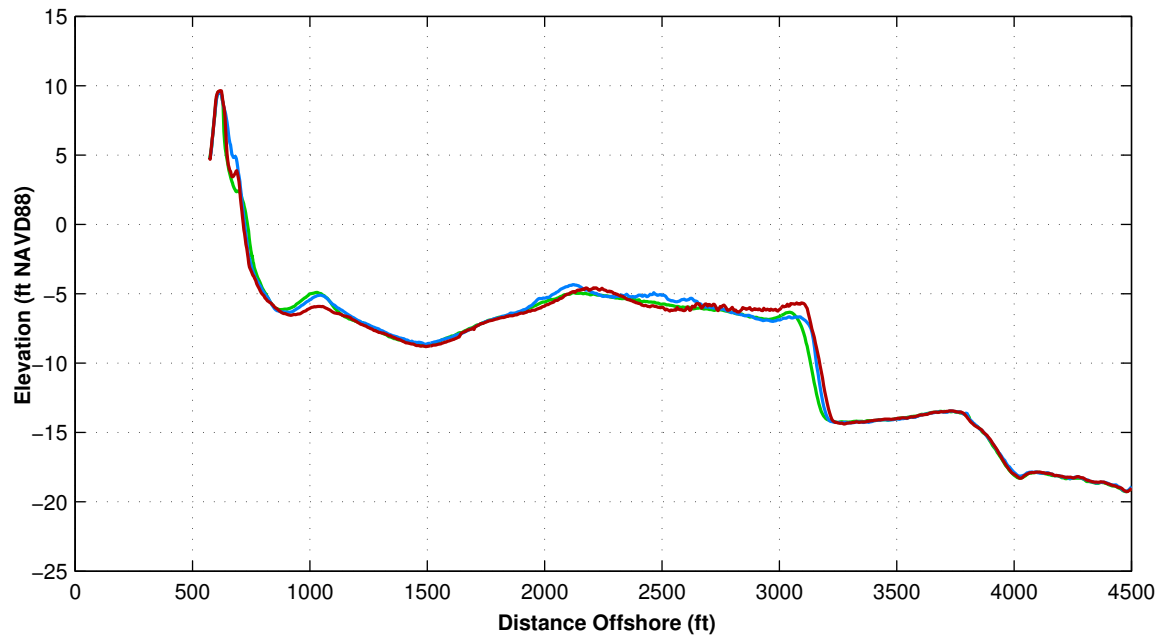
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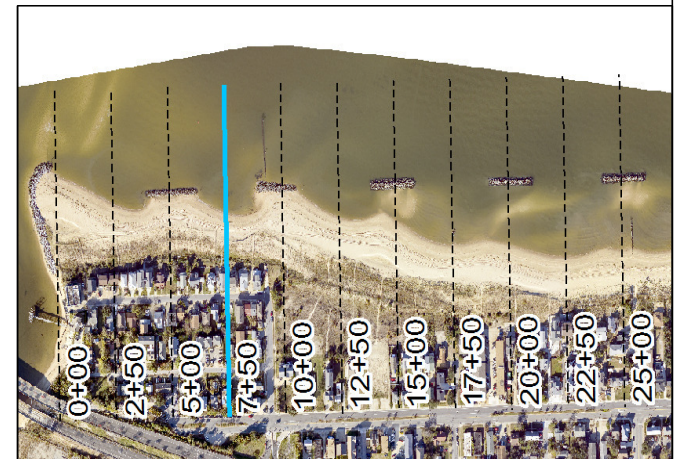
Survey Transect 7+50	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-14.17 ft/yr	-4.93 ft
Volume Change Above -15 ft NAVD88	6.81 cy/ft/yr	-11.33 cy/ft
Volume Change Above 0 ft NAVD88	1.34 cy/ft/yr	-3.52 cy/ft

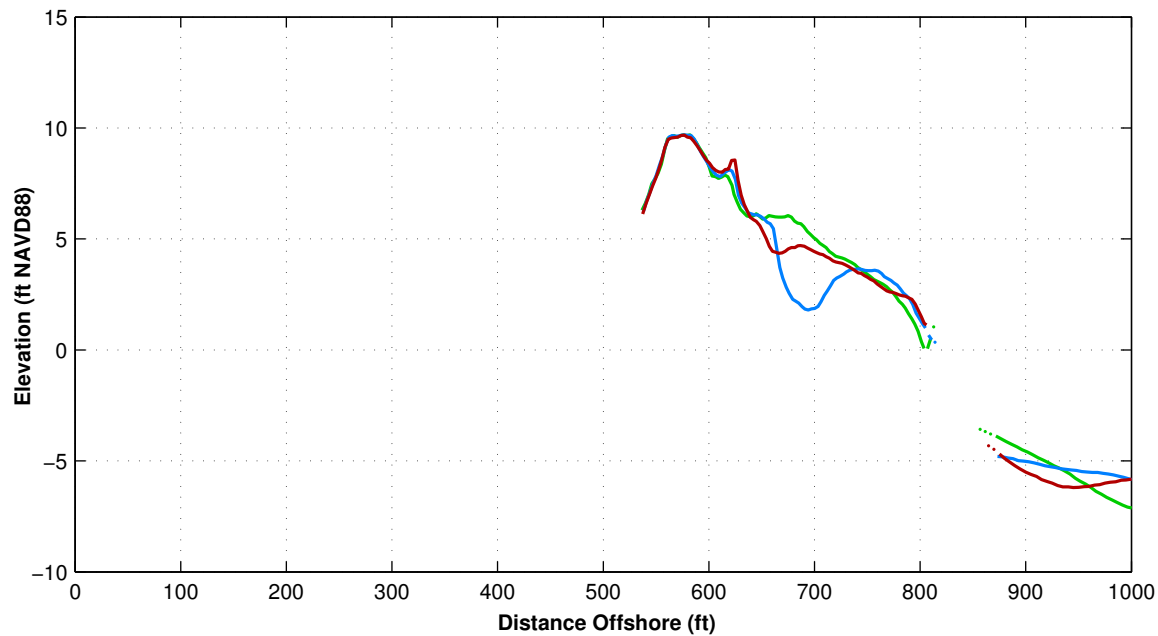
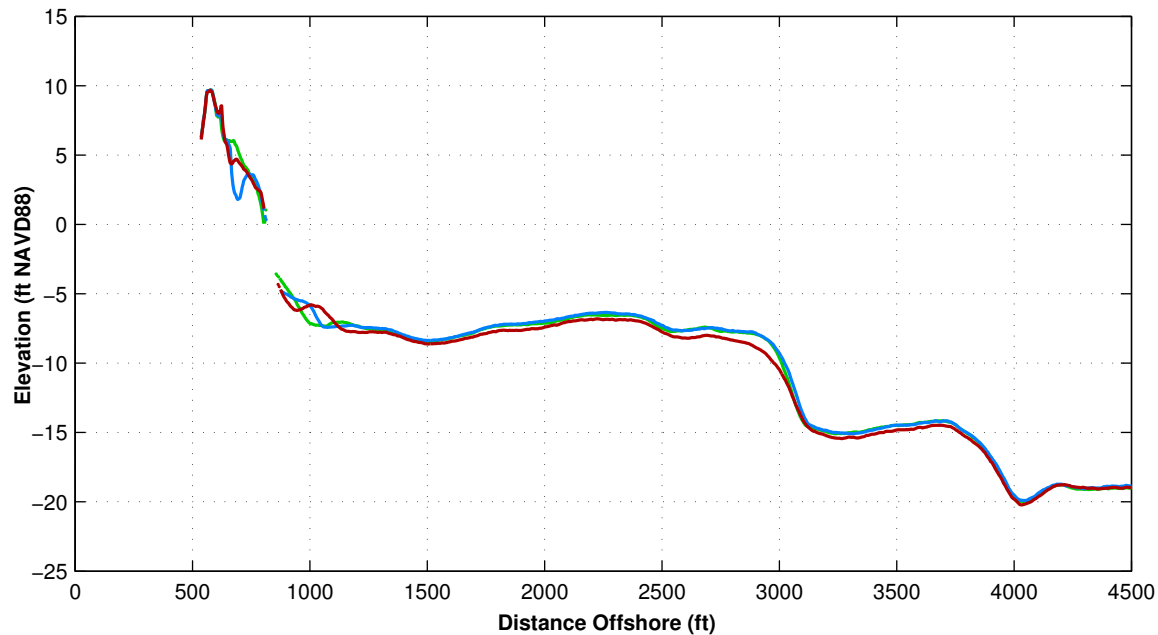
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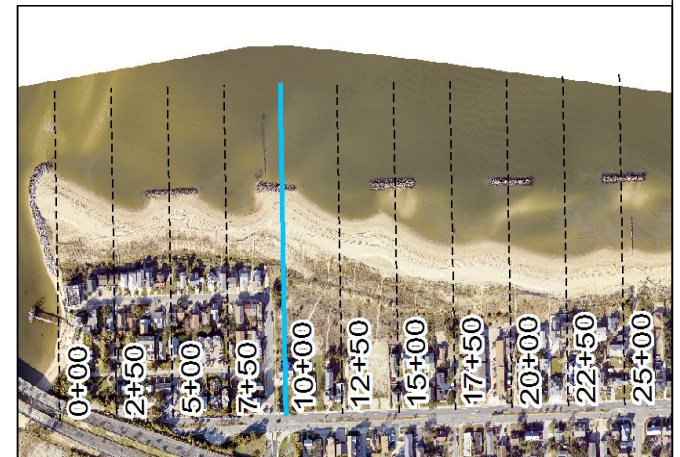
Survey Transect 10+00	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-5.57 ft/yr	2.54 ft
Volume Change Above -15 ft NAVD88	-31.28 cy/ft/yr	-37.11 cy/ft
Volume Change Above 0 ft NAVD88	-1.48 cy/ft/yr	3.46 cy/ft

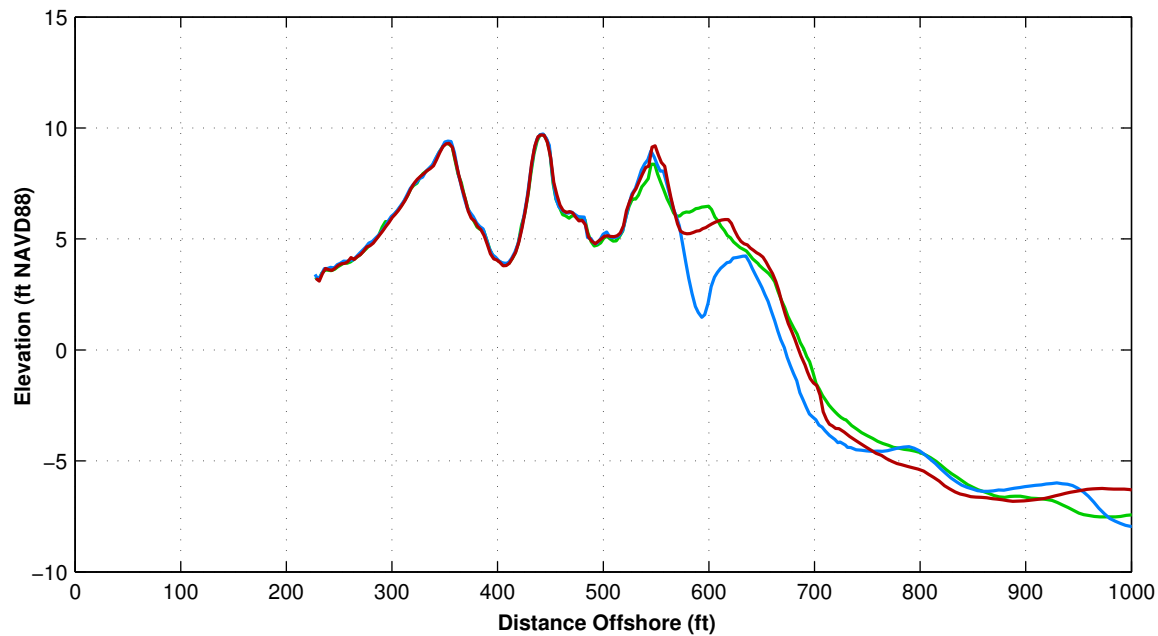
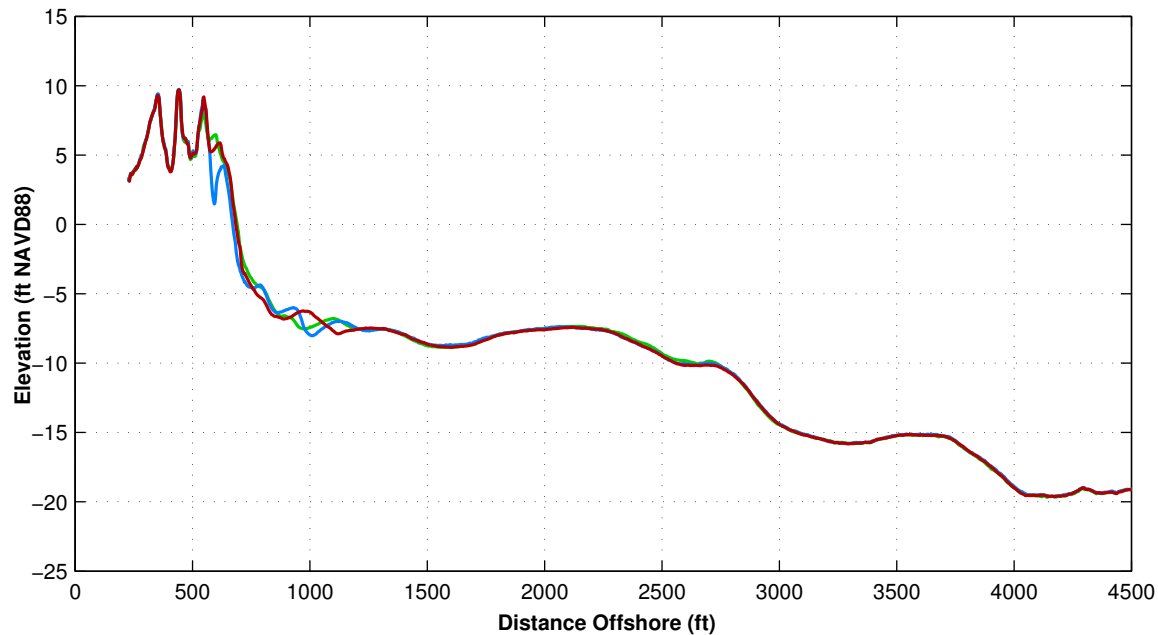
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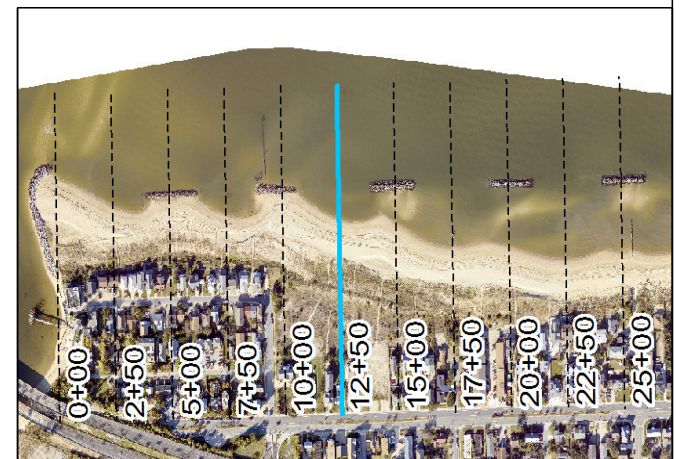
Survey Transect 12+50	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-3.14 ft/yr	12.74 ft
Volume Change Above -15 ft NAVD88	-6.29 cy/ft/yr	4.32 cy/ft
Volume Change Above 0 ft NAVD88	0.60 cy/ft/yr	6.93 cy/ft

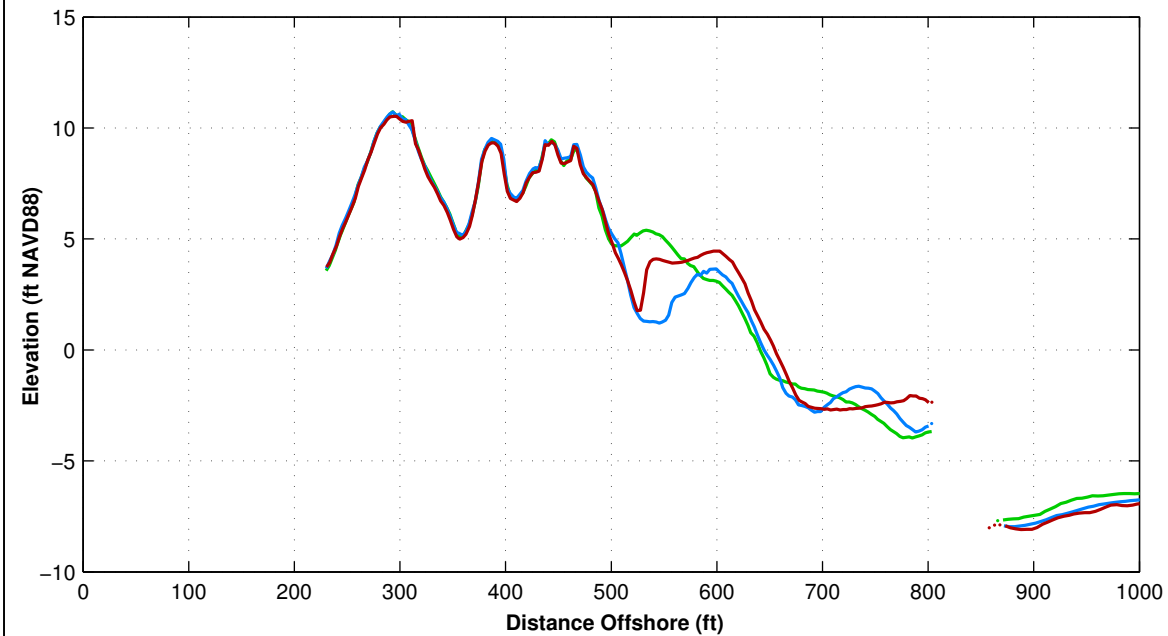
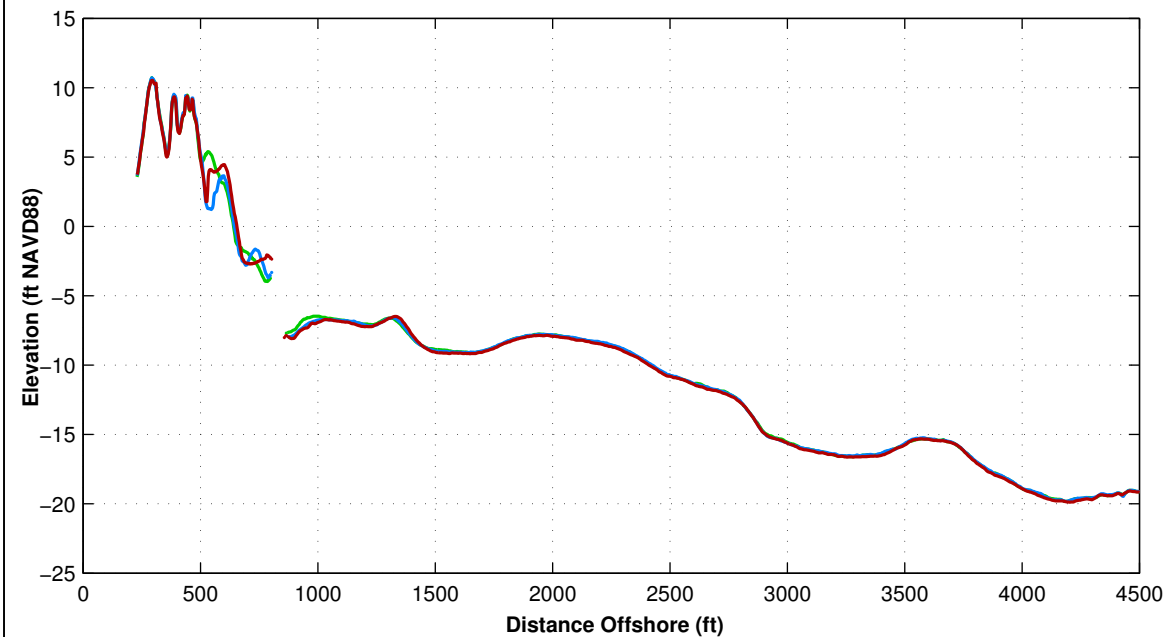
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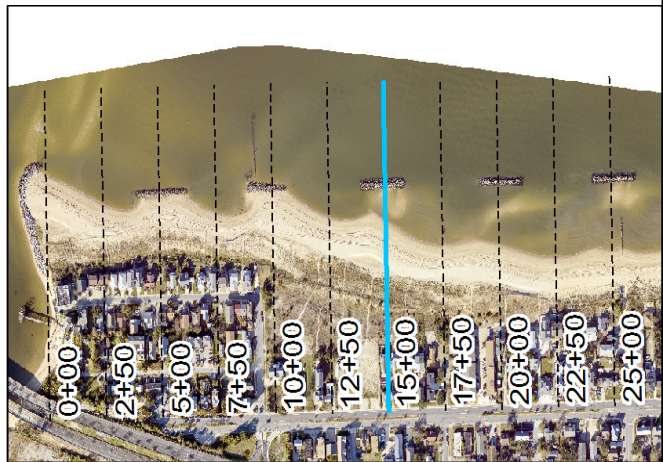
Survey Transect 15+00	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	13.47 ft/yr	8.45 ft
Volume Change Above -15 ft NAVD88	-5.36 cy/ft/yr	0.17 cy/ft
Volume Change Above 0 ft NAVD88	-0.45 cy/ft/yr	4.66 cy/ft

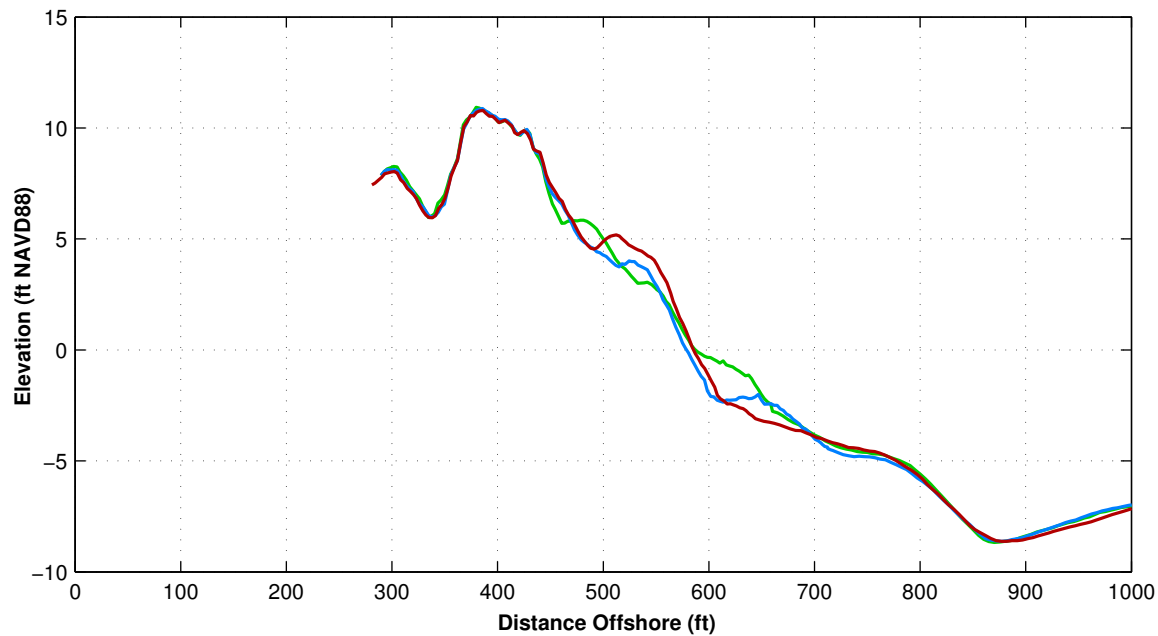
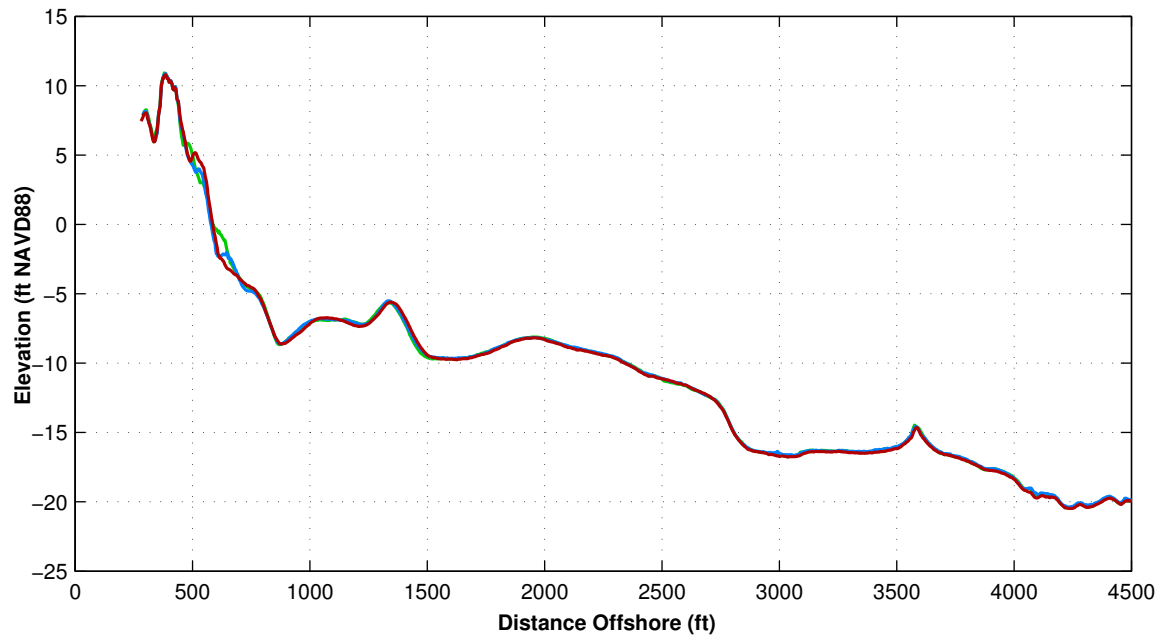
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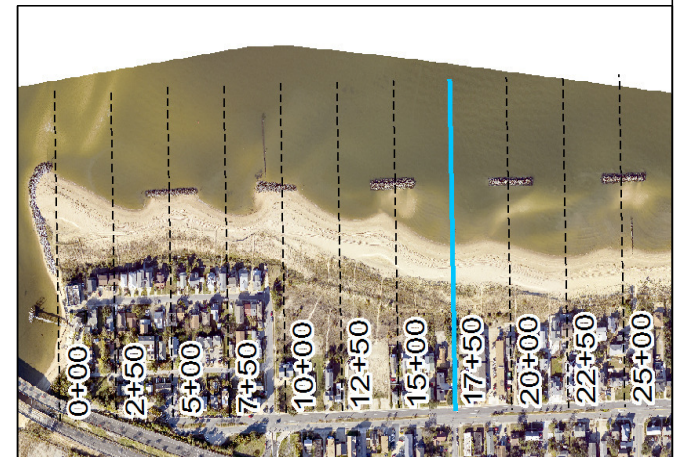
Survey Transect 17+50	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	3.04 ft/yr	8.06 ft
Volume Change Above –15 ft NAVD88	–3.26 cy/ft/yr	–0.49 cy/ft
Volume Change Above 0 ft NAVD88	1.96 cy/ft/yr	2.82 cy/ft

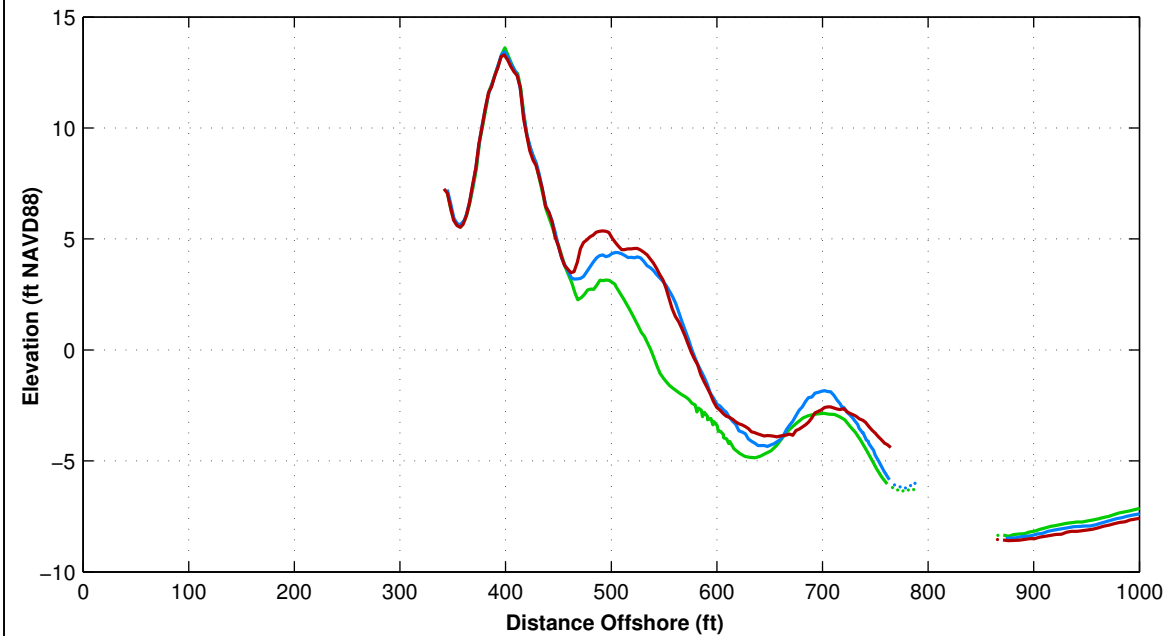
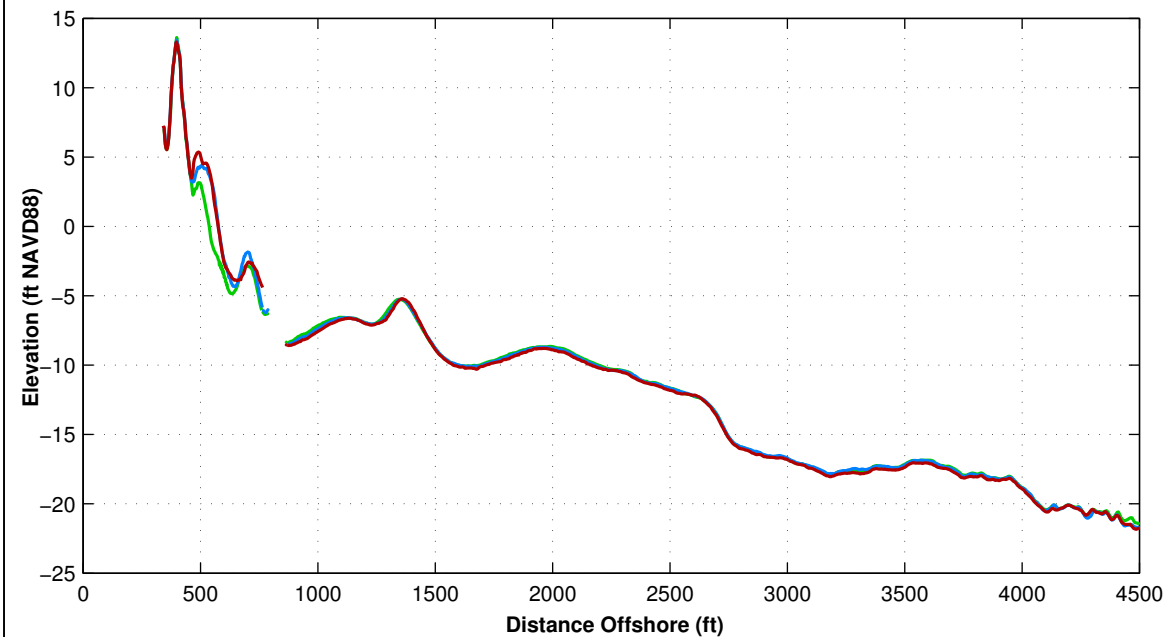
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OCT 2016 — (red line)
MAY 2016 — (blue line)
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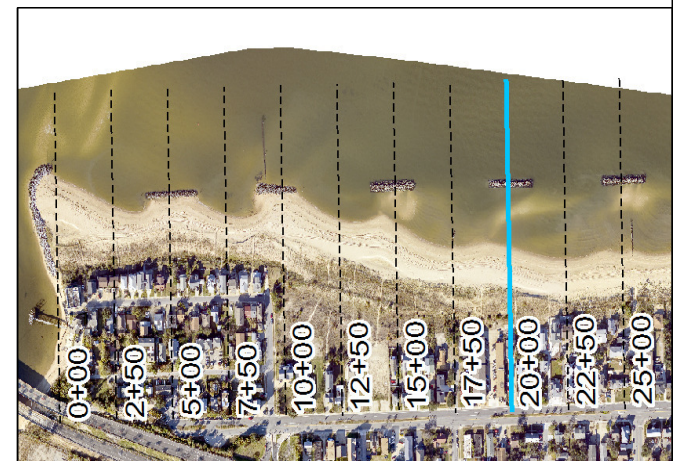
Survey Transect 20+00	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	39.07 ft/yr	-2.49 ft
Volume Change Above -15 ft NAVD88	6.90 cy/ft/yr	-4.84 cy/ft
Volume Change Above 0 ft NAVD88	9.53 cy/ft/yr	1.53 cy/ft

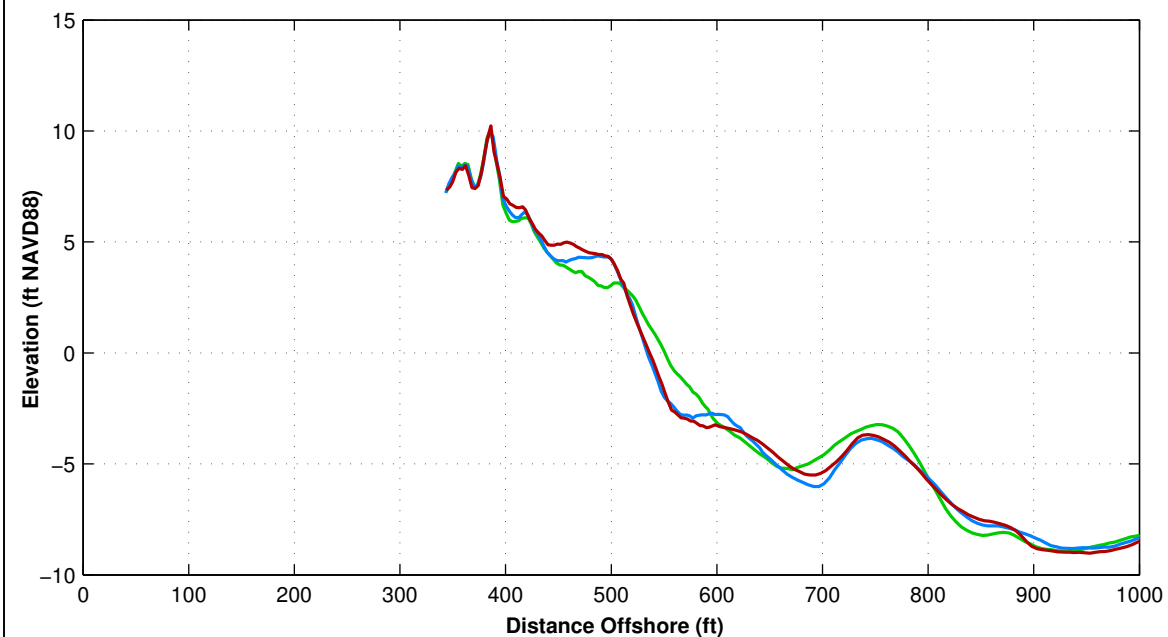
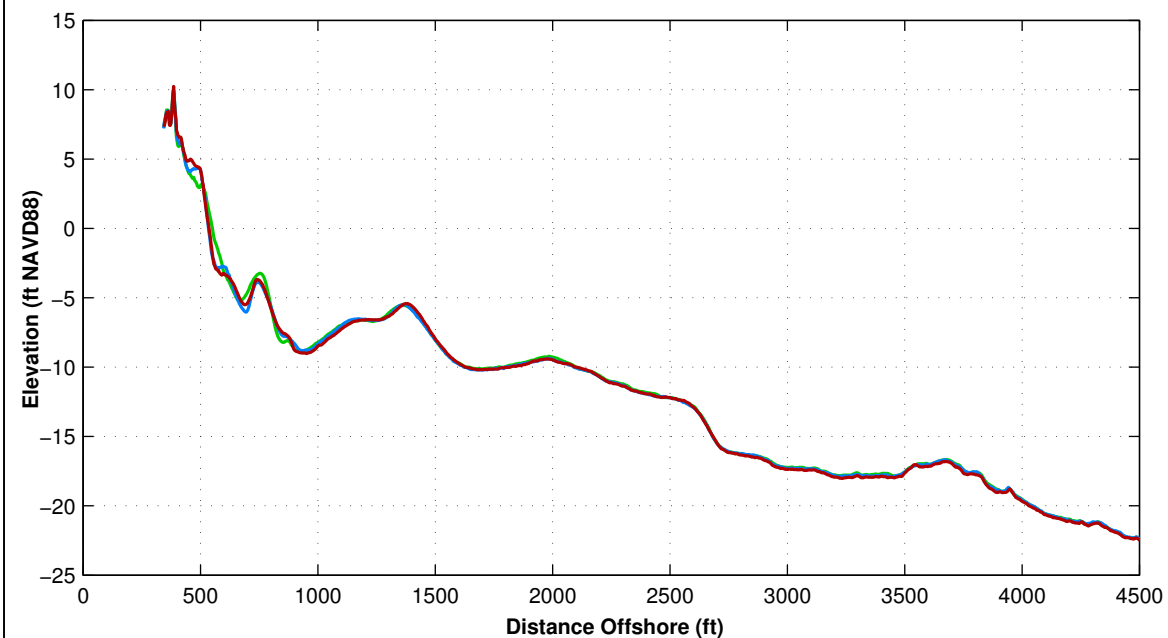
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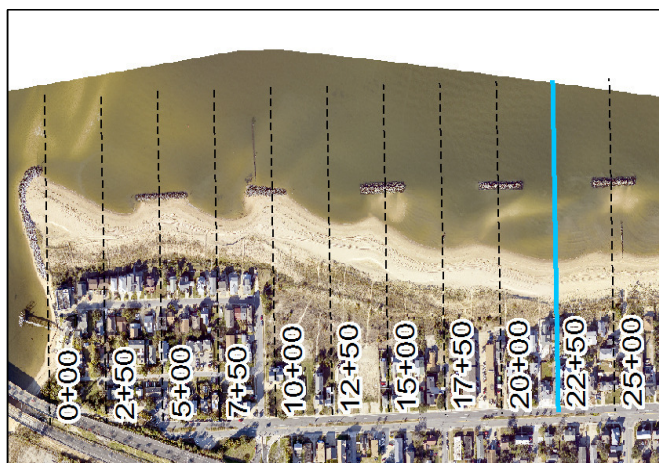
Survey Transect 22+50	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-11.49 ft/yr	0.18 ft
Volume Change Above -15 ft NAVD88	-5.43 cy/ft/yr	1.27 cy/ft
Volume Change Above 0 ft NAVD88	2.15 cy/ft/yr	1.18 cy/ft

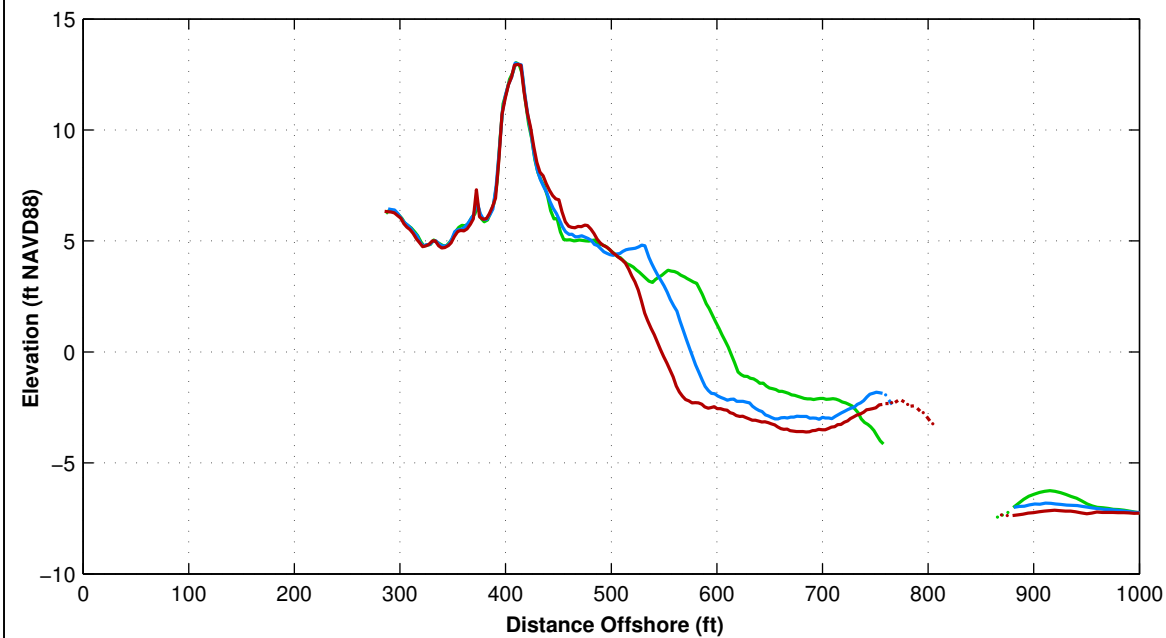
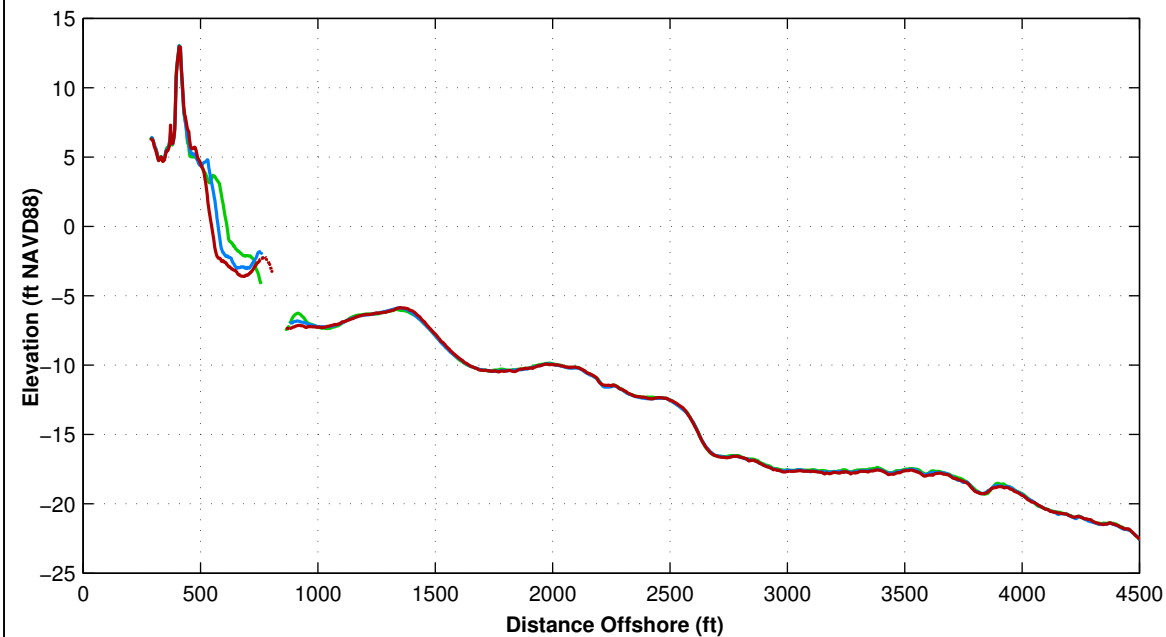
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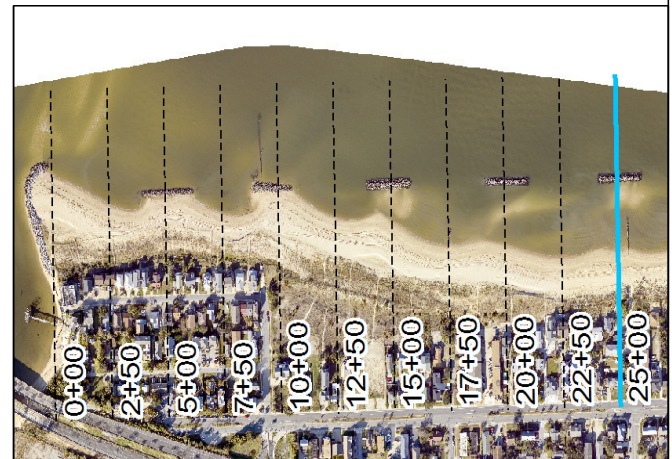
Survey Transect 25+00	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-62.34 ft/yr	-29.49 ft
Volume Change Above -15 ft NAVD88	-18.28 cy/ft/yr	-8.78 cy/ft
Volume Change Above 0 ft NAVD88	-6.59 cy/ft/yr	-3.91 cy/ft

LEGEND:

OCT 2016 ———
MAY 2016 ———
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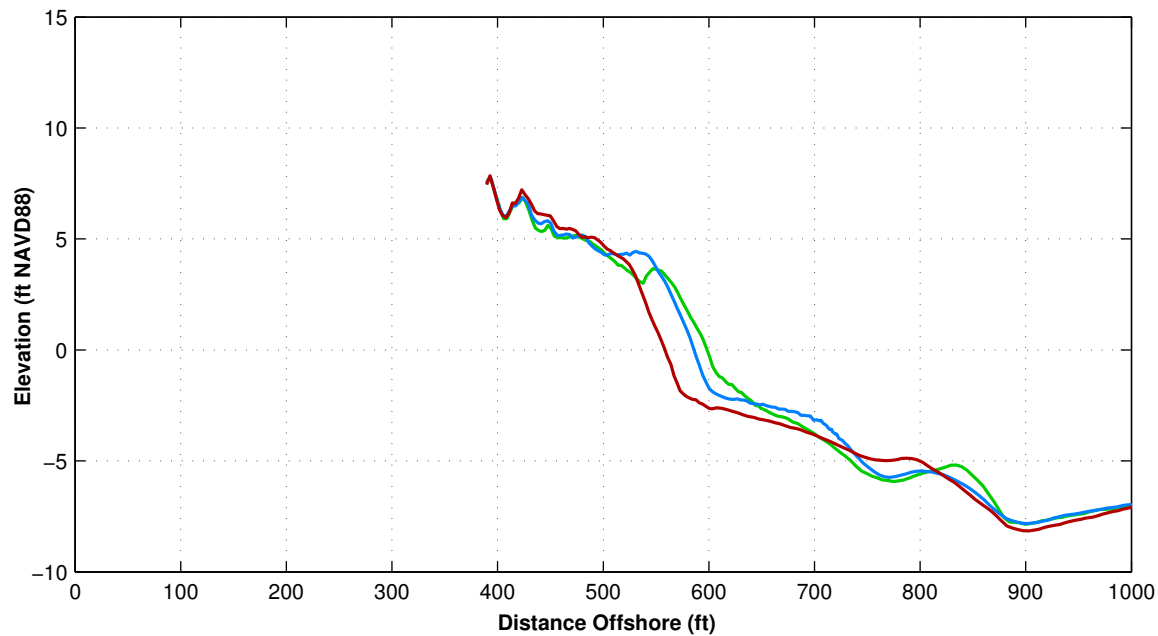
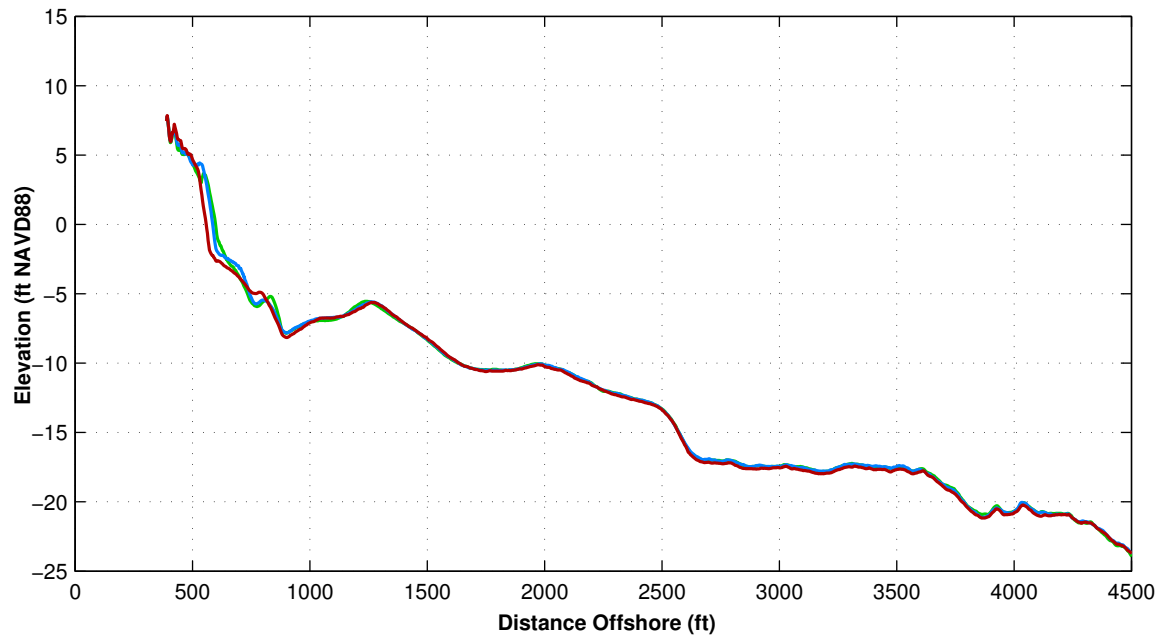
THE CITY OF NORFOLK
PUBLIC WORKS

**OCEAN VIEW PERIODIC
SURVEYING DATA &
ANALYSIS**

ST 25+00

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Fall 2016



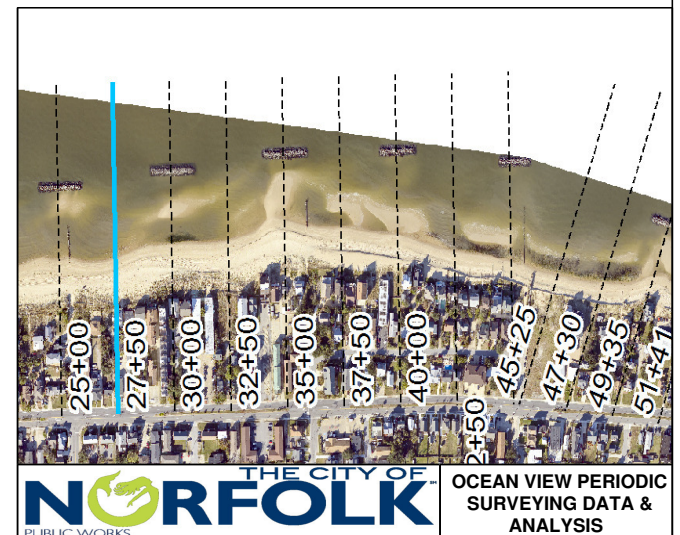
Survey Transect 27+50	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-37.89 ft/yr	-28.64 ft
Volume Change Above -15 ft NAVD88	-10.24 cy/ft/yr	-11.56 cy/ft
Volume Change Above 0 ft NAVD88	-2.87 cy/ft/yr	-3.37 cy/ft

LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

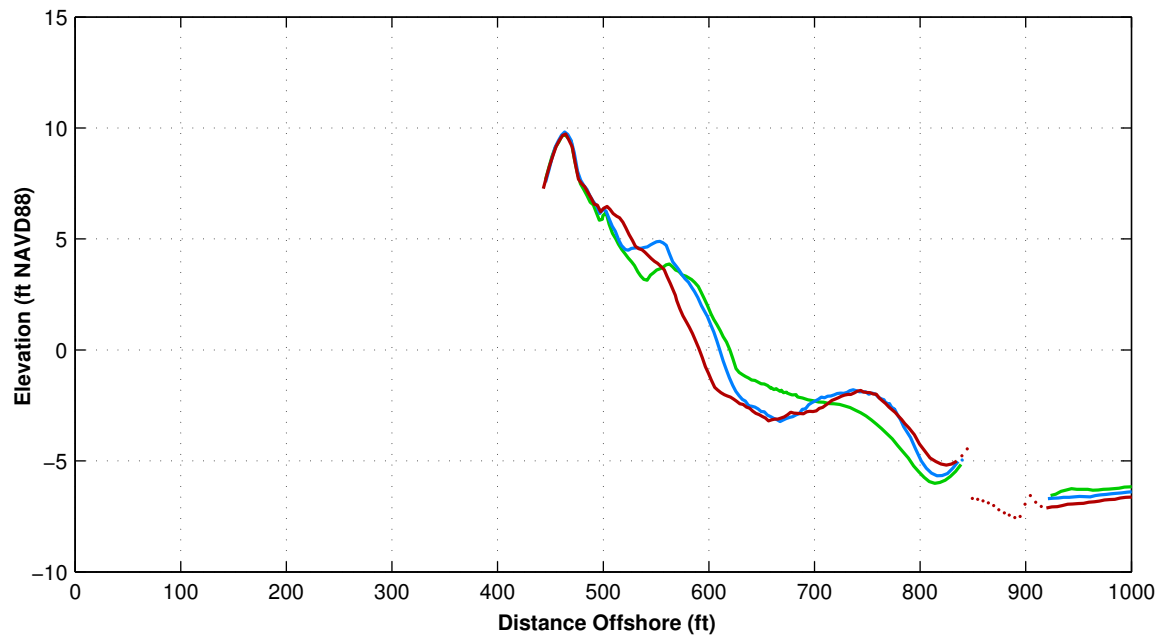
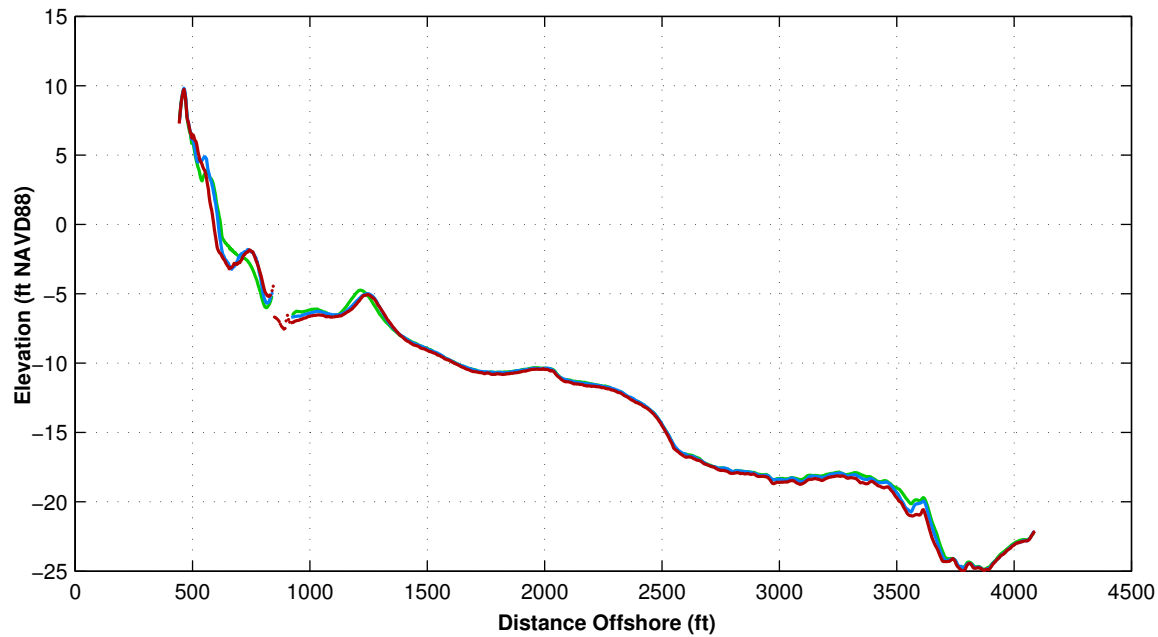
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5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.



ST 27+50

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Fall 2016



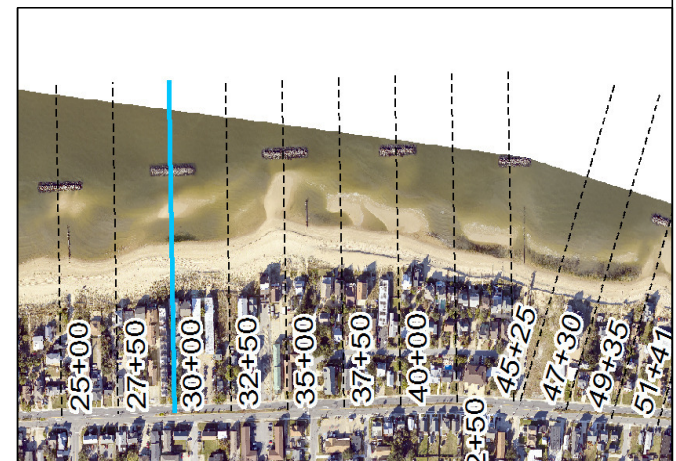
Survey Transect 30+00	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-26.83 ft/yr	-21.26 ft
Volume Change Above -15 ft NAVD88	-10.09 cy/ft/yr	-10.66 cy/ft
Volume Change Above 0 ft NAVD88	-1.46 cy/ft/yr	-2.87 cy/ft

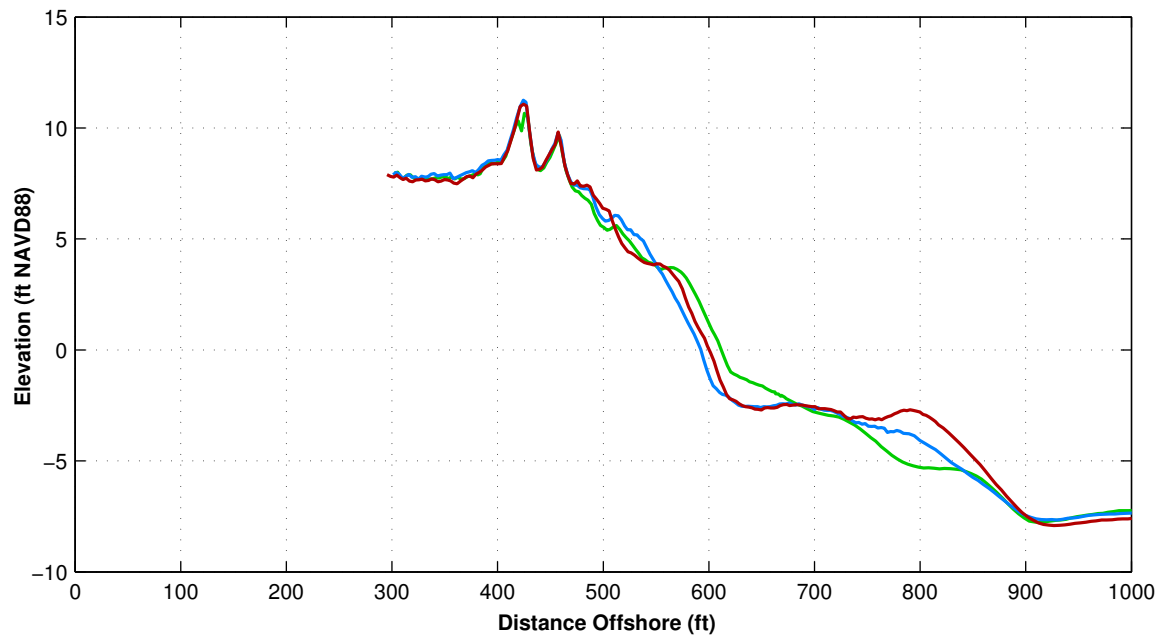
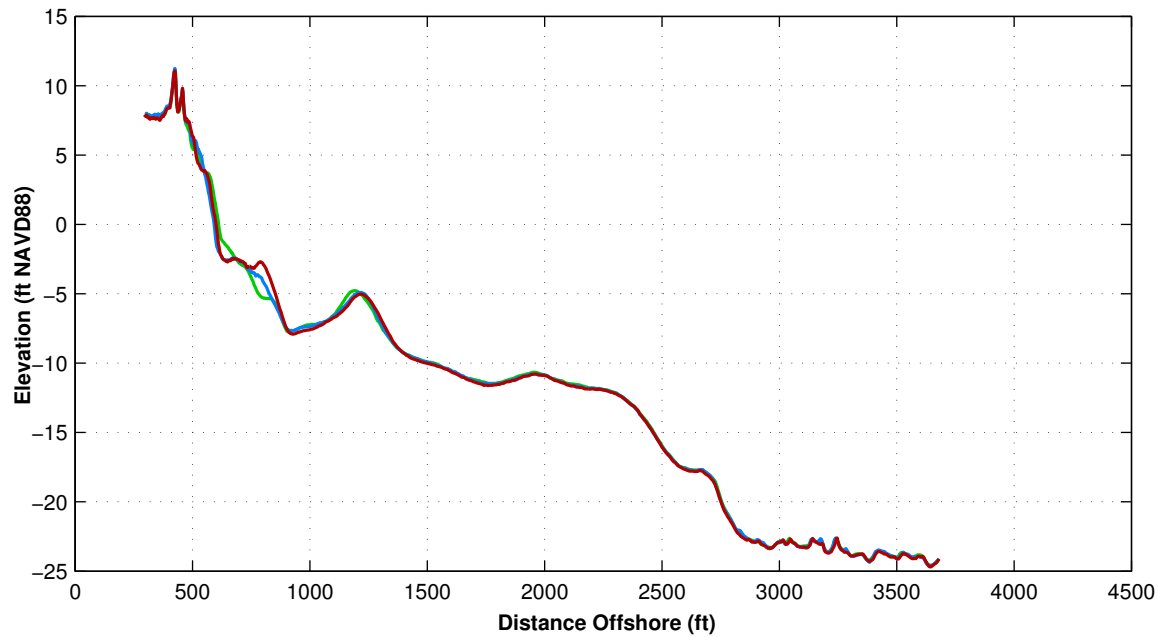
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
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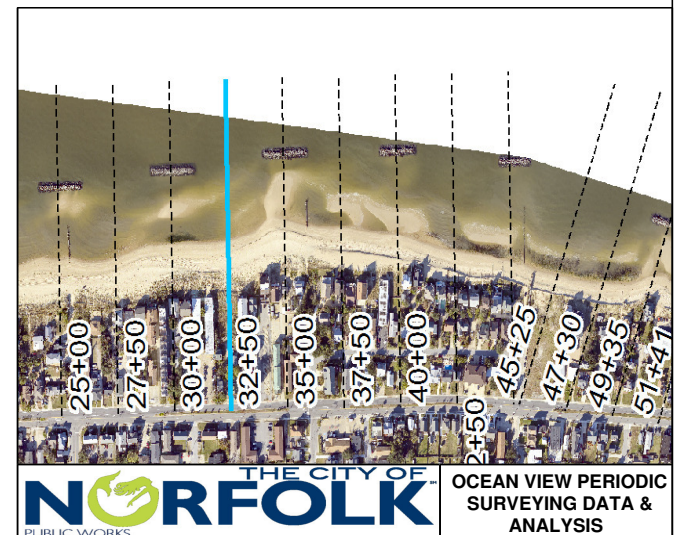
Survey Transect 32+50	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-11.55 ft/yr	7.32 ft
Volume Change Above -15 ft NAVD88	-1.57 cy/ft/yr	1.12 cy/ft
Volume Change Above 0 ft NAVD88	-0.93 cy/ft/yr	-0.49 cy/ft

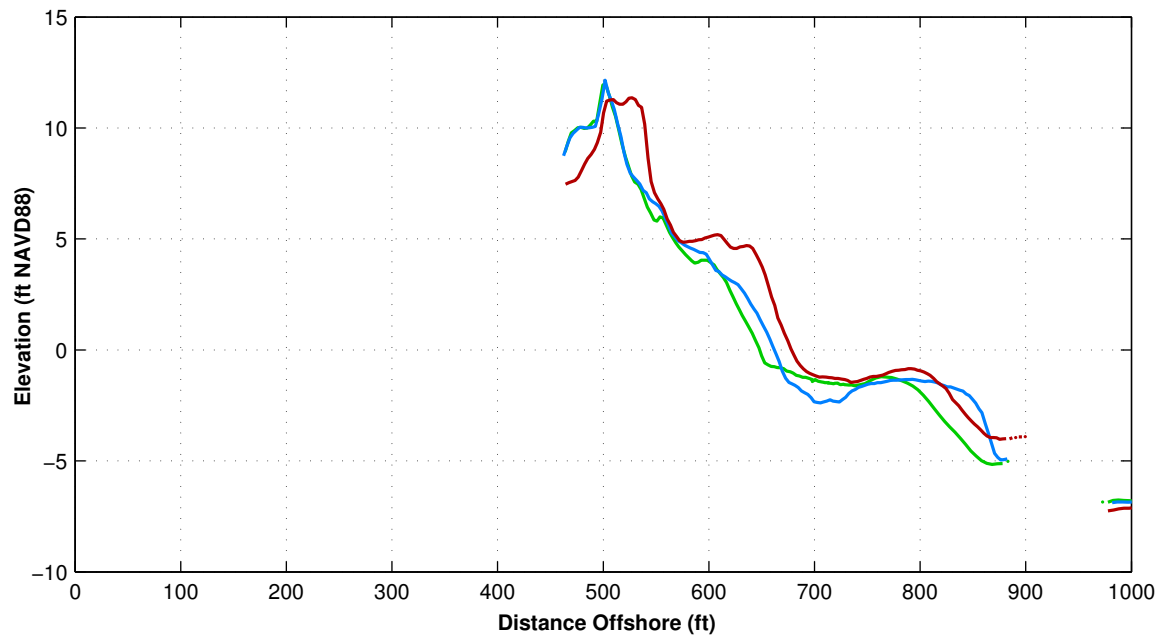
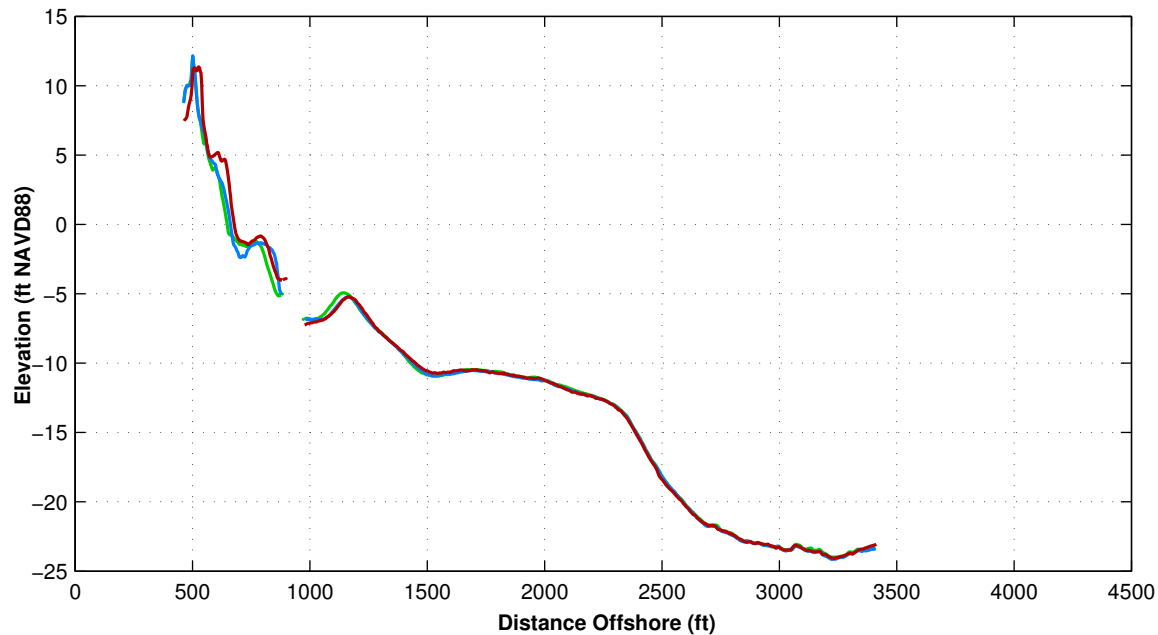
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

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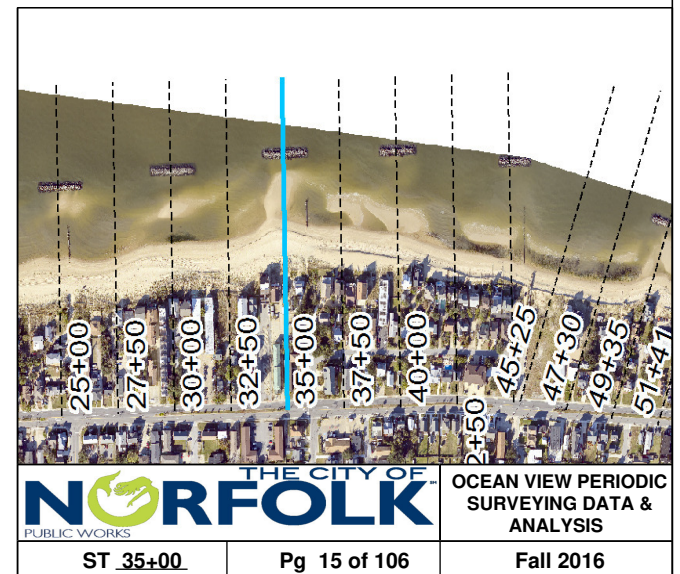
Survey Transect 35+00	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	30.36 ft/yr	16.94 ft
Volume Change Above -15 ft NAVD88	12.99 cy/ft/yr	11.78 cy/ft
Volume Change Above 0 ft NAVD88	8.89 cy/ft/yr	6.72 cy/ft

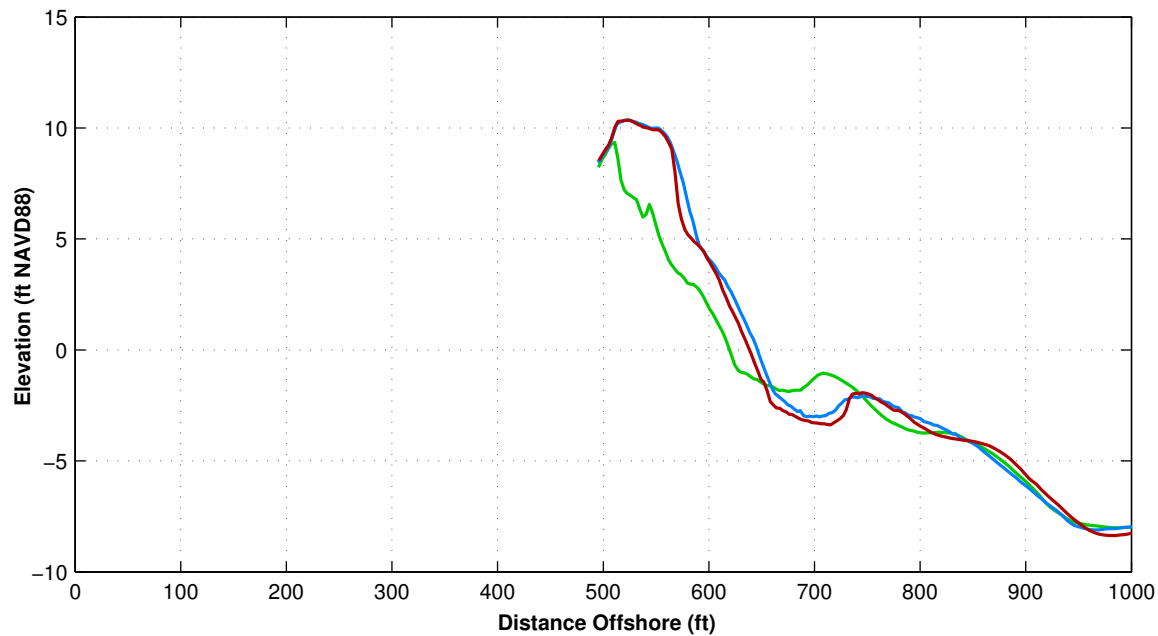
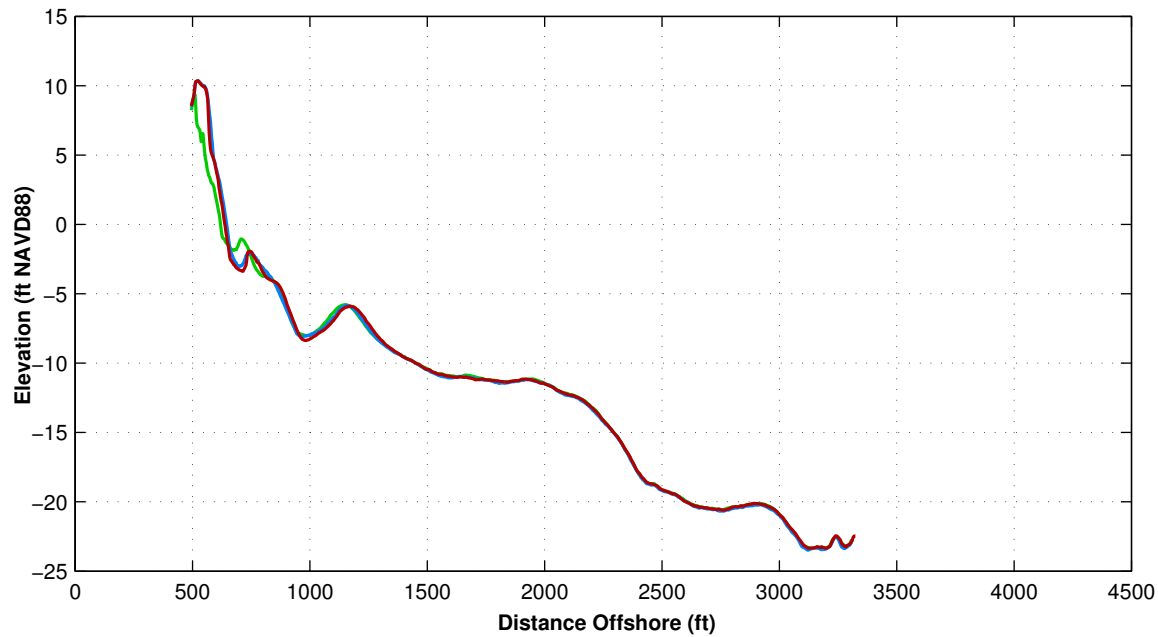
LEGEND:

OCT 2016 — (red line)
MAY 2016 — (blue line)
OCT 2015 — (green line)

Notes:

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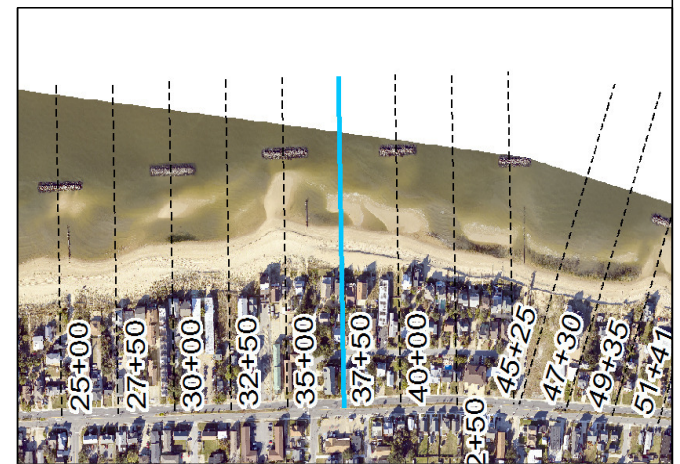
Survey Transect 37+50	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	18.28 ft/yr	-7.19 ft
Volume Change Above -15 ft NAVD88	9.19 cy/ft/yr	-1.12 cy/ft
Volume Change Above 0 ft NAVD88	12.75 cy/ft/yr	-2.08 cy/ft

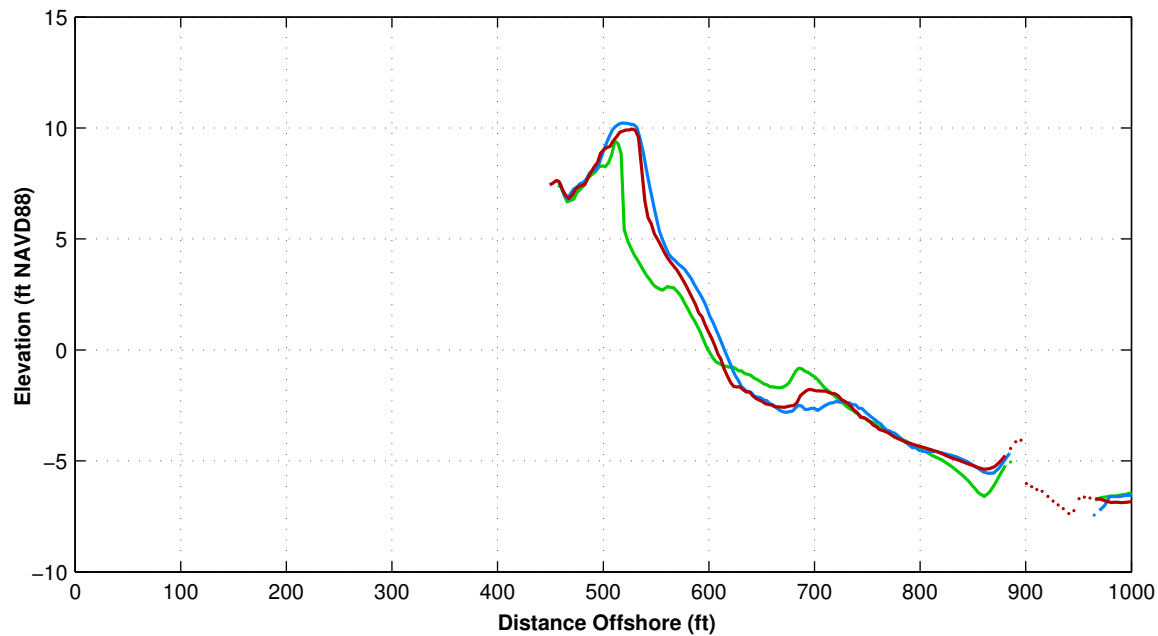
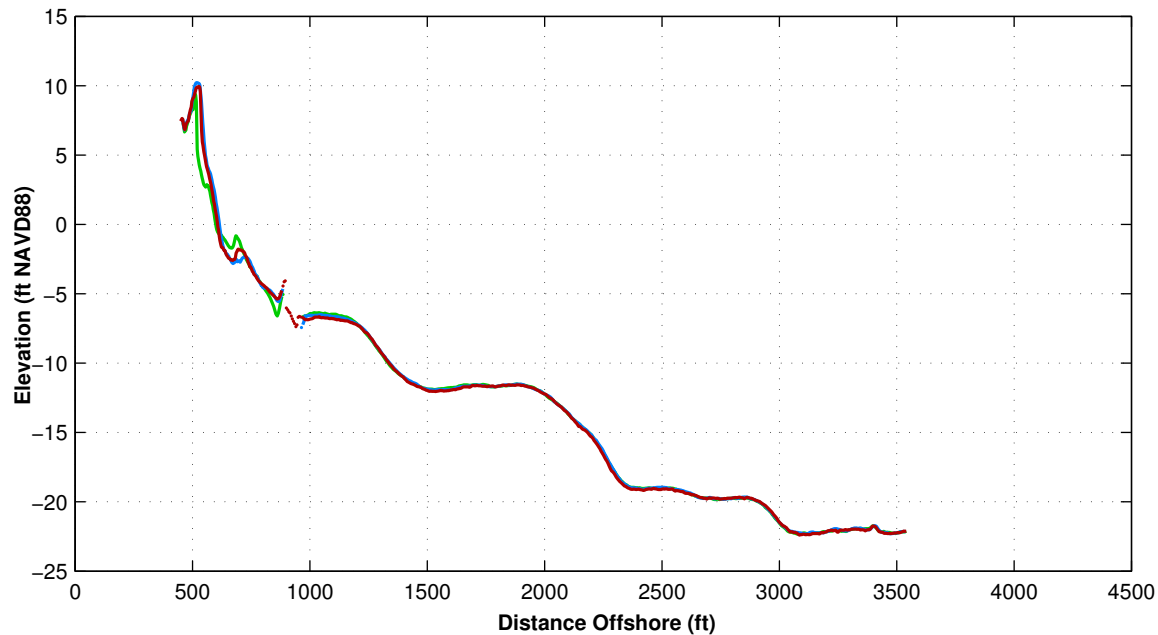
LEGEND:

OCT 2016 — (red line)
MAY 2016 — (blue line)
OCT 2015 — (green line)

