**FINAL REPORT FOR 2016**

# FOR
# THE BOROUGH OF MANTOLOKING, OCEAN COUNTY, NEW JERSEY
# REVIEWING CHANGES TO THE MUNICIPAL BEACHES SINCE HURRICANE SANDY

*View to the south during Hurricane Hermine's coastal transit of New Jersey in early September 2016. Far from the worst event during 2016, this storm essentially ended the summer's sand accretion phase for the year. Since Hermine, Hurricane Mathew and a September 2016 three-day mild event kept the beach in a state of flux between erosion and accumulation seaward of the steel wall.*


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**December 25, 2016**

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**Executive Summary:**

The Stockton University Coastal Research Center (CRC) continued the 23-year monitoring effort along the municipal shoreline in Mantoloking. This annual report provides the results and analyses from the fall 2015 to fall 2016 survey datasets.

Bids for the Manasquan to Barnegat Inlet US Army Shore Protection Project have been opened and the Weeks Marine Company was the low bidder with a number 30 million under the official ACOE estimate. Work continues to complete litigation over the project with private citizens not wishing to see this project built, feeling that the various hard structures currently in place provide all the shore protection necessary. Conventional wisdom has defined a period of about 5 years as the collective storm memory among those impacted by a severe event, and this opposition confirms that amnesia exists for Hurricane Sandy and the variation in the impact seen along the NJ coastline. The CRC staff made the effort to survey the entire NJ coastline between October 31st and November 23rd 2012, so armed with actual data on the variation in that storm's impact, can definitely state that the anticipated federal beach project when combined with the existing hard structures presents a unique opportunity to have an excellent margin of safety when the next in a long series of serious coastal storms arrives off the Ocean County coast.

**2016 Storm Activity:**

Recently the weather channel began naming northeast storm events similar to named hurricanes. Jonas was the name given to a January 23 & 24, 2016 event that was the first "Federal Disaster" declaration since Hurricane Sandy in NJ. This event was produced coastal flooding in Cape May County worse than seen during Sandy, and was particularly harsh at the Mantoloking shoreline documented in local citizen videos and drone flights afterwards. The steel wall was exposed on the beach its entire length with a 22-foot vertical face exposed near Herbert Street on January 24, 2016. Average exposure varied between 4-6 feet up to 10 to 12 feet along the wall length with pictures on video showing massive wave interaction between reflected and incoming waves in the surf zone. Another storm (Nacio) occurred in February, but was of shorter duration that resulted in lower wave energy. Conditions improved from that point forward allowing Mantoloking to begin a sand restoration effort harvesting material moved back landward after the storms and pushing it up against the vertical wall face. Sand was brought in from Ocean County quarries and added to the beach material. Slowly the wall was re-buried and a recreational dune and beach surface was restored by June 16, 2016 just in time for the summer season.

Hurricane Hermine passed by offshore September 7, 2016 exposing minor segments of the wall, with two minor northeast events plus some long-period swell from Hurricane Mathew in October. As of the writing of this report, there have been no further storm events, which mean the beaches in Mantoloking are open for public use during Striper Fishing Season in 2016.

**Beach Monitoring Program Methodology:**

There are five sites in the Borough that have been monitored by the CRC on a quarterly schedule over the last 22 years, ensuring a continuous and coherent data set, which provides the Borough with a valuable resource tool when determining coastal management issues. The monitoring shifted to semi-annual with the 2016 contract. The following is a list of the selected sites and locations:

- Mant-1: Beach access path at Carrigan Place
- Mant-2: Beach access path at 1041 Ocean Avenue
- Mant-3: 1117 Ocean Avenue (NJBPN site #153)*
- Mant-4: Princeton Avenue street end
- Mant-51: Beach access path at 1543 Ocean Avenue**

* 1117 Ocean Avenue was established on private land in 1986 for the New Jersey Beach Profile Network
* * Replaced Mant-5 formerly located on private property at 1547 Ocean Ave. following that property's sale.

This monitoring program is intended to provide municipal officials with a periodic review of shoreline stability, beach/dune erosion or accretion and changes to the vegetation and sand collecting systems installed by individual property owners. The CRC completed the semi-annual surveys for 2016 on the following dates:

| | | |
|---|---|---|
| Spring | Survey #96 | June 6, 2016 |
| Fall | Survey #97 | October 17, 2016 |

In addition, a separate effort was established following NE storm Jonas to measure the vertical wall exposure at 21 separate locations between Lyman Street and into Brick Township to document the amount and duration of wall exposure until a beach recovered sufficiently to have the bulldozer push up the berm sand into a seaward dune slope that connected directly with the sand lying landward of the wall.

Table 1 below shows the shoreline and sand volume changes at the five monitoring locations during the last half of 2016 (comparing surveys #96 and #97). Shoreline changes are measured in feet while sand volume changes are in cubic yards per foot ($yds^3/ft.$). Individual profile changes are averaged with adjacent sites and multiplied by the distance between sites to determine a net cell volume change. Total volume change for the Borough is determined by summing the net cell volume changes.

**Table 1**
**Semi-annual Shoreline & Sand Volumes Changes**
**June 6, 2016 to October 17, 2016**

| Profile Number | Shoreline Change (feet) | Volume Change ($yds^3/ft$) | Avg.Volume Change ($yds^3/ft$) | Distance Between (feet) | Net Volume Change ($yds^3$) |
|---|---|---|---|---|---|
| *Northern Municipal Boundary* | | | | | |
| | | | 25.46 | 294 | 7,485 |
| Mant-1 | 19 | 25.46 | | | |
| | | | 8.28 | 3,033 | 25,116 |
| Mant-2 | -12 | -8.90 | | | |
| | | | -1.76 | 2,584 | -4,556 |
| Mant-3 | -4 | 5.37 | | | |
| | | | 1.39 | 2,789 | 3,888 |
| Mant-4 | -3 | -2.58 | | | |
| | | | 1.64 | 2,164 | 3,555 |
| Mant-51 | -8 | 5.87 | | | |
| | | | 5.870 | 495 | 2,906 |
| *Southern Municipal Boundary* | | | | | |
| | | | **Total Volume Change** | | **38,395** |

The summer season followed the traditional format yielding a modest sand volume gain within the dune, beach and offshore regions of 3.38 $yds^3/ft.$ across the Mantoloking oceanfront. However, this gain was dominated by a large sand volume accretion offshore at Carrigan Place (Mant-1). At Mant-1 the offshore segment of the profile gained 24.005 $yds^3/ft.$ between elevation 2.82 and -17.82 feet NAVD 1988 across a distance from 388 to 824 feet from the dune reference position. All other changes were seen to occur as single digit gains or losses which generally cancelled each other (11.24 $yds^3/ft.$ as gains with 11.48 $yds^3/ft.$ as losses). Looking at the profile plot (Figure 1d), one can see that this gain was evenly distributed across the entire offshore region from the low tide position seaward.

Table 2 shows shoreline and sand volume changes that occurred between December 16, 2015 (Survey #95) and October 17, 2016 (Survey #97). Municipal beach volume losses declined from the loss seen in 2015 (-43,036 cubic yards) to an amount 8.3% of the 2015 loss (-3,577 cubic yards). This was in large part due to sand arriving at Carrigan Place between June 2016 and October 2016. The post-Jonas/Nacio survey in June shows no offshore deposition. It all occurred during the summer of 2016 with Bay Head as the likely source.

**Table 2**
**2016 Annual Shoreline & Sand Volumes Changes**
**December 16, 2015 to October 17, 2016**

| Profile Number | Shoreline Change (feet) | Volume Change ($yds^3/ft$) | Avg.Volume Change ($yds^3/ft$) | Distance Between (feet) | Net Volume Change ($yds^3$) |
|---|---|---|---|---|---|
| *Northern Municipal Boundary* | | | | | |
| | | | 17.09 | 294 | 5,024 |
| Mant-1 | 10 | 17.09 | | | |
| | | | 2.99 | 3,033 | 9,060 |
| Mant-2 | -9 | -11.12 | | | |
| | | | -5.09 | 2,584 | -13,144 |
| Mant-3 | -13 | 0.94 | | | |
| | | | -2.88 | 2,789 | -8,020 |
| Mant-4 | -5 | -6.69 | | | |
| | | | 0.06 | 2,164 | 130 |
| Mant-51 | 4 | 6.81 | | | |
| | | | 6.813 | 495 | 3,372 |
| *Southern Municipal Boundary* | | | | | |
| | | | **Total Volume Change** | | **-3,577** |

**Mantoloking Trend Analysis since 2002;**

Since 2002, the CRC has included figures that show the quarterly shoreline and volume trends for each of the Mantoloking locations and show how each profile responded to past storm events including Hurricane Sandy. The purpose is to provide a continuous view of accumulative changes and plot these changes versus time. These plots are included as figure (e) in each profile site description.

***Important Information from Before Hurricane Sandy to 2015;***

- Each of the five profiles shows an uptrend in volume beginning at various times between 2003 (Mant-4) and as late as 2010 (Mant-5).
- Each trend line had a pronounced "up-sweep" in sand volume in 2010 that more than doubled the sand volume than was present between 2002 and 2010.
- The CRC believes this result stems from when the Borough of Mantoloking assumed the role of general contractor for the beach bulldozing that provided consistent volume, slope and timing of the work.
- Hurricane Sandy (October 2012) cut deeply into the accumulated sand volume, reducing 3 of 5 sites to zero or below.
    - Sand volumes at site Mant-1 were just cut by half largely because sand was moved into Mantoloking from Bay Head.
    - Site Mant-2 was reduced from +35 $yds^3/ft.$ to -12 $yds^3/ft.$
    - Site Mant-3 (at the breach location) went from +7 $yds^3/ft.$ to -38 $yds^3/ft.$, but saw large volumes of sand restored from recovery of overwashed sands providing a pronounced increase in volume.

- Mant-4 lost the least sand volume dropping from 75 to 48yds$^3$/ft. without much recovery.
- The southernmost site (Mant-51) lost all 50 cubic yards of added material with about 20 recovered since Sandy. This lower recovery is largely due to no need to mechanically move overwash sand back to the beach since these dunes did not fail.

- Borough beach bulldozing had a demonstrable positive impact prior to Hurricane Sandy as sand was pushed into the dunes where ordinary winter storms do not pull it off the beach every winter.
- Comparison of pre-Sandy and 2015 profiles indicate volumetric losses (-171,459 cubic yards) of sand within the municipal beaches.
- The 2016 data shows that 3 of the 5 sites continued to lose material, but Mant-1 and Mant-51 both gained sand largely in the offshore region. Mant-2 is the only site where the sand volume today is less than it was in 2002 (-10.5 yds$^3$/ft.). Every other site has increased the sand volume present on the dune, beach and offshore (+40.8 yds$^3$/ft. average). These gains stem from managing the existing sand supplies rather than additions made over time, although some did occur.

**Profile Site Descriptions:**

Each site was surveyed two times in 2016. Cross section plots with three surveys are presented in the figures for each site. Photos from each site provide a visual record of changes during the year. A sand volume change trend chart is also included for each site to show the seasonal and annual trends from 2002 through 2016.

- **Mant-1 Carrigan Place**

Mant-1 is located at the seaward end of Carrigan Place, along the municipal beach access path between the private residential properties at #911 and #915 East Avenue. Carrigan Place is located about 500 feet south of the Bay Head – Mantoloking boundary. The profile reference location is a fire hydrant located along the west curb of East Avenue. The cross-section includes the road and beach access path on the landward dune toe between the oceanfront homes.

This location has shown fairly good recovery in the years that followed Hurricane Sandy, but during 2015, total volume losses were recorded. The most significant losses occurred in the last quarter (-23.04 yd$^3$/ft.) along with landward movement of the shoreline (-33 ft.) to its approximate location in March 2015. Trends in sand volumes are presented in Figure 1e and show the volume losses and landward movement of the 0.0 ft. datum in 2015 continued into the June survey of 2016, but followed with a significant recovery over the summer such that the site has recovered to within 5 yds$^3$/ft. of the best it has been since Sandy.

