

**FINAL REPORT FOR 2017  
ON CHANGES TO THE MUNICIPAL BEACHES  
FOR  
THE BOROUGH OF MANTOLOKING, OCEAN COUNTY, NEW JERSEY**



*Aerial view looking north along the region of Mantoloking devastated by Hurricane Sandy following yet another moderate nor'easter coastal storm in January 2017. This storm caused extensive beach erosion exposing the steel wall installed following Sandy. Storm waves and tidal surge reflexing off the exposed steel wall caused significant scouring and erosion removing a dry beach in this region. Although beach erosion was severe, the wall did prevent waves from impacting the remaining dune and from potential breaches occurring, averting over wash, property damage and serious community flooding. The storm deposited offshore parallel sand bar is clearly visible by the wave break and provided a source of sand for natural beach recovery in spring when the wave climate favored beach building. (Aerial photo courtesy of Ms. Jenny Buck)*

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**Annual Report for 2017**  
**On the**  
**Mantoloking**  
**Oceanfront Municipal Shoreline**

**Executive Summary:**

The Stockton University Coastal Research Center (CRC) continued the 24-year monitoring effort along the municipal shoreline in Mantoloking. This annual report provides the results and analyses from the fall 2016 to fall 2017 survey datasets. Surveys conducted in spring 2017 provided an estimate of the winter storm damage to the beaches and dune system. The fall 2017 survey showed the extent of natural recovery, maintenance efforts and provided a preview of the changes the U.S Army Corps of Engineers (USACE) Northern Ocean County Storm Damage Reduction project will provide for the Mantoloking oceanfront beaches. In 2016, a study commenced to evaluate the beach performance seaward of the steel shore protection structure. The study tracked the recovery of the beach following winter storm Jonas through additional measurements of the slope and vertical offset at the wall throughout the Borough. The study completed in late 2016 as natural recovery restored the beach sand volume and maintenance activity buried the wall and restored a seaward dune slope. Although winter storms exposed the seawall again in 2017, the traditional beach profiles were sufficient to track sand recovery.

A series of northeast storms dominated the wave climate during the winter season. A moderate storm event on January 23, 2017 one-year following Winter Storm Jonas caused significant beach erosion. Subsequent modest storms occurred in February and on March 14<sup>th</sup> with winds under 40 MPH from the northeast and a shorter duration. The storm waves eroded the beach and exposed the revetment rocks between the Bay Head border and Lyman Street in multiple spots. Storm erosion exposed the steel wall nearly the entire length of its installation in the Borough leaving a vertical offset between 4-8 feet from the top of the wall to the beach below.

By April, the five municipal profiles surveyed documented the net resulting sand volume deficits on the beach, compared to the October 2016 survey. With considerably less erosion and vertical exposure at the wall than seen following Jonas, recovery occurred relatively quickly. Natural sand transfer was underway in April and likely complete by summer. Despite the dune and beach erosion from these winter storms, the sand essentially transferred cross-shore to the offshore slope allowing for natural sand recovery as wave climate conditions in spring favored onshore cross-shore sand movement. The net sand volume from October 2016 to April 2017 actually increased 86,273 cubic yards with 80% accumulating offshore towards the survey envelope limits. Sand was removed from the dune, beach and nearshore then transferred cross-shore and longshore from beyond the municipal borders where it was deposited close enough to the beach to allow natural spring recovery.

When the spring wave climate favored natural beach building, sand moved back towards the beach, allowing maintenance activity to restore the seaward dune slope. By the late fall survey, conducted in December of 2017, the steel wall had been buried, a typical post summer beach berm was present and the seaward dune slope repaired pushing the dune toe seaward to recover the losses suffered over the winter.

As the beach recovered the USACE awarded Weeks Marine Inc. with a contract for the federal beach project, construction in Mantoloking began in late fall 2017. The project will expand the dune and beach widths and height to reduce coastal storm damage to local property and infrastructure. Sand source for the project is an offshore borrow site. Weeks Marine is using multiple dredges, including a cutter head dredge and several hopper dredges to transport the sand from the offshore borrow zone to the nearshore discharge stations. Current construction is ongoing in the southern section of Mantoloking expected completion is April 2018, to be followed by construction in Brick Township where completion is expected by mid-July 2018. For the northern section of Mantoloking, construction estimates are startup in mid-July and continue through mid-September. The northern project construction schedule has work starting near Lyman Street initially placing sand to the south, blending into the previous work zone then flip and pump sand north from Lyman Street into Bay Head.

During initial project construction in Mantoloking, the beach profile at Princeton Avenue completed by January 19, 2018, included in the fall survey data analysis showed the following dune and beach enhancements. The dune height increased approximately 3 feet from 19 to 22 feet NAVD88, its width at the toe increased from 130 feet to 200 feet and the beach width from the seaward dune toe to the zero elevation-datum shoreline position increased from 80 feet to 250 feet. The overall footprint of the dune and beach system increased from 210 feet to 460 feet. This does not include the massive gain of sand below the zero elevation-datum found nearshore and offshore that continued to the traditional survey limits near closure, 700 feet seaward of the profile reference location.

### **2017 Storm Activity:**

Compared to recent years 2017 was a relatively quiet year for coastal storm frequency and intensity. A moderate northeast storm occurred January 23-24, 2017. This storm was less severe than Jonas that occur the year before, but still packed strong onshore winds with gust over 60 mph along the Jersey shore recorded. The 2017 event caused coastal flooding, significant beach and dune erosion, as the surge and strong onshore winds pushed waves onshore and over seawalls. Later in the season periods of northeast winds occur in February preventing beach recovery but with limited additional erosion. A modest storm event on March 14, 2017, was the final recorded northeast storm for the year.

Although 13 named storms occurred during the 2017 Atlantic hurricane season and in spite of catastrophic events in Texas, Florida, Puerto Rico and the US Virgin Islands, New Jersey was spared any close passages of hurricanes during 2017. The mid-Atlantic hurricanes were distant from NJ with the closest passage occurring during Hurricane Jose a long-lived event that lingered as a tropical storm well off the Jersey shore with little onshore impacts. Hurricane Maria devastated sections of the Caribbean Islands before moving north along the US Atlantic seaboard brushing eastern North Carolina with tropical force winds before moving away toward the northeast and diminishing to a tropical storm as it passed well offshore of NJ with no damage to the Jersey shore.

### **USACE Northern Ocean County Storm Damage Reduction Project:**

USACE's Philadelphia District Commander Lt. Col. Michael Bliss summed the project's goals as stated, *"The engineered dune and berm system will serve the vital purposes of reducing risk and helping to protect people and property."* The project cost is approximately \$128 million the U.S. Army Corps of Engineers in partnership with NJDEP awarded the

project to build beaches and dunes in northern Ocean County. Contractor Weeks Marine Inc. began pumping sand in Ortley Beach in summer 2017 initially working south towards Seaside. Work in Mantoloking commenced in fall 2017 and has continued into April 2018 within the initial base area. The northern Mantoloking section extends from approximately 2000 feet north of Herbert Street to the Bay Head border, scheduled to begin in mid-July following the Brick Township section. Northern Mantoloking should be complete by mid-fall 2018.

