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THE RICHARD STOCKTON COLLEGE OF NEW JERSEY

**Beach-Dune Performance Assessment of  
New Jersey Beach Profile Network (NJBPN) Sites at  
Atlantic County, New Jersey**

**After Hurricane Sandy Related to FEMA Disaster DR-NJ 4086**

December 21, 2012

**Introduction;**

The Richard Stockton College of NJ Coastal Research Center (CRC) has initiated a post-storm survey and assessment of the New Jersey shoreline in response to severe beach erosion resulting from the impact and landfall of Hurricane Sandy. As a result of the Presidential Disaster Declaration, the Federal Emergency Management Agency (FEMA) has termed the event DR-NJ-4086 for reporting/assistance purposes. The analysis for the developed barrier islands of Atlantic County compares data collected before and after the storm. On Brigantine Island, the comparison survey dates were from late-October to mid-November. The Absecon Island comparison survey dates were from early June to early November. This initial report is focused on the impact to the Atlantic County dunes and beaches from Hurricane Sandy. The damage details have been organized specific to each municipal segment on the County's two developed barrier islands. The island of Little Beach is located within the Forsythe National Wildlife Refuge and is not surveyed under the NJBPN program.

**Hurricane Sandy's Impact on the New Jersey Ocean Shoreline;**

In general terms, damage to beaches, dunes and public or private property was significantly worse on the north side of the storm's zone of coastal landfall in Atlantic County. Southern Cape May County fared best with limited overwash, dune scarping and loss of beach elevation. Many Cape May coastal communities were beneficiaries of either USACE or NJ State co-sponsored Shore Protection Projects that yielded wider beaches and dunes designed with specific storm resistance in terms of elevation and width. Damages increased towards the region of landfall with moderate dune breaches, especially in southern Ocean City area, and damages to southern Absecon Island's oceanfront properties. Dune breaches, loss and scarping of dunes, and decreased beach width and elevation continued north into Brigantine. From the natural area of Holgate on Long Beach Island, north along the remainder of the Jersey coast, the intensity dramatically increased for dune breaching and overwash and/or complete erosion of the dunes, drastic lowering of the elevation on beaches with substantial sand transport onto and across Long Beach Island or Northern Ocean County's spit. In Monmouth County, the major observation was that Sandy's waves were dramatically higher upon breaking than they were further south, especially south of the center of rotation for the storm. Damage seen in Deal and Elberon demanded that waves exceeded 30 feet in NAVD 88 elevation levels on breaking on the bluff. These huge breakers essentially bulldozed the berm, beach and irregular dune system all along the Monmouth County Atlantic shoreline. Damages to oceanfront property (public and private) increased dramatically northward.

**Atlantic County Beach-Dune Susceptibility Assessment;**

In addition to comparing pre- and post-storm profile data, the CRC has added results from the state-wide, beach-dune susceptibility assessment for the 100-year storm event (or 1% base flood event as classified by FEMA).

The beach-dune assessment is based on year-2005 LiDAR elevation data and evaluates the storm protection performance potential of the oceanfront beach-dune system. The assessment was carried out by segmenting the beach-dune system, parallel to the shoreline from Little Egg Inlet to Great Egg Harbor Inlet (~19 miles), into 294 uniform zonal analysis areas, called "bins", that are 250-foot long parallel to the shoreline. For each bin, several variables are employed that relate to dune width, height, seaward slope, beach elevation and width, and nearshore geomorphology. The presence of vegetation and structures (such as groins), were collected, compiled, and evaluated in order to determine the susceptibility of the dune system to potential damage from storm activity. These susceptibility variables were quantified and, using expert knowledge, assigned a "weight of influence" with respect to their individual abilities to withstand or counteract the effects of storm-induced erosion. LiDAR elevation and profile survey bathymetry data were used as data input to a wave run-up erosion simulation (USACE's S-BEACH) to determine the failure point of the dune system for each bin (the point of failure is defined as the point when the dune crest is breached in response to landward recession of the fore-dune's seaward slope). The output of the erosion simulations were used to control how the susceptibility variables were integrated, and to classify the resulting susceptibility values into statistical intervals. The results for the 100-year storm are conveyed on a map as multicolored polygons that delineate the dune system prior to the storm simulation.

**Beach/Dune Damage Assessment by Municipal Segment:**

To measure the erosion, information previously collected at the 10 Atlantic County New Jersey Beach Profile Network (NJBPN) monitoring sites was used to provide the pre-storm view of existing shoreline conditions. On November 6, and 12, 2012 each site was visited and a GPS-based survey of the dune, beach and shallow offshore region was completed to provide an accurate comparison and assessment of storm related shoreline and beach volume changes. Data collected at the 10 oceanfront beach profile locations cover the municipal beaches from the City of Brigantine Beach to the Borough of Longport. Little Beach on Pullen Island to the north of Brigantine is a natural area and is not included in the NJBPN program.

In 2004 the US Army Corps of Engineers, Philadelphia District, conducted a Shore Protection project from Absecon Inlet, south to the Ventnor City/Margate City boundary on Absecon Island. The design was for a 150-foot wide beach in Atlantic City and a 100-foot beach width in Ventnor backed up by a 14.5-foot elevation at the crest dune that was vegetated and fenced with sand fencing and pedestrian access pathways to the beach. Since Margate and Longport declined to participate, their municipal shorelines did not receive direct sand placement. The maintenance cycles were delayed until 2011 when the ACOE return to place sand on the northern portion of the Atlantic City shoreline. Fortunately, this task was very recently completed when Sandy came ashore (June 2012). A second maintenance cycle is set to begin in 2013.

The ACOE project for Brigantine was focused on the northern third of the developed shoreline. A feeder beach was designed into the project at the southern 1,600 feet of the natural area north of development. The project extends south to 5<sup>th</sup> Street South in the City. In 2006 the initial Federal beach restoration was completed within the footprint of two prior State and local projects from 1997 and 2001. In 2011 an emergency maintenance was completed under the Flood Control and Coastal Emergencies funding program using trucked-in sand.

**Profile Locations:** The 10 sites on the Atlantic County barrier islands were surveyed in June 2012 or October 2012 and post-Sandy on November 3, 6, and 11, 2012. Individual site locations are given below.

<b>NJBPN 134</b>	Green Acres	Brigantine	<b>NJBPN 130</b>	North Carolina Ave.	Atlantic City
<b>NJBPN 133</b>	4 <sup>th</sup> Street North	Brigantine	<b>NJBPN 129</b>	Raleigh Ave.	Atlantic City
<b>NJBPN 132</b>	15 <sup>th</sup> Street South	Brigantine	<b>NJBPN 128</b>	Dorset Ave.	Ventnor City
<b>NJBPN 131</b>	43 <sup>rd</sup> Street South	Brigantine	<b>NJBPN 127</b>	Benson Ave.	Margate City

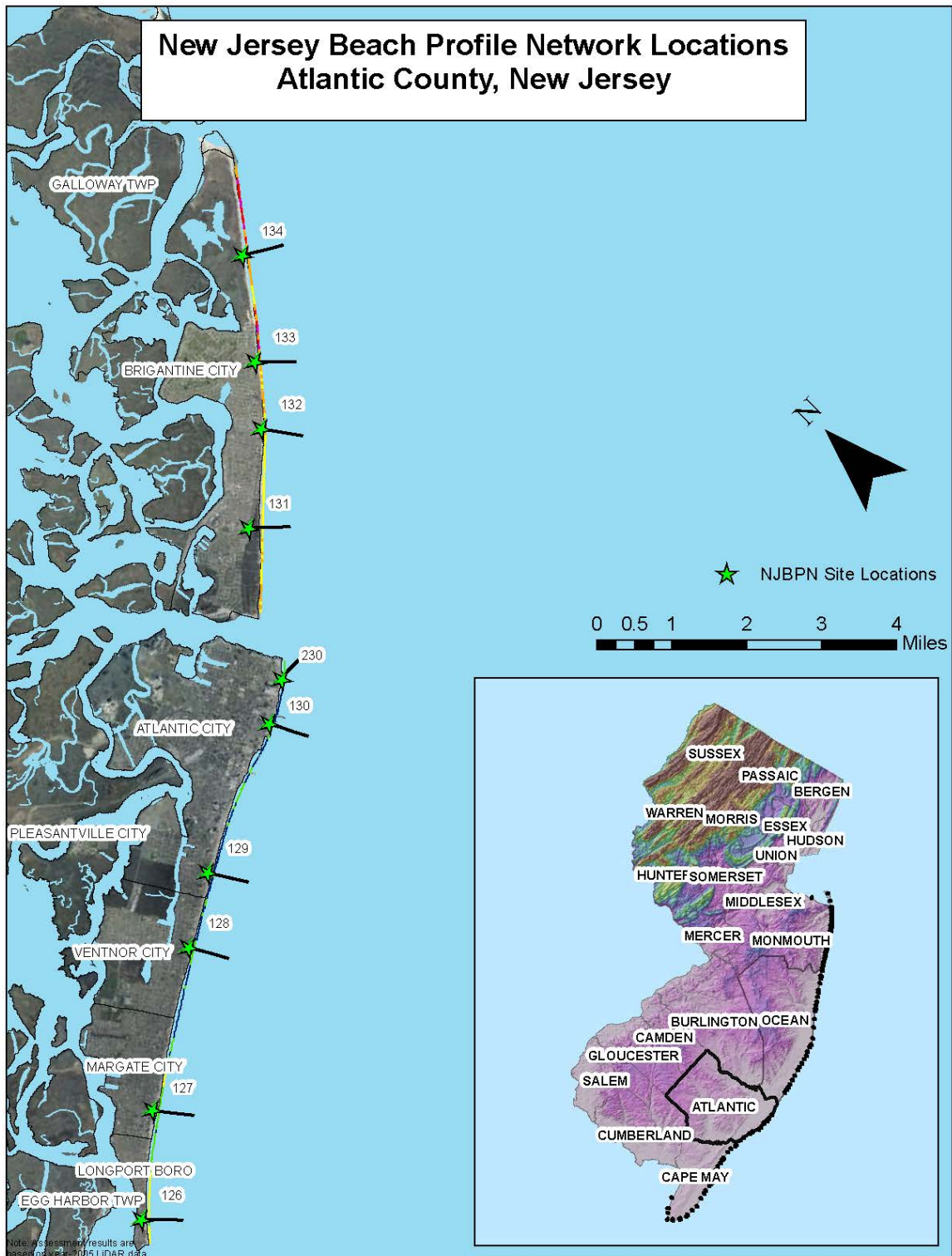


Figure 1. NJBPN Profile Locations and 100-year storm beach-dune susceptibility assessment results for Atlantic County, New Jersey

## **Brigantine;**

The northern-most profile site on the Island of Brigantine is located on the undeveloped northern end of the island now in the possession of the State of New Jersey. This location was overwashed by waves from the ocean to the bay marshes by Sandy. The vegetation survived behind the dune ridge, so re-growth is assured, but at a more landward location. The northeast storm of 1992 was the last time this occurred.