**1a. December 16, 2015**

**1c. October 17, 2016**

**1b. June 6, 2016**

***Mant-1 Photographs 1a, 1b, and 1c show views to the north from the beach berm.***

***Photograph 1a shows the view from the beach berm during the final survey for 2015 with a relatively robust berm and beach.***

***Photograph 1b shows the new dune grass at the instrument location with the beach to the seaward.***

***Photograph 1c shows the beach after the passing of Hurricane Hermine and late September storm. By the October survey there was a 3-foot scarp in the seaward dune toe without rock revetment exposure.***

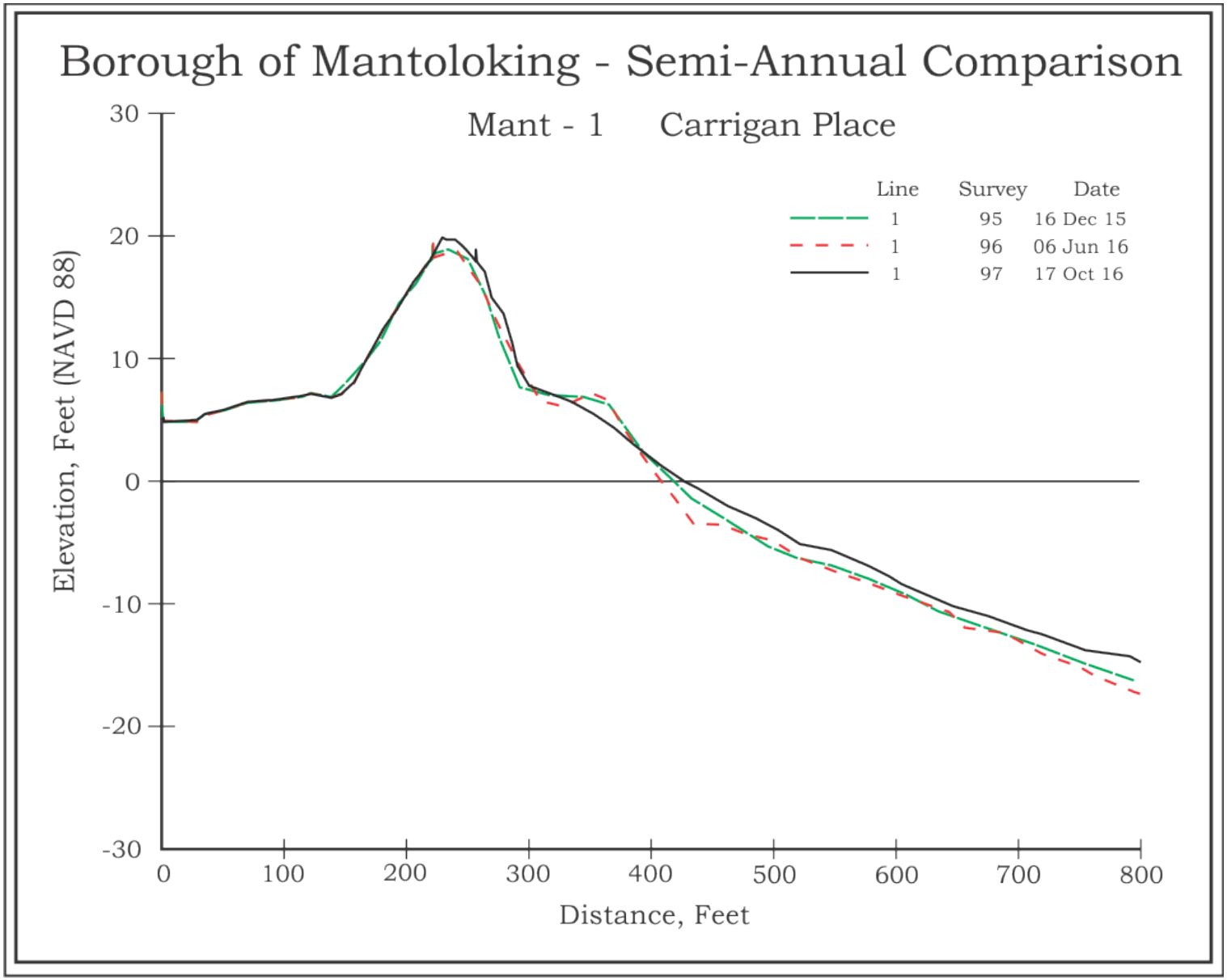



**Figure 1d: The cross sections are fairly similar in shape, but the October 2016 shows an offshore deposit of sand over a foot thick across 400 feet of survey. Between the second and third quarter of 2015, this site lost a large segment of sand in the offshore region, some of which has returned.**

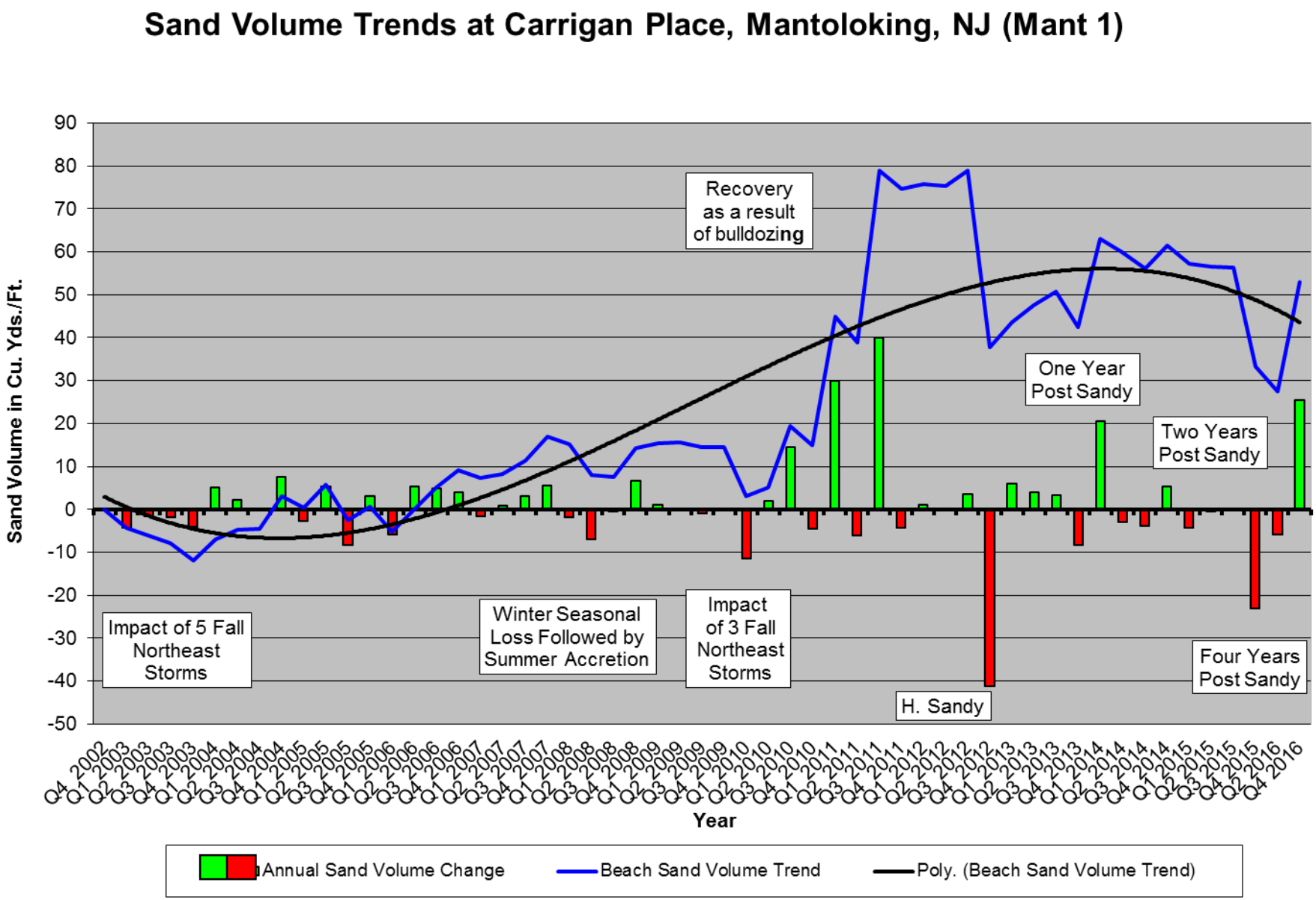



**Figure 1e. The quarterly sand volume trends show early impact of storms in 2003, 2006, and 2009. Net increase in sand volumes were maintained over 5 quarters in 2011 and early 2012 in part due to both natural and bulldozing actions. Hurricane Sandy cut the gain by half. The trend since Sandy has gone negative with the single exception in the final quarter of 2016 reversing over a year of chronic loss.**

- **Mant-2 #1041 Ocean Avenue**

Mant-2 is located along Ocean Avenue on the municipal beach access path between the private residences at #1039 and #1041 Ocean Avenue. The site location was selected because of its position approximately midway between Carrigan Place and the pre-existing New Jersey Beach Profile Network site located at #1117 Ocean Avenue and it has public accessibility. The profile starts at a reference location at a monument located midway along the access path.

The vertical steel wall was installed in September 2014 at approximately the location of the April 2014 dune crest. The seaward dune slope and crest elevation remained fairly consistent throughout 2015 through the Borough's efforts of bulldozing sand from the high water line to cover sections of the exposed wall. Annual shoreline change between December 2014 and December 2015 was less than one foot.

The trend here reflects the very serious impact of Hurricane Sandy which removed all the sand that accumulated since 2002 and left the site deficit relative to 2002 conditions. Both 2016 surveys produced minor deficits in sand volume further reducing this beach as shore protection. Standing currently at -10.5 $yds^3/ft.$, the site has had the worst performance in the Borough for 2016.

**2a. December 16, 2015**

**2c. October 17, 2016**

**2b. June 6, 2016**

***Mant-2 Photographs 2a and 2b. All views are to the north. Photos a and b were taken along the seaward dune crest (on top of the steel sheet wall). Photo c was taken from the berm.***

***Photograph 2a. shows the manmade dune that covers the steel wall. The dune crest remained at nearly the same 18.5 ft. (NAVD88) elevation during 2015.***

***Photograph 2b. shows the summer beach as a result of bulldozing sand from the lower berm to the dune. The beach is about the same width and elevation, but the orange plastic dune fence substitute is less durable than the cedar strip fence.***

***Photograph 2c. shows a steep, narrow beach resulting from Hurricane Hermine and a late September storm event that exposed 5.5 feet along 400 feet of the steel sheet wall.***

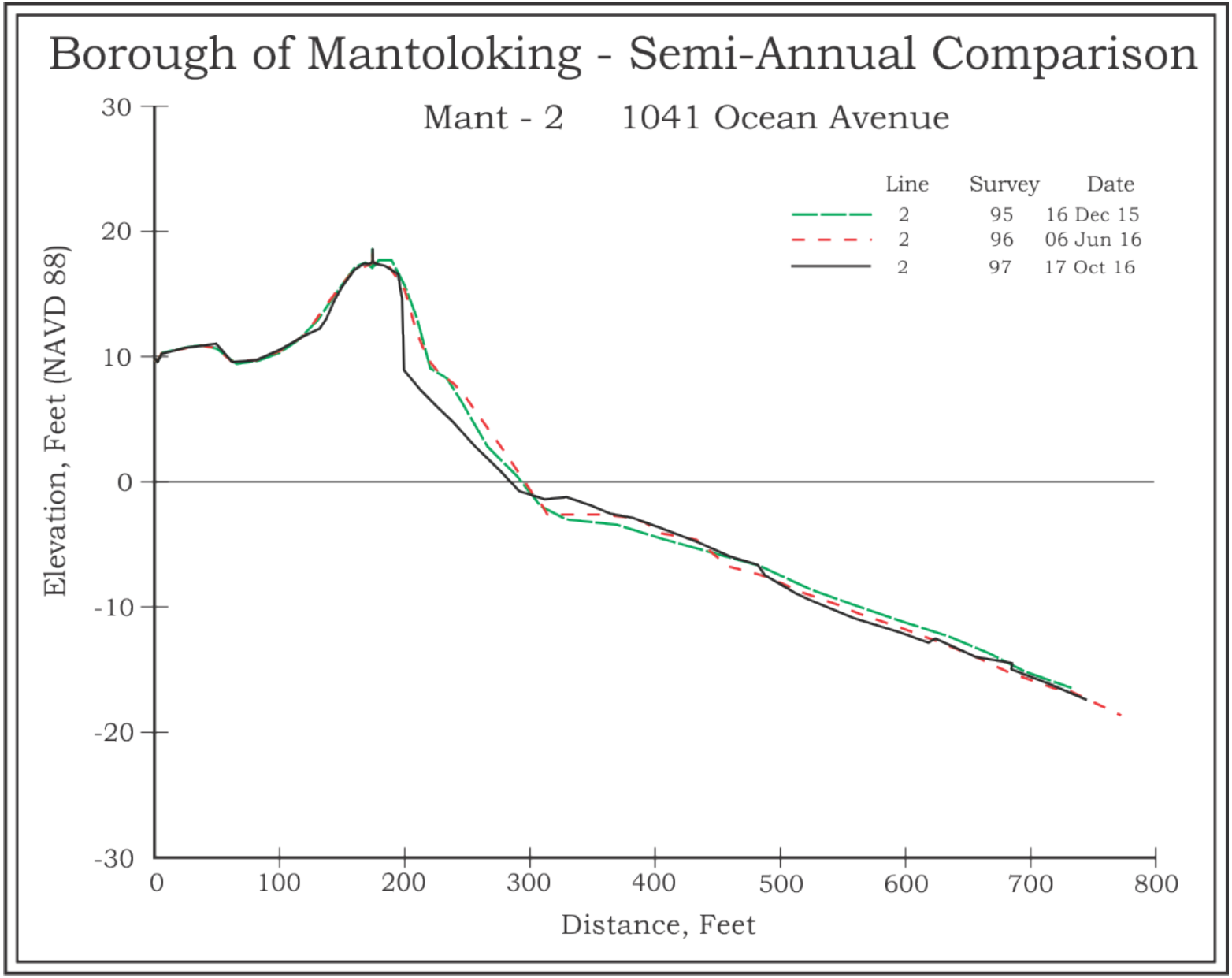



**Figure 2d: The cross sections at 1041 Ocean Avenue show that the shoreline retreated between June and October 2016, but sand accumulated just offshore. The beach was lower with a vertical scarp cut into the seaward dune toe in the most recent survey.**