The identified National Economic Development (NED) plan, which is the plan that maximizes beneficial contributions to the nation while meeting planning objectives, provides a degree of storm damage protection, which is greater than the cost of implementation. For Mantoloking that plan calls for a dune crest with elevation of 22ft NAVD88 with a crest width of 25 feet, dune slope is 1V:5H. The beach berm in front of the dune is 75 feet wide at elevation 8.5 feet NAVD88, beachface slope design is 1V:10H. This 75-foot distance is not the constructed berm width as the constructed berm width includes advanced nourishment to compensate for the offshore portion of the profile template. The constructed berm width will vary with existing conditions but will likely be more than double the design width. Example, the constructed berm width at Princeton Avenue extended approximately 150 feet from the seaward dune toe to the berm crest at elevation 8.5 feet NAVD88.

This method of construction known as “overbuilding method,” places the required design quantity at the proposed berm elevation, but with additional berm width added. The seaward slope of the construction berm is often equal to or steeper than the natural slope. The constructed berm is “overbuilt” so coastal processes can readjust the profile to a natural equilibrium state. This adjustment between slopes, known as compensating slopes, uses excess sand to achieve the desired beach and nearshore template. In this case, much of the overbuilt berm sand moves offshore to form the intended design profile nearshore while still achieving the 75-foot designed beach berm width that will support the expanded dune footprint.

Post-project monitoring will capture this process as the constructed beach profile template adjusts over time to the local wave climate. Beach profile monitoring will help the officials assess short and long-term project performance, quantify shoreline and sand volume losses throughout the Borough and help guide planning of periodic nourishment intervals to maintain adequate storm protection for the community. Monitoring will allow the community to assess storm damages to the beach and dune to advocate for possible emergency nourishment to maintain community storm preparedness between regular scheduled maintenance cycles.

### **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 24 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 and continued with this schedule in 2017. 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 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 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 and if continued help assess the federal project performance over time. The CRC completed the semi-annual surveys for 2017 on the following dates:

Spring            Survey #98            April 12, 2017  
 Fall                Survey #99            December 21, 2017\*

- \*Except site Mant-4, completed January 19, 2018 following completion of sand placement.

Table 1 below shows the shoreline and sand volume changes at the five monitoring locations during the last half of 2017 (comparing surveys #98 and #99). Shoreline changes shown measured in feet while sand volume changes are in cubic yards per foot (yds<sup>3</sup>/ft.). Individual profile changes averaged with adjacent sites and multiplied by the distance between sites 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**  
**April 12, 2017 to December 21, 2017**

<b>Profile Number</b>	<b>Shoreline Change (feet)</b>	<b>Volume Change (yds<sup>3</sup>/ft)</b>	<b>Avg. Volume Change (yds<sup>3</sup>/ft)</b>	<b>Distance Between (feet)</b>	<b>Net Volume Change (yds<sup>3</sup>)</b>
<i>Northern Municipal Boundary</i>					
			-7.36	294	-2,164
Mant-1	-5	-7.36			
			-10.26	3,033	-31,103
Mant-2	-30	-13.15			
			33.47	2,584	86,474
Mant-3	212	80.08			
			126.87	2,789	353,826
Mant-4	260	173.65			
			86.92	2,164	188,084
Mant-51	44	0.18			
			0.180	495	89
<i>Southern Municipal Boundary</i>					
<b>Total Volume Change</b>					<b>595,206</b>

Spring and summer natural beach building occurred, forming typical summer beach berms allowing maintenance activity to restore the eroded seaward dune slope following the winter storm season. Sand naturally moved between the offshore and beach as the seasonal wave climate determined the direction of cross-shore sand transfer. By late fall, the USACE

project's influence on sand volume changes and shoreline positions became apparent as the sites at 1117 Ocean Ave (Mant-3) and Princeton Ave (Mant-4) both showed massive sand volume gains and shoreline advancements. At both project locations, the shoreline position jumped seaward over 200 feet with the addition of 80.08 yds<sup>3</sup>/ft. of sand (Mant-3) and 173.65 yds<sup>3</sup>/ft. of sand at (Mant-4). These project numbers skewed the natural recovery volumes and shoreline changes during this period. Net result was a massive sand gain of 595,206 cubic yards of sand from April 2017 to December 2017, derived from the USACE project start up. The three sites not influenced by the project (Mant-1, Mant-2 and Mant-51) showed a more typical pattern of modest sand volume and shoreline position changes.

Table 2 shows shoreline and sand volume changes that occurred between October 17, 2016 (Survey #97) and December 21, 2017 (Survey #99). The shoreline and volume changes represent an annual assessment of changes to the Mantoloking shoreline. Shoreline changes shown measured in feet while sand volume changes are in cubic yards per foot (yds<sup>3</sup>/ft.). Individual profile changes averaged with adjacent sites and multiplied by the distance between sites determine a net cell volume change. Total volume change for the Borough is determined by summing the net cell volume changes.

**Table 2**  
**2017 Annual Shoreline & Sand Volumes Changes**  
**October 17, 2016 to December 21, 2017**

<b>Profile Number</b>	<b>Shoreline Change (feet)</b>	<b>Volume Change (yds<sup>3</sup>/ft)</b>	<b>Avg. Volume Change (yds<sup>3</sup>/ft)</b>	<b>Distance Between (feet)</b>	<b>Net Volume Change (yds<sup>3</sup>)</b>
<i>Northern Municipal Boundary</i>					
			3.89	294	1,144
Mant-1	4	3.89			
			6.62	3,033	20,063
Mant-2	6	9.34			
			36.68	2,584	94,781
Mant-3	185	64.02			
			126.38	2,789	352,474
Mant-4	255	188.74			
			96.17	2,164	208,112
Mant-51	33	3.60			
			3.600	495	1,782
<i>Southern Municipal Boundary</i>					
<b>Total Volume Change</b>					<b>678,356</b>

Table 2 shows the net volume change for 2017 was a massive gain of sand, 678,356 cubic yards. This volume does not represent natural beach recovery, skewed due to placement of approximately 600,000 cubic yards of sand during the federal project from 1117 Ocean Ave through Princeton Ave as the project progressed. The profile locations at Carrigan Pl, 1041 Ocean and 1543 Ocean better represent the natural recovery process that occurred over the spring and summer, following the winter storm season. Volume changes ranged from a gain of 3.60 yds<sup>3</sup>/ft. of sand to 9.34 yds<sup>3</sup>/ft. of sand as cross-shore transfer moved sand

between the nearshore and beach. Shoreline position changes at these three sites reflected the sand gain onshore advancing seaward the zero datum location from four to 33 feet. By comparison, the federal projects influence on volume and shoreline change is extremely obvious with 64.02 yds<sup>3</sup>/ft. added at 1117 Ocean Avenue and 188.74 yds<sup>3</sup>/ft. added to the beach profile at Princeton Avenue. Shoreline position changes reflect the massive project sand volume added to the beach with seaward advances ranging from 185 feet at Mant-3 to 255 feet at Mant-4.