Where development begins, the beach has been erosional due to the orientation of the physical infrastructure and the long-term changes in the shoreline. The Federal project includes a part of the natural shoreline where sand is placed to act as a feeder beach to the worst of the erosional segment. Waves crashed over the promenade and flooded Brigantine Boulevard. The beach was wet to the toe of the rock revetment, so provided little protection. Dunes and a dry beach appear near the southern end of the promenade where steep scarps were in evidence going south to approximately 25<sup>th</sup> Street South. The dune-defended section did much better in stopping the storm waves except at 15<sup>th</sup> Street South where a large, multistory building occupies the footprint of a dune. Both the street ends and the building's parking lot were overrun by waves and sand was transported into Ocean Avenue.

However, south of 15<sup>th</sup> Street South, the ever-widening beach absorbed the storm surge and the wave energy with no ill effects on any public or private property. The berm was eroded and sand pushed landward into the seaward dune area of fore-dunes.

## **Atlantic City;**

Absecon Island has been developed since 1852 when Atlantic City was founded. Beach nourishment has been a part of the shoreline management strategy since the 1930's with a Federal project in place since 2003. Most of the material has been placed between Absecon Inlet and Iowa Avenue. In 2003 the ACOE placed sand between Absecon Inlet to the Ventnor City/Margate City boundary. The towns of Margate and Longport declined to participate in the Federal project and the last beach material applied to either was 190,000 cubic yards deposited in Longport in 1990. The dunes were constructed to an elevation of 14.5 feet NAVD88 and were just high enough to withstand the wave run-up during Sandy. Post storm surveys encountered large dimensioned timber debris near of on the crest of the dune at North Carolina Avenue and among the lower dunes in Ventnor. The lack of consistent shore protection allowed significant wave damage to occur along the Absecon Inlet shoreline in the City. One source of debris causing damage was the decking from the inlet boardwalk that was destroyed. Slated for demolition, the decayed structure came apart during the storm and large sections of decking washed into the City along the inlet. The oceanfront beach lost width and elevation, but the dunes prevented damage to the City's famous boardwalk.

## **Ventnor City;**

Ventnor chose to participate in the 2003-2004 Federal beach restoration project. The Dorset Avenue site saw no serious impact from Sandy other than beach elevation loss and a narrower berm width. Further south toward Margate, the end-effect losses to the Federal project allowed waves to reach the timber bulkhead protecting the upland development and water came over the bulkhead at a variety of locations.

## **Margate City;**

Margate City had significant amounts of water wash over the timber bulkhead at the development limit and inundate the streets and properties immediately landward. At the Benson Avenue site a lack of dunes, but a very wide beach permitted wave energy to deposit sand to the very top of the bulkhead, over it and into the street. Workers were busy shoveling it into wheelbarrows and rolling it out of the restaurant kitchen that backs up to the bulkhead at the street end. The berm supplied most of the material transported landward. Some spots did have "island" dunes that acted to protect from the overwash process, but in many cases the water came into the City.

**Borough of Longport;**

The southern community has an old concrete seawall protecting the development with a narrow, low elevation beach to the seaward. Waves crashed into the wall and poured over it down most of the Borough streets into Atlantic Avenue. Since the homes are very close to the wall, house damage was evident as well. Flooding was apparent and structural damage was wide spread. Many oceanfront properties had expensive landscaping with outside structures in abundance. These were destroyed. Longport also has a southern tip with no beach and a rock revetment seaward of a timber bulkhead with homes pressed right up to the top of the timber structure. Each of these expensive properties had the first floor of each residence ripped open and flooded with enough force to transport the electric distribution substation into the street. The homes can be restored, but the price will be high.

**NJBPN 134 – Green Acres Area, Brigantine**



The photographs above were taken on October 26, 2012 (left) and November 11, 2012 (right). The dune on the left started from nothing in January 1993, and was washed flat by Sandy (right). It is likely that the posts in the right picture date from the original post-storm effort to re-create the dune along this open-space beach.

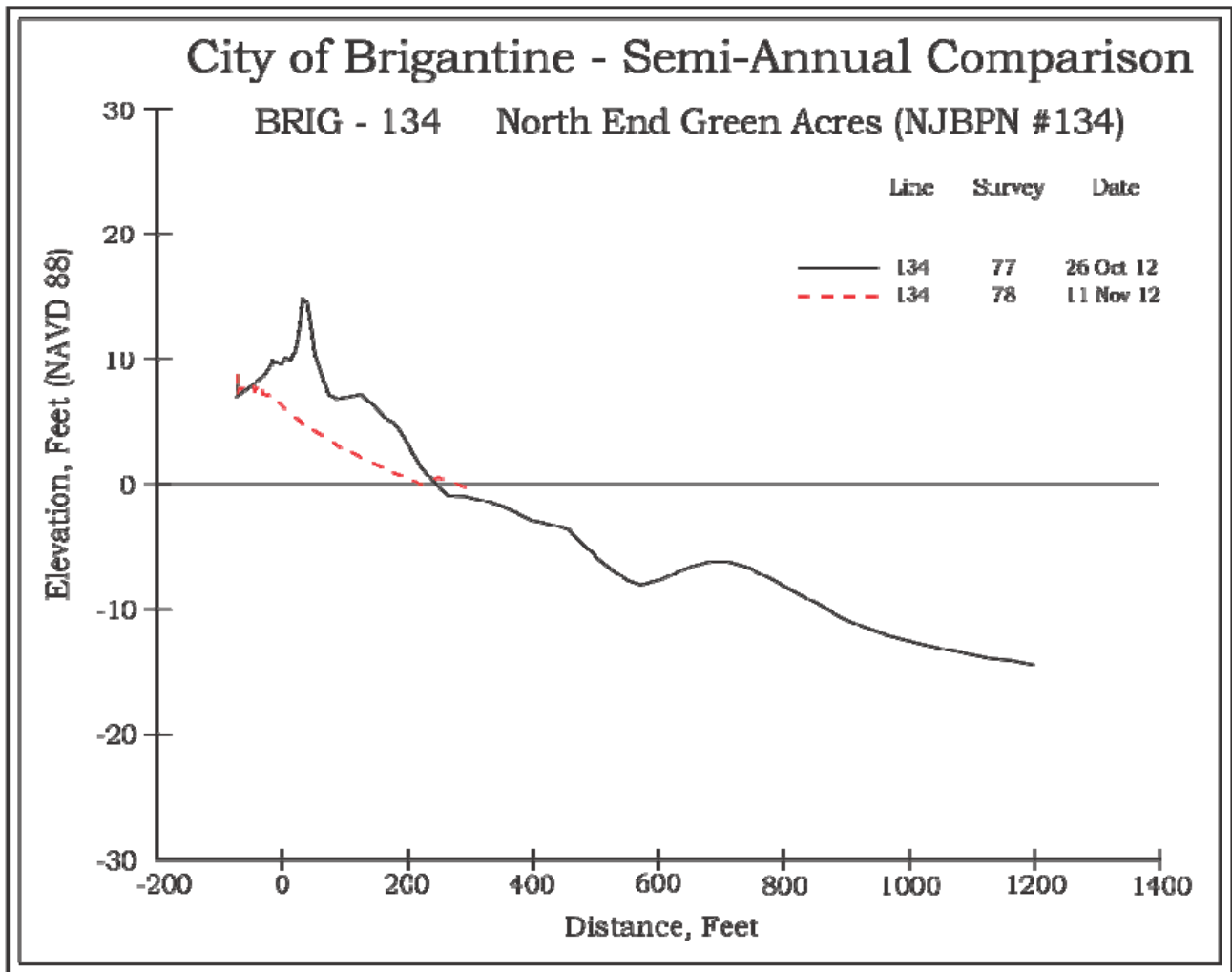
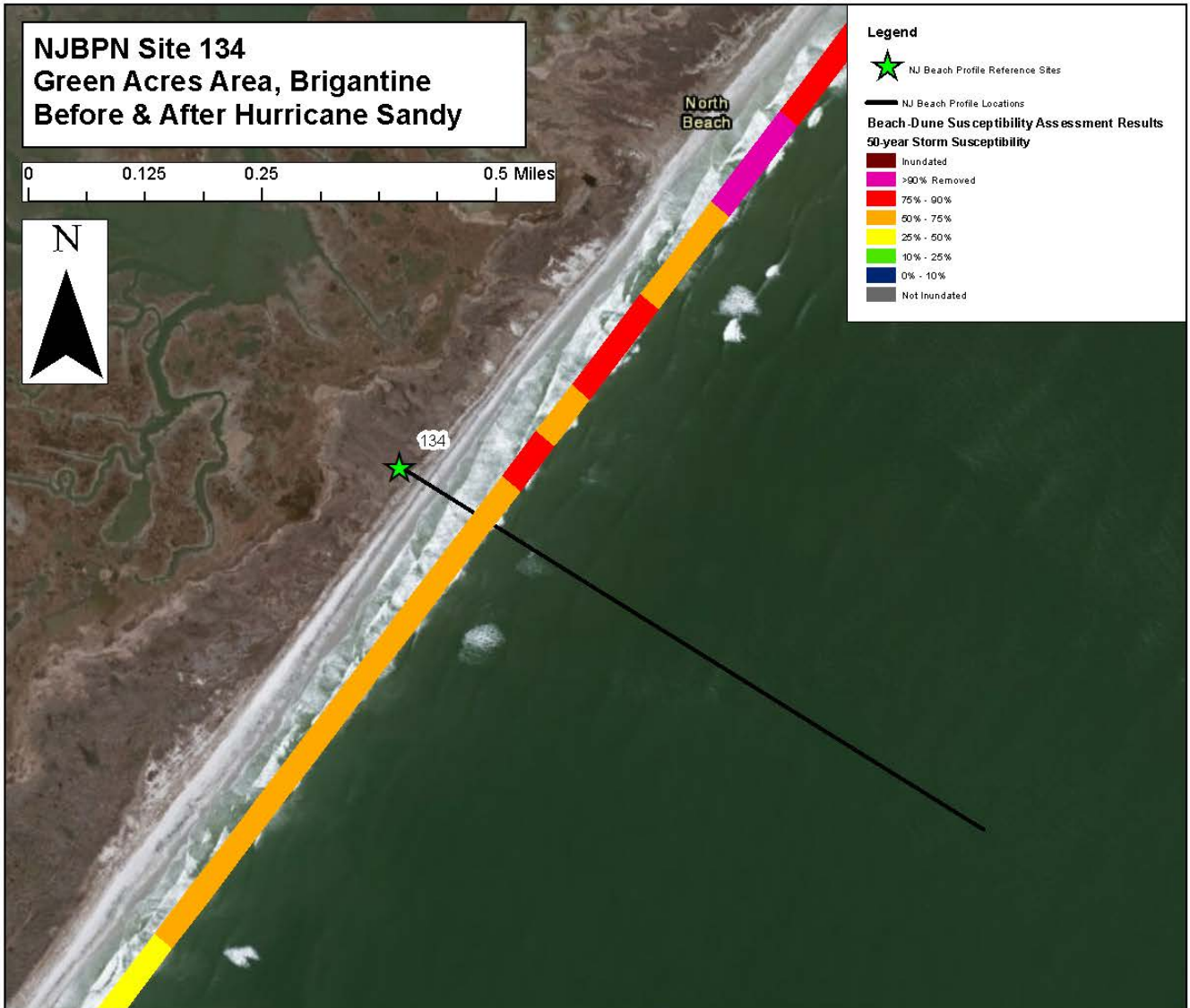
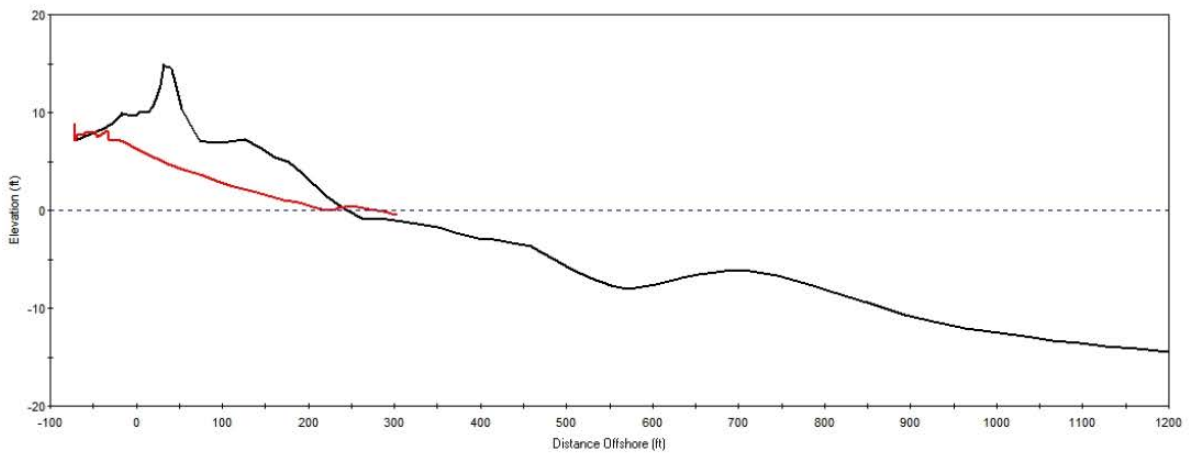