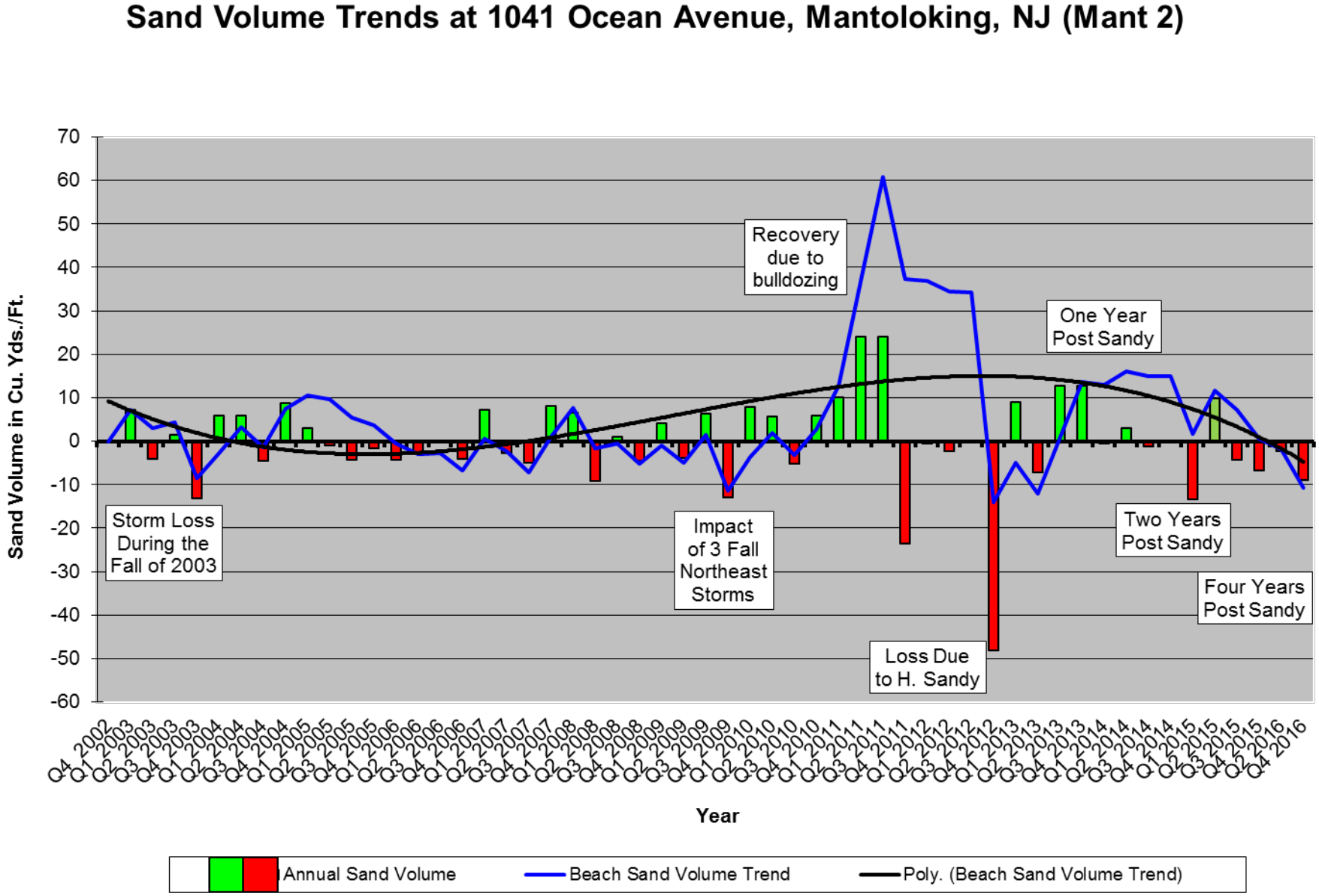



**Figure 2e. Quarterly sand volume changes since 2002 show modest annual or quarterly changes until 2011 when sand accretion commenced leading to a net increase of 60 yds³/ft. The volume loss late in 2011 was doubled by the impact of Hurricane Sandy with recovery by 2013 less than half of that removed by the storm. The site has undergone loss since Q1 of 2015 leading to a 14-year deficit of 10 yds³/ft.**

- **Mant-3 #1117 Ocean Avenue**

The #1117 Ocean Avenue monitoring site is located on private property. This site, originally established in 1986, is included in the State of New Jersey's coastal monitoring program (NJBPN). The site was later included in the beach-monitoring program in Mantoloking because of the pre-existing data collected for the State at this location. The profile line was set along the former home's dune walkover to minimize damage to the dune vegetation. Positioned nearly in the center of the municipal shoreline, this site has shown to be vulnerable to dune erosion over the years.

The net sand volume losses attributed to Hurricane Sandy was 131.97 $yds^3$/ft. of sand at this site. By December 12, 2012 a small dune ridge was reestablished as the beach began to recover both naturally and through restoration activities. Sand was returned from the streets, from the properties inland and from suitable sands pumped out of Barnegat Bay at the breach channel pathways. Since the installation of the steel wall in late 2014, the dune crest remained near 22 ft. (NAVD88) throughout 2015 due to the bulldozing efforts by the Borough. Dry beach widths ranged from 75 to 125 feet. The 2016 surveys produced one loss and one gain that exceeded the loss, so the site ended the year at a 37 $yds^3$/ft. net gain in sand volume over the 2002 beach condition.

This site contains the most quarry sand between here and Herbert Street per conversations with municipal officials and professionals. Therefore, the sand volume increase is attributable to the additional sand plus the sand management bulldozing activities.

**3a. December 16, 2015**

**3b. June 6, 2016**

**3c. October 16, 2016**

***Mant-3 Photographs 3a to 3b show the view to the south from the top of the steel wall/dune crest. Photo 3b is a view to the north from the site.***

***Photograph 3a shows the steep, narrow beach. The bulldozer work is evident as the material was being transferred from the berm to the seaward dune slope.***

***Photograph 3b shows both new quarry material and renewed bulldozing of berm sand to match the wall elevation for the summer season.***

***Photograph 3c. The October beach profile shows the impact of the late September NE storm that lasted several days with a mild wind set, but a long duration. This set the stage for the scarp seen in the dune toe. No wall exposed at this time.***

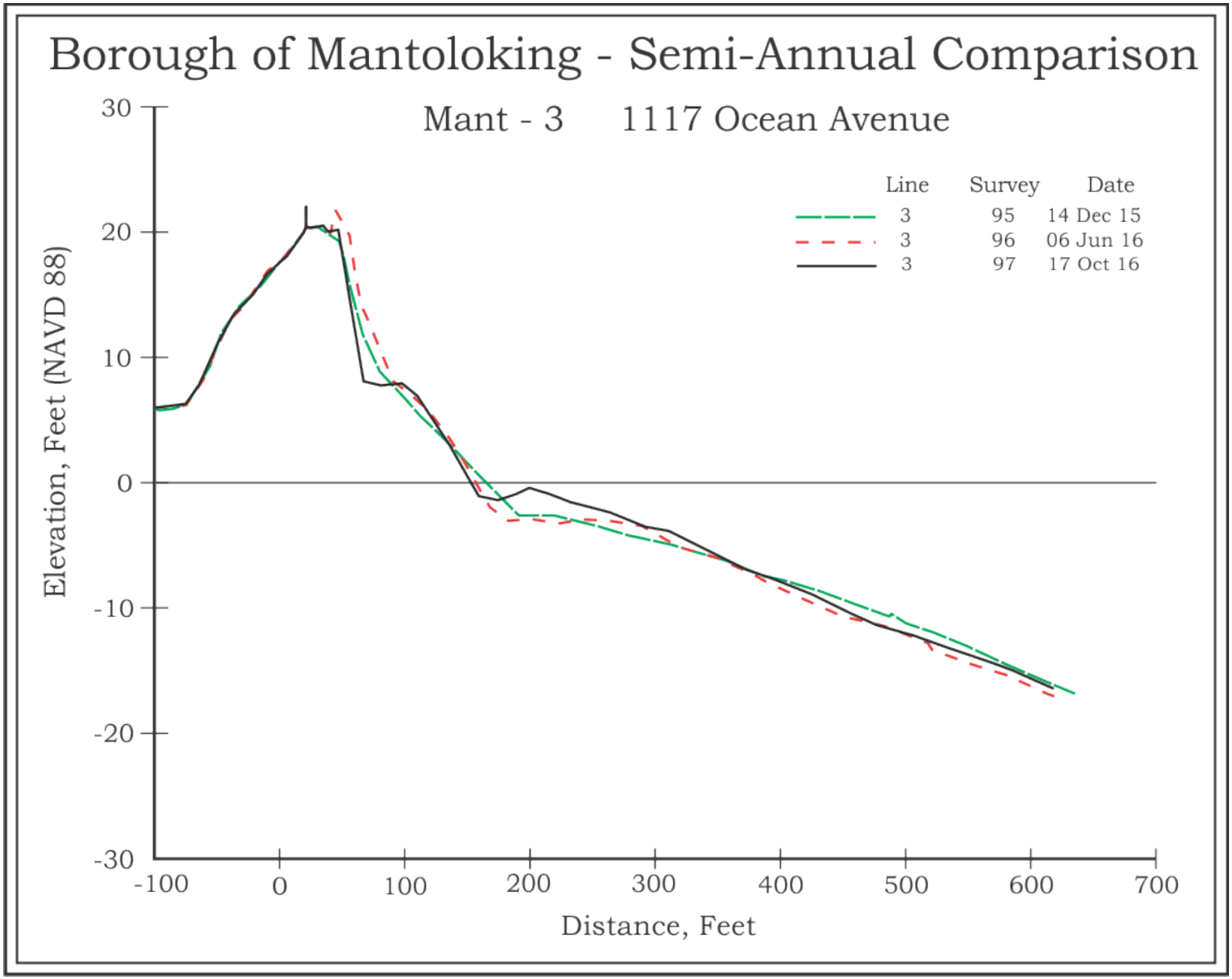



**Figure 3d: The cross sections show little shoreline change at 1117 Ocean Avenue. The dune elevation and position was consistent throughout 2015 into 2016 due to the Borough's bulldozing efforts. The erosion seen at Mant-2 was also present to a smaller extent at this site at the October 2016 survey date.**

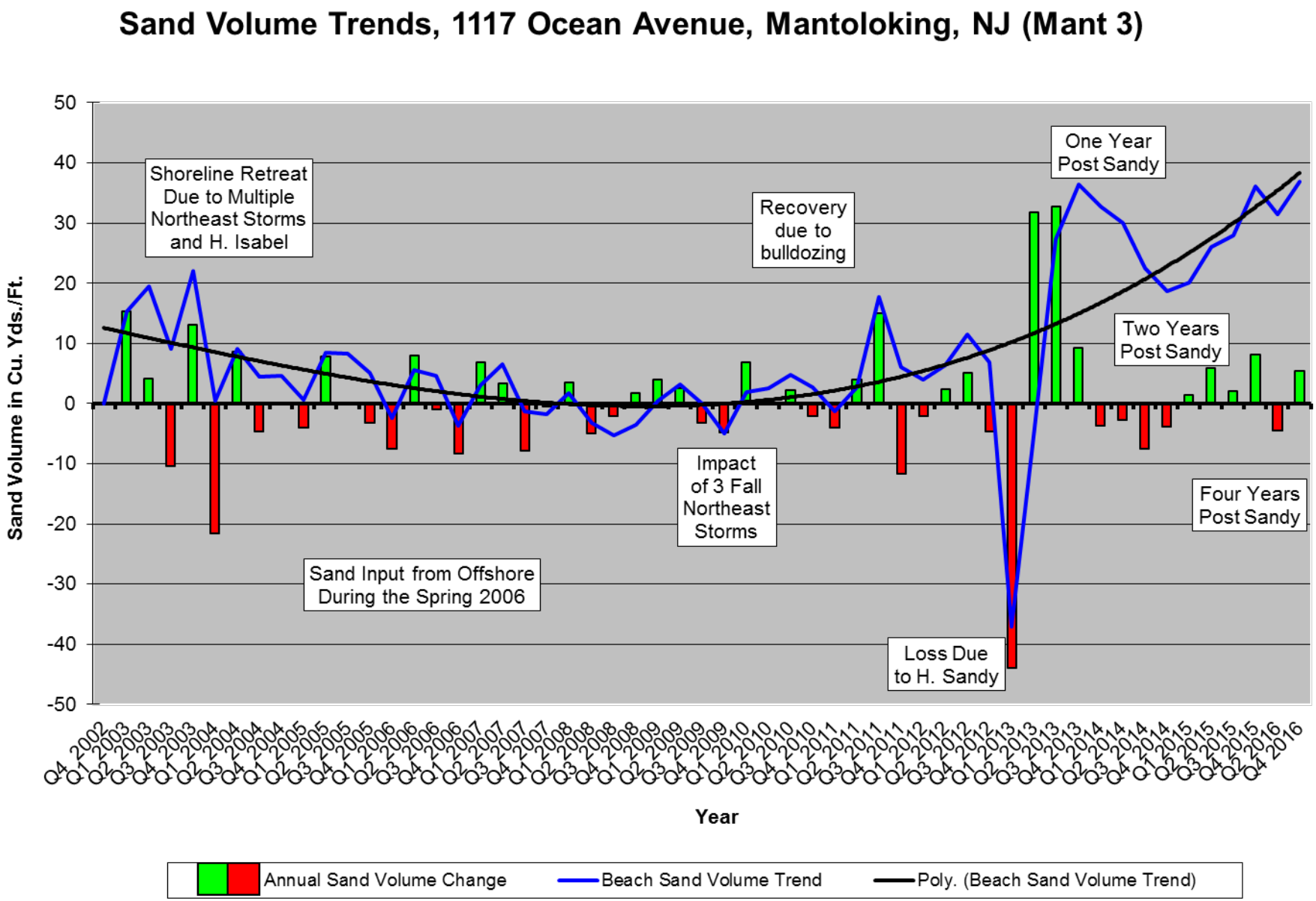



**Figure 3e. The Mant-3 site is located in the middle of the Borough and has been vulnerable to erosion. Hurricane Irene eroded landward of the crest in 2011, and the sand volume that was pushed back to the shoreline by the Borough did replace the volume lost. This site is located within a few hundred feet of the breaches that were opened by Hurricane Sandy and the volume losses are shown. Since then, Borough and state efforts (through the installation of the steel wall) have stabilized the dune crest position. Bulldozing efforts to move sand from the high water line to the wall/dune slope have allowed positive volume change since Q4 of 2014.**