### **Profile Site Descriptions:**

For 2017, beach profiles conducted semi-annually provided post storm season data, with the initial survey in early spring while data from the fall documented post summer natural recovery process. The fall profiles at Mant-3 and Mant-4 provide a preview of changes to come following completion of the federal project. Including the final survey in 2016, provide an annual assessment of changes to the Mantoloking shoreline. Cross section plots included in this section show the variations in the beach profile configuration between three surveys for each site. Photos from each site provide a visual record of changes during the year.

- **Mant-1 Carrigan Place**

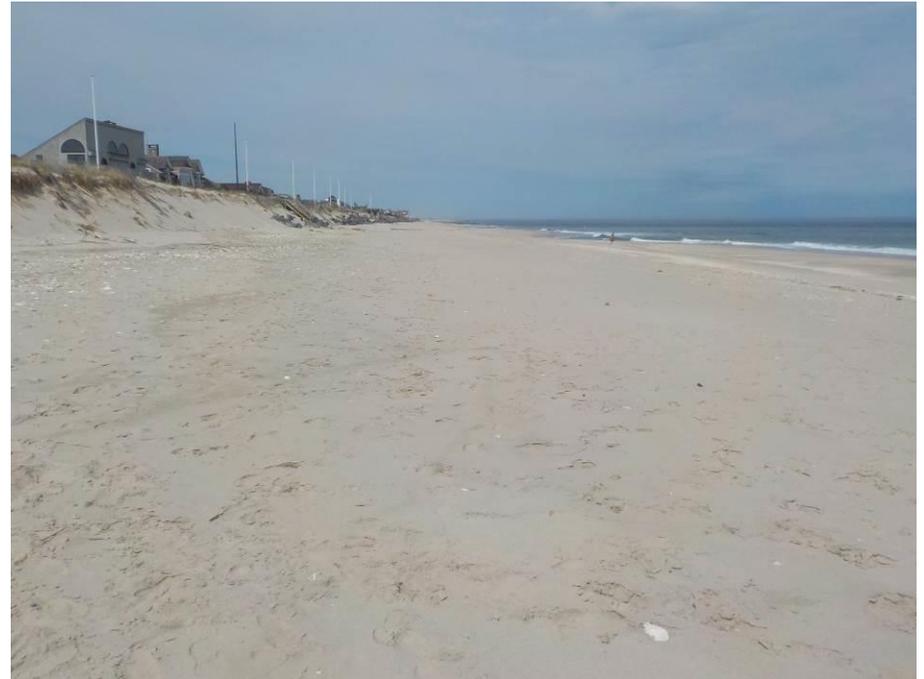
Mant-1 is located at the seaward end of Carrigan Place, along the municipal beach access path between the private residential properties at #911 and #915 East Avenue. Carrigan Place is located about 500 feet south of the Bay Head – Mantoloking boundary. The profile reference location is a fire hydrant 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.

Following Sandy, work commenced to extend the rock revetment south from Bayhead to include this location. South of Lyman Street installation of a steel wall provided enhanced shore protection for properties and infrastructure in the absence of a wider beach and dune system. By the final survey for 2016, the dune height was 19.5 feet NAVD88 with a crest width of approximately 20 feet and toe width of 150 feet. The beach berm width extended seaward approximately 50 feet seaward at elevation 6 feet NAVD88, a relatively minimal beach width to support the dune. From the berm, a steep slope on beach face continued relatively uniformly to near the profile limits.

The winter wave climate eroded the upper beach and seaward dune slope, creating a steeper slope and removing 25 feet of dune width. By April 2017, natural processes moved sand onshore, reforming a berm ridge on the lower beach. Sufficient sand returned to the beach (6.98 yds<sup>3</sup>/ft.) over the remainder of 2017 to allow maintenance efforts to move landward and restore a gentler seaward dune slope although offshore losses offset onshore gains for a net loss of -7.36 yds<sup>3</sup>/ft. of sand. The December 2017 survey, showed the dune toe width had actually expanded over the year to 180 feet while the crest elevation accumulated sand, at 20 feet NAVD88. Some sand shifted from the seaward crest to the landward slope but the net volume remained approximately the same from October 2016 to December 2017. The net changes for the year included a gain of 3.89 yds<sup>3</sup>/ft. of sand and a 4-foot advance in the shoreline position.