Figure 2. This site is located in the natural area on the northern segment of Brigantine Island, preserved as public open space. The dune (built since 1992) was washed landward onto the salt marshes. The photo above and cross-section below show the low and flat berm that was created by the large waves of Hurricane Sandy.



Pre vs. Post Sandy  
 Site 134 (Brig-134)  
 North End Green Acres, Brigantine

Volume Change = -41.182 cu. yd/ft



— BR134 121026 1200 — BR134 121111 1200

**NJBPN 133 – 4<sup>th</sup> Street North, Brigantine**



The photographs above were taken on October 26, 2012 (left) and November 3, 2012 (right). The seaward slope of the dunes was truncated by Sandy with sand moved seaward. Minor overwash at street ends occurred in places, but wholesale damage was absent.

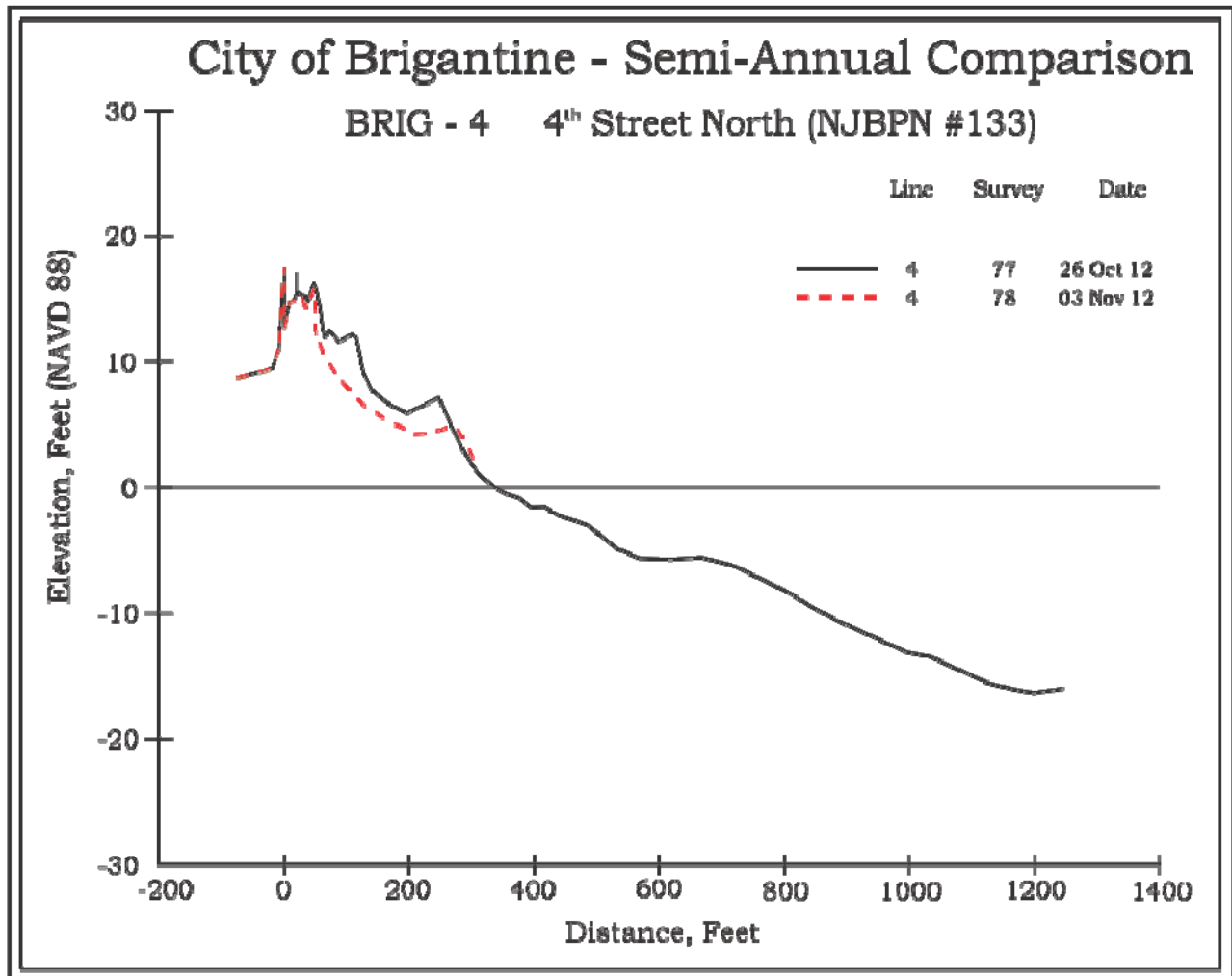
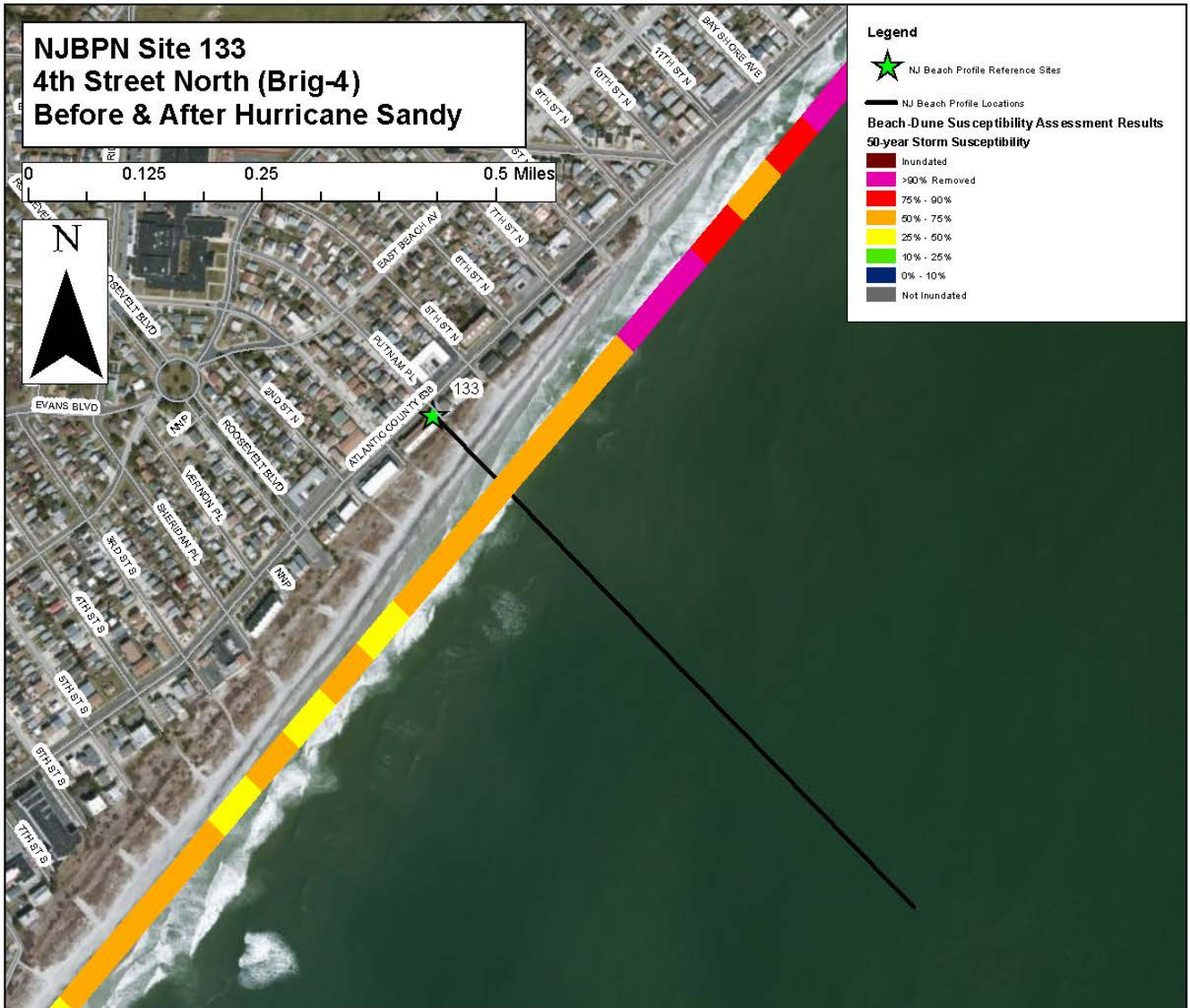