- **Mant-4 Princeton Avenue**

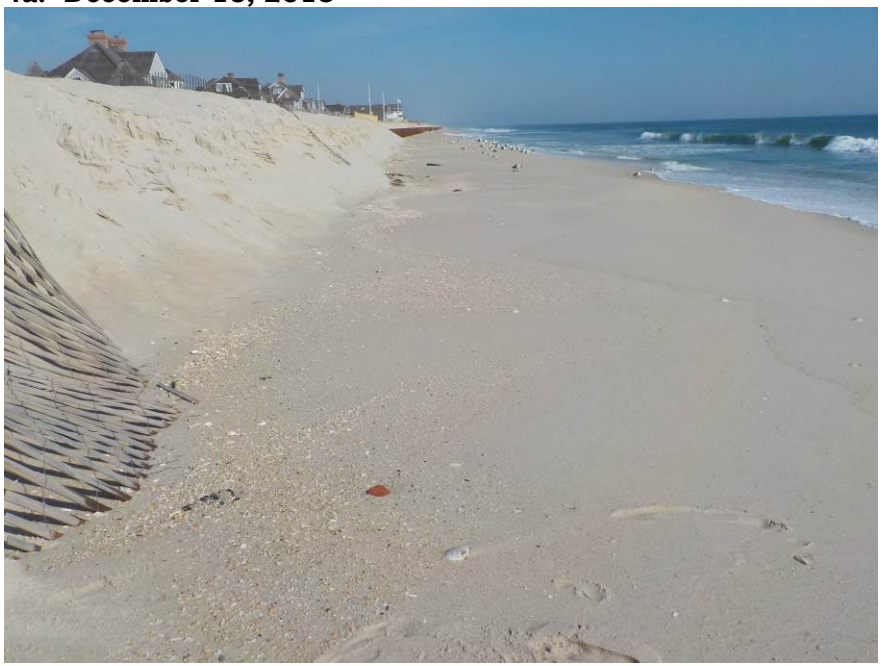
The Mant-4 beach profile is located at the seaward end of Princeton Avenue along the municipal dune walkover. This site was selected for the beach monitoring program in the Borough due to its location approximately midway between the #1117 and #1543 Ocean Avenue sites, and for its easy accessibility. Of special interest is the history of erosional problems associated with the vertical access shaft for the Ocean County Utilities Authority (OCUA) sewage discharge line, located on the seaward dune slope, adjacent to the profile line. Following the 1992 northeast storm Mantoloking installed individual geo-textile bags filled with sand around the street end and the access shaft at the municipal utility line.

Hurricane Sandy completely removed the dune and severely eroded the beach so that the street pavement simply ended at a continuation of that elevation out onto the dune's position, then down to the beach. The dune breach caused significant overwash to cascade into the Borough at this street-end opening. A volume loss of 76.32 $yds^3$/ft. of sand was attributed to Sandy at this location.

Since the storm, the restoration efforts have replaced a slightly lower and narrower dune with about the same width of beach. In fall 2014, the vertical steel sheet wall was installed with a top elevation of 14.8 ft. (NAVD88) and covered with sand. As in the other monitored locations, the Borough bulldozes sand from the high water line to the dune to maintain sand coverage along the wall and this has enabled the top elevation of the dune to remain at 19 ft. (NAVD88) throughout 2016.

In 2016 both surveys produced small net sand volume losses, but the site enjoyed a 46 $yds^3$/ft. net sand volume gain since 2002. Sand has been trucked to this site since the street end gives ready access. Exactly how much has been added is unknown, but the bulldozing definitely has produced sand transfer to the dunes over time.

**4a. December 16, 2015**



**4c. October 16, 2016**

**4b. June 6, 2016**

***Mant-4 Photographs 4a to 4c. All views are to the north from the toe of the dune at Princeton Avenue.***

***Photograph 4a shows a narrow beach and bulldozed sand on the dune slope. This was completed following a minor NE storm in October that lasted for 3 days.***

***Photograph 4b The view along the dune crest in June 2016 shows the results of beach recovery since NE storm Jonas cut the sand away from the steel wall.***

***Photograph 4c This view shows the impact of September storm erosion with exposed steel wall showing in the distance to the north. Beach recovery did occur since this event.***

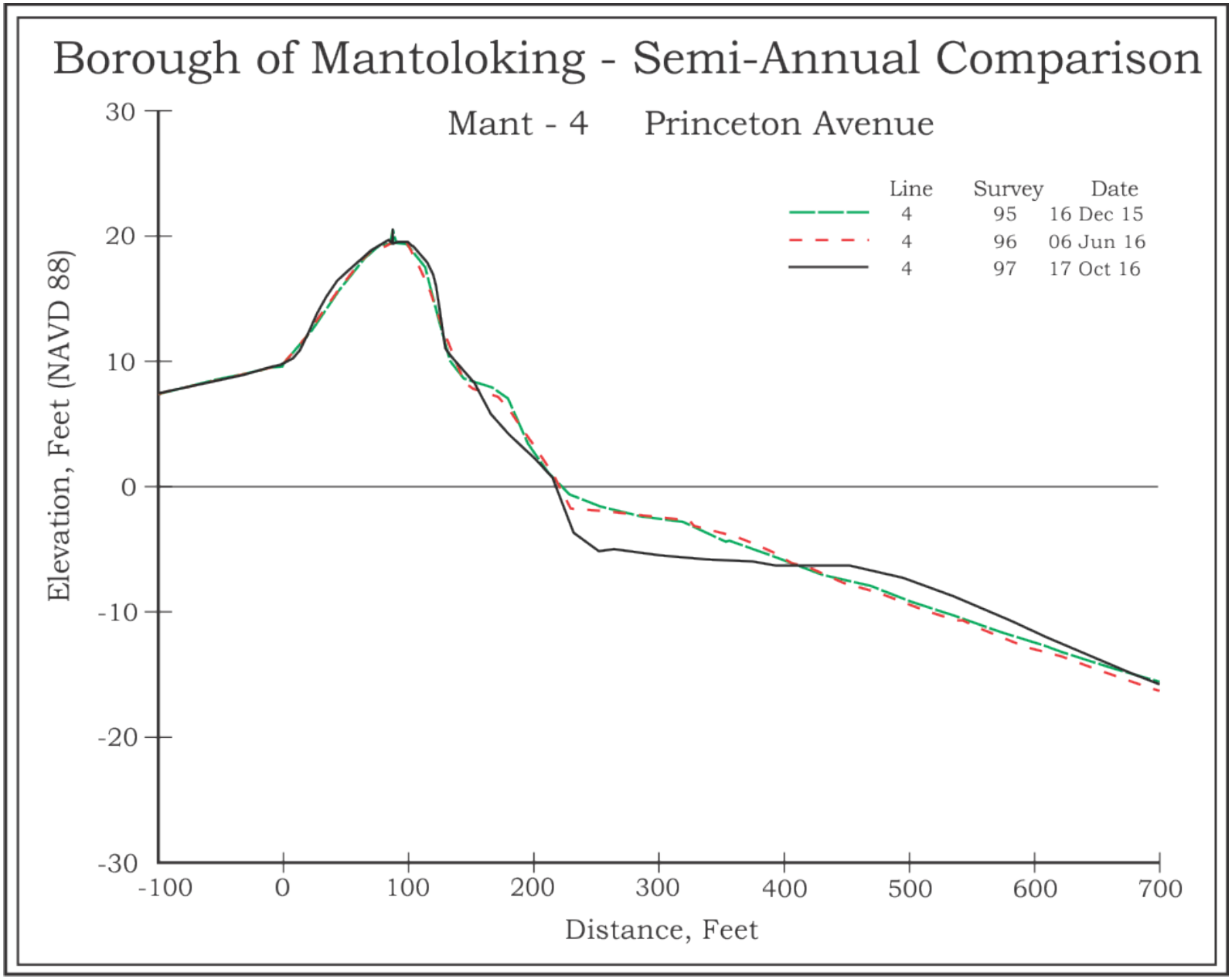



**Figure 4d: The dune remained constant during the survey period, but the beach changed configuration prior to the October 2016 survey because northeast winds of modest velocity dominated the time between September 28 to 30, 2016. The net result was a flatter beach with sand moved offshore creating a minor deficit.**

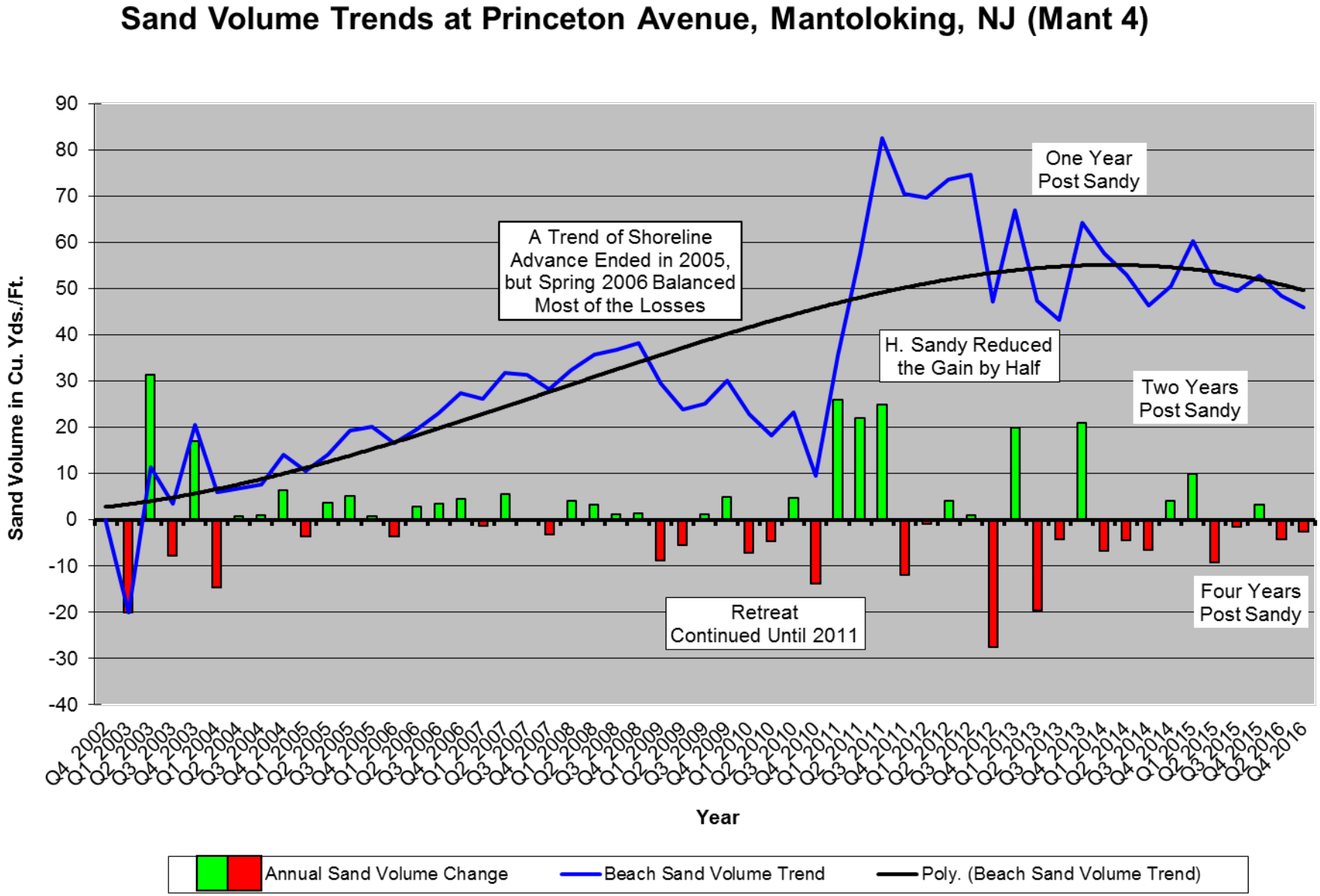



**Figure 4e. The trend in shoreline advance and volume gain at Mant-4 was influenced by multiple small sand fills to protect the MUA sewer line discharge pipeline that crosses the beach to the ocean ending at Q3 of 2011. Hurricane Sandy reduced the volume gains by half. In 2014, sand volume losses occurred from the 1st through 3rd quarters, with modest recovery in the 4th quarter following the NJDOT bulkhead installation. Loss appears to have outnumbered periods of gain since Sandy, but the site has achieved a 50 yds³/ft. sand volume advance ahead of Q4 of the 2002 situation.**

- **Mant-51 #1543 Ocean Avenue**

This monitoring site was initially located on private property between the homes at #1547 and #1549 Ocean Avenue. Because of its proximity to the border with Brick Township, this location became the southernmost site for the Borough monitoring program. A profile line was established along the southern property line of #1547 Ocean Avenue with a reference location at the landward dune toe. During 2005, the site was moved to the public access pathway between #1543 and #1539 Ocean Avenue because of a new owner limiting accessibility on private property at the previous site location. The shift in the line's location was 202 feet to the north.