**1a. October 17, 2016**



**1b. April 12, 2017**



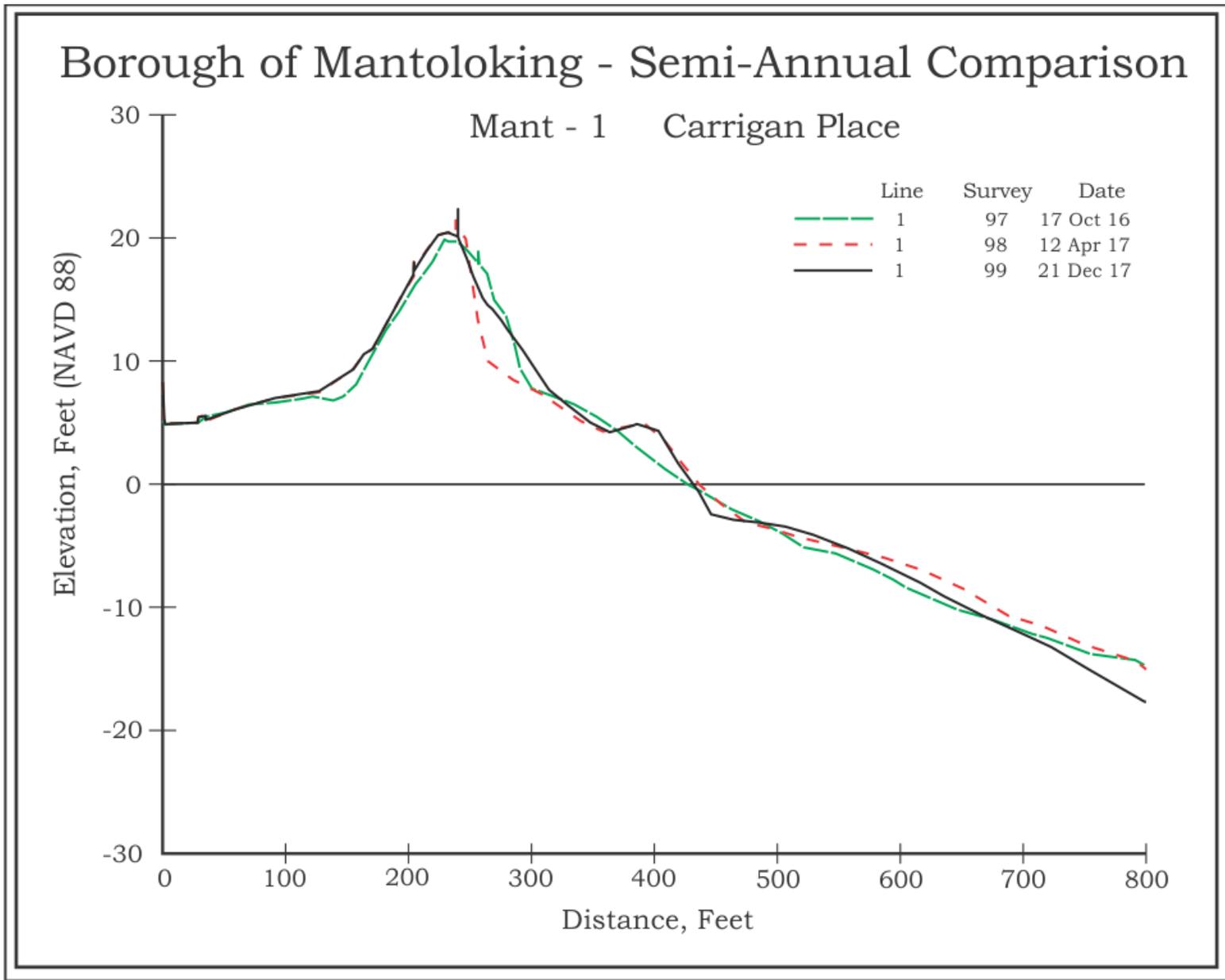
**1c. December 21, 2017**

***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 2016 with a relatively intact berm and beach but there is a dune scarp at the seaward dune toe indicating storm waves had recently over washed the beach and reached the dune.***

***Photograph 1b shows a steeper seaward dune face, indicating winter storms had cut away at the seaward dune slope. By April, the beach had partially recovered through natural processes, reforming a berm ridge on the lower beach. To the north, the rock revetment is partially exposed.***

***Photograph 1c shows the beach following the summer and fall seasons. By the December survey, the seaward dune slope and width of the toe, partially restored through maintenance efforts covered the rock revetment. The beach width and elevation mimicked its fall 2016 appearance.***



**Figure 1d: The cross section comparison above shows a significant loss of sand and width from the seaward dune slope over the winter season. The April survey showed some sand accumulated on the landward dune crest and slope and there was sand accumulation nearshore while the beach elevation was relatively stable with development of a new berm ridge on the beach face slope. By late fall 2017, the upper beach and seaward dune slope accumulated sand, fully restoring the October 2016 beach configuration and partially restoring the seaward dune slope.**

- **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 selection is 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 monument, midway along the access path 150 feet landward of the landward dune toe.

The vertical steel wall installed in September 2014 at approximately the location of the April 2014 dune crest, cycles between erosional exposures and buried through maintenance efforts. This pattern existed in 2017 with exposure of the wall during winter storms then buried after natural recovery moved enough sand onshore for maintenance activities to push sand landward. This trend continued following Sandy and installation of the wall because of insufficient beach width to support and shelter the dune system in its current location from storm waves.

In 2017, the wall exposed at the end of 2016 and during the winter months through several storm events. Sand accumulated nearshore and on the lower beachface slope by April 2017. The early spring volume gain of 24.07 yds<sup>3</sup>/ft., most of which accumulated below the datum (19.54 yds<sup>3</sup>/ft.) pushed the shoreline position seaward (37 ft.). Over the summer and early fall sand moved onshore through natural processes from the nearshore then pushed higher onto beach to restore the seaward dune slope through maintenance activity. The movement of sand from the beachface slope to the dune resulted in 30 feet of shoreline position retreat by December 2017. Although sand may have accumulated on the beach in greater volumes over the summer, by December the fall wave climate likely eroded any beach berm that developed. The net onshore accumulation of 3.49 yds<sup>3</sup>/ft. of sand didn't offset the significant loss (-16.64 yds<sup>3</sup>/ft.) of sand offshore resulting in a net profile volume loss of -13.15 yds<sup>3</sup>/ft. of sand. Despite this loss in the second half of 2017, the net annual changes still resulted in a net gain here of 9.34 yds<sup>3</sup>/ft. of sand, mostly to the dune and beach (8.02 yds<sup>3</sup>/ft.), that advanced the shoreline seaward 6 feet.