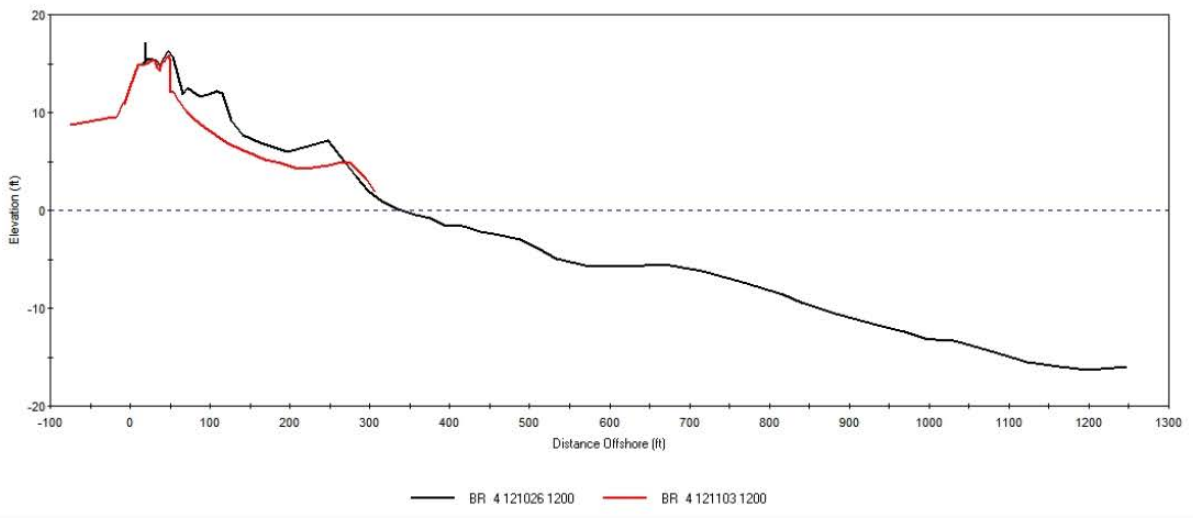
Figure 3. This site is located in the developed section of the island at the south end of the 1997 State beach nourishment project and the subsequent Federal project in 2006. Maintenance or emergency fills did not extend to this location in 2012. Though the berm and dune lost sand from the impact of Sandy, the primary dune remains.





Pre vs. Post Sandy  
 Site 133 (Brig-4)  
 4th Street North, Brigantine

Volume Change = -17.707 cu. yd/ft



NJBPN 132 – 15<sup>th</sup> Street South, Brigantine



The photographs above were taken on October 25, 2012 (left) and November 3, 2012 (right). This part of the beach lies in a zone where little erosion or accretion has occurred until beach nourishment started in 1997. Since then the shoreline has moved seaward by 200 feet. But the damage was caused by a lack of dunes in front of the parking lot and the building at 15<sup>th</sup> Street South.

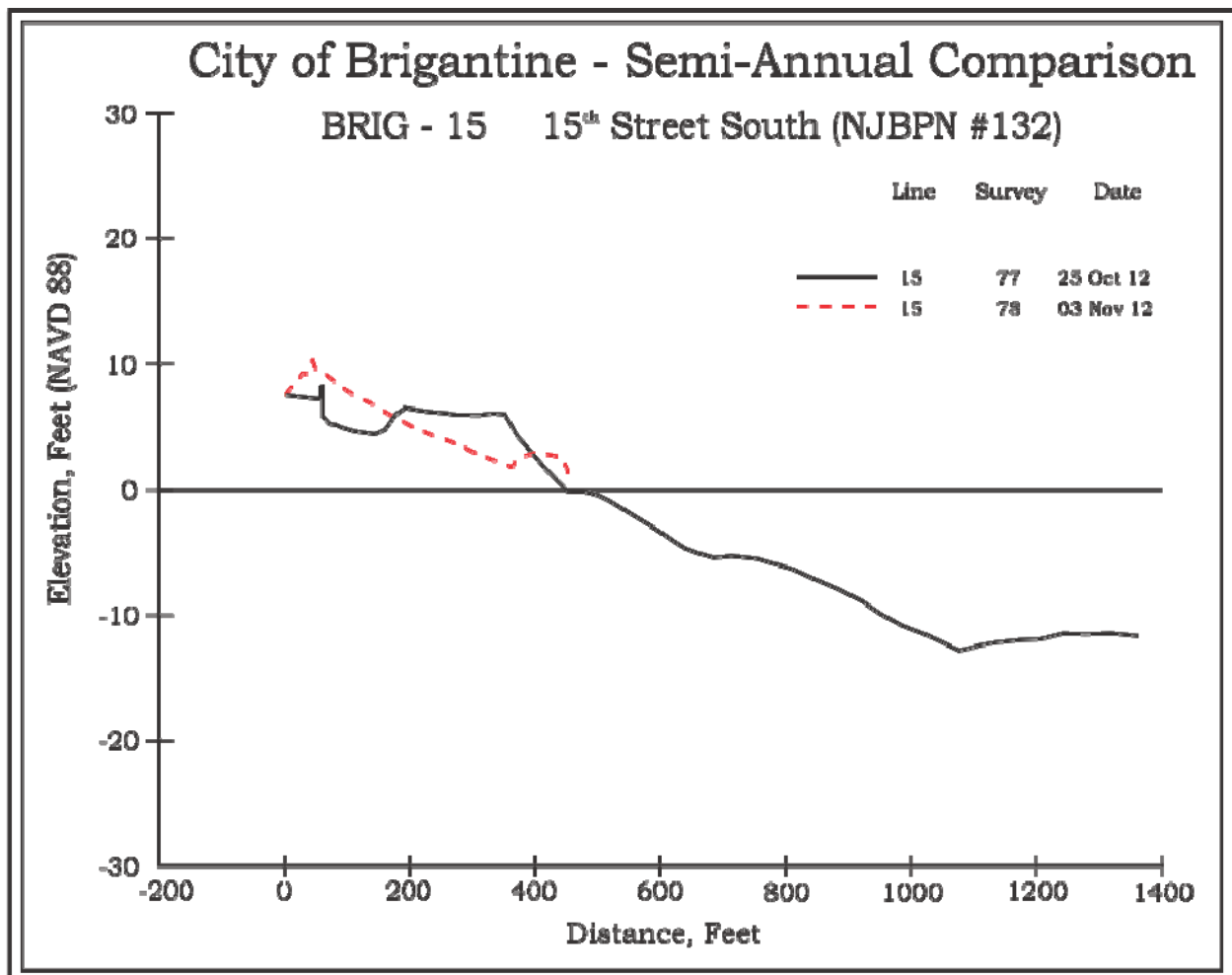
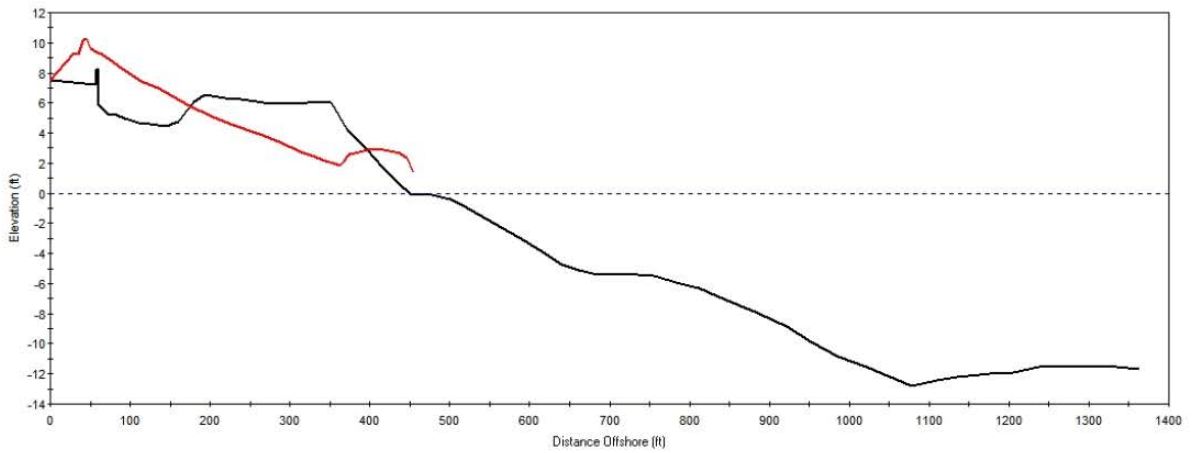