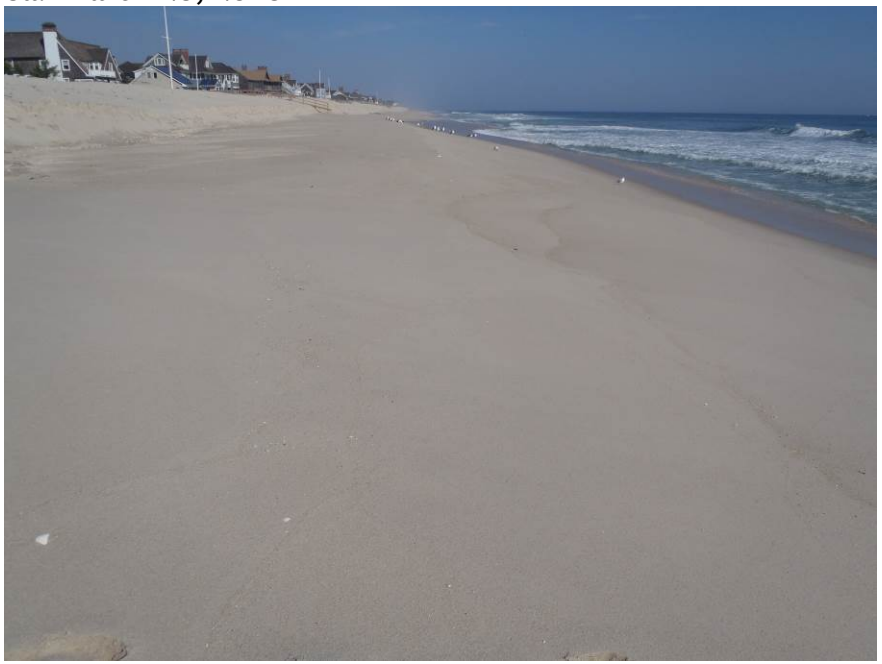
The dune system along the southern 1,500 feet of Mantoloking is the widest and highest in the municipality. Homes are set back to the natural toe of the back slope of the dune. In November 2010, the dune was 180 feet wide at the toe and 90 feet along the crest with an elevation of 23 feet NAVD 88. These dunes are among the best seen along the developed northern Ocean County shoreline outside of Island Beach State Park.

Hurricane Sandy's storm surge and fierce waves impacted the dune toe almost immediately as the ocean surge inundated the narrow beach rapidly allowing near continuous erosion throughout the storm. As a result over half the dune volume above the 10.0-foot elevation (NAVD88) was eroded away, but the dune elevation landward of the 24-foot crest elevation at the site remained above 20 feet in spite of the significant erosion and prevented overwash.

In recovery efforts following the storm, sand was bulldozed from the berm crest to the dune slope with the new dune crest at 24 feet (NAVD88) and approximately 100 feet landward of its pre-Sandy position. The dune elevation and position have been maintained throughout 2016.

The two surveys in 2016 showed that the site gained modest sand volumes on each occasion ending the year with a sand volume growth of 28 $yds^3/ft.$ above that present in 2002.

**5a. March 25, 2015**



**5c. October 16, 2016**

**5b. June 6, 2016**

***Mant-51 Photographs 5a to 5c. All views are to the north from 1543 Ocean Ave.***

***Photograph 5a December 2015 shows the steep dune-beach profile that was initiated by the October 2-5, 2015 northeast storm which generated above datum volume losses (-19.66 $yds^3/ft.$) and shoreline retreat (-62.4 ft.).***

***View 5b shows the summertime accretion by June 2016. The beach is wider as sand moved onto the shoreline.***

***View 5c The post-September NE storm beach was flatter and narrower with a scarp cut into the seaward dune toe, but no exposed steel wall here. Sand deposited offshore balanced the beach loss yielding a small net gain in sand volume.***

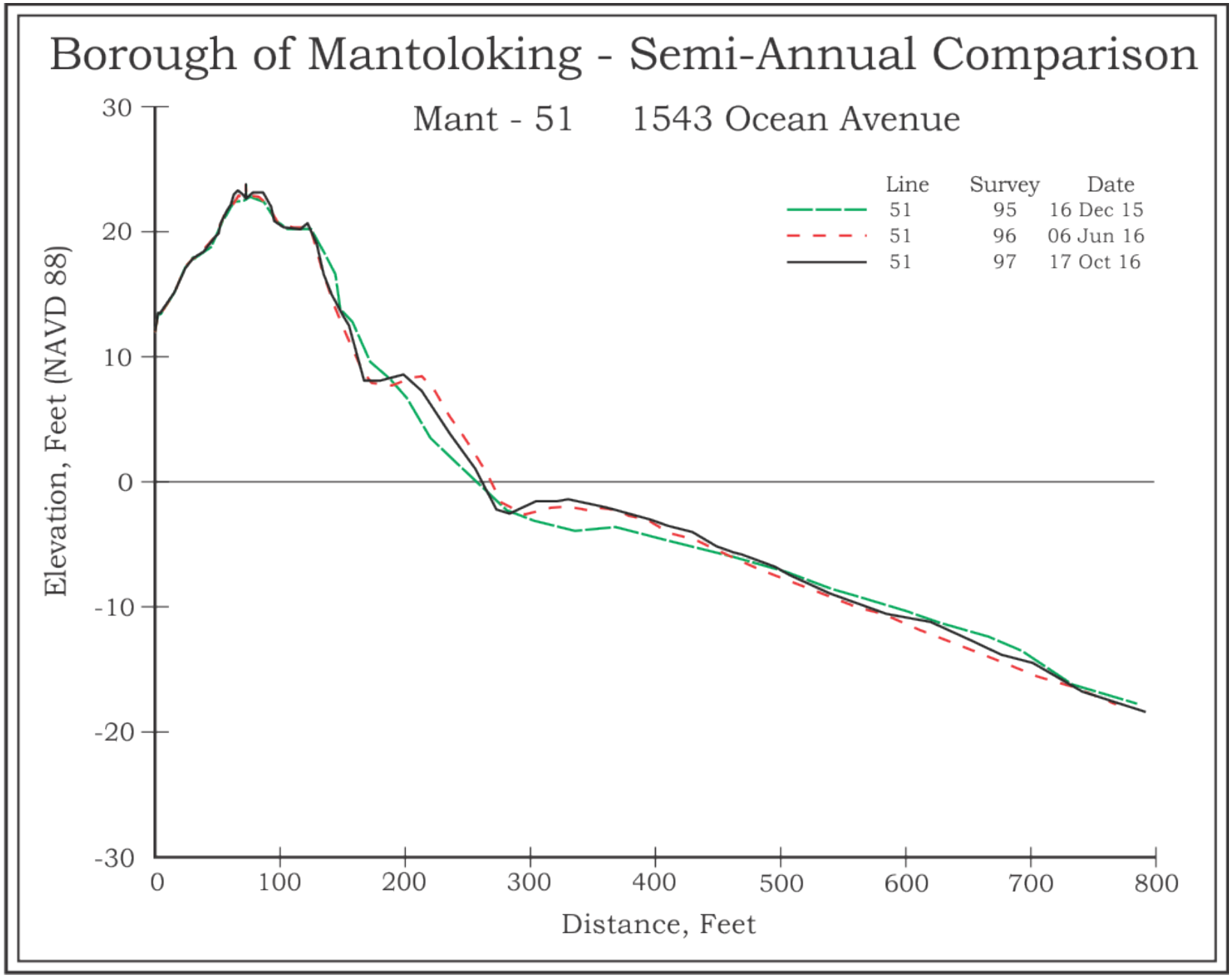



**Figure 5d: Little sand was extracted from the dune in south Mantoloking and the sand distribution favored both berm growth and offshore deposition leaving the June and October survey profiles nearly identical. Both Hermine and the September NE storm period had minimal impact on the site.**

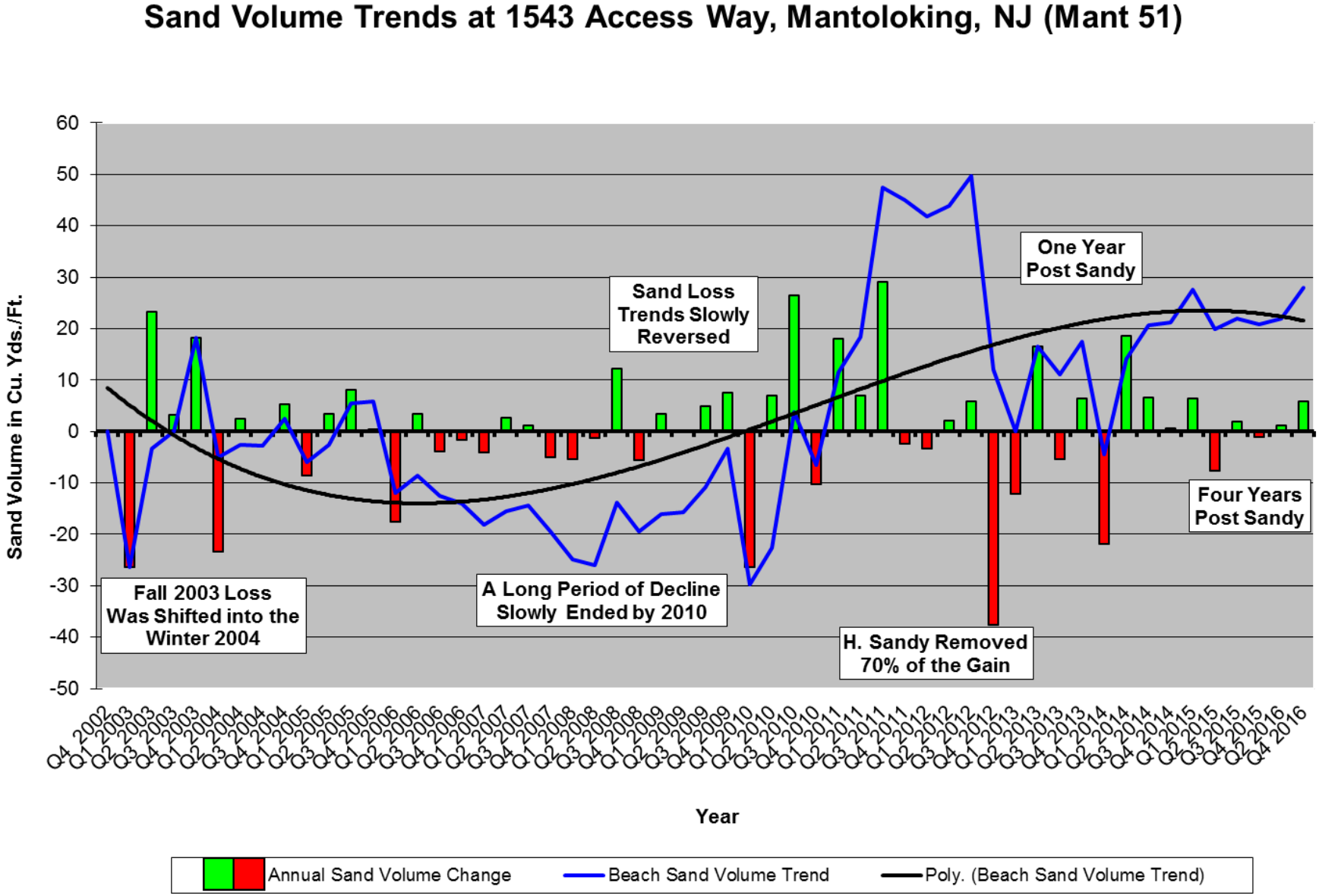



**Figure 5e. The highest and widest dune system in Mantoloking was located at the Mant 51 site. There was a long period of volume losses (2004 to 2009) but the trend changed in 2010 when the Borough began to more consistently bulldoze sand from the beach to the dune. Hurricane Sandy moved 70% of the volume gains to the nearshore, or, south into Brick Township. Since the 2nd quarter of 2014 there have been 4 of 6 consecutive quarters with recovery. The December 2014 to December 2015 volume change was 0.31 yds³/ft. where the losses were mostly from above the datum. Gains in 2016 have pushed the net change into positive territory since Sandy.**