**2a. October 17, 2016**



**2c. December 21, 2017**



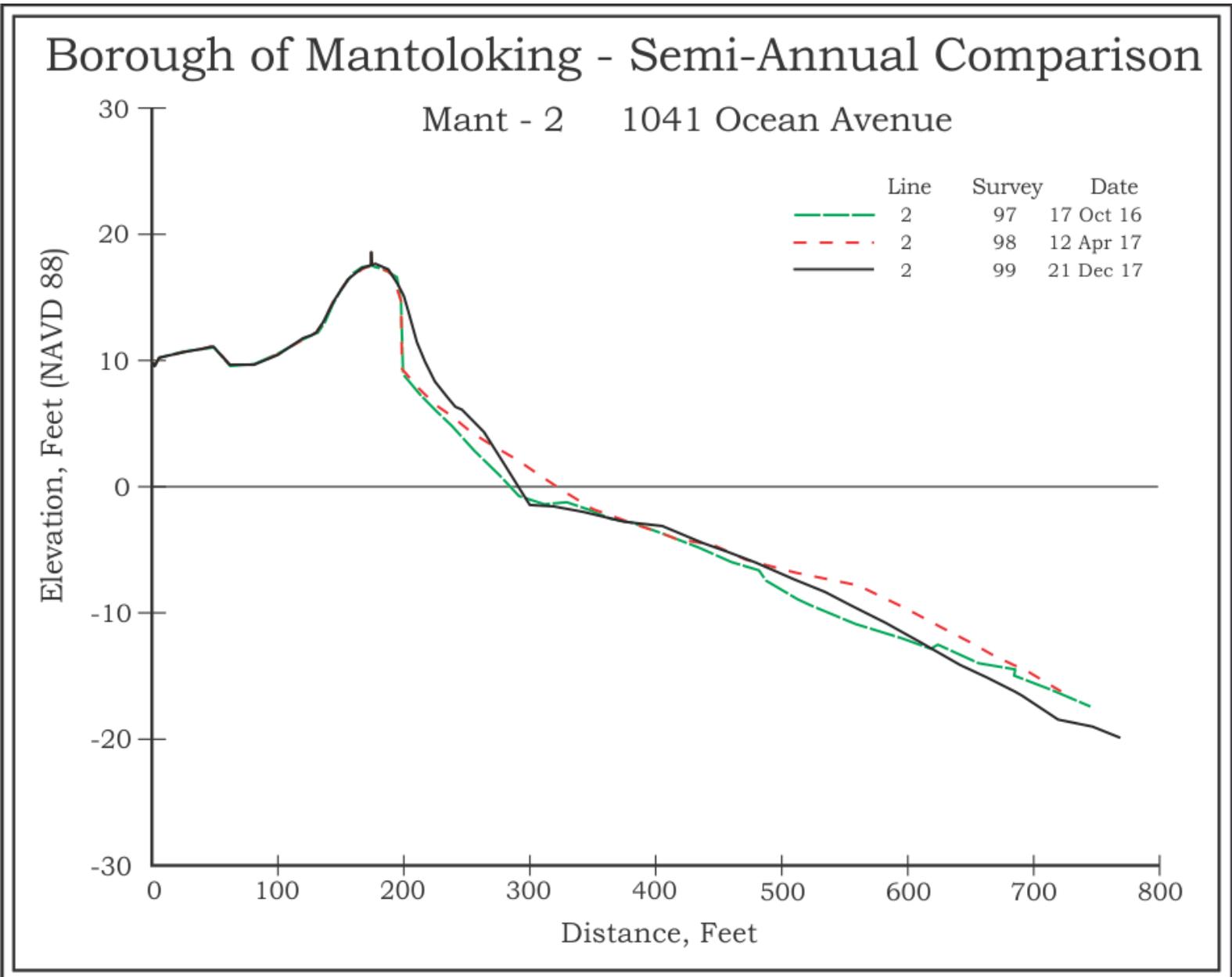
**2b. April 12, 2017**

***Mant-2 Photographs 2a and 2b. All views are to the north. Photos a and c were taken from the berm. Photo c taken along the seaward base of the steel wall.***

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

***Photograph 2b. shows the winter storms prevented any significant sand recovery along the steel wall but lower on the beach natural processes pushed sand onshore expanding the beach width. The thin strip of sand seaward of the wall provided minimal beach access in this section.***

***Photograph 2c. Natural sand recovery occurred over the summer and fall as sand moved landward cross-shore from the offshore slope. Maintenance efforts moved sand onto the seaward dune slope covering the steel wall, restoring the seaward slope and a modest recreational beach.***



**Figure 2d: The cross sections at 1041 Ocean Avenue show the shoreline position advanced from October 2016 to April 2017 with sand accumulation on the beach face slope and further offshore. By December 2017, sand moved onshore, but waves and maintenance efforts moved the sand higher onto the beach and to the seaward dune slope. The steeper beachface slope resulted in shoreline retreat while the loss of sand offshore resulted in a net sand volume loss from April and December. The annual change was a modest volume gain.**

- **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.

Super storm Sandy's storm surge and waves completely breached this dune system. The net sand volume losses attributed to Sandy was 131.97 yds<sup>3</sup>/ft. of sand at this site. Following the storm, both restoration activities and natural recovery helped to restore a modest dune and beach width. To help prevent another complete storm breach the state installed a steel wall, completed in late 2014. The dune crest following these restoration efforts remained near 22 ft. (NAVD88) with dry beach widths that ranged from 75 to 125 feet.

Erosion continued to plague this site over the winter of 2017, following several moderate northeast storms the beach berm eroded and the seaward dune slope eroded to the steel wall, exposing the feature with a 5-6 foot vertical drop to the beach. Nearshore wave scouring transferred sand from the shoreline to further offshore, partially offsetting the onshore and nearshore loss. Net loss from October 2016 to April 2017 included 28 feet of shoreline position retreat and -16.28 yds<sup>3</sup>/ft. of sand loss.

Over the remainder of the spring through early fall conditions favored natural beach building and sand recovery. Maintenance activity restored the seaward dune slope and buried the steel wall to restore beach access. The greatly anticipated USACE federal shore protection project for northern Ocean County began placing sand on the Mantoloking shoreline in late fall 2017 and by December 21, 2017 sand had accumulated at this location. The project added a wedge of sand to the beachface and nearshore extending the shoreline position seaward 212 feet. A wider beach width supports continued development of the dune and enhanced shore protection for this once vulnerable section of shoreline. Although the project was ongoing at the time of this survey the site had already received 80.08 yds<sup>3</sup>/ft. of sand. The anticipated final sand placement volume should exceed the volume of material eroded during Sandy. Based upon past monitoring this should remain a relatively stable shoreline as cross-shore transport dominates sand movement in this region, exchanging sand between the dune and beach and nearshore based on the seasonal wave climate. Now that the beach width is sufficient to support dune growth the need and frequency of maintenance diminishes in moving sand from the beach to restore the dune slope and keep the steel wall buried.