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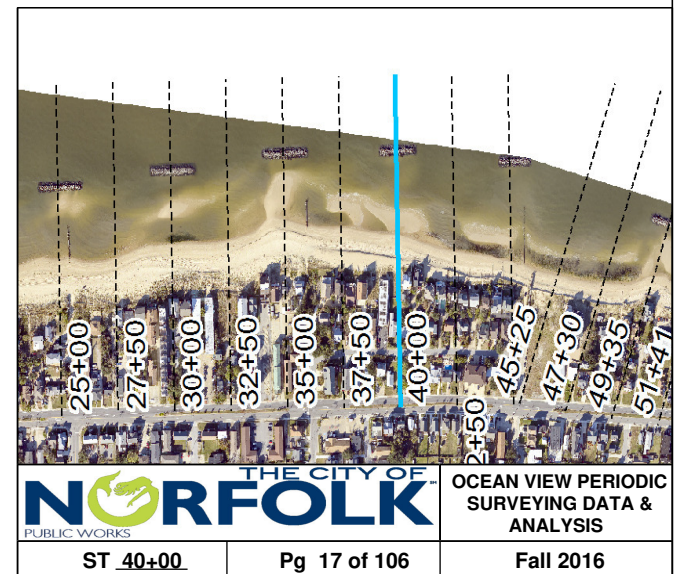
Survey Transect 40+00	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	7.72 ft/yr	-8.22 ft
Volume Change Above -15 ft NAVD88	2.83 cy/ft/yr	-5.37 cy/ft
Volume Change Above 0 ft NAVD88	7.56 cy/ft/yr	-2.67 cy/ft

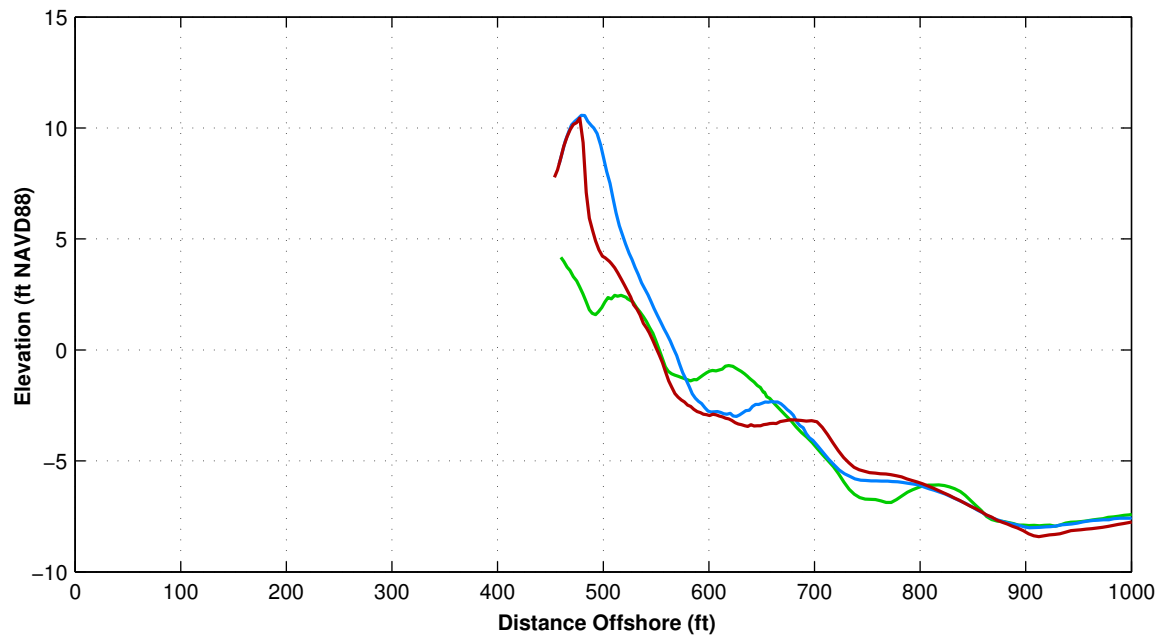
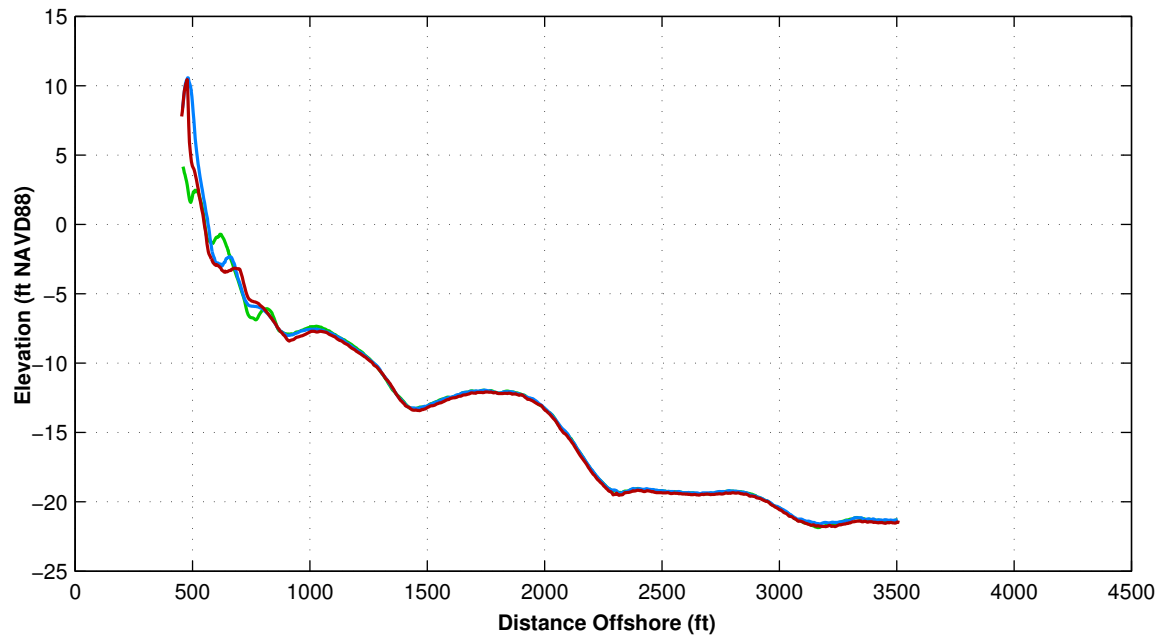
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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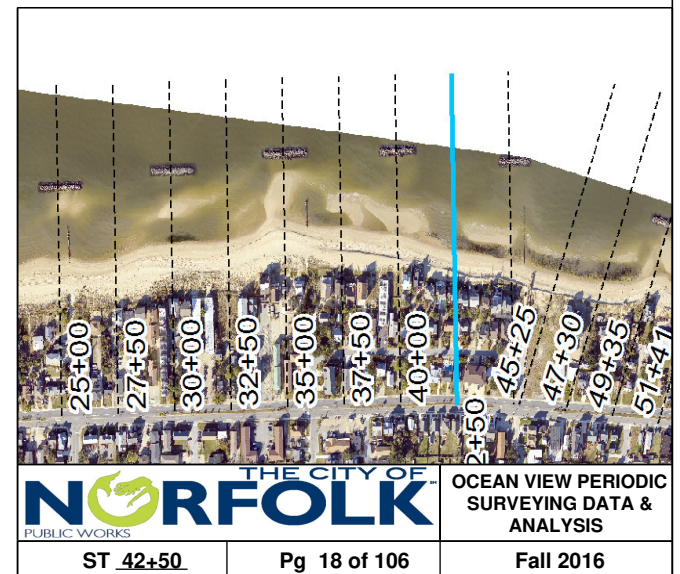
Survey Transect 42+50	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-3.06 ft/yr	-16.11 ft
Volume Change Above -15 ft NAVD88	-0.80 cy/ft/yr	-14.45 cy/ft
Volume Change Above 0 ft NAVD88	8.31 cy/ft/yr	-7.79 cy/ft

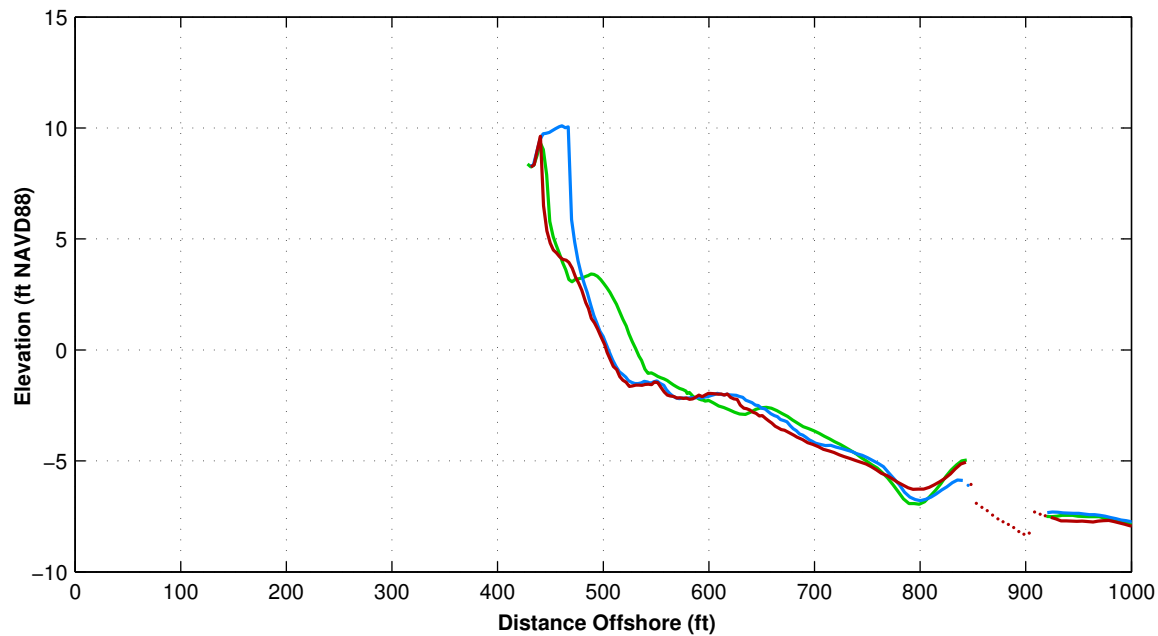
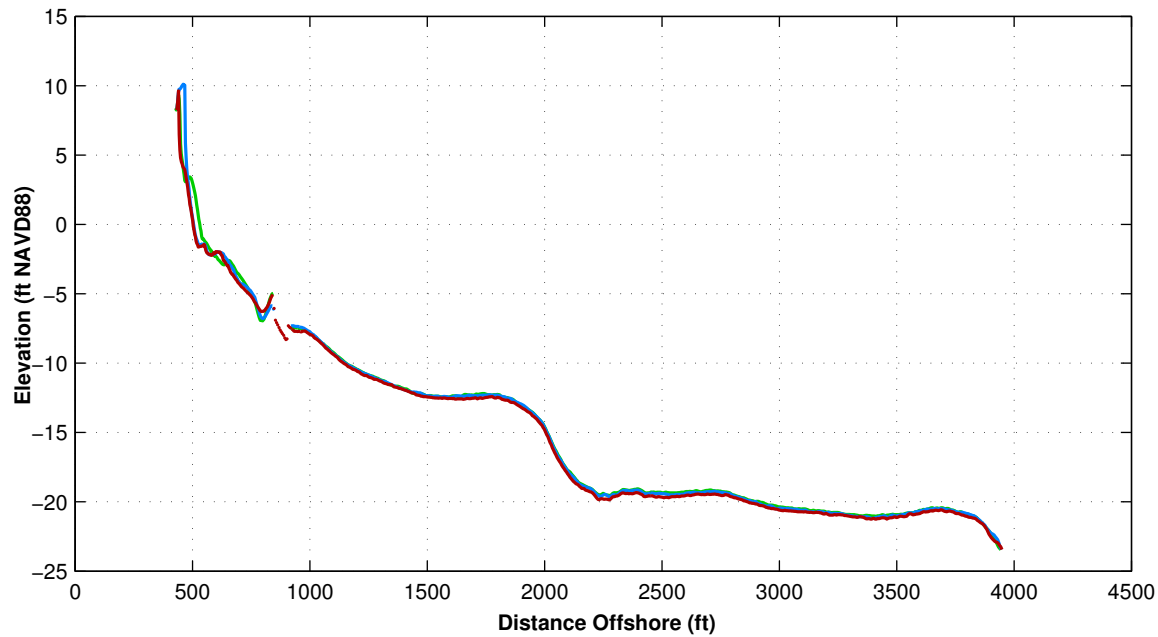
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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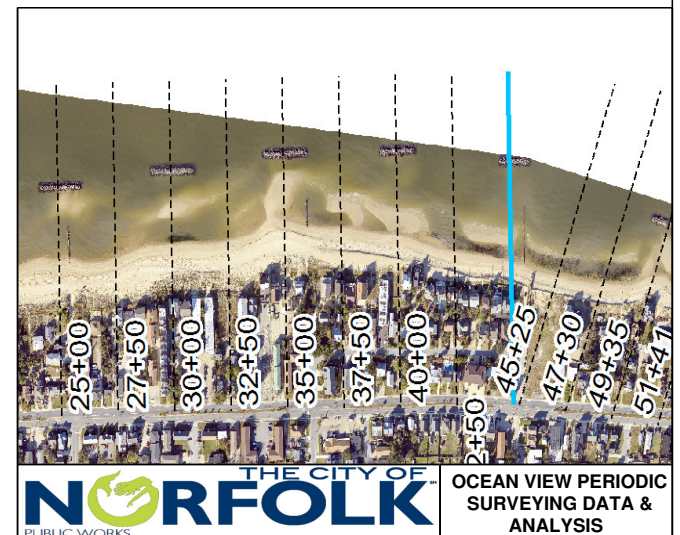
Survey Transect 45+00	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-27.31 ft/yr	-1.48 ft
Volume Change Above -15 ft NAVD88	-12.32 cy/ft/yr	-12.60 cy/ft
Volume Change Above 0 ft NAVD88	-3.68 cy/ft/yr	-6.05 cy/ft

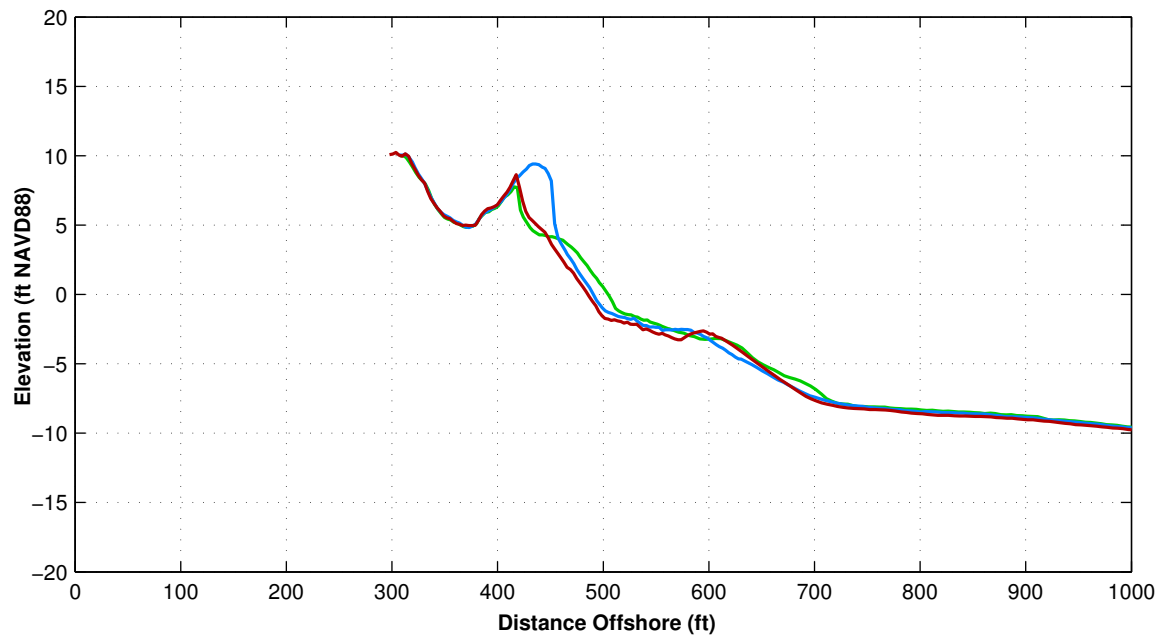
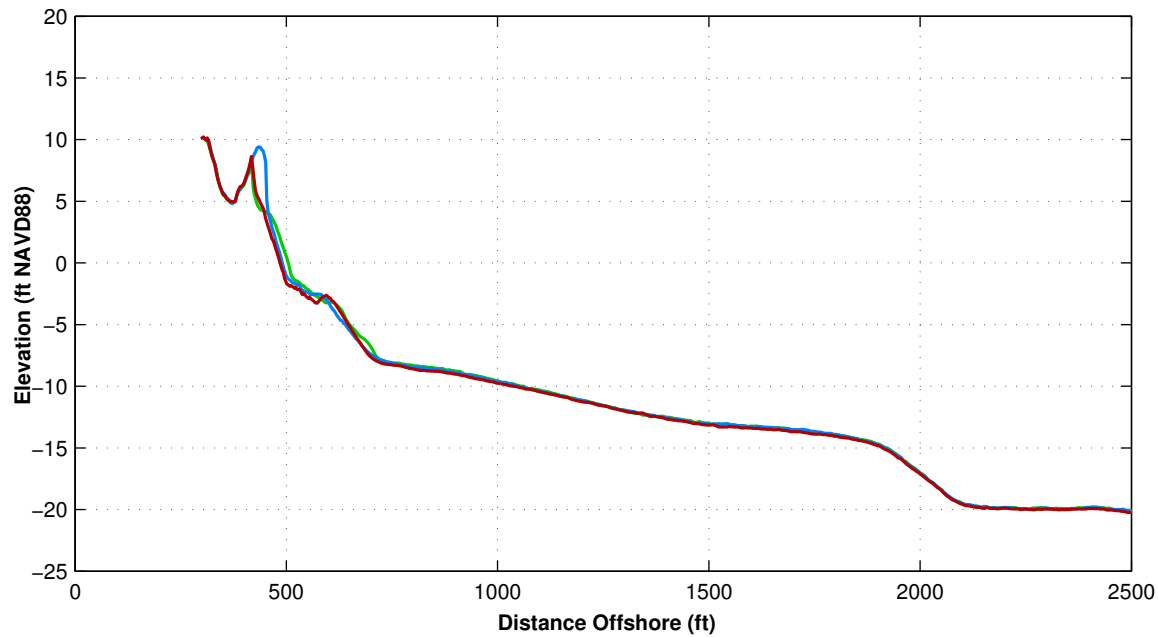
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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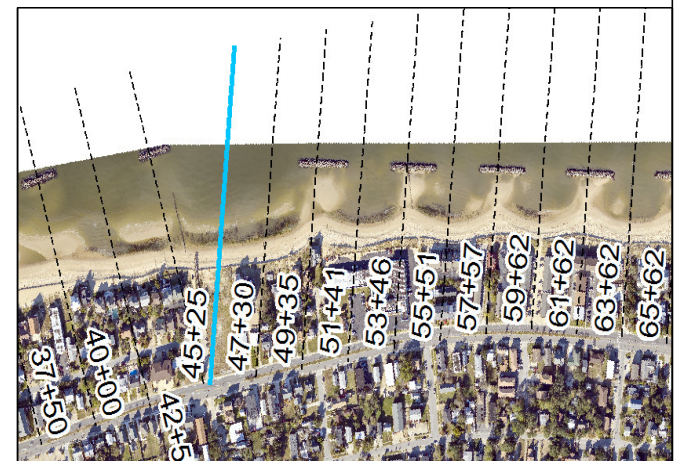
Survey Transect 45+25	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-18.15 ft/yr	-6.00 ft
Volume Change Above -15 ft NAVD88	-11.22 cy/ft/yr	-11.35 cy/ft
Volume Change Above 0 ft NAVD88	-1.52 cy/ft/yr	-5.70 cy/ft

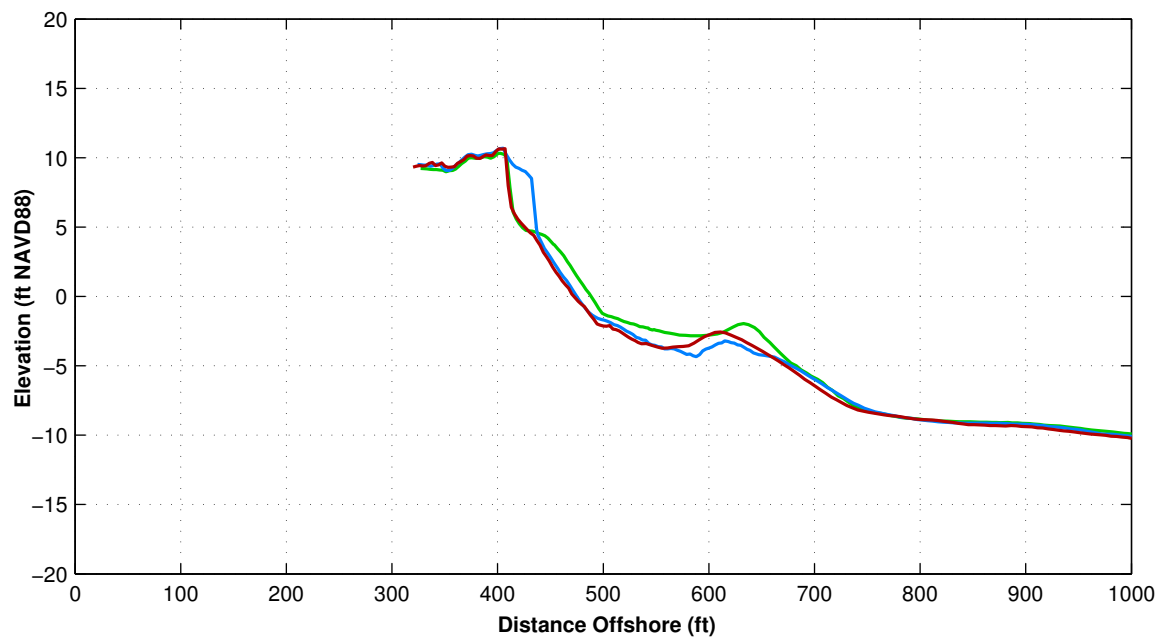
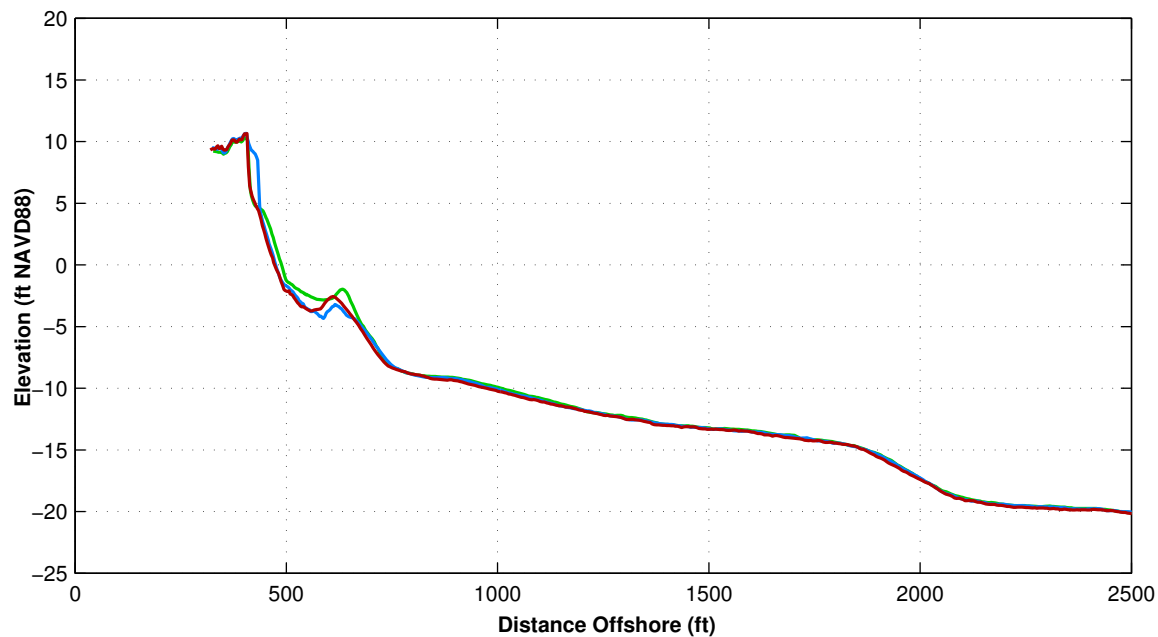
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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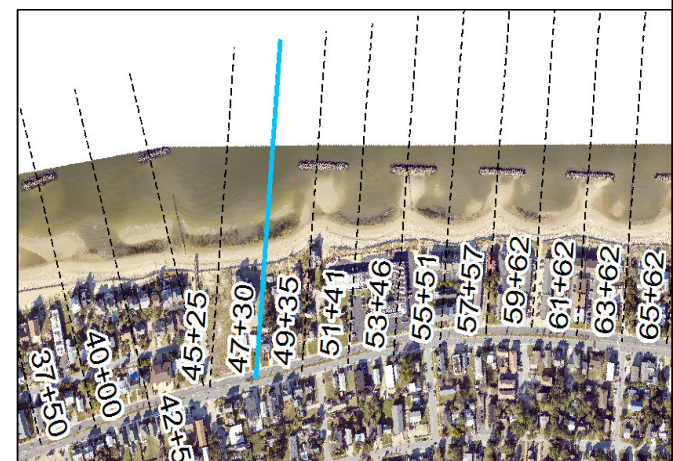
Survey Transect 47+30	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-16.19 ft/yr	-4.10 ft
Volume Change Above -15 ft NAVD88	-14.63 cy/ft/yr	-6.74 cy/ft
Volume Change Above 0 ft NAVD88	-1.96 cy/ft/yr	-4.04 cy/ft

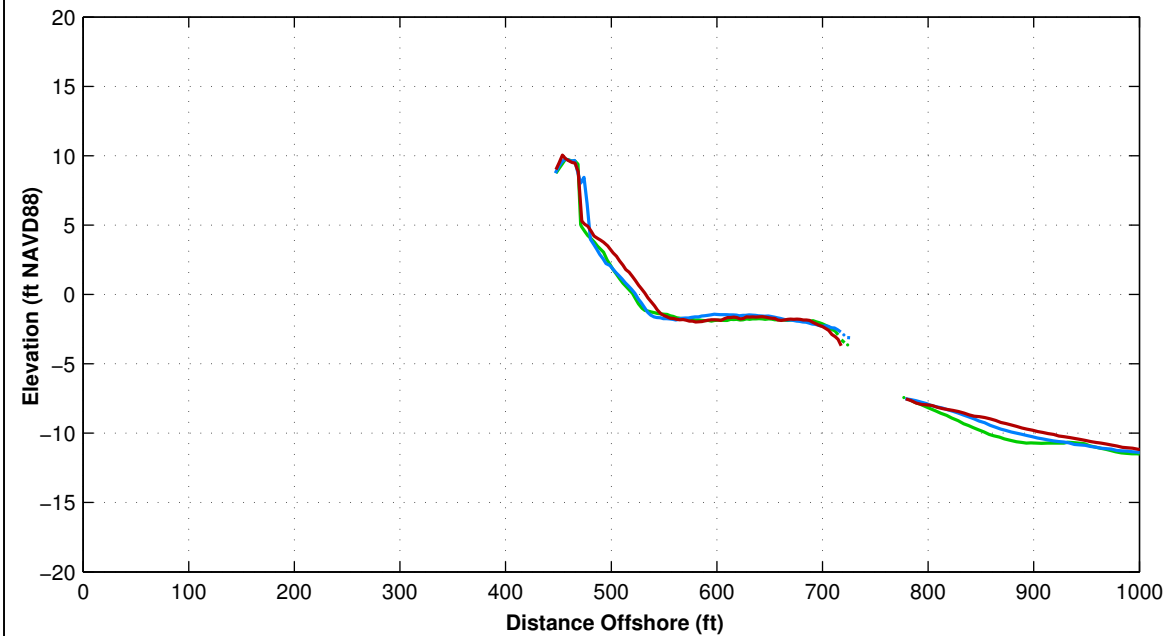
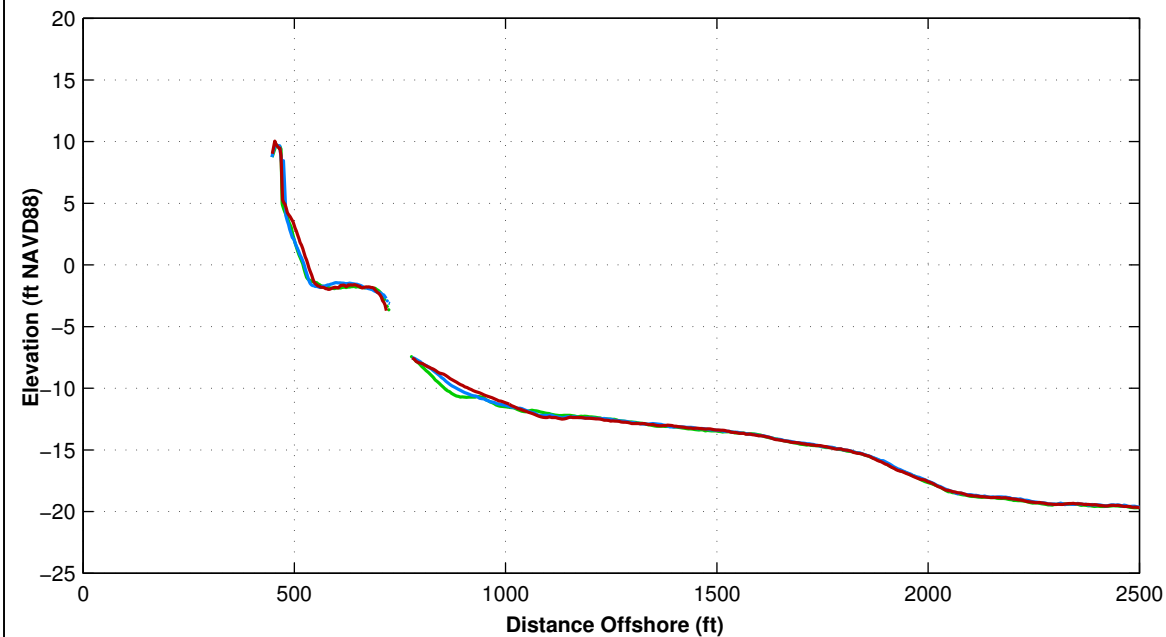
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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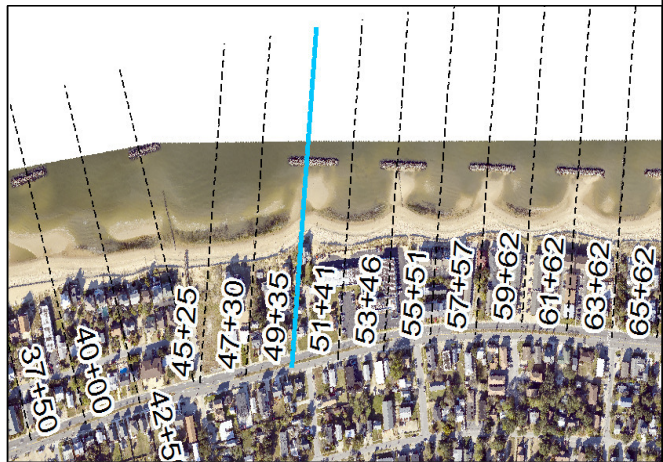
Survey Transect 49+35	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	13.21 ft/yr	11.28 ft
Volume Change Above -15 ft NAVD88	6.40 cy/ft/yr	2.26 cy/ft
Volume Change Above 0 ft NAVD88	2.02 cy/ft/yr	1.21 cy/ft

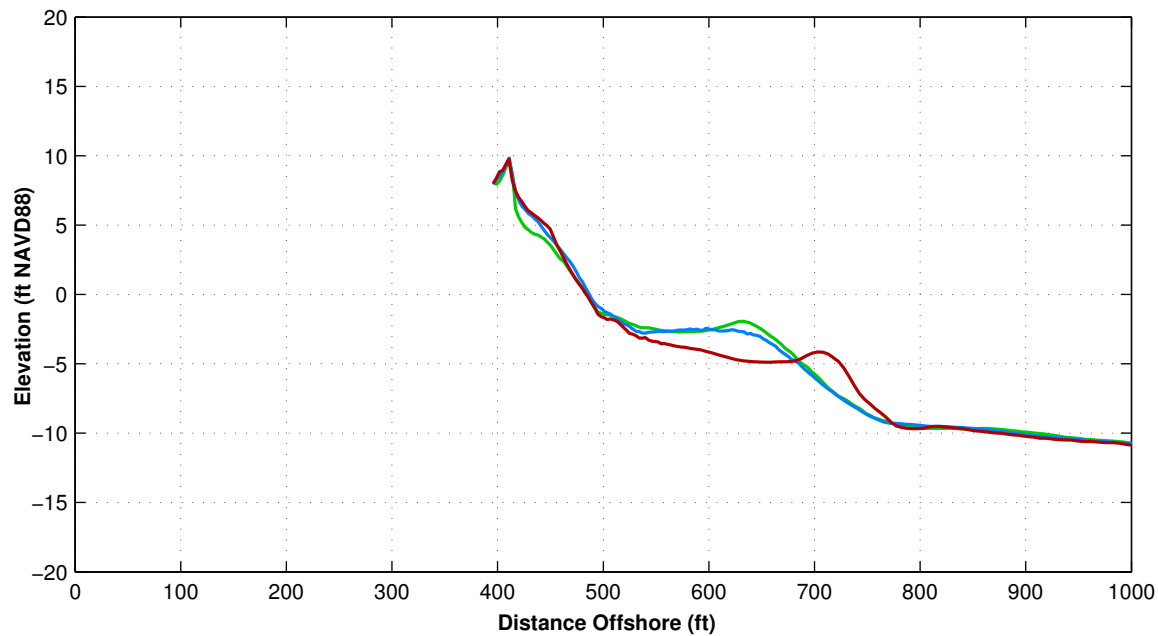
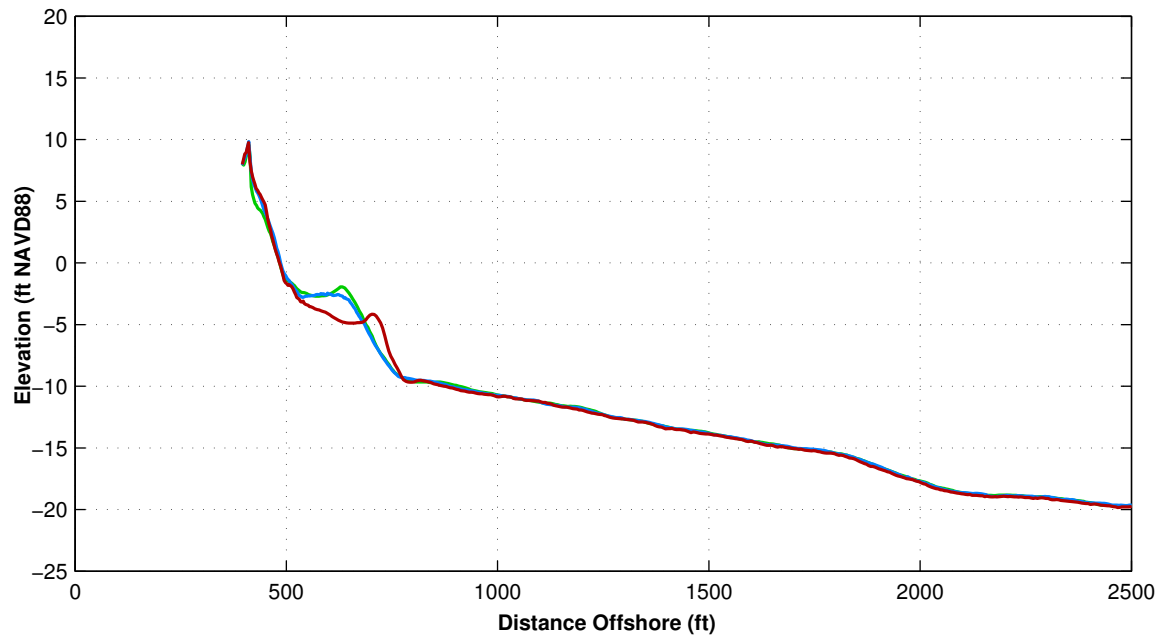
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

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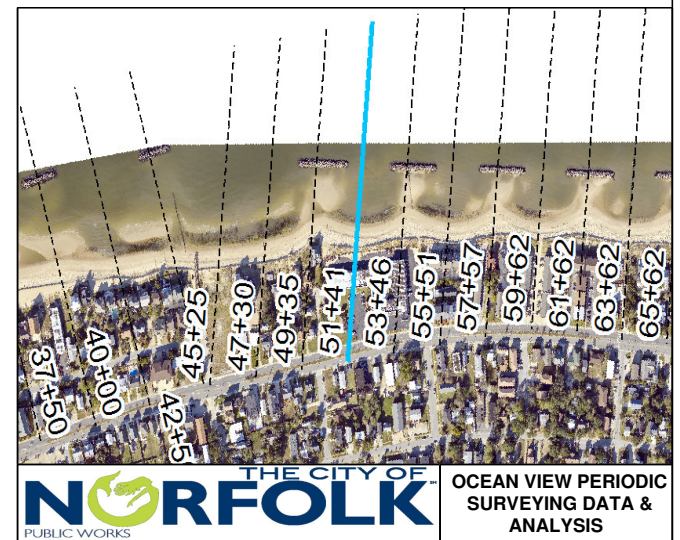
Survey Transect 51+41	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-0.50 ft/yr	-4.85 ft
Volume Change Above -15 ft NAVD88	-5.78 cy/ft/yr	-5.79 cy/ft
Volume Change Above 0 ft NAVD88	2.10 cy/ft/yr	0.00 cy/ft

LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

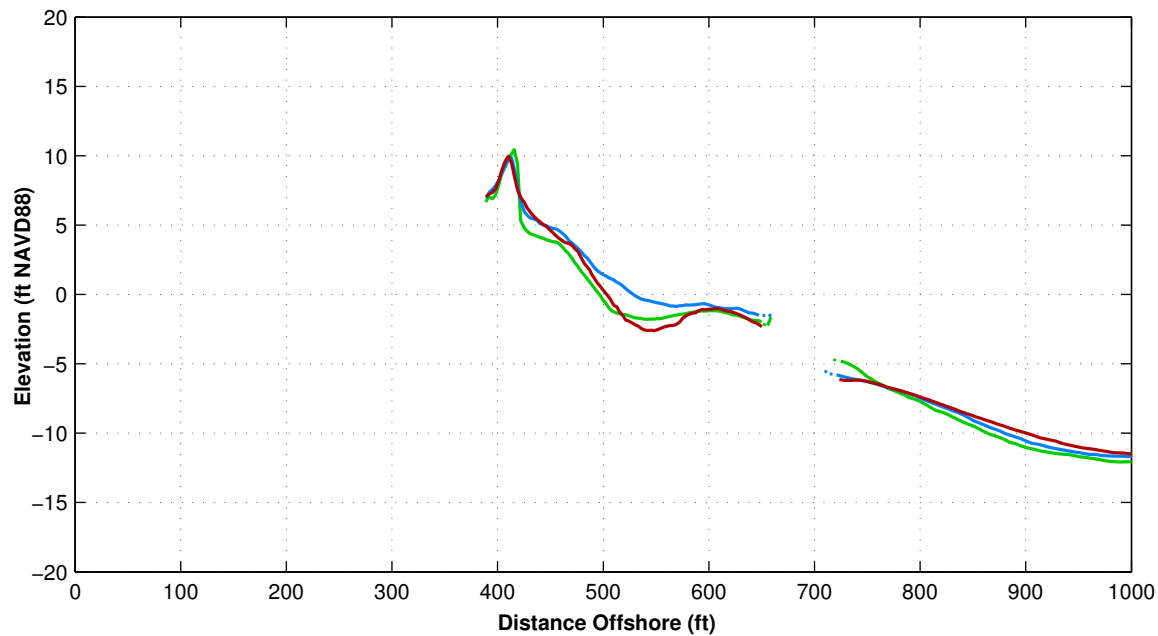
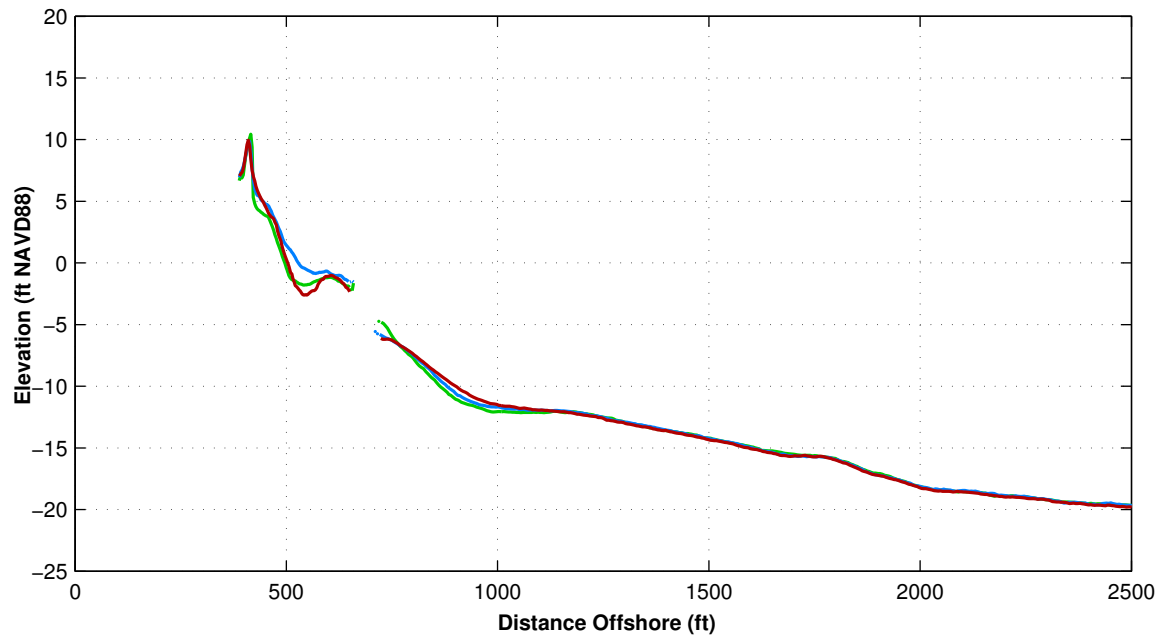
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ST 51+41

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Fall 2016



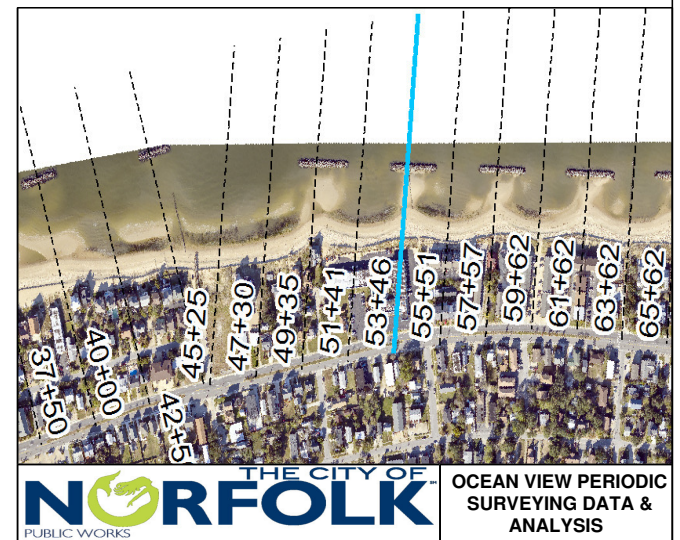
Survey Transect 53+46	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	6.56 ft/yr	-17.72 ft
Volume Change Above -15 ft NAVD88	6.42 cy/ft/yr	-5.50 cy/ft
Volume Change Above 0 ft NAVD88	2.54 cy/ft/yr	-1.62 cy/ft

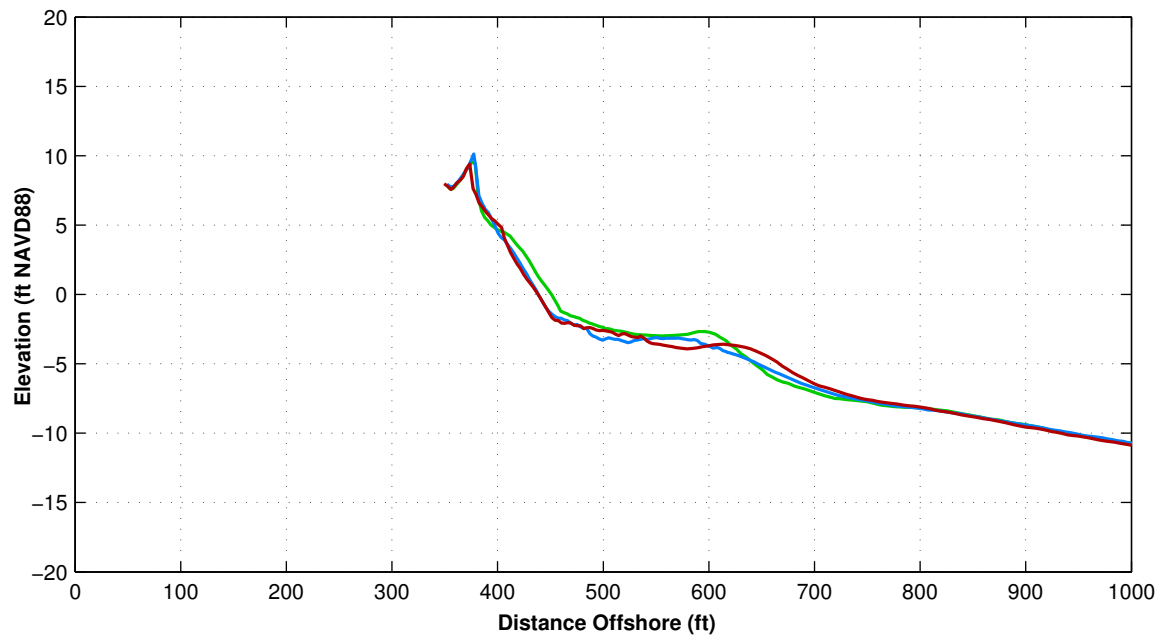
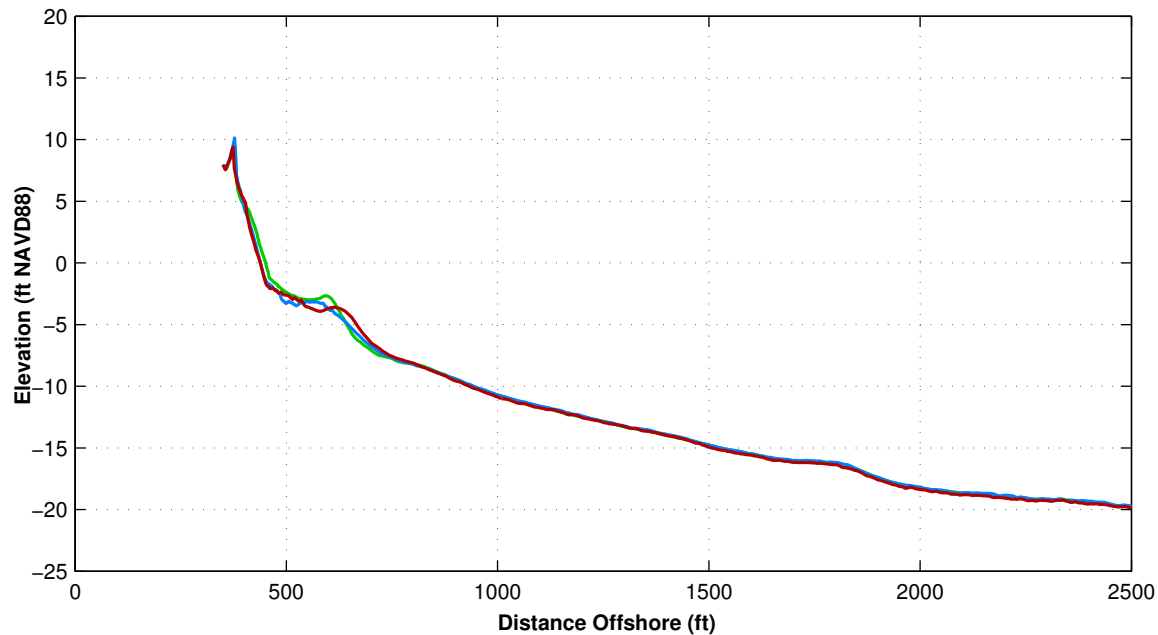
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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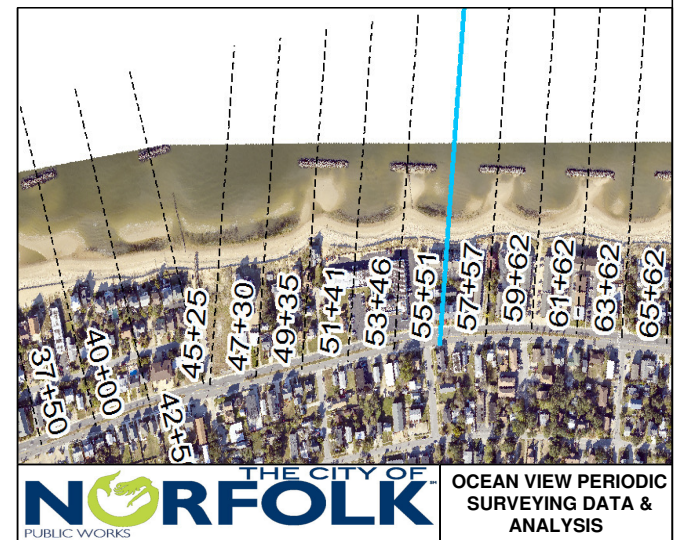
Survey Transect 55+51	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-12.11 ft/yr	-1.94 ft
Volume Change Above -15 ft NAVD88	-3.77 cy/ft/yr	-0.90 cy/ft
Volume Change Above 0 ft NAVD88	-1.84 cy/ft/yr	-0.72 cy/ft

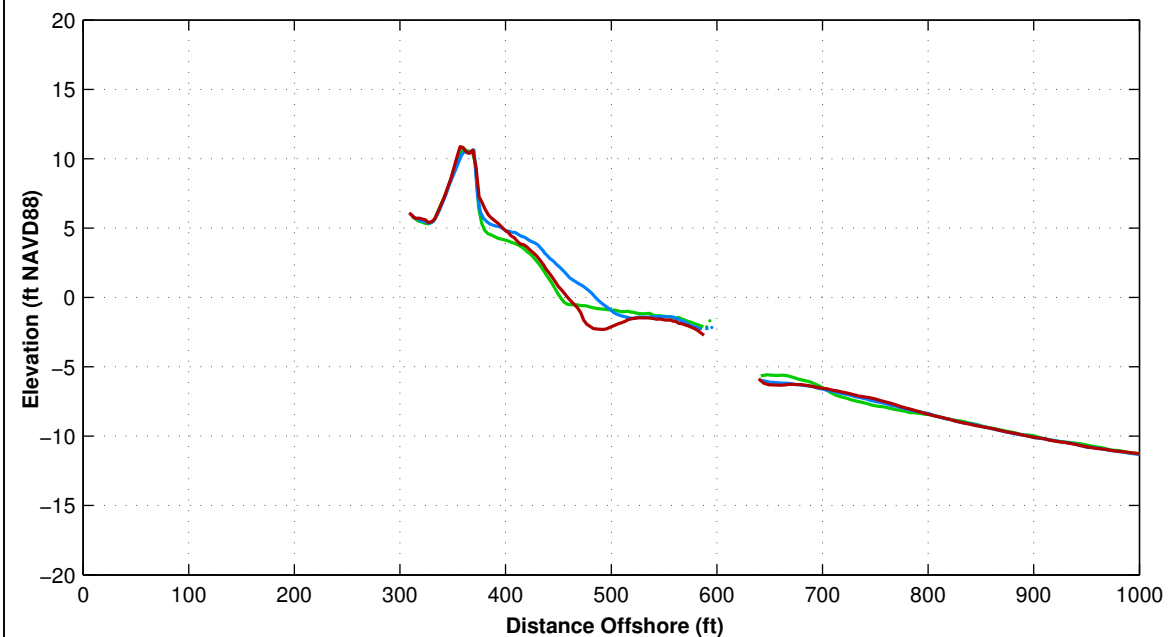
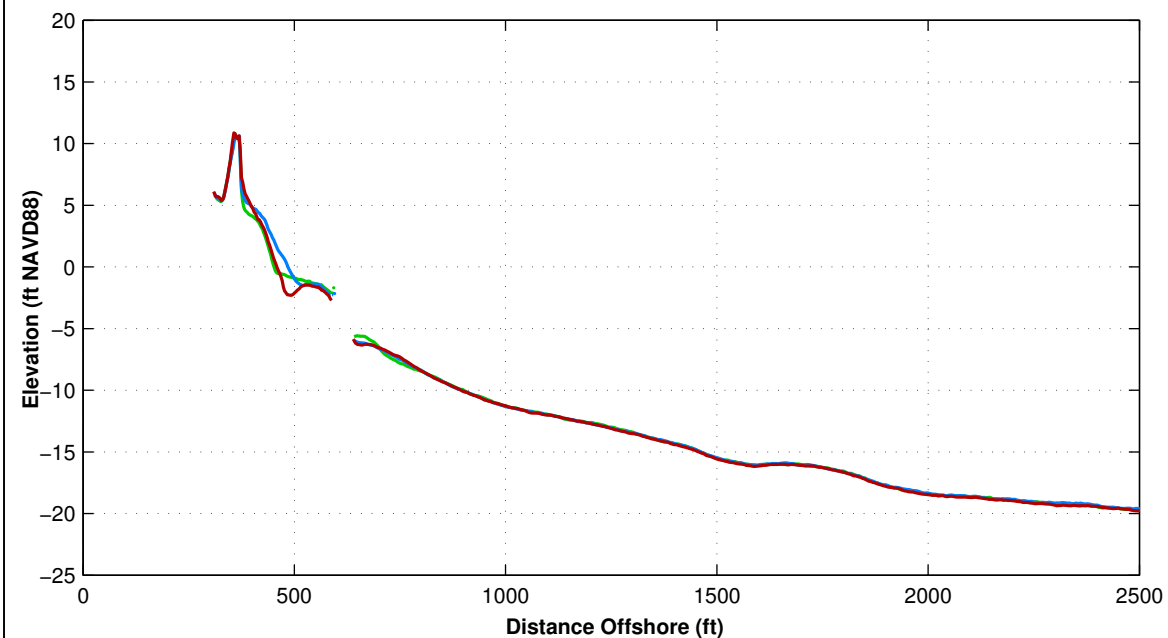
LEGEND:

OCT 2016 — (red line)
MAY 2016 — (blue line)
OCT 2015 — (green line)

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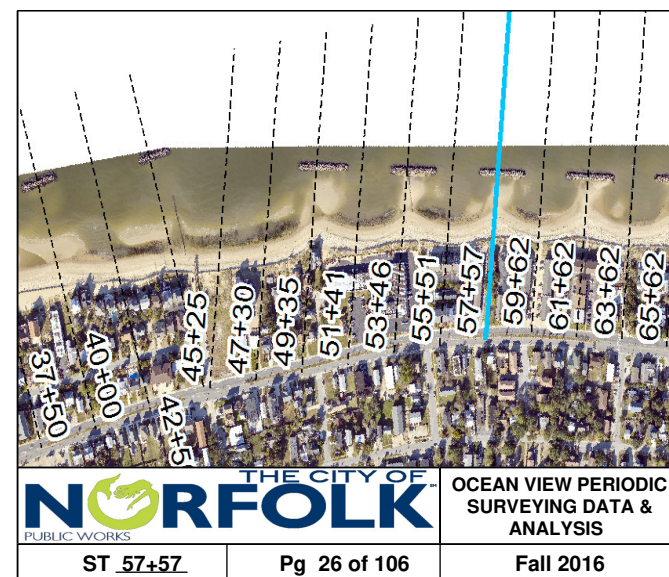
Survey Transect 57+57	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	4.11 ft/yr	-21.14 ft
Volume Change Above -15 ft NAVD88	-1.58 cy/ft/yr	-5.16 cy/ft
Volume Change Above 0 ft NAVD88	2.23 cy/ft/yr	-1.82 cy/ft

LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

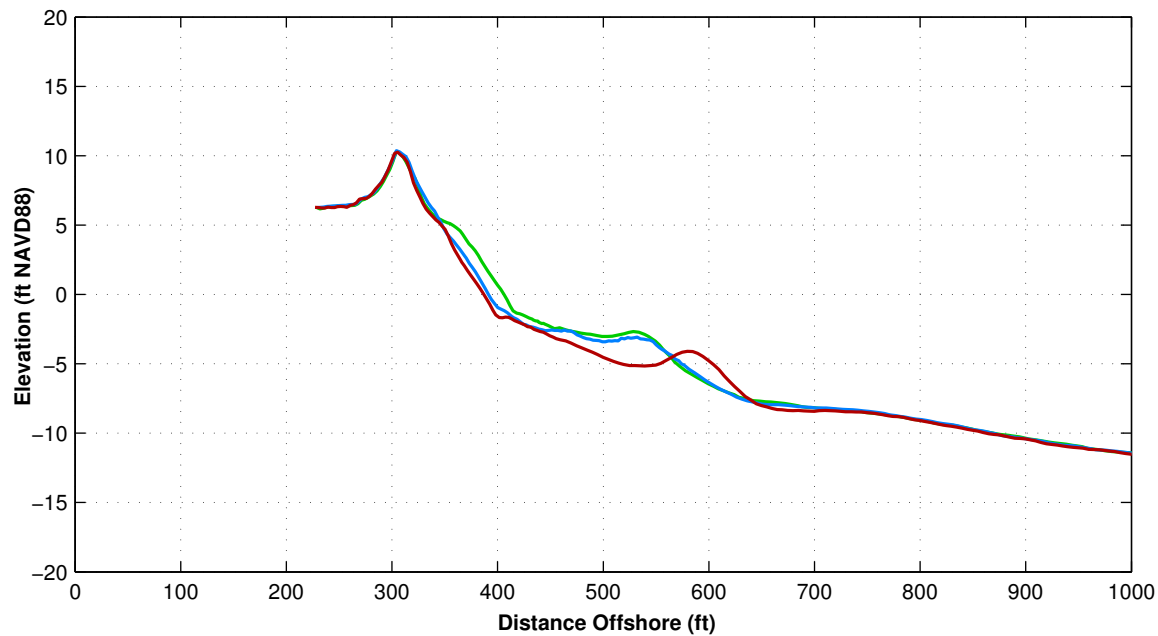
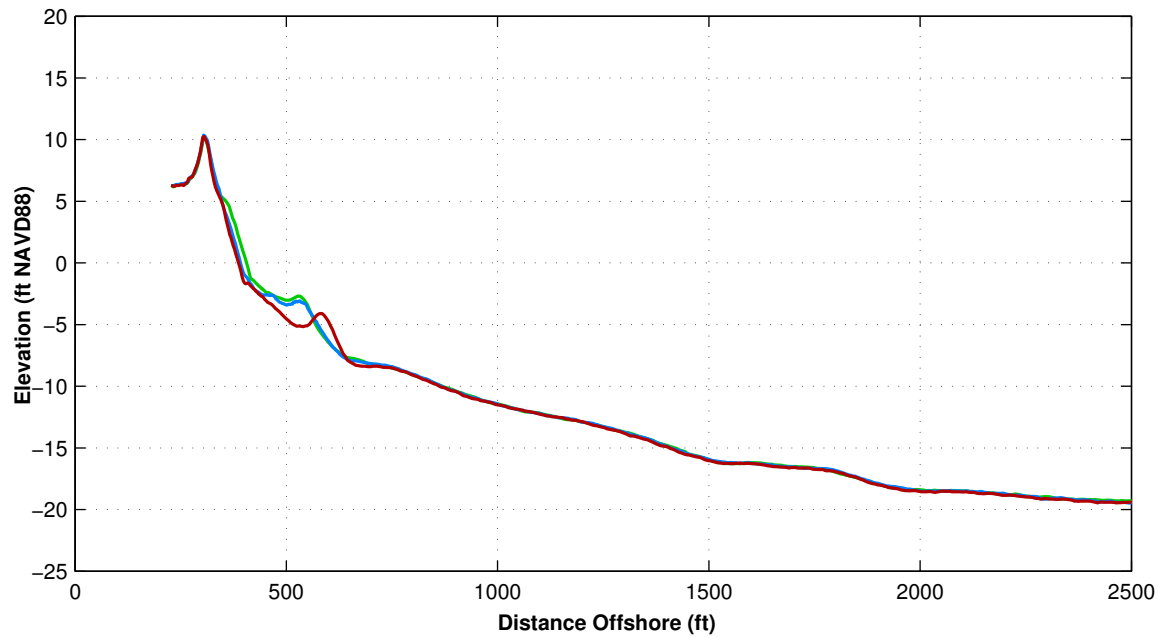
1. Station From West To East At Varying Intervals.
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ST 57+57

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Fall 2016



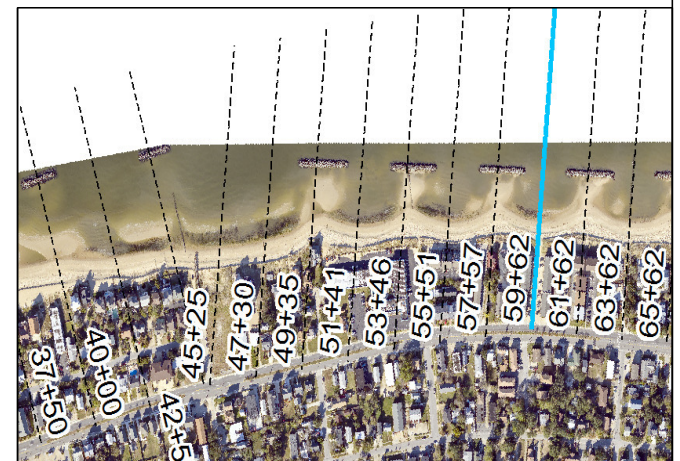
Survey Transect 59+62	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-18.22 ft/yr	-5.68 ft
Volume Change Above -15 ft NAVD88	-10.64 cy/ft/yr	-6.92 cy/ft
Volume Change Above 0 ft NAVD88	-3.33 cy/ft/yr	-1.57 cy/ft

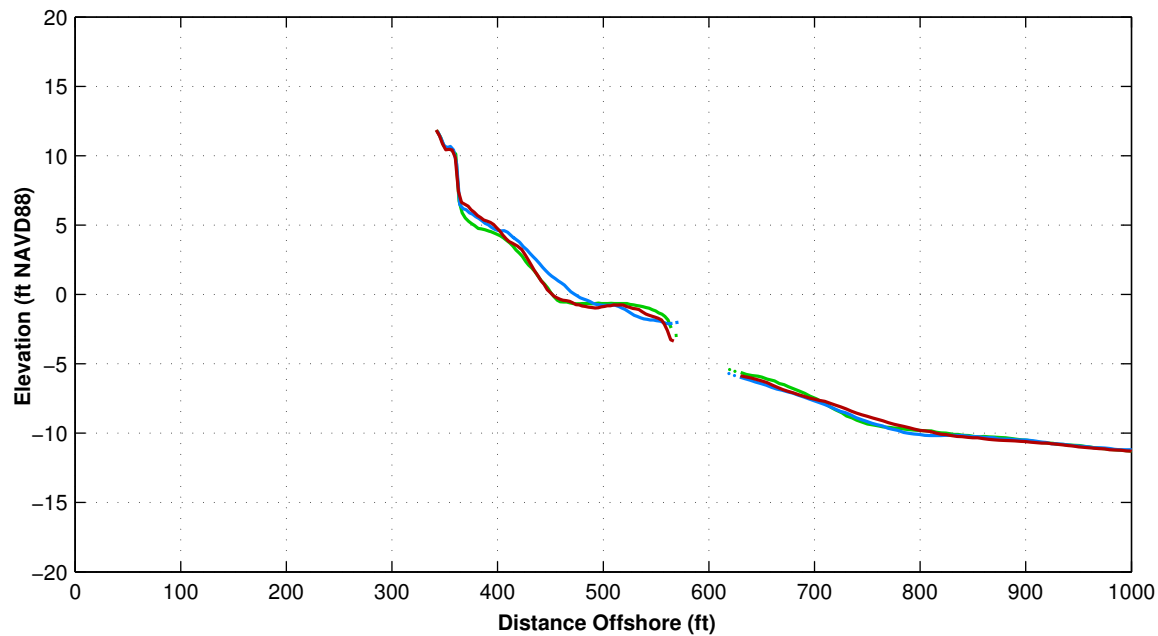
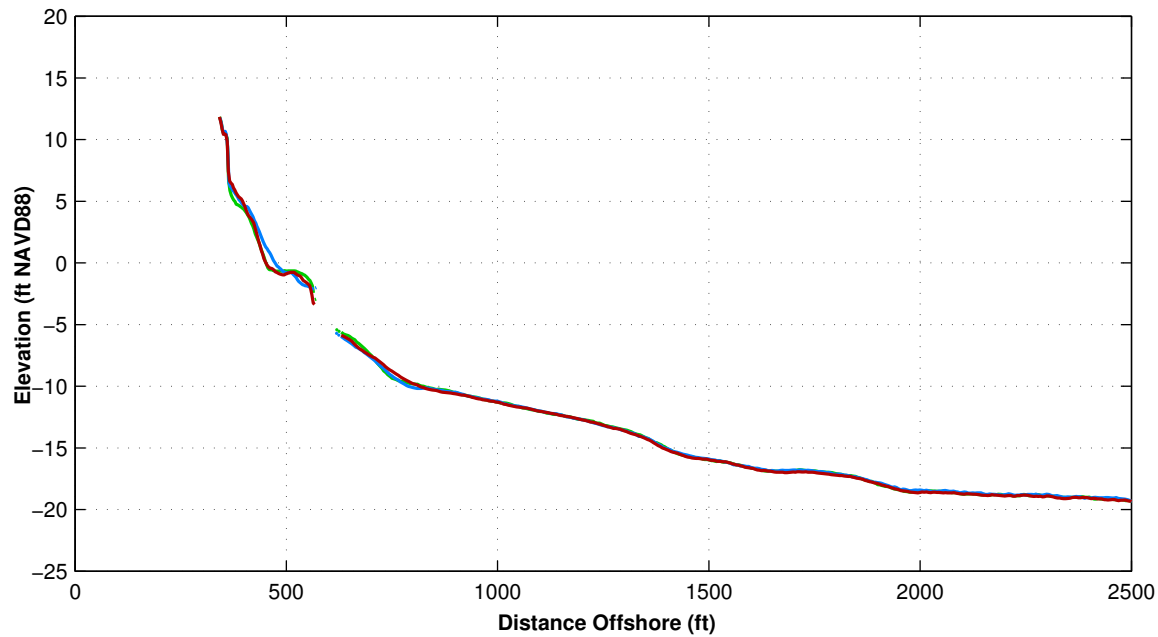
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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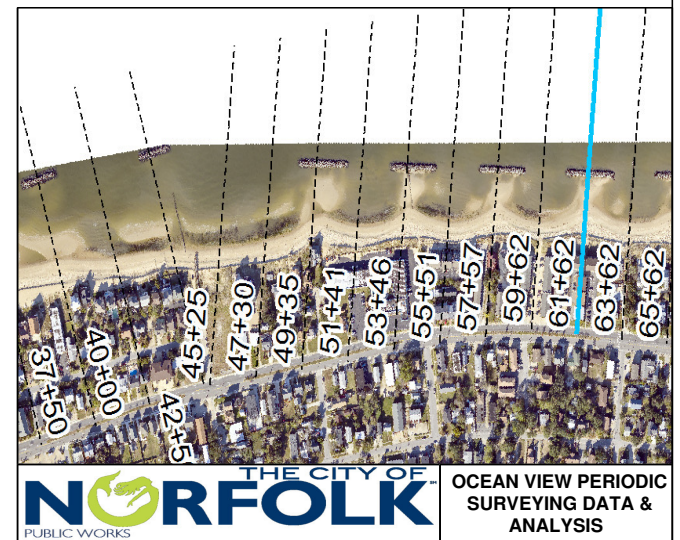
Survey Transect 61+62	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-0.60 ft/yr	-16.31 ft
Volume Change Above -15 ft NAVD88	-0.51 cy/ft/yr	-1.13 cy/ft
Volume Change Above 0 ft NAVD88	1.25 cy/ft/yr	-1.61 cy/ft

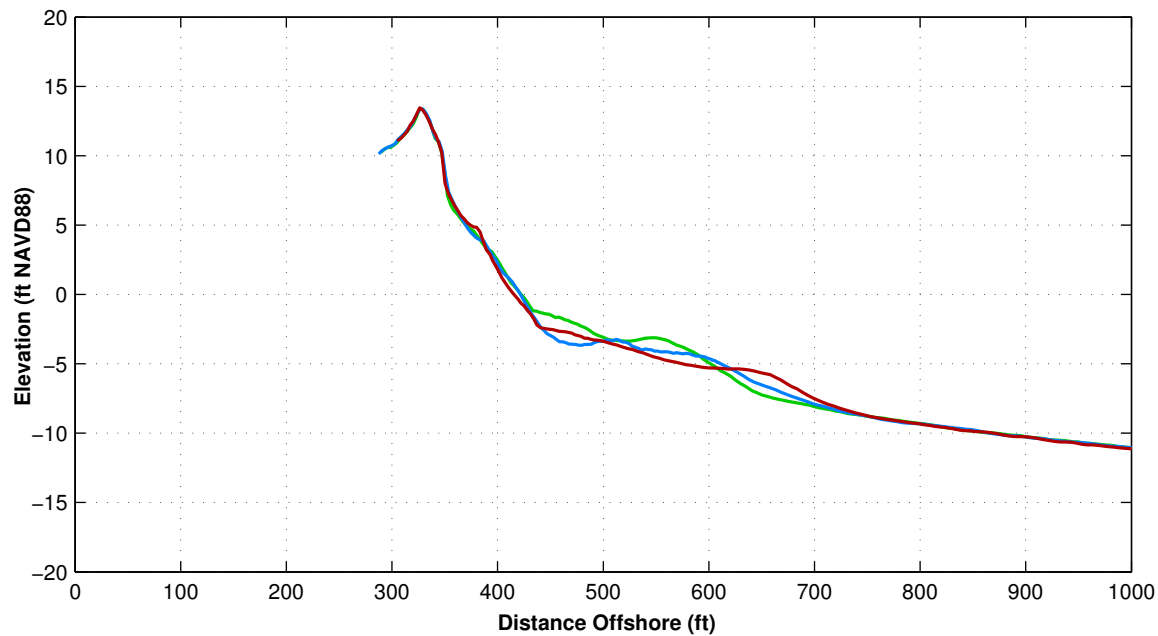
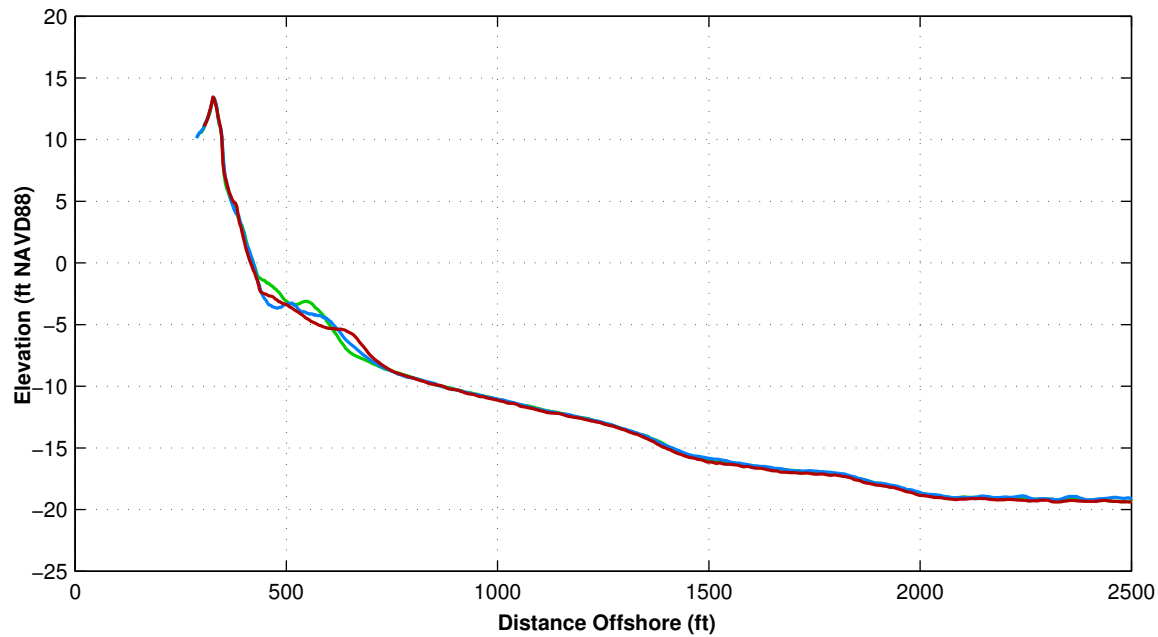
LEGEND:

OCT 2016 — (red line)
MAY 2016 — (blue line)
OCT 2015 — (green line)

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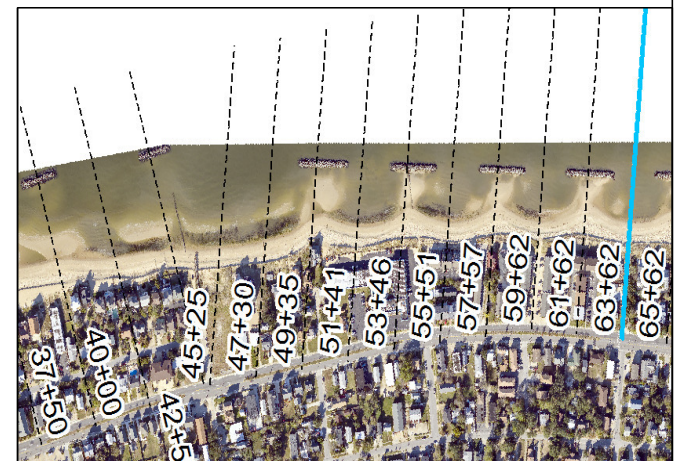
Survey Transect 63+62	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-5.42 ft/yr	-6.86 ft
Volume Change Above -15 ft NAVD88	-3.65 cy/ft/yr	-1.26 cy/ft
Volume Change Above 0 ft NAVD88	-0.13 cy/ft/yr	-0.41 cy/ft

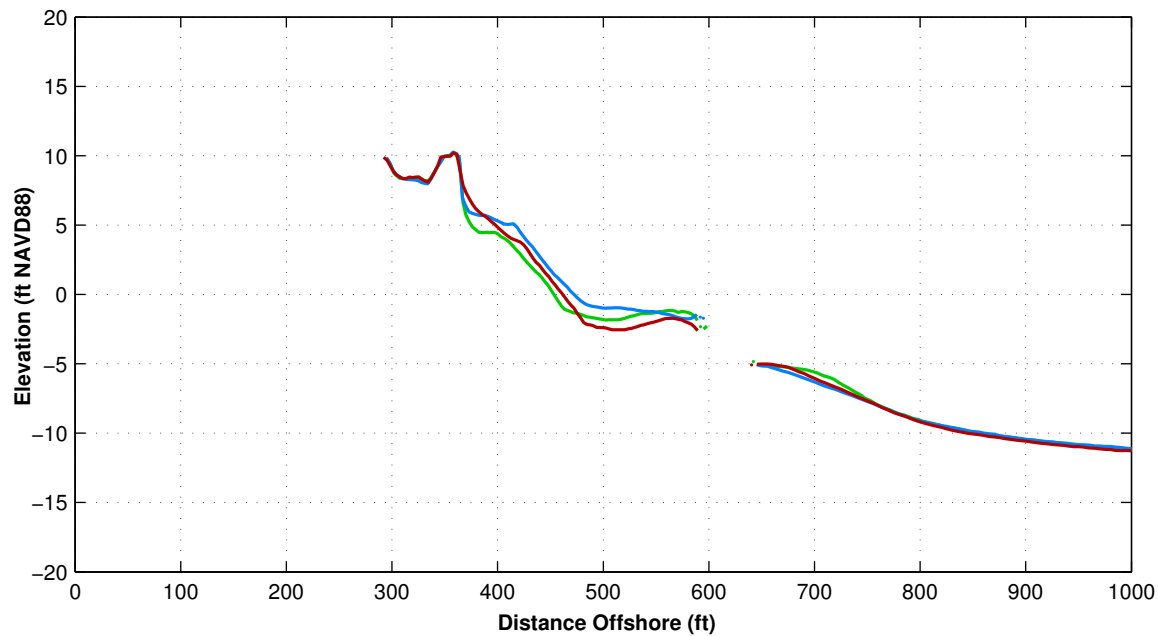
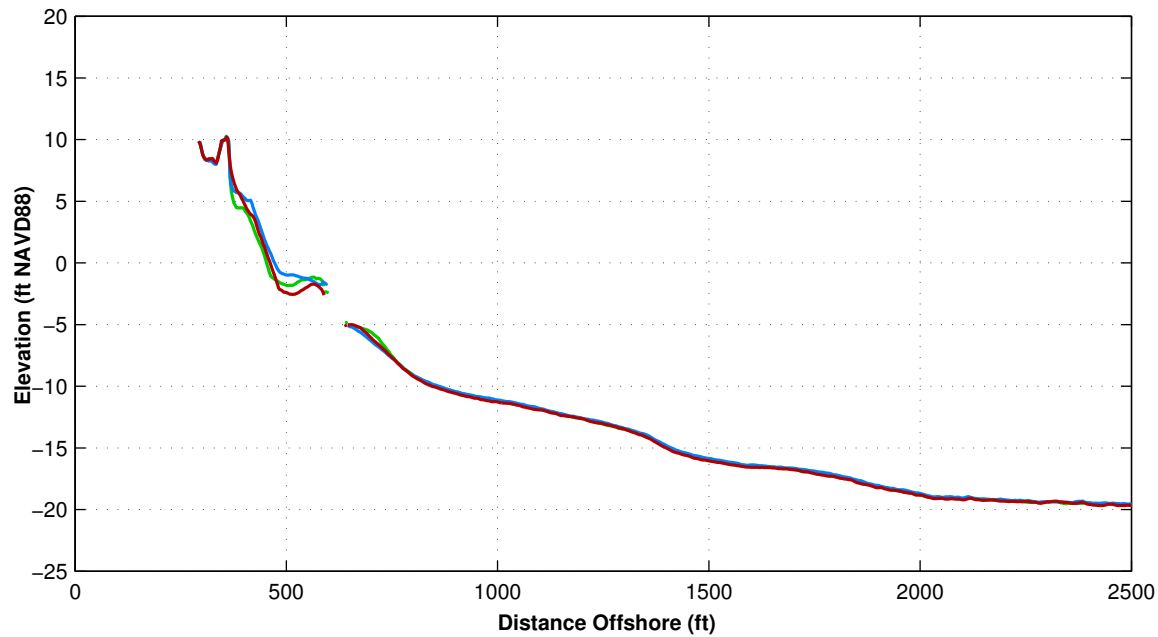
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

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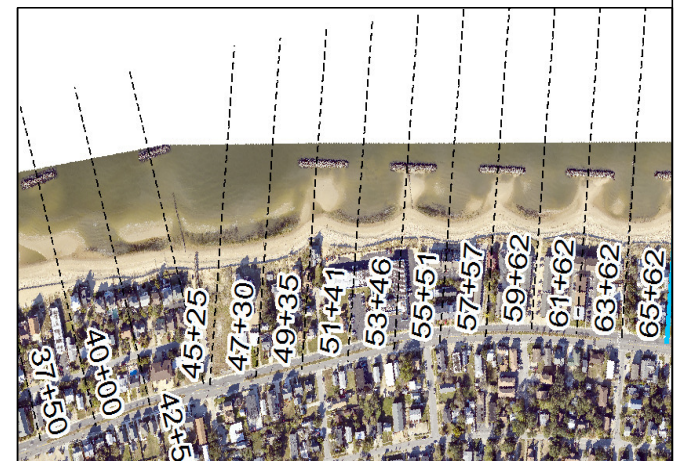
Survey Transect 65+62	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	6.62 ft/yr	-8.88 ft
Volume Change Above -15 ft NAVD88	-1.94 cy/ft/yr	-8.25 cy/ft
Volume Change Above 0 ft NAVD88	2.93 cy/ft/yr	-1.37 cy/ft