Figure 4. This site has never been included in the beach replenishment projects but is the recipient of sand due to the littoral transport of that material to the south. The result is a wide berm and some dune growth. Hurricane Sandy's waves relocated the berm sand landward and buried the bulkhead. The deposit covered the immediate street end at 15<sup>th</sup> Street South.



Pre vs. Post Sandy  
Site 132 (Brig-15)  
15th Street South, Brigantine

Volume Change = -0.737 cu. yd/ft



— BR 15 121025 1200 — BR 15 121103 1200

**NJBPN 131 – 43<sup>rd</sup> Street South, Brigantine**



The photographs above were taken on October 25, 2012 (left) and November 3, 2012 (right). The large building at 15<sup>th</sup> Street South shows in both pictures in the distance. From there to a mile south of this site, the beach width is huge with multiple rows of vegetated dune ridges to the landward site. The storm surge and wave energy expended itself in the dunes closest to the back beach margin with no ill effect on the development.

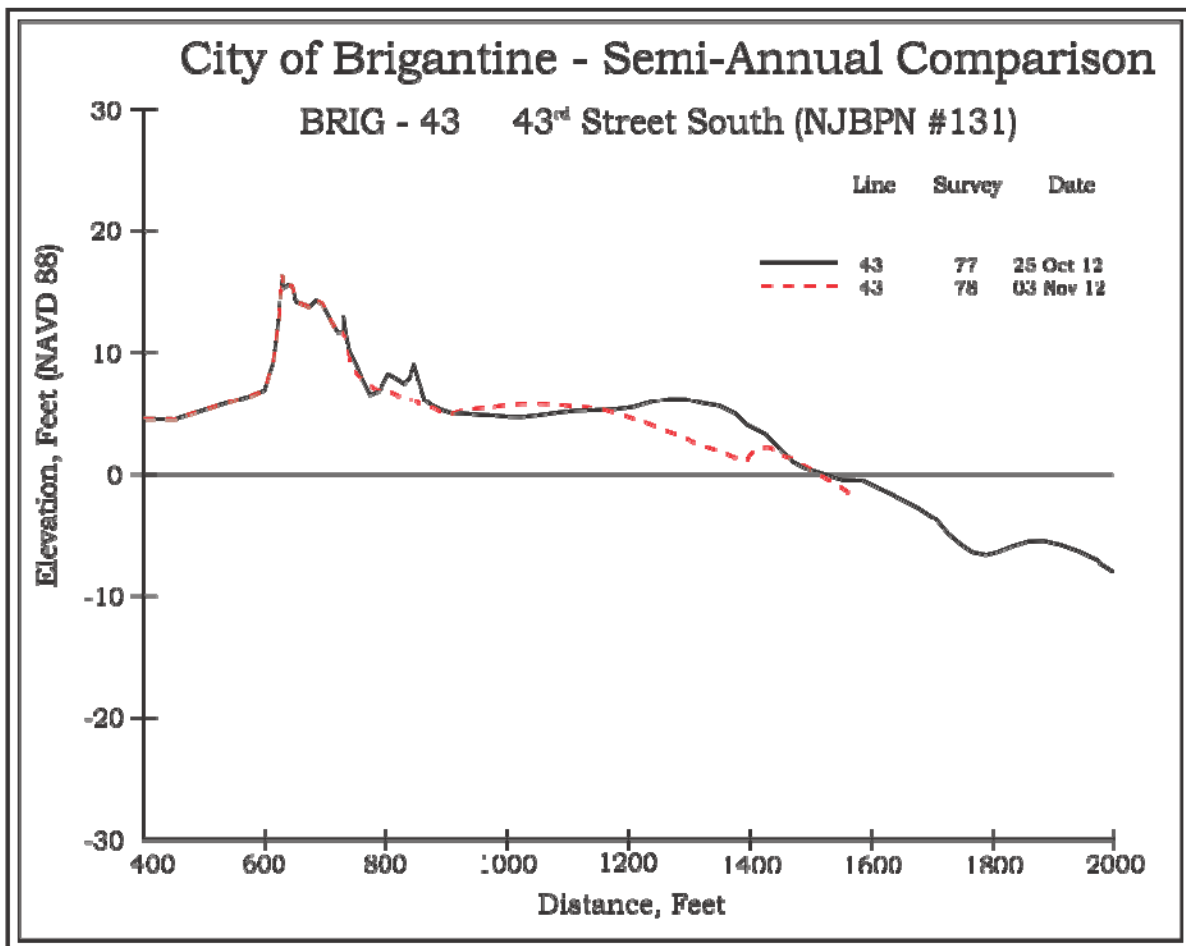
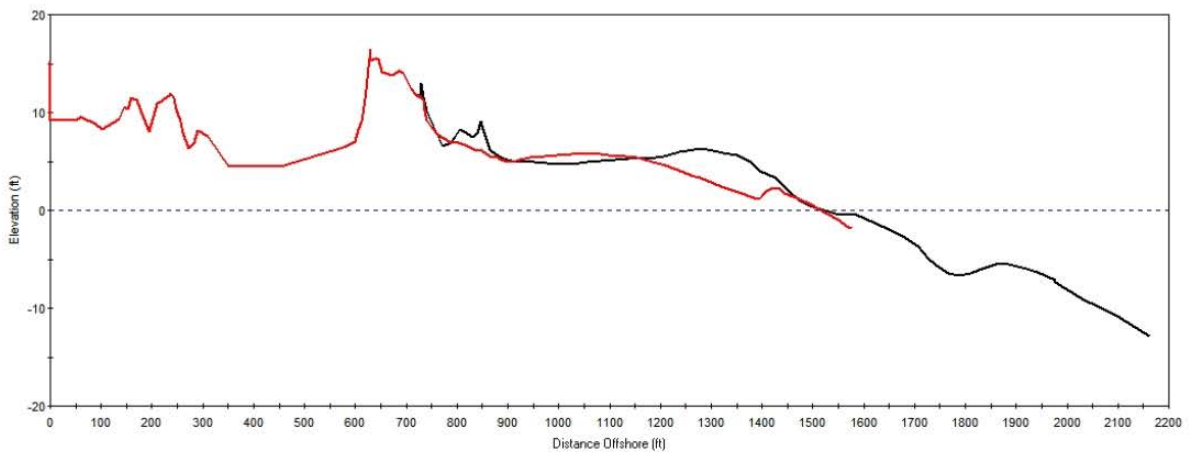


Figure 5. Sand has been accumulating at this profile location since the NJBPN’s initial 1986 survey. The healthy dune system and wide berm protected landward properties and infrastructure from Hurricane Sandy’s waves and storm surge. Sand was moved landward into the dunes from the berm. The large, primary dune diverted all flow to the sides with water and sediment moving landward along pedestrian paths leading back to the development 400 feet further landward than the graph displays. The zero distance starts at the 43<sup>rd</sup> Street South street end.