**3a. October 16, 2016**



**3c. December 21, 2017**



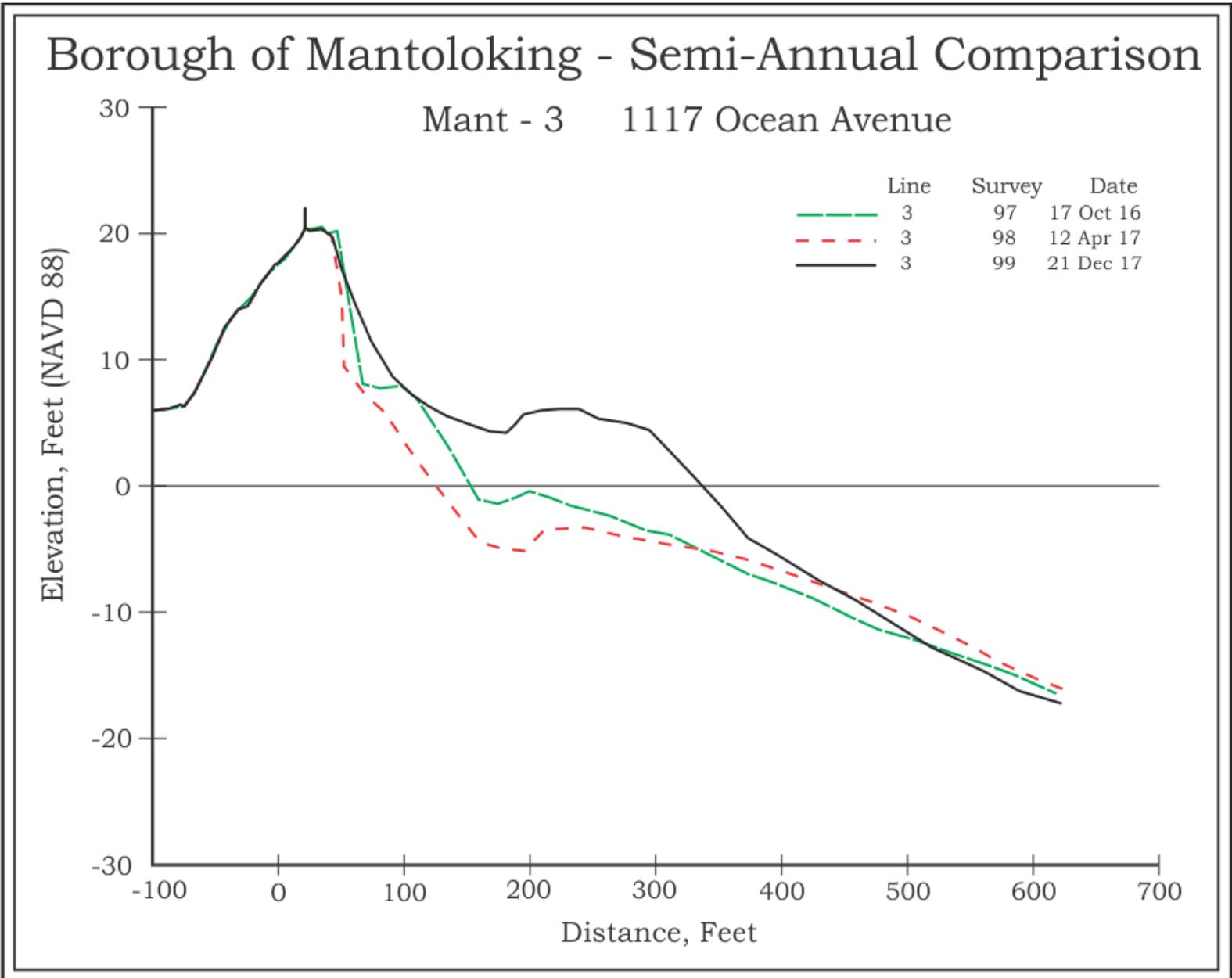
**3b. April 12, 2017**

***Mant-3 Photographs 3a & 3c show the view to the north from the seaward dune crest. Photo 3b is along the steel wall.***

***Photograph 3a The October beach profile shows the impact of a late September 2016 NE storm that lasted several days with a mild wind set, but a long duration. This resulted in the scarp seen in the dune toe and narrow beach. Erosion did not expose the wall exposed in this location.***

***Photograph 3b shows the winter wave climate further eroded the beach, exposed the steel wall and steepened the dune scarp on the seaward slope. By April, the beach showed multiple beach cusp along the shoreline. Scouring along the wall resulted in about 6 feet of vertical relief to the beach.***

***Photograph 3c. By December, a combination of natural sand recovery over the summer and an infusion of sand from the startup of the federal shore protection project in fall restored the seaward dune slope and added significant beach width.***



**Figure 3d: The cross sections show significant shoreline changes at 1117 Ocean Avenue. The dune and beach initially retreats landward following several storms with modest sand accumulation offshore by April. Over the summer, some sand did move back onshore naturally and sand pushed up to restore the seaward dune slope and cover the wall. By December 2017, sand from the federal project had accumulated nearshore as a wedge at the shoreline, raising the elevation over 6 feet and moving the shoreline seaward over 200 feet.**

- **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 is located approximately midway between the #1117 and #1543 Ocean Avenue sites, and readily accessible. Erosional concerns here include protection of 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.

During super storm Sandy, the surge and waves generated caused a dune breach, completely removed the dune and severely eroded the beach leaving the street pavement level with the sand where previously the dune existed. The dune breach caused significant overwash to cascade into the Borough at this street-end opening. At this location 76.32 yds<sup>3</sup>/ft. of sand loss occurred, attributed to Sandy. Following the storm restoration efforts rebuilt a smaller dune feature as the beach recovered. By fall 2014, installation of the steel wall reached this location. Crests elevation of the dune reached 19 feet while the wall top elevation just under 15 feet NAVD88. The remaining beach width was insufficient to support further dune growth and left the existing feature subject to erosion from modest storm waves and surge.

Erosion of the seaward dune slope occurred over the winter of 2017. Waves removed 20 feet of width at the toe and cut away the sand covering the steel wall. Erosion left a steep 10-foot near vertical drop from the dune crest to the beach, with 5-6 feet of vertical relief along the wall exposed from top to base. During the same period sand accumulated nearshore to the offshore profile limits offsetting the onshore losses. By April 2017, the site accumulated a net 14.96 yds<sup>3</sup>/ft. of sand, despite the dune and beach erosion. This offshore sand deposit provided a source of sand for natural sand recovery and beach building as the weather pattern and wave climate shifted to favorable conditions for beach building in late spring and summer.

The USACE project started in this region during late fall, a massive quantity of sand placed by January 19, 2018 masked any natural changes that occurred since April. The dune volume nearly doubled while the crest elevation reached 22 feet and 30 feet wide with a dune toe width of 200 feet. The project dune expansion provided significant shore protection and should keep the steel wall buried for some time to come. The beach berm width went from approximately 40 feet to over 150 feet seaward of the dune toe but since the dune also expanded the net gain in width was over 250 feet. Sand accumulation continued across the nearshore to the profile limits with 173.65 yds<sup>3</sup>/ft. of sand added during the project. Comparing October 2016, to the post project survey, revealed an amazing annual transformation with the shoreline position advancing seaward 255 feet, 188.74 yds<sup>3</sup>/ft. of sand added. The project improvements will enhance shoreline stabilization while protecting property and infrastructure from storm events in this section of Mantoloking.