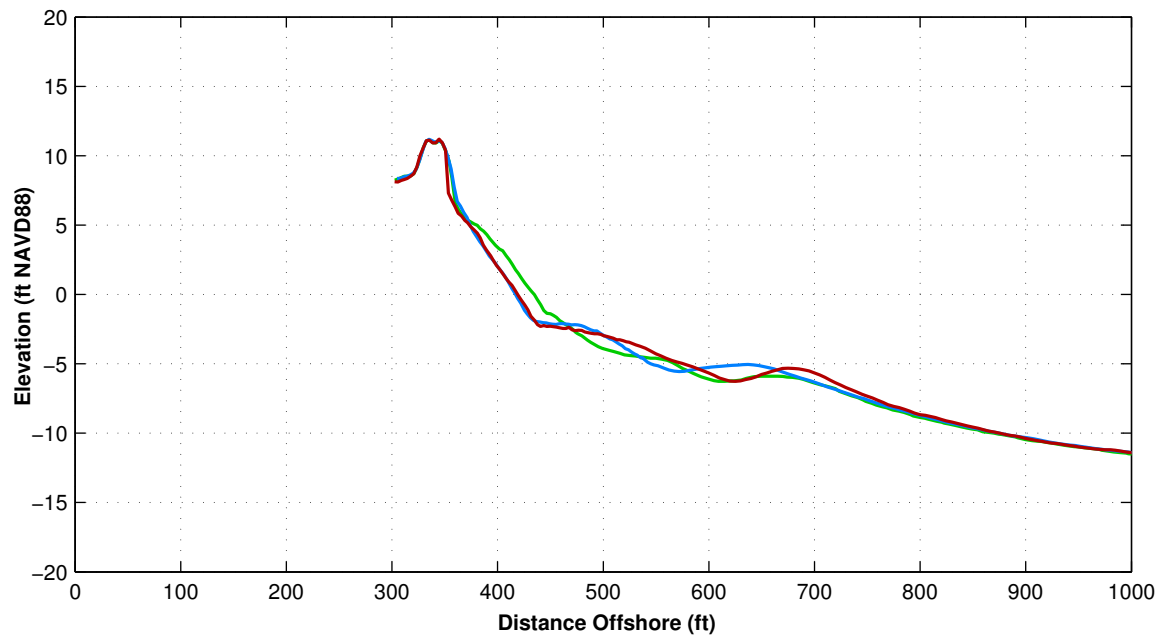
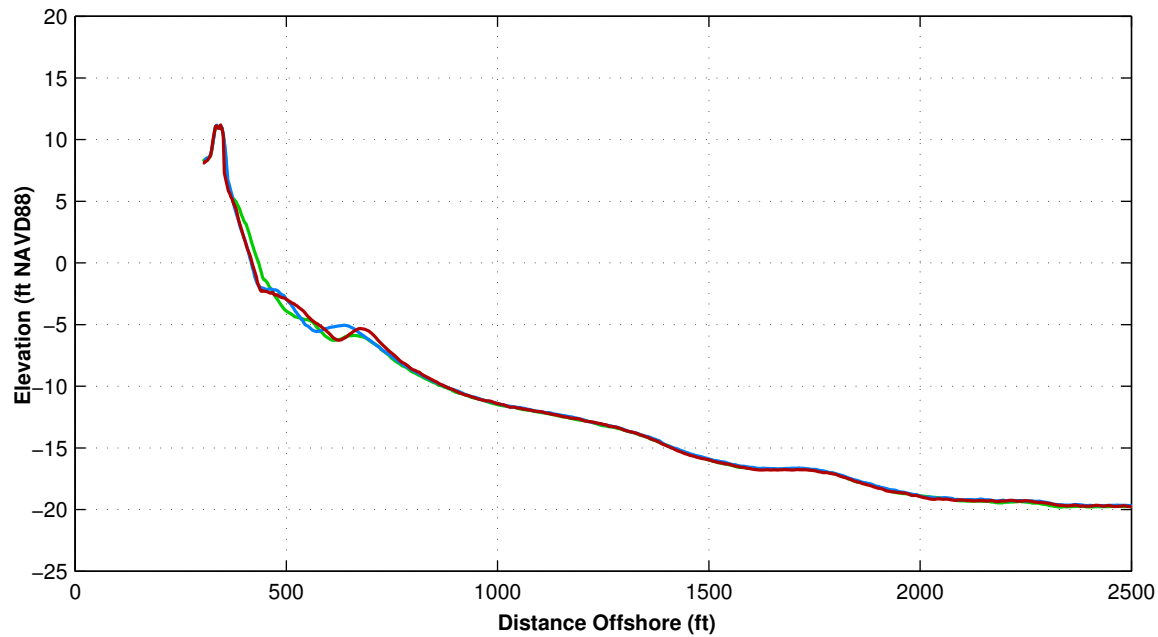
LEGEND:

OCT 2016 — (red line)
MAY 2016 — (blue line)
OCT 2015 — (green line)

Notes:

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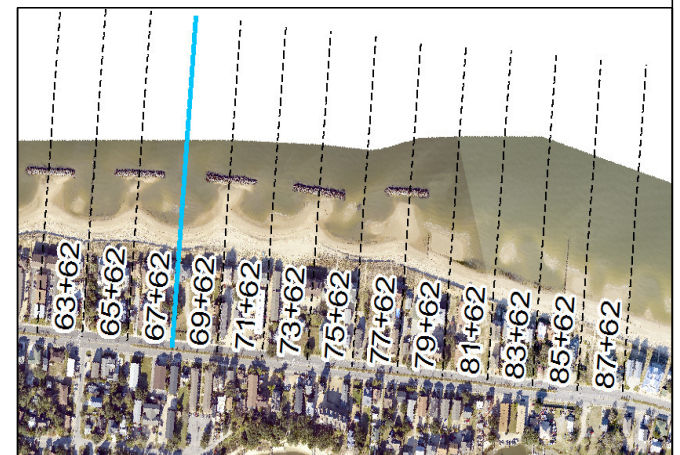
Survey Transect 67+62	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-14.14 ft/yr	0.12 ft
Volume Change Above -15 ft NAVD88	1.73 cy/ft/yr	-0.05 cy/ft
Volume Change Above 0 ft NAVD88	-2.96 cy/ft/yr	-0.75 cy/ft

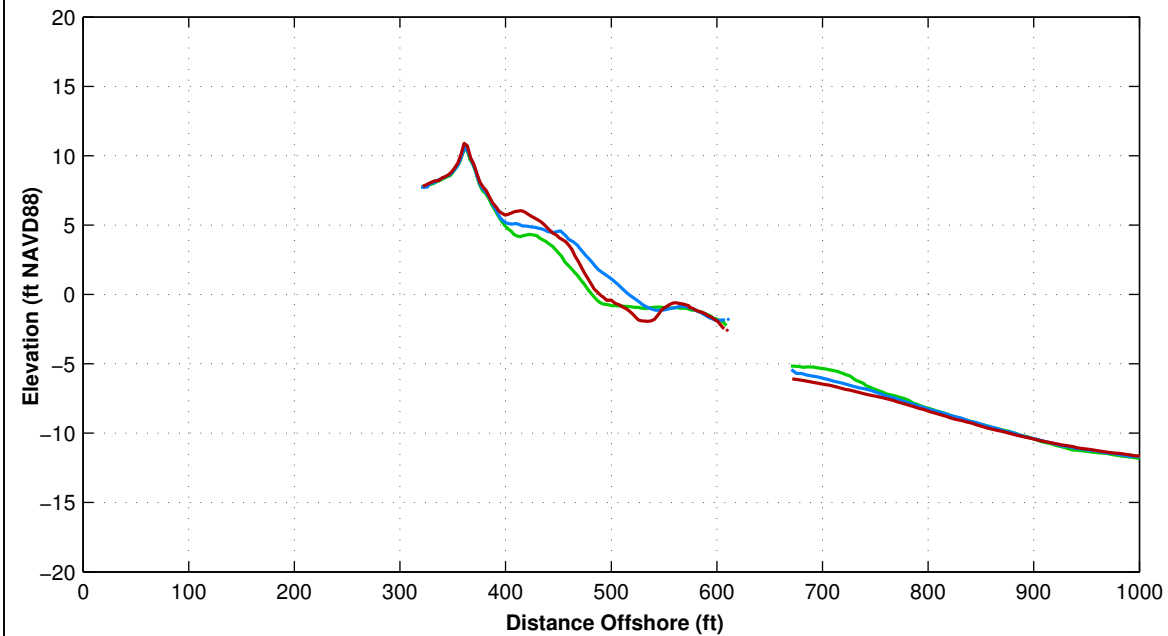
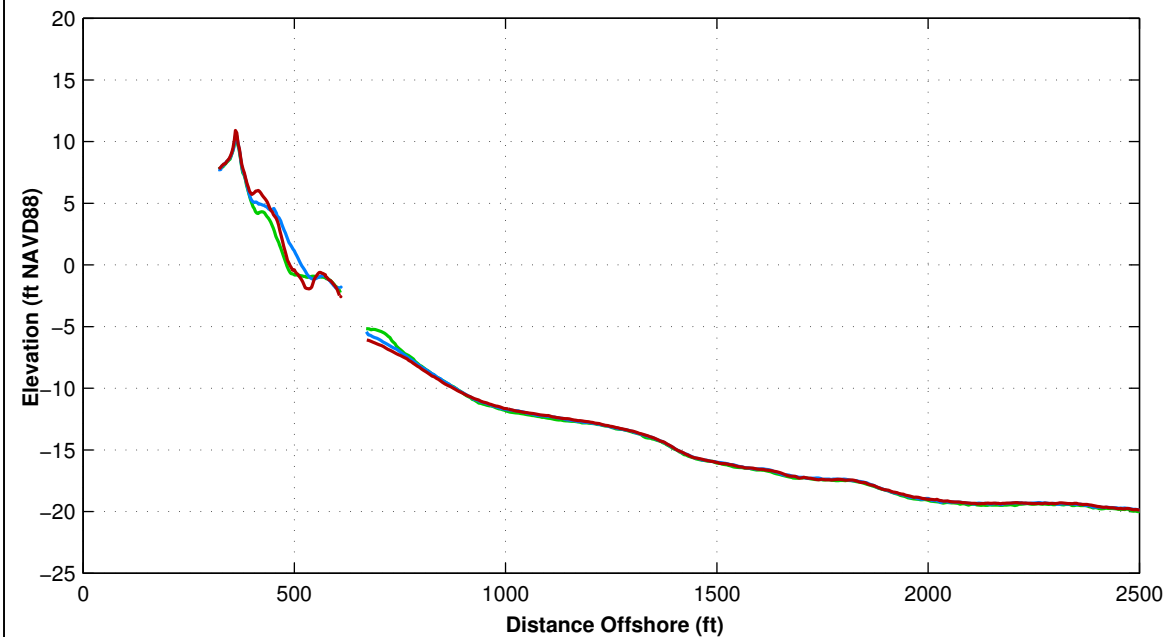
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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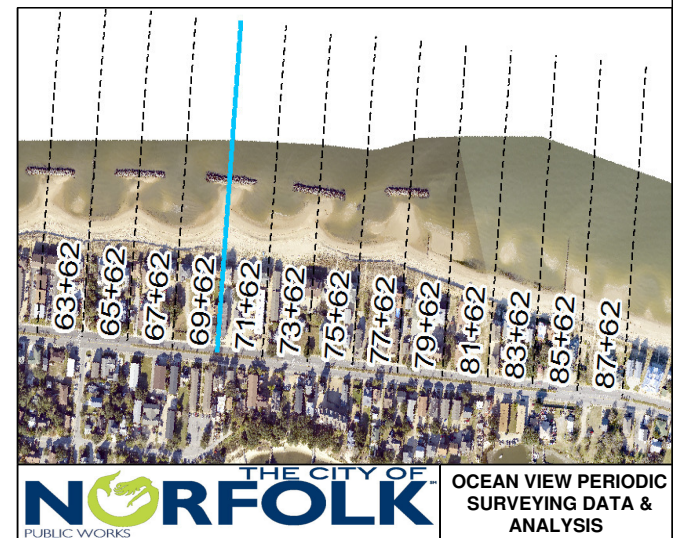
Survey Transect 69+62	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	7.14 ft/yr	-23.06 ft
Volume Change Above -15 ft NAVD88	2.40 cy/ft/yr	-3.82 cy/ft
Volume Change Above 0 ft NAVD88	4.42 cy/ft/yr	-0.98 cy/ft

LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

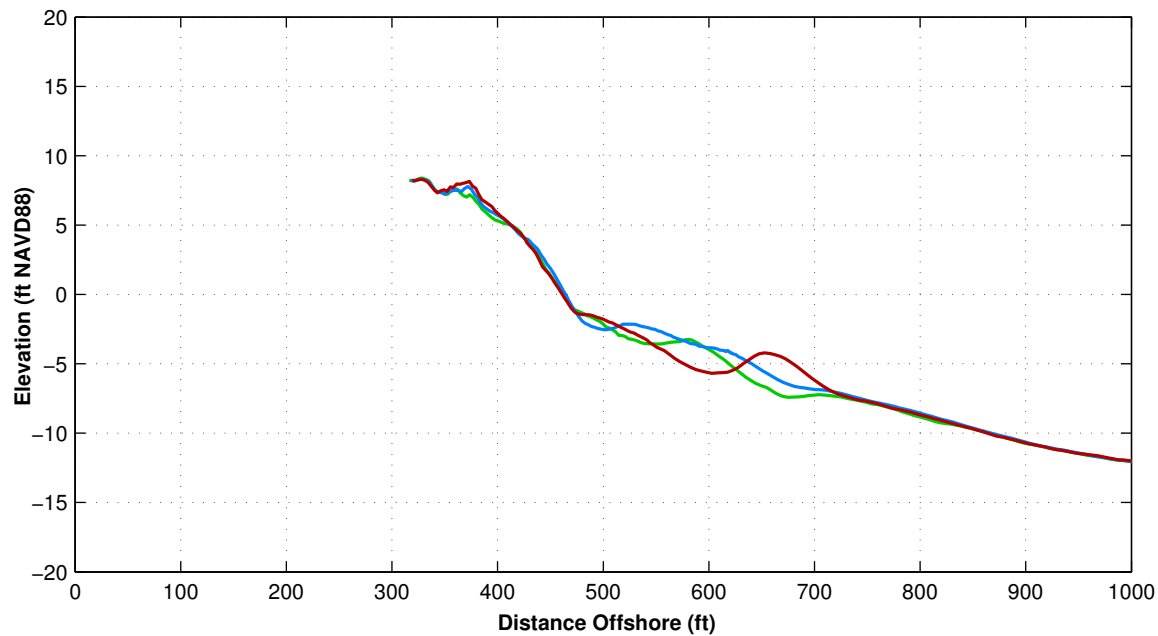
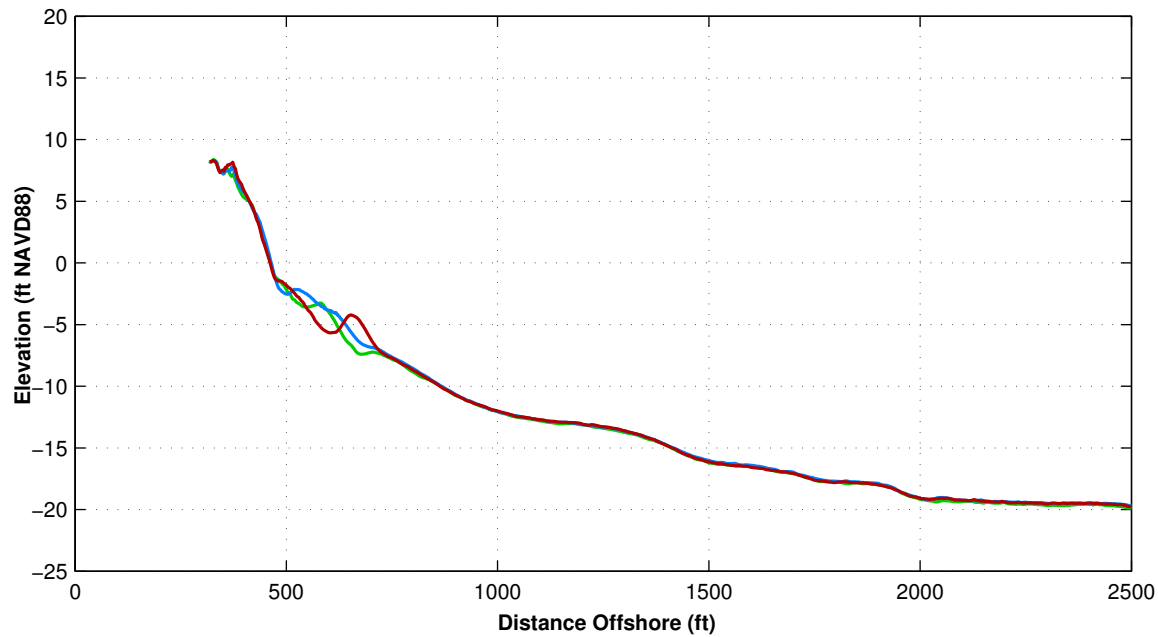
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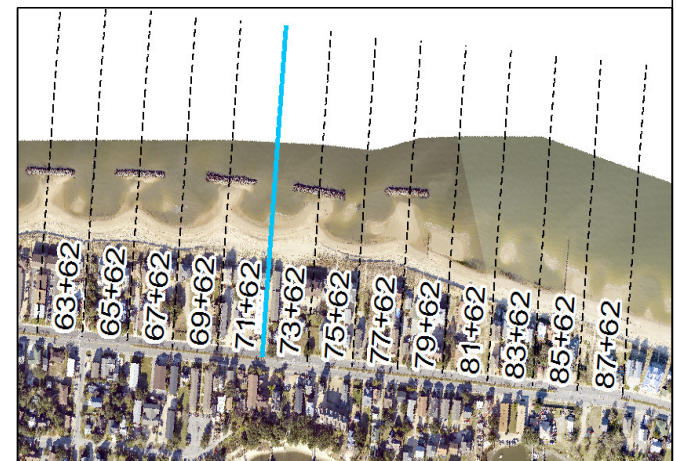
Survey Transect 71+62	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-0.89 ft/yr	-4.22 ft
Volume Change Above -15 ft NAVD88	6.01 cy/ft/yr	-1.97 cy/ft
Volume Change Above 0 ft NAVD88	1.08 cy/ft/yr	0.09 cy/ft

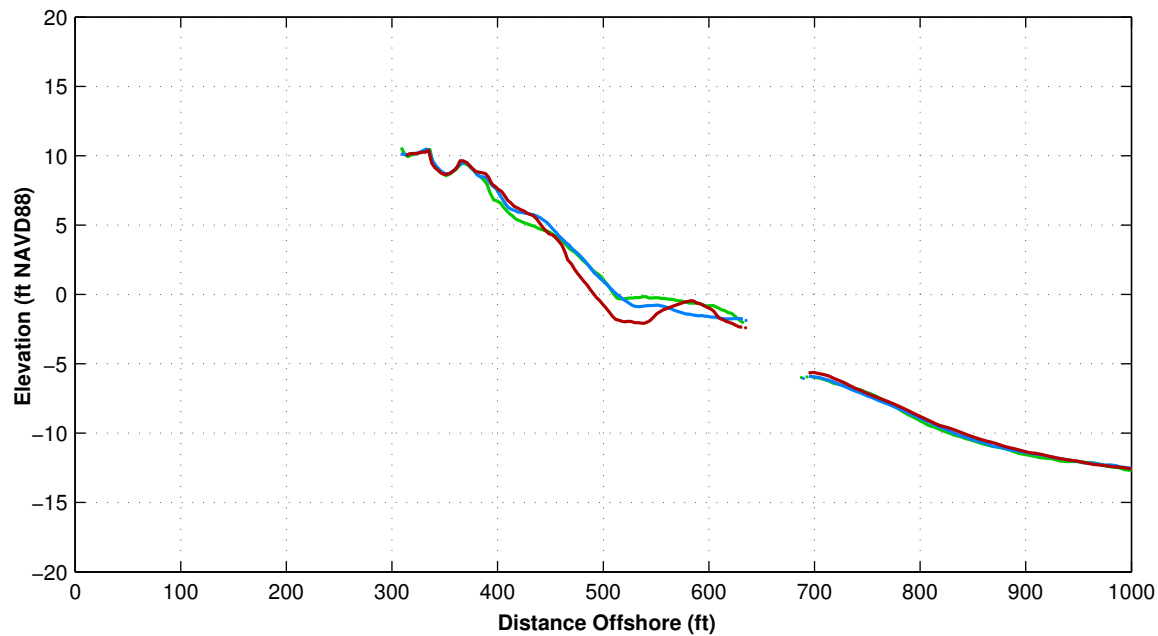
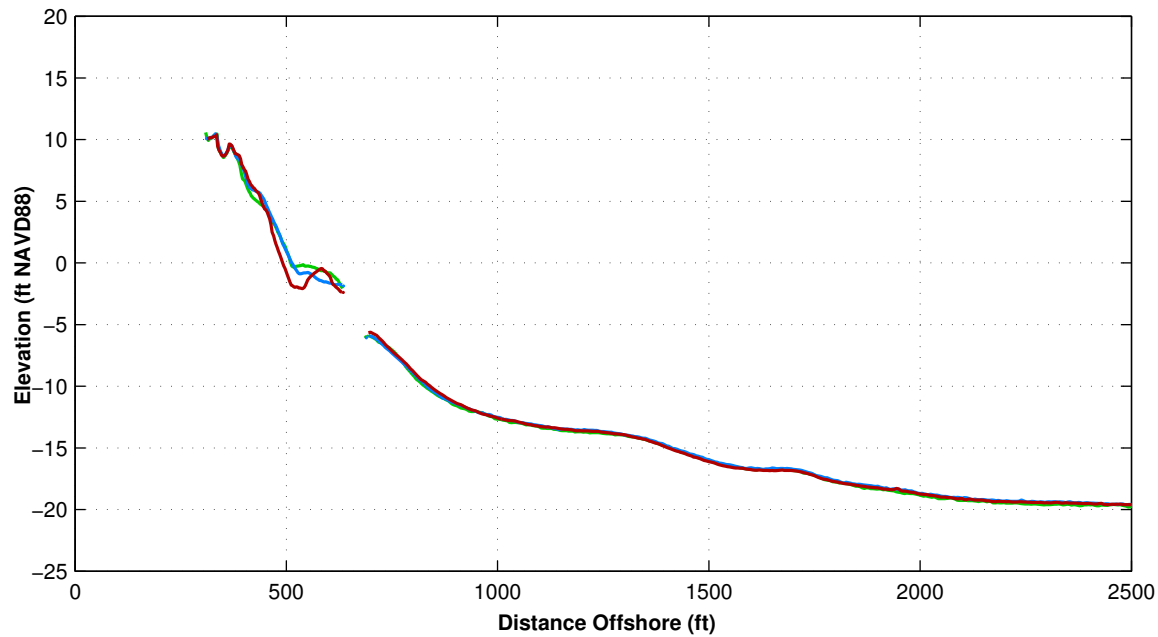
LEGEND:

OCT 2016 — (red line)
MAY 2016 — (blue line)
OCT 2015 — (green line)

Notes:

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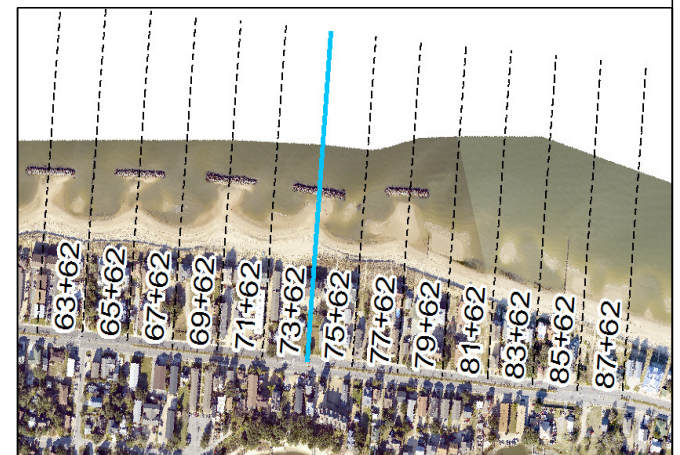
Survey Transect 73+62	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-19.12 ft/yr	-18.48 ft
Volume Change Above -15 ft NAVD88	-1.62 cy/ft/yr	-3.30 cy/ft
Volume Change Above 0 ft NAVD88	-0.34 cy/ft/yr	-2.16 cy/ft

LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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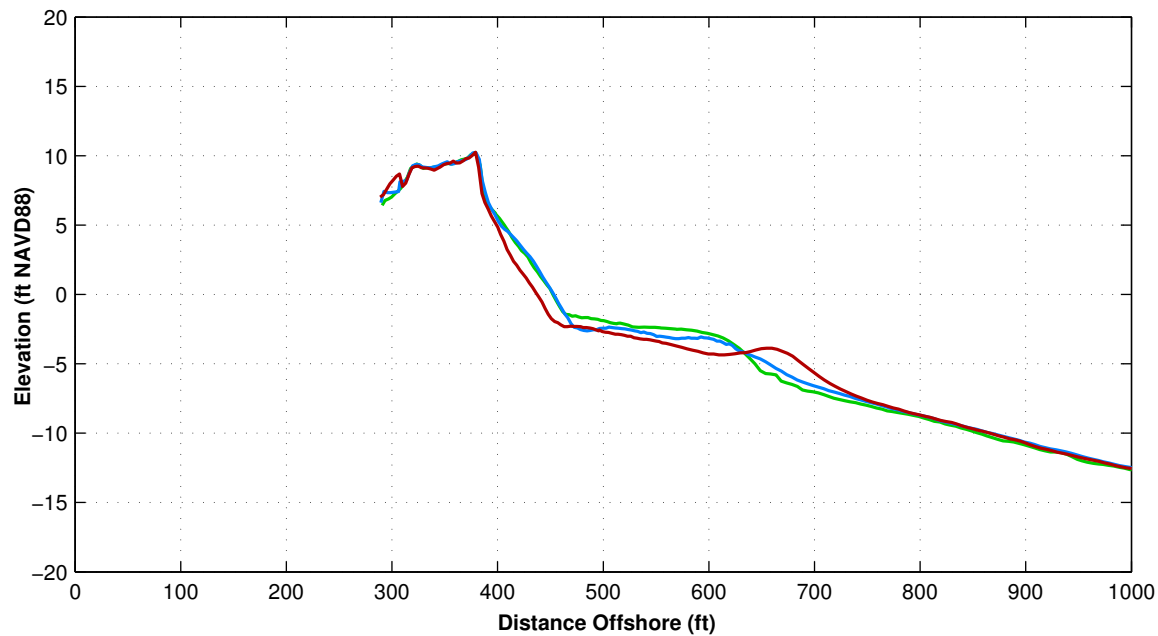
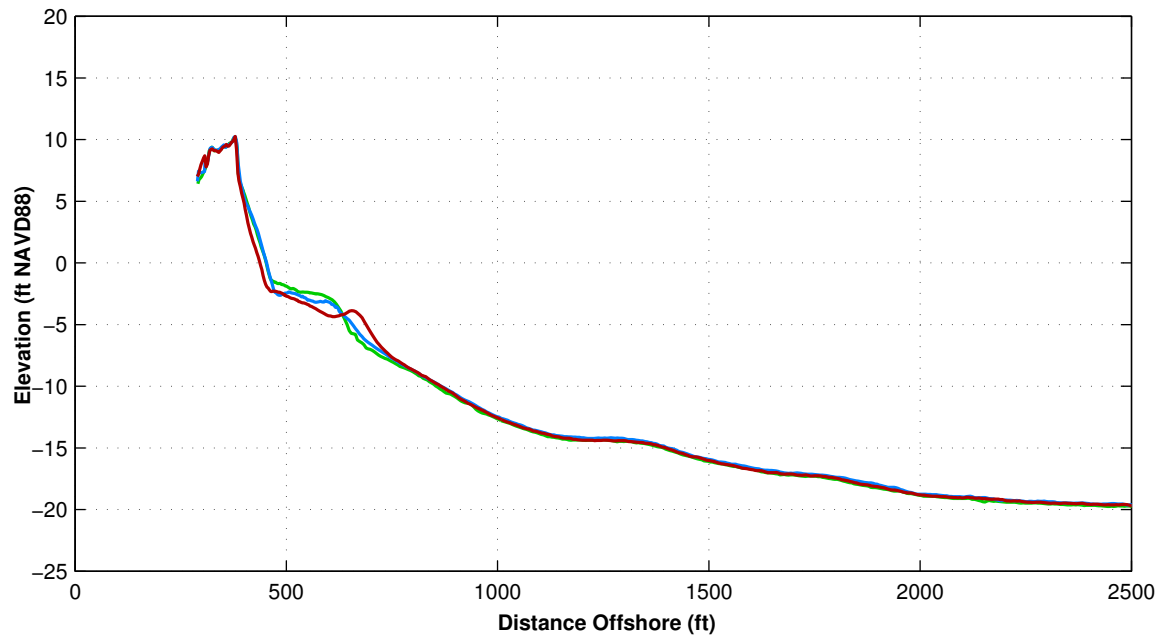
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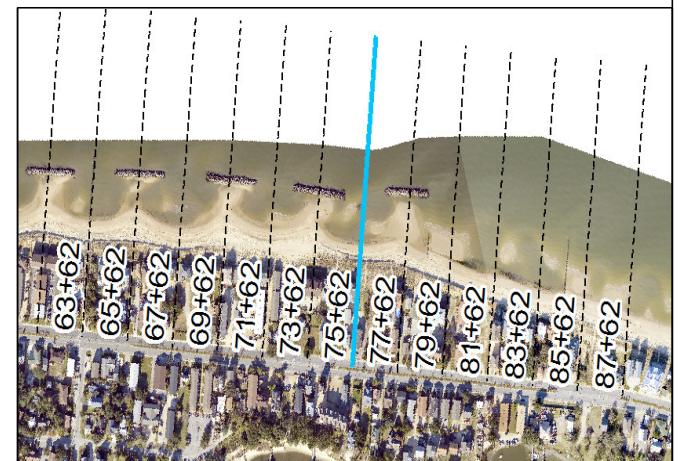
Survey Transect 75+62	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-14.56 ft/yr	-16.26 ft
Volume Change Above -15 ft NAVD88	-1.64 cy/ft/yr	-6.05 cy/ft
Volume Change Above 0 ft NAVD88	-2.37 cy/ft/yr	-3.05 cy/ft

LEGEND:

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OCT 2015 —

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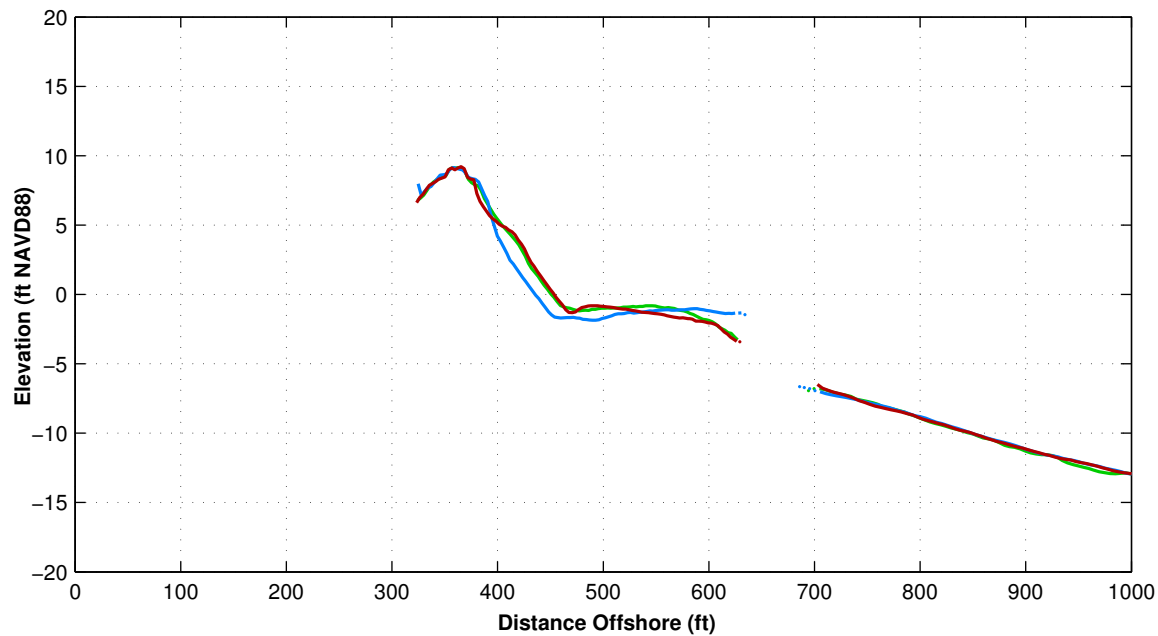
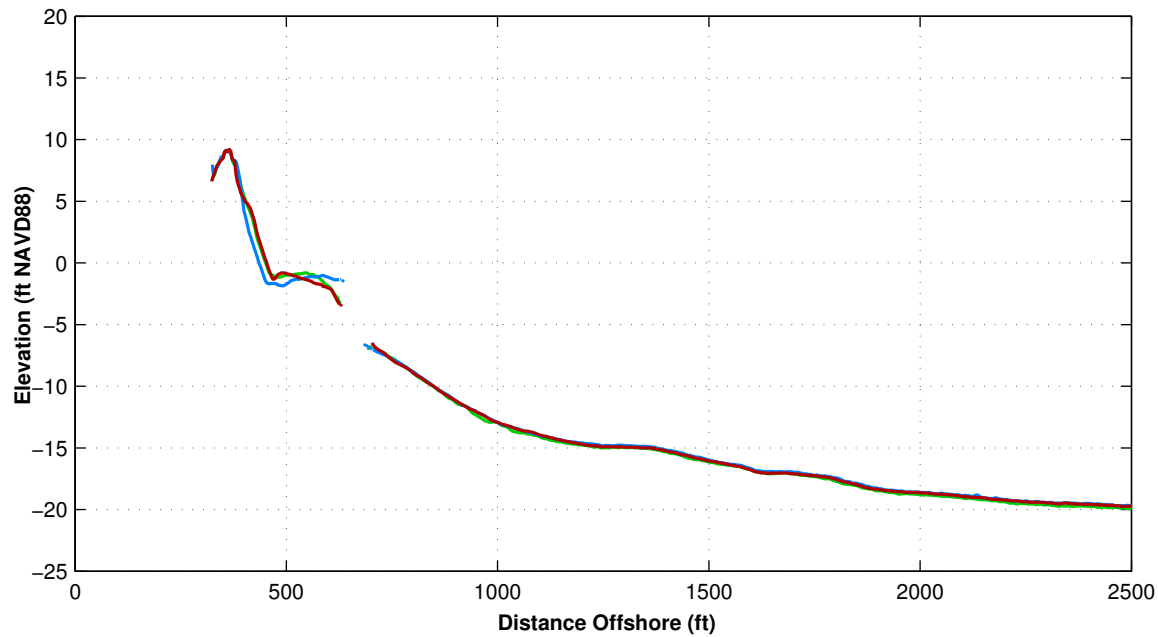
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PUBLIC WORKS

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ANALYSIS

ST 75+62

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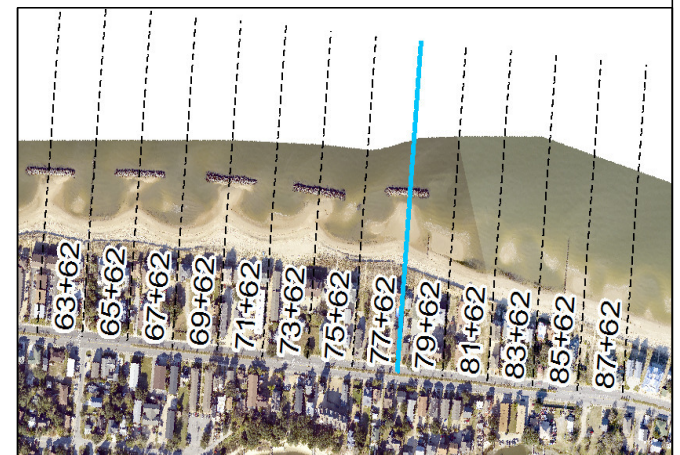
Survey Transect 77+62	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	2.63 ft/yr	17.74 ft
Volume Change Above -15 ft NAVD88	1.13 cy/ft/yr	1.86 cy/ft
Volume Change Above 0 ft NAVD88	0.11 cy/ft/yr	2.66 cy/ft

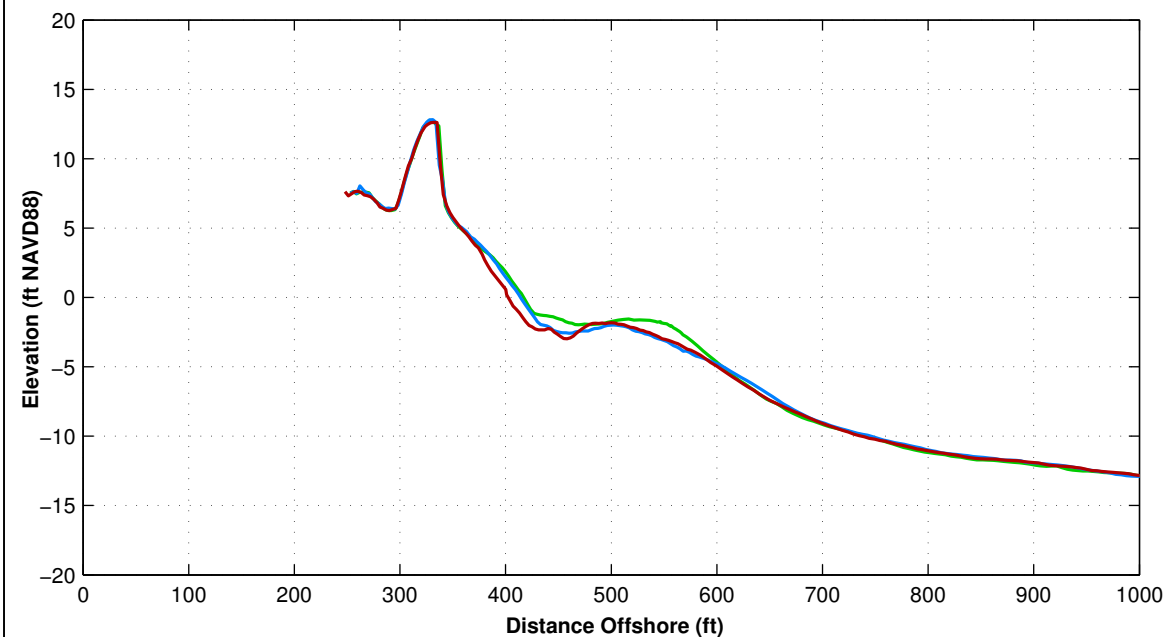
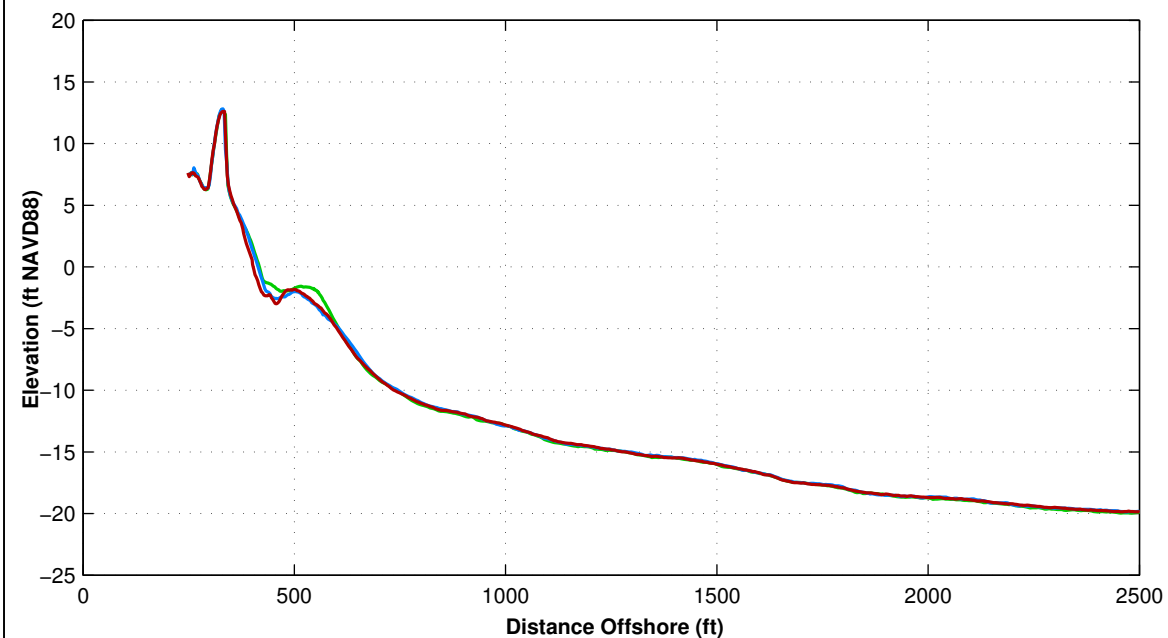
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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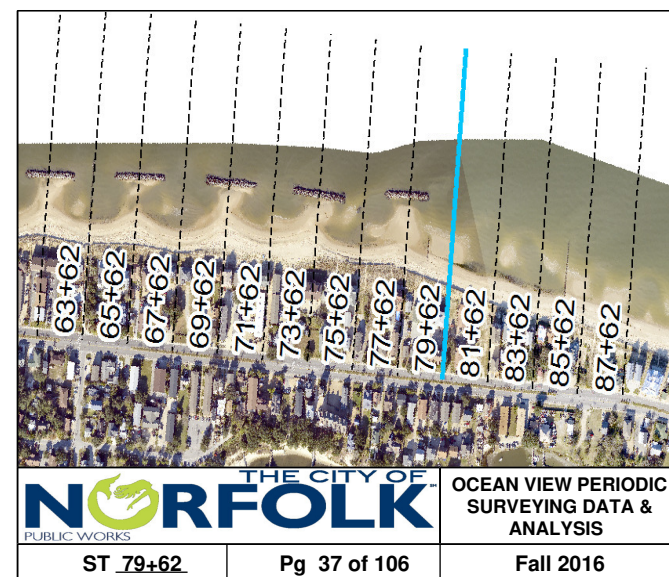
Survey Transect 79+62	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-11.58 ft/yr	-9.07 ft
Volume Change Above -15 ft NAVD88	-4.84 cy/ft/yr	-2.91 cy/ft
Volume Change Above 0 ft NAVD88	-1.60 cy/ft/yr	-1.39 cy/ft

LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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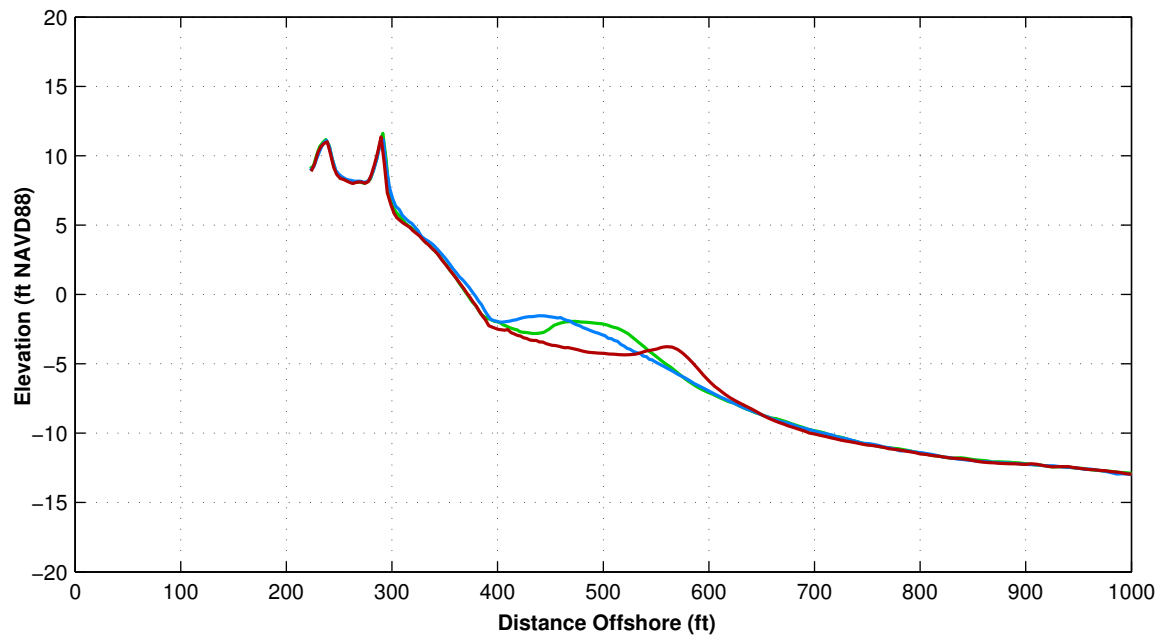
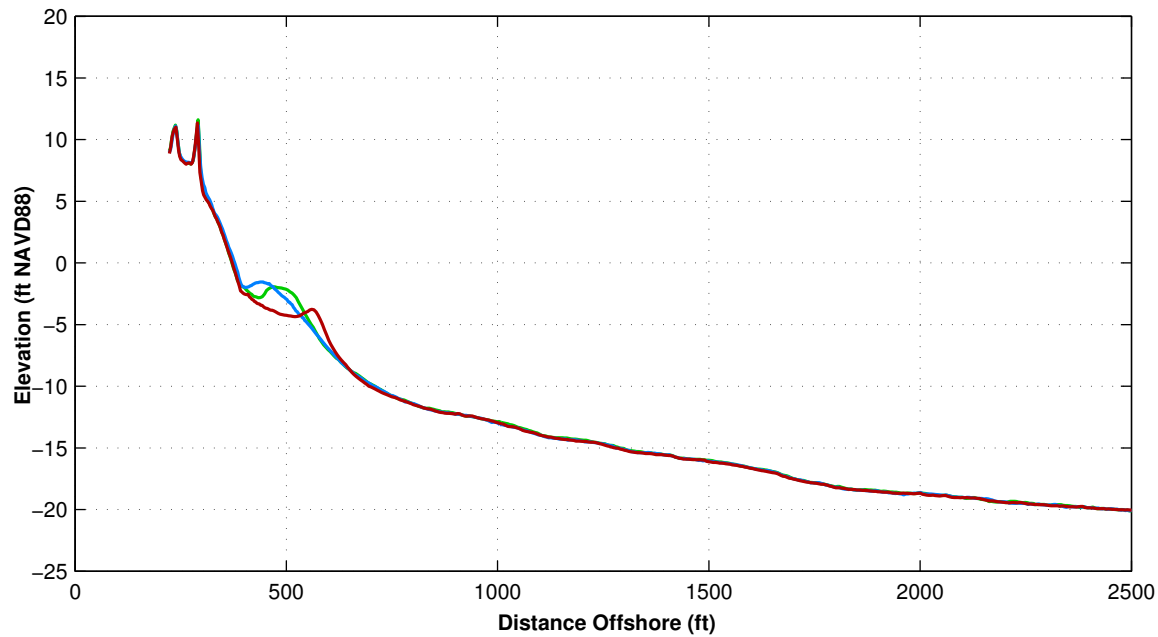
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ST 79+62

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Fall 2016



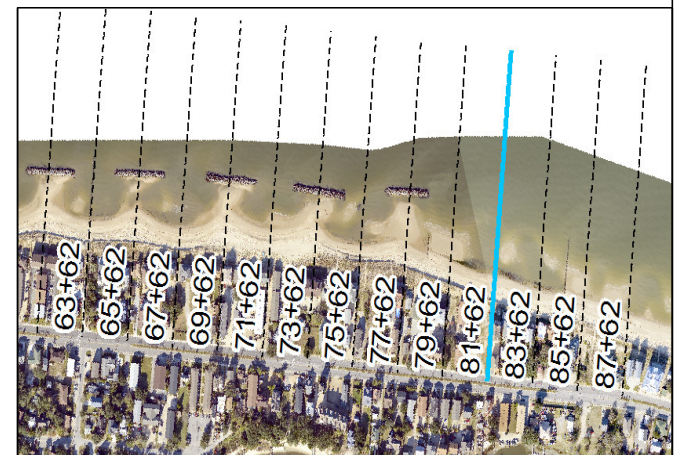
Survey Transect 81+62	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	0.24 ft/yr	-5.23 ft
Volume Change Above -15 ft NAVD88	-6.13 cy/ft/yr	-6.18 cy/ft
Volume Change Above 0 ft NAVD88	-0.62 cy/ft/yr	-1.62 cy/ft

LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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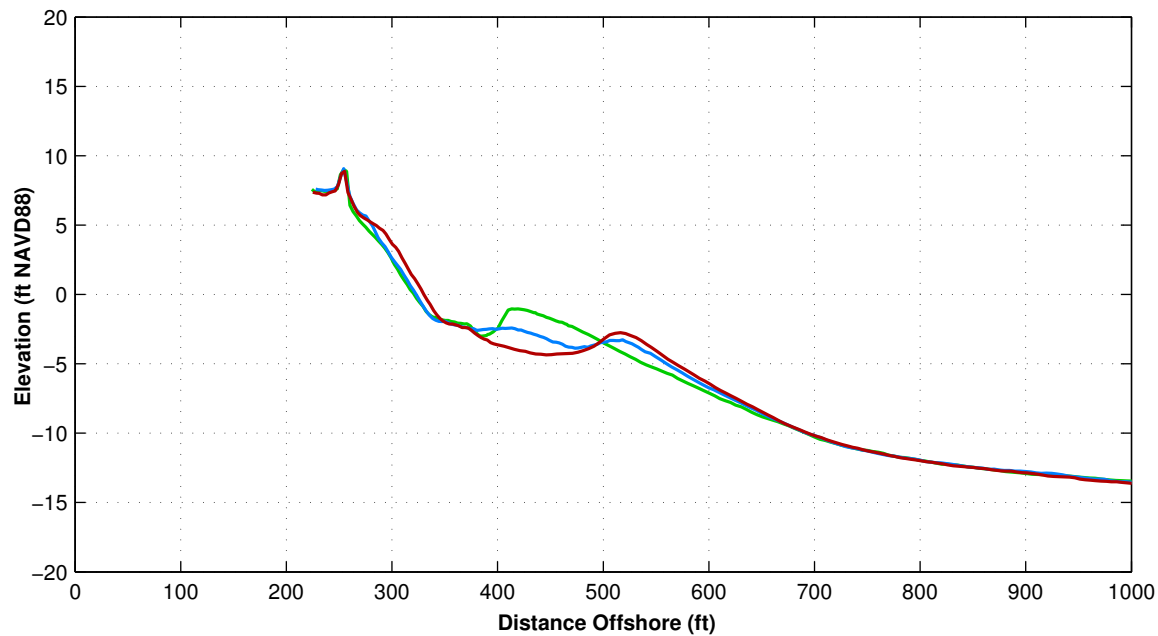
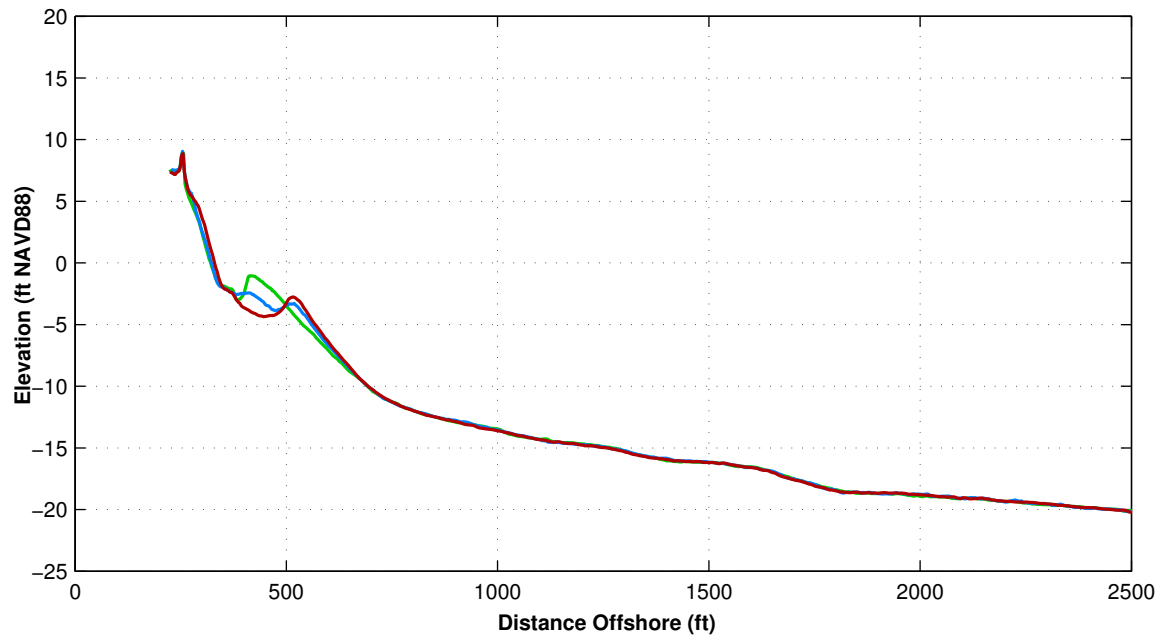
THE CITY OF
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OCEAN VIEW PERIODIC
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ST 81+62

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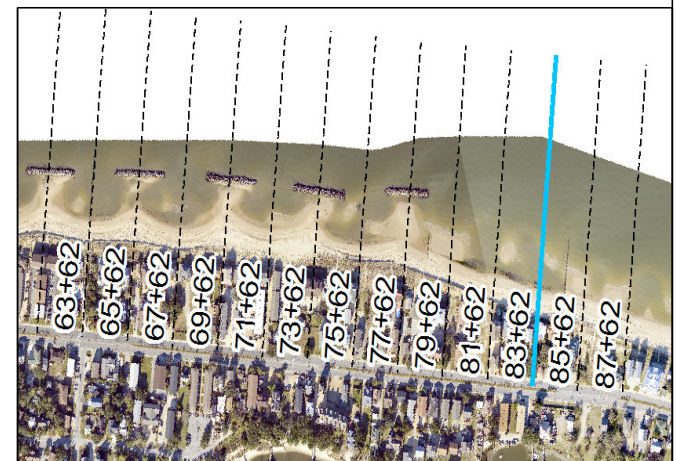
Survey Transect 83+62	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	10.28 ft/yr	7.74 ft
Volume Change Above –15 ft NAVD88	–1.12 cy/ft/yr	–0.63 cy/ft
Volume Change Above 0 ft NAVD88	2.09 cy/ft/yr	1.27 cy/ft

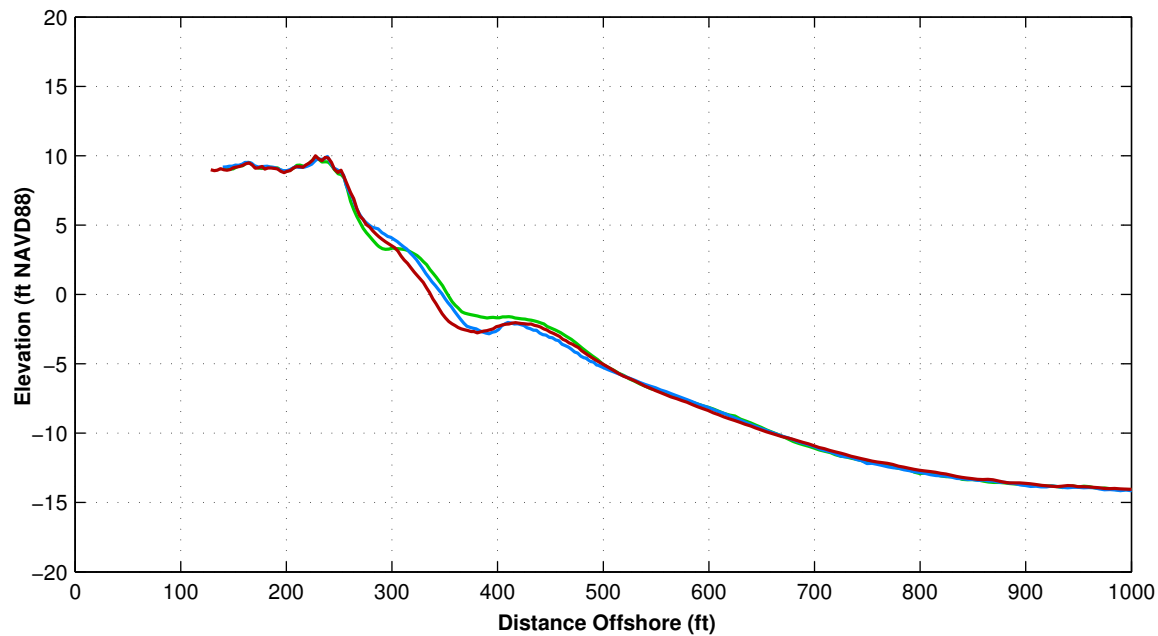
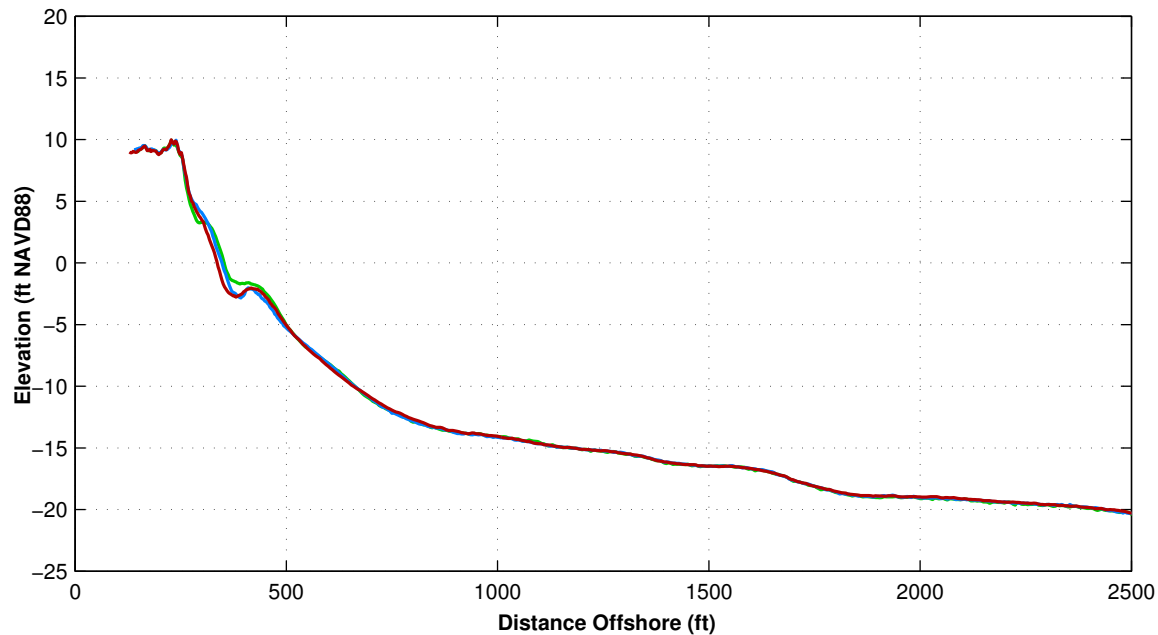
LEGEND:

OCT 2016 —
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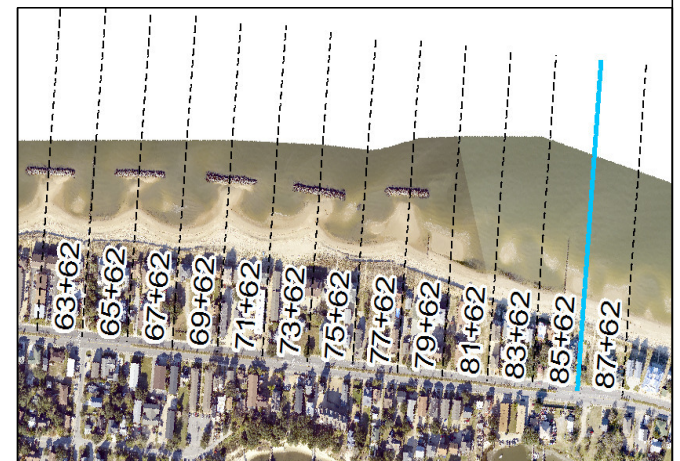
Survey Transect 85+62	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-15.75 ft/yr	-9.06 ft
Volume Change Above -15 ft NAVD88	-4.34 cy/ft/yr	-1.27 cy/ft
Volume Change Above 0 ft NAVD88	-0.89 cy/ft/yr	-1.93 cy/ft

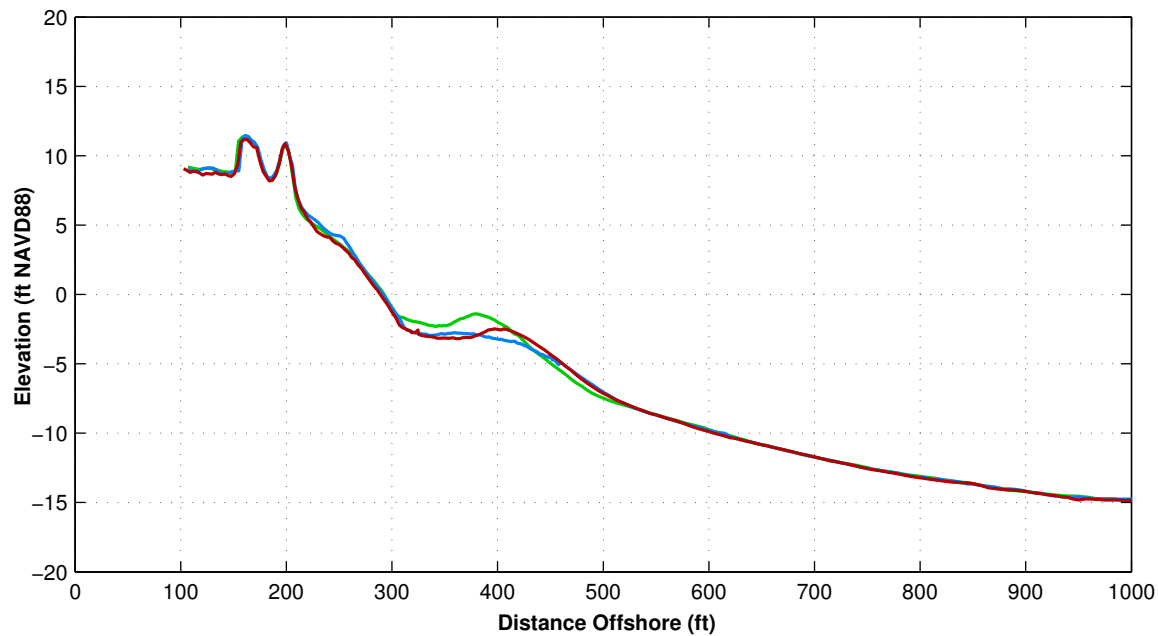
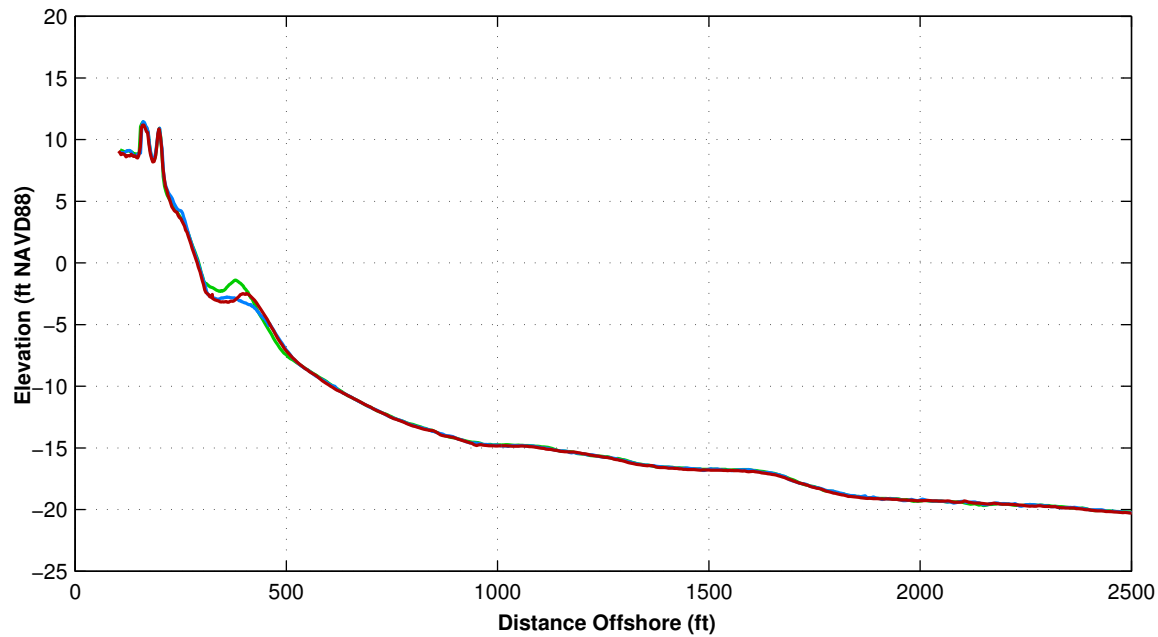
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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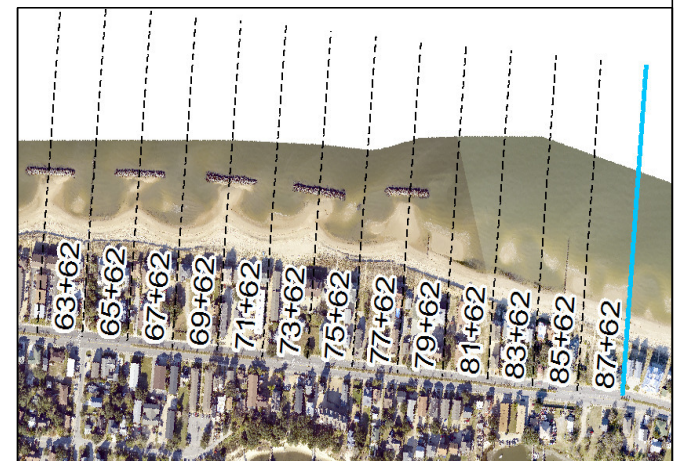
Survey Transect 87+62	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-3.47 ft/yr	-2.50 ft
Volume Change Above -15 ft NAVD88	-4.42 cy/ft/yr	-1.89 cy/ft
Volume Change Above 0 ft NAVD88	-1.16 cy/ft/yr	-1.77 cy/ft

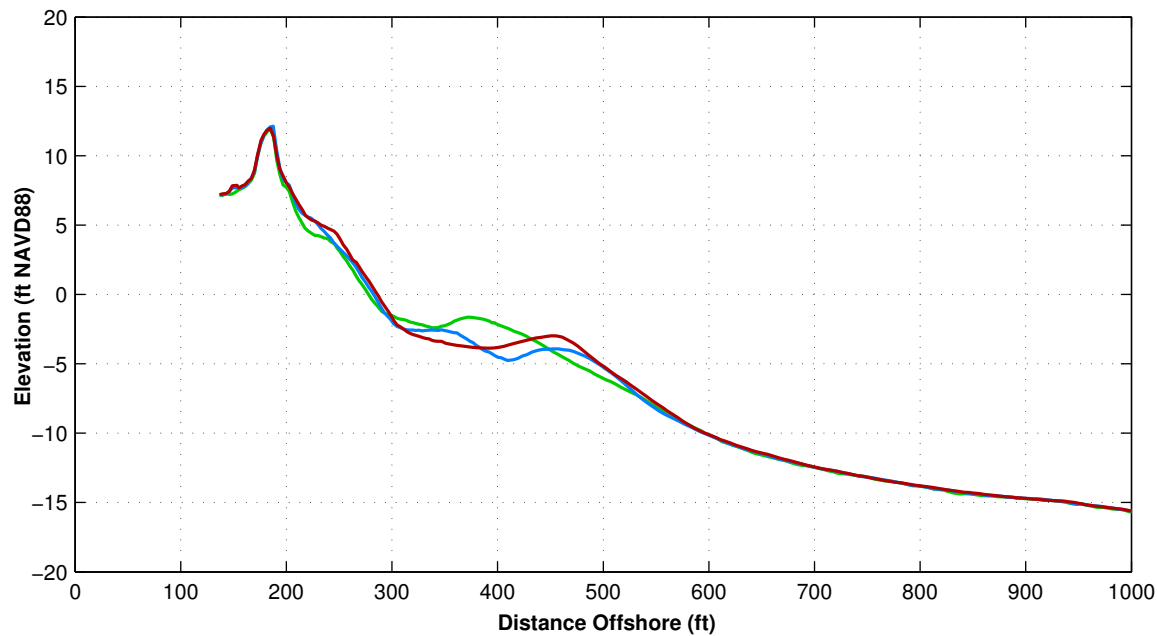
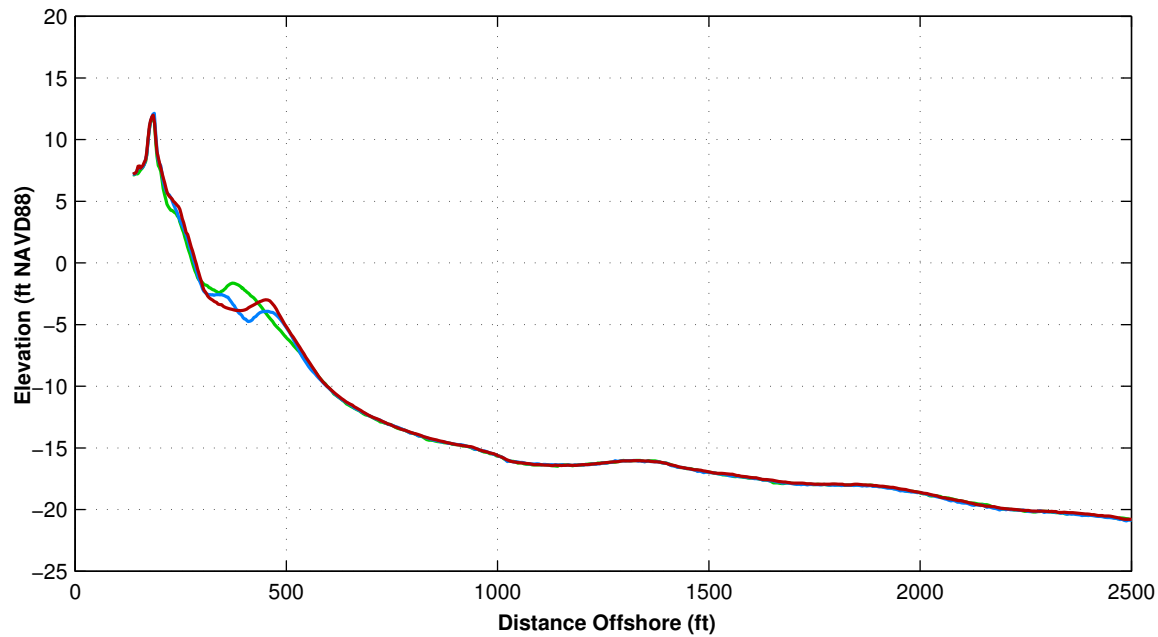
LEGEND:

OCT 2016 —
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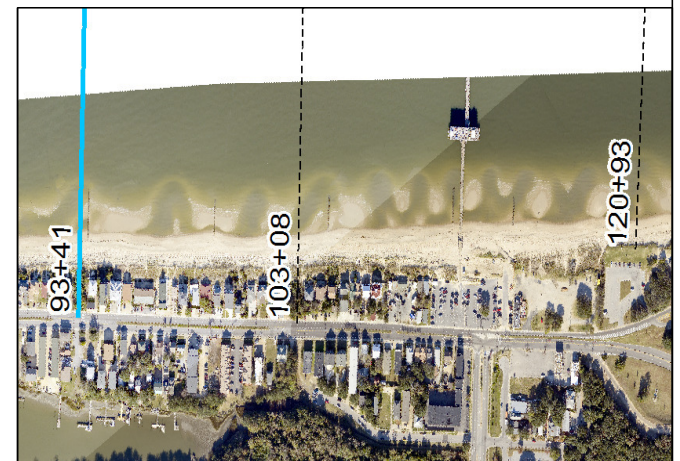
Survey Transect 93+41	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	8.63 ft/yr	3.87 ft
Volume Change Above –15 ft NAVD88	1.91 cy/ft/yr	4.01 cy/ft
Volume Change Above 0 ft NAVD88	3.04 cy/ft/yr	1.07 cy/ft

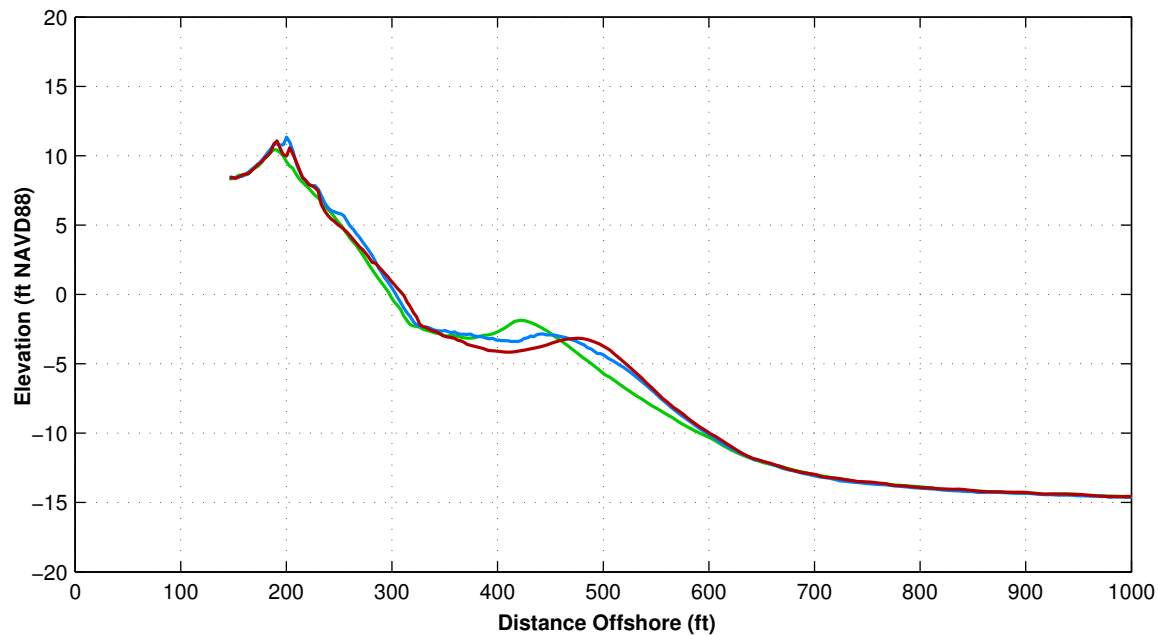
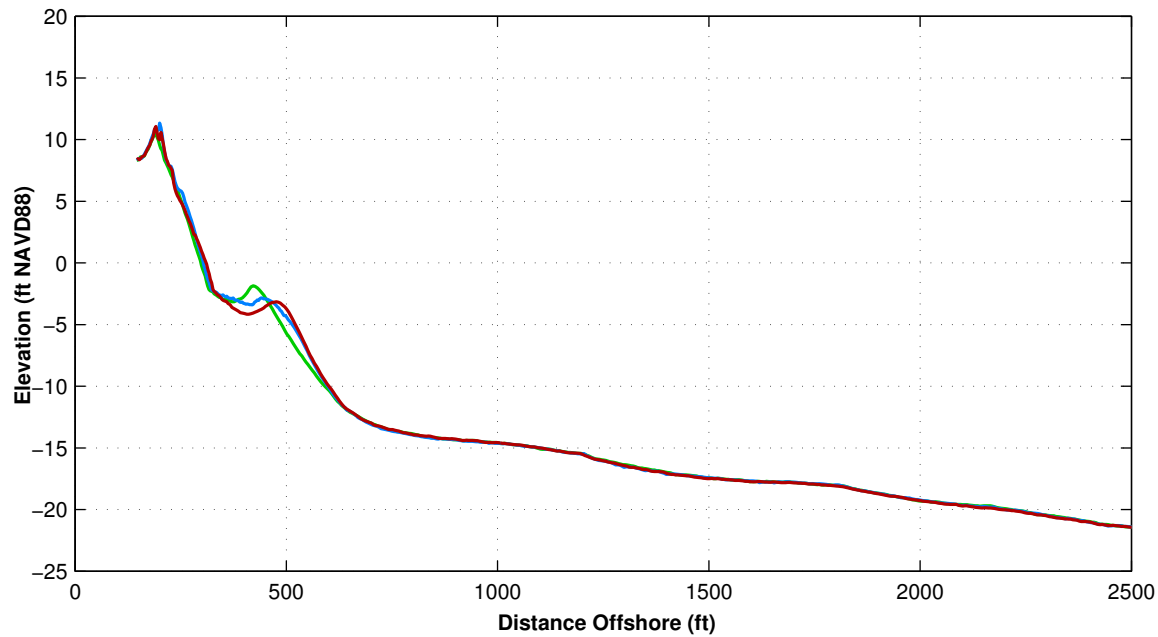
LEGEND:

OCT 2016 — (red line)
MAY 2016 — (blue line)
OCT 2015 — (green line)

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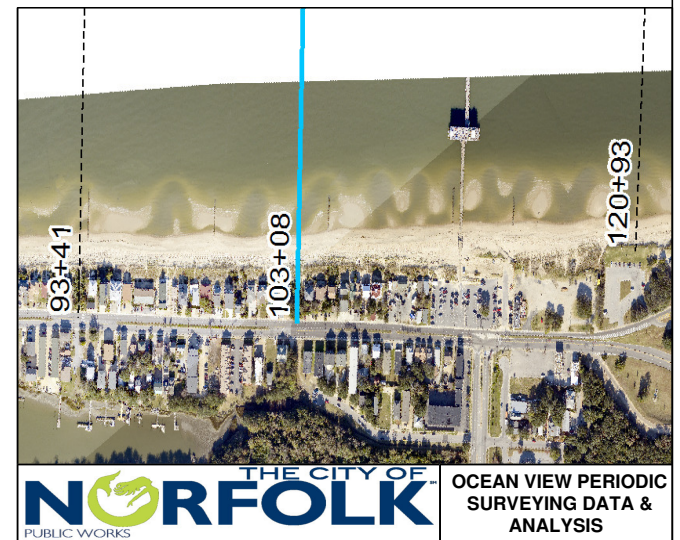
Survey Transect 103+08	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	9.86 ft/yr	3.61 ft
Volume Change Above –15 ft NAVD88	4.94 cy/ft/yr	–1.38 cy/ft
Volume Change Above 0 ft NAVD88	1.74 cy/ft/yr	–1.40 cy/ft

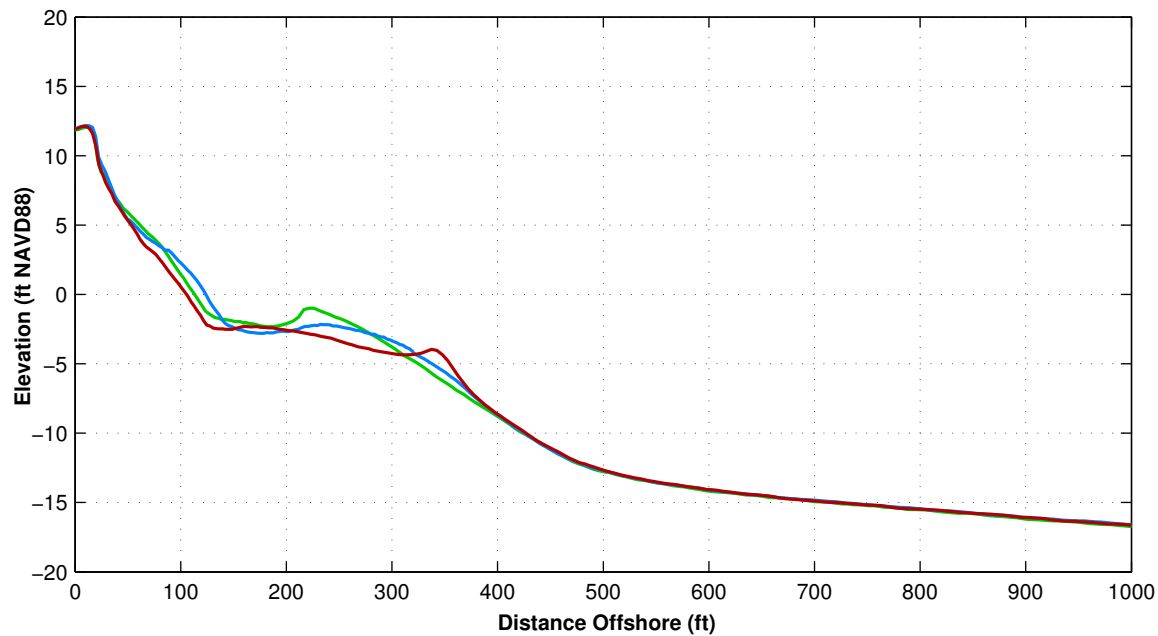
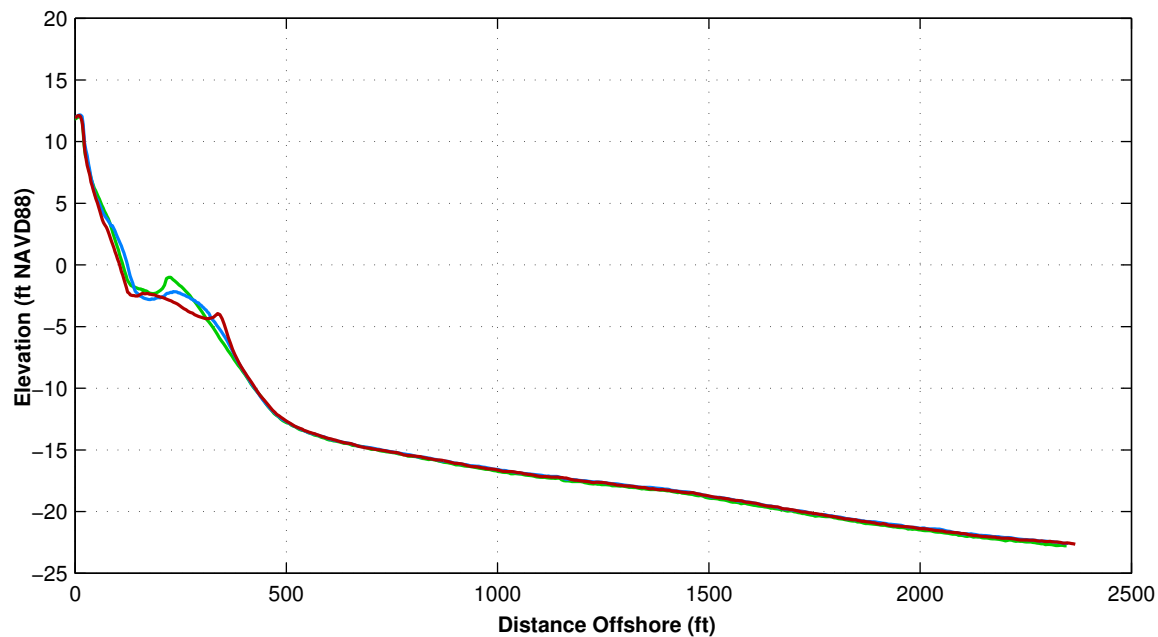
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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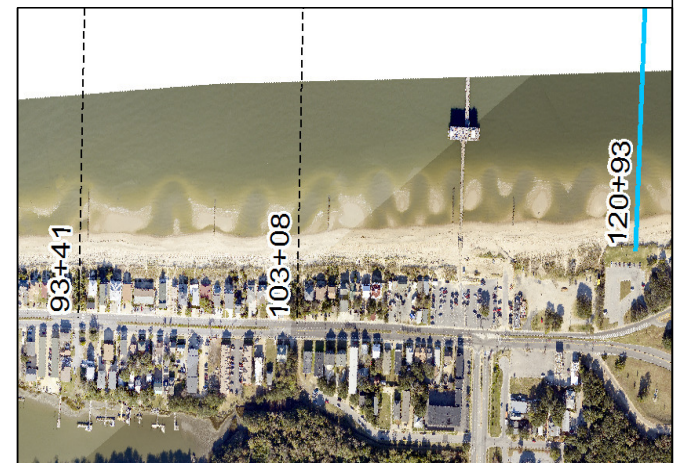
Survey Transect 120+93	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-8.27 ft/yr	-19.59 ft
Volume Change Above -15 ft NAVD88	-5.11 cy/ft/yr	-6.61 cy/ft
Volume Change Above 0 ft NAVD88	-2.36 cy/ft/yr	-3.59 cy/ft