**Evaluation of the Beach Performance Seaward of the Steel Shore Protection Structure:**

Since this structure was completed in 2014, there have been storm related incidents that allowed wave action to reach the wall by eroding the beach and seaward dune toe to the point of impact on the vertical steel surface. This greatly enhances the water turbulence due to high levels of wave reflection off the wall and enhanced reflected/incoming wave interactions when they impact each other. Scour at the base of the wall during northeast storm Jonas reached a maximum of 22 feet of vertical steel surface exposed on January 24, 2016. The mid-year report covered that event and detailed the municipal effort to recover sand from the post-storm on shore migration of that eroded material and additional trucked in sand purchased from local quarries to restore a seaward dune toe slope and a berm seaward of the structure. This was successful as of June 16, 2016. The wall remained covered through Hurricane Hermine in early September 2016, although photographs show a bare minimum of quarry sand remaining in front of the wall at site #6 located at Herbert Street. However, between the 28th and 30th of September a mild, but long duration northeast storm period exposed between 4 and 6 feet of the wall at three locations (Downer Avenue, Herbert Street and centered at Mant-2, 1041 Ocean Avenue). As of the final survey completed November 30, 2016, the Downer Avenue site was restored to a normal beach slope, and work was proceeding at Herbert Street, with 1041 Ocean Avenue still exposed. The only other wall exposure was seen at 8th Avenue in Brick Township where 5 feet was exposed on 11/30/2016.

**Site #6 located at Herbert Street shows the impacts of Hurricane Hermine to the left and the results on Nov 30, 2016 following a 3-day duration storm in late September.**


The next set of photographs are of site #2, located at 1041 Ocean Avenue where Hurricane Hermine did not produce wall exposure in spite of substantial berm erosion and cutting into the seaward dune toe slope seaward of the steel wall. However, by November 30th there was an 800-foot extent of wall exposed centered on the site where the measurements and profile were taken.

**Site #2 is located at 1041 Ocean Avenue and did not erode to the point of wall exposure during Hurricane Hermine in early September (left), but saw 5 feet of surface exposed following the 3-day northeast period in September. Photo below was taken November 30, 2016.**


At Downer Avenue the effect of Hermine was to create a scarp in the seaward dune toe, but not to expose the steel wall. By the October 13th survey, the wall was exposed following the 3-day northeast event in late September.

**The left photograph was taken as Hurricane Hermine was ending and shows the dune toe scarp. By October 13th the wall was exposed.**


**By the November 30th survey, the bulldozers had moved berm sand back to the wall creating a uniform slope once again to the beach. Work was progressing to the north toward Herbert Street as well.**

**Conclusions:**

Since the installation of the vertical steel wall in late 2014, the Borough's beaches have been subjected to minor and moderate storms that have eroded sand from the seaward dune slope and exposed sections of the wall. To fight the losses in 2015, the Borough of Mantoloking continued its shoreline management practice of pushing sand from the high water line to the seaward dune slope. This has allowed for general volume gains above the datum for the three central municipal locations (Mant-2, Mant-3, Mant-4) that ranged from 3.0 to 8.0 $yds^3$/ft. and above datum losses at the north and south end locations (Mant-1, Mant-51) that ranged from -2.0 to -5.8 $yds^3$/ft.

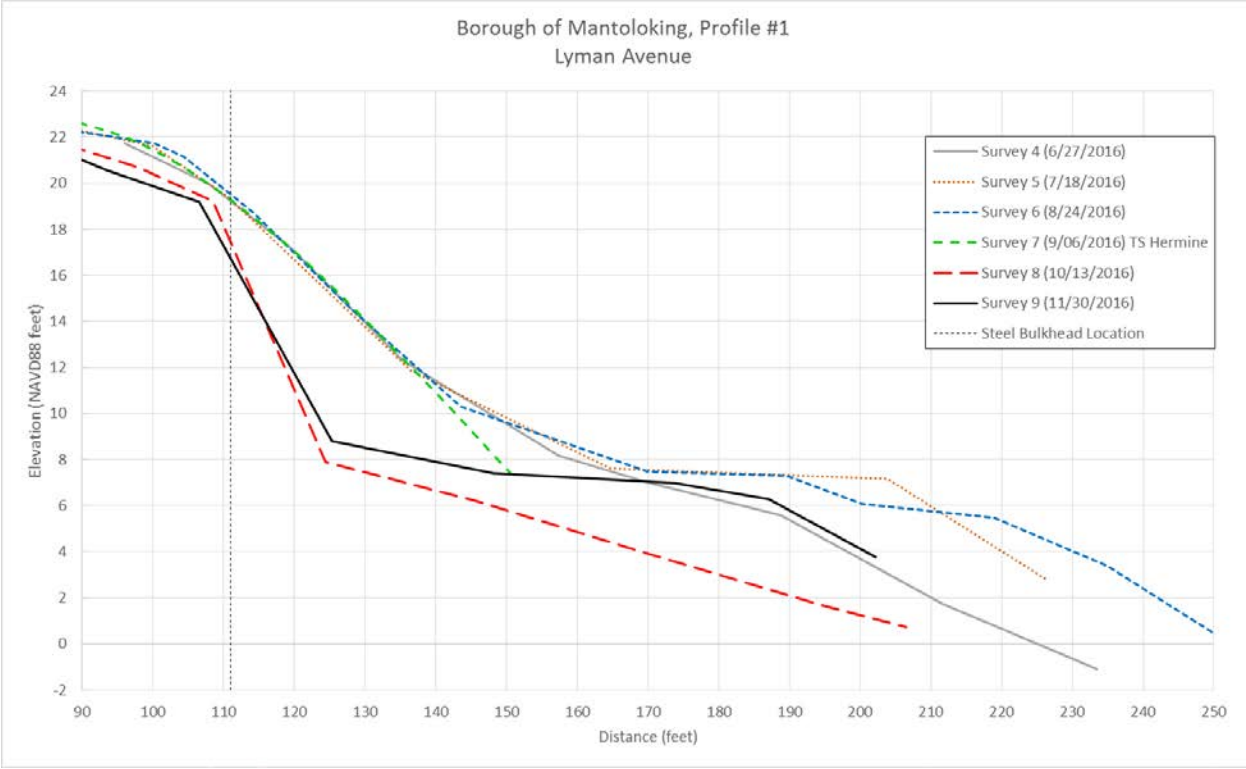
In January 2016, winter storm Jonas impacted the New Jersey coast and later received a Federal Disaster declaration. This weather event produced significant beach/dune damage increasing in intensity moving south from Monmouth County. Tidal flooding worse than seen during Hurricane Sandy occurred in several communities in Cape May County. The effect in Mantoloking was exposure of the entire extent of the steel sheet wall with some stretches just south of Herbert Street measuring 22 feet of exposed wall. This height was only present over several hundred feet and diminished rapidly both north and south to ranges between 14 and 16 feet across about a quarter of the Mantoloking oceanfront. Lower values in the single digit range occurred elsewhere. Work proceeded to restore a full beach/dune gradient from the crest to the water line.

All of the municipal beaches remain at a sand deficit with respect to the conditions prior to Hurricane Sandy. The net volume change between the September 2012 and December 2015 surveys was -171,459 cubic yards. Adding in the minor loss seen in 2016, the net loss of sand is presently 175,036 cubic yards. While the bulldozing practices are effective at some locations for increasing the amounts of beach sand, a large shore protection project (engineered beach fill) will be needed to compensate the losses attributed to Hurricane Sandy. Since the bids have been opened and a winner has been announced, the project could start sometime during 2017 leading to the addition of up to a million new cubic yards of sand to the municipal oceanfront. This material is entirely new to the modern NJ shoreline because its source is from deposits several miles offshore related to other stages of sea level in the past.

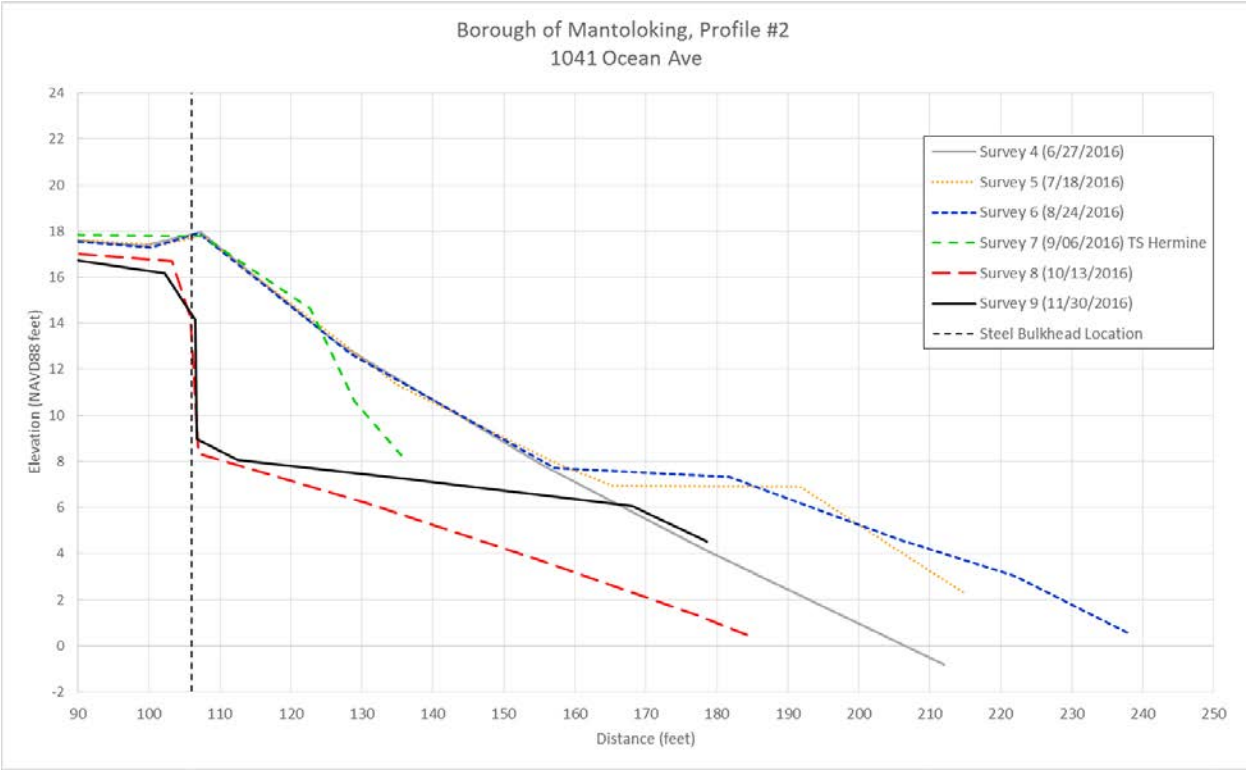
Decades of research provides confidence that this new sand will have an extended residence time on the Mantoloking shoreline because of the balance between sand transport to the north with that to the south over time. Sand is moved laterally along the shoreline by what are called littoral currents generated by wave approaches not parallel with the beach orientation. Northern Ocean County is unique in NJ in that the duration and velocity of movement balances over extended time periods so sand moves south during northeast storms, but the southeast wind waves provide an equal timeframe for moving the sand north reversing the storm impacts. Further north and the northeast fetch is limited by Long Island, so waves are not as effective moving sand south, and further south the fetch is far less limited, so NE storm systems are more effective transporting agents and the net sand movement is to the south over time. The coming 12 months should provide a stunning difference in shore protection in Mantoloking.