**4a. October 16, 2016**



**4b. April 12, 2017**



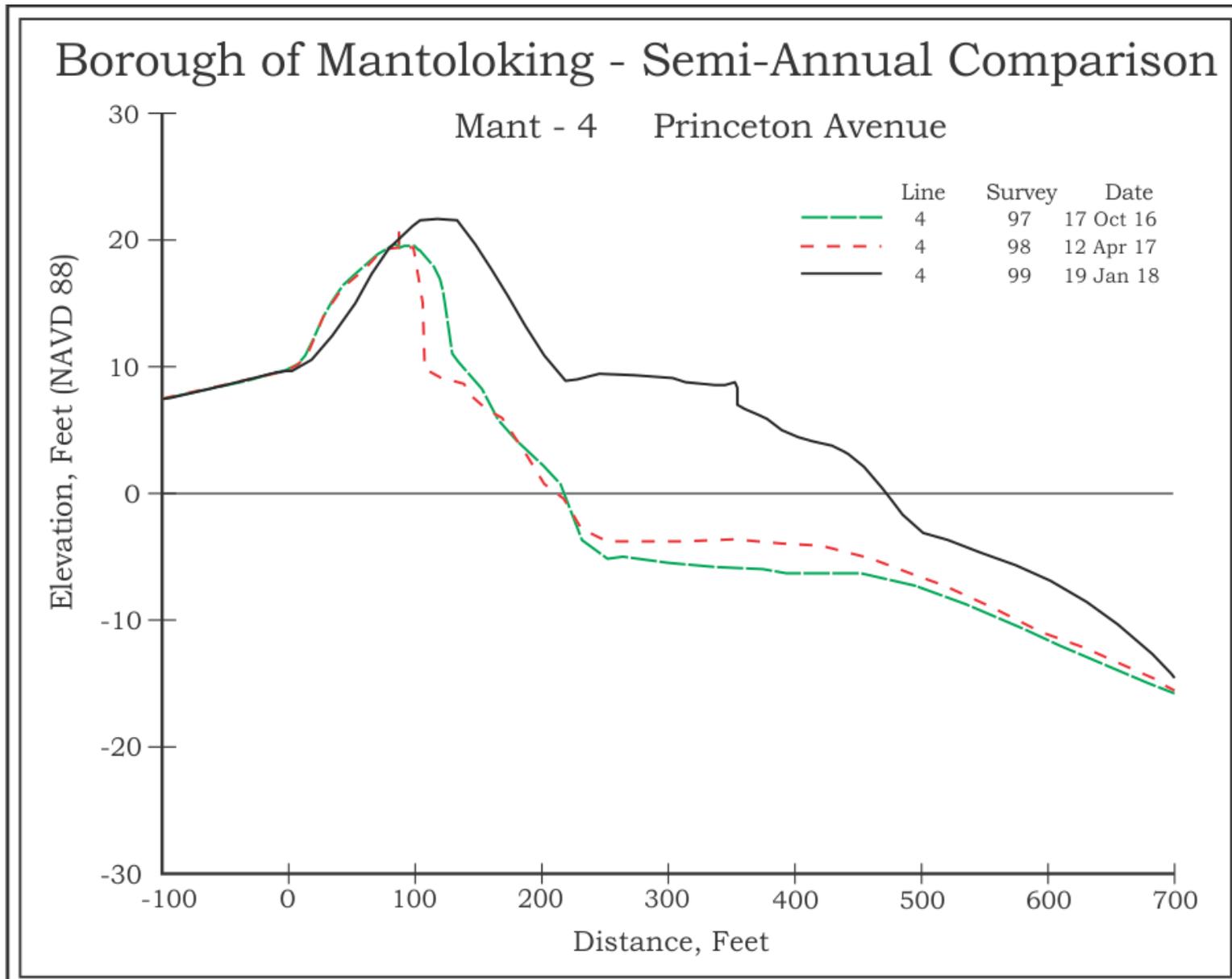
**4c. January 19, 2018**

***Mant-4 Photographs 4a to 4c. All views are to the north from essentially the same location at Princeton Avenue.***

***Photograph 4a This view shows the impact of September 2016 storm erosion that exposed the steel wall visible in the distance to the north but remained buried here. Large waves are breaking on the shallow platform created by the transfer of eroded sand from the beach cross-shore where it accumulated nearshore.***

***Photograph 4b Winter storms caused significant beach and dune erosion, exposing the steel wall and leaving 4-6 feet of vertical relief from the remaining seaward dune slope to the beach below the wall.***

***Photograph 4c The Federal shore protection project, completed here by January 19, 2018, added a massive quantity of sand to this site that extended seaward to the profile limits. The dune more than doubled in size and beach width expanded seaward several hundred feet.***



**Figure 4d: Initially the seaward dune slope eroded to a vertical scarp in response to the winter wave climate, by April the steel wall was fully exposed. The beach width was relatively stable over the winter and sand accumulated nearshore. Natural recovery occurred over the summer months but by the end of the year the USACE project had started here. By January, a massive wedge of sand added transformed the typical minimal beach profile seen here for the last three decades into a formable shore protection feature. Note that the new federal beach profile comes to closure 700 feet from the reference position indicating possible future adjustment seaward.**

- **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. During 2005, new property owners limited accessibility to the private property and site resulting in the site relocation to the public access pathway between #1543 and #1539 Ocean Avenue. The shift in the line's location was 202 feet to the north.

Prior to the 2018 USACE project, 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. Super storm Sandy's surge and waves rapidly eroded the narrow beach and cut away over half the dune but the dune elevation at the landward erosional scarp remained above 20 feet and prevented overwash and breaching.

In recovery efforts following the storm, sand bulldozed from the berm crest restored the dune slope with a new dune crest at 24 feet (NAVD88) and approximately 100 feet landward of its pre-Sandy position. The dune elevation and position throughout 2016 remained stable through modest maintenance efforts.

For 2017, winter storms initially eroded the beach and seaward dune slope exposing the steel wall. The seaward dune toe retreated landward 20 feet with similar shoreline retreat that occurred as the waves scoured the nearshore. Sand accumulated offshore transferred cross-shore from the dune, beach and nearshore. Offshore accumulation offset the beach loss for a modest net volume gain of 3.48 yds<sup>3</sup>/ft. of sand from October 2016 to April 2017.

Wave climate during spring and summer favored natural beach building and sand recovery. By December 2017, sand had accumulated across the dune crest, the seaward slope restored through maintenance and natural accumulation and a typical summer beach berm developed as cross-shore sand transfer shifted offshore sand to the beach. The net volume change of 0.18 yds<sup>3</sup>/ft. reinforces the pattern of cross-shore sand motion with a loss of -18.95 yds<sup>3</sup>/ft. of sand offshore offset by a gain of 19.12 yds<sup>3</sup>/ft. of sand onshore.

This cross-shore dominance pattern bodes well for long-term beach stability once the USACE project is complete and the net sand budget for Mantoloking increases significantly to allow the natural transfer of sand between the beach and offshore to occur without negatively affecting the dune stability. Net changes for the year here included a gain of 3.60 yds<sup>3</sup>/ft. of sand with 33 feet of shoreline position advancement as the USACE project sand remained north of this site at the time of the final survey for 2017.