LEGEND:

OCT 2016 —
 MAY 2016 —
 OCT 2015 —

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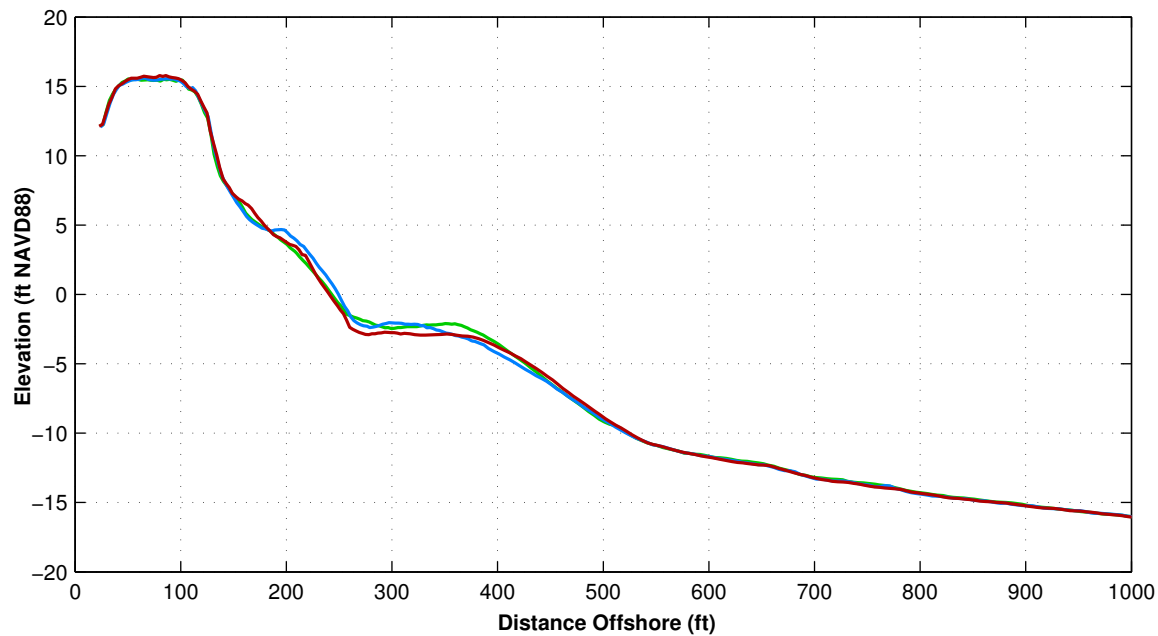
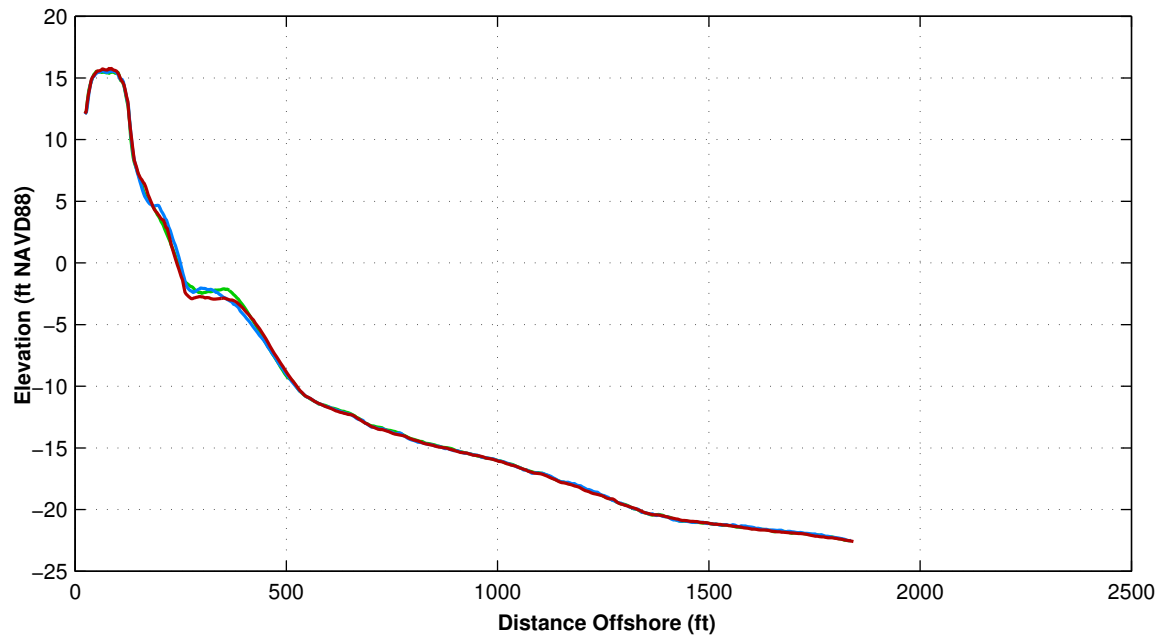
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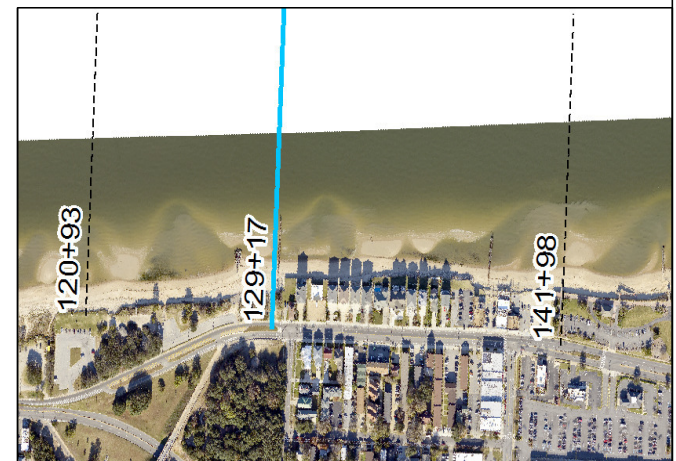
Survey Transect 129+17	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-1.53 ft/yr	-9.54 ft
Volume Change Above -15 ft NAVD88	-1.82 cy/ft/yr	-1.01 cy/ft
Volume Change Above 0 ft NAVD88	1.37 cy/ft/yr	-0.37 cy/ft

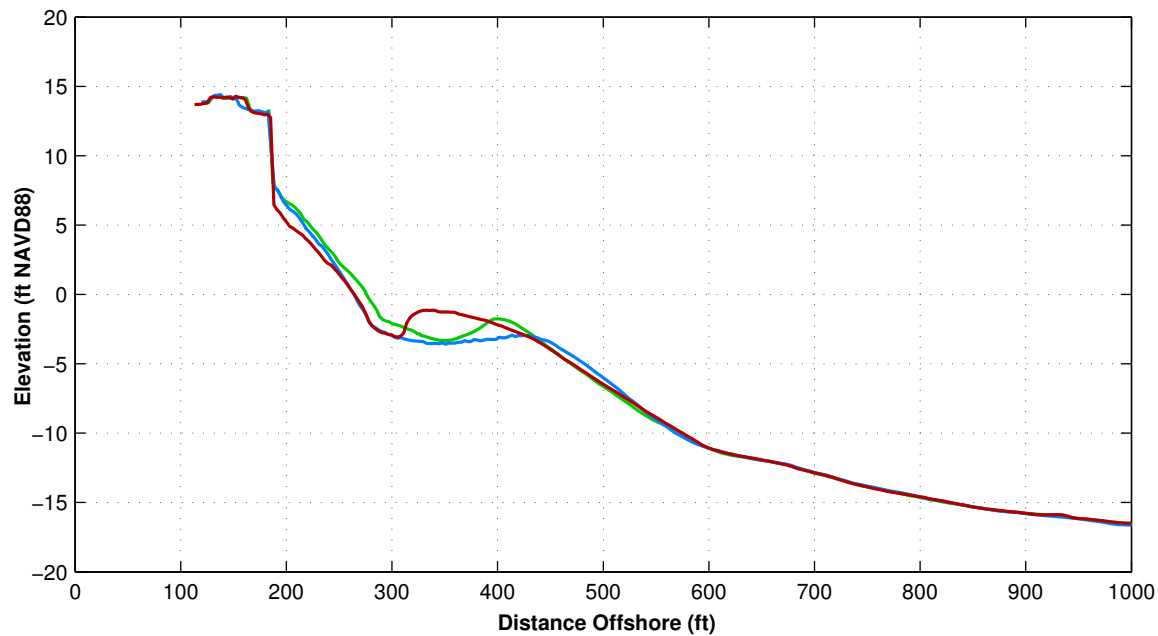
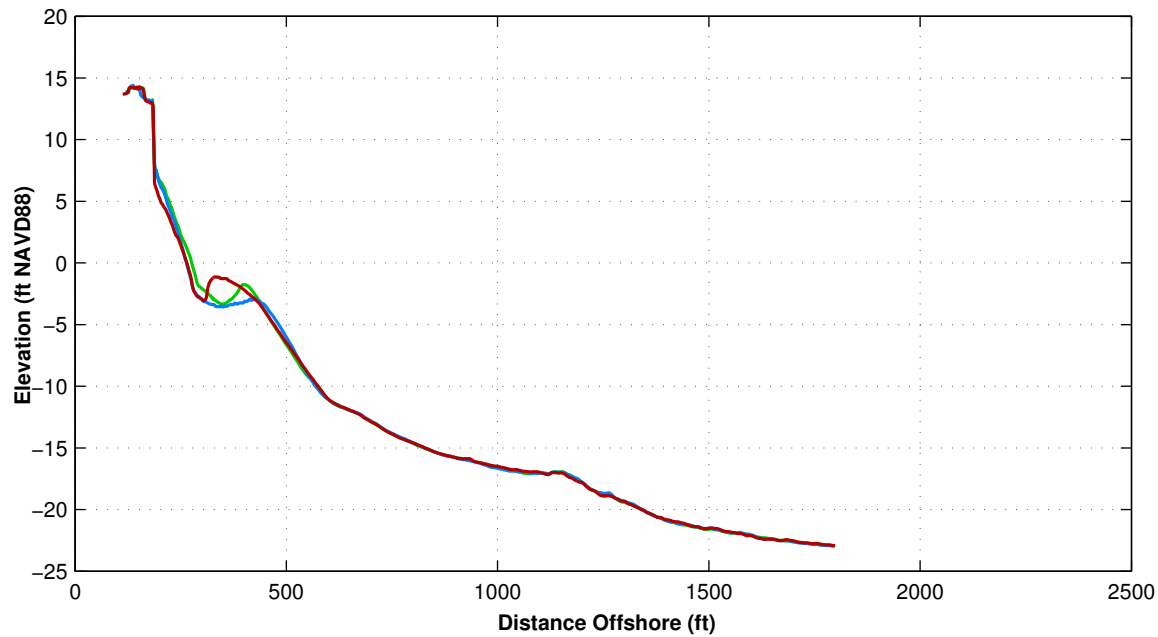
LEGEND:

OCT 2016 — (red line)
MAY 2016 — (blue line)
OCT 2015 — (green line)

Notes:

1. Station From West To East At Varying Intervals.
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4. Survey Comparison Made to OCT 2015 and MAY 2016
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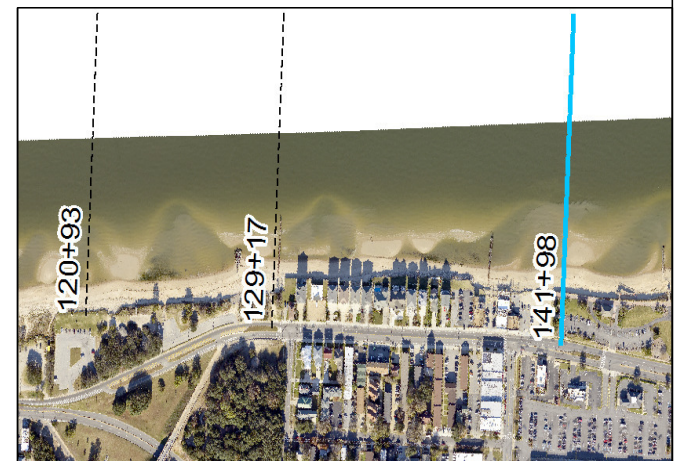
Survey Transect 141+98	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-11.57 ft/yr	-1.07 ft
Volume Change Above -15 ft NAVD88	-1.04 cy/ft/yr	3.40 cy/ft
Volume Change Above 0 ft NAVD88	-3.65 cy/ft/yr	-1.90 cy/ft

LEGEND:

OCT 2016 — (red line)
MAY 2016 — (blue line)
OCT 2015 — (green line)

Notes:

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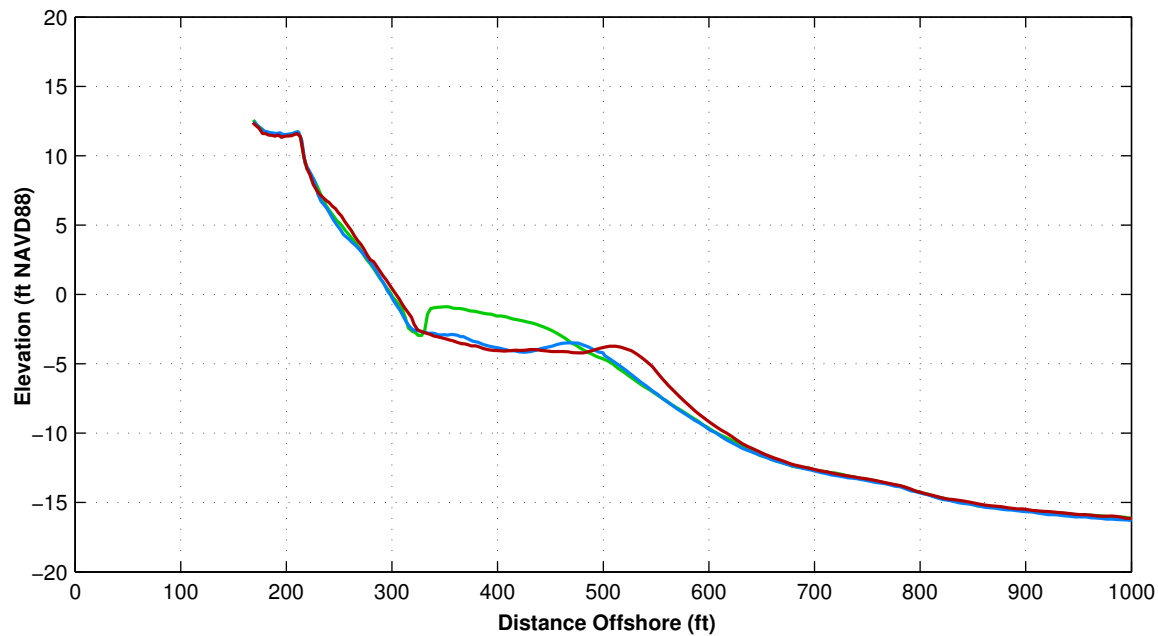
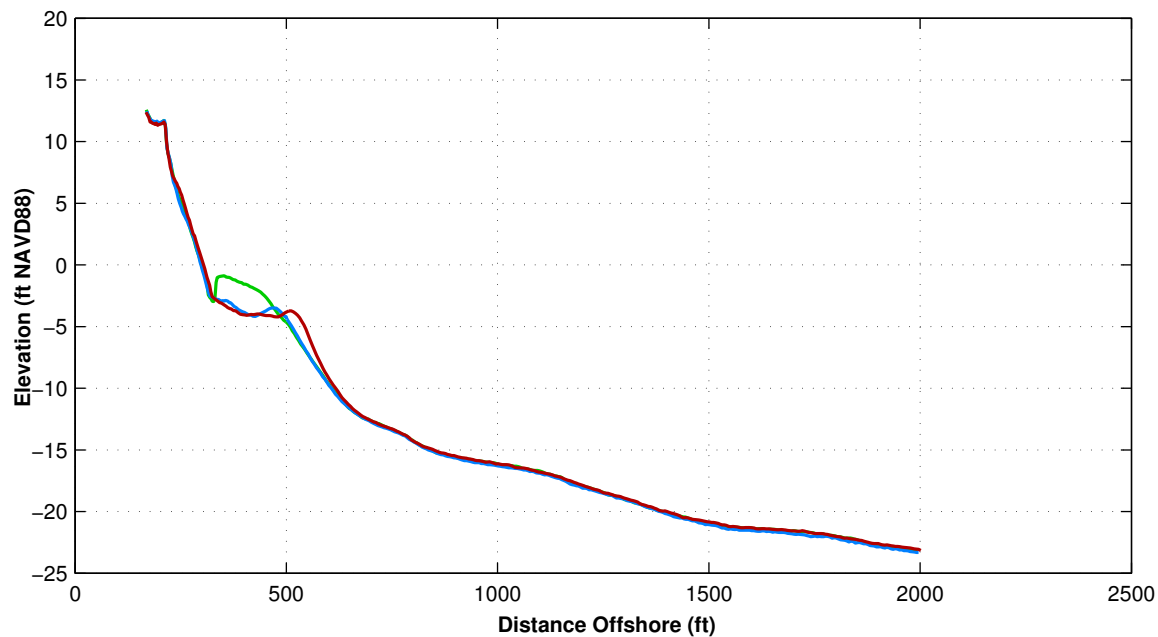
THE CITY OF NORFOLK
PUBLIC WORKS

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Survey Transect 152+01	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	4.69 ft/yr	4.67 ft
Volume Change Above –15 ft NAVD88	–3.32 cy/ft/yr	6.36 cy/ft
Volume Change Above 0 ft NAVD88	0.89 cy/ft/yr	1.25 cy/ft

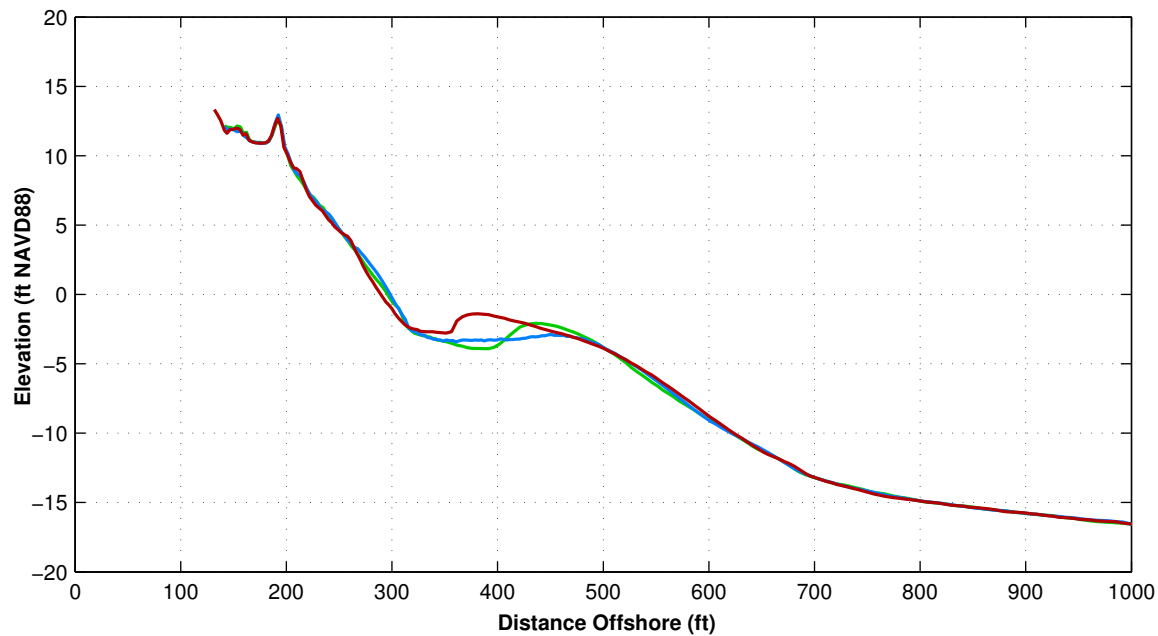
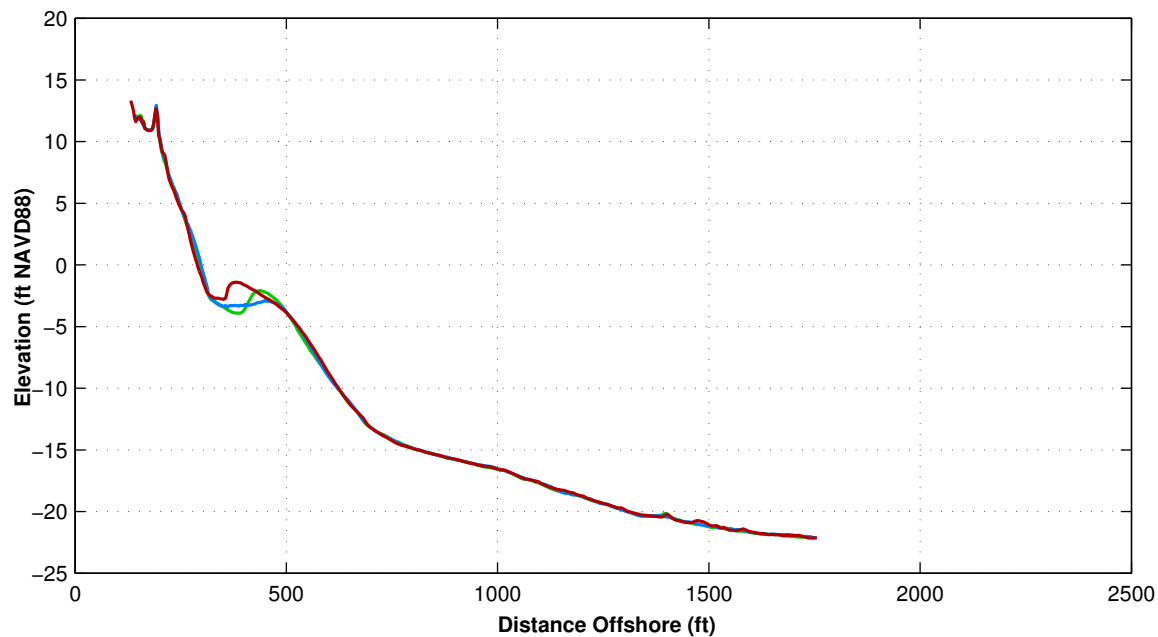
LEGEND:

OCT 2016 ———
MAY 2016 ———
OCT 2015 ———

Notes:

1. Station From West To East At Varying Intervals.
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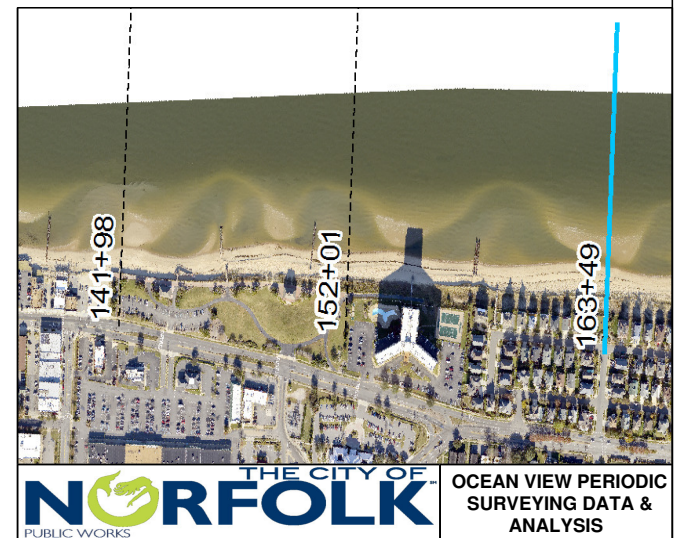
Survey Transect 163+49	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-5.11 ft/yr	-9.68 ft
Volume Change Above -15 ft NAVD88	4.47 cy/ft/yr	4.07 cy/ft
Volume Change Above 0 ft NAVD88	-0.62 cy/ft/yr	-1.25 cy/ft

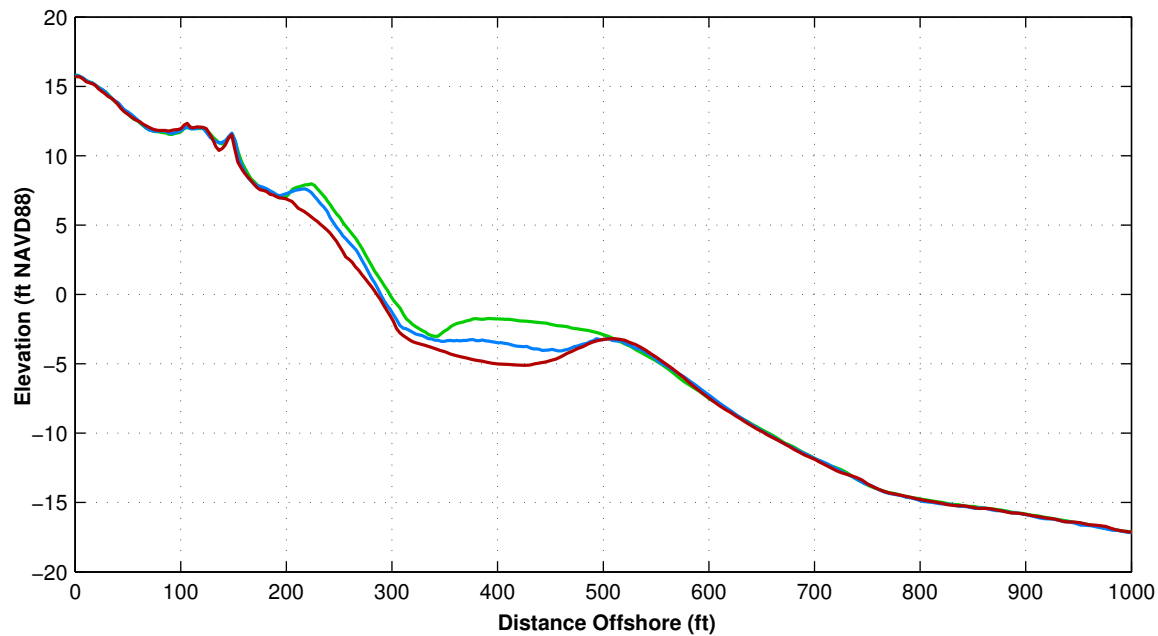
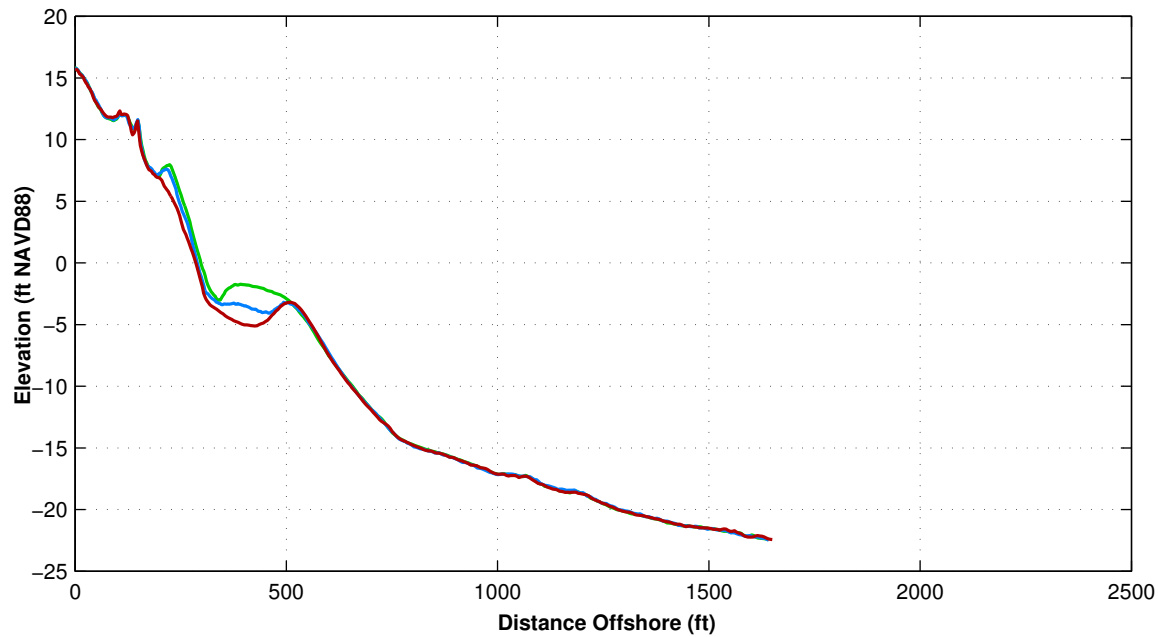
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
3. All Survey Elevations In Feet Referenced to NAVD88.
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Survey Transect 169+63	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-13.17 ft/yr	-6.21 ft
Volume Change Above -15 ft NAVD88	-22.07 cy/ft/yr	-11.03 cy/ft
Volume Change Above 0 ft NAVD88	-6.51 cy/ft/yr	-4.37 cy/ft

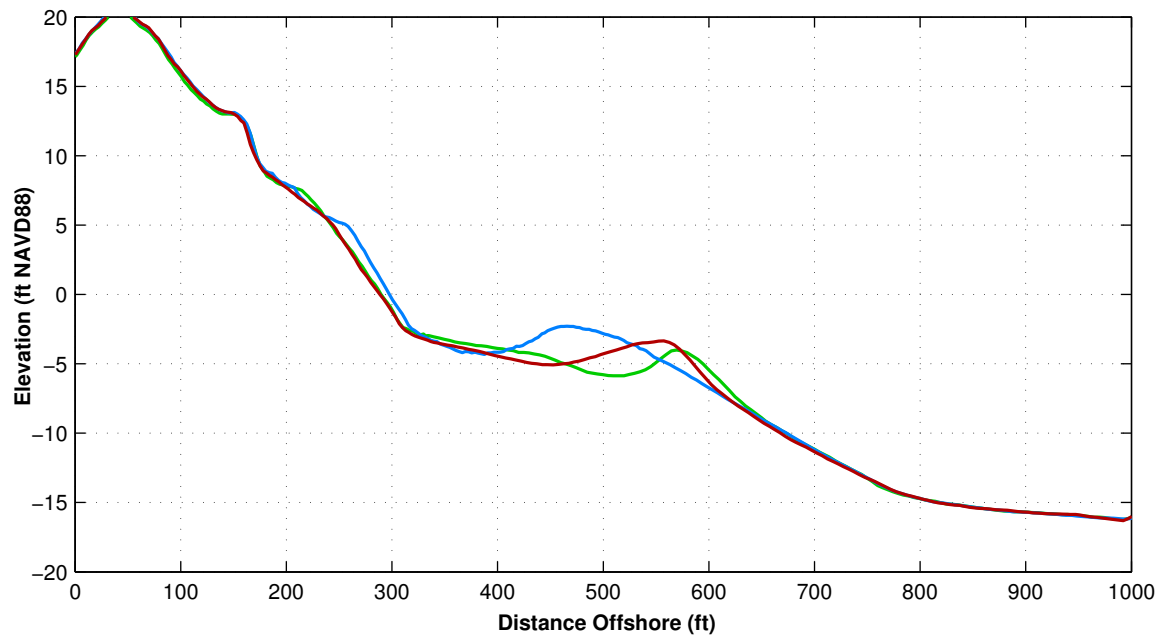
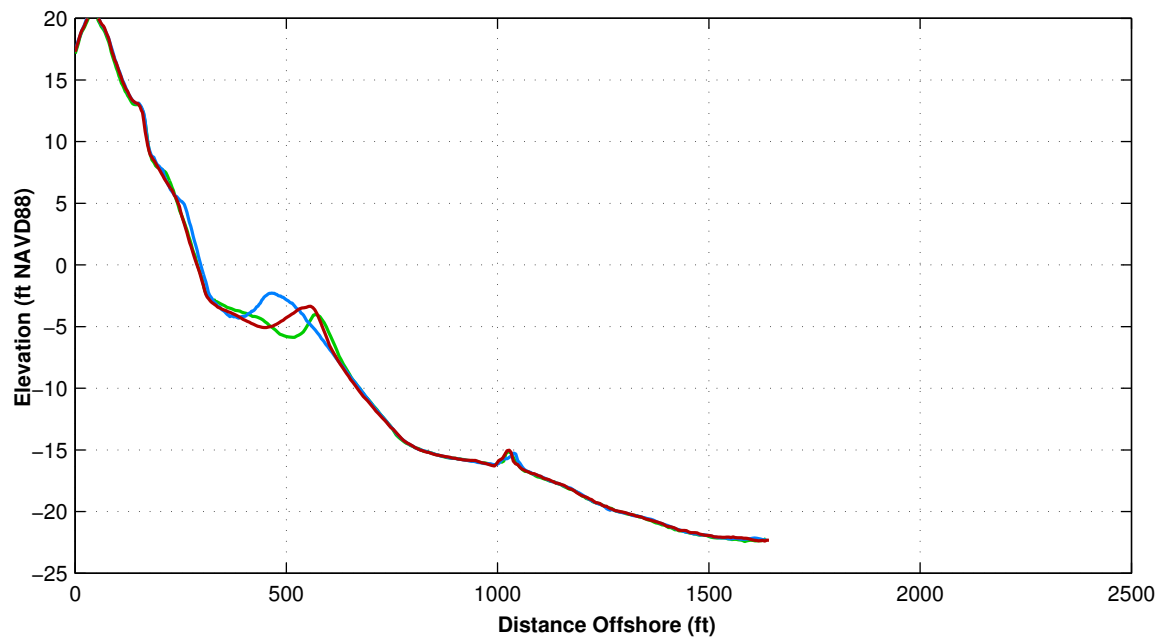
LEGEND:

OCT 2016 — (red line)
MAY 2016 — (blue line)
OCT 2015 — (green line)

Notes:

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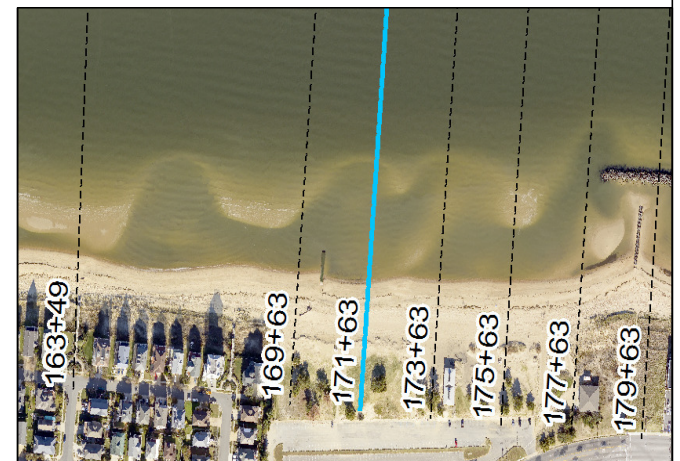
Survey Transect 171+63	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-1.83 ft/yr	-11.15 ft
Volume Change Above -15 ft NAVD88	0.86 cy/ft/yr	-9.50 cy/ft
Volume Change Above 0 ft NAVD88	0.25 cy/ft/yr	-3.33 cy/ft

LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

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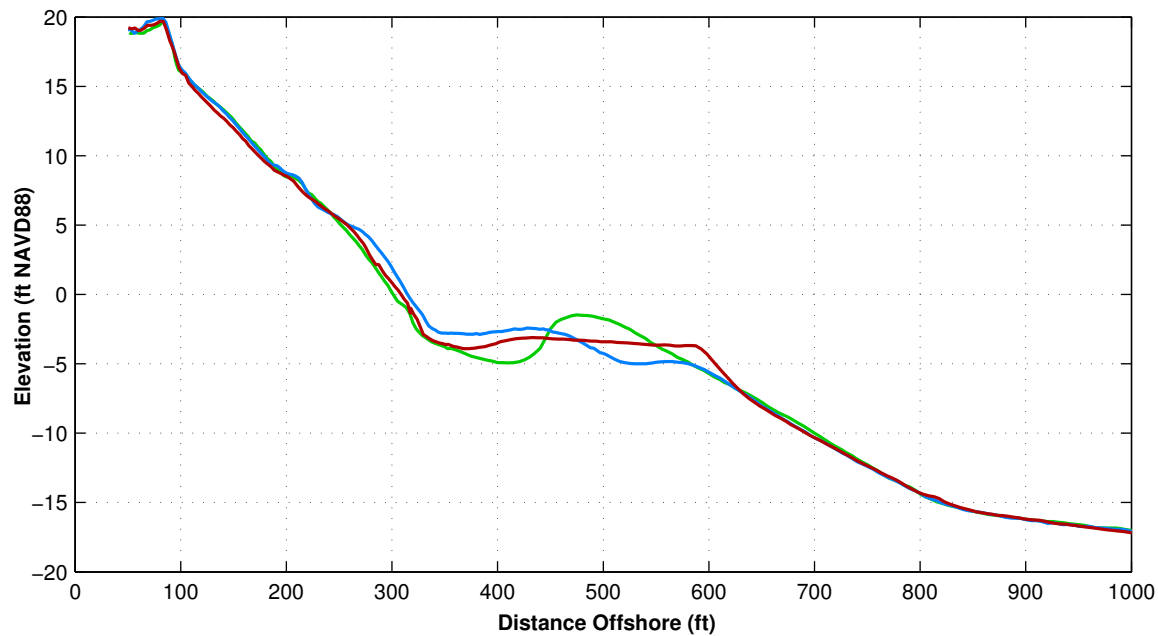
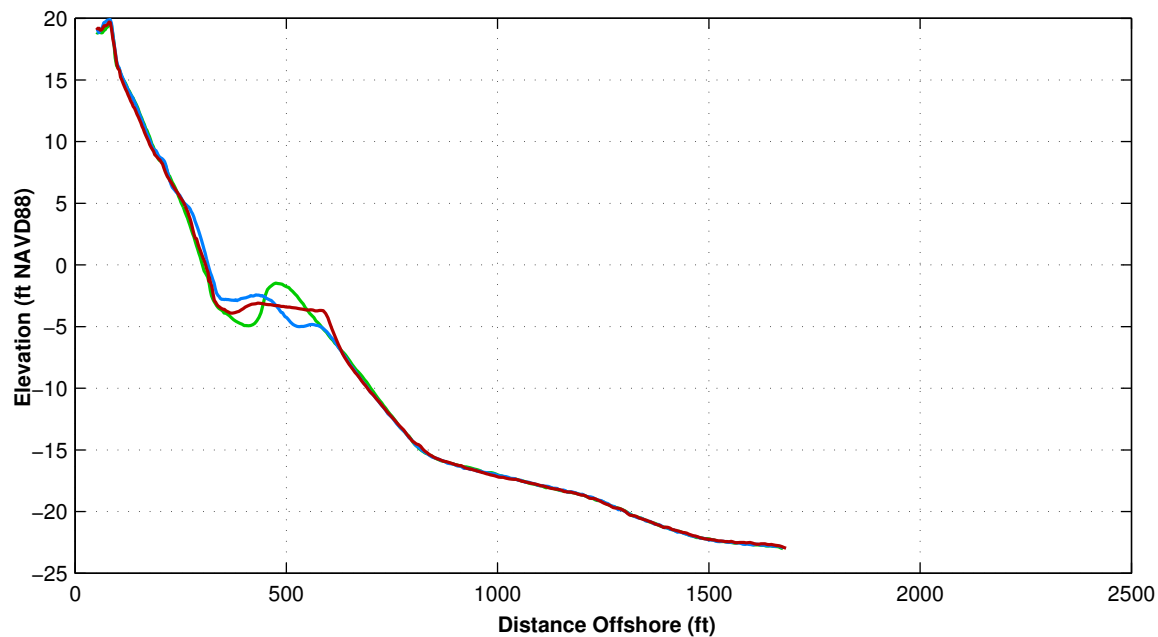


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Survey Transect 173+63	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	5.64 ft/yr	-9.00 ft
Volume Change Above -15 ft NAVD88	0.01 cy/ft/yr	-2.52 cy/ft
Volume Change Above 0 ft NAVD88	-0.62 cy/ft/yr	-3.81 cy/ft

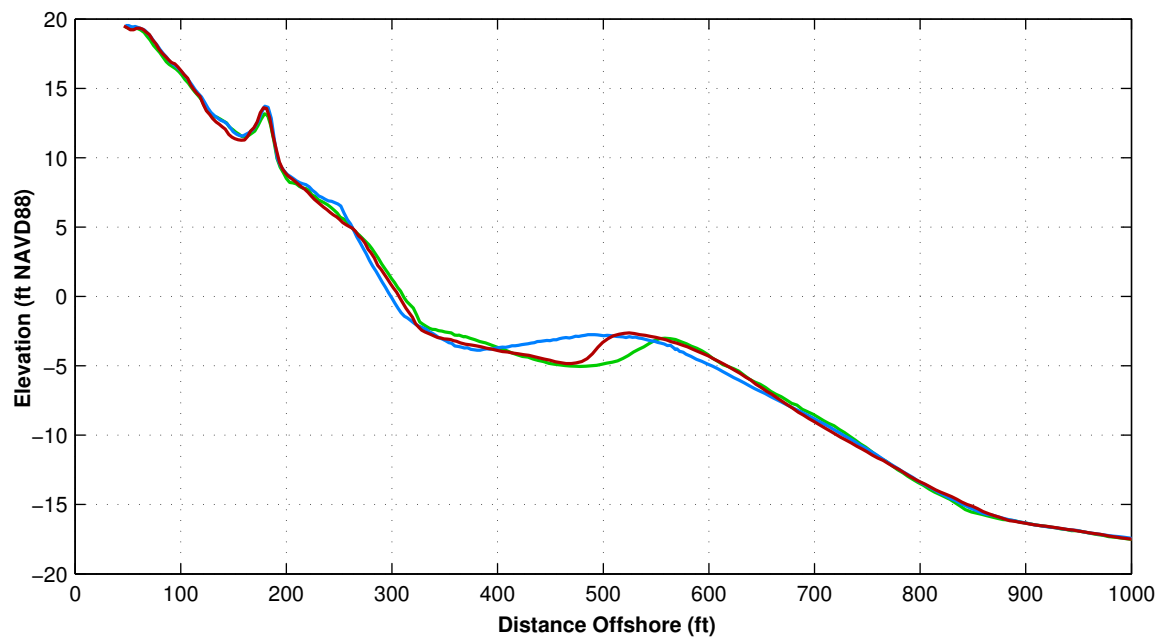
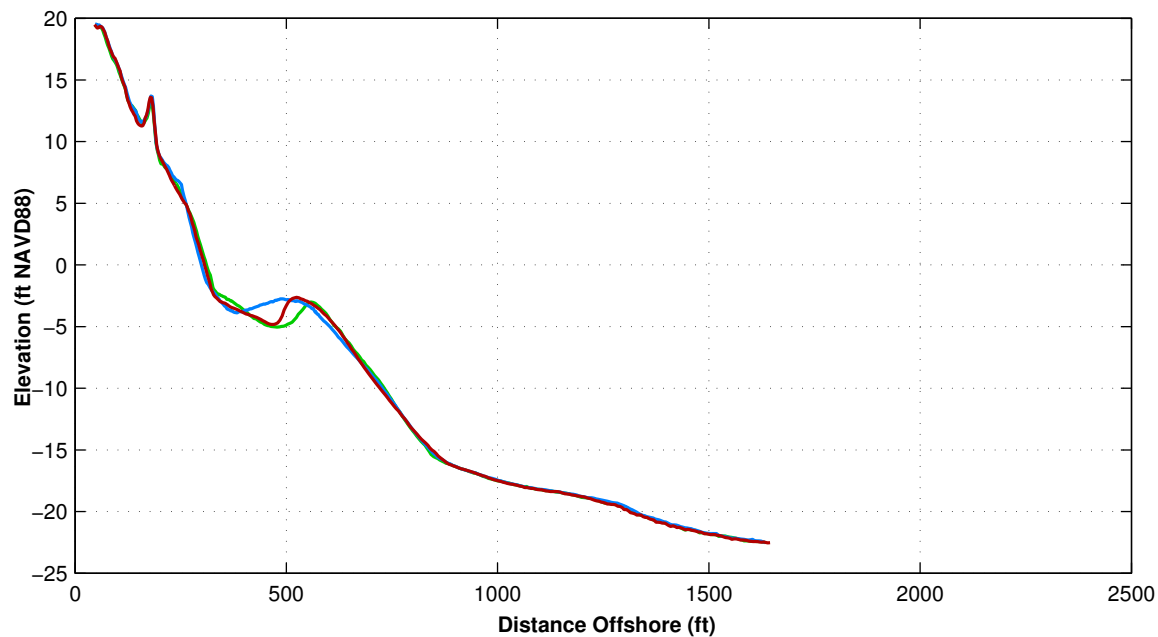
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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Survey Transect 175+63	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-4.41 ft/yr	6.83 ft
Volume Change Above -15 ft NAVD88	-0.15 cy/ft/yr	-2.94 cy/ft
Volume Change Above 0 ft NAVD88	-0.59 cy/ft/yr	-1.03 cy/ft

LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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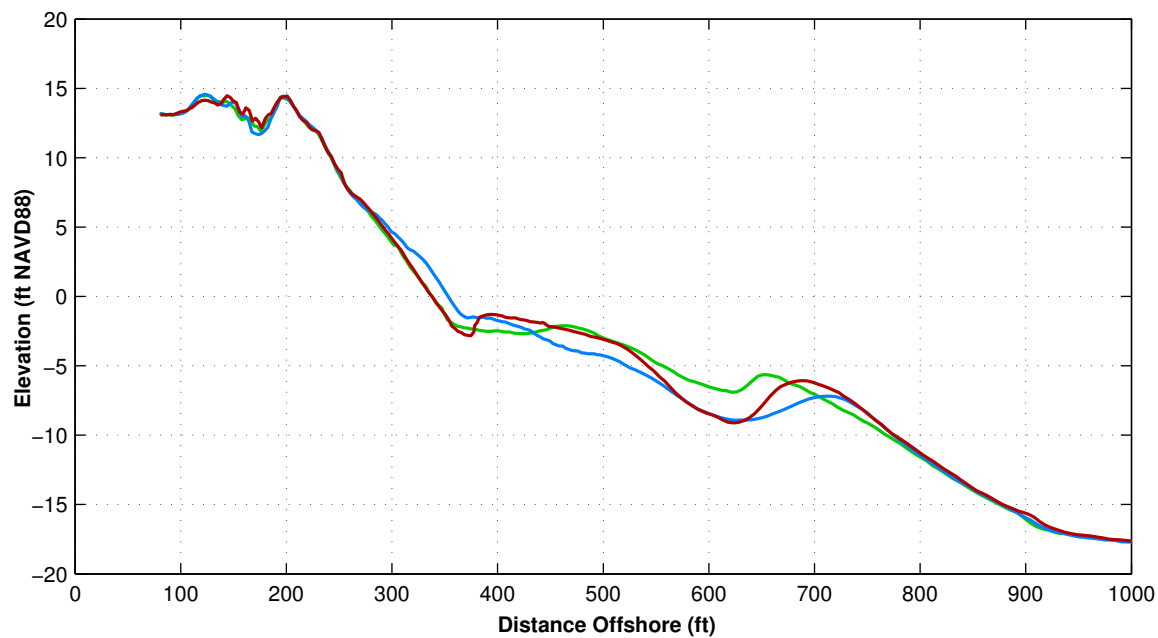
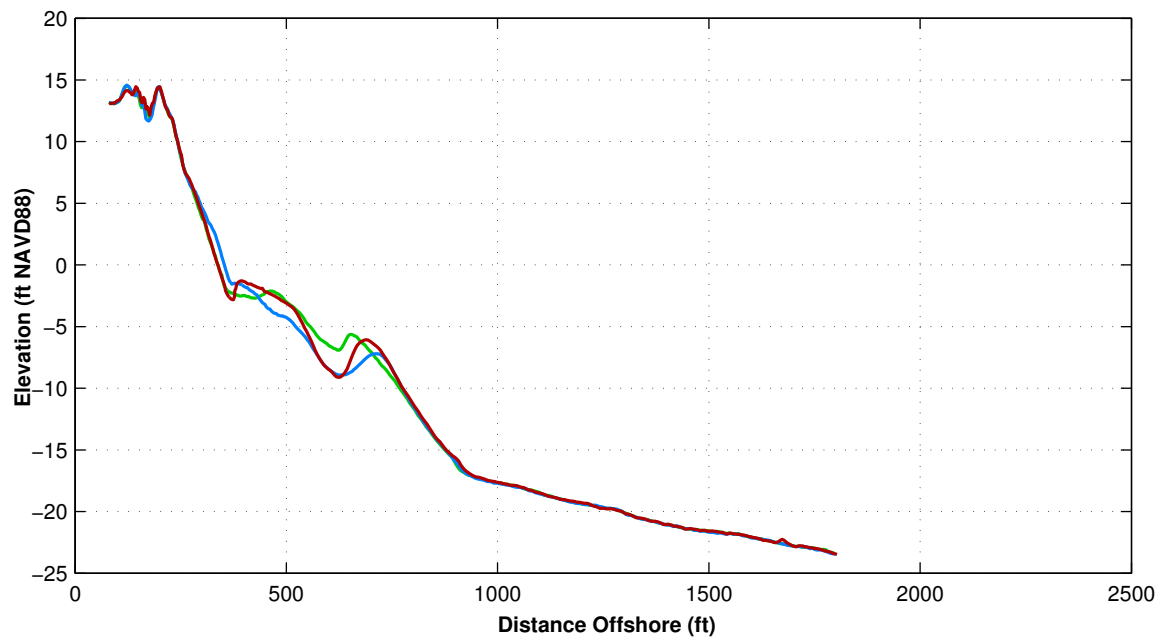


OCEAN VIEW PERIODIC
SURVEYING DATA &
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Fall 2016



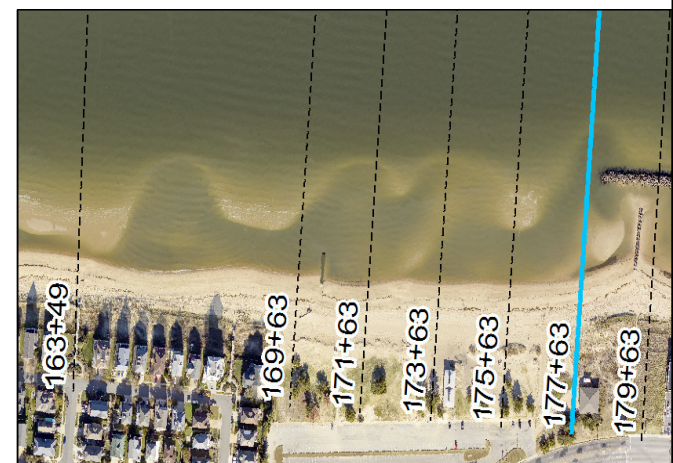
Survey Transect 177+63	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	0.24 ft/yr	-16.35 ft
Volume Change Above -15 ft NAVD88	-2.17 cy/ft/yr	6.54 cy/ft
Volume Change Above 0 ft NAVD88	1.08 cy/ft/yr	-1.60 cy/ft

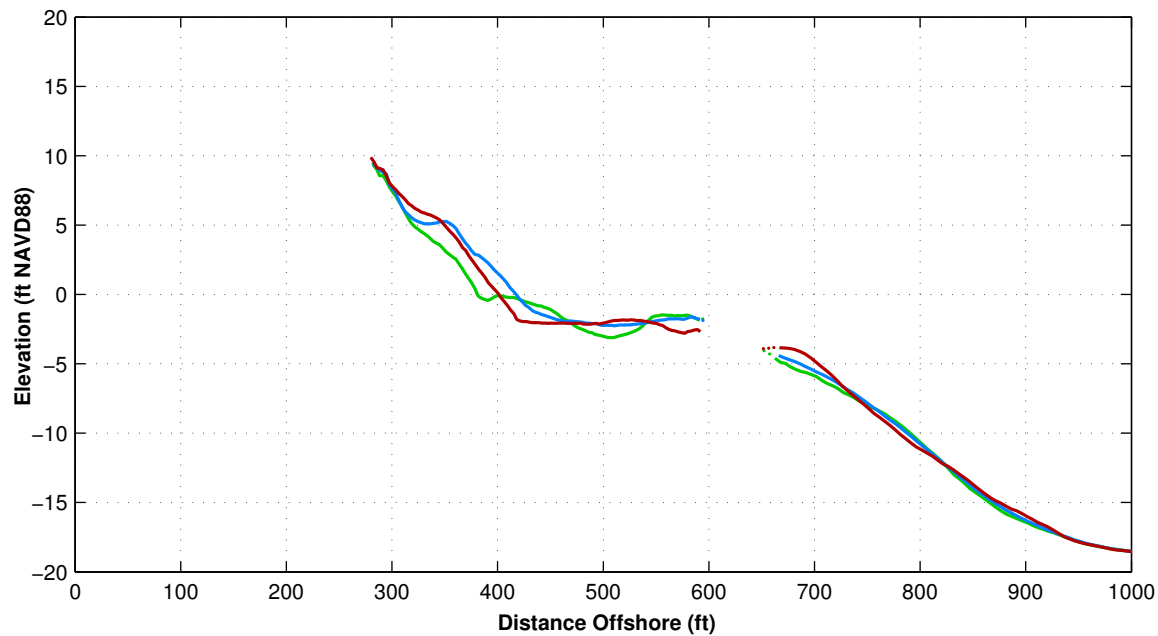
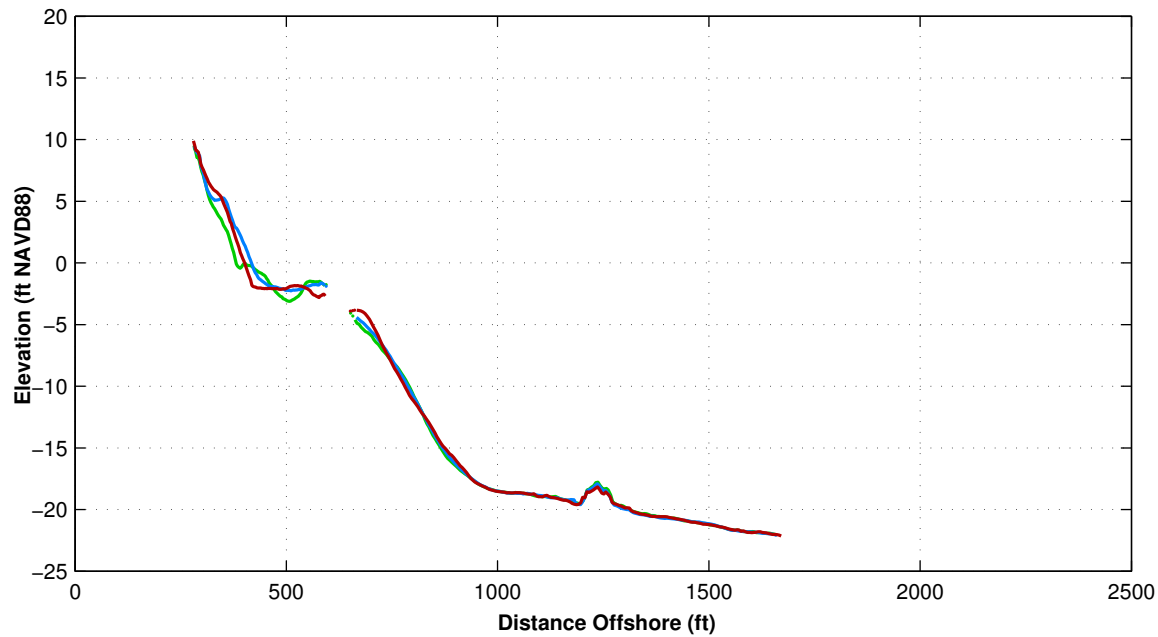
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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Survey Transect 179+63	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	15.59 ft/yr	-16.83 ft
Volume Change Above -15 ft NAVD88	5.14 cy/ft/yr	-3.07 cy/ft
Volume Change Above 0 ft NAVD88	5.08 cy/ft/yr	-1.00 cy/ft

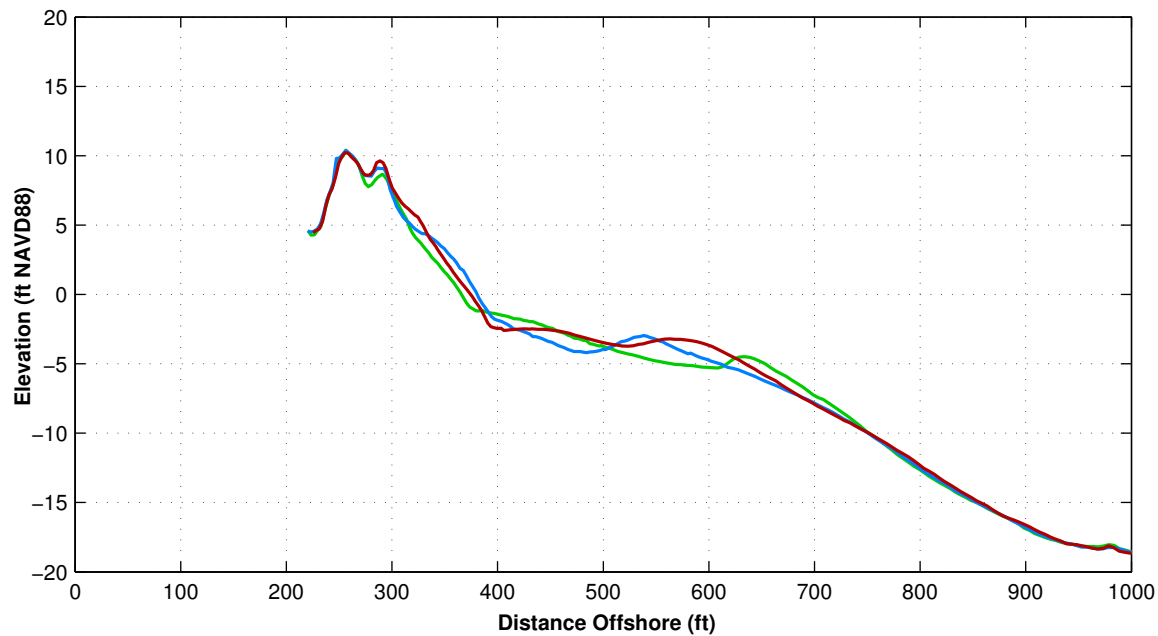
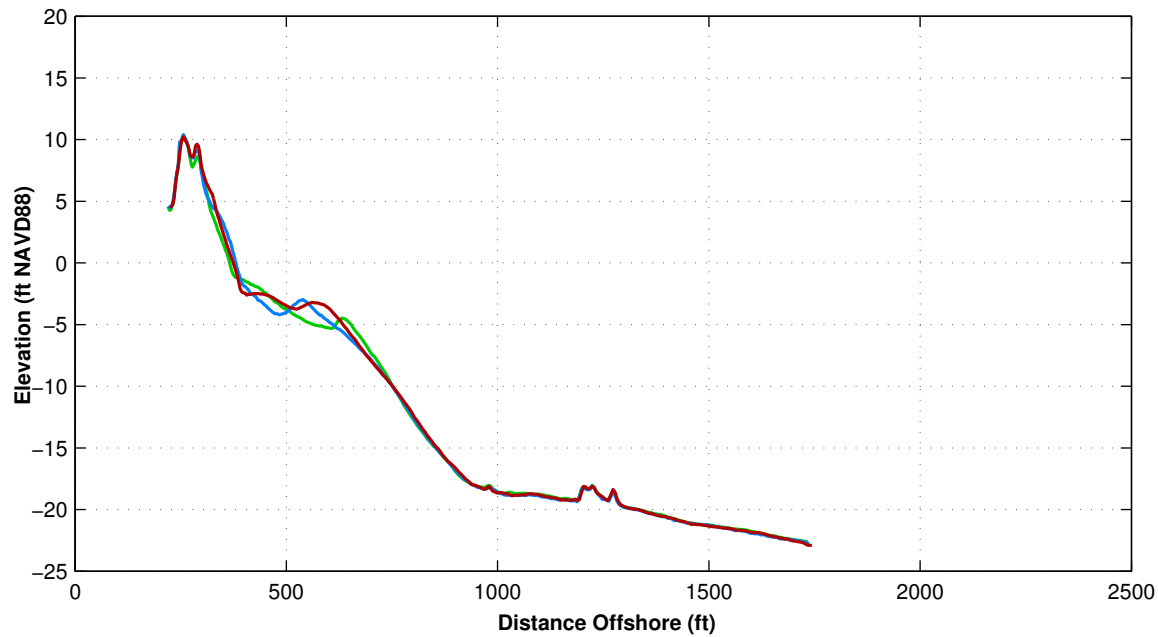
LEGEND:

OCT 2016 — (red line)
MAY 2016 — (blue line)
OCT 2015 — (green line)

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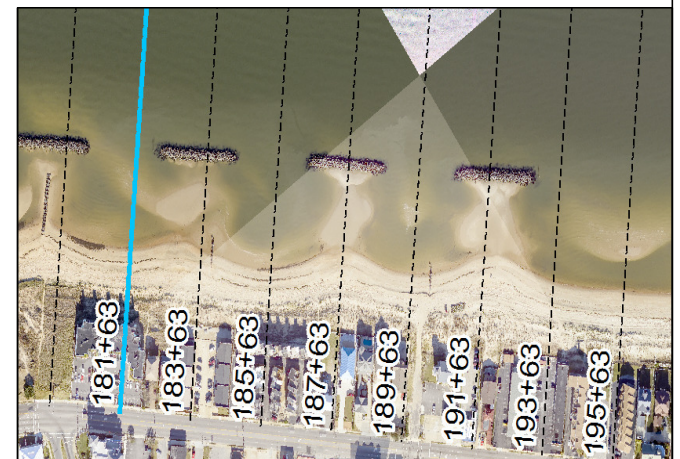
Survey Transect 181+63	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	6.81 ft/yr	-9.14 ft
Volume Change Above -15 ft NAVD88	5.76 cy/ft/yr	4.48 cy/ft
Volume Change Above 0 ft NAVD88	3.12 cy/ft/yr	-0.21 cy/ft

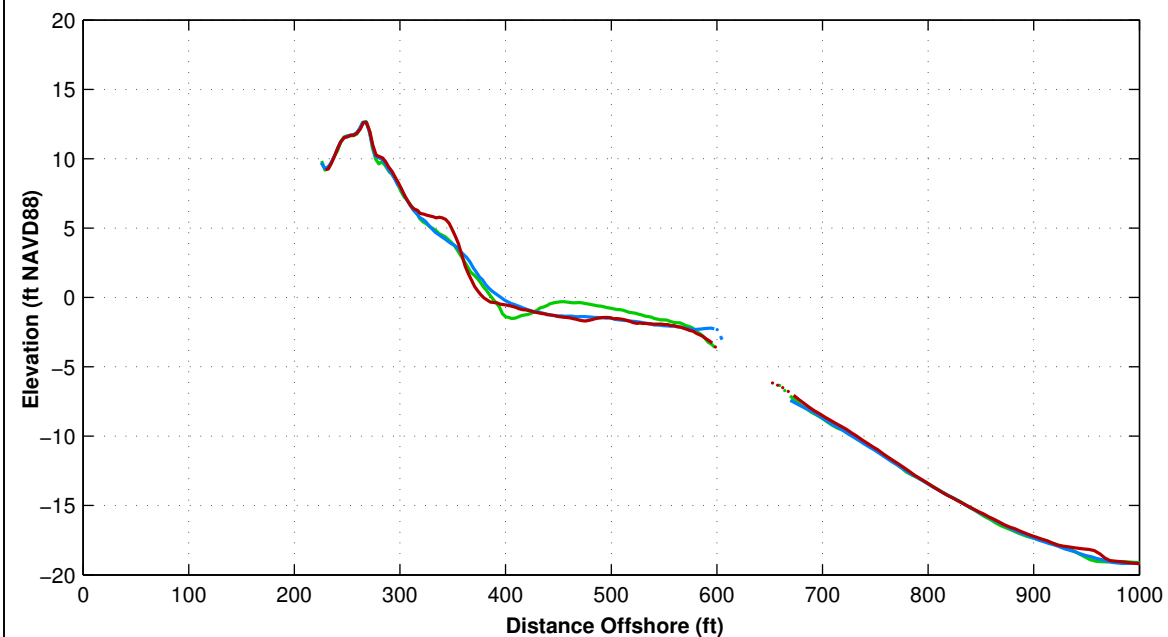
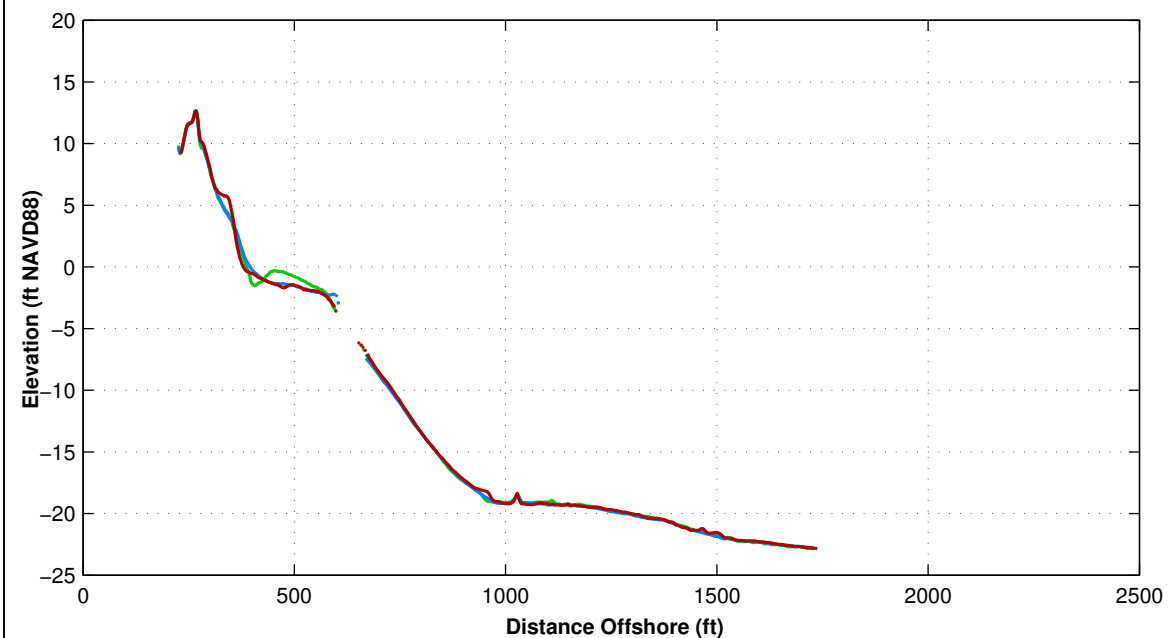
LEGEND:

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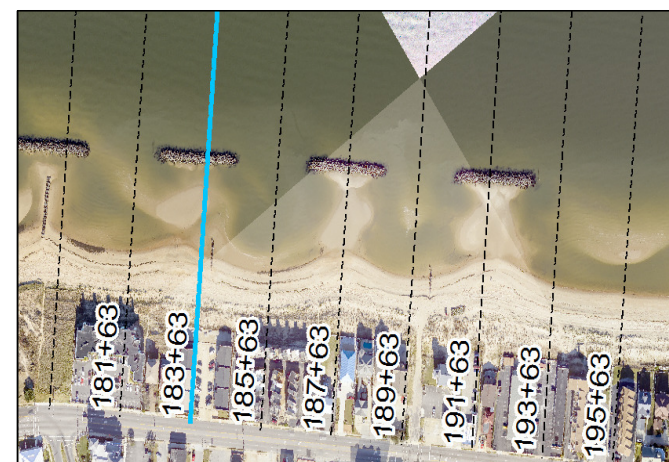
Survey Transect 183+63	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-7.46 ft/yr	-11.19 ft
Volume Change Above -15 ft NAVD88	-1.29 cy/ft/yr	0.19 cy/ft
Volume Change Above 0 ft NAVD88	1.10 cy/ft/yr	0.40 cy/ft

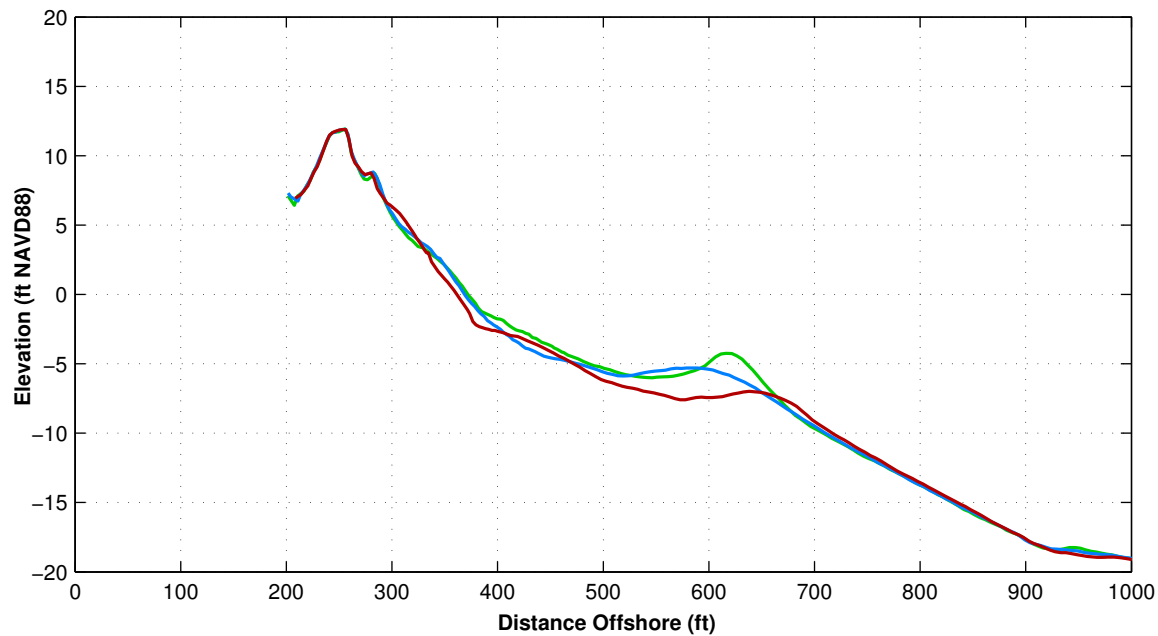
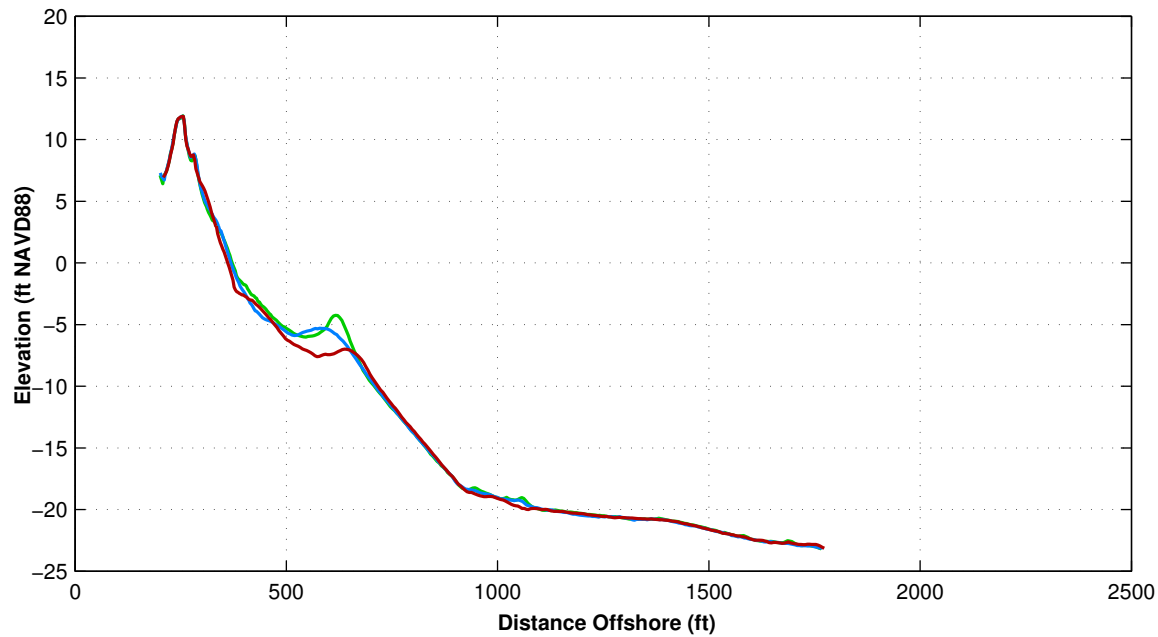
LEGEND:

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OCT 2015 — (green line)

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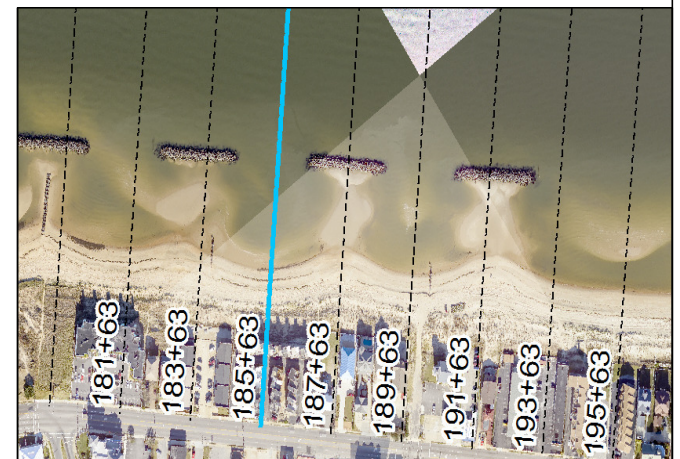
Survey Transect 185+63	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-10.61 ft/yr	-8.34 ft
Volume Change Above -15 ft NAVD88	-11.09 cy/ft/yr	-7.27 cy/ft
Volume Change Above 0 ft NAVD88	-0.21 cy/ft/yr	-0.82 cy/ft

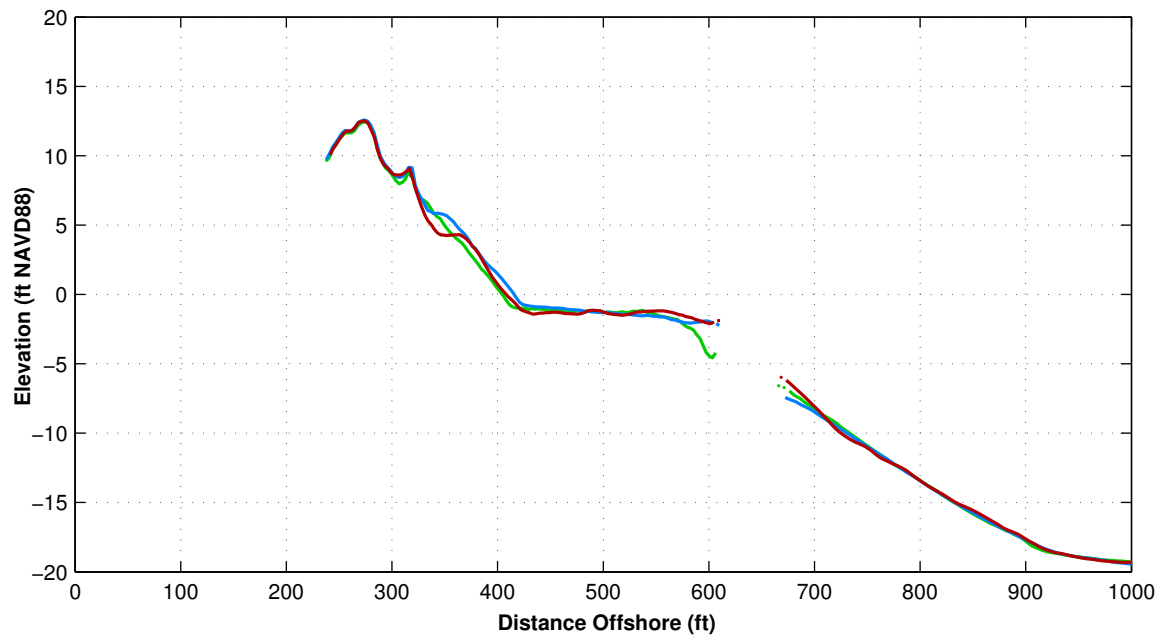
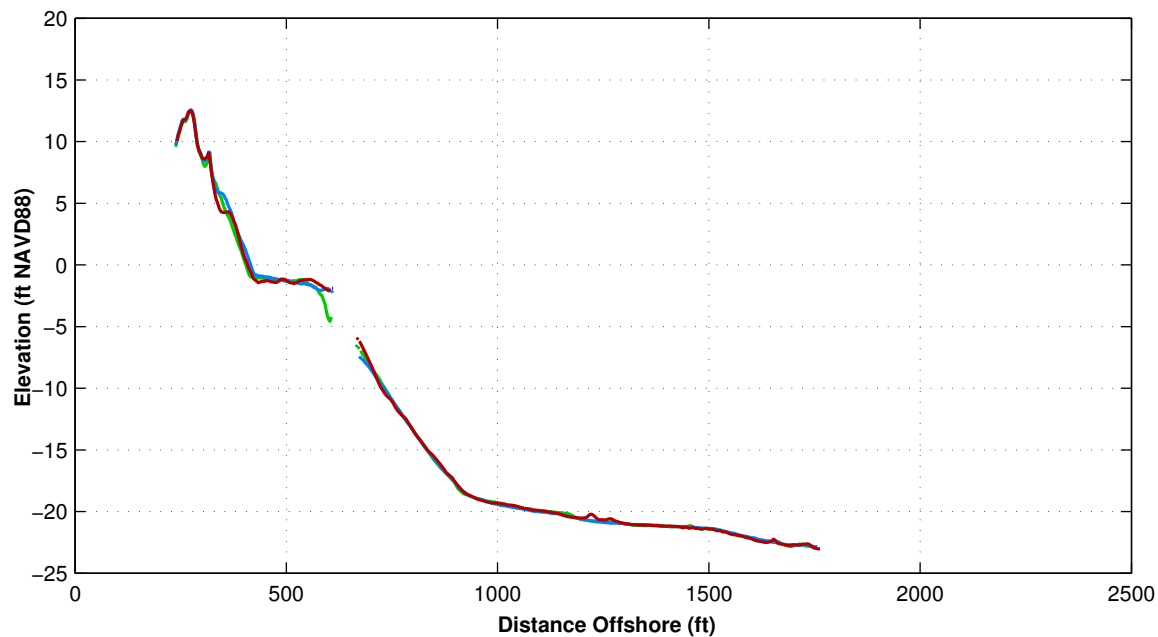
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

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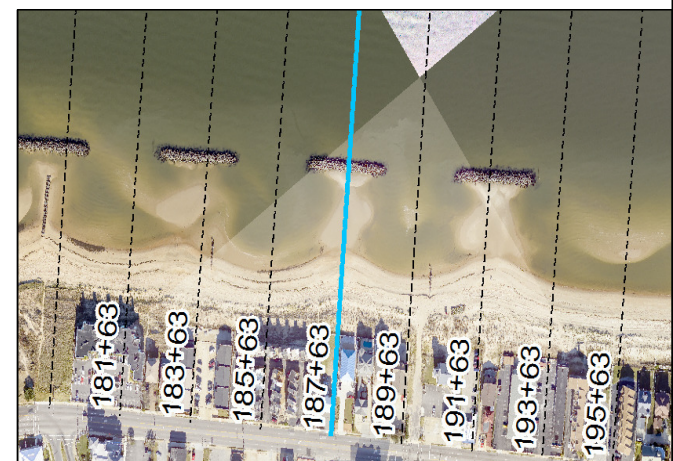
Survey Transect 187+63	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	2.94 ft/yr	-8.00 ft
Volume Change Above -15 ft NAVD88	1.83 cy/ft/yr	-1.97 cy/ft
Volume Change Above 0 ft NAVD88	0.32 cy/ft/yr	-2.45 cy/ft