Pre vs. Post Sandy  
Site 131 (Brig-43)  
43rd Street South, Brigantine

Volume Change = -22.748 cu. yd/ft

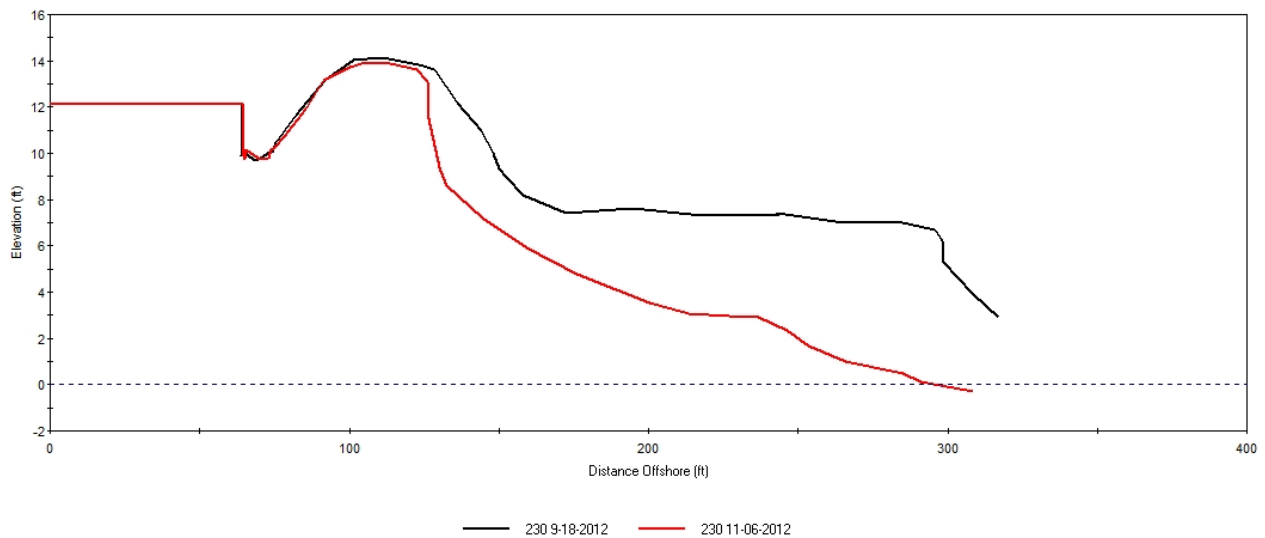


**NJBPN 230 – Rhode Island Avenue, Atlantic City**



The photographs above were taken on September 18, 2012 (left) and November 6, 2012 (right). Work was continuing on the rock sill being placed between the Massachusetts and Vermont Avenue groins in northern Atlantic City. The new Revel Entertainment casino was built here and the owner’s desire to have a usable beach with amenities resulted in an attempt to construct a submerged, shore-parallel rock sill between the two groins to trap sand as a “perched” beach for a longer time period between the maintenance interval for the Federal beach project. Since the maintenance was just completed following hurricane Irene in 2011, the dune/beach system resisted the storm damage from Sandy with about three quarters of the dune surviving.

**Pre vs. Post Sandy  
Site 230  
Rhode Island Ave., Atlantic City**

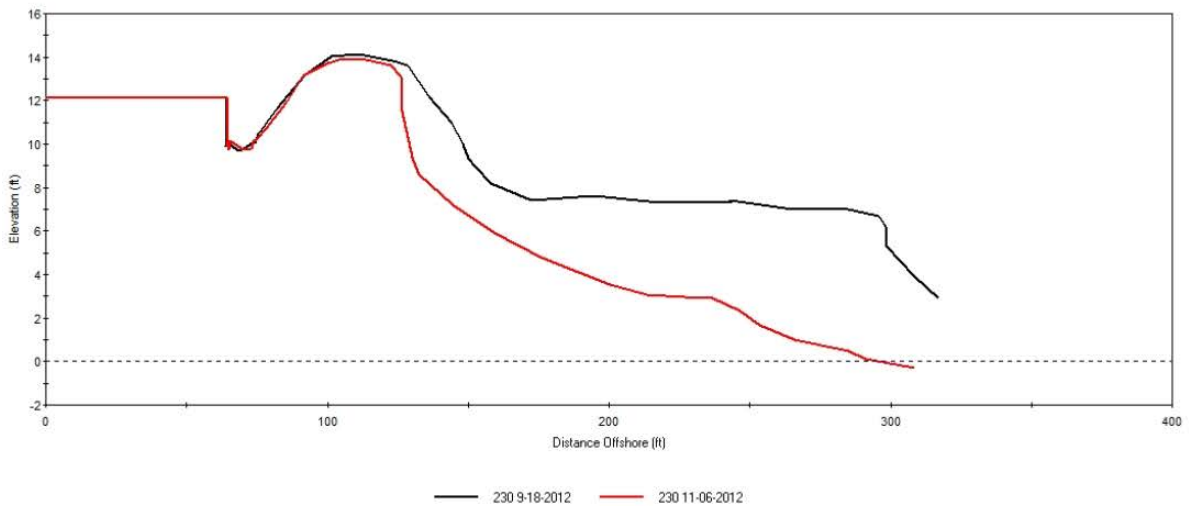


**Figure 6. This profile site is located near the Absecon Inlet jetty. The berm was wide following a Federal maintenance in 2012, which helped the un-vegetated dune survive the storm. Construction of a perched beach began in the summer of 2012 and was underway during the passage of Hurricane Sandy. The volume of sand in the berm was drastically reduced by Sandy.**



Pre vs. Post Sandy  
Site 230  
Rhode Island Ave., Atlantic City

Volume Change = -29.836 cu.yd/ft

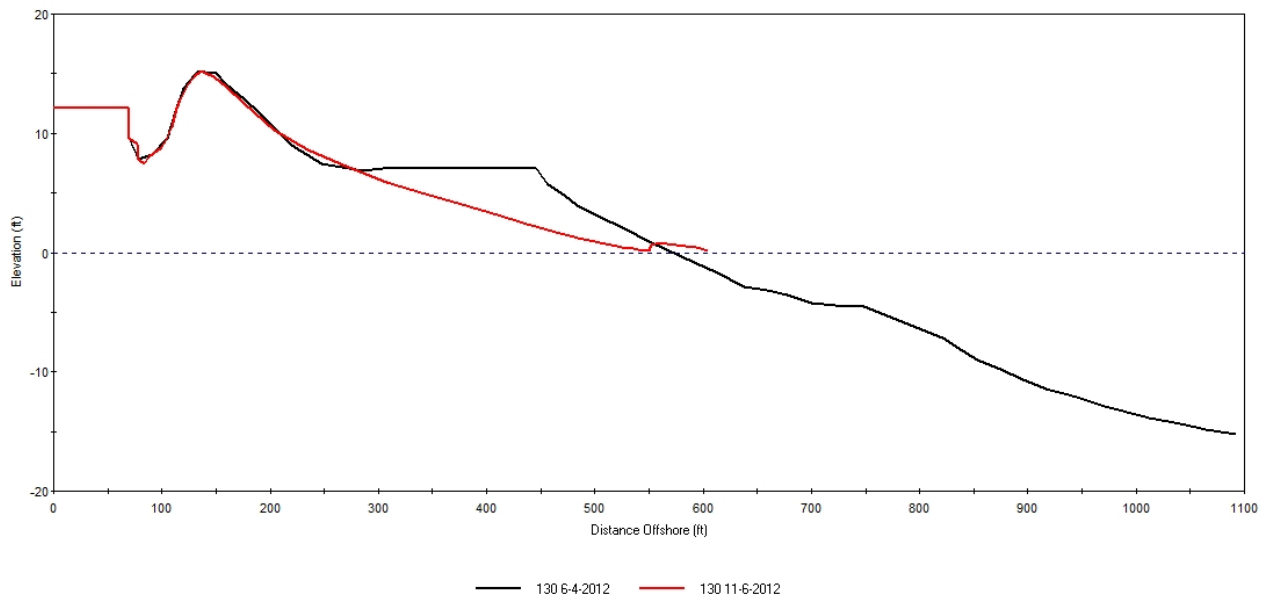


**NJBPN 130 – North Carolina Avenue, Atlantic City**



The photographs above were taken on June 4, 2012 (left) and November 6, 2012 (right). The beach lost much of the berm sand volume, but the dune survived by being just high enough. Note that there is abundant debris deposited near the crest of the dune and stream gullying was in evidence on the landward side of the dune indicating that sea water had crossed it in significant volume at the height of the storm.

**Pre vs. Post Sandy  
Site 130  
North Carolina Ave., Atlantic City**



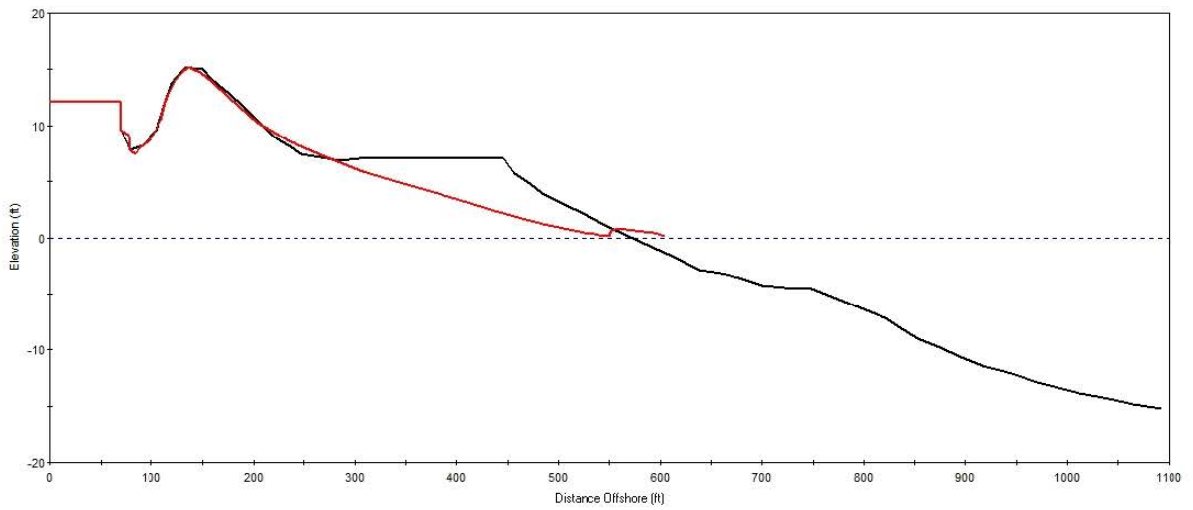
**Figure 7. The 2003 Federal beach nourishment project established a protective dune at this site. A 2011 Federal beach maintenance fill added to the dune, berm and nearshore. The dune remained intact during Hurricane Sandy while the berm was lowered in elevation. The wave run-up elevation here was 14.0 feet NAVD88, about 10 feet less than measured in Long Branch, NJ.**





Pre vs. Post Sandy  
Site 130  
North Carolina Ave., Atlantic City

Volume Change = -25.133 cu. yd/ft



## NJBPN 129 – Raleigh Avenue, Atlantic City



The photographs above were taken on April 13, 2012 (left) and November 6, 2012 (right). Raleigh Avenue lies in the middle of the Federal beach project and this meant that little damage was done. The dunes were invaded on the seaward slope depositing sand in the grass and knocking down an incipient foredune.