**5a. October 16, 2016**



**5c. December 21, 2017**



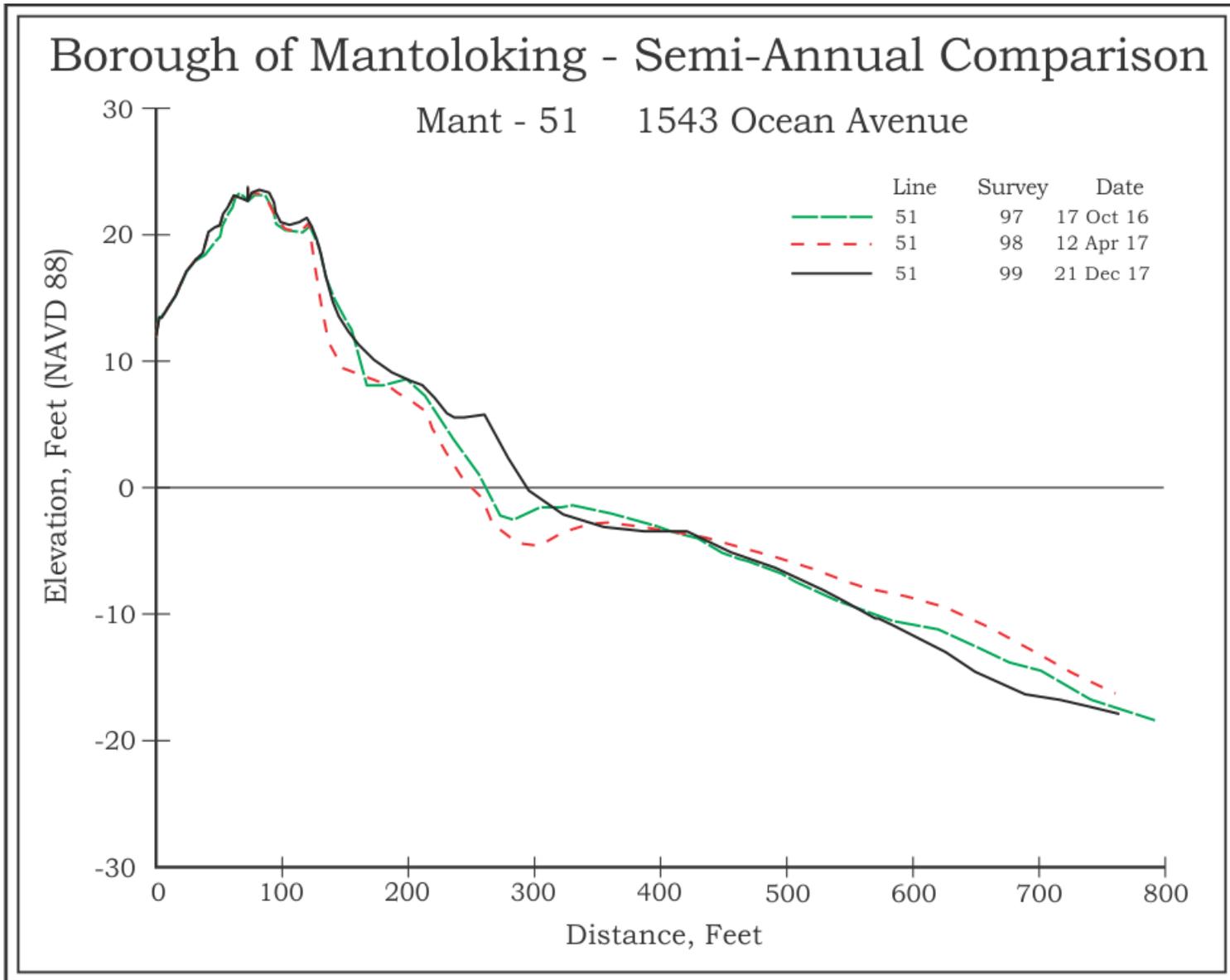
**5b. April 12, 2017**

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

***Photograph 5a 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.***

***View 5b Shows the beach following the winter season. Storm waves eroded the beach and seaward dune slope, exposing the steel wall to varying degrees in nearby sections, ranging from several feet of seaward face exposed to just the top of the steel wall uncovered.***

***View 5c Natural recovery onshore over the summer and fall months restored the beach width by December 2017, with the seaward dune slope regraded through maintenance activity. The ongoing USACE project activity and resulting seaward beach offset is visible in the far distance.***



**Figure 5d: The southern site suffered beach and dune erosion over the winter months. By April, the seaward slope eroded, cut vertically and retreated, exposing the top of the steel wall. The beachface slope and shoreline position retreated landward but sand accumulated below the zero datum, indicating cross-shore transport dominated here. By December 2017, the beach had recovered and sand pushed onto the seaward slope to restore the pre-winter configuration, burying the steel wall. Sand also accumulated on the dune crest and a large summer beach berm was still present at the end of the year.**

## **Conclusions:**

All of the municipal beaches remain at a sand deficit with respect to the conditions prior to Hurricane Sandy through 2016 amounting approximately to 175,000 cubic yards, based on the September 2012 to October 2016 surveys. This pattern reversed in 2017, from October 2016 to April 2017 the net sand volume actually increased 86,273 cubic yards. Winter storms eroded the beach and exposed the steel wall once again, leaving approximately 4-8 feet of vertical relief from the top of the wall to the beach. Sand eroded during the 2017 winter storm events was deposited close enough to the beach to allow natural spring recovery. By April 2017, 80% of the sand accumulation over the winter months occurred offshore towards the limits of the survey envelope. Winter storm waves and surge removed sand from the dune, beach and nearshore then transferred cross-shore seaward along the profile. In addition, sand moved longshore from beyond the municipal borders to the offshore region where it accumulated, adding to the municipal sand budget.

A massive gain in the municipal sand supply occurred from April 2017 to December 2017 with the addition of 595,206 cubic yards of sand, derived from the USACE project start up. Three sites not influenced by the project (Mant-1, Mant-2 and Mant-51) showed a more typical pattern of modest sand volume and shoreline position changes with modest net losses in volume. The shoreline changes ranged from seaward advances of 260 feet at Princeton Avenue within the project area to a landward retreat of -30 feet at Mant-2 where typical summer beach berm building steepened the beachface slope. Natural sand recovery on the beaches outside the project areas resulted in sufficient sand available to allow maintenance activity to restore the eroded seaward dune slope and cover the sheet pile wall.

While the bulldozing practices are effective at some locations for restoring eroded dune slopes where sufficient amounts of beach sand accumulate in late spring and early summer, these efforts remain temporary fixes. The region continued to need a massive influx of sand to compensate for losses attributed to Hurricane Sandy and increase the regions sand budget to support sufficient dune growth to provide adequate storm protection. The USACE Northern Ocean County Storm Damage Reduction Project awarded to Weeks Marine started in summer of 2017 south of Mantoloking. By fall 2017, work began on the southern section of the Mantoloking shoreline, the influence of which seen at Mant-3 and Mant-4 in this report showed the tremendous enhancements to the dune and beach. Before the project was halfway complete, the Mantoloking shoreline sand budget increased for the year by 678,356 cubic yards. Approximately 600,000 cubic yards of sand already added during the federal project from 1117 Ocean Ave through Princeton Ave as the project progressed. As the project progresses through Mantoloking, it is likely over a million new cubic yards of sand will be placed on 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 recent geologic past. The net result is overall enhanced stability of the Mantoloking shoreline with the increase in the regions sand budget.

Northern Ocean County is unique in NJ in that the duration and velocity of sand movement tends to balance over extended time-periods absent of large storm events. The CRC's extensive research and monitoring along the Mantoloking shoreline indicates that the project material will remain within the Mantoloking regional sand budget and beach system for a longer duration than is normally associated with barrier island beach nourishment. Sand will continue to erode during modest and moderate storm events and be transported cross-shore to the nearshore bars then migrate landward during summer naturally restoring the beach, creating relative equilibrium in the shoreline and balance in the overall sand budget. Larger storm events will transfer sand seaward into deeper water beyond the normal transport capabilities of the typical spring summer beach building wave climate to move sand back towards the beach, resulting in a loss of sand to the system. Over-time, littoral currents will also move sand north but with the entire northern Ocean County shoreline, receiving sand through the USACE project equilibrium between beaches should persist for some time to come. Continued monitoring will allow officials to assess short and long-term project performance, plan for periodic nourishment intervals and emergency responses to storm damage to maintain community storm preparedness. By fall 2018, the transformation of the Mantoloking shoreline should be complete as the USACE project continues north towards Pt. Pleasant leaving a massive increase to the regional sand budget and an expanded dune system with wider beaches that will provide a stunning difference in shore protection in Mantoloking.

During 2018 as the federal project progresses, the Coastal Center will not survey the five sites. We have received authorization to conduct a late fall survey of the community beach sites and do a post-project comparison with the extensive historical data the center holds. We thank the Borough Council for the long period of beach observation and documentation and do earnestly trust that the federal project will provide the citizens of Mantoloking decades of storm protection.