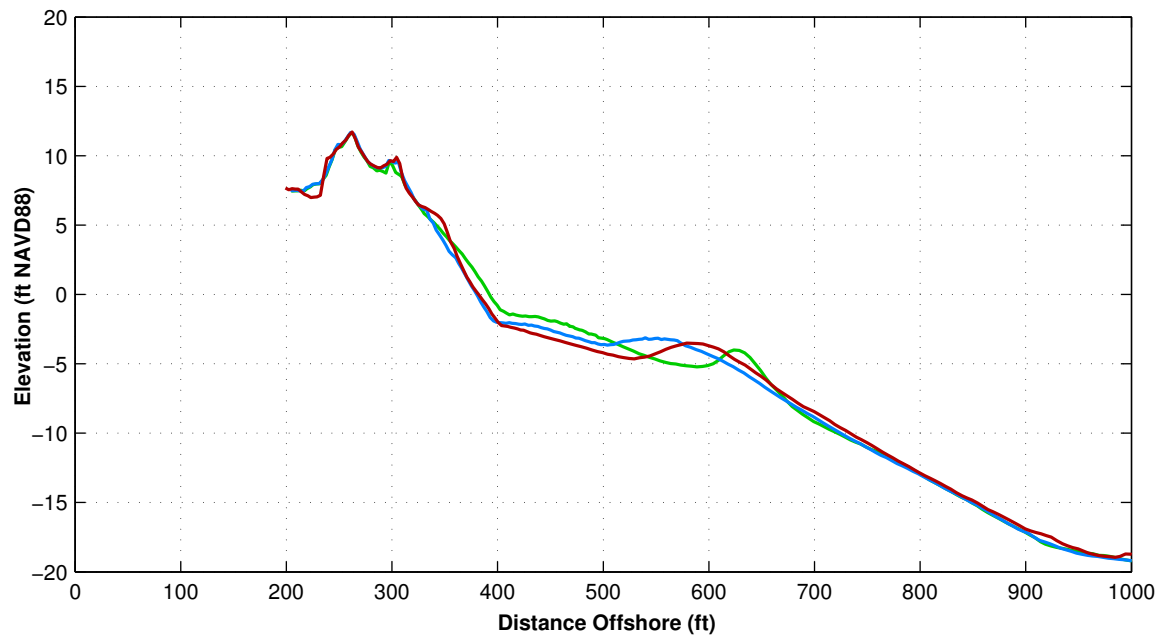
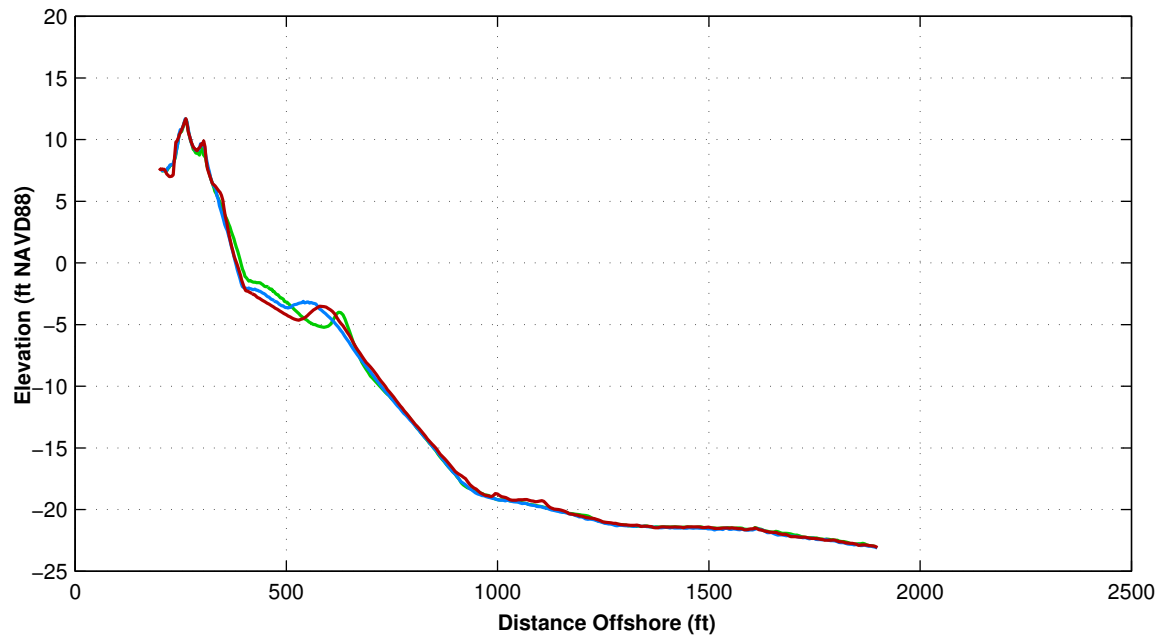
LEGEND:

OCT 2016 — (red line)
MAY 2016 — (blue line)
OCT 2015 — (green line)

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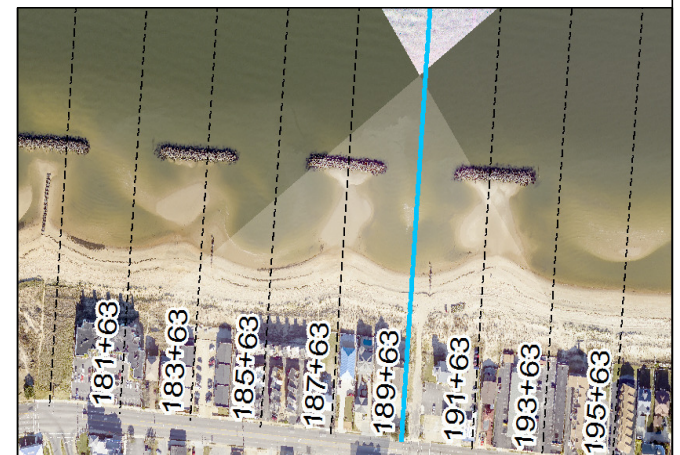
Survey Transect 189+63	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-10.99 ft/yr	0.68 ft
Volume Change Above -15 ft NAVD88	-1.79 cy/ft/yr	0.27 cy/ft
Volume Change Above 0 ft NAVD88	-0.30 cy/ft/yr	0.66 cy/ft

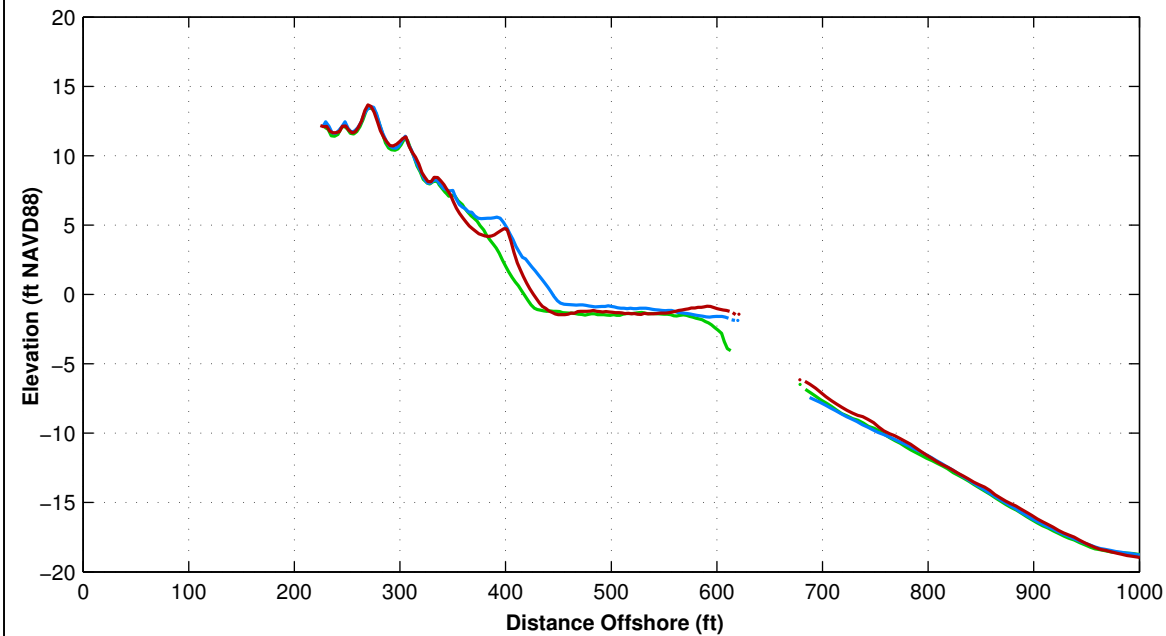
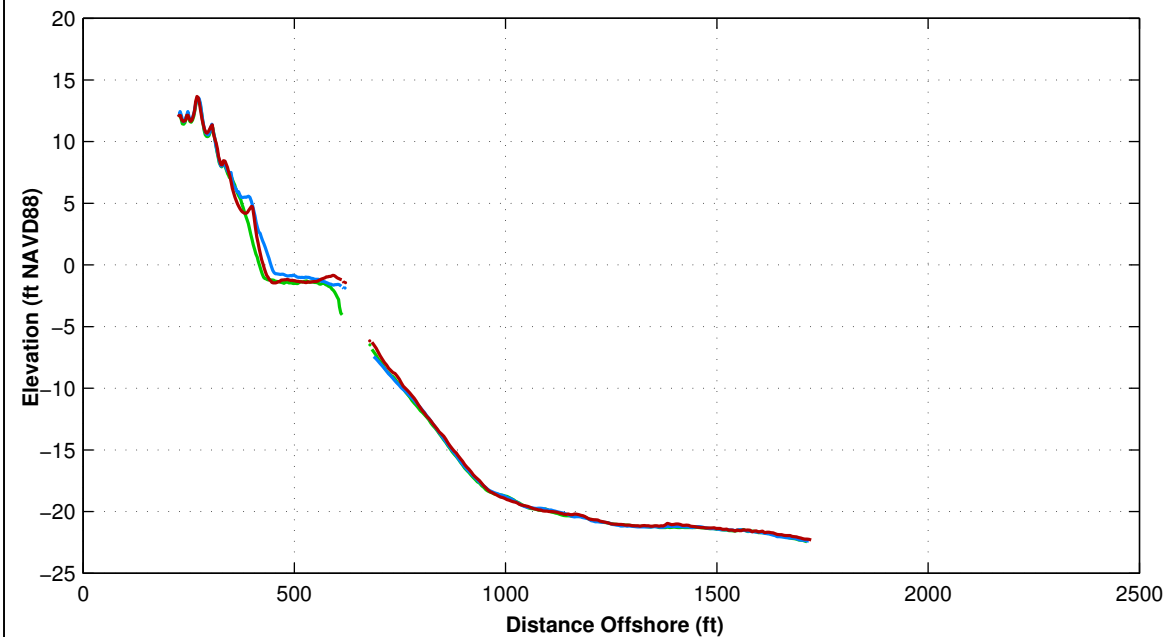
LEGEND:

OCT 2016 — (red line)
MAY 2016 — (blue line)
OCT 2015 — (green line)

Notes:

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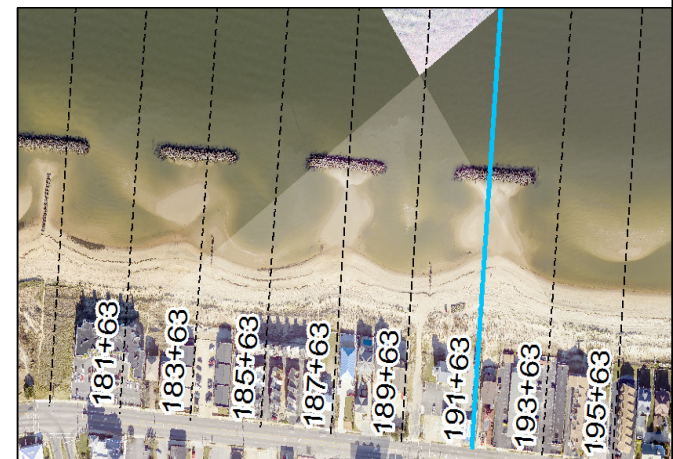
Survey Transect 191+63	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	10.19 ft/yr	-16.49 ft
Volume Change Above -15 ft NAVD88	6.84 cy/ft/yr	-2.92 cy/ft
Volume Change Above 0 ft NAVD88	2.02 cy/ft/yr	-3.43 cy/ft

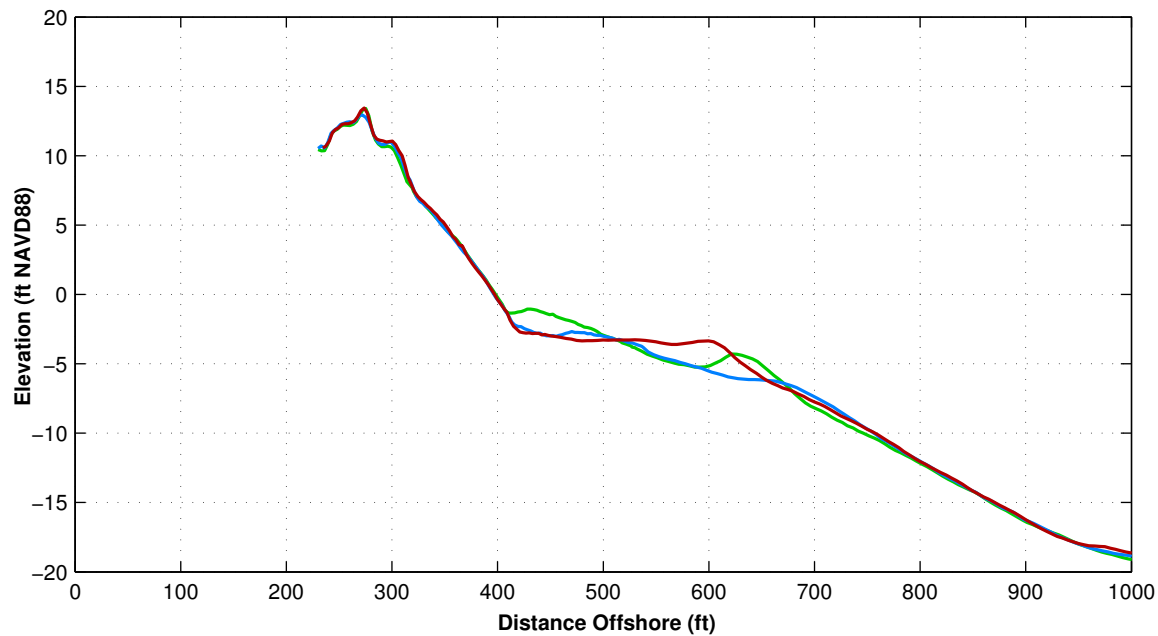
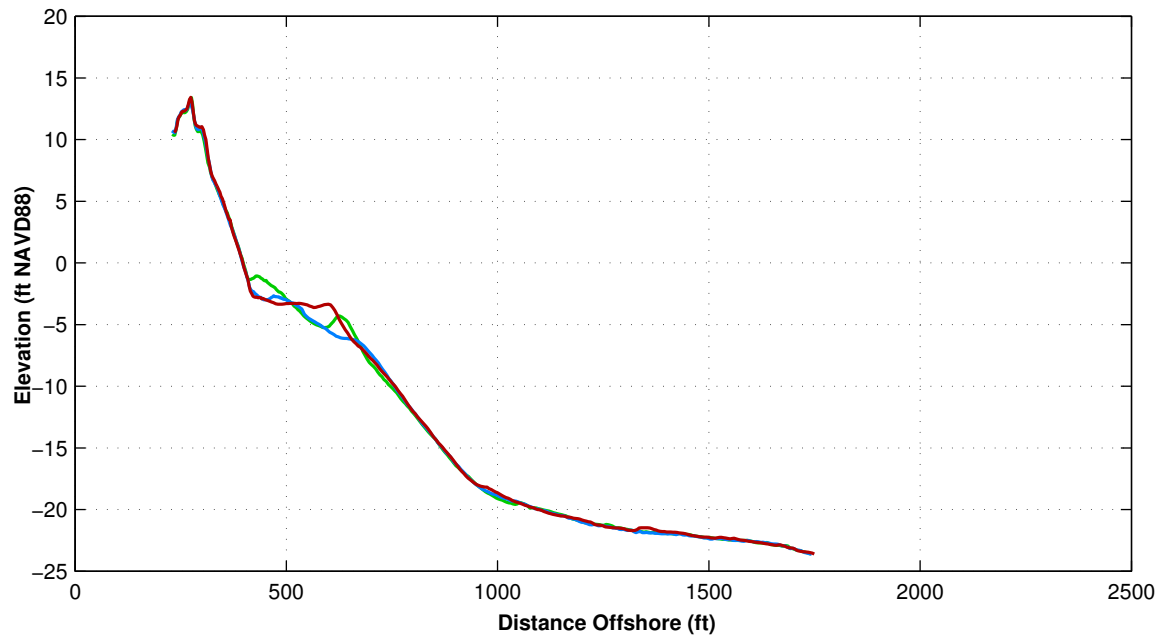
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

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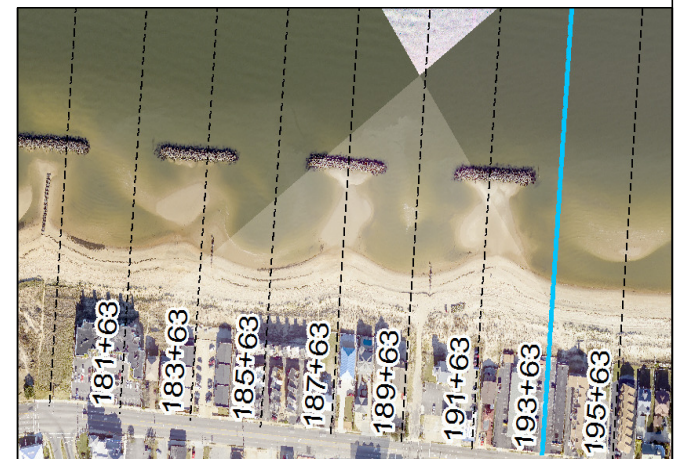
Survey Transect 193+63	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-1.12 ft/yr	-0.45 ft
Volume Change Above -15 ft NAVD88	1.69 cy/ft/yr	4.77 cy/ft
Volume Change Above 0 ft NAVD88	0.85 cy/ft/yr	0.63 cy/ft

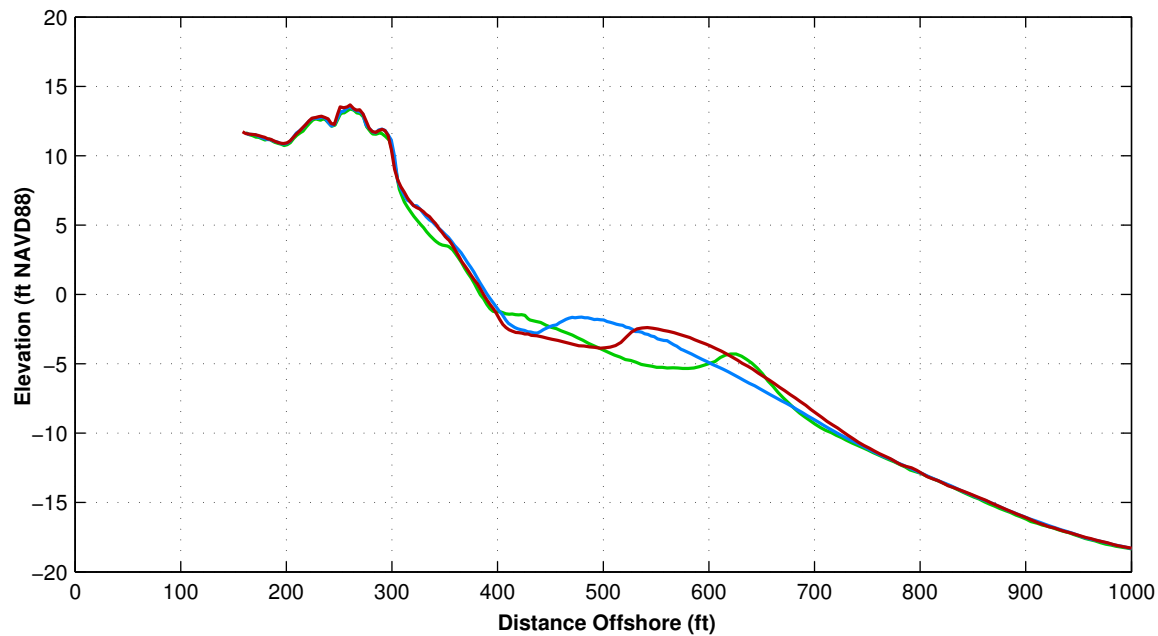
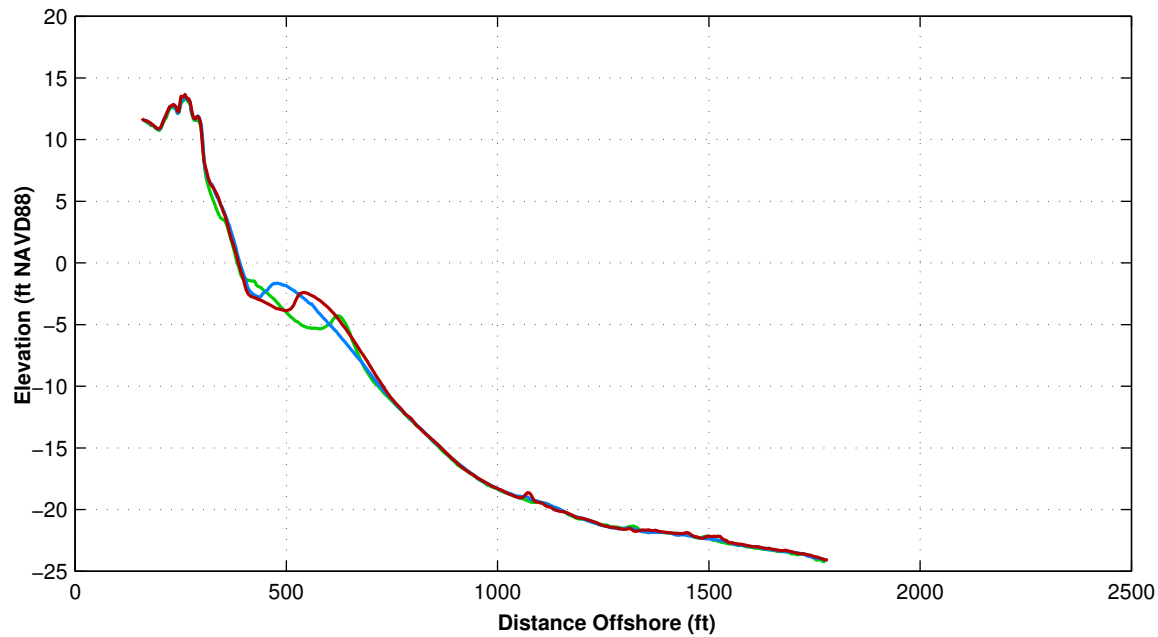
LEGEND:

OCT 2016 — (red line)
MAY 2016 — (blue line)
OCT 2015 — (green line)

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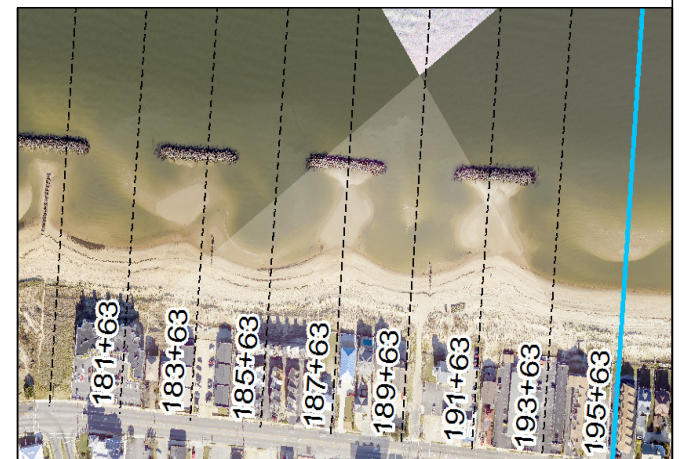
Survey Transect 195+63	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	2.03 ft/yr	-3.58 ft
Volume Change Above -15 ft NAVD88	9.46 cy/ft/yr	0.64 cy/ft
Volume Change Above 0 ft NAVD88	2.65 cy/ft/yr	-0.32 cy/ft

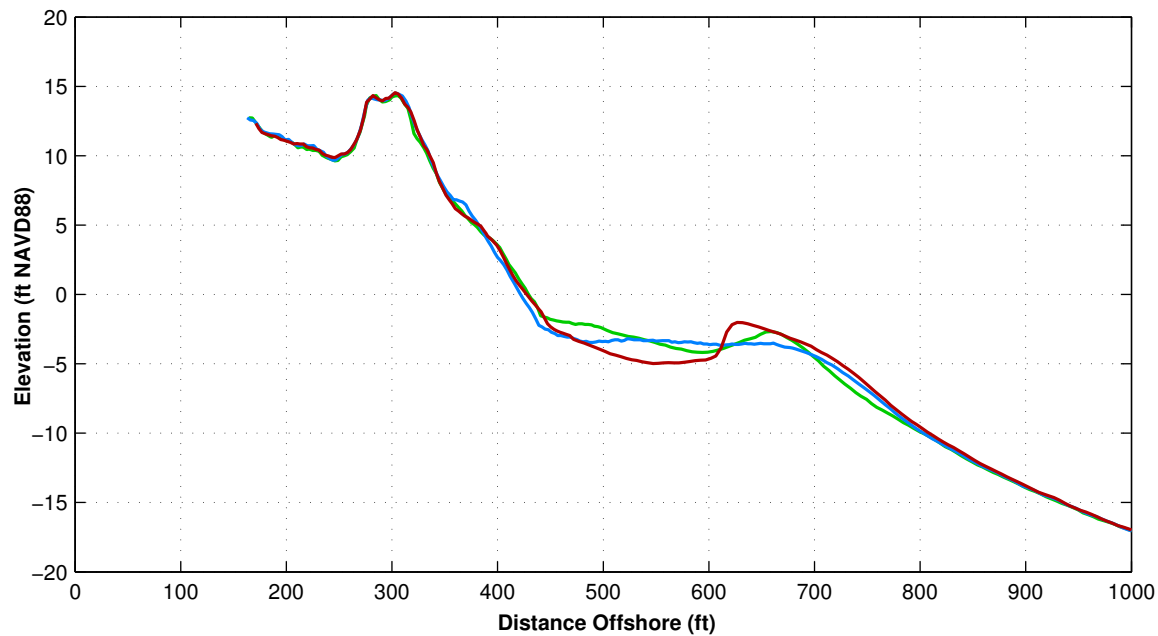
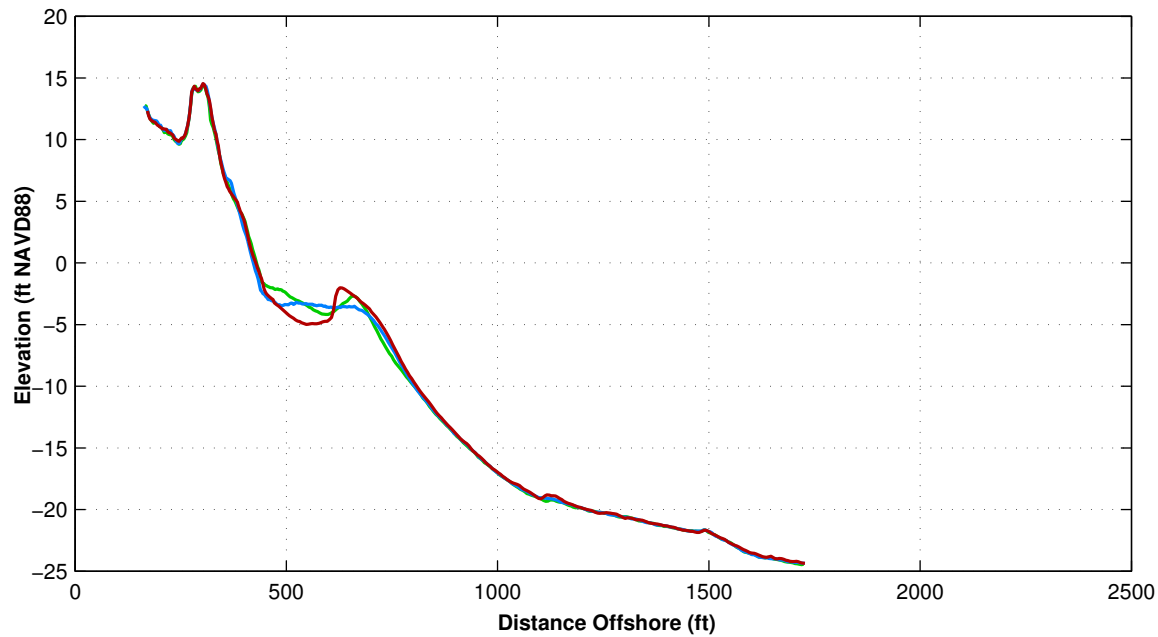
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
3. All Survey Elevations In Feet Referenced to NAVD88.
4. Survey Comparison Made to OCT 2015 and MAY 2016
5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.





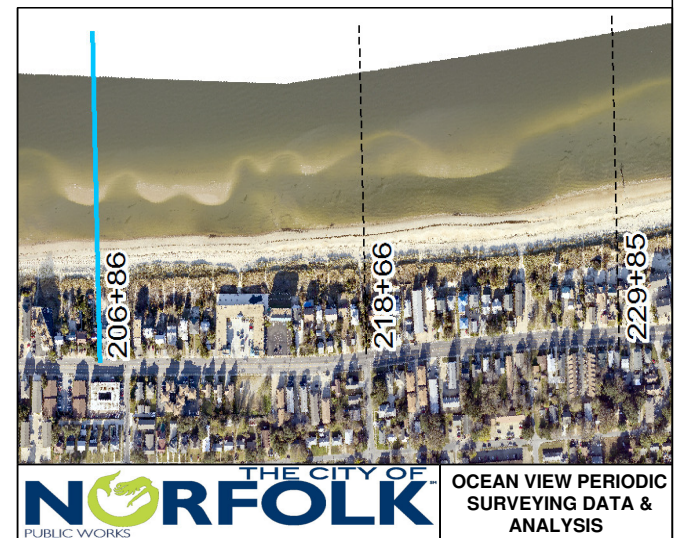
Survey Transect 206+86	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-3.50 ft/yr	3.19 ft
Volume Change Above -15 ft NAVD88	-0.31 cy/ft/yr	0.39 cy/ft
Volume Change Above 0 ft NAVD88	0.57 cy/ft/yr	-0.11 cy/ft

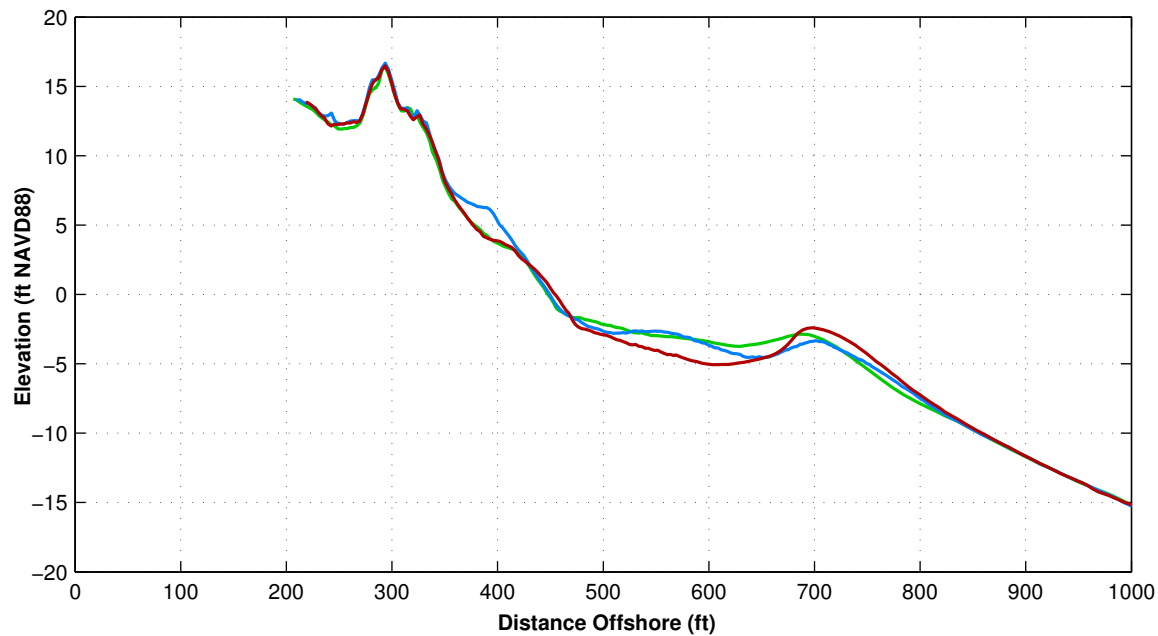
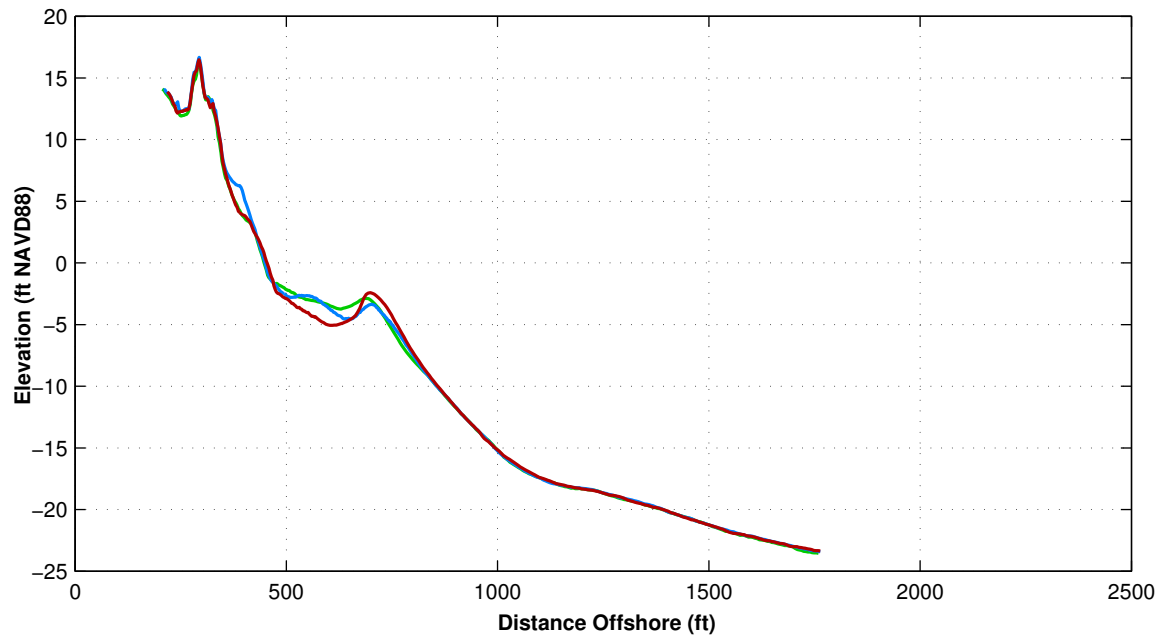
LEGEND:

OCT 2016 — (red line)
MAY 2016 — (blue line)
OCT 2015 — (green line)

Notes:

1. Station From West To East At Varying Intervals.
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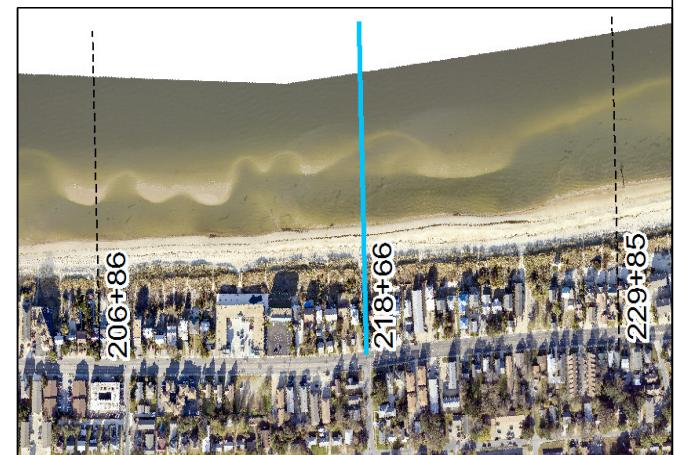
Survey Transect 218+66	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	6.12 ft/yr	4.81 ft
Volume Change Above –15 ft NAVD88	–2.29 cy/ft/yr	–5.48 cy/ft
Volume Change Above 0 ft NAVD88	1.38 cy/ft/yr	–3.46 cy/ft

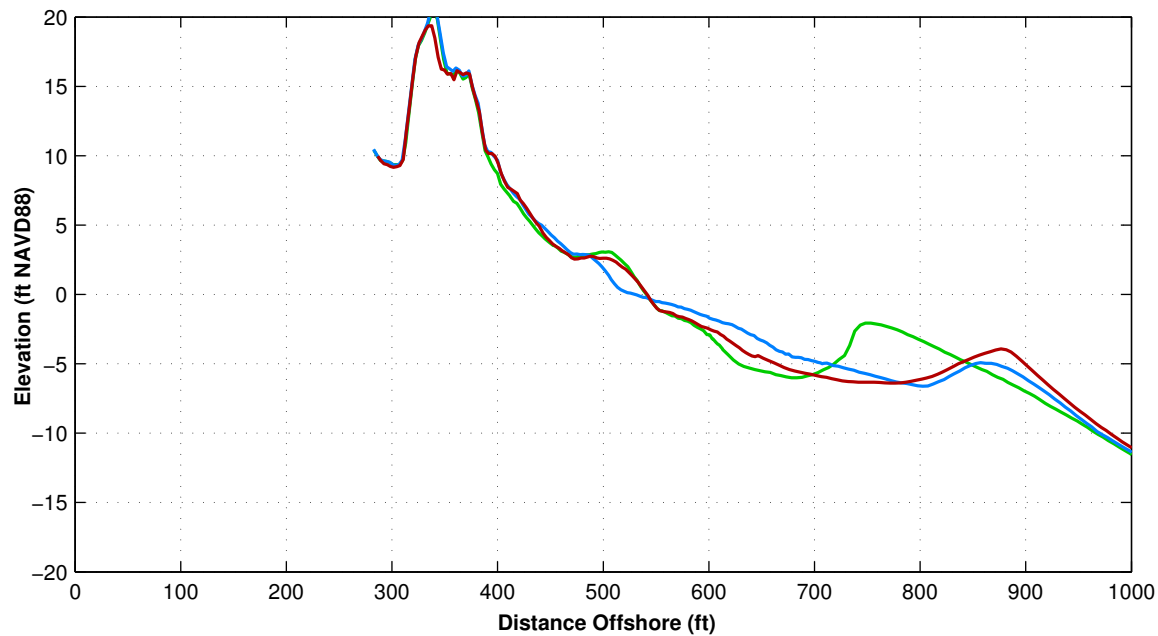
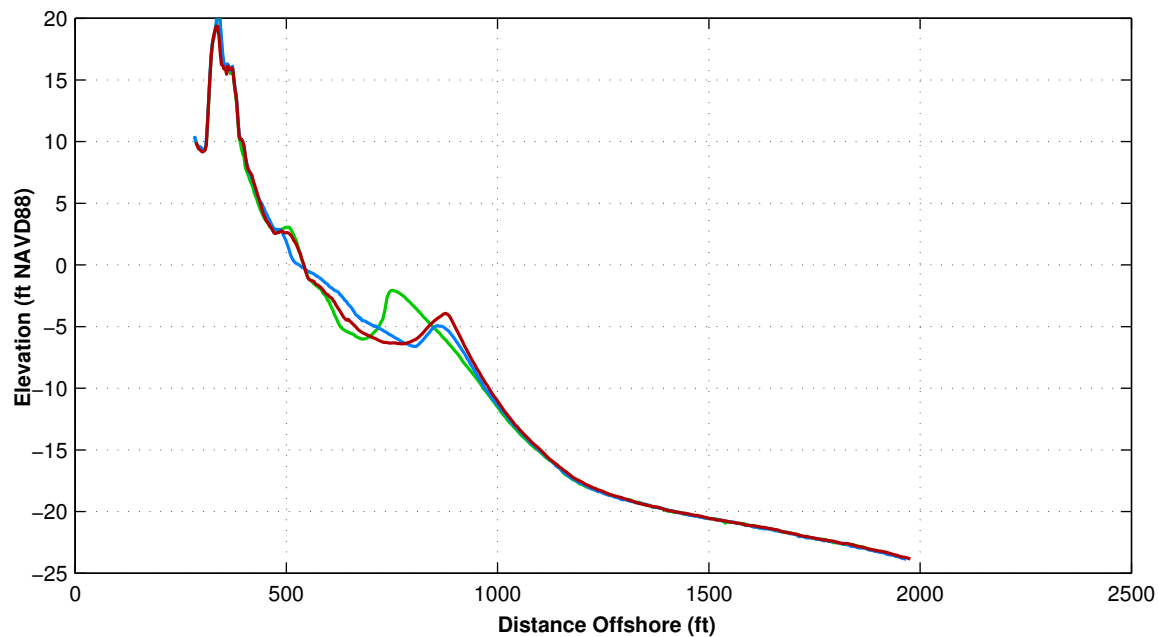
LEGEND:

OCT 2016 — (red line)
MAY 2016 — (blue line)
OCT 2015 — (green line)

Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
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5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.





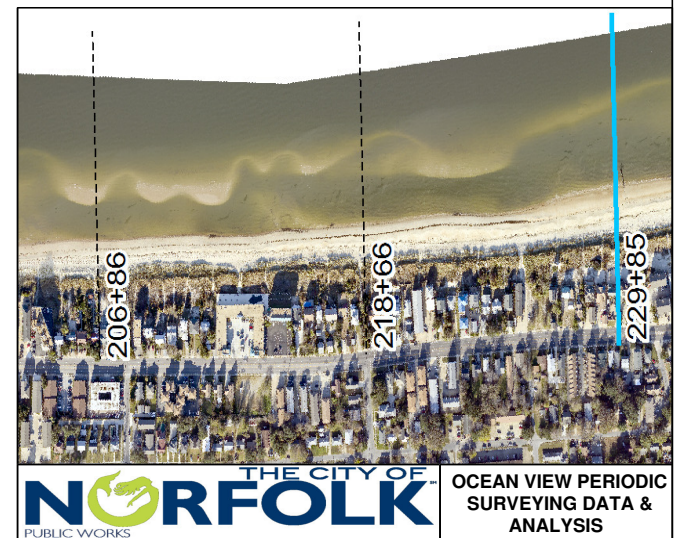
Survey Transect 229+85	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-0.55 ft/yr	23.39 ft
Volume Change Above -15 ft NAVD88	-1.66 cy/ft/yr	-1.94 cy/ft
Volume Change Above 0 ft NAVD88	-0.04 cy/ft/yr	-0.11 cy/ft

LEGEND:

OCT 2016 — (red line)
MAY 2016 — (blue line)
OCT 2015 — (green line)

Notes:

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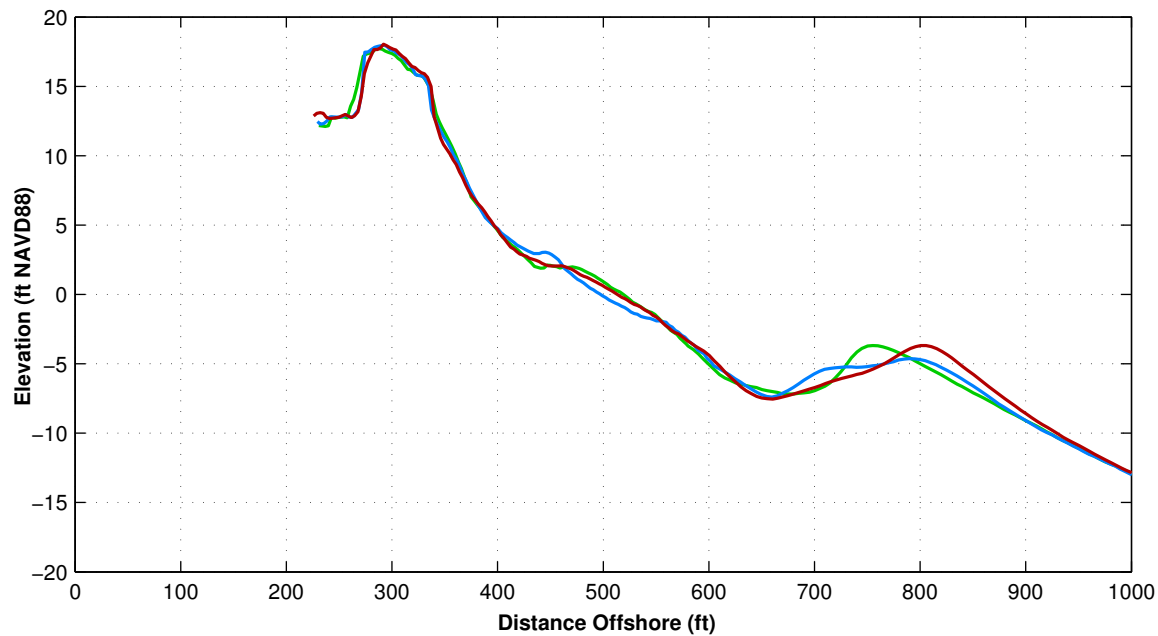
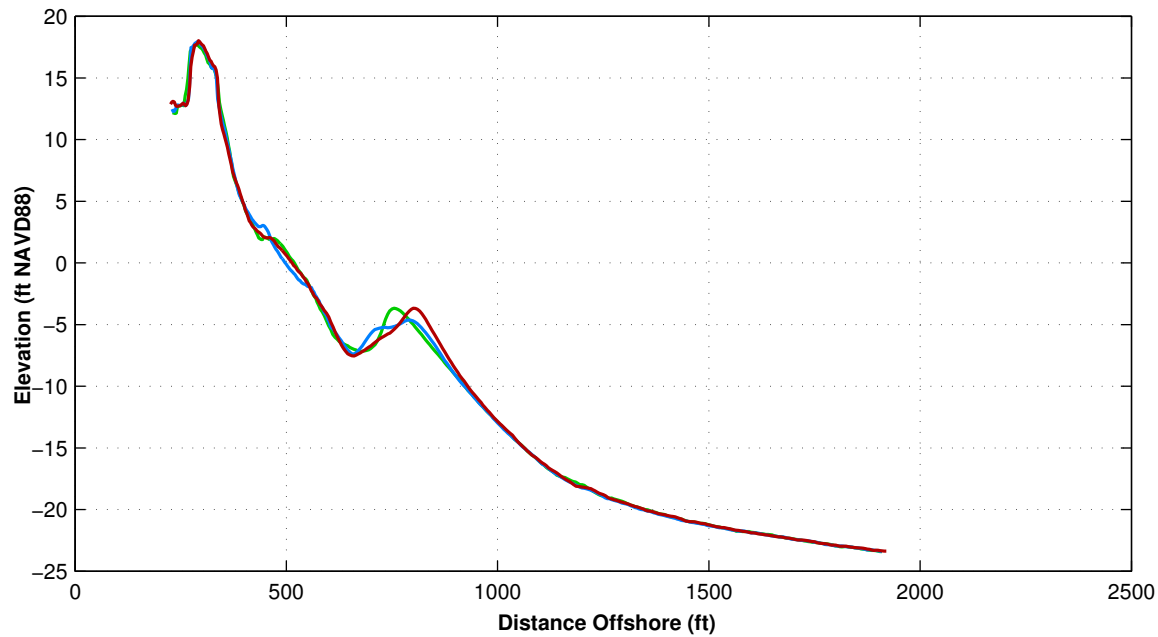
THE CITY OF NORFOLK
PUBLIC WORKS

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SURVEYING DATA &
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ST 229+85

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Fall 2016



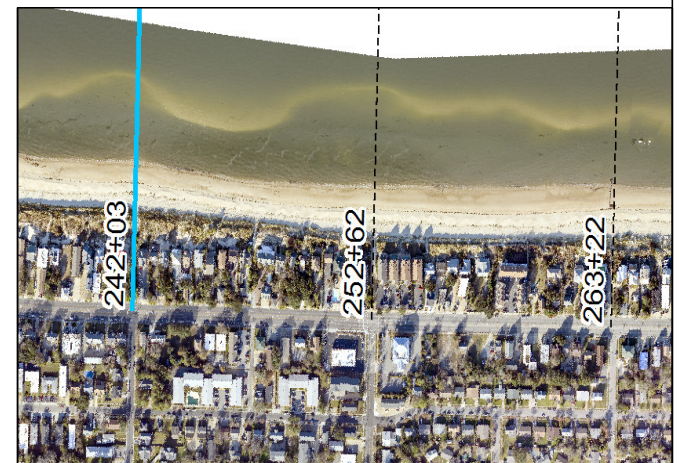
Survey Transect 242+03	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-7.71 ft/yr	12.50 ft
Volume Change Above -15 ft NAVD88	2.30 cy/ft/yr	3.02 cy/ft
Volume Change Above 0 ft NAVD88	-1.09 cy/ft/yr	-0.44 cy/ft

LEGEND:

OCT 2016 — (red line)
MAY 2016 — (blue line)
OCT 2015 — (green line)

Notes:

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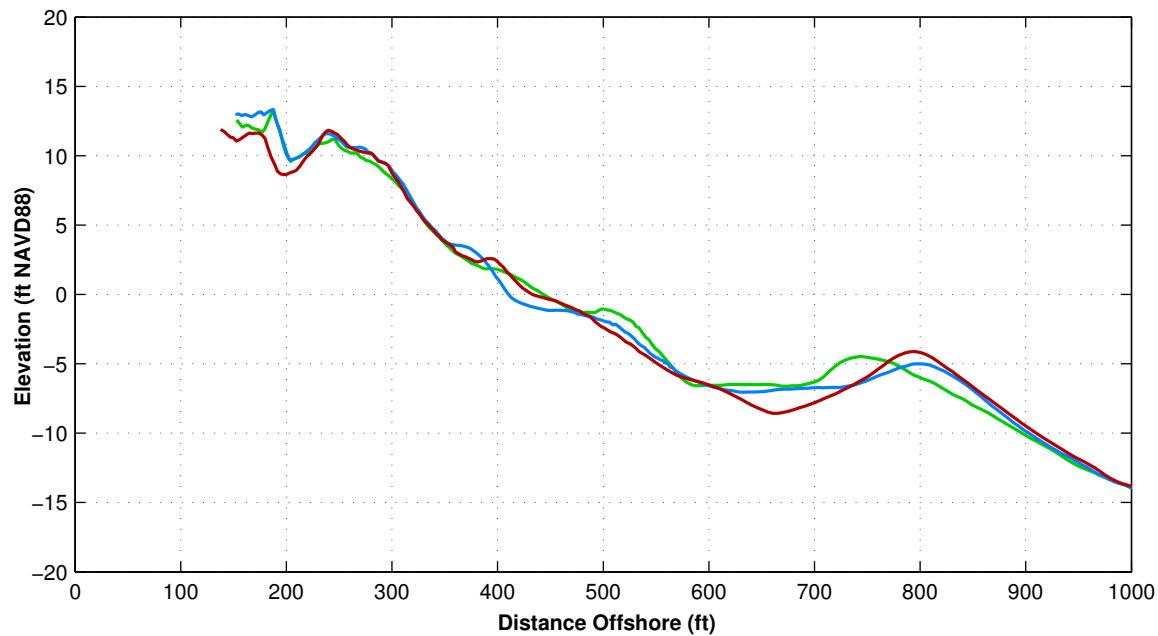
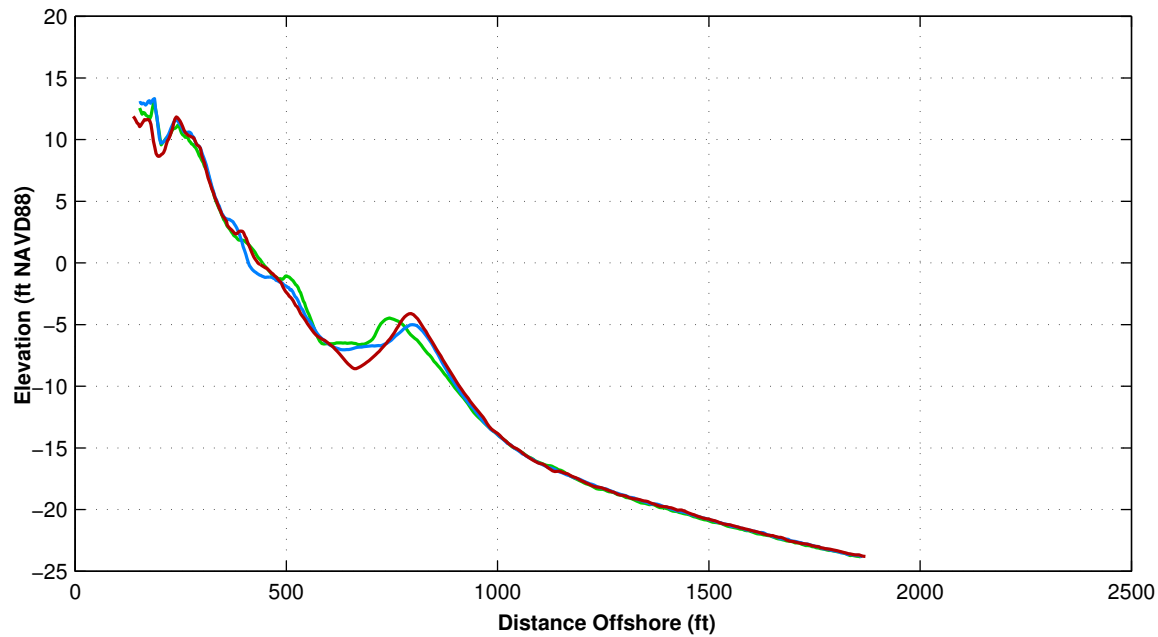


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SURVEYING DATA &
ANALYSIS

ST 242+03

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Fall 2016



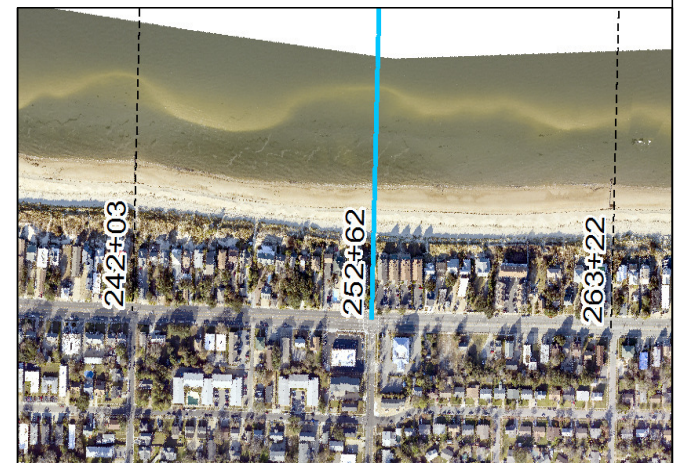
Survey Transect 252+62	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-6.55 ft/yr	15.46 ft
Volume Change Above -15 ft NAVD88	-6.10 cy/ft/yr	-4.42 cy/ft
Volume Change Above 0 ft NAVD88	-1.38 cy/ft/yr	-3.97 cy/ft

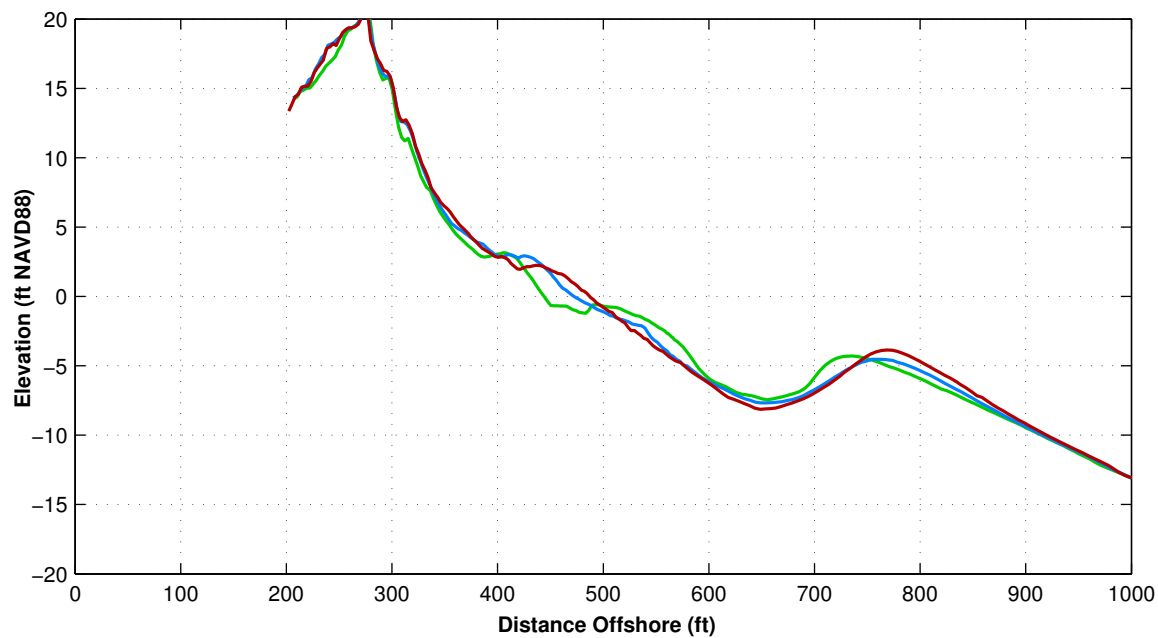
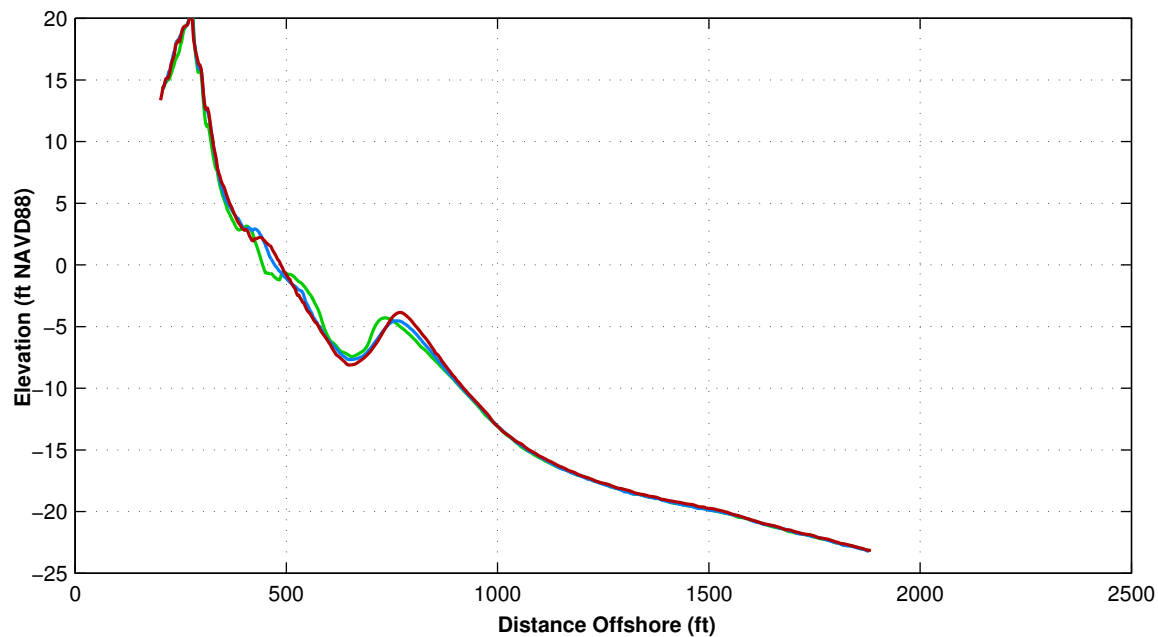
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

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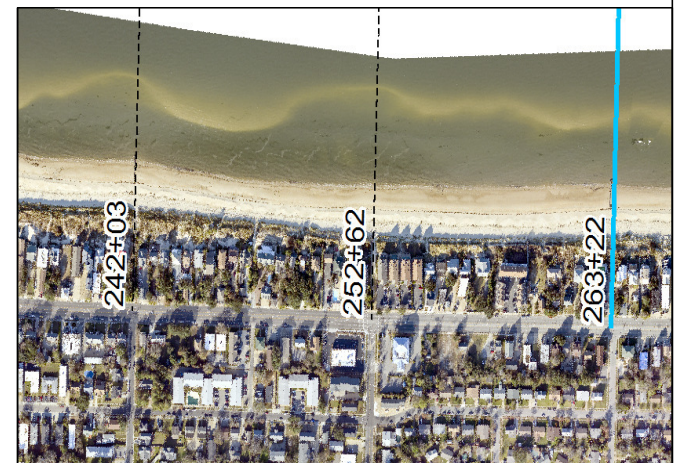
Survey Transect 263+22	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	35.48 ft/yr	14.34 ft
Volume Change Above –15 ft NAVD88	5.22 cy/ft/yr	2.03 cy/ft
Volume Change Above 0 ft NAVD88	6.42 cy/ft/yr	0.58 cy/ft

LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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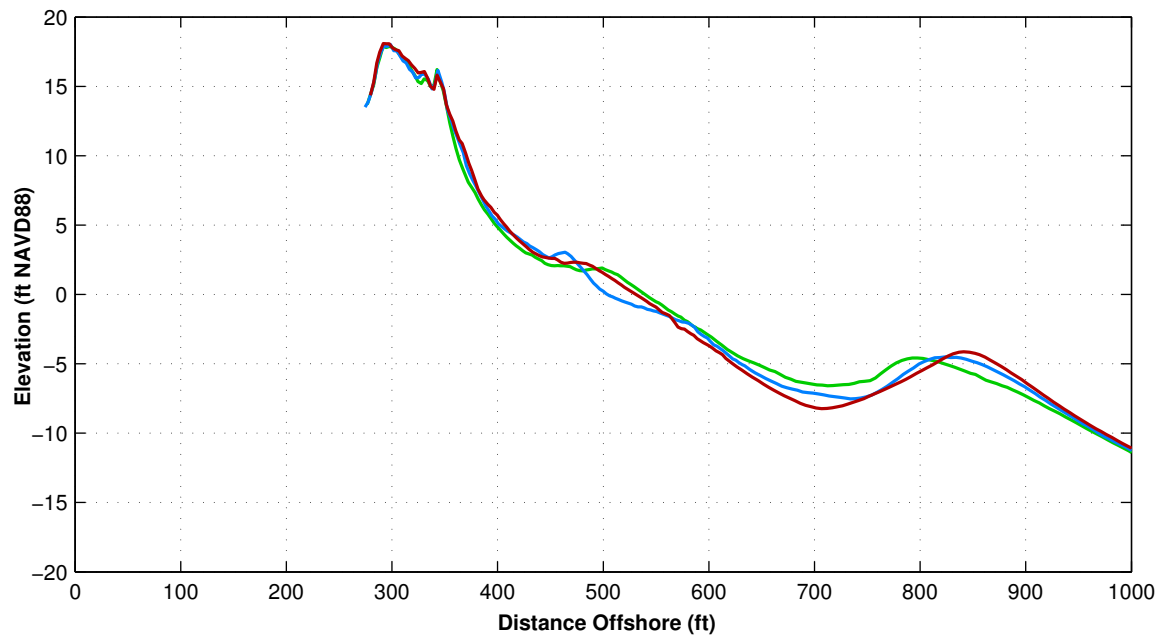
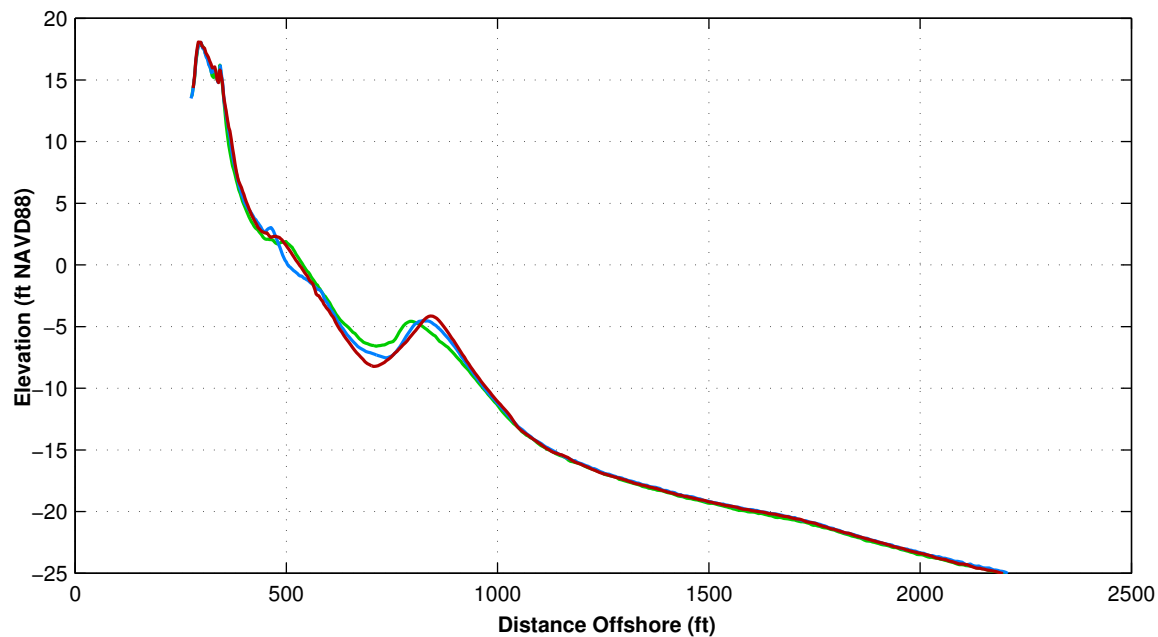


OCEAN VIEW PERIODIC
SURVEYING DATA &
ANALYSIS

ST 263+22

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Survey Transect 274+53	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-9.30 ft/yr	22.36 ft
Volume Change Above -15 ft NAVD88	-1.75 cy/ft/yr	0.53 cy/ft
Volume Change Above 0 ft NAVD88	3.09 cy/ft/yr	2.13 cy/ft

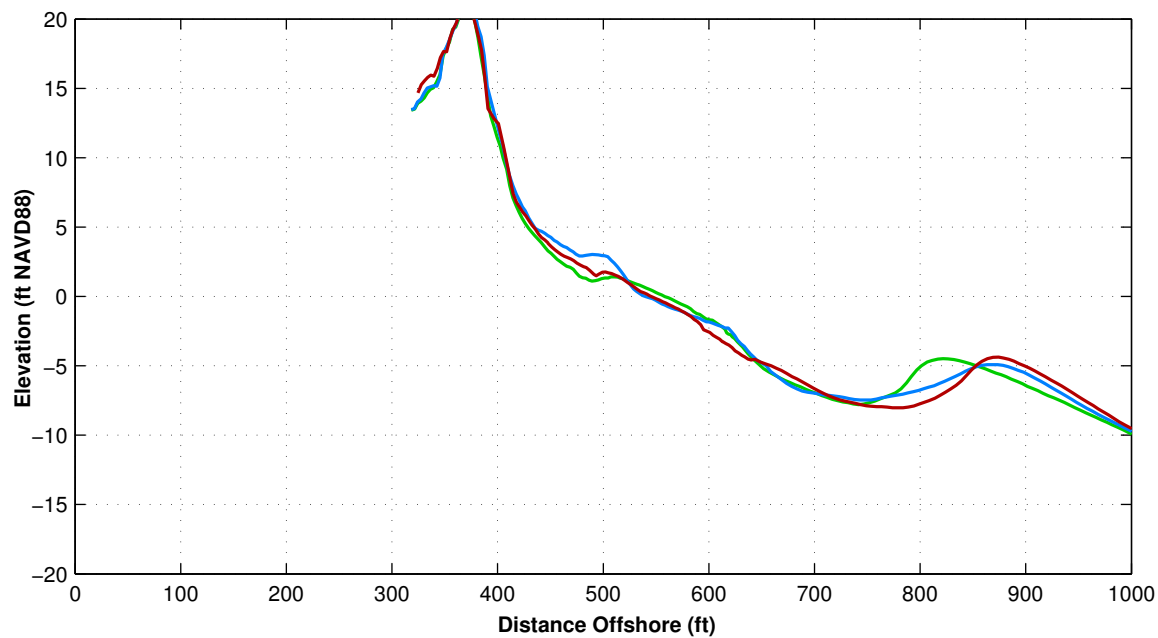
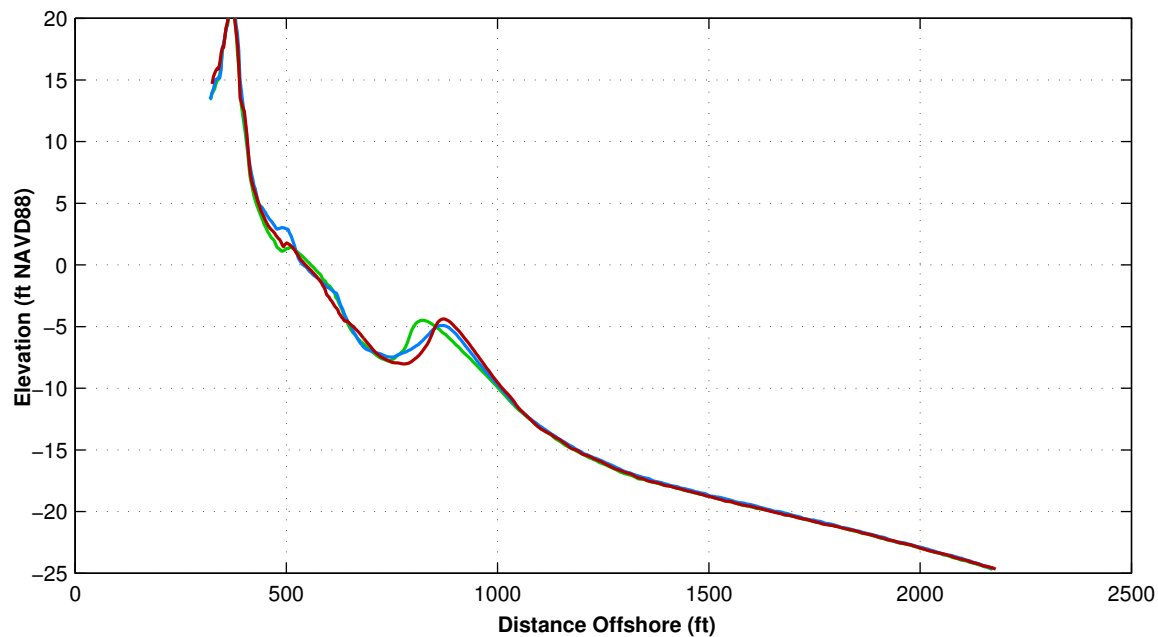
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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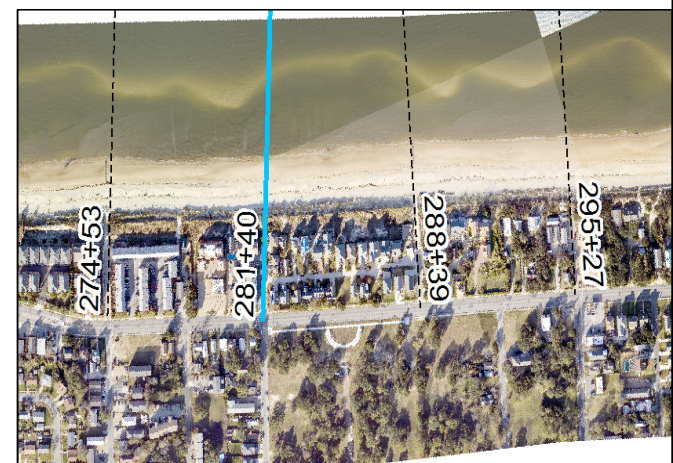
Survey Transect 281+40	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-4.63 ft/yr	-0.80 ft
Volume Change Above -15 ft NAVD88	1.96 cy/ft/yr	-3.61 cy/ft
Volume Change Above 0 ft NAVD88	3.07 cy/ft/yr	-2.31 cy/ft

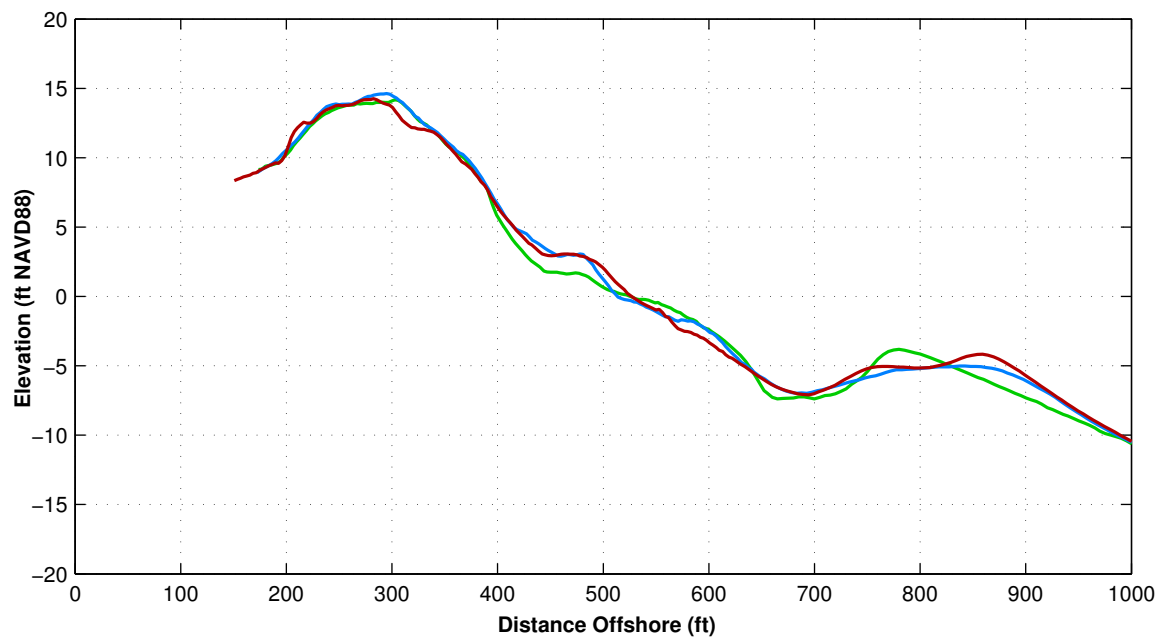
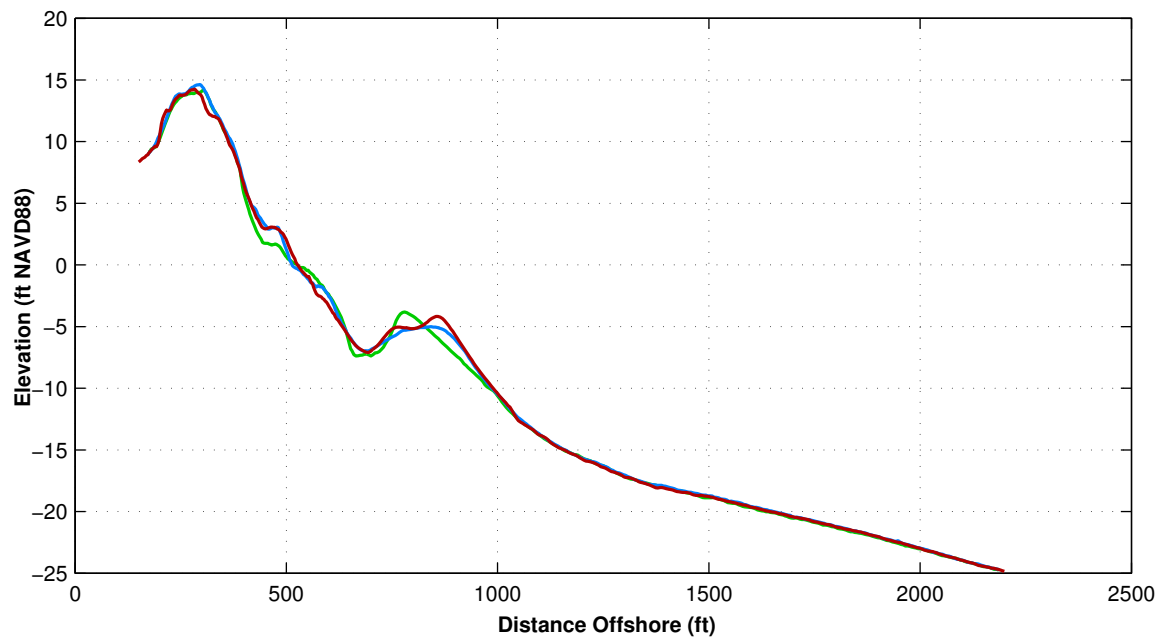
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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Survey Transect 288+39	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	18.30 ft/yr	9.78 ft
Volume Change Above –15 ft NAVD88	8.74 cy/ft/yr	–0.14 cy/ft
Volume Change Above 0 ft NAVD88	4.66 cy/ft/yr	–1.89 cy/ft

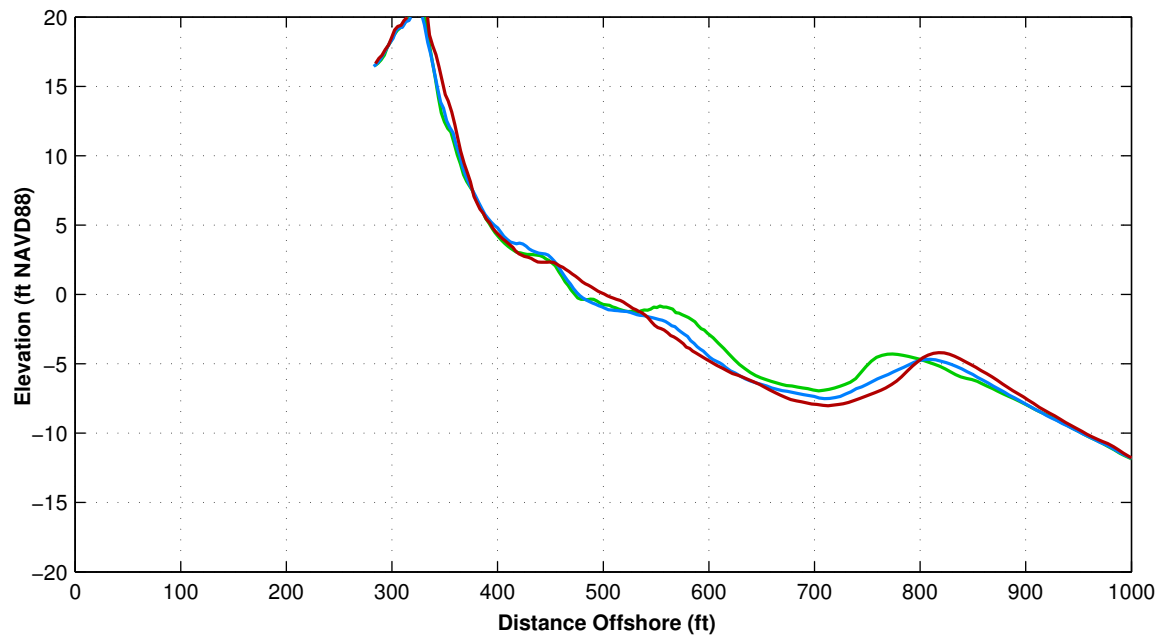
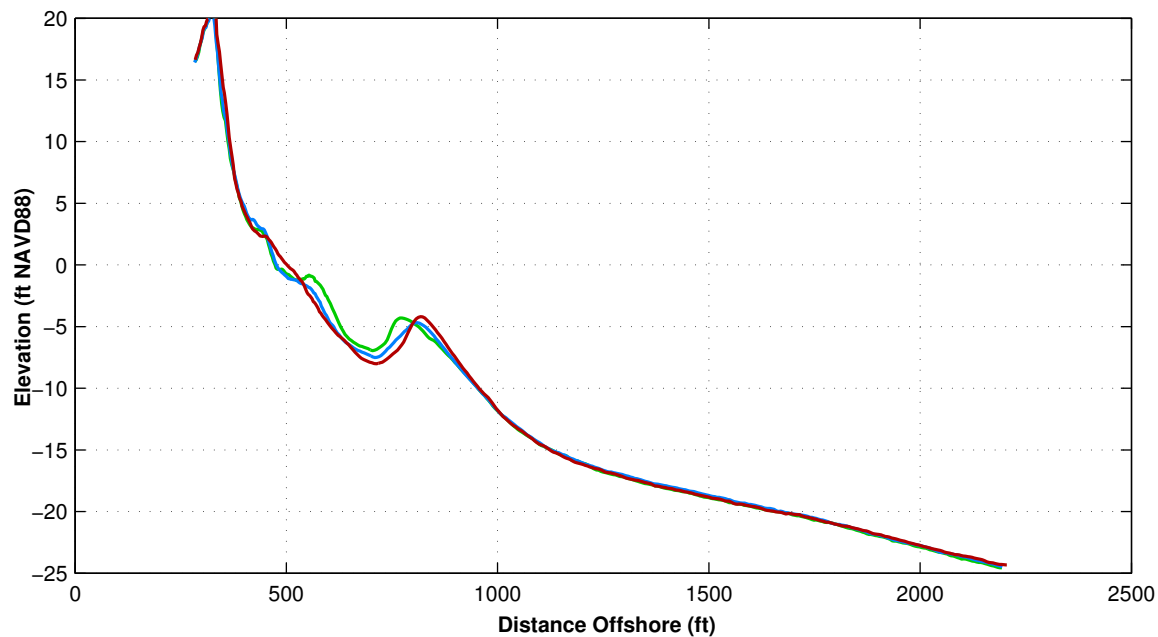
LEGEND:

OCT 2016 — (red line)
MAY 2016 — (blue line)
OCT 2015 — (green line)

Notes:

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Survey Transect 295+27	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	15.15 ft/yr	12.56 ft
Volume Change Above –15 ft NAVD88	–4.45 cy/ft/yr	1.39 cy/ft
Volume Change Above 0 ft NAVD88	3.71 cy/ft/yr	2.24 cy/ft

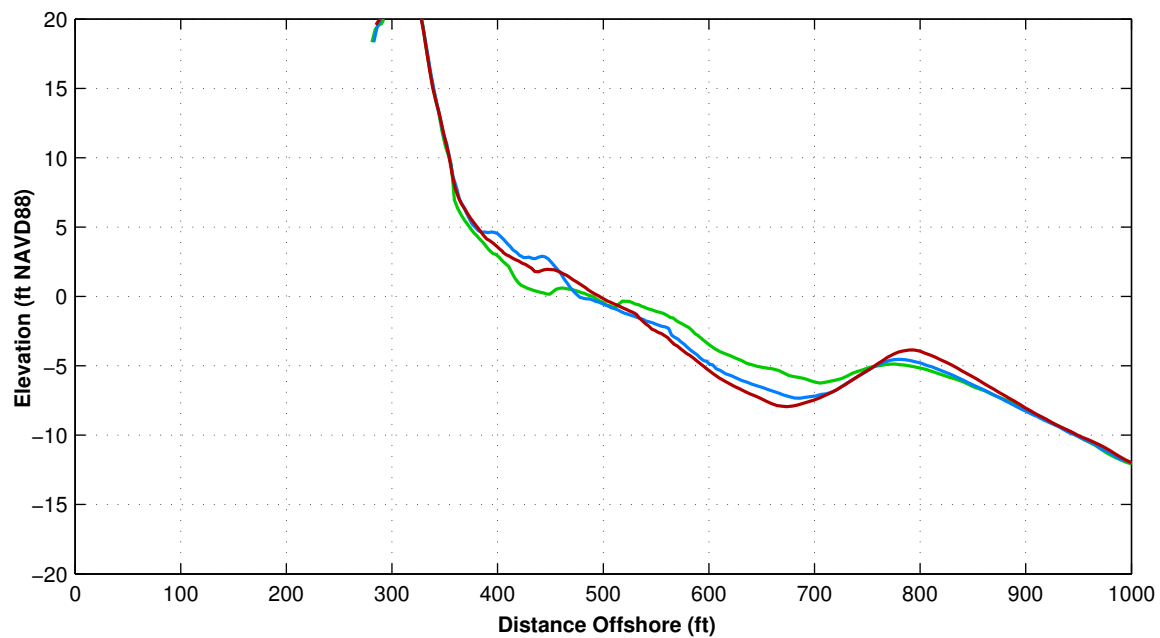
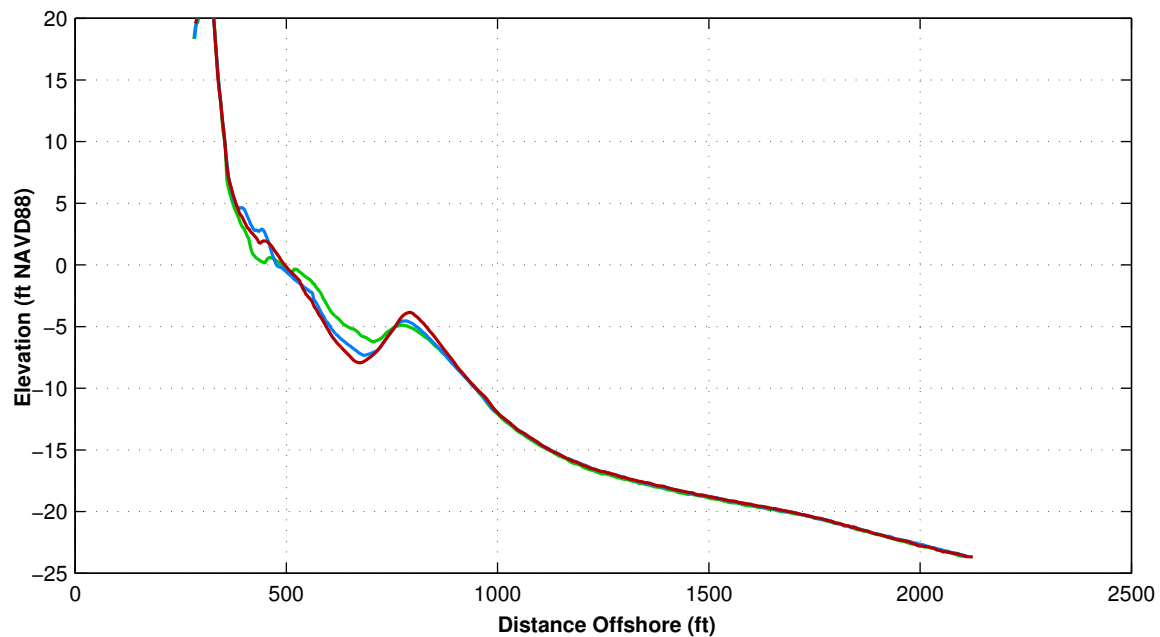
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

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Survey Transect 302+24	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	54.83 ft/yr	10.61 ft
Volume Change Above –15 ft NAVD88	–2.86 cy/ft/yr	–0.76 cy/ft
Volume Change Above 0 ft NAVD88	5.43 cy/ft/yr	–1.03 cy/ft

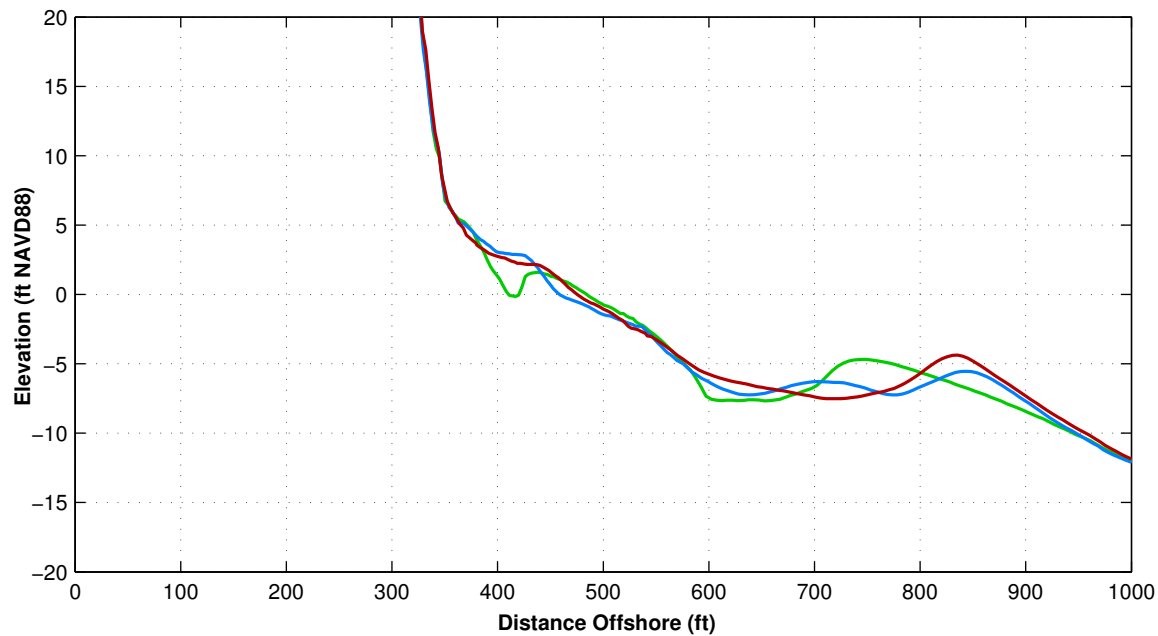
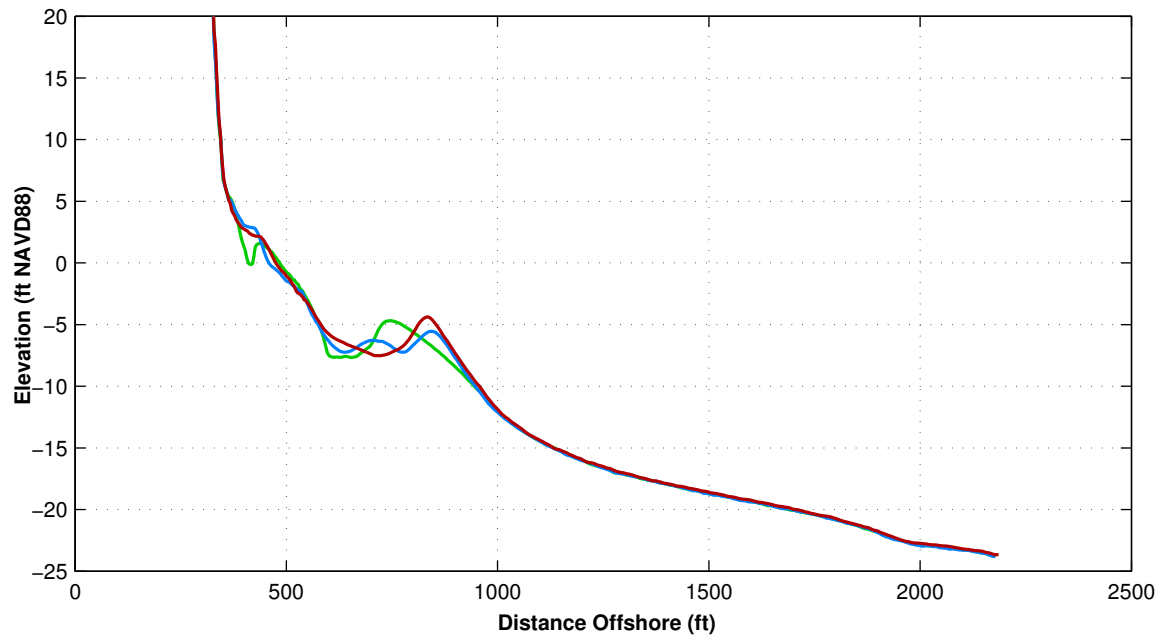
LEGEND:

OCT 2016 — (red line)
MAY 2016 — (blue line)
OCT 2015 — (green line)

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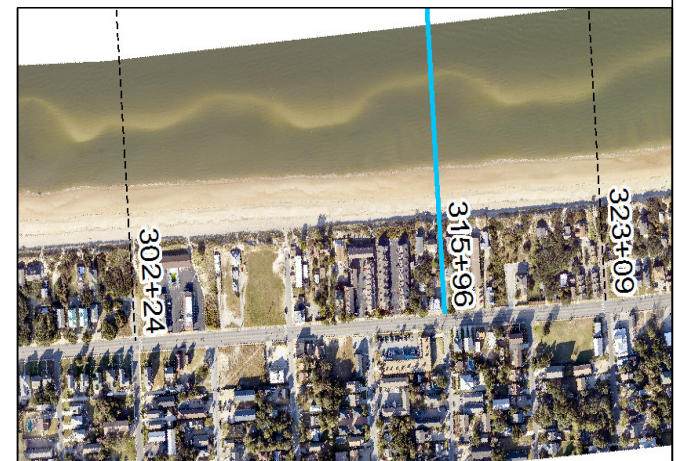
Survey Transect 315+96	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-1.29 ft/yr	13.80 ft
Volume Change Above -15 ft NAVD88	6.57 cy/ft/yr	6.18 cy/ft
Volume Change Above 0 ft NAVD88	2.92 cy/ft/yr	0.46 cy/ft

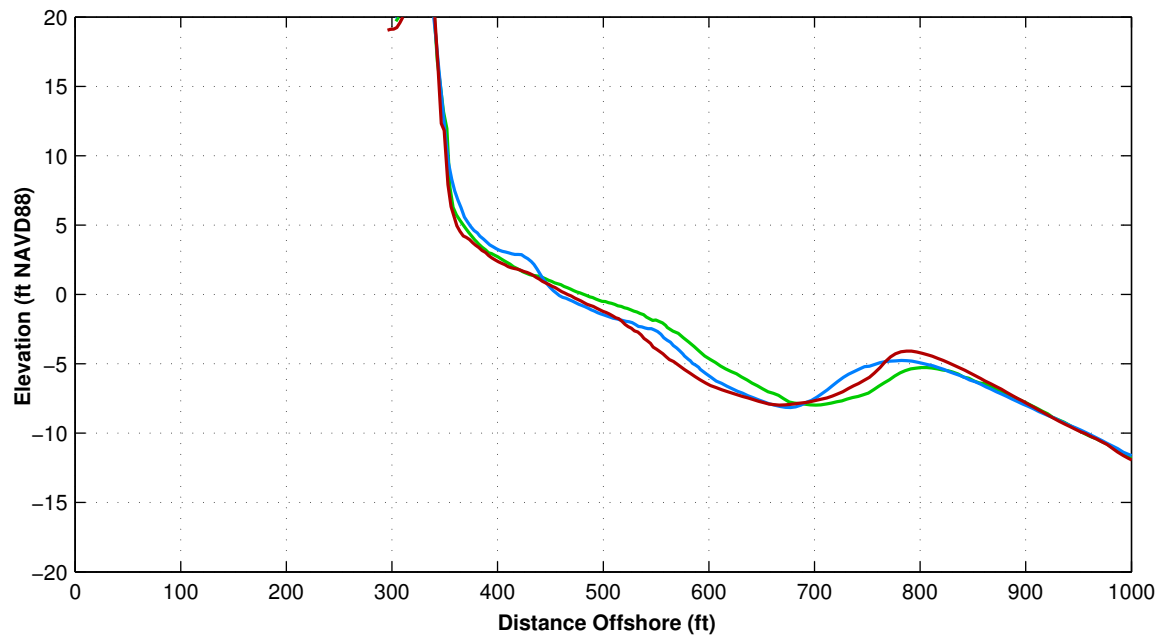
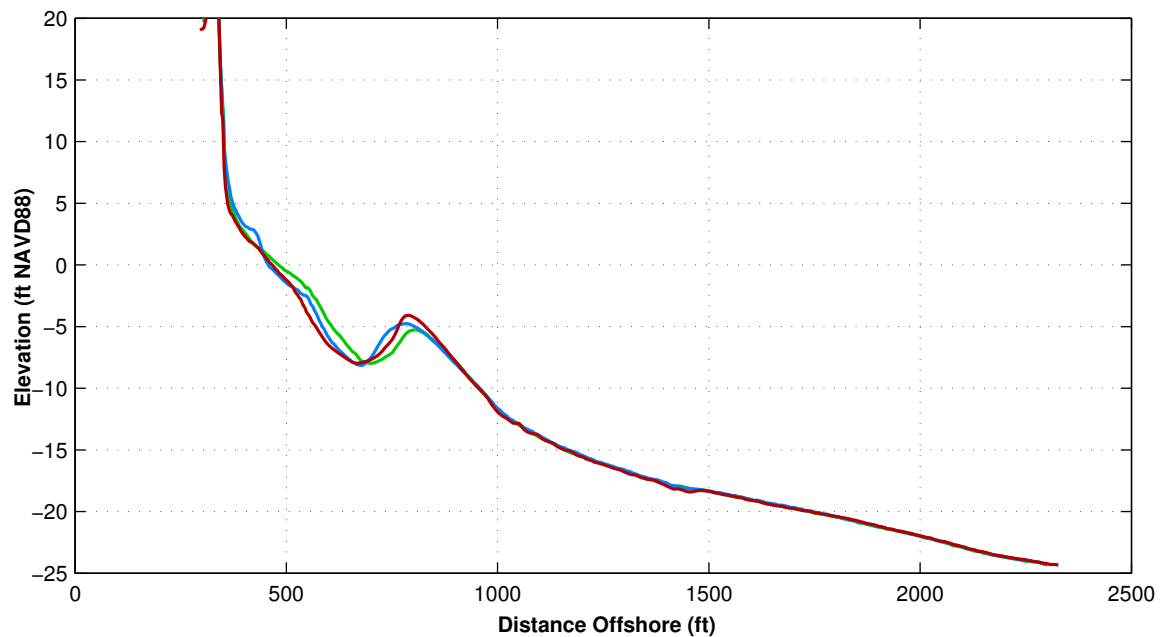
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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Survey Transect 323+09	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	ft/yr	ft
Volume Change Above –15 ft NAVD88	cy/ft/yr	cy/ft
Volume Change Above 0 ft NAVD88	cy/ft/yr	cy/ft

LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

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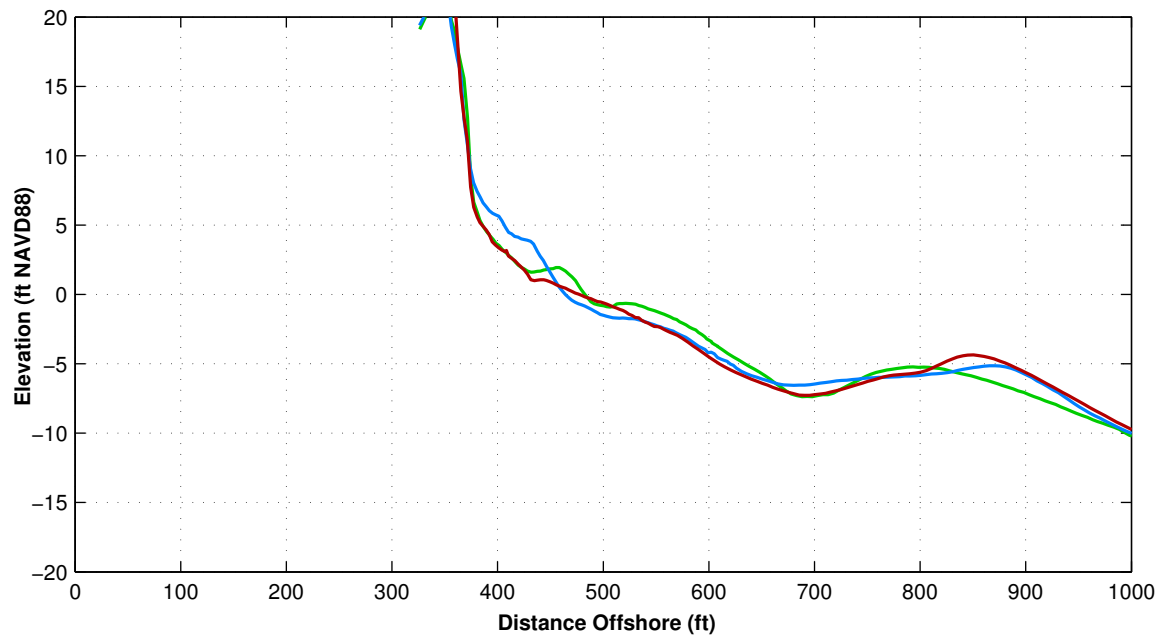
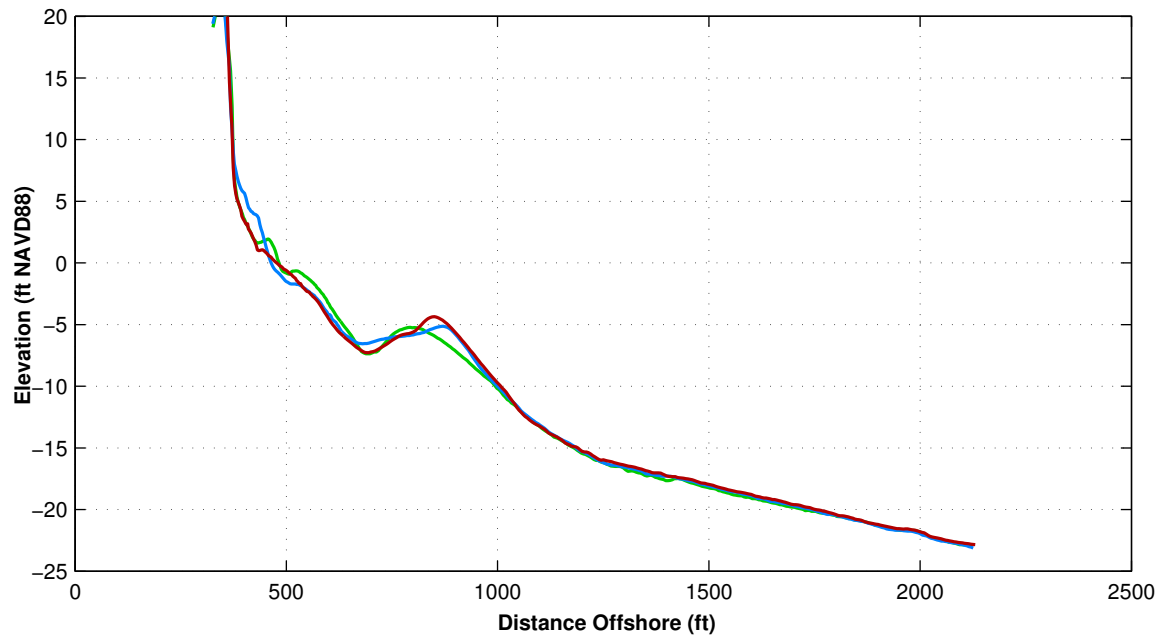


OCEAN VIEW PERIODIC
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ST 323+09

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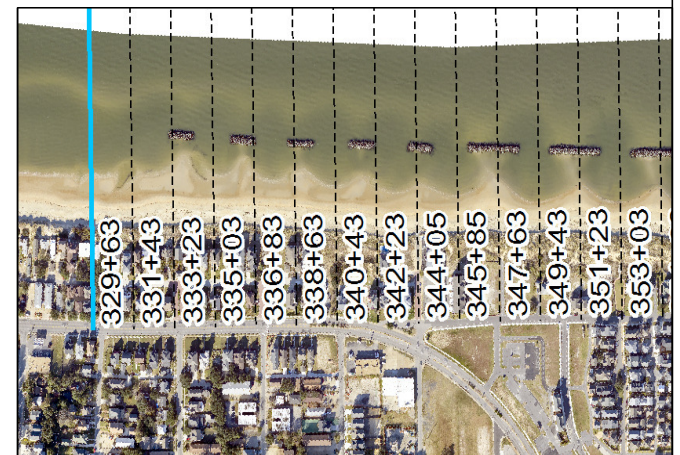
Survey Transect 329+63	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-25.93 ft/yr	-7.35 ft
Volume Change Above -15 ft NAVD88	0.44 cy/ft/yr	-2.28 cy/ft
Volume Change Above 0 ft NAVD88	-1.45 cy/ft/yr	-3.72 cy/ft

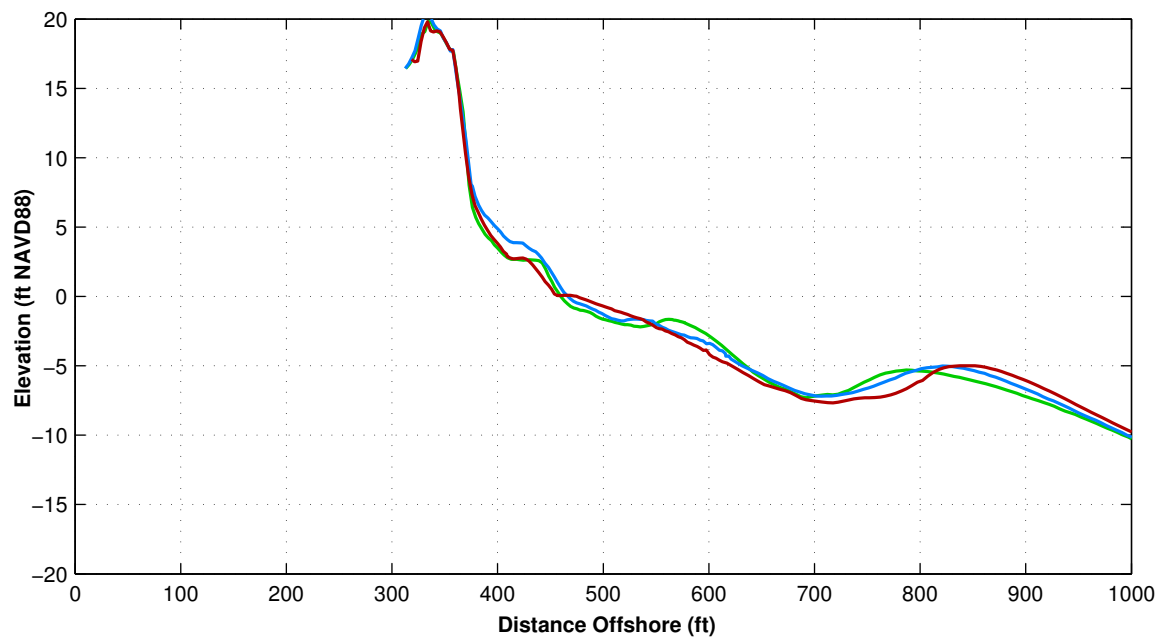
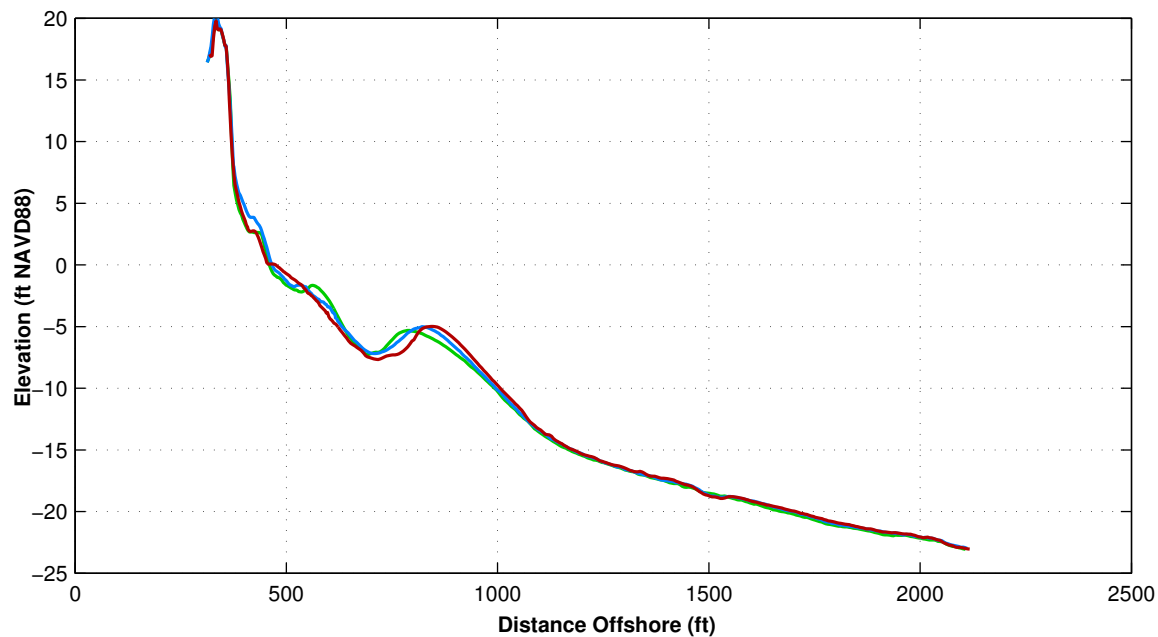
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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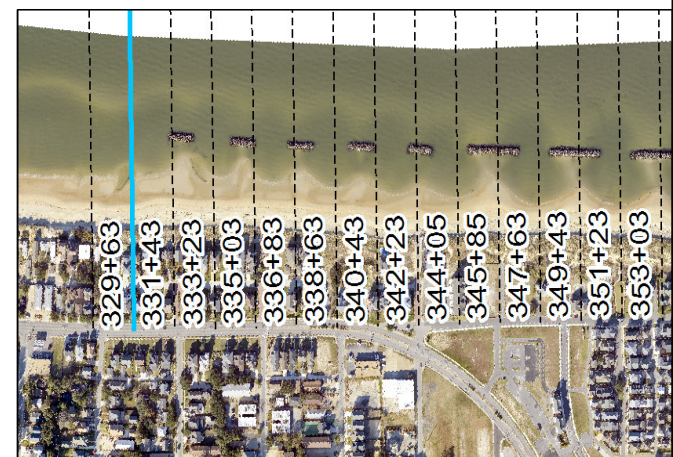
Survey Transect 331+43	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-5.61 ft/yr	-10.76 ft
Volume Change Above -15 ft NAVD88	1.92 cy/ft/yr	-4.81 cy/ft
Volume Change Above 0 ft NAVD88	-0.47 cy/ft/yr	-4.35 cy/ft

LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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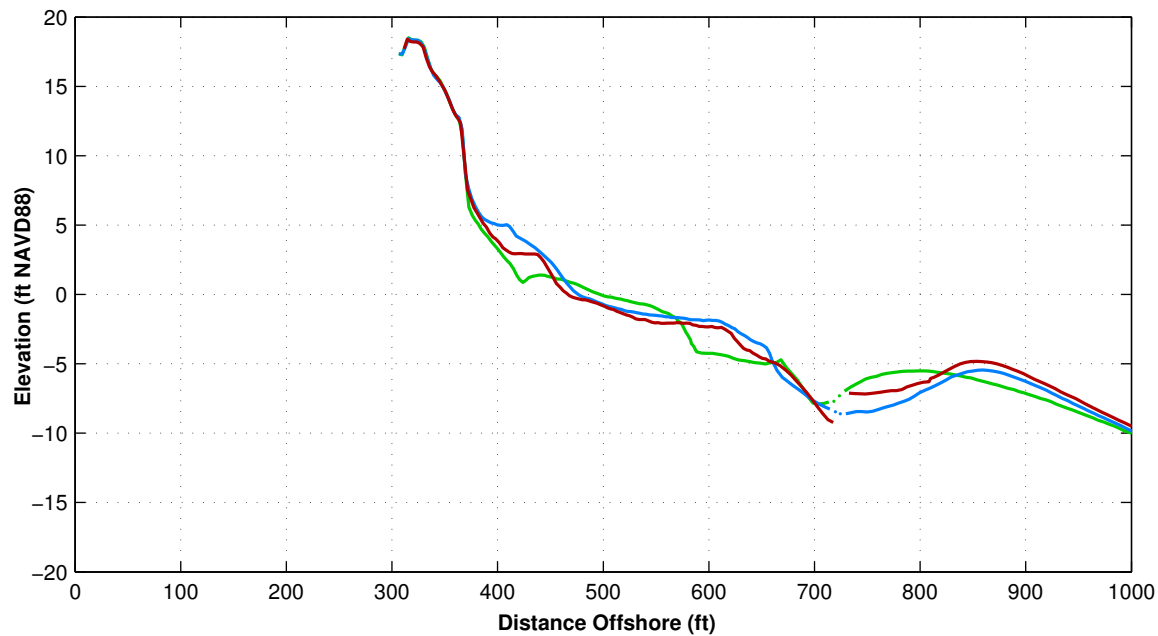
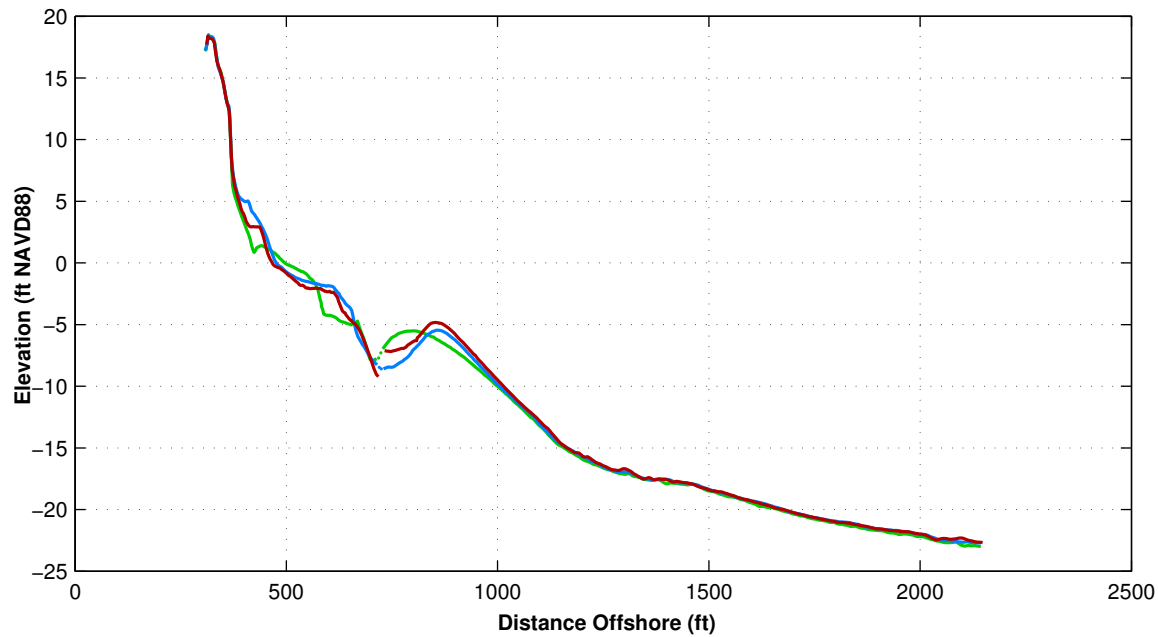


OCEAN VIEW PERIODIC
SURVEYING DATA &
ANALYSIS

ST 331+43

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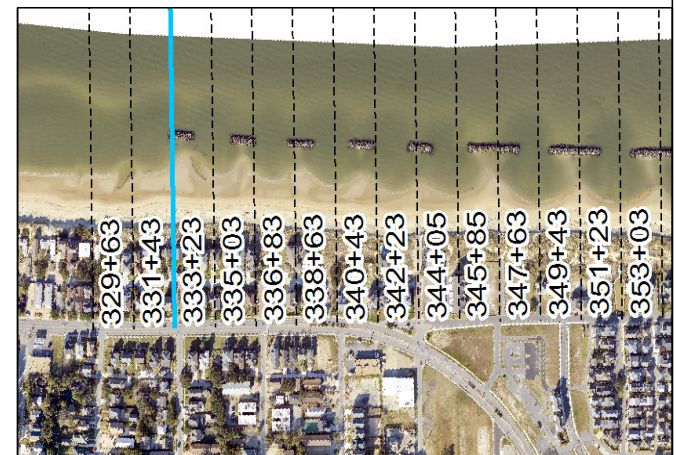
Survey Transect 333+23	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-9.97 ft/yr	-9.47 ft
Volume Change Above -15 ft NAVD88	7.80 cy/ft/yr	1.63 cy/ft
Volume Change Above 0 ft NAVD88	1.93 cy/ft/yr	-3.22 cy/ft

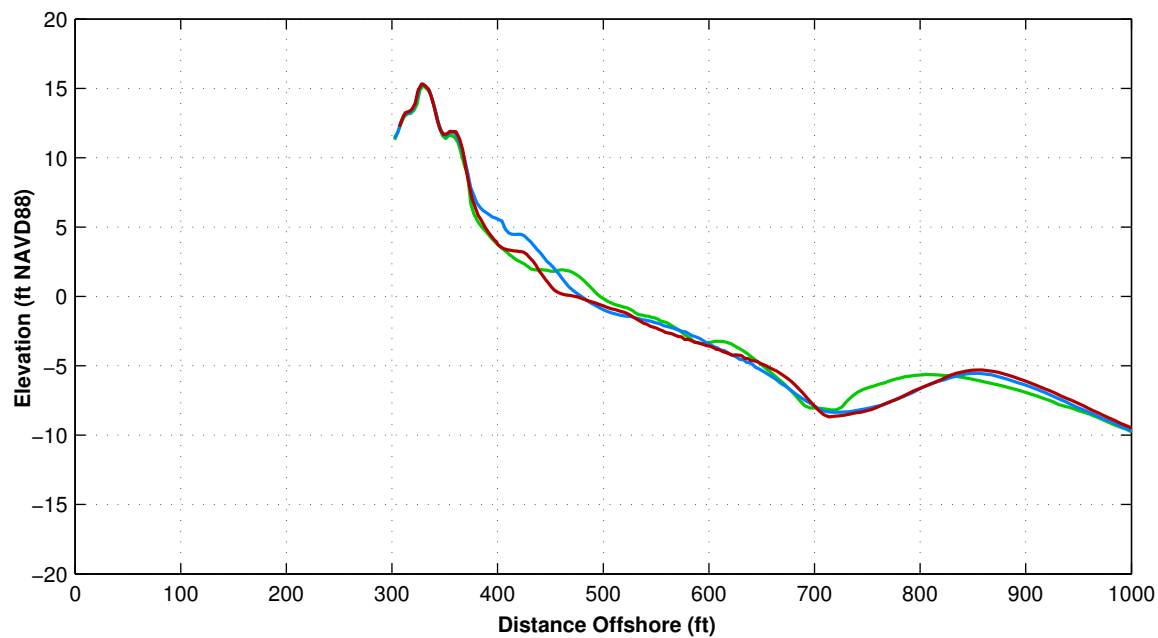
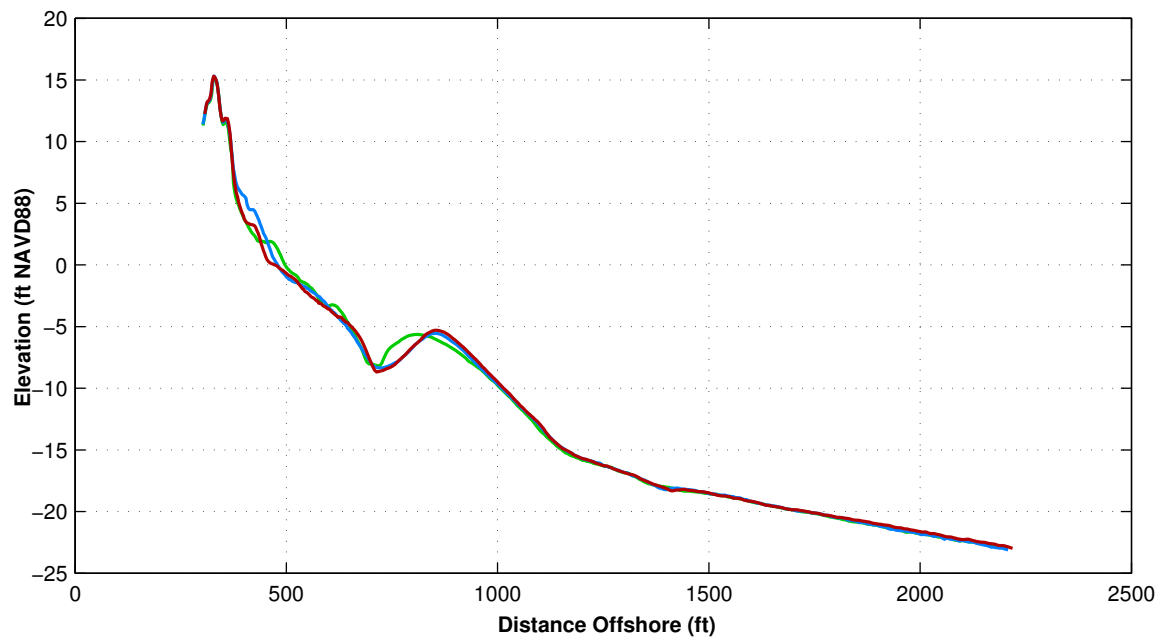
LEGEND:

OCT 2016 — (red line)
MAY 2016 — (blue line)
OCT 2015 — (green line)

Notes:

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Survey Transect 335+03	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-34.93 ft/yr	-16.36 ft
Volume Change Above -15 ft NAVD88	-1.88 cy/ft/yr	-2.03 cy/ft
Volume Change Above 0 ft NAVD88	-0.79 cy/ft/yr	-4.38 cy/ft

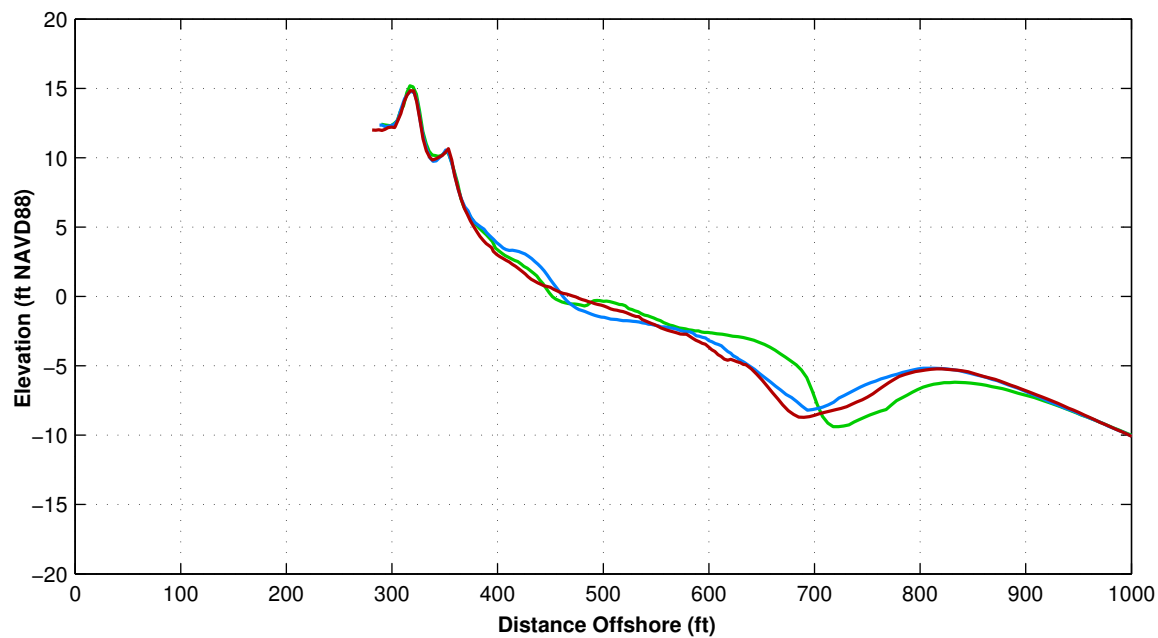
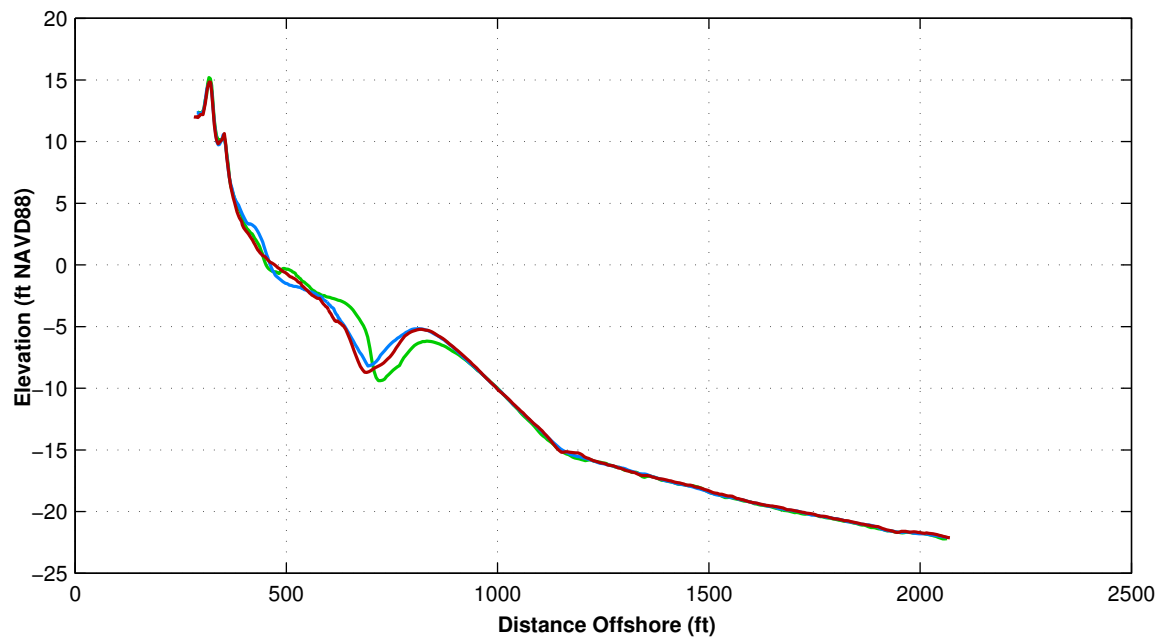
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

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4. Survey Comparison Made to OCT 2015 and MAY 2016
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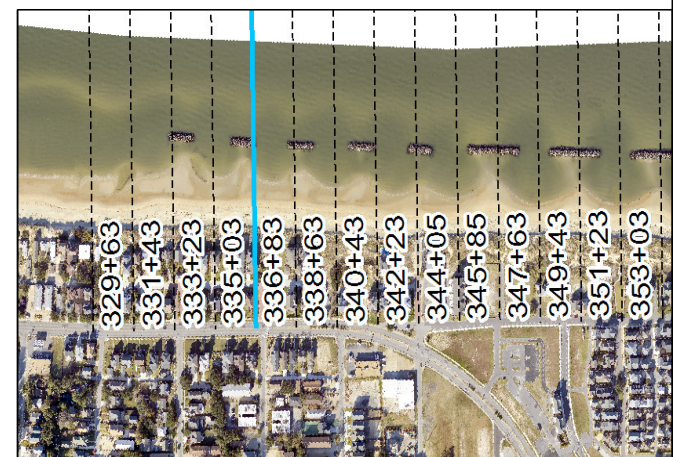
Survey Transect 336+83	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-4.37 ft/yr	-14.42 ft
Volume Change Above -15 ft NAVD88	-3.47 cy/ft/yr	-5.65 cy/ft
Volume Change Above 0 ft NAVD88	-1.39 cy/ft/yr	-2.99 cy/ft

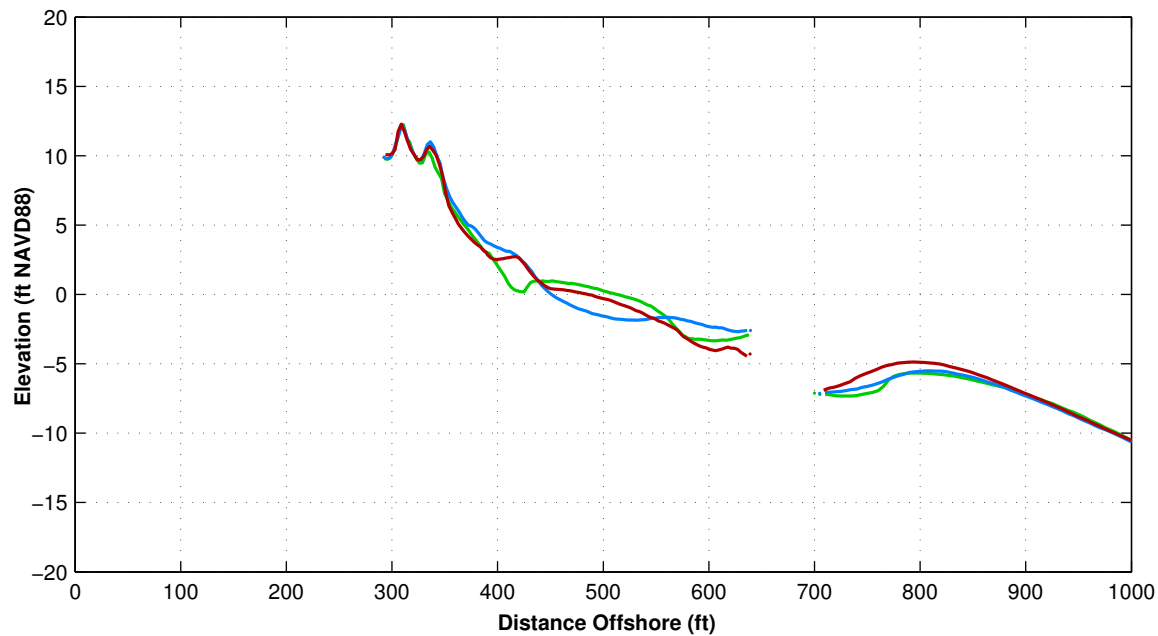
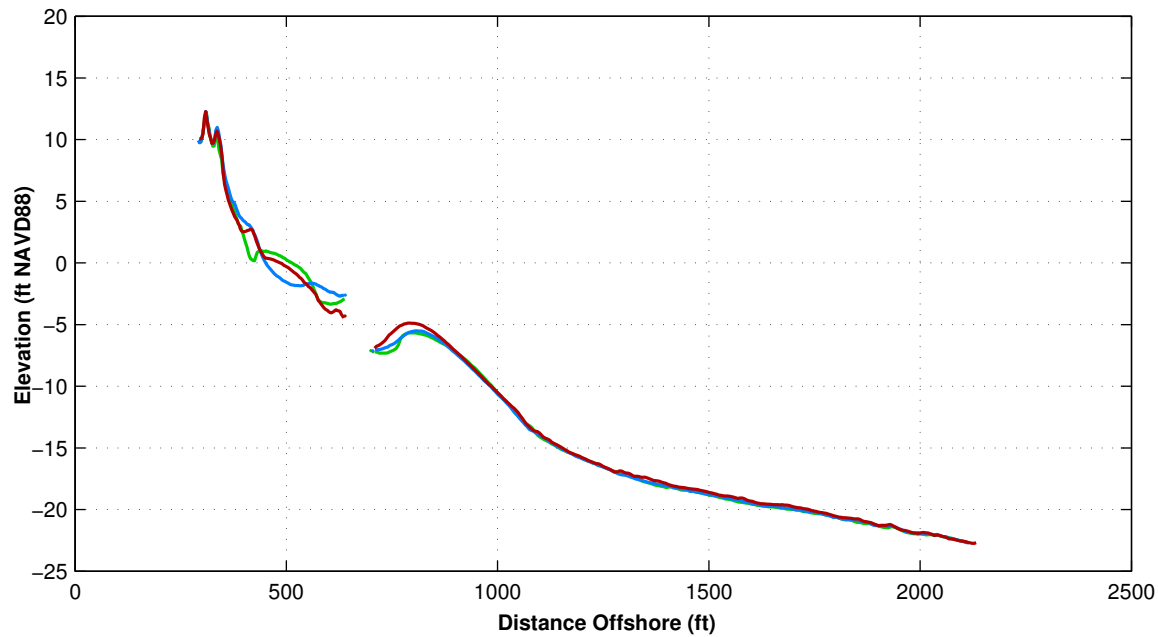
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

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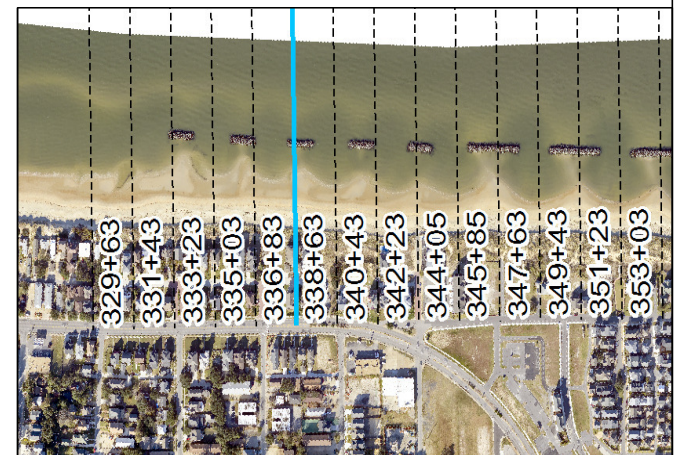
Survey Transect 338+63	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	29.05 ft/yr	0.53 ft
Volume Change Above –15 ft NAVD88	3.42 cy/ft/yr	2.39 cy/ft
Volume Change Above 0 ft NAVD88	0.99 cy/ft/yr	–1.71 cy/ft

LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

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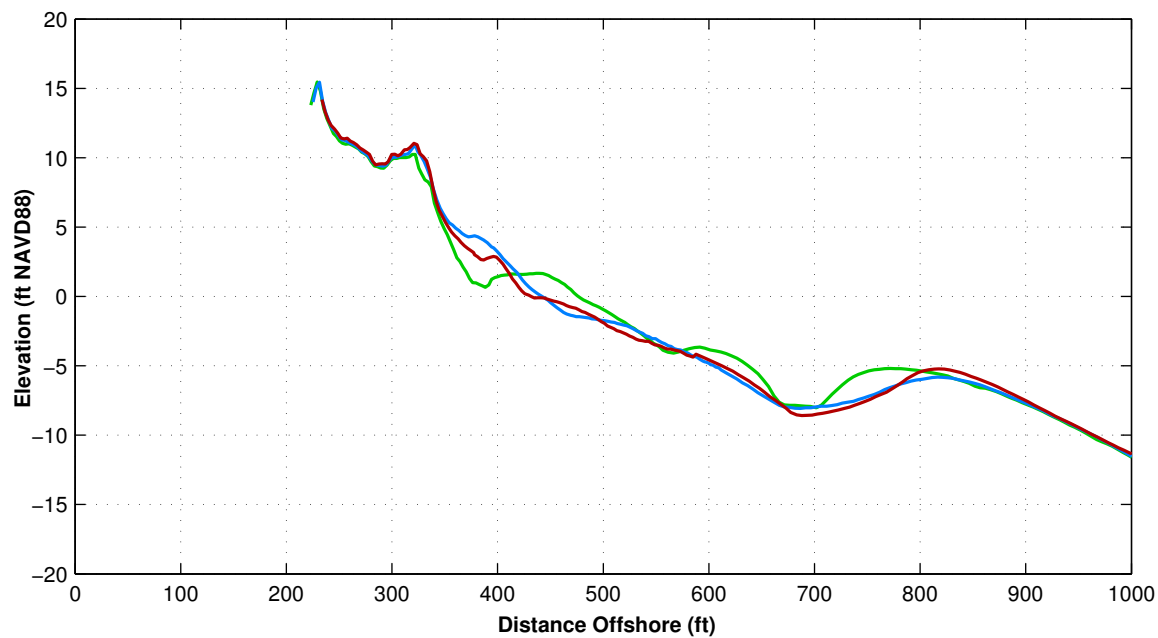
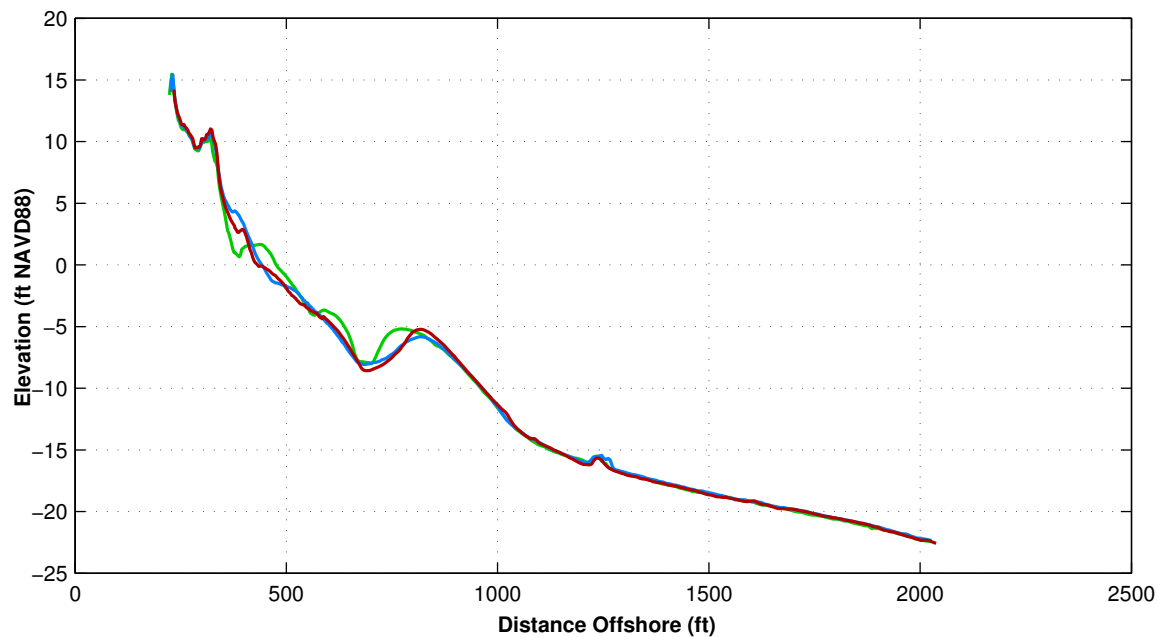


OCEAN VIEW PERIODIC
SURVEYING DATA &
ANALYSIS

ST 338+63

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Fall 2016



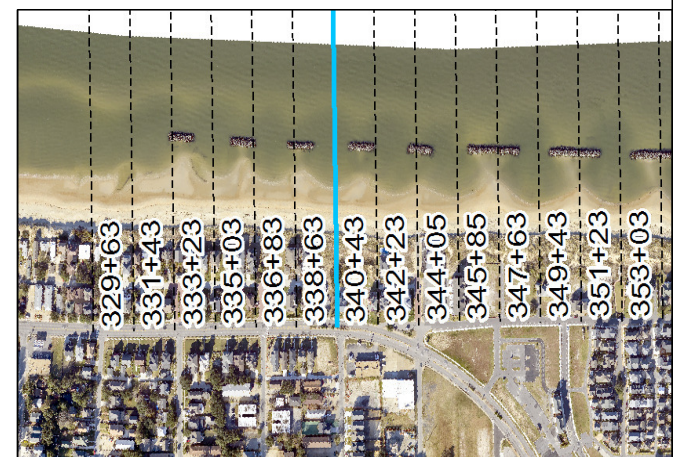
Survey Transect 340+43	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-42.56 ft/yr	-8.66 ft
Volume Change Above -15 ft NAVD88	-5.21 cy/ft/yr	-0.41 cy/ft
Volume Change Above 0 ft NAVD88	2.50 cy/ft/yr	-2.03 cy/ft

LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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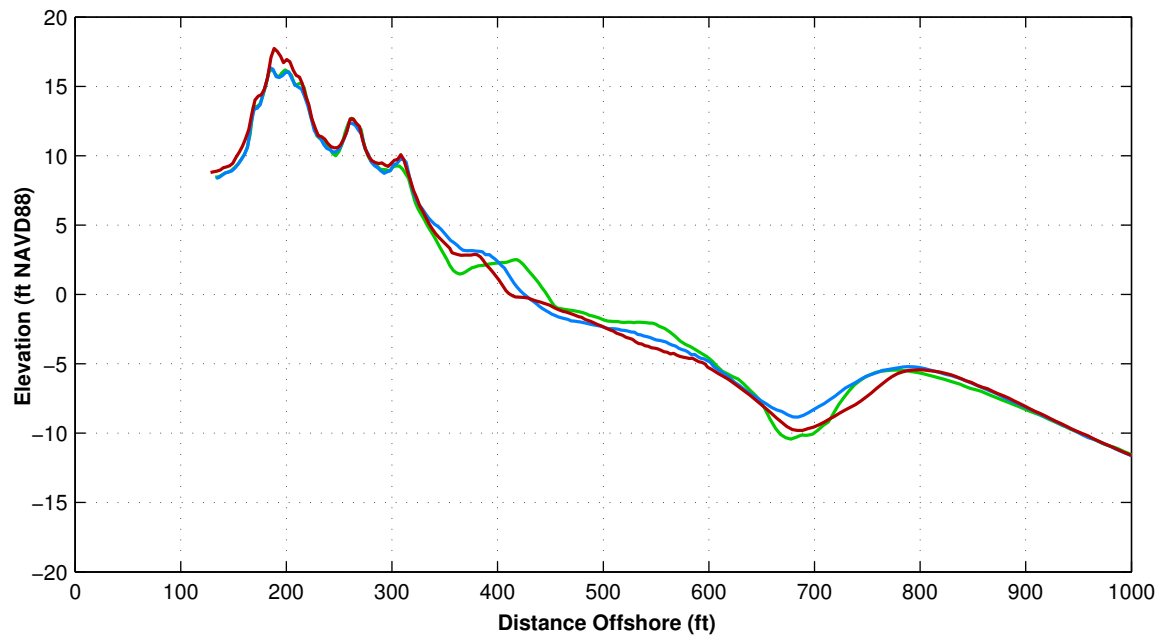
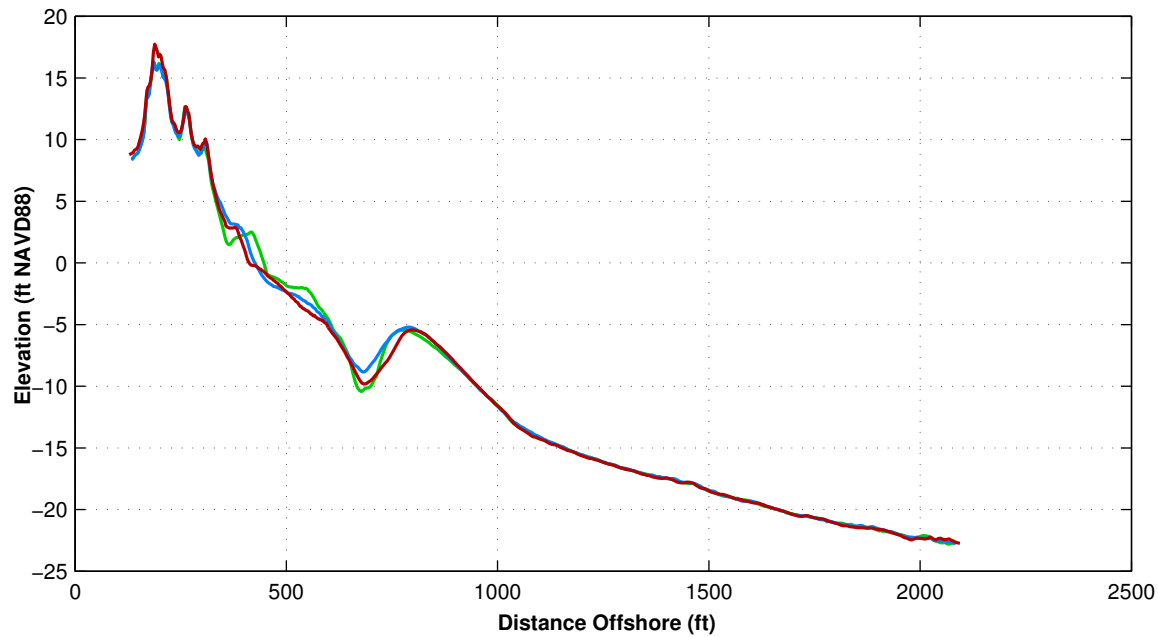


OCEAN VIEW PERIODIC
SURVEYING DATA &
ANALYSIS

ST 340+43

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Fall 2016



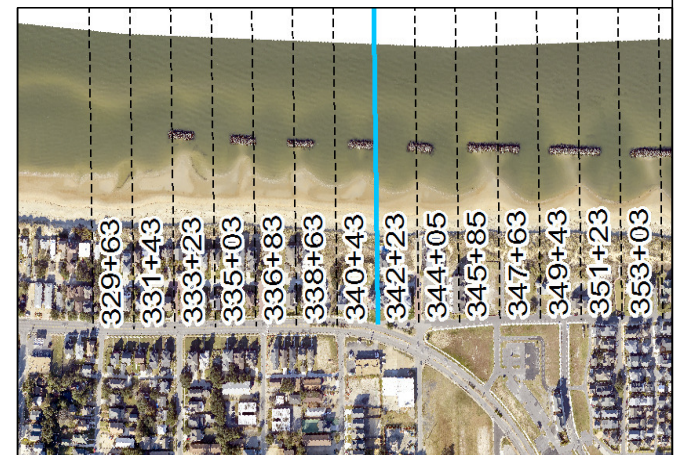
Survey Transect 342+23	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-34.50 ft/yr	-12.22 ft
Volume Change Above -15 ft NAVD88	-4.01 cy/ft/yr	-6.35 cy/ft
Volume Change Above 0 ft NAVD88	1.81 cy/ft/yr	0.74 cy/ft

LEGEND:

OCT 2016 — (red line)
MAY 2016 — (blue line)
OCT 2015 — (green line)

Notes:

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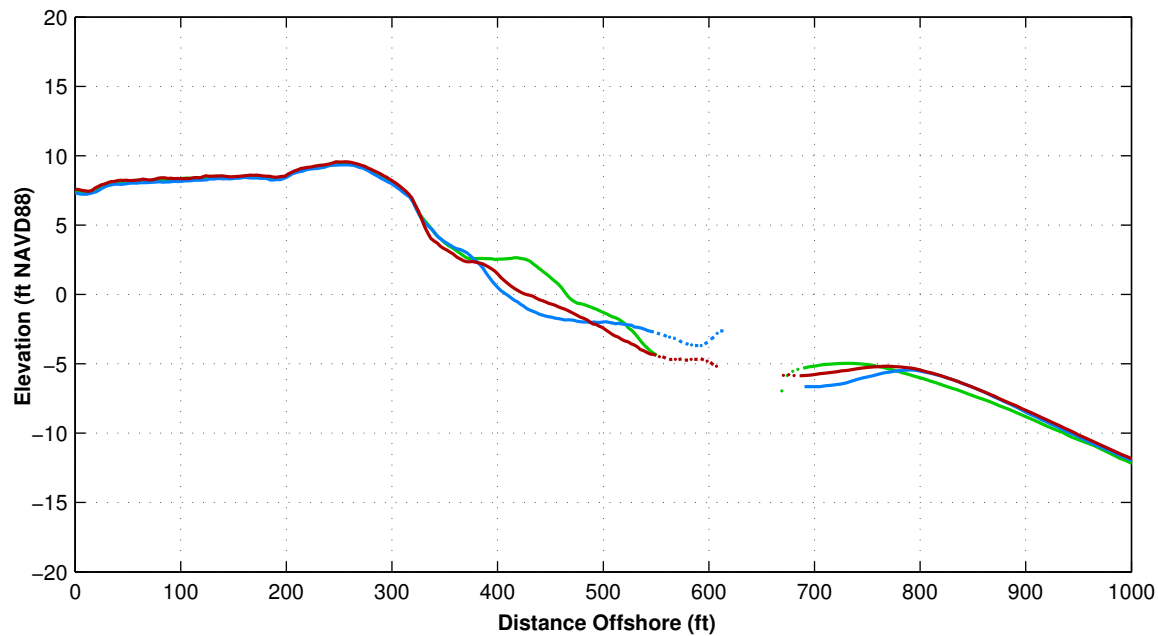
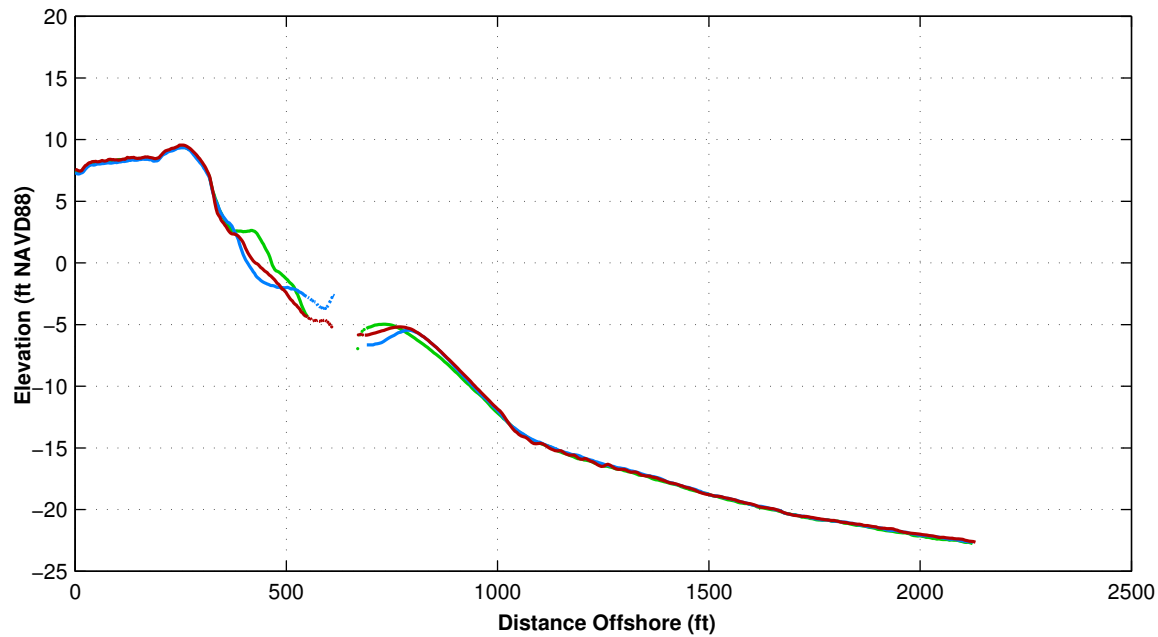


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SURVEYING DATA &
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ST 342+23

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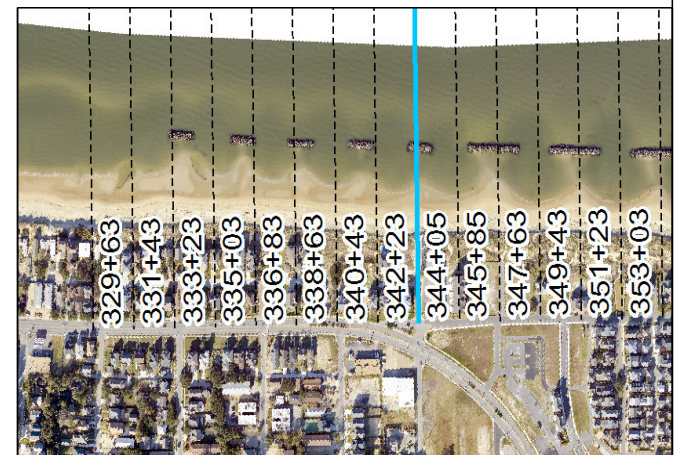
Survey Transect 344+05	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-45.75 ft/yr	12.12 ft
Volume Change Above -15 ft NAVD88	-5.10 cy/ft/yr	5.03 cy/ft
Volume Change Above 0 ft NAVD88	-3.97 cy/ft/yr	2.61 cy/ft

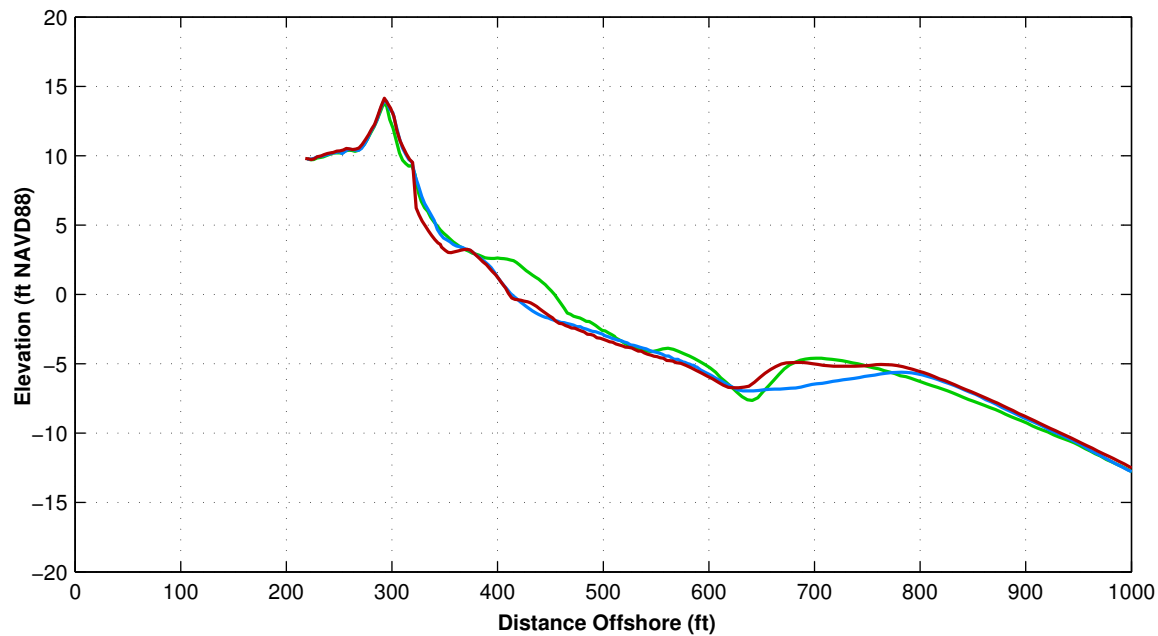
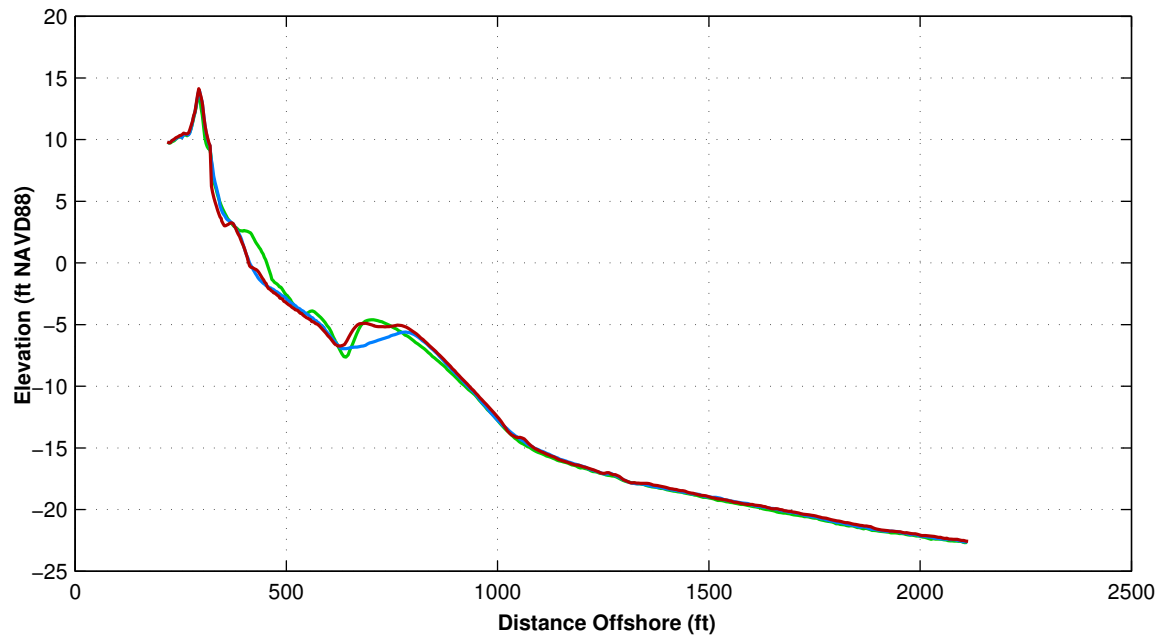
LEGEND:

OCT 2016 — (red line)
MAY 2016 — (blue line)
OCT 2015 — (green line)

Notes:

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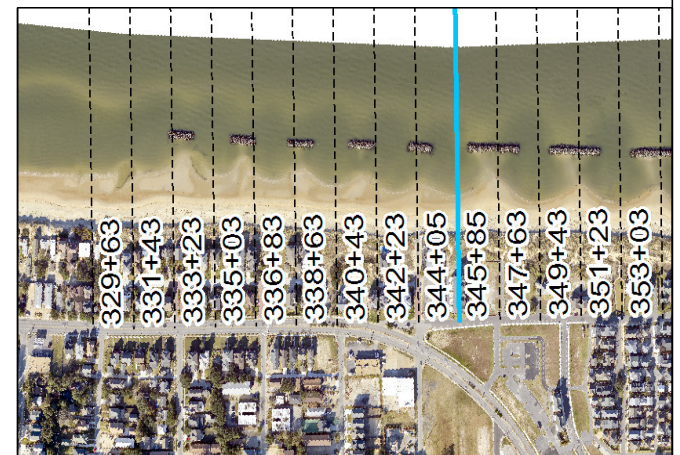
Survey Transect 345+85	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-37.18 ft/yr	-0.04 ft
Volume Change Above -15 ft NAVD88	-3.53 cy/ft/yr	4.74 cy/ft
Volume Change Above 0 ft NAVD88	-4.03 cy/ft/yr	-1.66 cy/ft

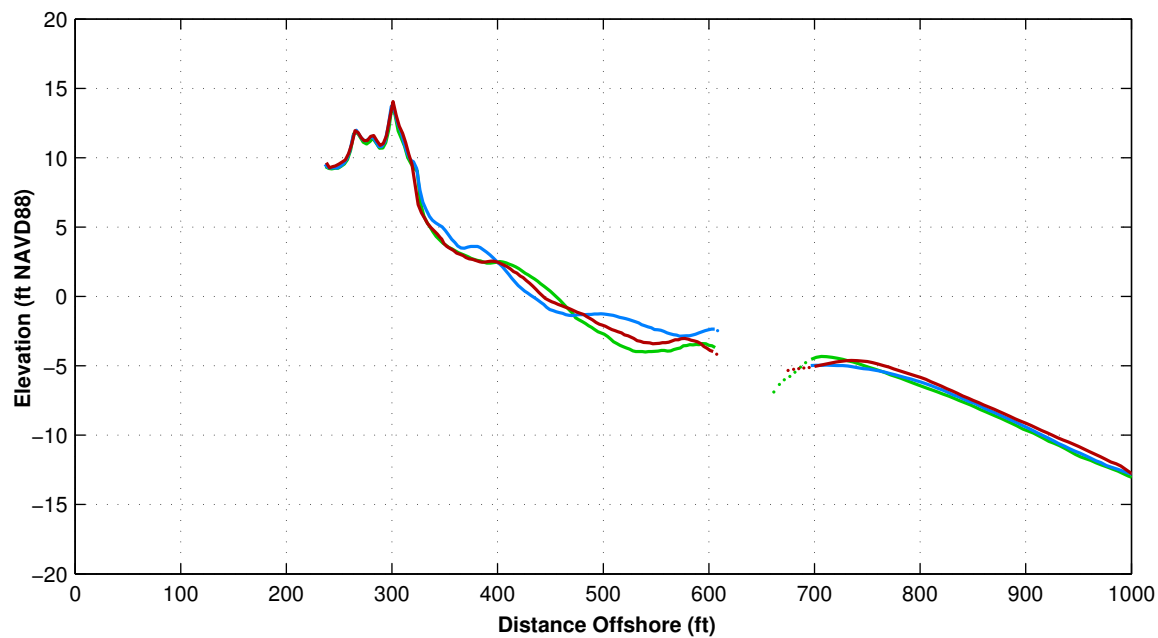
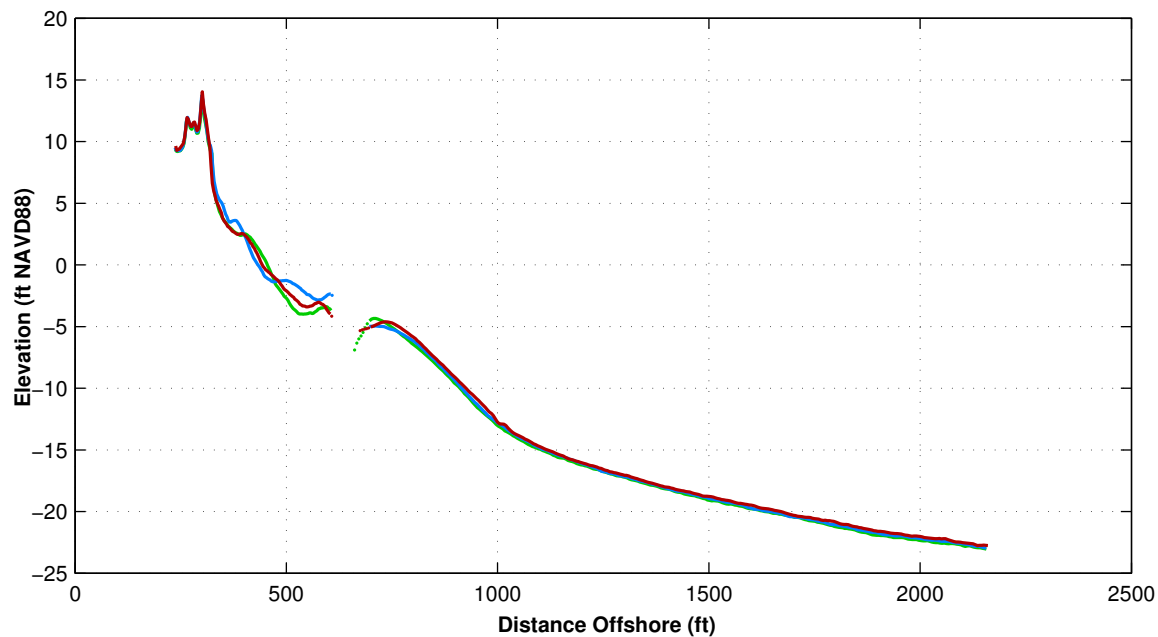
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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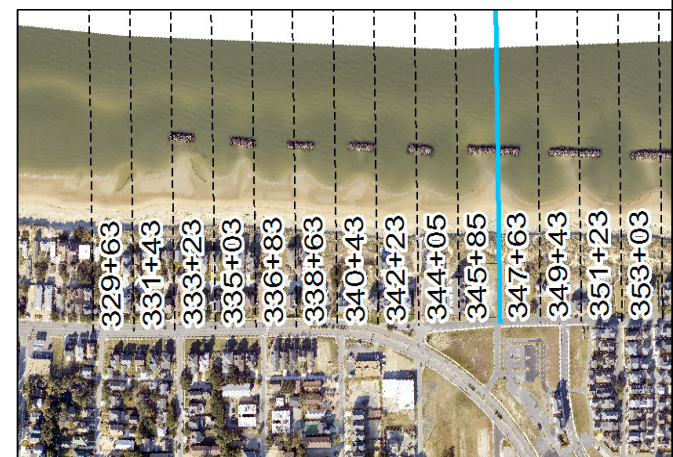
Survey Transect 347+63	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-9.60 ft/yr	12.60 ft
Volume Change Above -15 ft NAVD88	7.21 cy/ft/yr	-0.45 cy/ft
Volume Change Above 0 ft NAVD88	-0.43 cy/ft/yr	-1.27 cy/ft