Pre vs. Post Sandy  
Site 129  
Raleigh Ave., Atlantic City

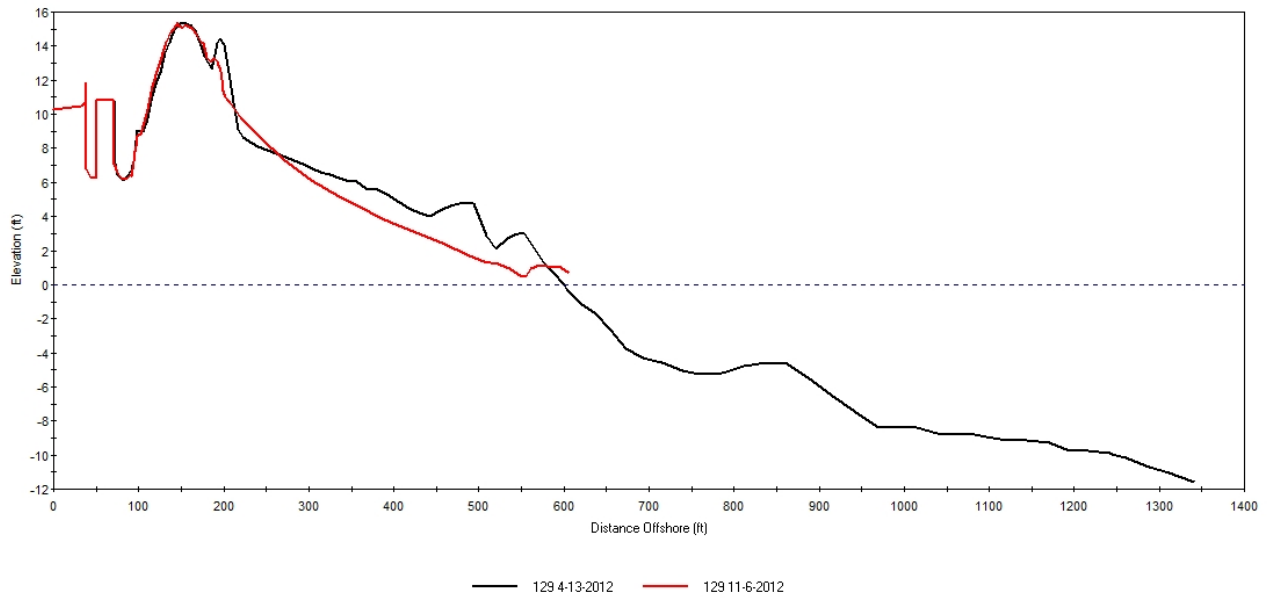


Figure 8. This profile has been relatively stable over the past 25 years due to its mid-island location and the past beach nourishment projects up-drift of the site. The comparison plot between the pre- and post-storm survey shows little loss of the foredune but lowering of the berm.

**NJBPN Site 129**  
**Raleigh Avenue, Atlantic City**  
**Before & After Hurricane Sandy**

0 0.125 0.25 0.5 Miles



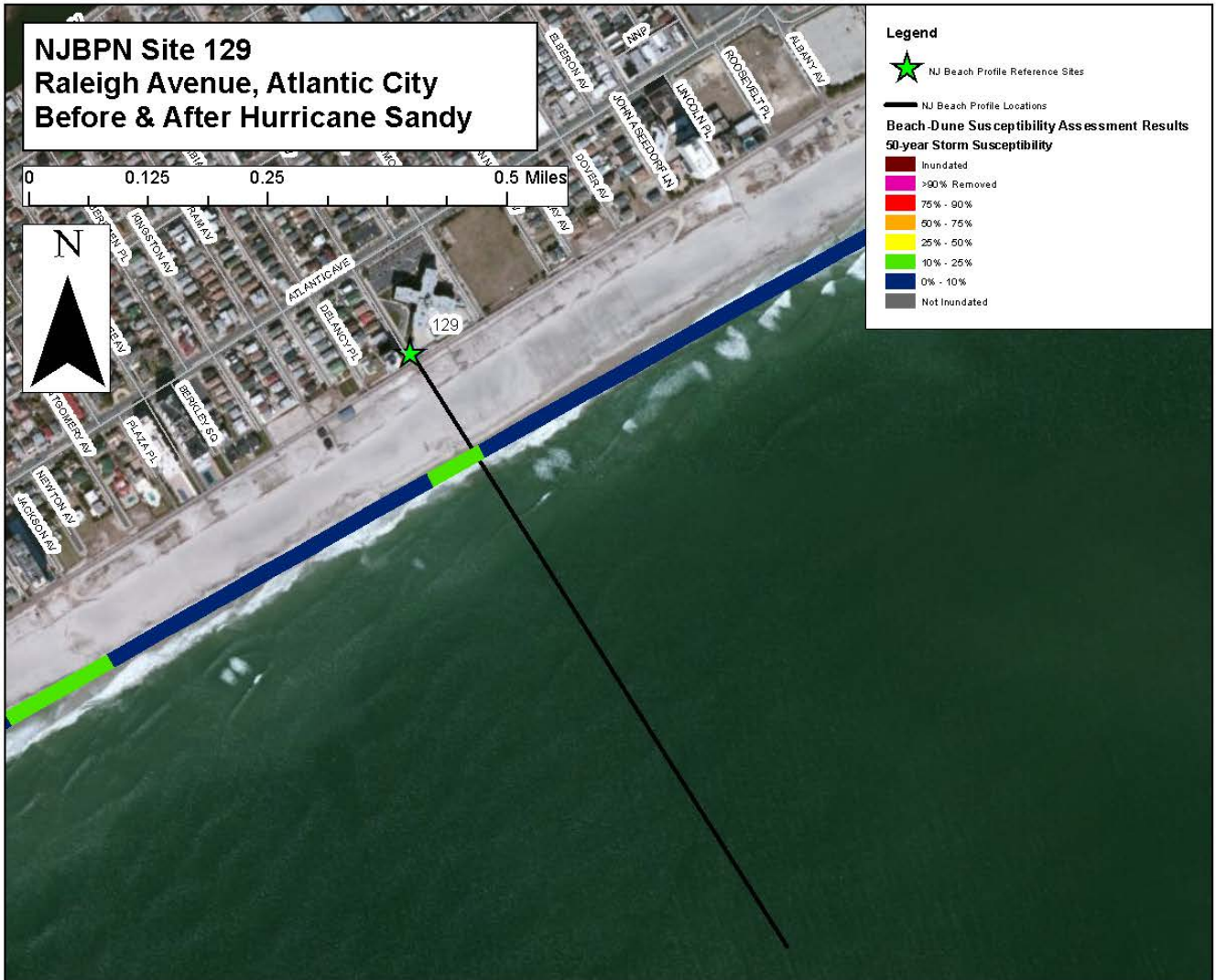
**Legend**

NJ Beach Profile Reference Sites

NJ Beach Profile Locations

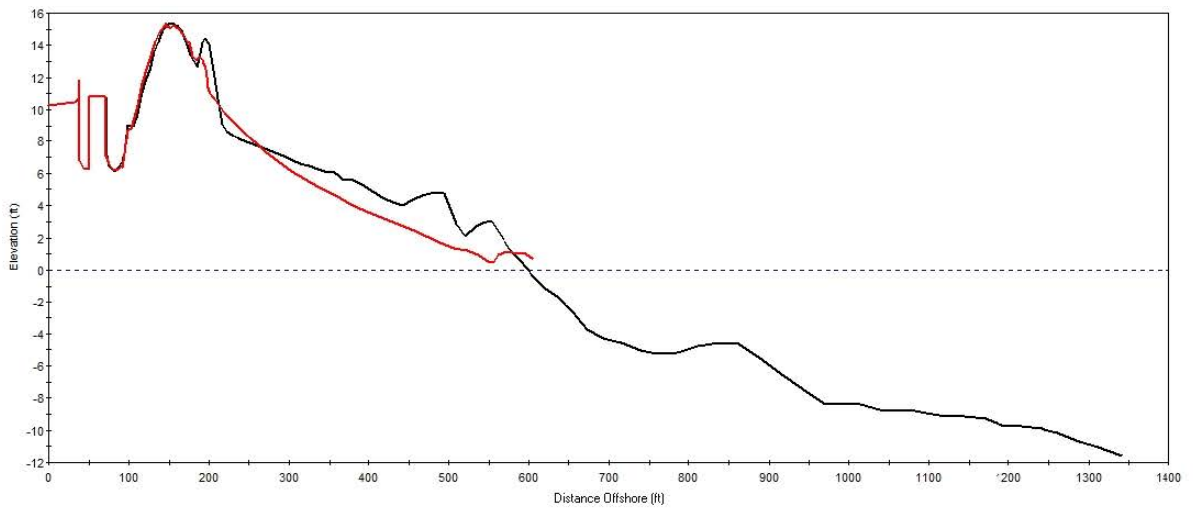
**Beach-Dune Sus ceptibility Assessment Results**  
**50-year Storm Sus ceptibility**

- Inundated
- >90% Removed
- 75% - 90%
- 50% - 75%
- 25% - 50%
- 10% - 25%
- 0% - 10%
- Not Inundated