## APPENDIX

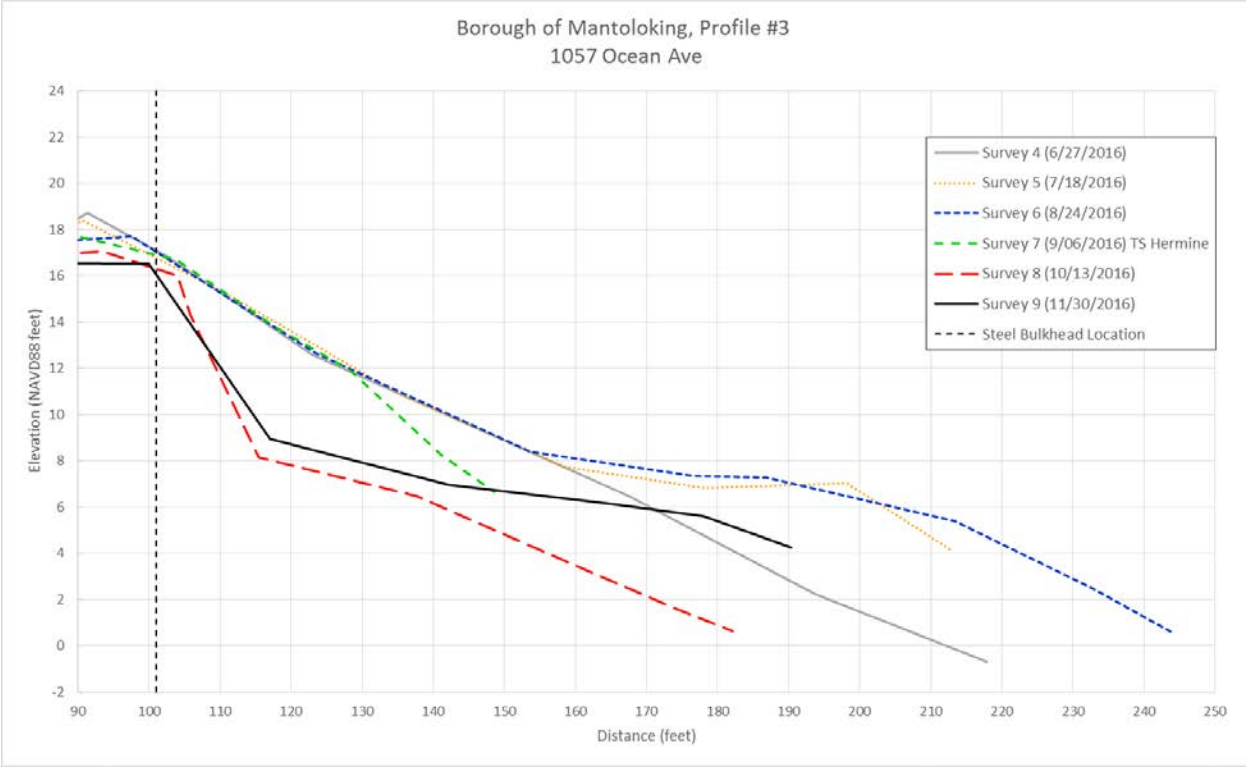
Below are a series of cross sections generated at the 11 locations along the oceanfront beach showing surveys since June 2016 following recovery of a seaward dune toe and beach slope seaward of the steel wall following NE Storm Jonas. These are done using a Leica GPS rover and set to established reference positions on the dune landward of the wall.



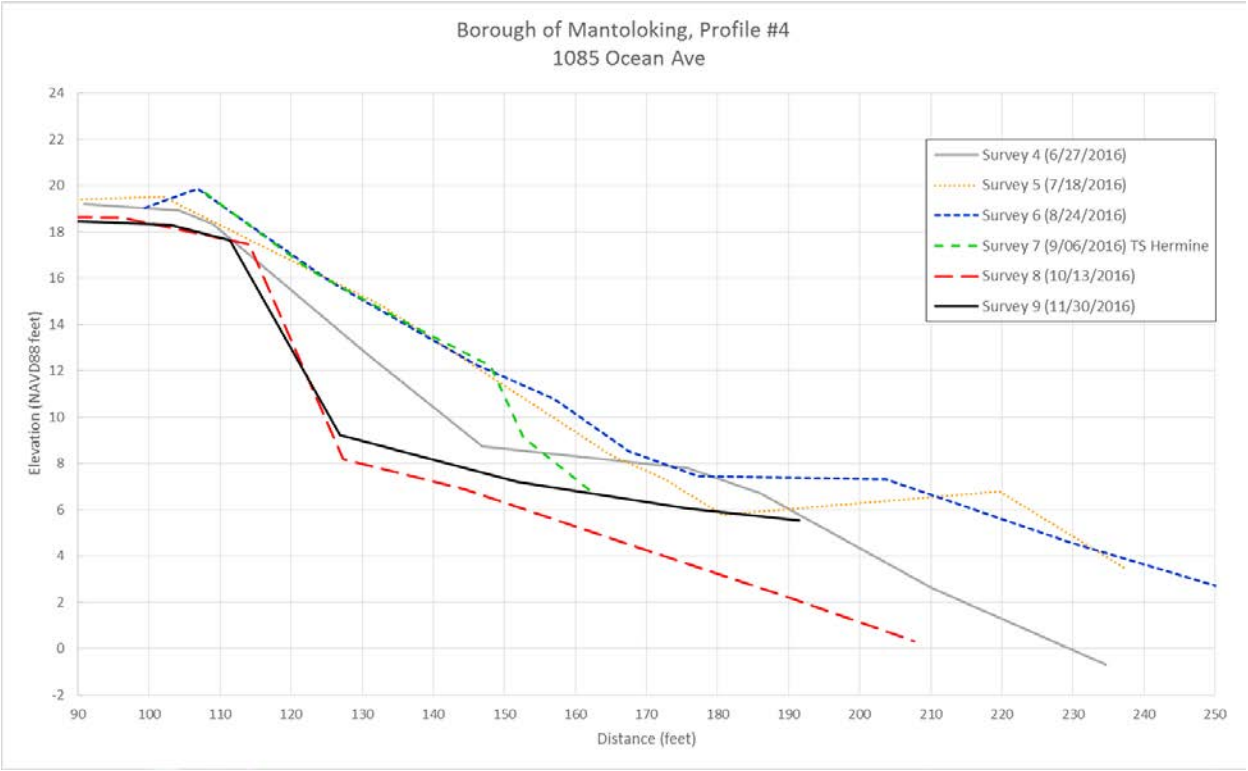

Lyman Avenue is at the northern extent of the wall where it merges with a rock revetment constructed south from Bay Head by individual property owners. No wall exposure was observed here, but slope erosion did occur.



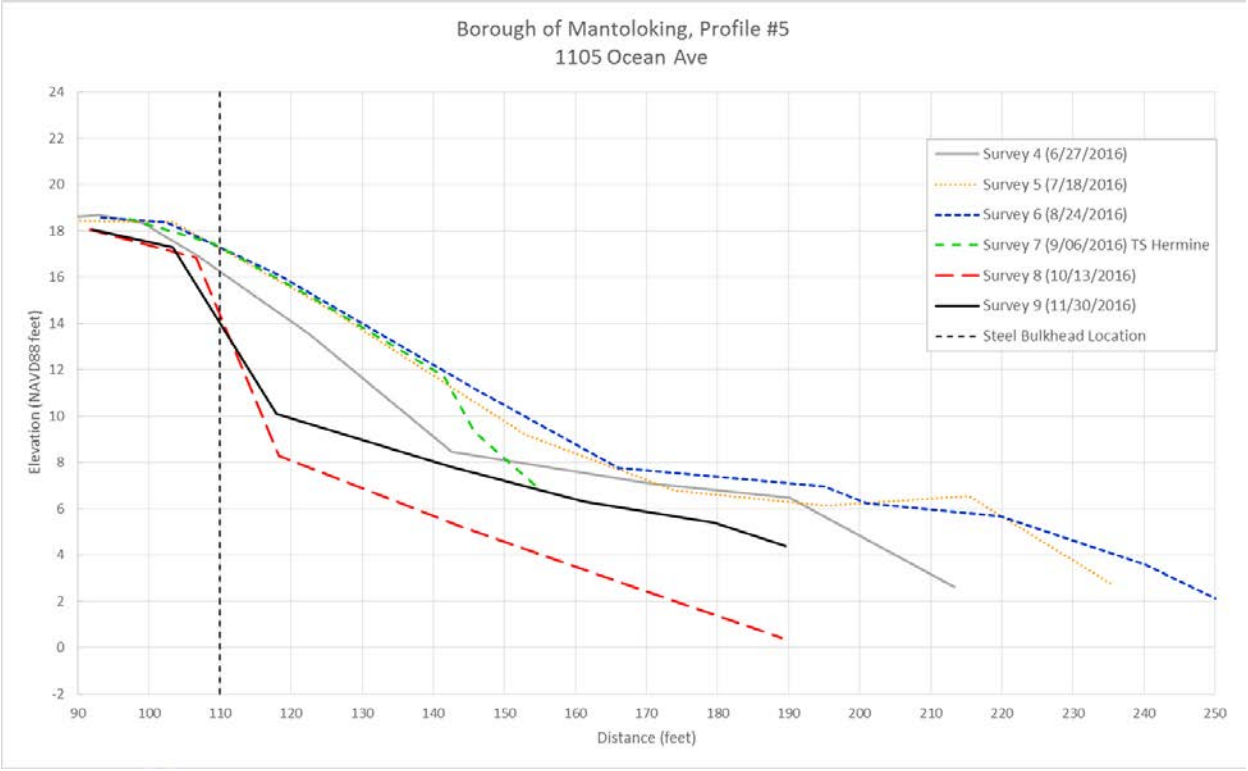

At 1041 Ocean Avenue Hermine did not expose the wall, in fact produced relateively little erosion, while the September 3-day event exposed the wall by 5 feet. This has remained through the Nov. 30th survey.



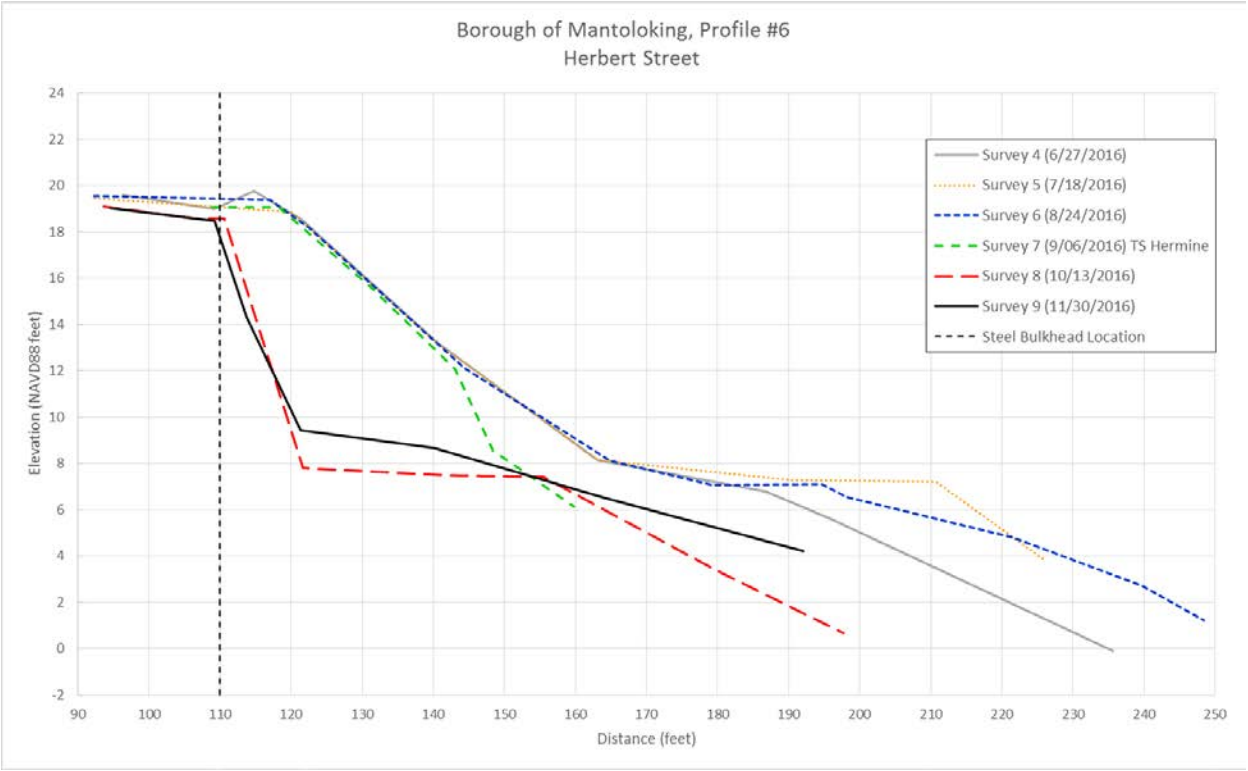

Dune toe slope erosion has occurred since the August survey, but Hermine did little damage. Significant slope retreat occurred in September, but no wall exposed as of 11/30/2016.