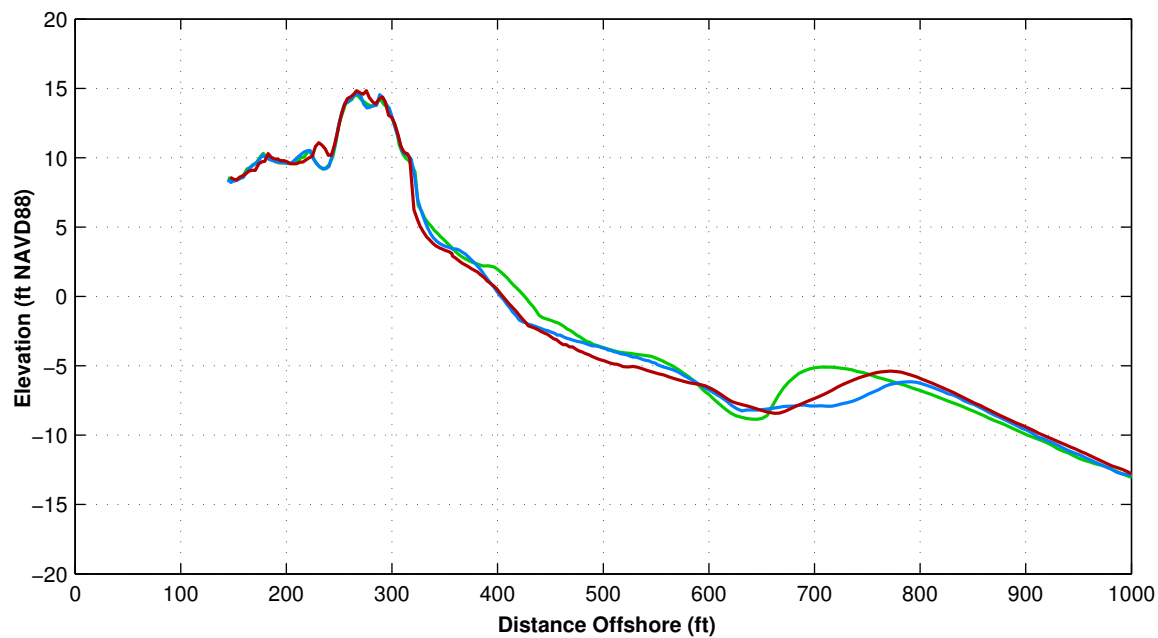
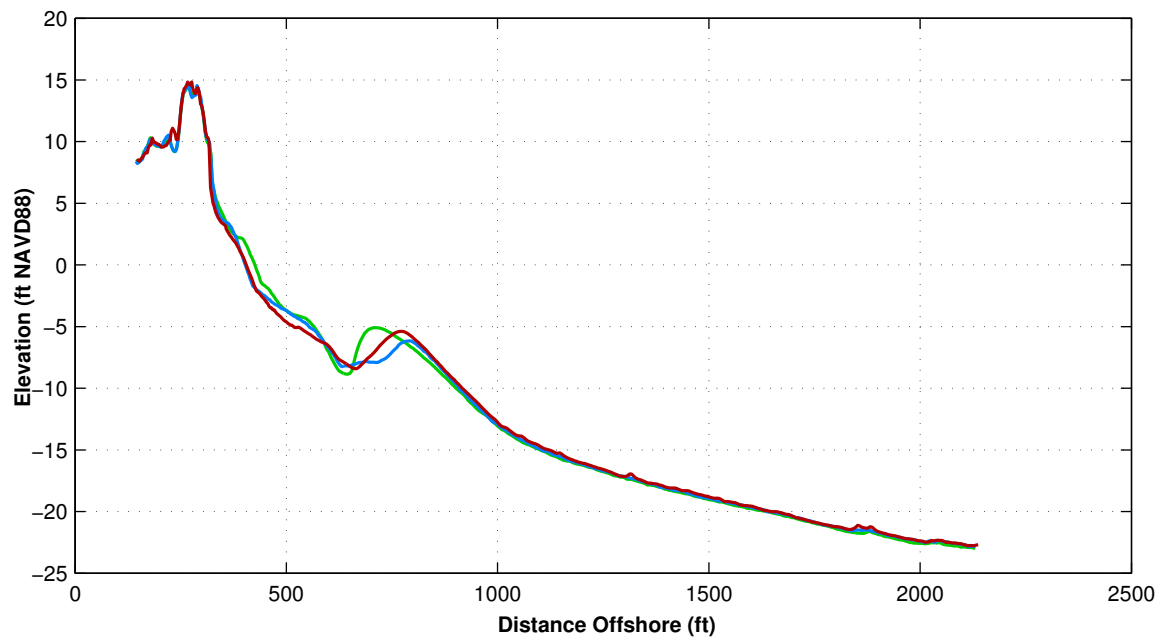
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

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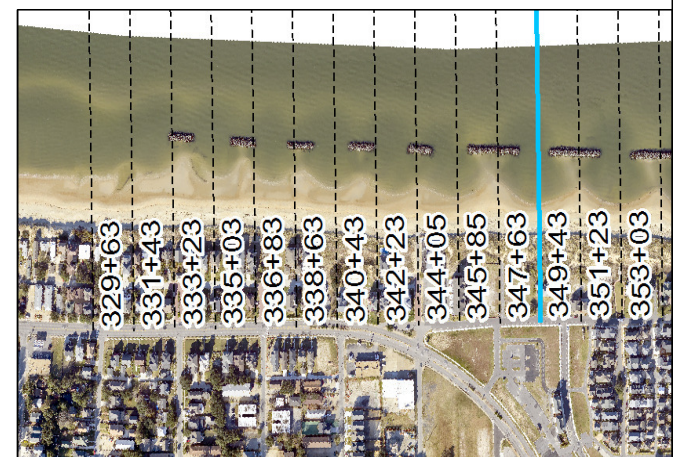
Survey Transect 349+43	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-19.96 ft/yr	-0.44 ft
Volume Change Above -15 ft NAVD88	-6.06 cy/ft/yr	2.49 cy/ft
Volume Change Above 0 ft NAVD88	-2.54 cy/ft/yr	-1.05 cy/ft

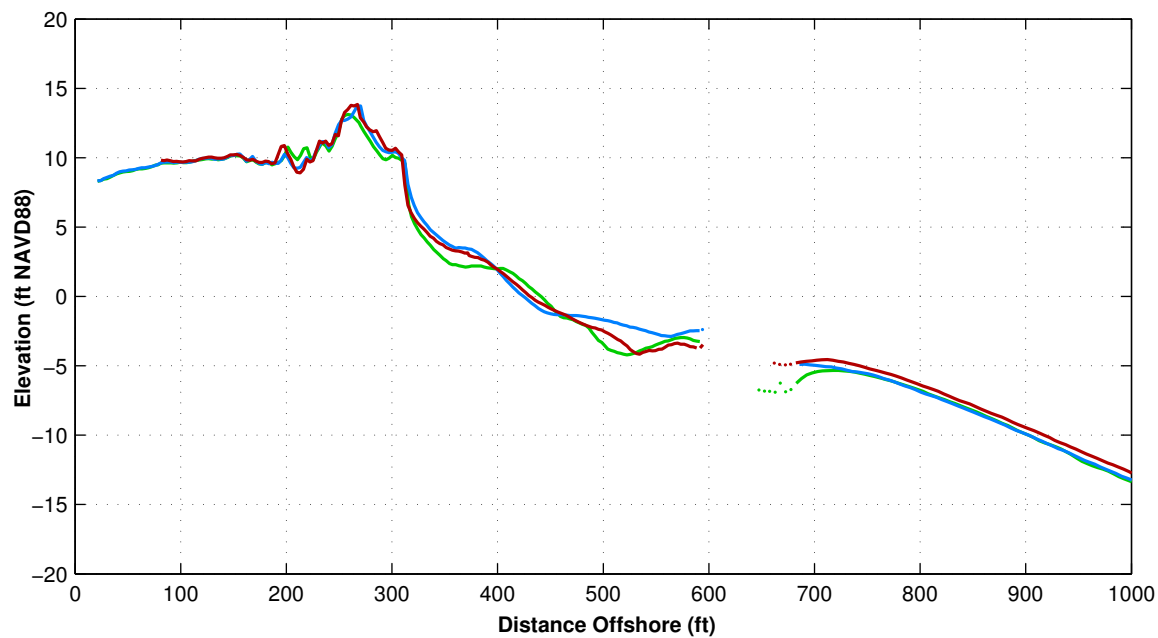
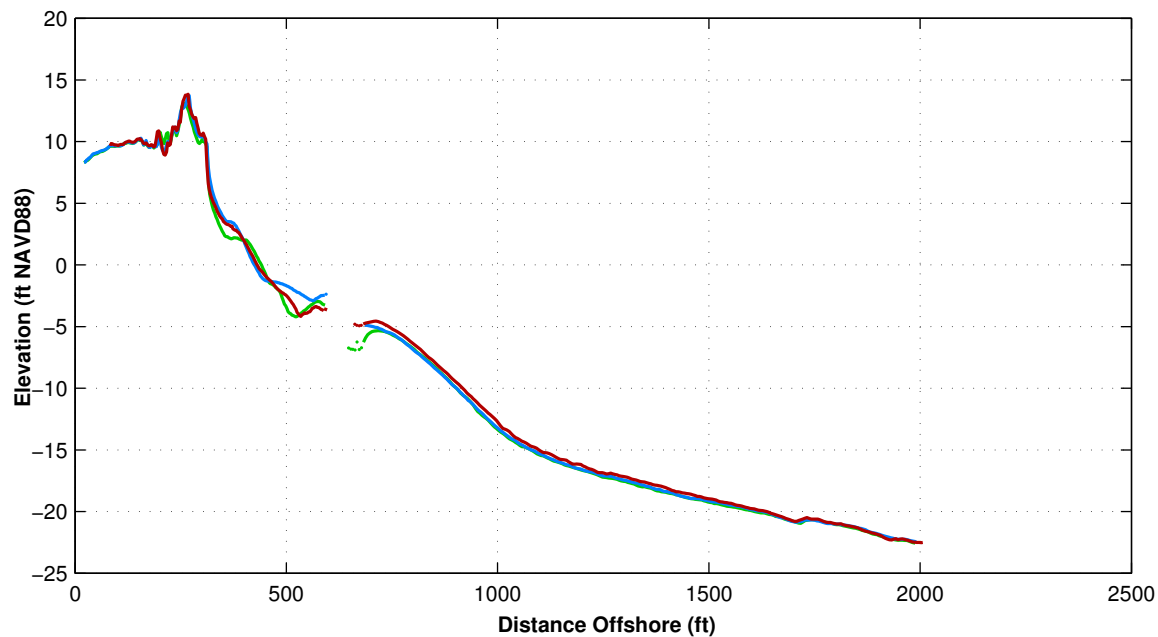
LEGEND:

OCT 2016 — (red line)
MAY 2016 — (blue line)
OCT 2015 — (green line)

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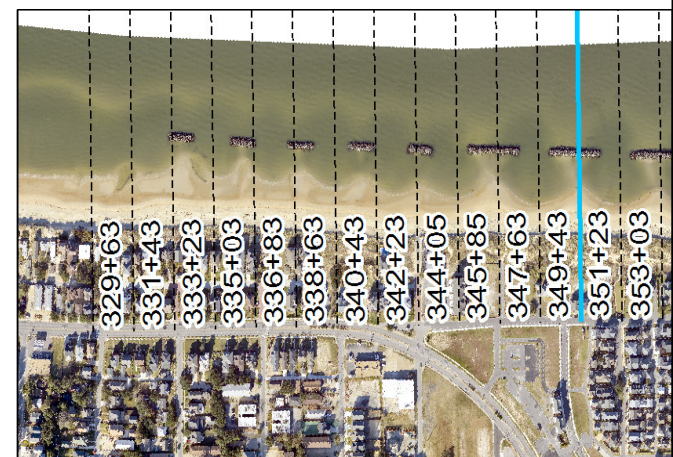
Survey Transect 351+23	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-9.80 ft/yr	5.18 ft
Volume Change Above -15 ft NAVD88	11.77 cy/ft/yr	1.95 cy/ft
Volume Change Above 0 ft NAVD88	2.67 cy/ft/yr	-0.33 cy/ft

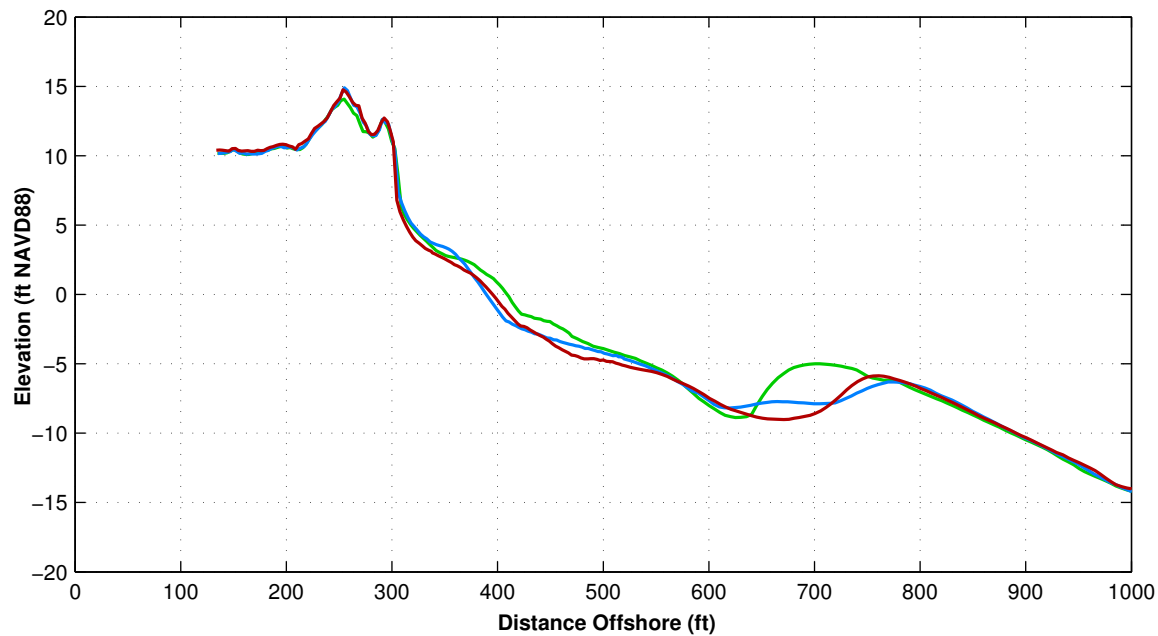
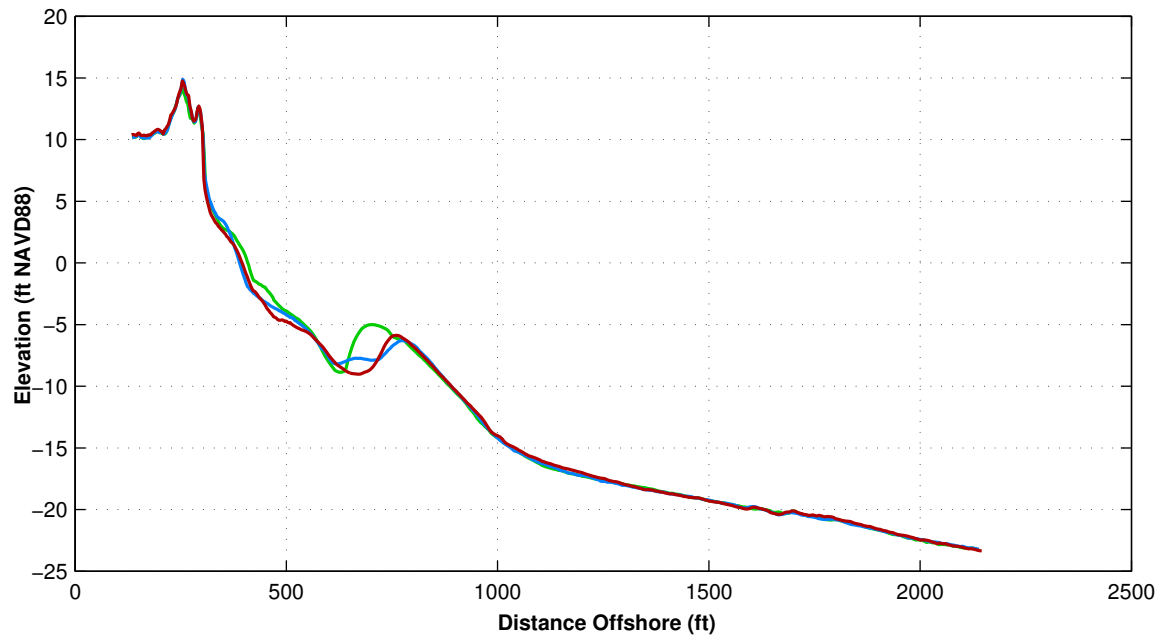
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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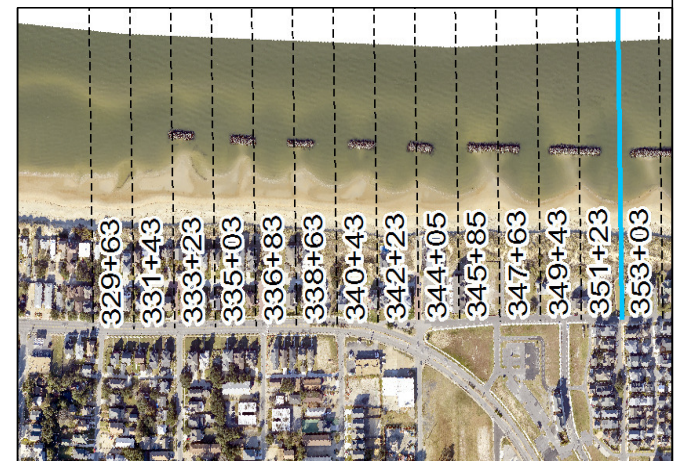
Survey Transect 353+03	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-14.27 ft/yr	2.83 ft
Volume Change Above -15 ft NAVD88	-13.30 cy/ft/yr	-3.51 cy/ft
Volume Change Above 0 ft NAVD88	-1.18 cy/ft/yr	-1.10 cy/ft

LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

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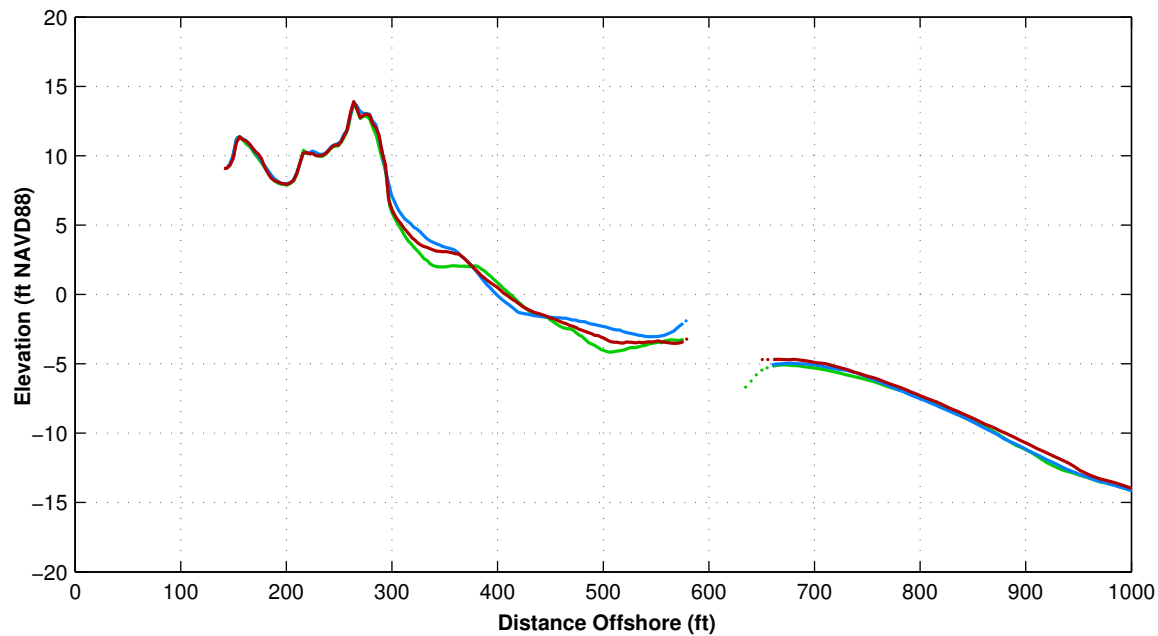
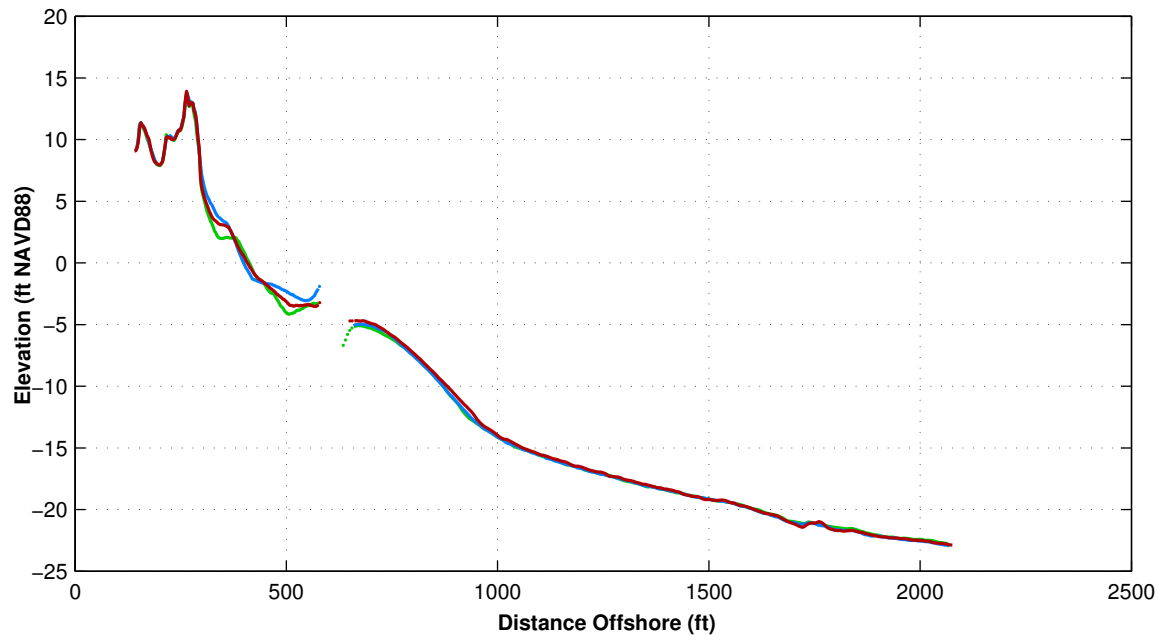


OCEAN VIEW PERIODIC
SURVEYING DATA &
ANALYSIS

ST 353+03

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Fall 2016



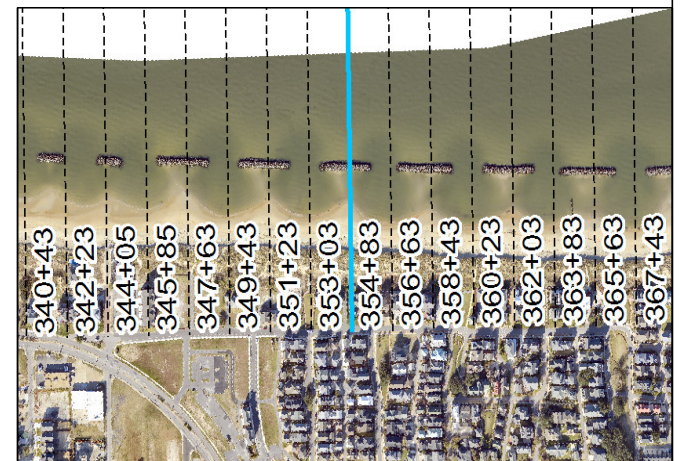
Survey Transect 354+83	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-7.18 ft/yr	3.81 ft
Volume Change Above -15 ft NAVD88	8.09 cy/ft/yr	-0.17 cy/ft
Volume Change Above 0 ft NAVD88	2.04 cy/ft/yr	-1.64 cy/ft

LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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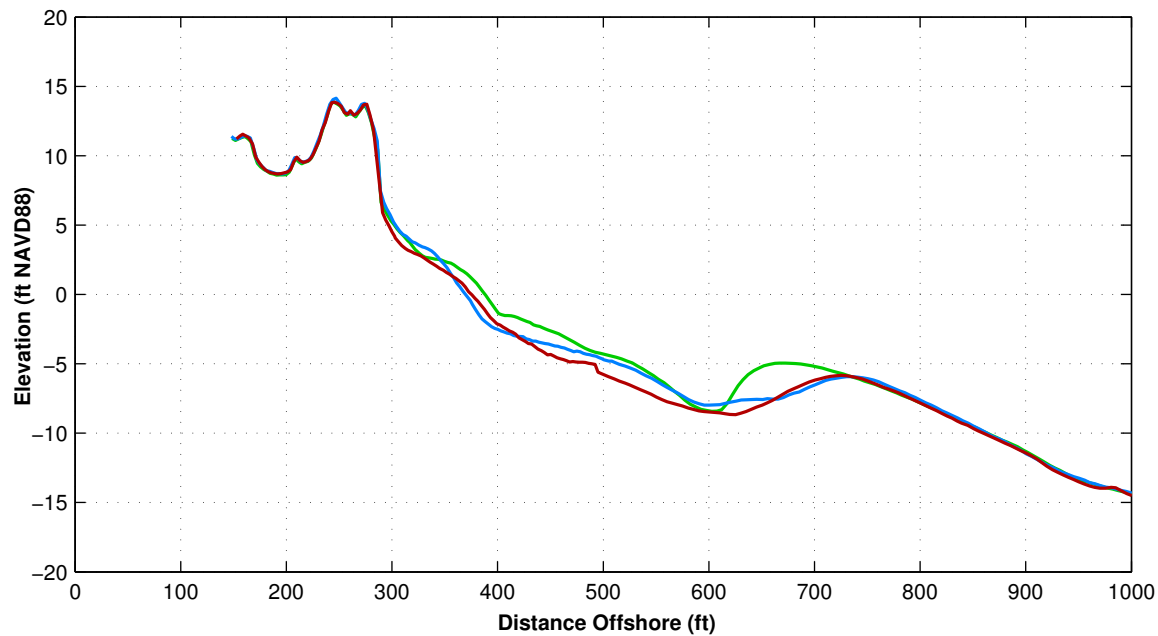
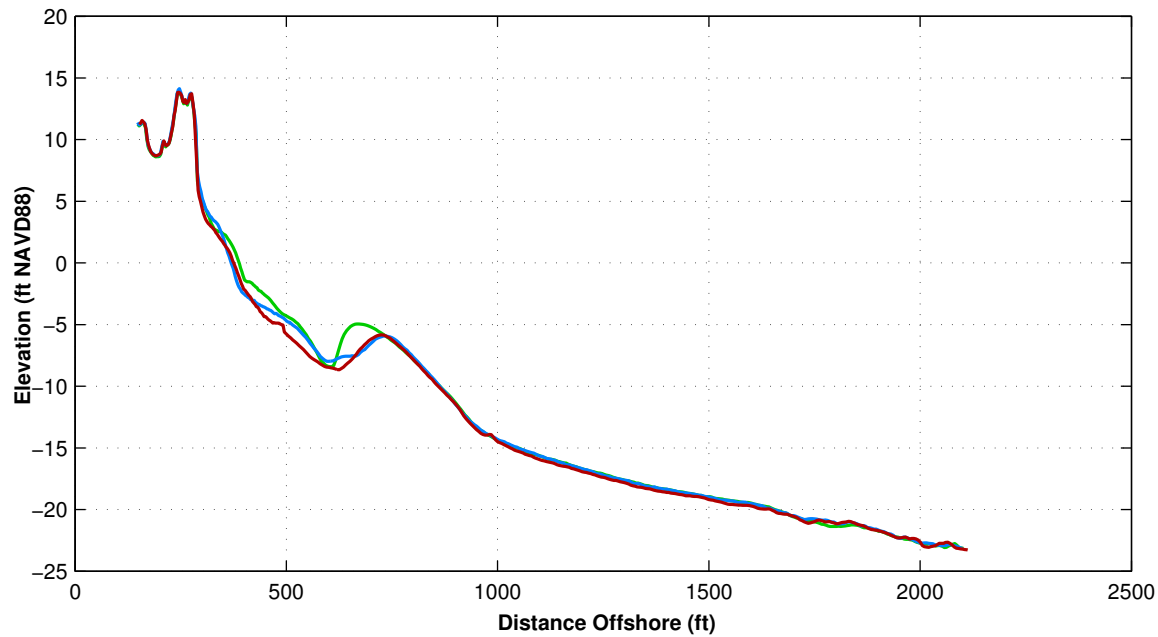


OCEAN VIEW PERIODIC
SURVEYING DATA &
ANALYSIS

ST 354+83

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Fall 2016



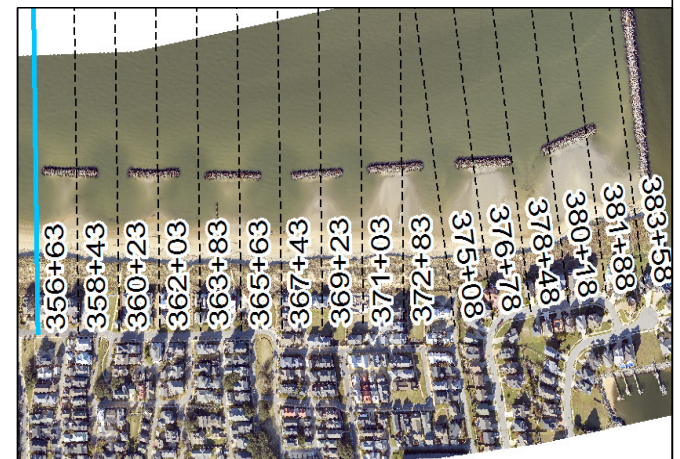
Survey Transect 356+63	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-13.90 ft/yr	3.34 ft
Volume Change Above -15 ft NAVD88	-19.43 cy/ft/yr	-9.39 cy/ft
Volume Change Above 0 ft NAVD88	-2.00 cy/ft/yr	-2.17 cy/ft

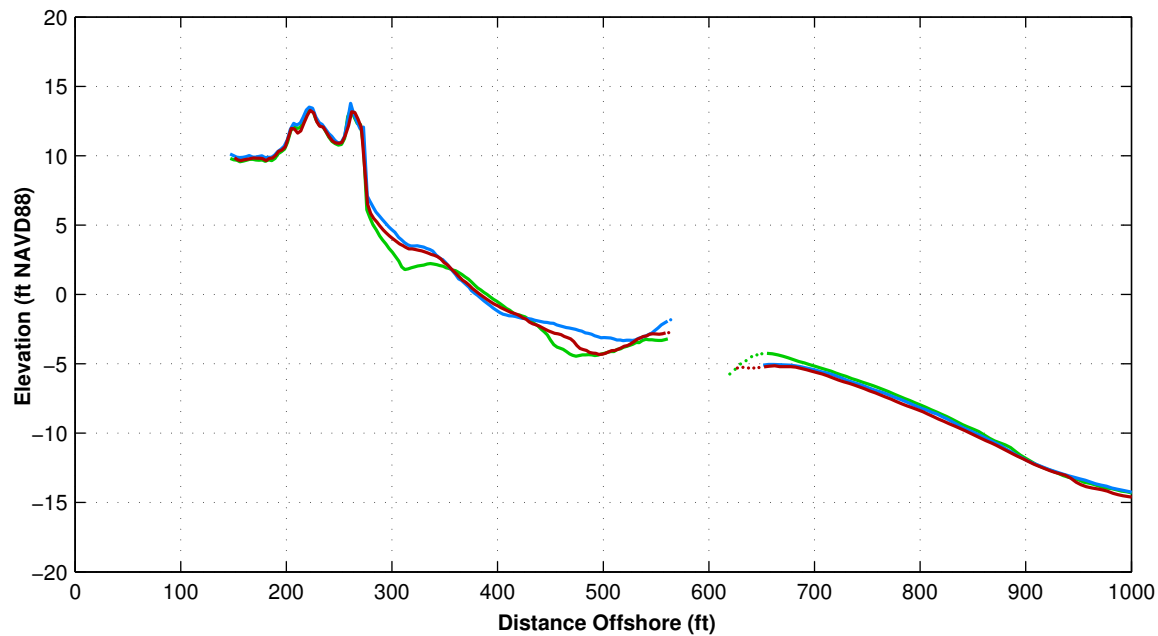
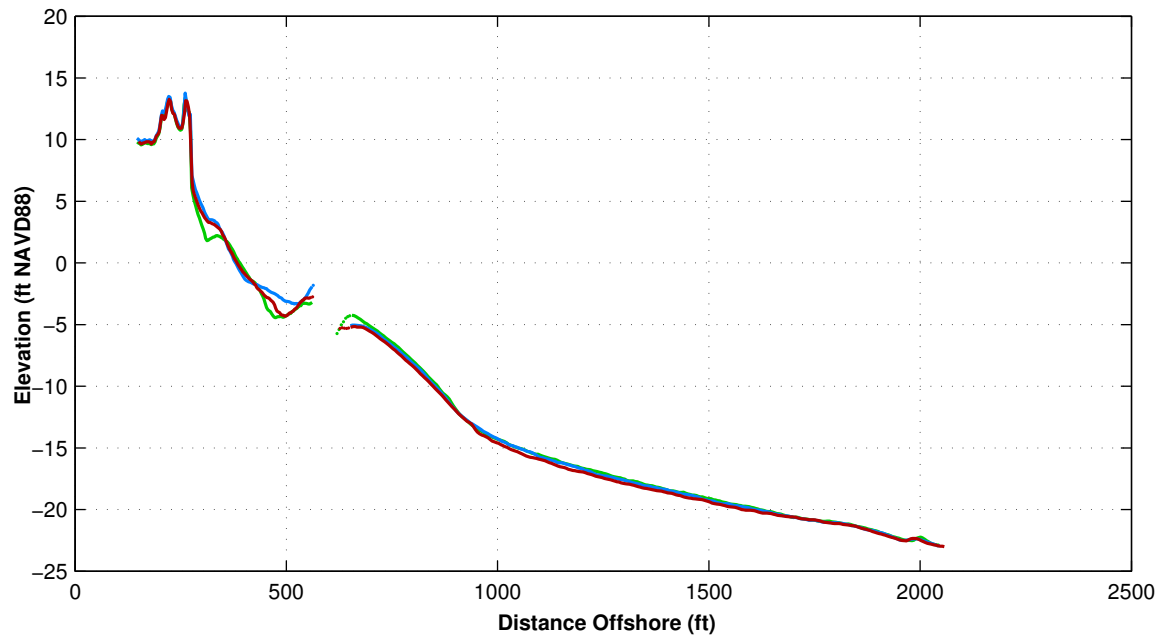
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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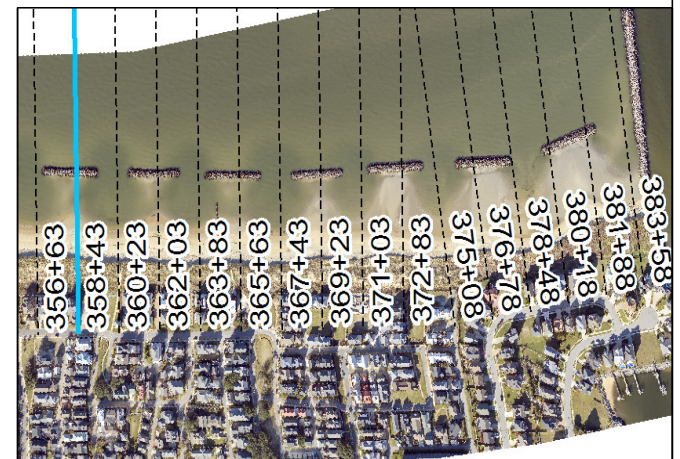
Survey Transect 358+43	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-6.26 ft/yr	1.47 ft
Volume Change Above -15 ft NAVD88	-1.47 cy/ft/yr	-7.67 cy/ft
Volume Change Above 0 ft NAVD88	2.22 cy/ft/yr	-2.02 cy/ft

LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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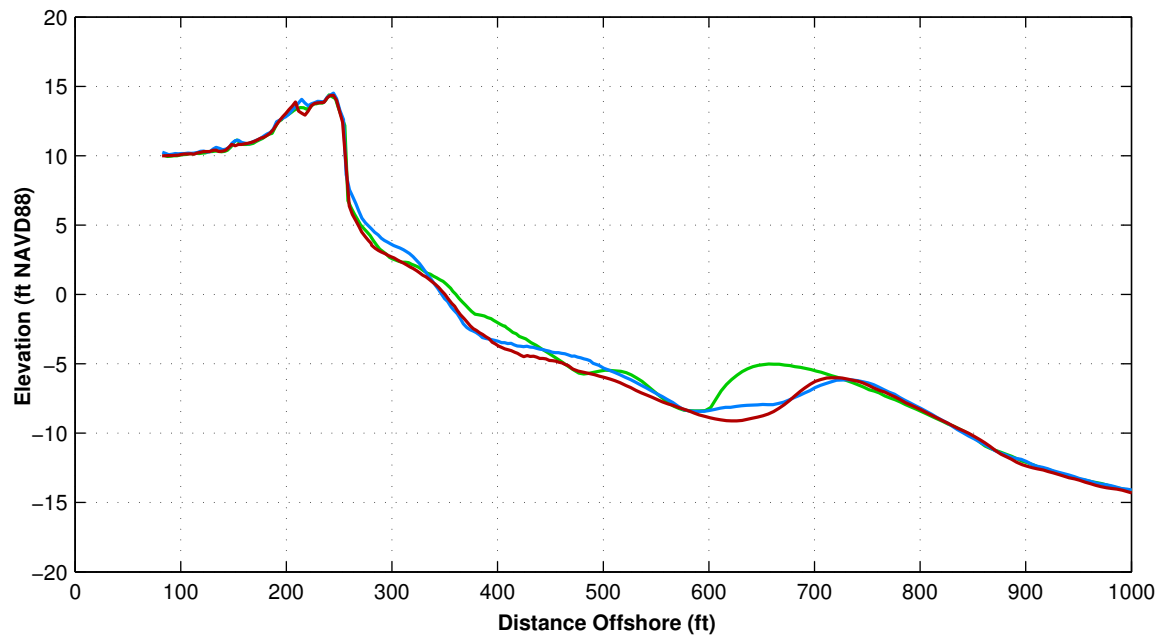
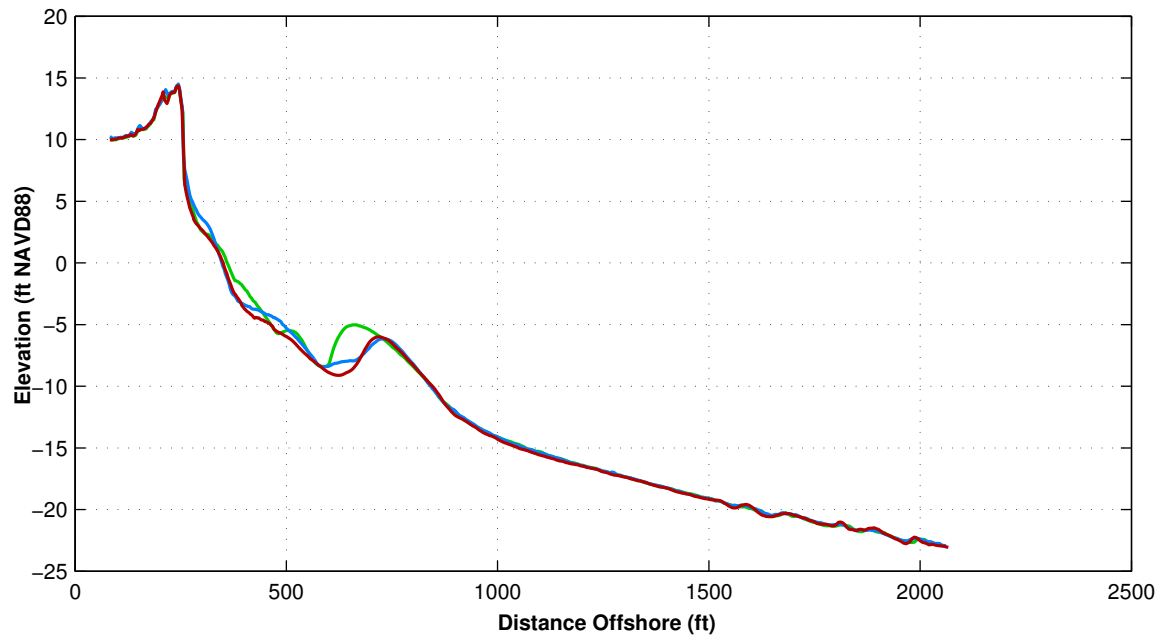


OCEAN VIEW PERIODIC
SURVEYING DATA &
ANALYSIS

ST 358+43

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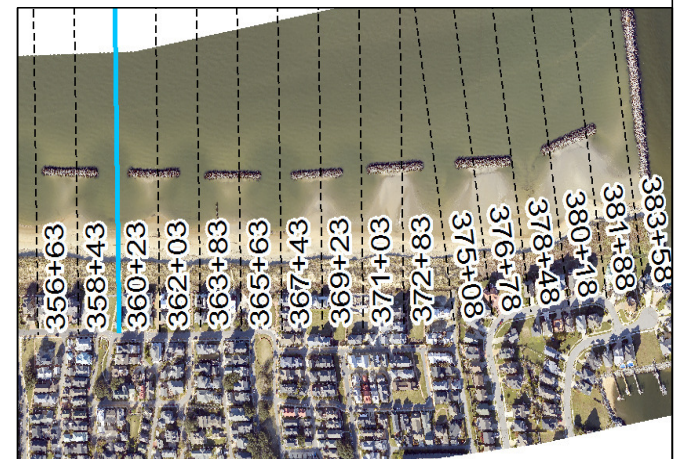
Survey Transect 360+23	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-10.20 ft/yr	-1.08 ft
Volume Change Above -15 ft NAVD88	-17.22 cy/ft/yr	-9.88 cy/ft
Volume Change Above 0 ft NAVD88	-1.06 cy/ft/yr	-3.30 cy/ft

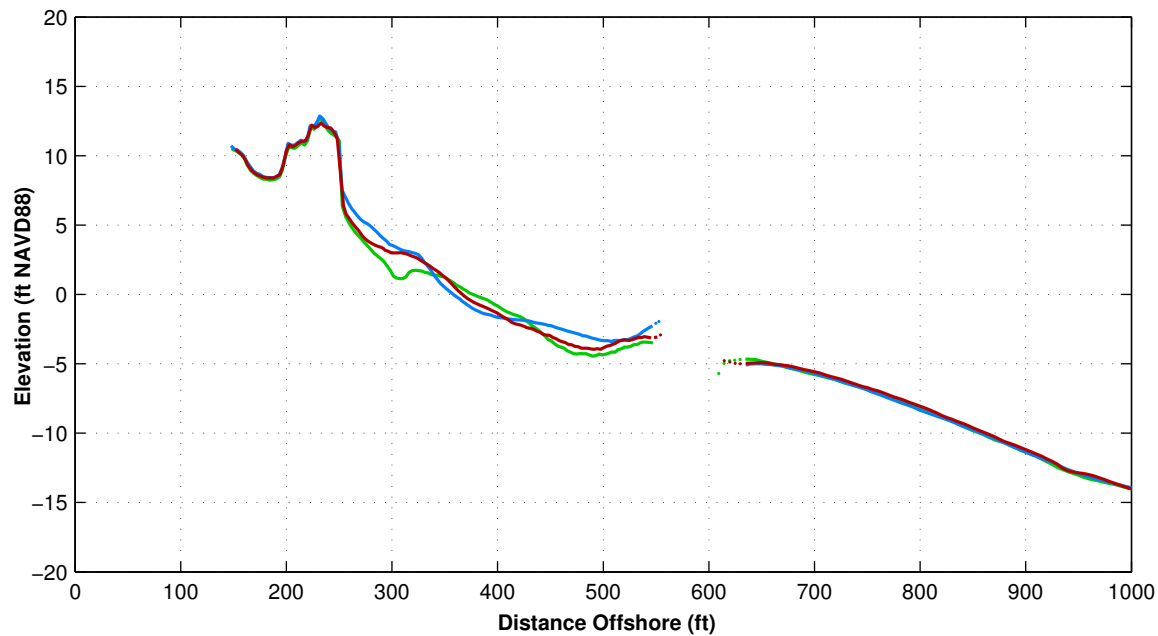
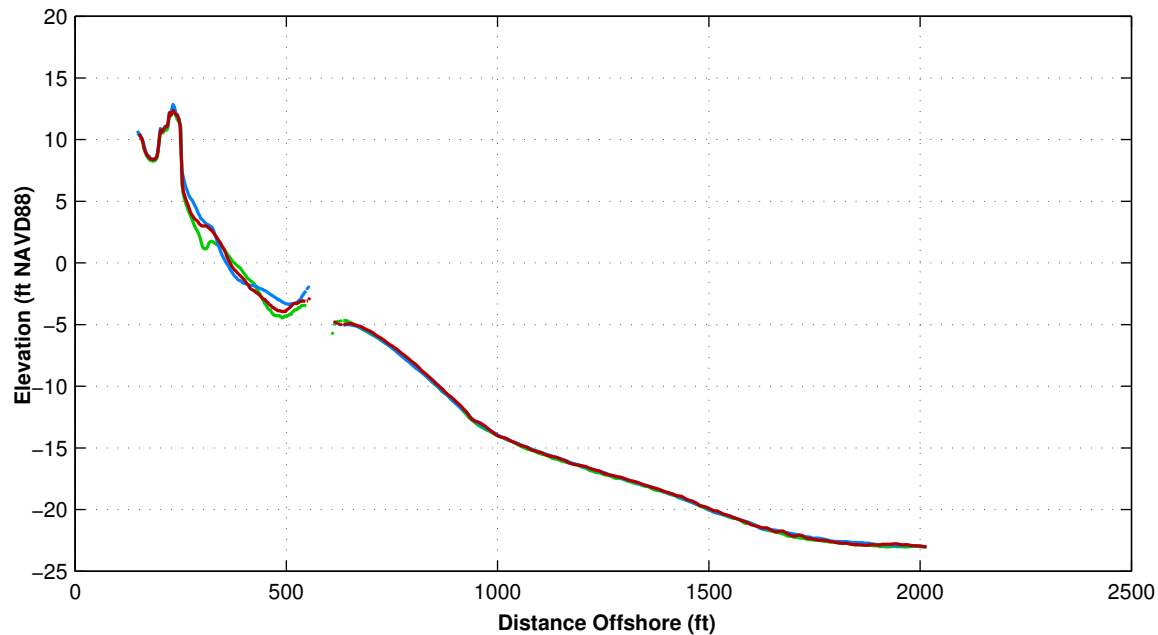
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

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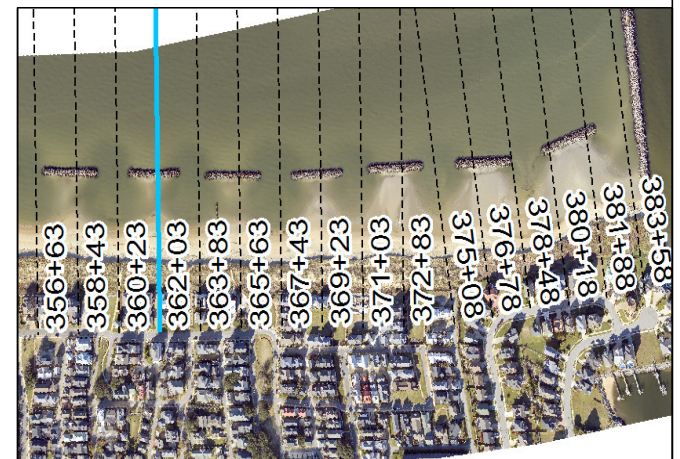
Survey Transect 362+03	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-1.67 ft/yr	9.90 ft
Volume Change Above -15 ft NAVD88	5.13 cy/ft/yr	-2.09 cy/ft
Volume Change Above 0 ft NAVD88	2.75 cy/ft/yr	-1.79 cy/ft

LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

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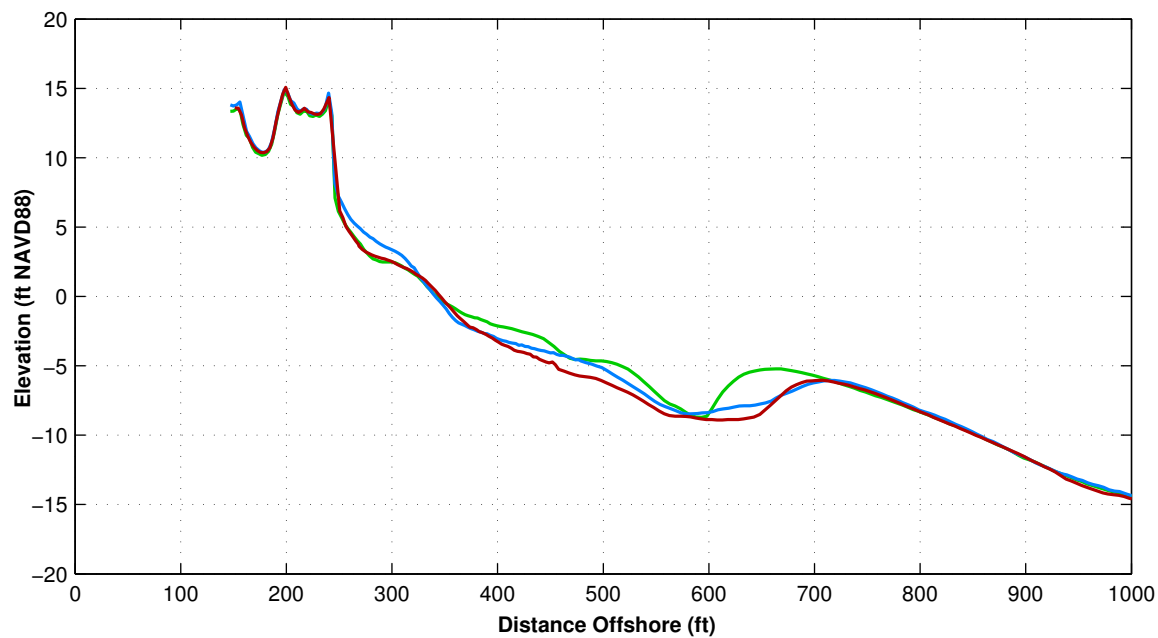
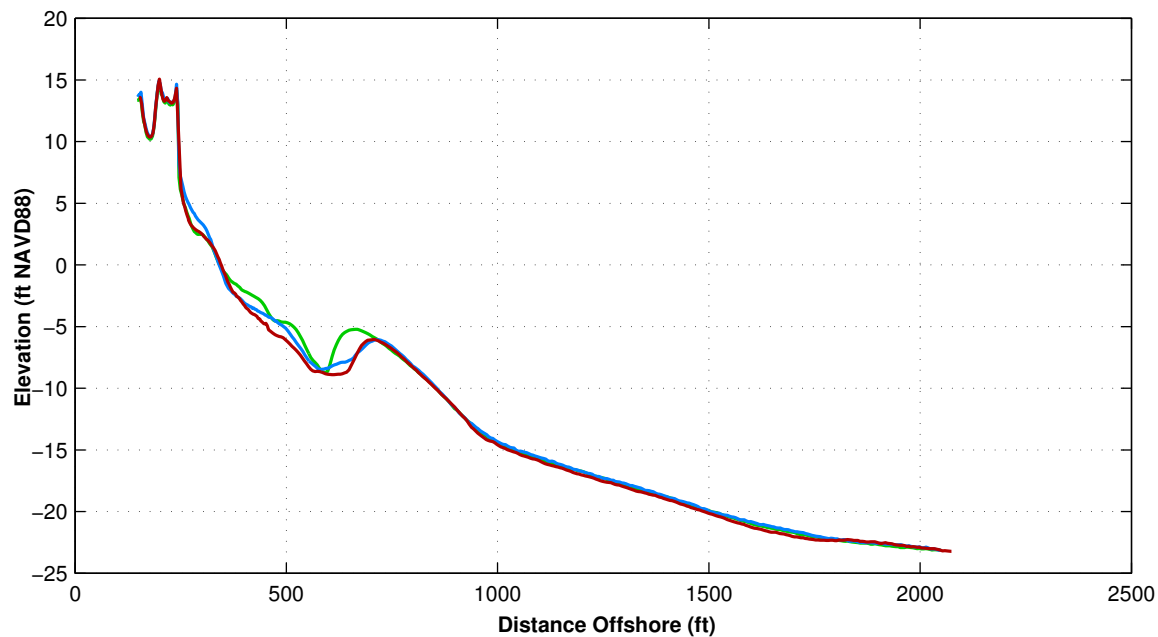
THE CITY OF
NORFOLK
PUBLIC WORKS

OCEAN VIEW PERIODIC
SURVEYING DATA &
ANALYSIS

ST 362+03

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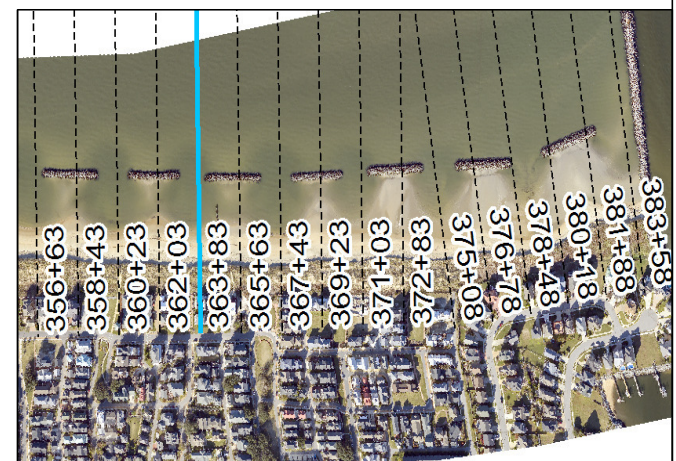
Survey Transect 363+83	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	3.52 ft/yr	3.21 ft
Volume Change Above –15 ft NAVD88	–16.54 cy/ft/yr	–10.49 cy/ft
Volume Change Above 0 ft NAVD88	1.07 cy/ft/yr	–2.66 cy/ft

LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

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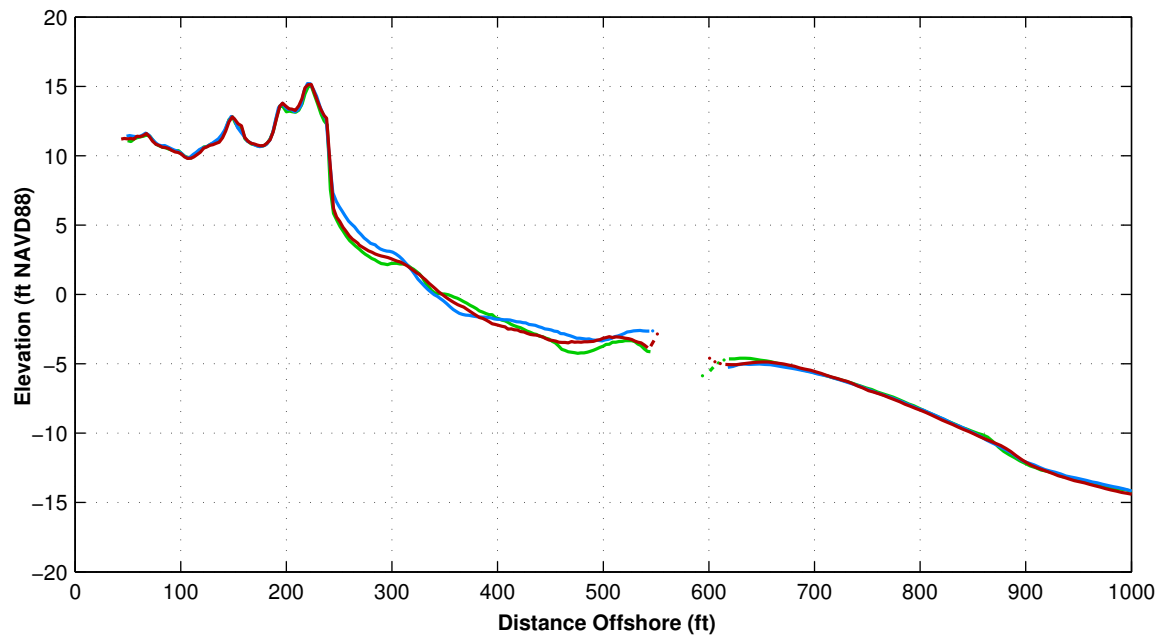
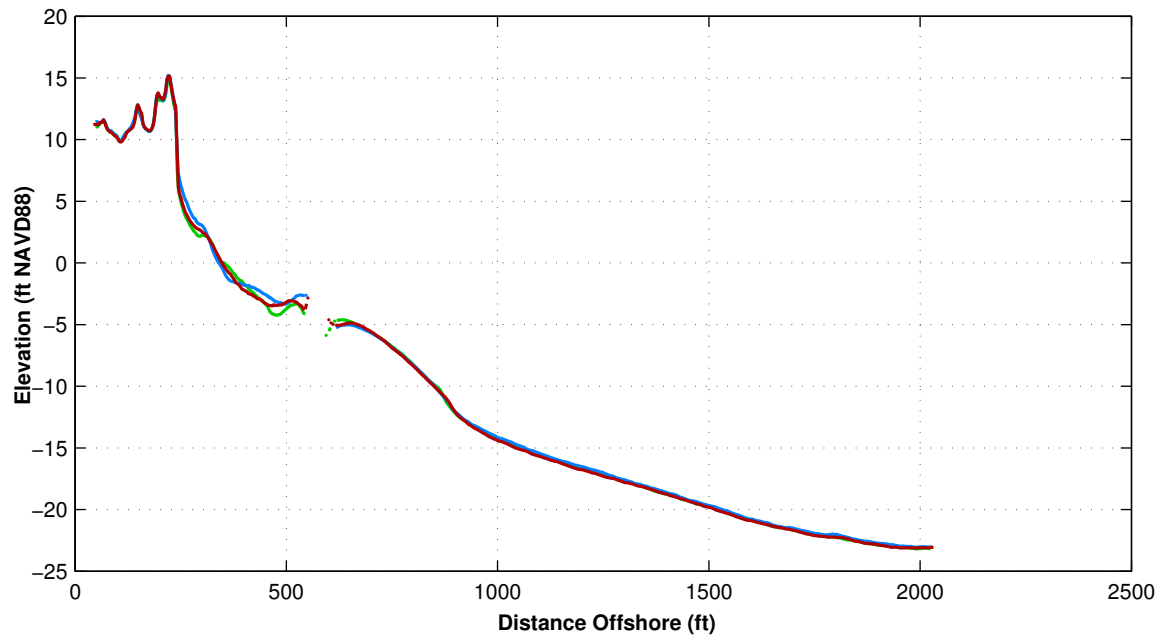
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NORFOLK
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OCEAN VIEW PERIODIC
SURVEYING DATA &
ANALYSIS

ST 363+83

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Fall 2016



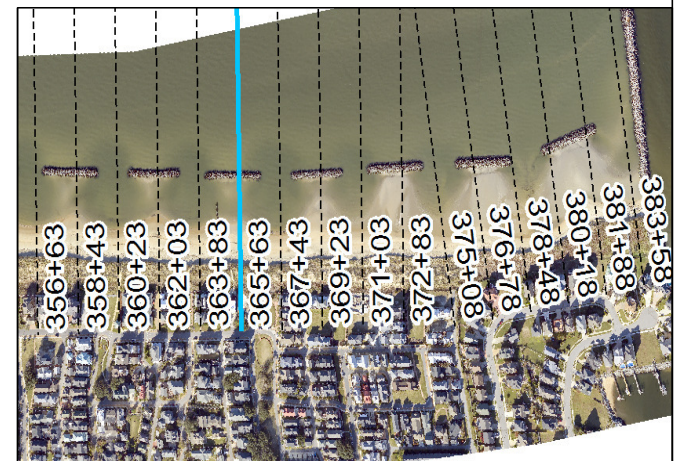
Survey Transect 365+63	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	2.01 ft/yr	6.45 ft
Volume Change Above –15 ft NAVD88	0.50 cy/ft/yr	–4.77 cy/ft
Volume Change Above 0 ft NAVD88	1.45 cy/ft/yr	–1.66 cy/ft

LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
3. All Survey Elevations In Feet Referenced to NAVD88.
4. Survey Comparison Made to OCT 2015 and MAY 2016
5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.

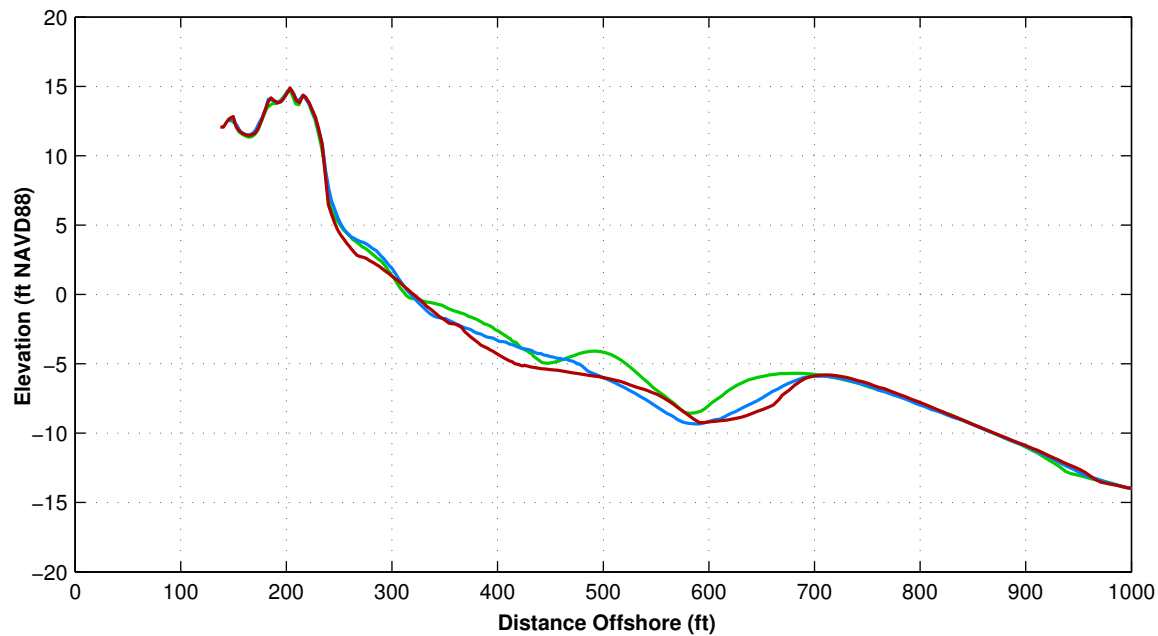
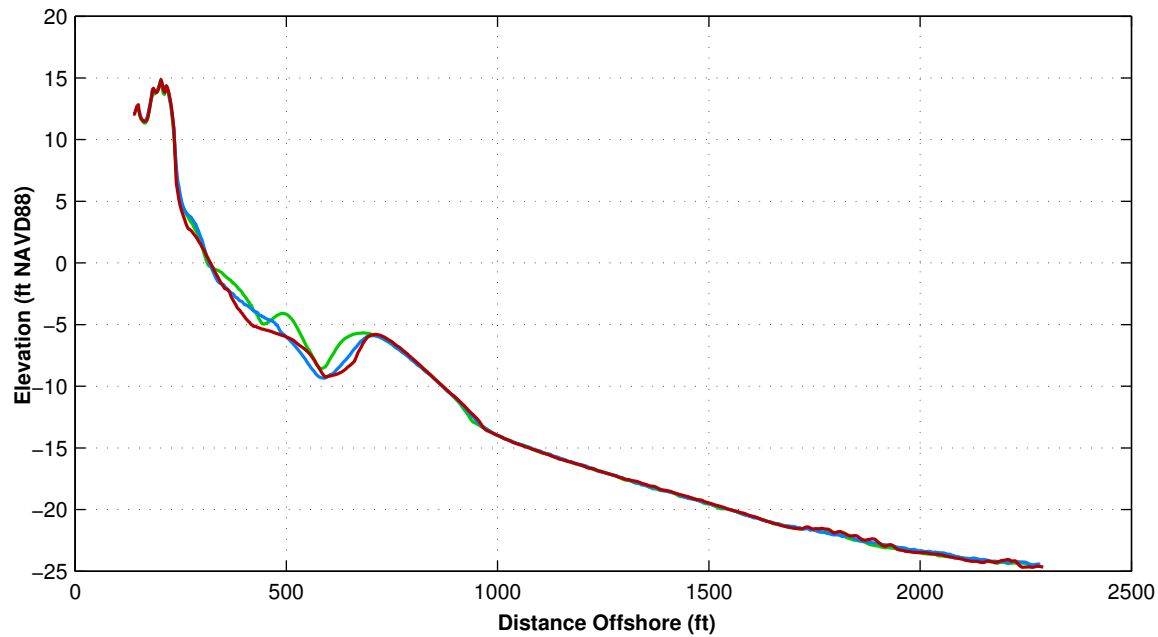


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SURVEYING DATA &
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ST 365+63

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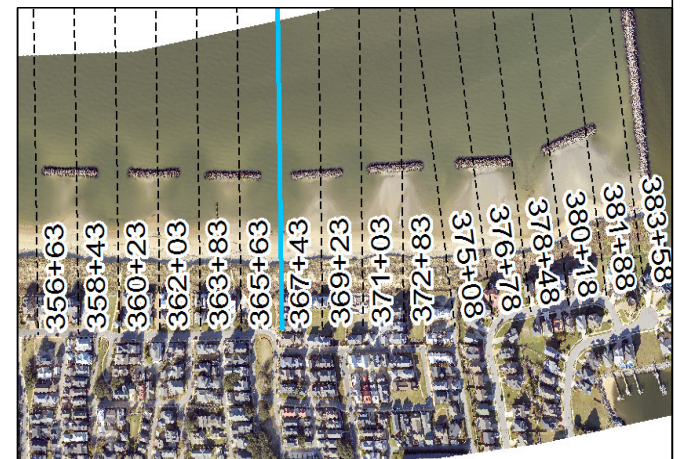
Survey Transect 367+43	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	2.47 ft/yr	-1.83 ft
Volume Change Above -15 ft NAVD88	-15.45 cy/ft/yr	-4.99 cy/ft
Volume Change Above 0 ft NAVD88	-0.69 cy/ft/yr	-2.31 cy/ft

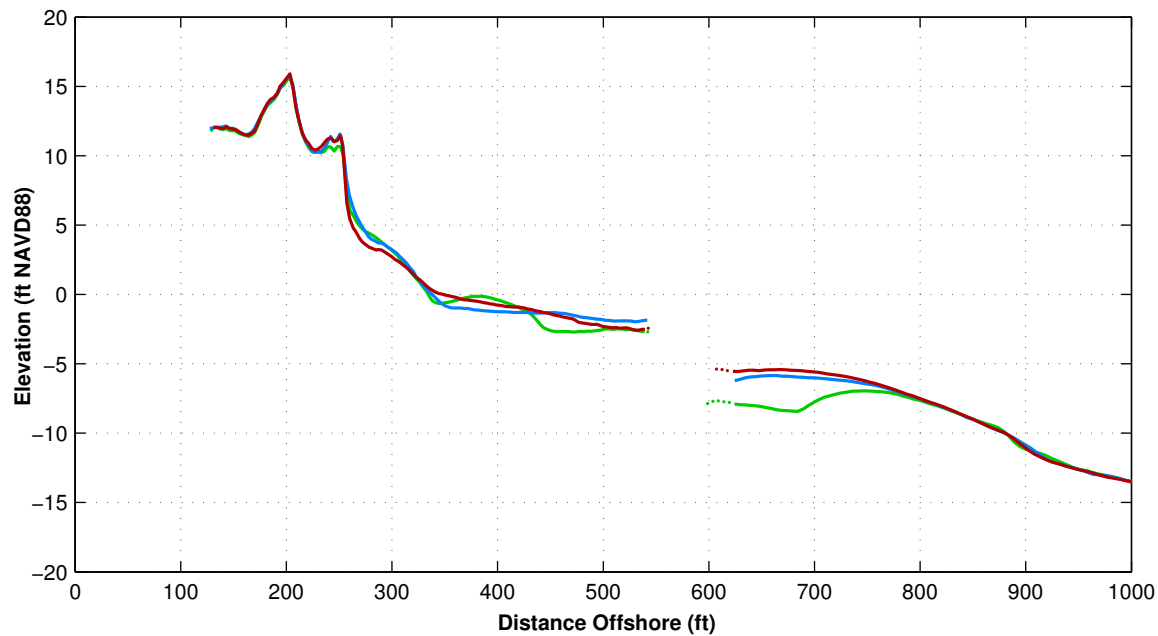
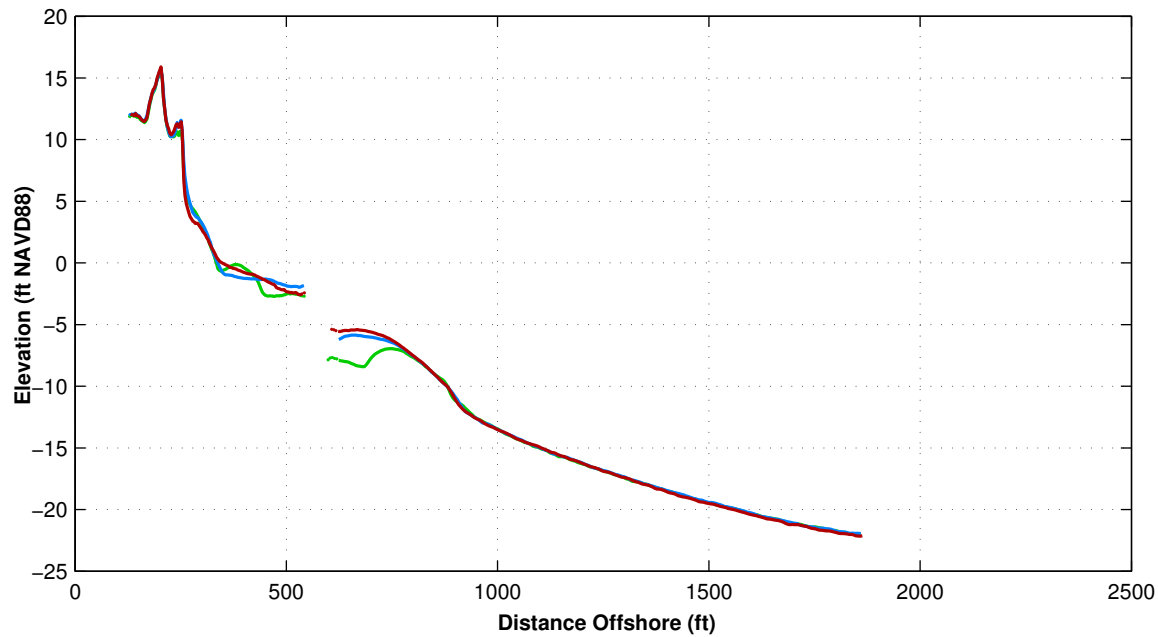
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
3. All Survey Elevations In Feet Referenced to NAVD88.
4. Survey Comparison Made to OCT 2015 and MAY 2016
5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.





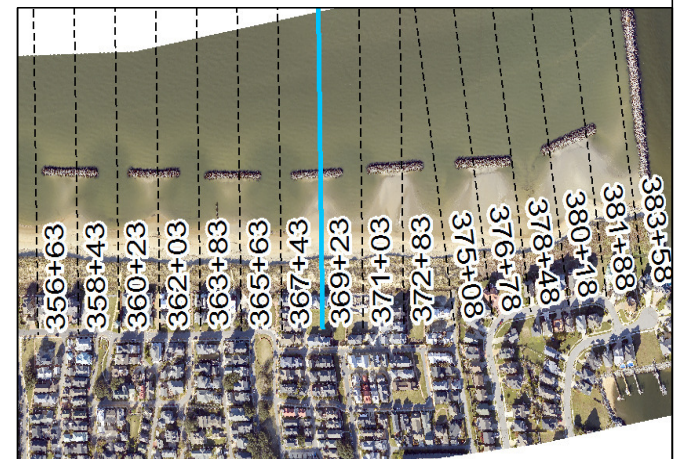
Survey Transect 369+23	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	2.54 ft/yr	1.57 ft
Volume Change Above –15 ft NAVD88	11.90 cy/ft/yr	0.76 cy/ft
Volume Change Above 0 ft NAVD88	–0.26 cy/ft/yr	–1.52 cy/ft

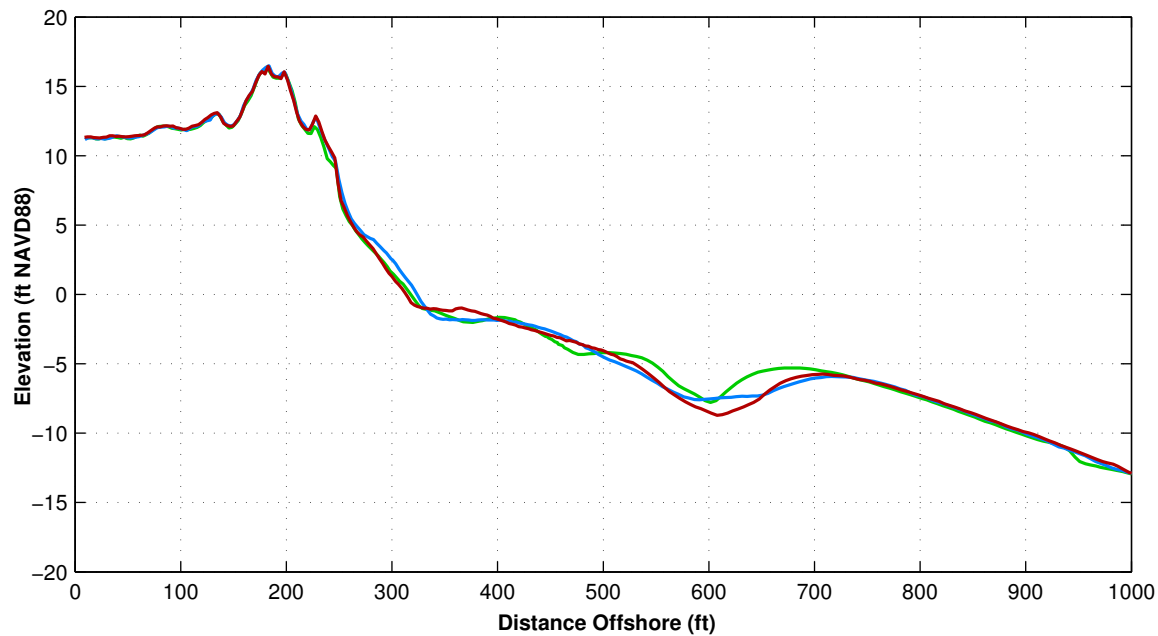
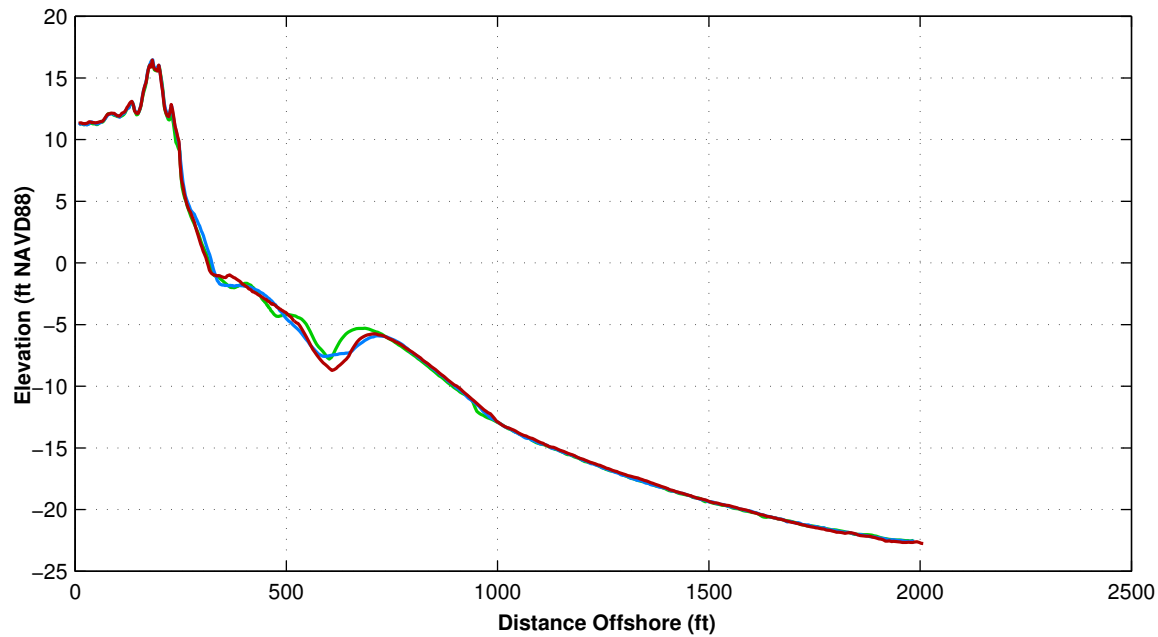
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
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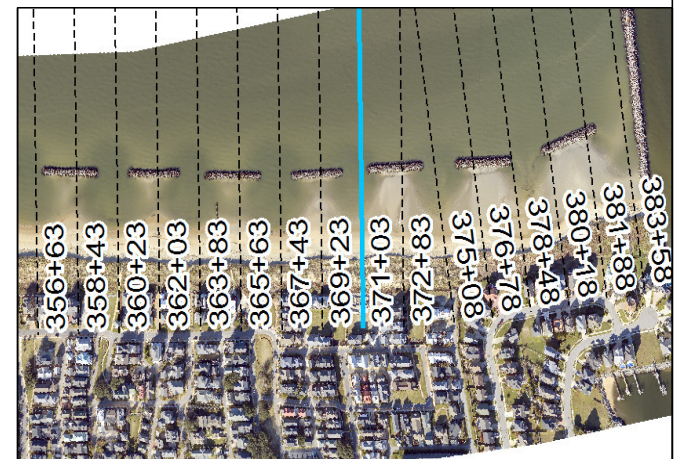
Survey Transect 371+03	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	ft/yr	ft
Volume Change Above –15 ft NAVD88	cy/ft/yr	cy/ft
Volume Change Above 0 ft NAVD88	cy/ft/yr	cy/ft

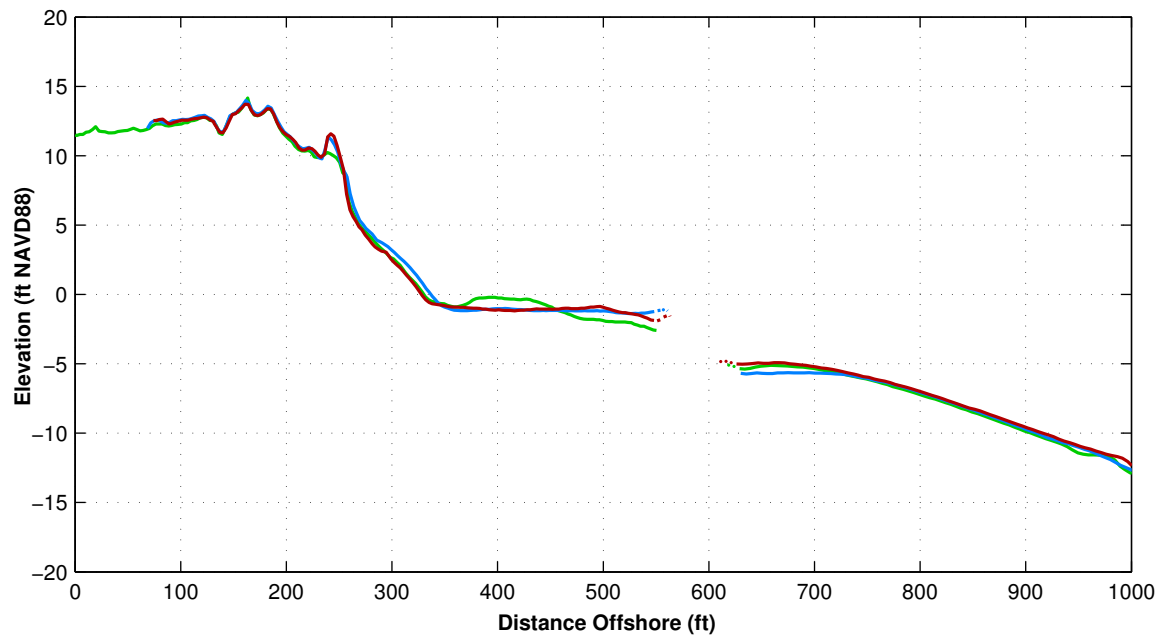
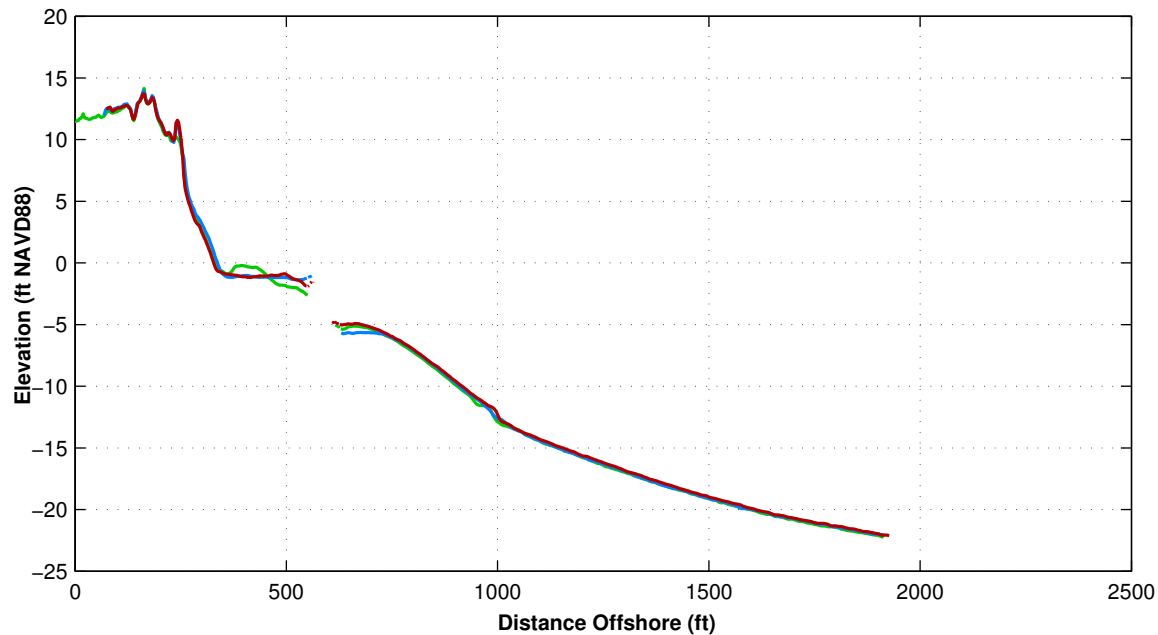
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

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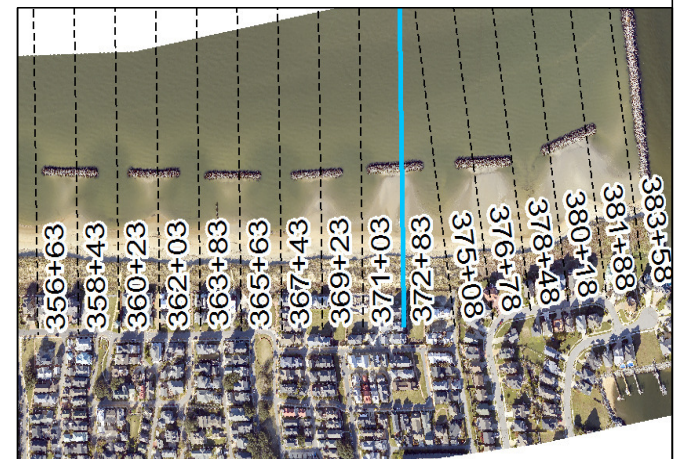
Survey Transect 372+83	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-1.43 ft/yr	-8.92 ft
Volume Change Above -15 ft NAVD88	4.95 cy/ft/yr	1.72 cy/ft
Volume Change Above 0 ft NAVD88	0.58 cy/ft/yr	-2.36 cy/ft

LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
3. All Survey Elevations In Feet Referenced to NAVD88.
4. Survey Comparison Made to OCT 2015 and MAY 2016
5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.