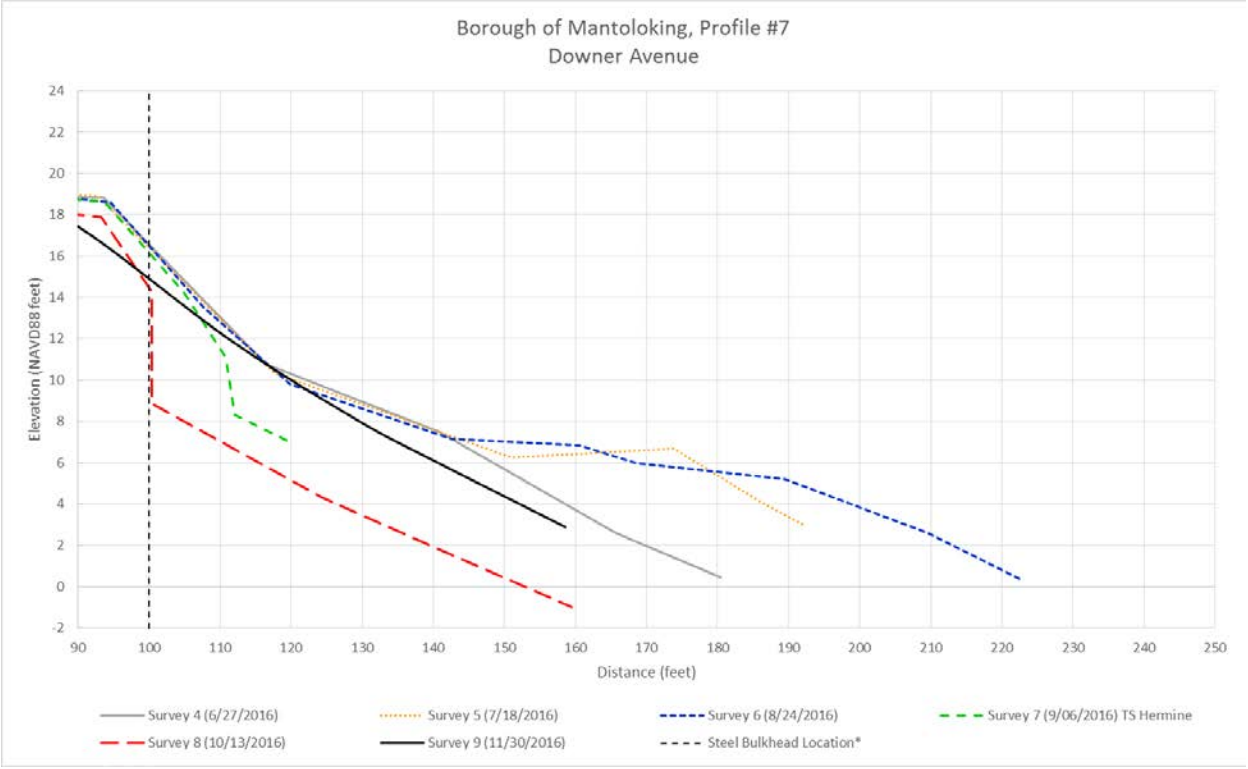

At 1085 Ocean Avenue, the slope retreated substantially during the 3-day September northeast storm, but no wall was exposed. Its location lies buried under the dune crest and has not been seen during this study.



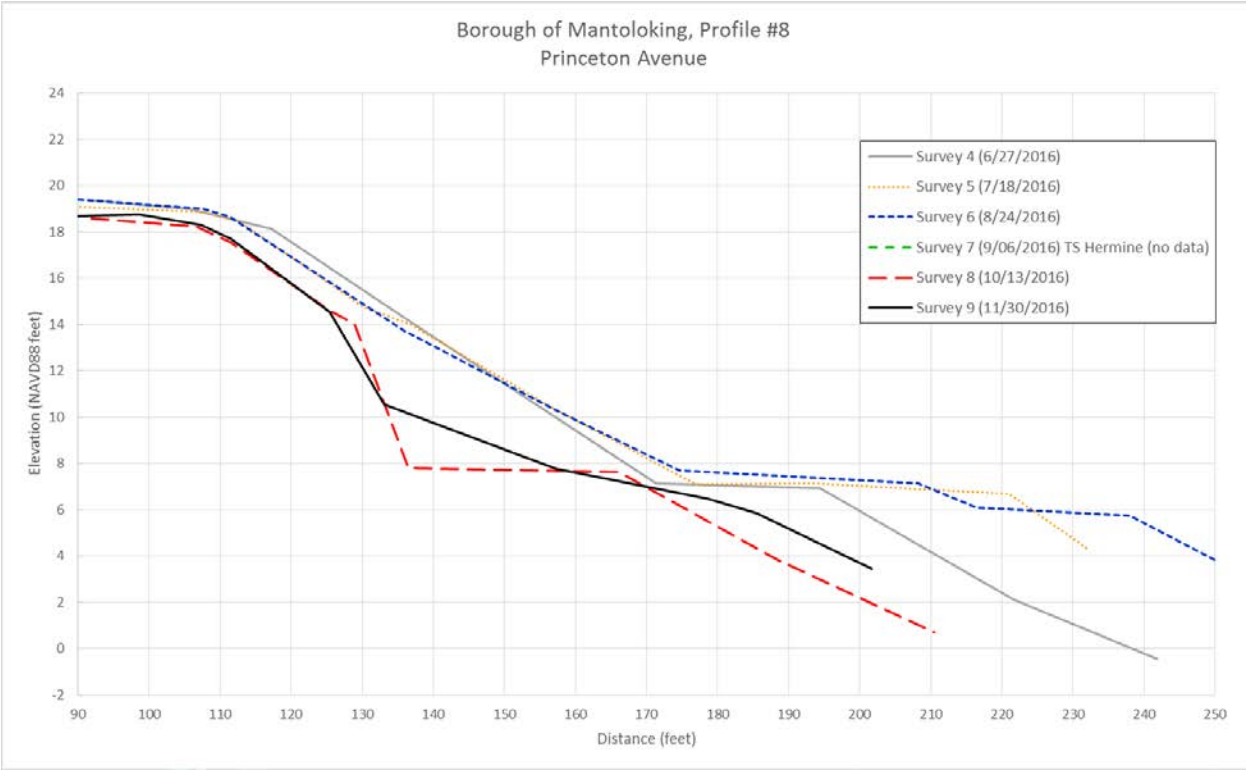

The 1105 Ocean Avenue site also did not see wall exposure, in spite of substantial dune toe slope retreat in the September event. The wall remains buried under the dune crest.



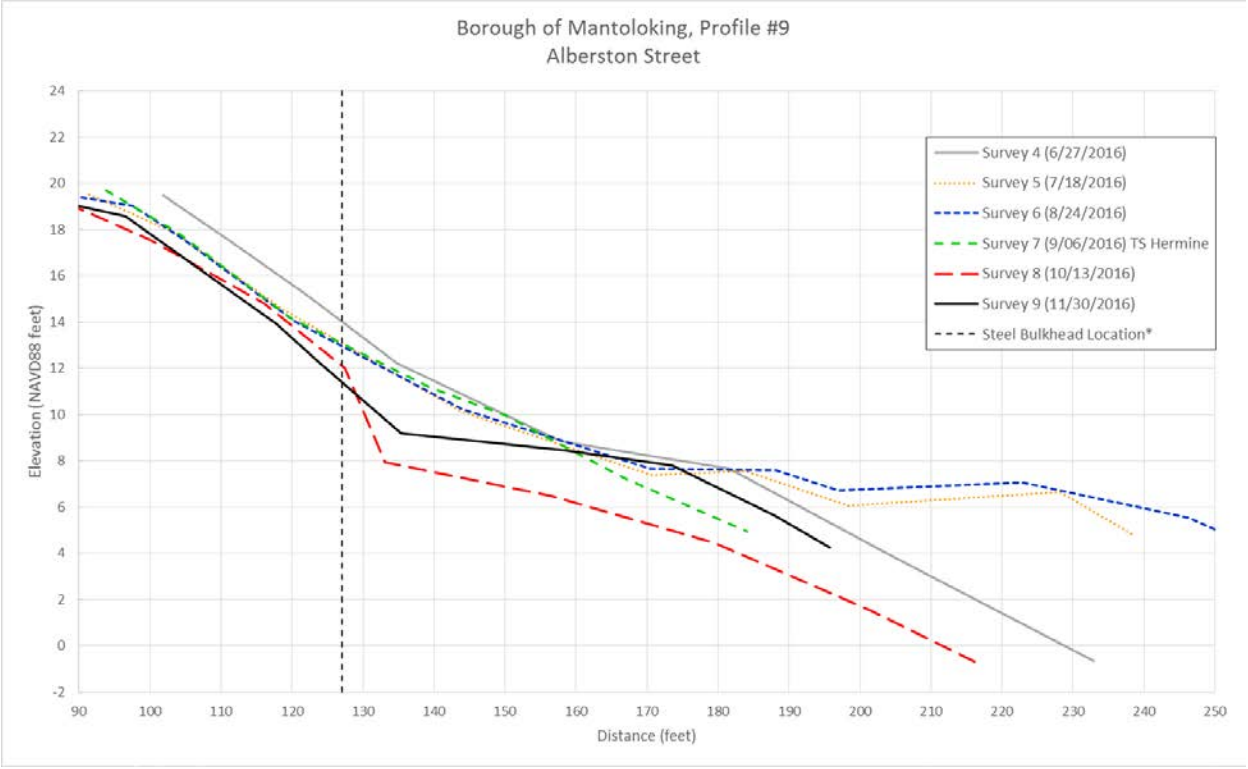

At Herbert Street Hermine almost exposed the wall to the immediate south of this location. The exposure was complete during the 3-day September NE storm event.




At Downer Avenue, Hermine produced substantial dune toe retreat, but stopped 11 feet short of the wall. The September event completed a 5-foot vertical exposure that was restored as of the November 30, 2016 survey.

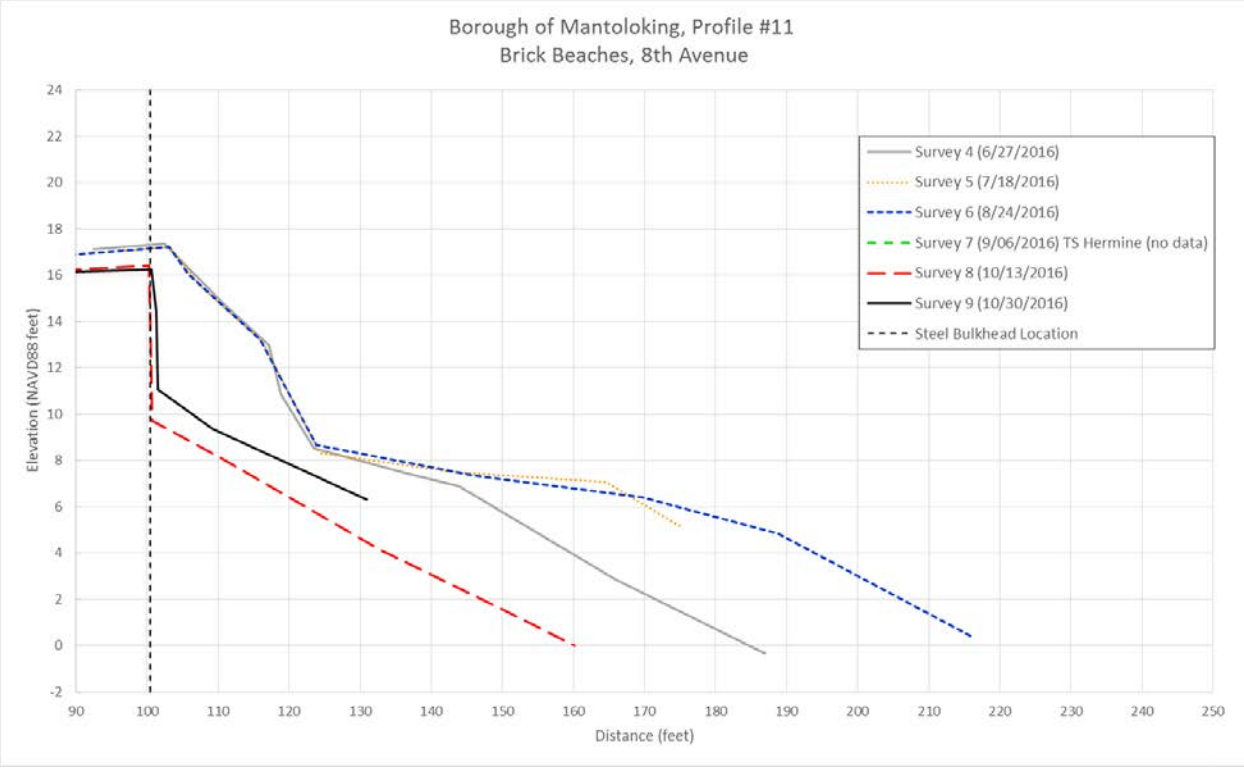



No wall exposure occurred at Princeton Avenue although the September event did produce significant dune toe slope retreat.




The Albertson Street site saw slope erosion in September but little impact from Hurricane Hermine. The wall was almost exposed in September, but remains buried with an excellent growth in the beach berm seaward by November 30th.


The southernmost survey site at 1537 Ocean Avenue saw minimal erosion during the fall up to November 30, 2016. Some toe steepening occurred due to the September 3-day storm, but no wall exposure has been observed since Jonas.




A control site was established in Brick Township at 8th Avenue where the wall remains exposed at 4 feet since the 3-day NE storm in September, which left hundreds of feet exposed to the north of this site. About a foot of sand has been deposited at the wall's base since mid-October.