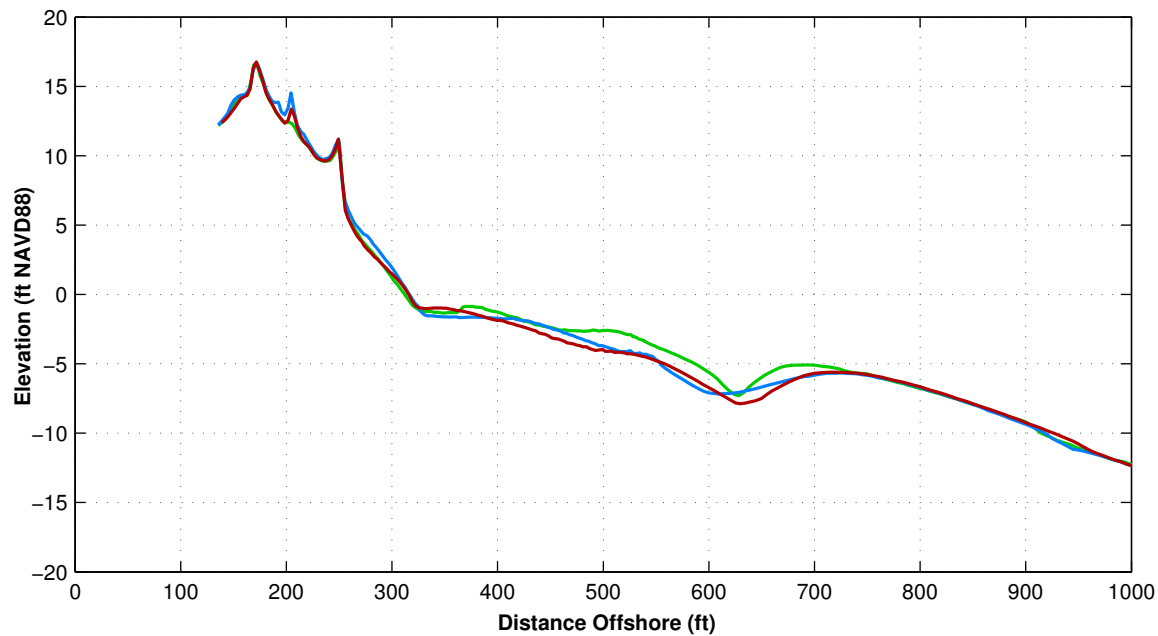
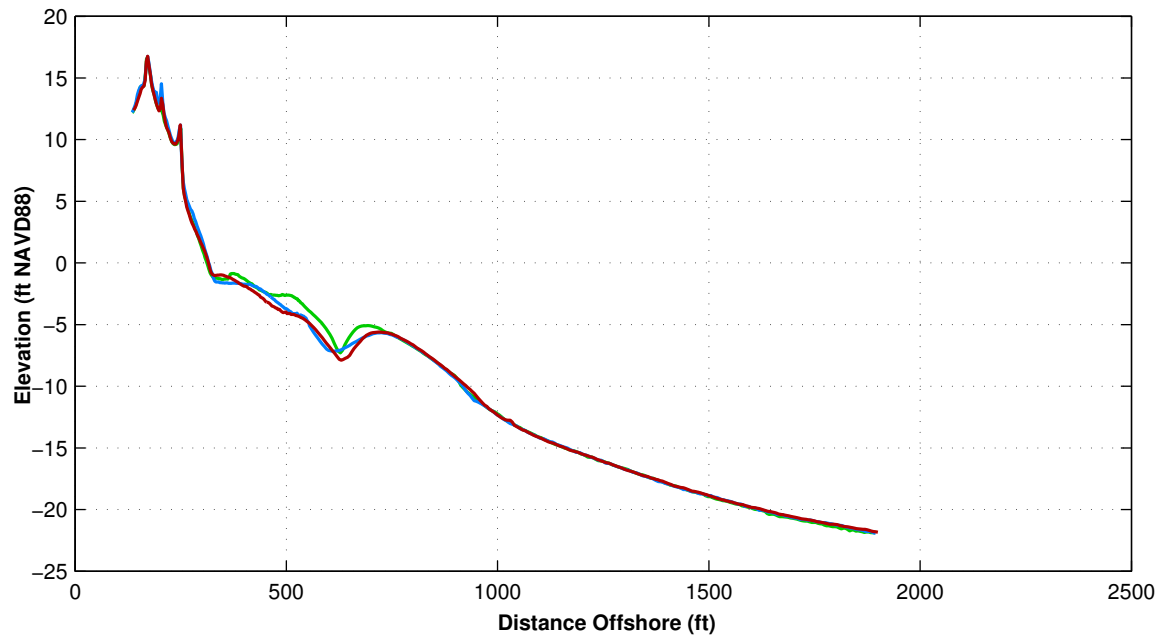
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ST 372+83

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Fall 2016



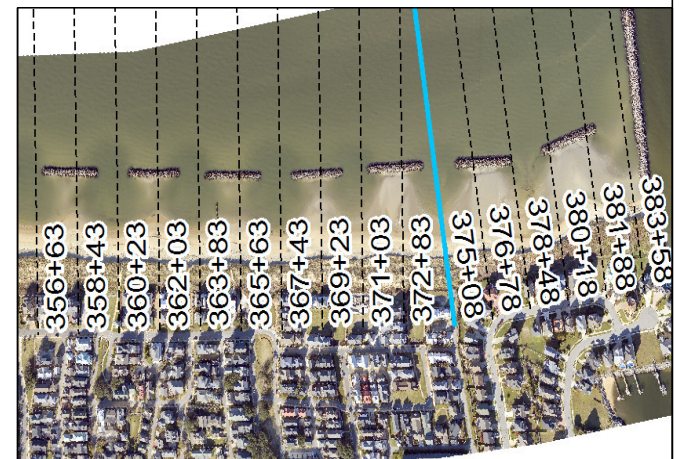
Survey Transect 375+08	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	4.24 ft/yr	-1.64 ft
Volume Change Above -15 ft NAVD88	-10.26 cy/ft/yr	-3.02 cy/ft
Volume Change Above 0 ft NAVD88	0.25 cy/ft/yr	-2.60 cy/ft

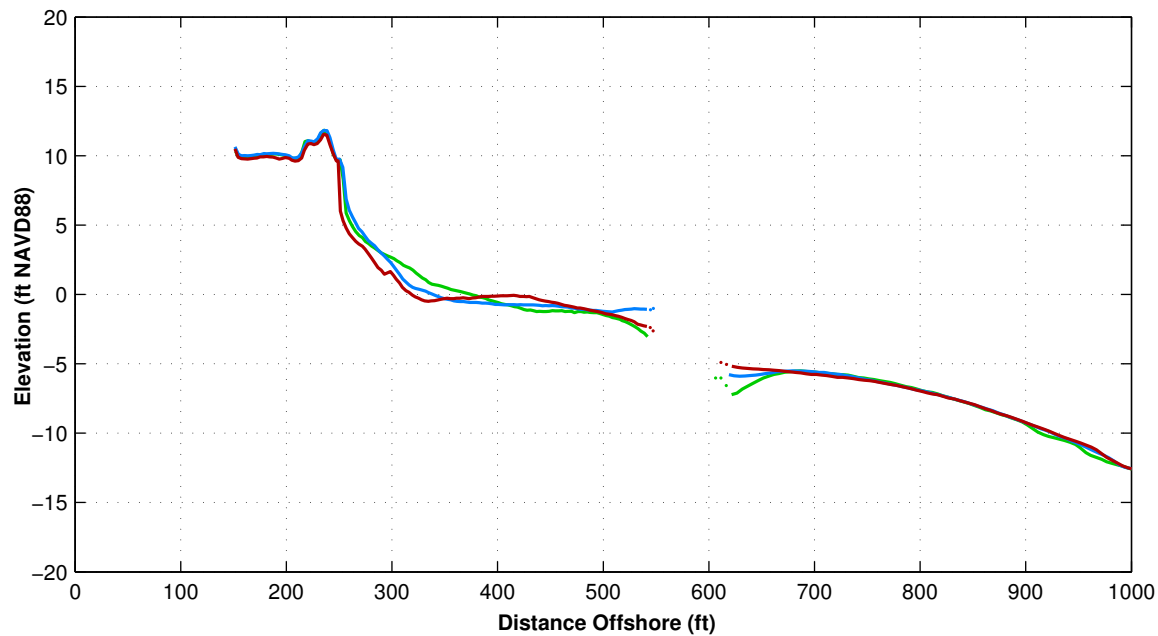
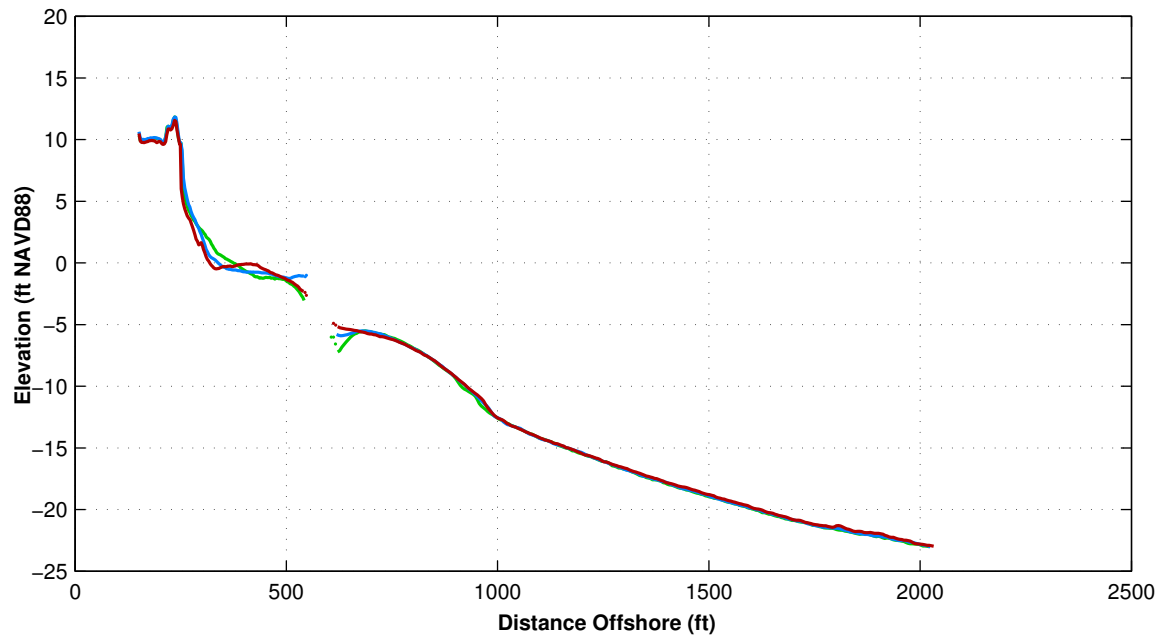
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

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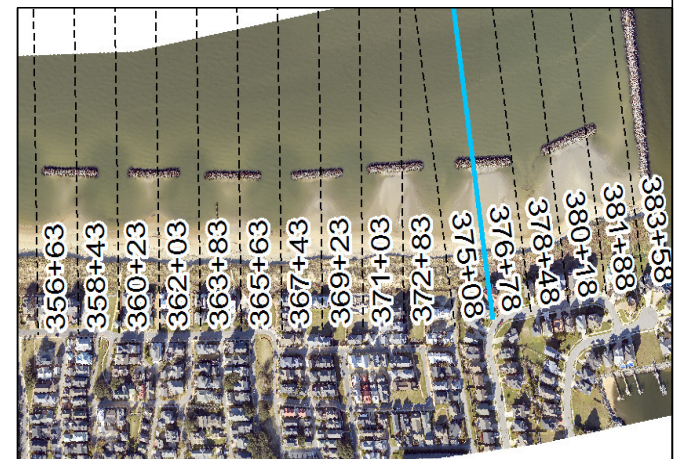
Survey Transect 376+78	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-26.57 ft/yr	-6.46 ft
Volume Change Above -15 ft NAVD88	-0.88 cy/ft/yr	-3.31 cy/ft
Volume Change Above 0 ft NAVD88	-5.16 cy/ft/yr	-4.28 cy/ft

LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
3. All Survey Elevations In Feet Referenced to NAVD88.
4. Survey Comparison Made to OCT 2015 and MAY 2016
5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.



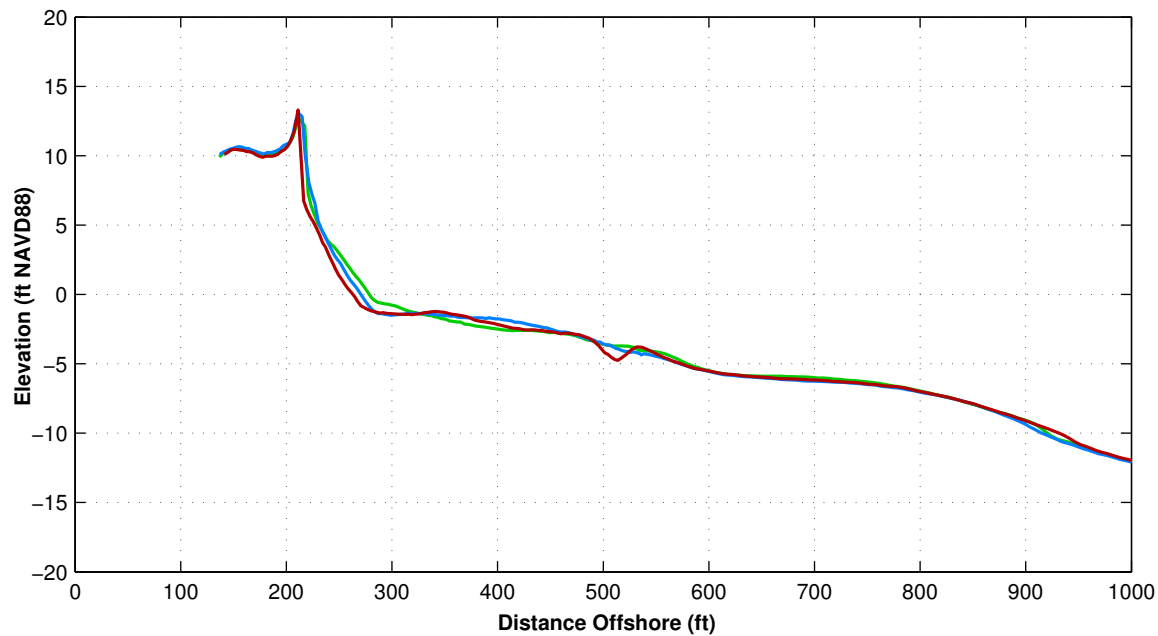
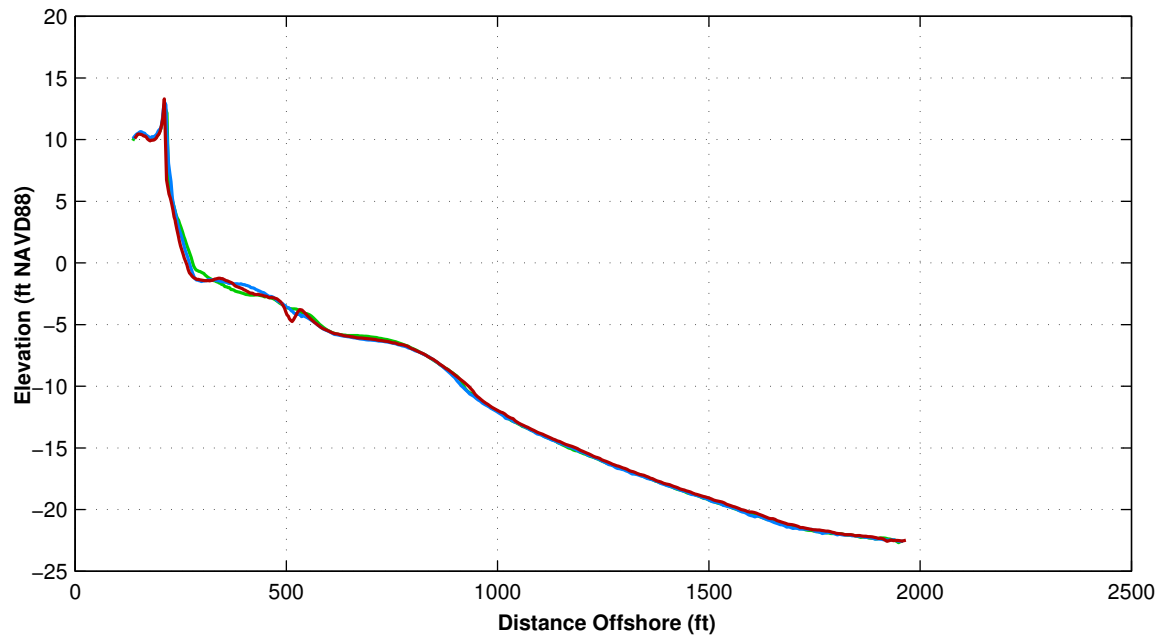
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NORFOLK
PUBLIC WORKS

OCEAN VIEW PERIODIC
SURVEYING DATA &
ANALYSIS

ST 376+78

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Fall 2016



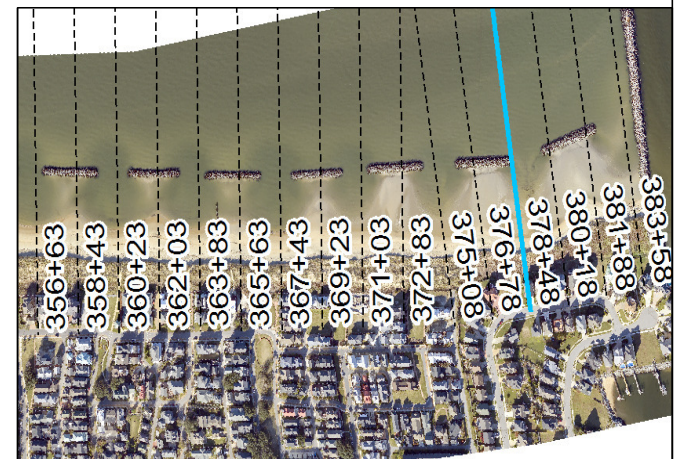
Survey Transect 378+48	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-15.62 ft/yr	-7.75 ft
Volume Change Above -15 ft NAVD88	-3.79 cy/ft/yr	-2.04 cy/ft
Volume Change Above 0 ft NAVD88	-3.44 cy/ft/yr	-3.30 cy/ft

LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
3. All Survey Elevations In Feet Referenced to NAVD88.
4. Survey Comparison Made to OCT 2015 and MAY 2016
5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.



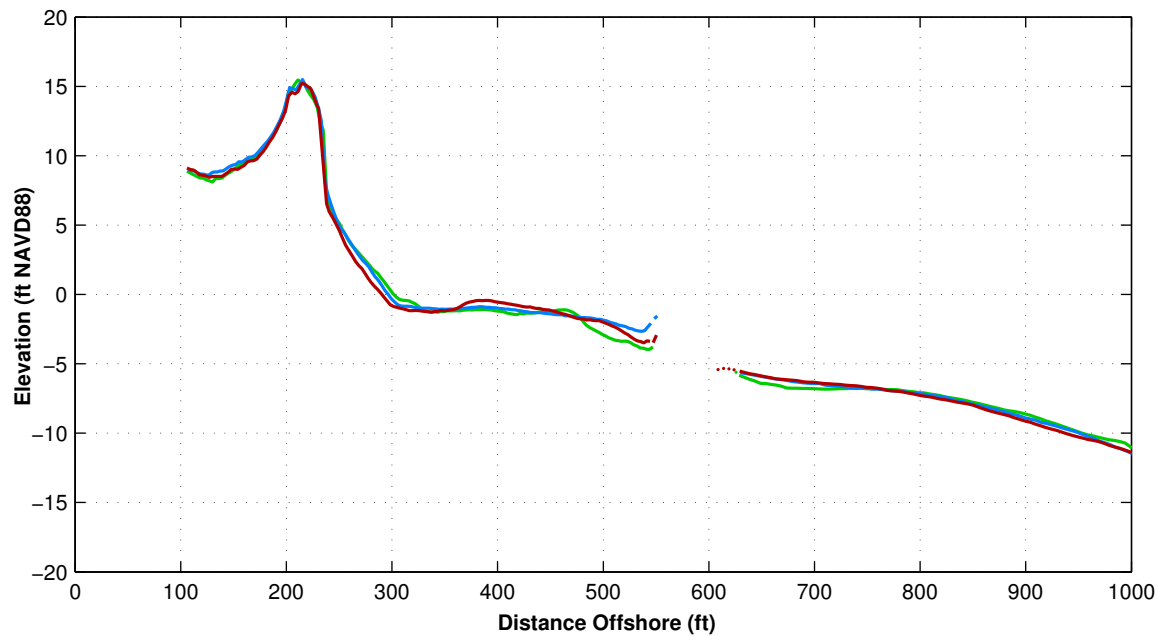
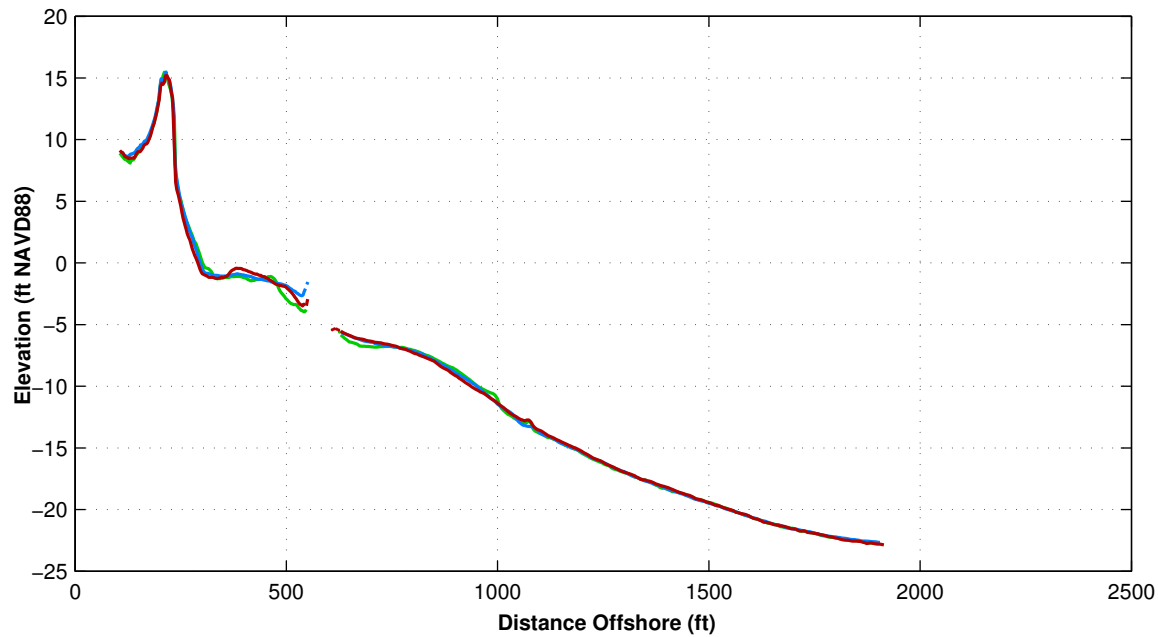
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PUBLIC WORKS

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SURVEYING DATA &
ANALYSIS

ST 378+48

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Fall 2016



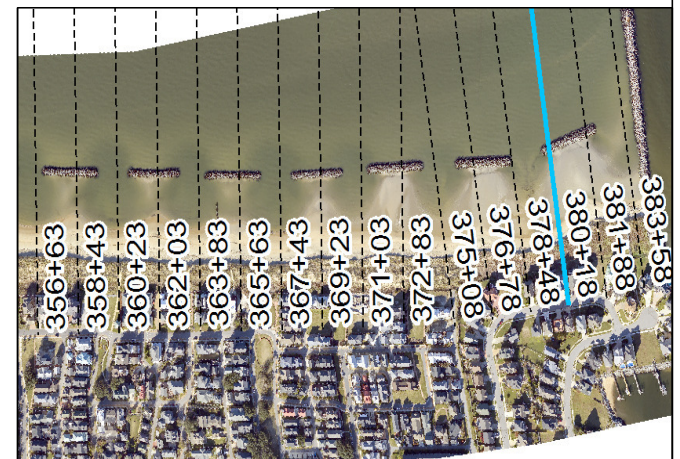
Survey Transect 380+18	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-12.41 ft/yr	-8.28 ft
Volume Change Above -15 ft NAVD88	0.19 cy/ft/yr	-3.11 cy/ft
Volume Change Above 0 ft NAVD88	-2.07 cy/ft/yr	-2.69 cy/ft

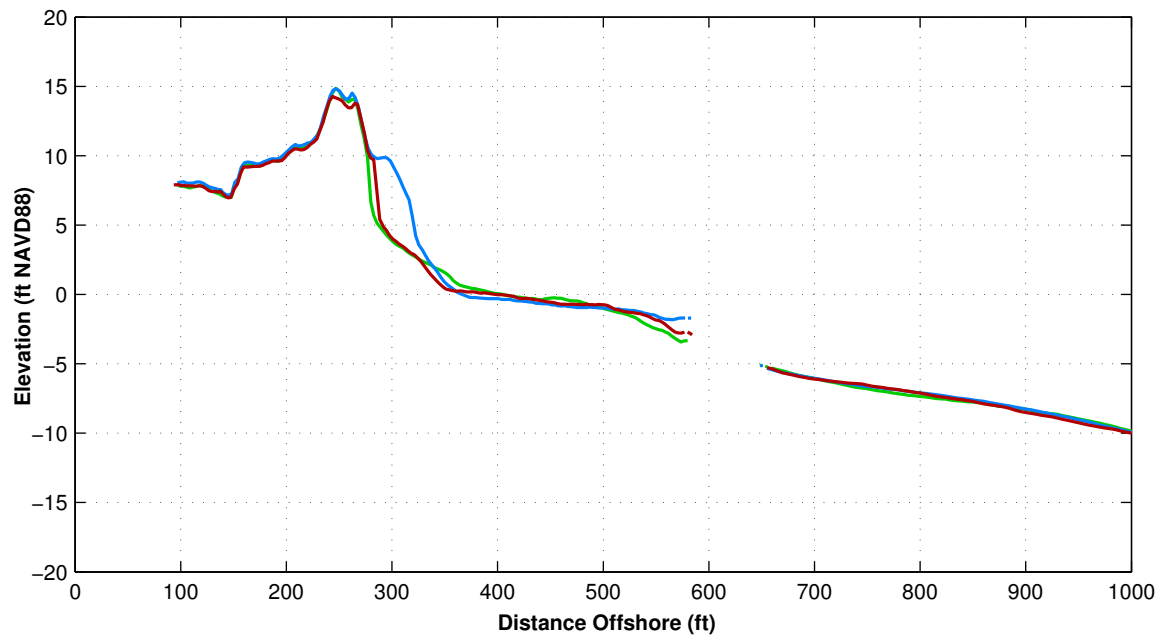
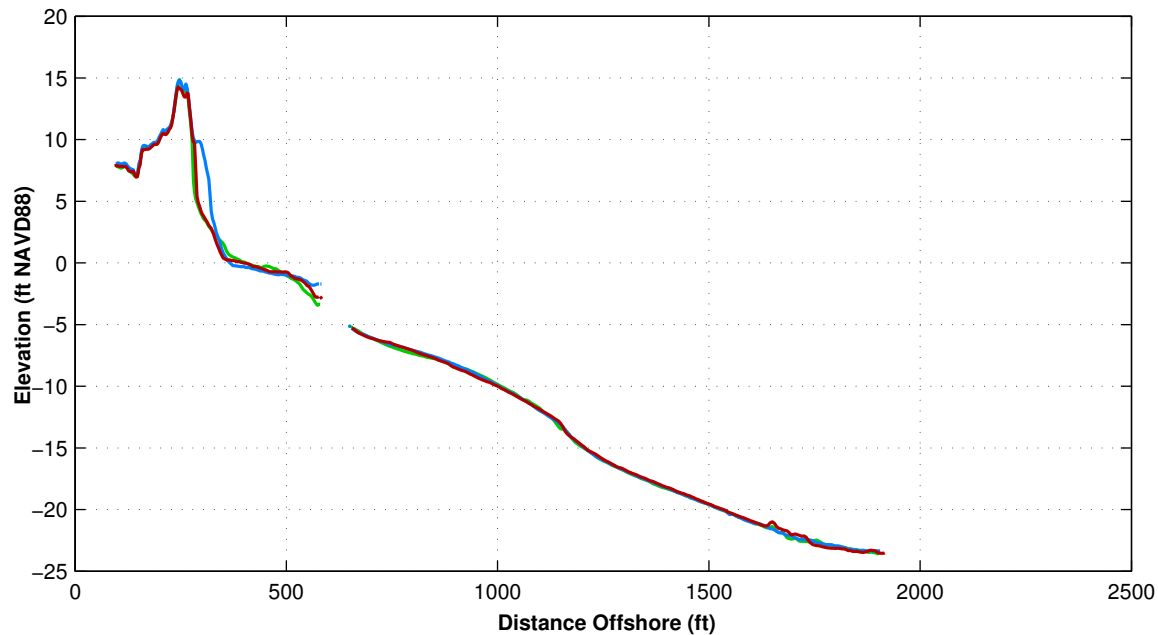
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
3. All Survey Elevations In Feet Referenced to NAVD88.
4. Survey Comparison Made to OCT 2015 and MAY 2016
5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.





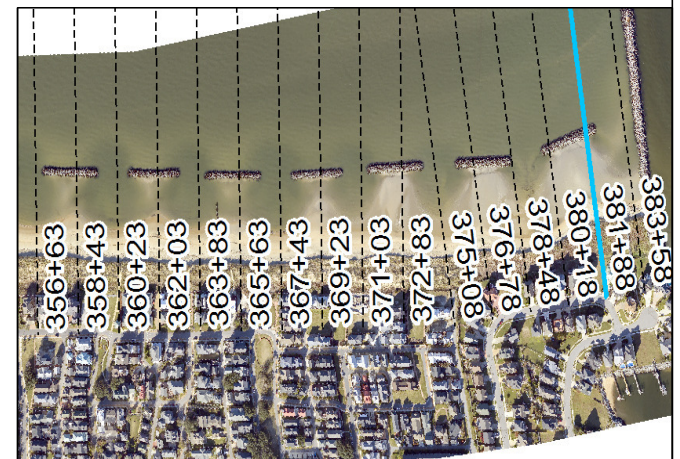
Survey Transect 381+88	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-15.47 ft/yr	-6.51 ft
Volume Change Above -15 ft NAVD88	0.32 cy/ft/yr	-9.39 cy/ft
Volume Change Above 0 ft NAVD88	-0.44 cy/ft/yr	-8.59 cy/ft

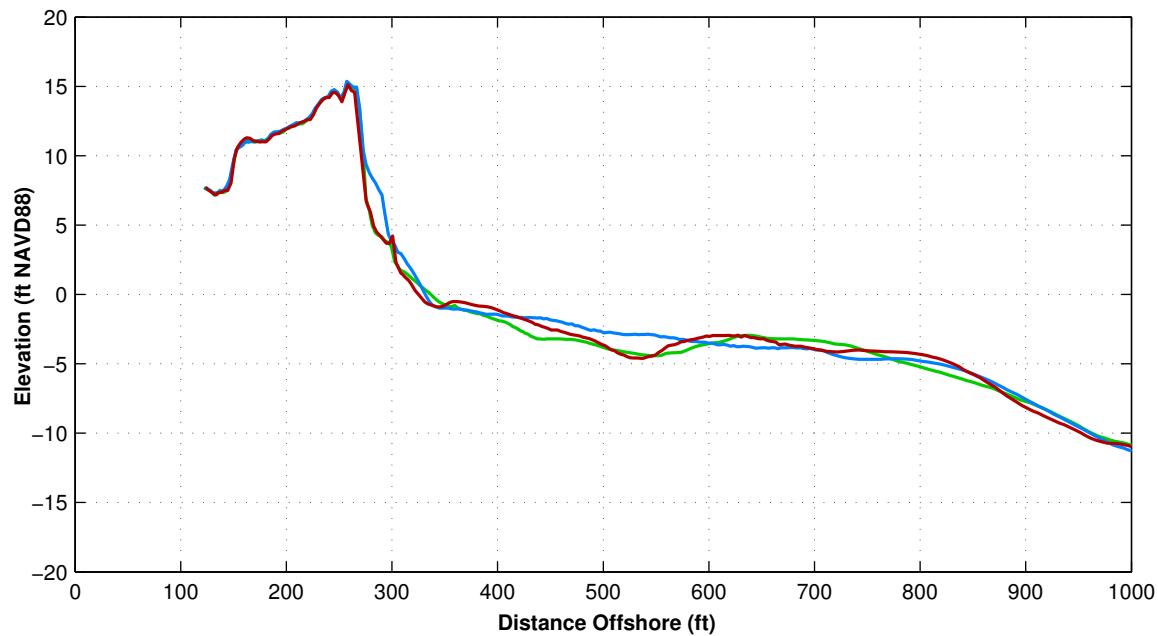
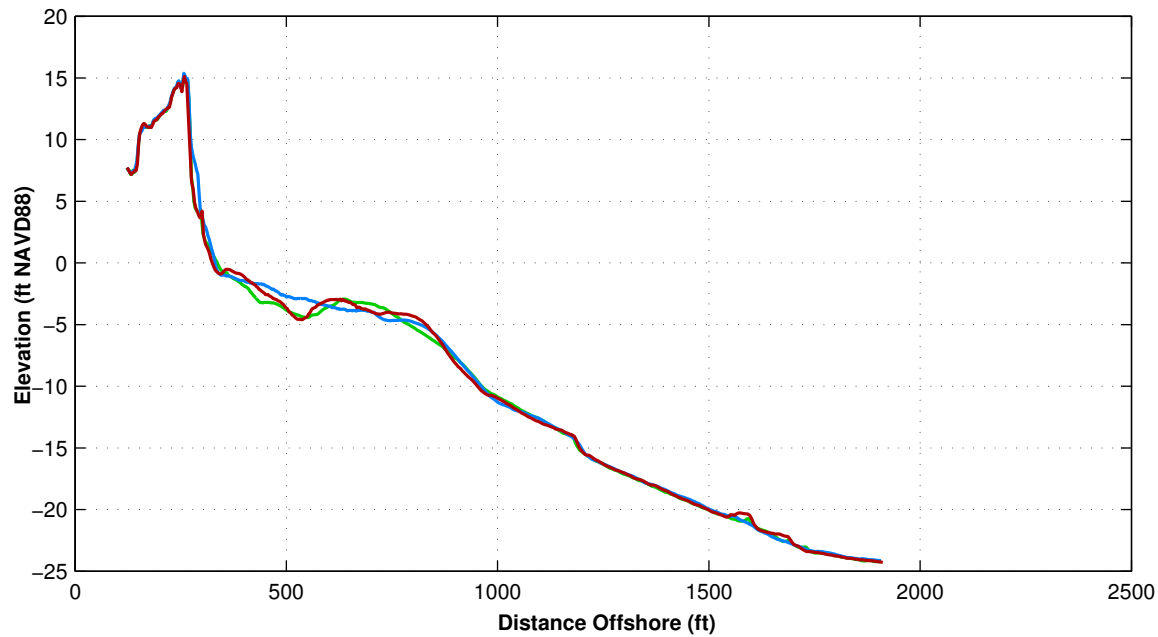
LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
3. All Survey Elevations In Feet Referenced to NAVD88.
4. Survey Comparison Made to OCT 2015 and MAY 2016
5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.





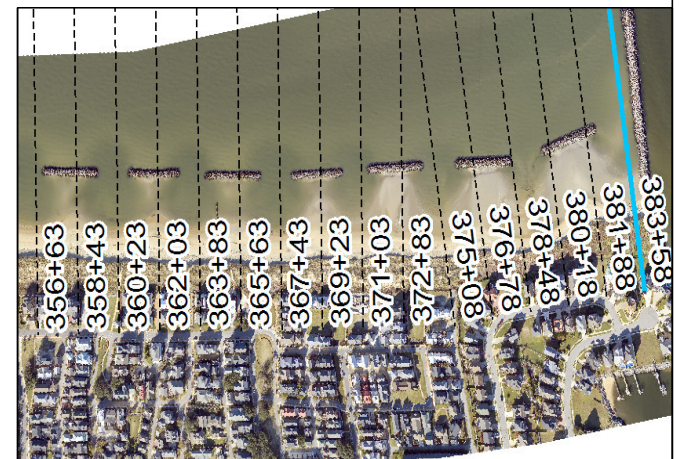
Survey Transect 383+58	OCT 2016 – OCT 2015	OCT 2016 – MAY 2016
Shoreline Change at MHW (0.98 ft NAVD88)	-5.56 ft/yr	-8.59 ft
Volume Change Above -15 ft NAVD88	1.90 cy/ft/yr	-6.36 cy/ft
Volume Change Above 0 ft NAVD88	-1.00 cy/ft/yr	-4.43 cy/ft

LEGEND:

OCT 2016 —
MAY 2016 —
OCT 2015 —

Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
3. All Survey Elevations In Feet Referenced to NAVD88.
4. Survey Comparison Made to OCT 2015 and MAY 2016
5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.



**Table C-1. Summary of Shoreline Change and Volume Change
(October 2015 to October 2016)**

NOTES:

1. Positive changes indicate accretion or gain in volume along the profile and negative changes indicate erosion or loss of volume along the profile.
2. MHW assumed at +0.98 ft-NAVD88.
3. Shoreline Change and Volume Change is calculated for the period between surveys from October 8, 2015 to October 18, 2016.

Transect Number (Station)	Old Survey Date	New Survey Date	Shoreline Change Rate at MHW (ft/yr)	Volume Change Rate Above 0 ft NAVD88 (cy/ft/yr)	Volume Change Rate Above -15 ft NAVD88 (cy/ft/yr)
0+00	10/8/2015	10/18/2016	-14.10	-10.20	-20.26
2+50	10/8/2015	10/18/2016	-4.83	2.65	8.69
5+00	10/8/2015	10/18/2016	-44.37	-0.27	9.78
7+50	10/8/2015	10/18/2016	-14.17	1.34	6.81
10+00	10/8/2015	10/18/2016	-5.57	-1.48	-31.28
12+50	10/8/2015	10/18/2016	-3.14	0.60	-6.29
15+00	10/8/2015	10/18/2016	13.47	-0.45	-5.36
17+50	10/8/2015	10/18/2016	3.04	1.96	-3.26
20+00	10/8/2015	10/18/2016	39.07	9.53	6.90
22+50	10/8/2015	10/18/2016	-11.49	2.15	-5.43
25+00	10/8/2015	10/18/2016	-62.34	-6.59	-18.28
27+50	10/8/2015	10/18/2016	-37.89	-2.87	-10.24
30+00	10/8/2015	10/18/2016	-26.83	-1.46	-10.09
32+50	10/8/2015	10/18/2016	-11.55	-0.93	-1.57
35+00	10/8/2015	10/18/2016	30.36	8.89	12.99
37+50	10/8/2015	10/18/2016	18.28	12.75	9.19
40+00	10/8/2015	10/18/2016	7.72	7.56	2.83
42+50	10/8/2015	10/18/2016	-3.06	8.31	-0.80
45+00	10/8/2015	10/18/2016	-27.31	-3.68	-12.32
45+25	10/8/2015	10/18/2016	-18.15	-1.52	-11.22
47+30	10/8/2015	10/18/2016	-16.19	-1.96	-14.63
49+35	10/8/2015	10/18/2016	13.21	2.02	6.40
51+41	10/8/2015	10/18/2016	-0.50	2.10	-5.78
53+46	10/8/2015	10/18/2016	6.56	2.54	6.42
55+51	10/8/2015	10/18/2016	-12.11	-1.84	-3.77
57+57	10/8/2015	10/18/2016	4.11	2.23	-1.58
59+62	10/8/2015	10/18/2016	-18.22	-3.33	-10.64
61+62	10/8/2015	10/18/2016	-0.60	1.25	-0.51
63+62	10/8/2015	10/18/2016	-5.42	-0.13	-3.65
65+62	10/8/2015	10/18/2016	6.62	2.93	-1.94
67+62	10/8/2015	10/18/2016	-14.14	-2.96	1.73
69+62	10/8/2015	10/18/2016	7.14	4.42	2.40
71+62	10/8/2015	10/18/2016	-0.89	1.08	6.01
73+62	10/8/2015	10/18/2016	-19.12	-0.34	-1.62
75+62	10/8/2015	10/18/2016	-14.56	-2.37	-1.64
77+62	10/8/2015	10/18/2016	2.63	0.11	1.13
79+62	10/8/2015	10/18/2016	-11.58	-1.60	-4.84
81+62	10/8/2015	10/18/2016	0.24	-0.62	-6.13
83+62	10/8/2015	10/18/2016	10.28	2.09	-1.12
85+62	10/8/2015	10/18/2016	-15.75	-0.89	-4.34
87+62	10/8/2015	10/18/2016	-3.47	-1.16	-4.42

**Table C-1. Summary of Shoreline Change and Volume Change
(October 2015 to October 2016) Cont.**

Central Ocean View Nourishment (March 2005 to May 2016) Cont.

1. Positive changes indicate accretion or gain in volume along the profile and negative changes indicate erosion or loss of volume along the profile.
2. MHW assumed at +0.98 ft-NAVD88.
3. Shoreline Change and Volume Change is calculated for the period between surveys from October 8, 2015 to October 18, 2016.

Transect Number (Station)	Old Survey Date	New Survey Date	Shoreline Change Rate at MHW (ft/yr)	Volume Change Rate Above 0 ft NAVD88 (cy/ft/yr)	Volume Change Rate Above -15 ft NAVD88 (cy/ft/yr)
93+41	10/8/2015	10/18/2016	8.63	3.04	1.91
103+08	10/8/2015	10/18/2016	9.86	1.74	4.94
120+93	10/8/2015	10/18/2016	-8.27	-2.36	-5.11
129+17	10/8/2015	10/18/2016	-1.53	1.37	-1.82
141+98	10/8/2015	10/18/2016	-11.57	-3.65	-1.04
152+01	10/8/2015	10/18/2016	4.69	0.89	-3.32
163+49	10/8/2015	10/18/2016	-5.11	-0.62	4.47
169+63	10/8/2015	10/18/2016	-13.17	-6.51	-22.07
171+63	10/8/2015	10/18/2016	-1.83	0.25	0.86
173+63	10/8/2015	10/18/2016	5.64	-0.62	0.01
175+63	10/8/2015	10/18/2016	-4.41	-0.59	-0.15
177+63	10/8/2015	10/18/2016	0.24	1.08	-2.17
179+63	10/8/2015	10/18/2016	15.59	5.08	5.14
181+63	10/8/2015	10/18/2016	6.81	3.12	5.76
183+63	10/8/2015	10/18/2016	-7.46	1.10	-1.29
185+63	10/8/2015	10/18/2016	-10.61	-0.21	-11.09
187+63	10/8/2015	10/18/2016	2.94	0.32	1.83
189+63	10/8/2015	10/18/2016	-10.99	-0.30	-1.79
191+63	10/8/2015	10/18/2016	10.19	2.02	6.84
193+63	10/8/2015	10/18/2016	-1.12	0.85	1.69
195+63	10/8/2015	10/18/2016	2.03	2.65	9.46
206+86	10/8/2015	10/18/2016	-3.50	0.57	-0.31
218+66	10/8/2015	10/18/2016	6.12	1.38	-2.29
229+85	10/8/2015	10/18/2016	-0.55	-0.04	-1.66
242+03	10/8/2015	10/18/2016	-7.71	-1.09	2.30
252+62	10/8/2015	10/18/2016	-6.55	-1.38	-6.10
263+22	10/8/2015	10/18/2016	35.48	6.42	5.22
274+53	10/8/2015	10/18/2016	-9.30	3.09	-1.75
281+40	10/8/2015	10/18/2016	-4.63	3.07	1.96
288+39	10/8/2015	10/18/2016	18.30	4.66	8.74
295+27	10/8/2015	10/18/2016	15.15	3.71	-4.45
302+24	10/8/2015	10/18/2016	54.83	5.43	-2.86
315+96	10/8/2015	10/18/2016	-1.29	2.92	6.57
323+09	10/8/2015	10/18/2016	-7.54	-2.19	-7.44
329+63	10/8/2015	10/18/2016	-25.93	-1.45	0.44
331+43	10/8/2015	10/18/2016	-5.61	-0.47	1.92
333+23	10/8/2015	10/18/2016	-9.97	1.93	7.80
335+03	10/8/2015	10/18/2016	-34.93	-0.79	-1.88
336+83	10/8/2015	10/18/2016	-4.37	-1.39	-3.47
338+63	10/8/2015	10/18/2016	29.05	0.99	3.42
340+43	10/8/2015	10/18/2016	-42.56	2.50	-5.21
342+23	10/8/2015	10/18/2016	-34.50	1.81	-4.01

**Table C-1. Summary of Shoreline Change and Volume Change
(October 2015 to October 2016) Cont.**

NOTES:

1. Positive changes indicate accretion or gain in volume along the profile and negative changes indicate erosion or loss of volume along the profile.
2. MHW assumed at +0.98 ft-NAVD88.
3. Shoreline Change and Volume Change is calculated for the period between surveys from October 8, 2015 to October 18, 2016.

Transect Number (Station)	Old Survey Date	New Survey Date	Shoreline Change Rate at MHW (ft/yr)	Volume Change Rate Above 0 ft NAVD88 (cy/ft/yr)	Volume Change Rate Above -15 ft NAVD88 (cy/ft/yr)
344+05	10/8/2015	10/18/2016	-45.75	-3.97	-5.10
345+85	10/8/2015	10/18/2016	-37.18	-4.03	-3.53
347+63	10/8/2015	10/18/2016	-9.60	-0.43	7.21
349+43	10/8/2015	10/18/2016	-19.96	-2.54	-6.06
351+23	10/8/2015	10/18/2016	-9.80	2.67	11.77
353+03	10/8/2015	10/18/2016	-14.27	-1.18	-13.30
354+83	10/8/2015	10/18/2016	-7.18	2.04	8.09
356+63	10/8/2015	10/18/2016	-13.90	-2.00	-19.43
358+43	10/8/2015	10/18/2016	-6.26	2.22	-1.47
360+23	10/8/2015	10/18/2016	-10.20	-1.06	-17.22
362+03	10/8/2015	10/18/2016	-1.67	2.75	5.13
363+83	10/8/2015	10/18/2016	3.52	1.07	-16.54
365+63	10/8/2015	10/18/2016	2.01	1.45	0.50
367+43	10/8/2015	10/18/2016	2.47	-0.69	-15.45
369+23	10/8/2015	10/18/2016	2.54	-0.26	11.90
371+03	10/8/2015	10/18/2016	-3.88	0.94	-2.43
372+83	10/8/2015	10/18/2016	-1.43	0.58	4.95
375+08	10/8/2015	10/18/2016	4.24	0.25	-10.26
376+78	10/8/2015	10/18/2016	-26.57	-5.16	-0.88
378+48	10/8/2015	10/18/2016	-15.62	-3.44	-3.79
380+18	10/8/2015	10/18/2016	-12.41	-2.07	0.19
381+88	10/8/2015	10/18/2016	-15.47	-0.44	0.32
383+58	10/8/2015	10/18/2016	-5.56	-1.00	1.90

**Table C-2. Summary of Shoreline Change and Volume Change
(May 2016 to October 2016)**

NOTES:

1. Positive changes indicate accretion or gain in volume along the profile and negative changes indicate erosion or loss of volume along the profile.
2. MHW assumed at +0.98 ft-NAVD88.
3. Shoreline Change and Volume Change is calculated for the period between surveys from May 10, 2016 to October 18, 2016.

Transect Number (Station)	Old Survey Date	New Survey Date	Shoreline Change at MHW (ft)	Volume Change Above 0 ft NAVD88 (cy/ft)	Volume Change Above -15 ft NAVD88 (cy/ft)
0+00	5/10/2016	10/18/2016	-4.17	5.63	0.42
2+50	5/10/2016	10/18/2016	2.19	0.84	8.45
5+00	5/10/2016	10/18/2016	-7.84	-2.14	2.27
7+50	5/10/2016	10/18/2016	-4.93	-3.52	-11.33
10+00	5/10/2016	10/18/2016	2.54	3.46	-37.11
12+50	5/10/2016	10/18/2016	12.74	6.93	4.32
15+00	5/10/2016	10/18/2016	8.45	4.66	0.17
17+50	5/10/2016	10/18/2016	8.06	2.82	-0.49
20+00	5/10/2016	10/18/2016	-2.49	1.53	-4.84
22+50	5/10/2016	10/18/2016	0.18	1.18	1.27
25+00	5/10/2016	10/18/2016	-29.49	-3.91	-8.78
27+50	5/10/2016	10/18/2016	-28.64	-3.37	-11.56
30+00	5/10/2016	10/18/2016	-21.26	-2.87	-10.66
32+50	5/10/2016	10/18/2016	7.32	-0.49	1.12
35+00	5/10/2016	10/18/2016	16.94	6.72	11.78
37+50	5/10/2016	10/18/2016	-7.19	-2.08	-1.12
40+00	5/10/2016	10/18/2016	-8.22	-2.67	-5.37
42+50	5/10/2016	10/18/2016	-16.11	-7.79	-14.45
45+00	5/10/2016	10/18/2016	-1.48	-6.05	-12.60
45+25	5/10/2016	10/18/2016	-6.00	-5.70	-11.35
47+30	5/10/2016	10/18/2016	-4.10	-4.04	-6.74
49+35	5/10/2016	10/18/2016	11.28	1.21	2.26
51+41	5/10/2016	10/18/2016	-4.85	0.00	-5.79
53+46	5/10/2016	10/18/2016	-17.72	-1.62	-5.50
55+51	5/10/2016	10/18/2016	-1.94	-0.72	-0.90
57+57	5/10/2016	10/18/2016	-21.14	-1.82	-5.16
59+62	5/10/2016	10/18/2016	-5.68	-1.57	-6.92
61+62	5/10/2016	10/18/2016	-16.31	-1.61	-1.13
63+62	5/10/2016	10/18/2016	-6.86	-0.41	-1.26
65+62	5/10/2016	10/18/2016	-8.88	-1.37	-8.25
67+62	5/10/2016	10/18/2016	0.12	-0.75	-0.05
69+62	5/10/2016	10/18/2016	-23.06	-0.98	-3.82
71+62	5/10/2016	10/18/2016	-4.22	0.09	-1.97
73+62	5/10/2016	10/18/2016	-18.48	-2.16	-3.30
75+62	5/10/2016	10/18/2016	-16.26	-3.05	-6.05
77+62	5/10/2016	10/18/2016	17.74	2.66	1.86
79+62	5/10/2016	10/18/2016	-9.07	-1.39	-2.91
81+62	5/10/2016	10/18/2016	-5.23	-1.62	-6.18
83+62	5/10/2016	10/18/2016	7.74	1.27	-0.63
85+62	5/10/2016	10/18/2016	-9.06	-1.93	-1.27
87+62	5/10/2016	10/18/2016	-2.50	-1.77	-1.89

**Table C-2. Summary of Shoreline Change and Volume Change
(May 2016 to October 2016) Cont.**

Central Ocean View Nourishment (March 2005 to May 2016) Cont.

1. Positive changes indicate accretion or gain in volume along the profile and negative changes indicate erosion or loss of volume along the profile.
2. MHW assumed at +0.98 ft-NAVD88.
3. Shoreline Change and Volume Change is calculated for the period between surveys from May 10, 2016 to October 18, 2016.

Transect Number (Station)	Old Survey Date	New Survey Date	Shoreline Change at MHW (ft)	Volume Change Above 0 ft NAVD88 (cy/ft)	Volume Change Above -15 ft NAVD88 (cy/ft)
93+41	5/10/2016	10/18/2016	3.87	1.07	4.01
103+08	5/10/2016	10/18/2016	3.61	-1.40	-1.38
120+93	5/10/2016	10/18/2016	-19.59	-3.59	-6.61
129+17	5/10/2016	10/18/2016	-9.54	-0.37	-1.01
141+98	5/10/2016	10/18/2016	-1.07	-1.90	3.40
152+01	5/10/2016	10/18/2016	4.67	1.25	6.36
163+49	5/10/2016	10/18/2016	-9.68	-1.25	4.07
169+63	5/10/2016	10/18/2016	-6.21	-4.37	-11.03
171+63	5/10/2016	10/18/2016	-11.15	-3.33	-9.50
173+63	5/10/2016	10/18/2016	-9.00	-3.81	-2.52
175+63	5/10/2016	10/18/2016	6.83	-1.03	-2.94
177+63	5/10/2016	10/18/2016	-16.35	-1.60	6.54
179+63	5/10/2016	10/18/2016	-16.83	-1.00	-3.07
181+63	5/10/2016	10/18/2016	-9.14	-0.21	4.48
183+63	5/10/2016	10/18/2016	-11.19	0.40	0.19
185+63	5/10/2016	10/18/2016	-8.34	-0.82	-7.27
187+63	5/10/2016	10/18/2016	-8.00	-2.45	-1.97
189+63	5/10/2016	10/18/2016	0.68	0.66	0.27
191+63	5/10/2016	10/18/2016	-16.49	-3.43	-2.92
193+63	5/10/2016	10/18/2016	-0.45	0.63	4.77
195+63	5/10/2016	10/18/2016	-3.58	-0.32	0.64
206+86	5/10/2016	10/18/2016	3.19	-0.11	0.39
218+66	5/10/2016	10/18/2016	4.81	-3.46	-5.48
229+85	5/10/2016	10/18/2016	23.39	-0.11	-1.94
242+03	5/10/2016	10/18/2016	12.50	-0.44	3.02
252+62	5/10/2016	10/18/2016	15.46	-3.97	-4.42
263+22	5/10/2016	10/18/2016	14.34	0.58	2.03
274+53	5/10/2016	10/18/2016	22.36	2.13	0.53
281+40	5/10/2016	10/18/2016	-0.80	-2.31	-3.61
288+39	5/10/2016	10/18/2016	9.78	-1.89	-0.14
295+27	5/10/2016	10/18/2016	12.56	2.24	1.39
302+24	5/10/2016	10/18/2016	10.61	-1.03	-0.76
315+96	5/10/2016	10/18/2016	13.80	0.46	6.18
323+09	5/10/2016	10/18/2016	-2.49	-4.22	-7.22
329+63	5/10/2016	10/18/2016	-7.35	-3.72	-2.28
331+43	5/10/2016	10/18/2016	-10.76	-4.35	-4.81
333+23	5/10/2016	10/18/2016	-9.47	-3.22	1.63
335+03	5/10/2016	10/18/2016	-16.36	-4.38	-2.03
336+83	5/10/2016	10/18/2016	-14.42	-2.99	-5.65
338+63	5/10/2016	10/18/2016	0.53	-1.71	2.39
340+43	5/10/2016	10/18/2016	-8.66	-2.03	-0.41

**Table C-2. Summary of Shoreline Change and Volume Change
(May 2016 to October 2016) Cont.**

NOTES:

1. Positive changes indicate accretion or gain in volume along the profile and negative changes indicate erosion or loss of volume along the profile.
2. MHW assumed at +0.98 ft-NAVD88.
3. Shoreline Change and Volume Change is calculated for the period between surveys from May 10, 2016 to October 18, 2016.

Transect Number (Station)	Old Survey Date	New Survey Date	Shoreline Change at MHW (ft)	Volume Change Above 0 ft NAVD88 (cy/ft)	Volume Change Above -15 ft NAVD88 (cy/ft)
342+23	5/10/2016	10/18/2016	-12.22	0.74	-6.35
344+05	5/10/2016	10/18/2016	12.12	2.61	5.03
345+85	5/10/2016	10/18/2016	-0.04	-1.66	4.74
347+63	5/10/2016	10/18/2016	12.60	-1.27	-0.45
349+43	5/10/2016	10/18/2016	-0.44	-1.05	2.49
351+23	5/10/2016	10/18/2016	5.18	-0.33	1.95
353+03	5/10/2016	10/18/2016	2.83	-1.10	-3.51
354+83	5/10/2016	10/18/2016	3.81	-1.64	-0.17
356+63	5/10/2016	10/18/2016	3.34	-2.17	-9.39
358+43	5/10/2016	10/18/2016	1.47	-2.02	-7.67
360+23	5/10/2016	10/18/2016	-1.08	-3.30	-9.88
362+03	5/10/2016	10/18/2016	9.90	-1.79	-2.09
363+83	5/10/2016	10/18/2016	3.21	-2.66	-10.49
365+63	5/10/2016	10/18/2016	6.45	-1.66	-4.77
367+43	5/10/2016	10/18/2016	-1.83	-2.31	-4.99
369+23	5/10/2016	10/18/2016	1.57	-1.52	0.76
371+03	5/10/2016	10/18/2016	-12.18	-1.90	-1.09
372+83	5/10/2016	10/18/2016	-8.92	-2.36	1.72
375+08	5/10/2016	10/18/2016	-1.64	-2.60	-3.02
376+78	5/10/2016	10/18/2016	-6.46	-4.28	-3.31
378+48	5/10/2016	10/18/2016	-7.75	-3.30	-2.04
380+18	5/10/2016	10/18/2016	-8.28	-2.69	-3.11
381+88	5/10/2016	10/18/2016	-6.51	-8.59	-9.39
383+58	5/10/2016	10/18/2016	-8.59	-4.43	-6.36

**Table C-3. Summary of Shoreline Change and Volume Change from
East Ocean View Nourishment (March 2009 to October 2016)**

NOTES:

1. Positive changes indicate accretion or gain in volume along the profile and negative changes indicate erosion or loss of volume along the profile.
2. MHW assumed at +0.98 ft-NAVD88.
3. Shoreline Change and Volume Change is calculated for the period between surveys from March 20, 2009 to October 18, 2016.

Transect Number (Station)	Old Survey Date	New Survey Date	Shoreline Change Rate at MHW (ft/yr)	Volume Change Rate Above 0 ft NAVD88 (cy/ft/yr)	Volume Change Rate Above -15 ft NAVD88 (cy/ft/yr)
329+63	3/20/2009	10/18/2016	-15.57	-3.43	-
331+43	3/20/2009	10/18/2016	-15.58	-3.13	-
333+23	3/20/2009	10/18/2016	-12.32	-2.29	-
335+03	3/20/2009	10/18/2016	-11.65	-1.71	-
336+83	3/20/2009	10/18/2016	-11.81	-1.74	-
338+63	3/20/2009	10/18/2016	-9.84	-1.54	-
340+43	3/20/2009	10/18/2016	-12.27	-1.11	-
342+23	3/20/2009	10/18/2016	-13.32	-1.43	-
344+05	3/20/2009	10/18/2016	-11.54	-2.26	-
345+85	3/20/2009	10/18/2016	-11.13	-2.48	-
347+63	3/20/2009	10/18/2016	-8.79	-2.35	-
349+43	3/20/2009	10/18/2016	-11.49	-2.49	-
351+23	3/20/2009	10/18/2016	-8.44	-1.99	-
353+03	3/20/2009	10/18/2016	-10.13	-2.25	-
354+83	3/20/2009	10/18/2016	-8.61	-2.10	-
356+63	3/20/2009	10/18/2016	-10.93	-2.83	-
358+43	3/20/2009	10/18/2016	-10.32	-2.52	-
360+23	3/20/2009	10/18/2016	-12.63	-3.09	-
362+03	3/20/2009	10/18/2016	-9.57	-2.56	-
363+83	3/20/2009	10/18/2016	-7.76	-2.37	-
365+63	3/20/2009	10/18/2016	-7.45	-2.15	-
367+43	3/20/2009	10/18/2016	-13.56	-2.91	-
369+23	3/20/2009	10/18/2016	-12.89	-2.43	-
371+03	3/20/2009	10/18/2016	-18.79	-3.44	-
372+83	3/20/2009	10/18/2016	-20.33	-4.04	-
375+08	3/20/2009	10/18/2016	-22.79	-4.83	-
376+78	3/20/2009	10/18/2016	-23.76	-5.02	-
378+48	3/20/2009	10/18/2016	-29.25	-5.96	-
380+18	3/20/2009	10/18/2016	-27.55	-5.40	-
381+88	3/20/2009	10/18/2016	-20.59	-4.18	-
383+58	3/20/2009	10/18/2016	-26.18	-5.13	-

**Table C-4. Summary of Shoreline Change and Volume Change from
Central Ocean View Nourishment (March 2005 to October 2016)**

NOTES:

1. Positive changes indicate accretion or gain in volume along the profile and negative changes indicate erosion or loss of volume along the profile.
2. MHW assumed at +0.98 ft-NAVD88.
3. Shoreline Change and Volume Change is calculated for the period between surveys from March 15, 2005 to October 18, 2016.

Transect Number (Station)	Old Survey Date	New Survey Date	Shoreline Change Rate at MHW (ft/yr)	Volume Change Rate Above 0 ft NAVD88 (cy/ft/yr)	Volume Change Rate Above -15 ft NAVD88 (cy/ft/yr)
15+00	3/15/2005	10/18/2016	5.35	1.51	-
17+50	3/15/2005	10/18/2016	5.82	1.58	-
20+00	3/15/2005	10/18/2016	4.04	0.65	-
22+50	3/15/2005	10/18/2016	-0.28	-0.66	-
25+00	3/15/2005	10/18/2016	0.53	-0.77	-
27+50	3/15/2005	10/18/2016	-0.16	-0.90	-
30+00	3/15/2005	10/18/2016	0.11	-0.39	-
32+50	3/15/2005	10/18/2016	-1.65	-0.98	-
35+00	3/15/2005	10/18/2016	3.20	0.66	-
37+50	3/15/2005	10/18/2016	-0.90	-0.29	-
40+00	3/15/2005	10/18/2016	-5.19	-1.21	-
42+50	3/15/2005	10/18/2016	-6.46	-2.16	-
45+00	3/15/2005	10/18/2016	-8.54	-2.69	-
45+25	3/15/2005	10/18/2016	-9.77	-3.02	-
47+30	3/15/2005	10/18/2016	-10.37	-3.21	-
49+35	3/15/2005	10/18/2016	-6.17	-1.98	-
51+41	3/15/2005	10/18/2016	-6.05	-1.69	-
53+46	3/15/2005	10/18/2016	-5.12	-1.52	-
55+51	3/15/2005	10/18/2016	-7.03	-2.29	-
57+57	3/15/2005	10/18/2016	-3.39	-1.20	-
59+62	3/15/2005	10/18/2016	-5.87	-1.62	-
61+62	3/15/2005	10/18/2016	-1.36	-0.15	-
63+62	3/15/2005	10/18/2016	-5.10	-0.69	-
65+62	3/15/2005	10/18/2016	-3.47	-0.15	-
67+62	3/15/2005	10/18/2016	-11.45	-1.50	-
69+62	3/15/2005	10/18/2016	-6.43	-0.56	-
71+62	3/15/2005	10/18/2016	-9.20	-0.99	-
73+62	3/15/2005	10/18/2016	-5.66	-0.20	-
75+62	3/15/2005	10/18/2016	-7.04	-0.69	-
77+62	3/15/2005	10/18/2016	-3.20	0.14	-
79+62	3/15/2005	10/18/2016	-4.32	-0.99	-
81+62	3/15/2005	10/18/2016	-4.54	-1.56	-
83+62	3/15/2005	10/18/2016	-6.20	-2.08	-
85+62	3/15/2005	10/18/2016	-3.75	-1.30	-
87+62	3/15/2005	10/18/2016	-3.29	-0.88	-
93+41	3/15/2005	10/18/2016	-0.81	-0.66	-
103+08	3/15/2005	10/18/2016	-2.50	-0.98	-
120+93	3/15/2005	10/18/2016	-5.09	-2.06	-
129+17	3/15/2005	10/18/2016	-5.03	-2.41	-
141+98	3/15/2005	10/18/2016	-3.31	-1.32	-
152+01	3/15/2005	10/18/2016	-4.27	-1.61	-

**Table C-4. Summary of Shoreline Change and Volume Change from
Central Ocean View Nourishment (March 2005 to October 2016) Cont.**

NOTES:

1. Positive changes indicate accretion or gain in volume along the profile and negative changes indicate erosion or loss of volume along the profile.
2. MHW assumed at +0.98 ft-NAVD88.
3. Shoreline Change and Volume Change is calculated for the period between surveys from March 15, 2005 to October 18, 2016.

Transect Number (Station)	Old Survey Date	New Survey Date	Shoreline Change Rate at MHW (ft/yr)	Volume Change Rate Above 0 ft NAVD88 (cy/ft/yr)	Volume Change Rate Above -15 ft NAVD88 (cy/ft/yr)
163+49	3/15/2005	10/18/2016	-2.82	-1.03	-
169+63	3/15/2005	10/18/2016	-1.84	-0.86	-
171+63	3/15/2005	10/18/2016	-3.30	-0.92	-
173+63	3/15/2005	10/18/2016	-2.11	-1.09	-
175+63	3/15/2005	10/18/2016	-4.03	-0.98	-
177+63	3/15/2005	10/18/2016	-3.67	-0.56	-
179+63	3/15/2005	10/18/2016	-3.39	-0.88	-
181+63	3/15/2005	10/18/2016	-1.32	-0.65	-
183+63	3/15/2005	10/18/2016	-0.27	0.27	-
185+63	3/15/2005	10/18/2016	-0.55	-0.07	-
187+63	3/15/2005	10/18/2016	2.55	0.92	-
189+63	3/15/2005	10/18/2016	0.30	0.96	-
191+63	3/15/2005	10/18/2016	2.83	1.55	-
193+63	3/15/2005	10/18/2016	-0.36	0.70	-
195+63	3/15/2005	10/18/2016	-0.82	0.46	-

ENGINEERING ACTIVITIES LOG AND LOG OF SURVEYS FOR ENTIRE OCEAN VIEW SHORELINE

No	Date	Project Type	Location	Description	Vol (cy)	Extent (ft)	Unit Vol (cy/ft)	Sand Source
1	1920-1937	Groin Construction	Willoughby Spit Shoreline	62 groins built by private property owners				
2	Dec 1926-Jan 1928	Jetty Construction	Little Creek Inlet	East Jetty Construction				
3	Dec 1926-Nov 1928	Jetty Construction	Little Creek Inlet	West Jetty Construction				
4	1938	Groin Construction	Between Willoughby Spit and Chesapeake Blvd.	37 timber groins built by City of Norfolk				
5	1953	Beach Nourishment	18th Bay St to 27th Bay St (East Ocean View)	Beach Nourishment	1,260,000	3,000	420	
6	1953	Beach Nourishment	27th Bay St to West Jetty (East Ocean View)	Beach Nourishment	500,000	1,800	278	
7	1960	Beach Nourishment	East End Parking Lot to West Jetty (East Ocean View)	Beach Nourishment	159,000	900	177	
8	1962	Beach Nourishment	Terminal Groin to 9th View St (Willoughby Spit)	Beach Nourishment	176,000	6,900	25	
9	1981	Groin reconstruction	Willoughby Spit area	5 timber groins were reconstructed				
10	1982	Beach Nourishment	East Ocean View	Beach Nourishment	400,000			Pretty Lake
11	1983	Groin Removal	Ocean View Park area	3 groins removed				
12	1983	Groin Construction	Western end of Willoughby Spit	5 groins built by the City of Norfolk				
13	Jan-Apr 1984	Beach Nourishment	Terminal Groin to 5th View St (Willoughby Spit)	Beach Nourishment	537,500	11,000	49	Navy Piers
14	Aug-Nov 1984	Beach Nourishment	21st Bay St to East End Parking Lot (East Ocean View)	Beach Nourishment	400,000	3,000	133	Pretty Lake
15	1985	Beach Nourishment	6th View St to Sarah Constant Shrine Park	Beach Nourishment	50,000			Navy's Willoughby project site
16	1987	Beach Nourishment	5th View St to Mason Creek	Beach Nourishment	50,000	2,000	25	Truck Haul
17	1988	Beach Access Construction	Willoughby and Ocean View	19 pedestrian beach access ways constructed				
18	Spring 1988	Dune Repair	Willoughby Beach	used 10,000 cy of accretion from terminal groin				
19	June, 1989	Dune Repair	Willoughby Beach	used 25,000 cy of accretion from terminal groin				
20	1989	Beach Nourishment	21st Bay St to East End Parking Lot (East Ocean View)	Beach Nourishment	133,000	3,000	44	Cape Henry Channel
21	1990	Breakwater Construction	Western end of Willoughby Spit-Lea View Ave.	2 near shore breakwaters				
22	1990	Terminal Groin Reconstruction	Western end of Willoughby Spit-Lea View Ave.	Original wooden groin raised and extended using rock				
23	1990	Beach Nourishment	Willoughby Spit-Near Terminal Groin	Beach Nourishment	100,000			West of Terminal Groin
24	1990-1991	Dune Stabilization/repair	Various Locations	dune vegetation planting,sand fence construction, elevated public access way, cross-over structures, and timber roads for vehicles				
25	1995	Beach Nourishment	Willoughby Spit	Beach Nourishment	240,000			15th View
26	December, 1995	Beach Nourishment	13th View St to 12 View St (in 4 groin pockets)	Beach Nourishment	4,000			15th View
27	December, 1995	Beach Nourishment	Critical Area 1: 8th View St to 7th View St	Beach Nourishment	30,000	1,000	30	15th View
28	March, 1997	Terminal Groin (trunk) Elevated	Willoughby Spit	terminal groin (trunk) elevated +4 ft				
29	Jan 1997- April 1997	Breakwater Construction	Critical Area 1: Worth St to 8th View	nearshore breakwaters 1-4 constructed				
30	December 1997 - March 1998	Breakwater Construction	Critical Area 1: Worth St to 8th View	nearshore breakwaters 5-7 constructed				
31	October 1998 City Survey		Entire Ocean View Shoreline					
32	December, 1998	Beach Nourishment	Critical Area 1: East of 8th View St-near site of future groin spur	Beach Nourishment	500	175	3	
33	October 1999 City Survey		Entire Ocean View Shoreline					
34	1999	Breakwater Construction	Critical Area 2: Just east of Community Beach	4 nearshore breakwaters constructed				
35	November-December 1999	Groin Spur Construction	Critical Area 1: Worth St to 8th View	groin spur construction				
36	December, 1999	Beach Nourishment	Center of COV breakwaters	Beach Nourishment	4,000			
37	December, 1999	Beach Nourishment	Critical Area 1: East of 8th View St-leeward of newly constructed groin spur	Beach Nourishment	1,000	200	5	15th View
38	July 2000 City Survey		From Approx. 9th View St to Little Creek Inlet					
39	August, 2000	Breakwater Construction	Critical Area 3: 21st Bay to Little Creek Inlet	nearshore breakwaters 2,3,4 constructed				
40	October 2000 City Survey		From Approx. 12th View St to Little Creek Inlet					
41	July, 2001	Beach Nourishment	Critical Area 1: Worth St to 8th View	Beach Nourishment	500			Truck Haul
42	September, 2001	Beach Nourishment	Critical Area 1: East of 8th View St-between breakwater 7 and groin spur	Beach Nourishment	2,000	300	7	15th View
43	October 2001 City Survey		Entire Ocean View Shoreline					
44	November, 2001	Breakwater Construction	Critical Area 3: 21st Bay to Little Creek Inlet	nearshore breakwaters 1,5,6,7 constructed				
45	March - April, 2002	Breakwater Work	Critical Area 1: breakwater 7	work on toe extensions				
46	May, 2002	Beach Nourishment	Critical Area 1: East of 8th View St-between breakwater 7 and groin spur	Beach Nourishment	3,438	300	11	15th View
47	June, 2002	Groin Removal	Critical Area 1: Worth St to 8th View	Removal of timber groin channelward of rock spur				
48	July 2002 City Survey		Entire Ocean View Shoreline - excluding approx. Sherwood Pl. to Warwick Ave.					
49	October 2002 City Survey		Entire Ocean View Shoreline - minimal survey data (no beach or bathymetric survey points)					
50	March 2003 City Survey		East Ocean View Shoreline (19th Bay to Little Creek Inlet)					
51	April 2003 City Survey		East Ocean View Shoreline (17th Bay to Little Creek Inlet)					
52	June 2003 Waterway Survey		East Ocean View Shoreline (17th Bay to Little Creek Inlet)					
53	September, 2003	Beach Nourishment	Critical Area 1: West of 8th View St beach access	Beach Nourishment	1,100	350	3	15th View

No	Date	Project Type	Location	Description	Vol (cy)	Extent (ft)	Unit Vol (cy/ft)	Sand Source
54	October 2003 Waterway Survey		Post-Isabel Survey - East Ocean View Shoreline (17th Bay to Little Creek Inlet)					
55	October, 2003	Beach Nourishment	Critical Area 3: 19th Bay St	Beach Nourishment	6,000	545	11	upland sand trucked in
56	October, 2003	Beach Nourishment	Critical Area 3: East of 30th Bay St	Beach Nourishment	1,000	150	7	upland sand trucked in
57	December, 2003	Beach Nourishment	Critical Area 3: 17th Bay St to Little Creek Inlet	Beach Nourishment	359,000	5,280	68	Thimble Shoal Channel
58	December, 2003	Beach Nourishment	Critical Area 1: 9th View St to 7th View St (+400 ft)	Beach Nourishment	39,800	1,260	32	
59	Nov-Dec 2003 Post-Fill Survey		East OceanView Shoreline (17th Bay to Little Inlet Creek)					
60	Feb-April, 2004 Waterway Survey		From Approx. Willoughby Spit to 17th Bay St					
61	August, 2004	Beach Nourishment	13th View to 11th View, Behind Western 4 Breakwaters at 800 Block, 1200' East of dogleg	Beach Nourishment	37,000	4,950	7	Truck Haul
62	January-March, 2005	Dune Restoration	Willoughby Spit to Central Ocean View (14th View St to Warwick Ave)	Willoughby Spit to Central Ocean View Dune Restoration Project	504,329	18,300	28	Thimble Shoal Channel
63	January-March 2005 Post-Fill Survey		Willoughby Spit to Warwick Ave.					
64	September 2005 McKim & Creed Periodic Survey		Entire Ocean View Shoreline					
65	January-February, 2006	Groin Spur & Toe Extension Removal	Critical Area 1: East of 8th View	groin spur removal				
66	January-February, 2006	Breakwater Construction	Critical Area 1: East of 8th View	nearshore breakwater 8 constructed				
67	January-February, 2006	Breakwater Construction	Critical Area 3: 29th Bay to Little Creek Inlet	nearshore breakwaters 8, 9, & 10 constructed				
68	March 2006 McKim & Creed Periodic Survey		Entire Ocean View Shoreline					
69	October 2006 McKim & Creed Periodic Survey		Entire Ocean View Shoreline					
70	March 2007 McKim & Creed Periodic Survey		Entire Ocean View Shoreline					
71	October 2007 McKim & Creed Periodic Survey		Entire Ocean View Shoreline					
72	March 2008 McKim & Creed Periodic Survey		Entire Ocean View Shoreline					
73	October 2008 McKim & Creed Periodic Survey		Entire Ocean View Shoreline					
74	March, 2009	Beach Nourishment	East Ocean View and Bay Oaks	Beach Nourishment	196,000			
75	April 2009 McKim & Creed Periodic Survey		Entire Ocean View Shoreline					
76	August-October, 2009	Breakwater Construction	Bay Oaks	5 Nearshore Breakwaters Constructed				
77	October 2009 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
78	November-December 2009 Post-Storm Survey		Entire Ocean View Shoreline					
79	March 2010 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
80	April, 2010	Dune Restoration	Willoughby Spit and 800 Block	Dune restoration using sediment from terminal groin and 800 block breakwaters				
81	October 2010 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
82	April 2011 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
83	October 2011 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
84	March 2012 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
85	October 2012 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
86	January-May, 2013	Breakwater Construction	Willoughby Spit	7 Nearshore Breakwaters Constructed				
87	January-May, 2013	Dune Restoration/Beach Nourishment	Willoughby Spit	Dune Restoration at Lea View Ave and Beach Nourishment from 11th View to 13th View	35,000			Willoughby Spit / Truck Hual
87	January-May, 2013	Breakwater Relocation	800 Block	Breakwater 7 moved further offshore				
88	April 2013 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
89	May-October, 2013	Timber Groin Removal	West Ocean View	7 Timber Groins removed east of the Pier				
90	October, 2013	Rock Groin Construction	West Ocean View	Rock Groin Constructed between Sarah Constant Shrine Park and the 200 Block				
91	October 2013 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
92	November 2013	Beach Nourishment	West Ocean View	Beach Nourishment	73,600			Truck Haul
93	March 2014 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
94	October 2014 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
95	April 2015 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
96	October 2015 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
97	January-February 2016	Beach Nourishment	Toler Place (between 11th View and 12th View Streets)	Emergency nourishemnt placed above MHW	16,400			Willoughby Spit
98	February 2016	Beach Nourishment	Adjacent to Terminal Groin	Emergency nourishemnt placed above MHW	1,500			Truck Hual Upland Source
99	May 2016 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
100	October 2016 Geodynamics Periodic Survey		Entire Ocean View Shoreline					

REFERENCE*
Critical area 1: Worth St to 8th View
Critical area 2: Chesapeake Blvd. to Atlans St.
Critical area 3: 21st Bay to Little Creek Inlet

*Critical areas of concern for erosional damage defined in
Andrews, Miller & Assoc., Inc. "Beach Management Plan, City of Norfolk Virginia", January, 1993.