**Pre vs. Post Sandy**  
**Site 129**  
**Raleigh Ave., Atlantic City**

Volume Change = -15.355 cu.yd/ft



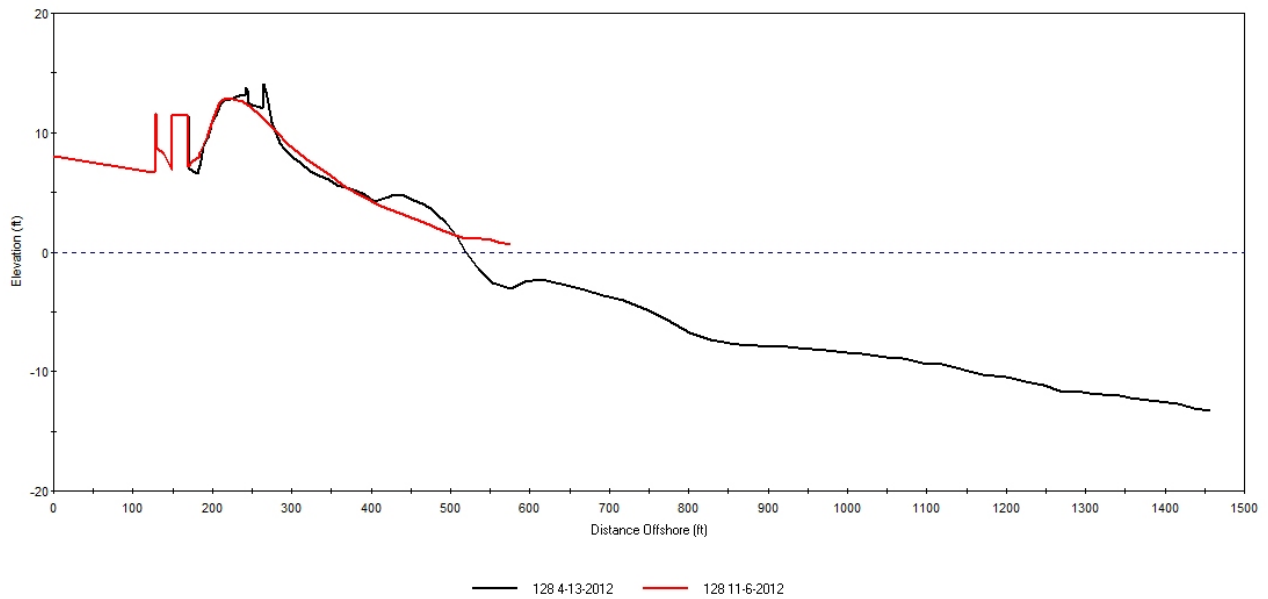
— 129 4-13-2012 — 129 11-6-2012

**NJBPN 128 – Dorset Avenue, Ventnor City**



The photographs above were taken on April 13, 2012 (left) and November 6, 2012 (right). Dorset Avenue in Ventnor City also is located in the middle of the Federal project with excellent retention of the sand placed in 2004.

**Pre vs. Post Sandy  
Site 128  
Dorset Ave., Ventnor**

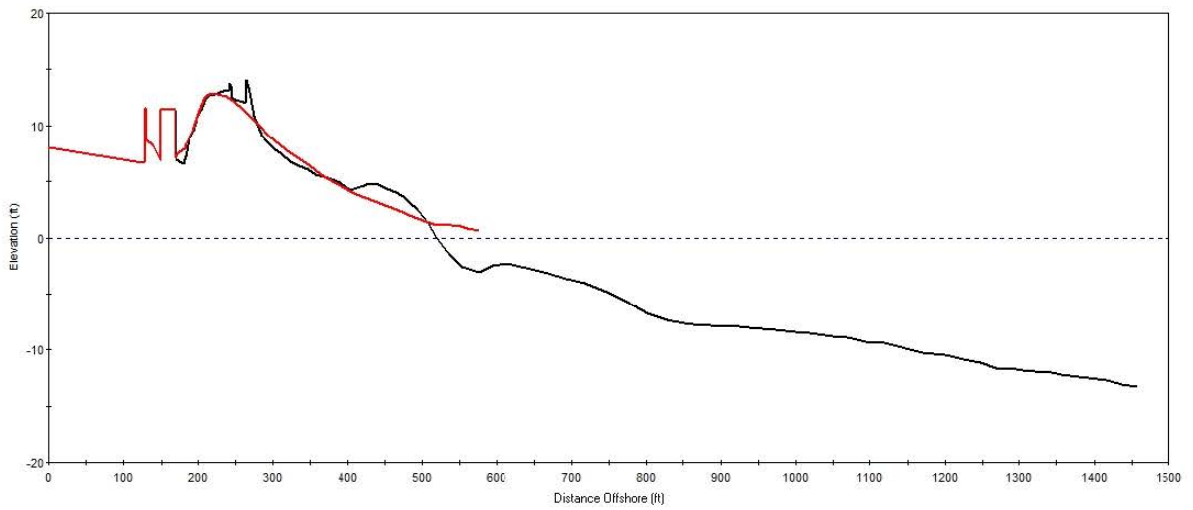


**Figure 9. The 2004 Federal beach nourishment project created a wide berm and dune which has remained relatively stable since that time. Minor amounts of sand were relocated seaward of the berm during Hurricane Sandy.**



Pre vs. Post Sandy  
Site 128  
Dorset Ave., Ventnor

Volume Change = 2.947 cu.yd/ft



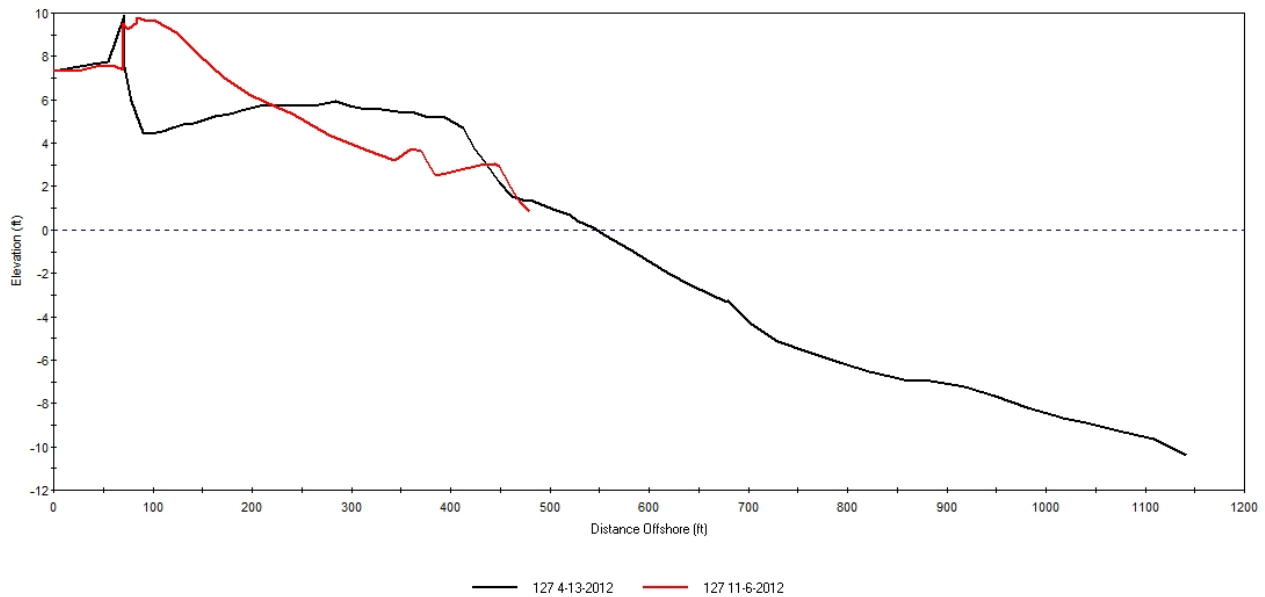
— 128-4-13-2012 — 128-11-6-2012

## NJBPN 127 – Benson Avenue, Margate City



The photographs above were taken on April 13, 2012 (left) and November 6, 2012 (right). The relatively robust berm was cut down and pushed landward as a substantial deposit that included Benson Avenue and environs. The work was underway to excavate the sand at the sea-side of the bulkhead to keep water from simply running over it.

Pre vs. Post Sandy  
Site 127  
Benson Ave., Margate

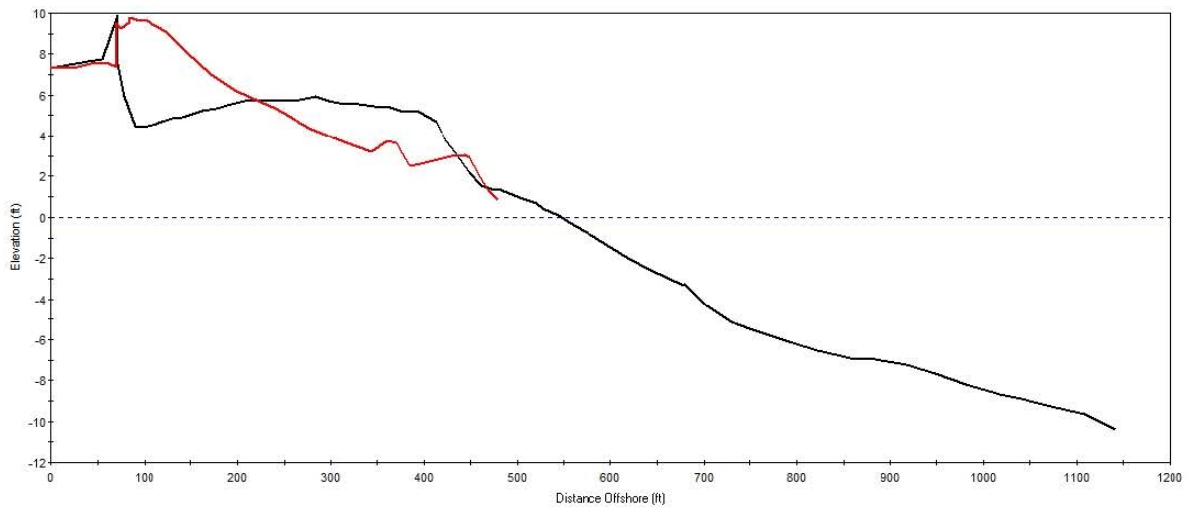


**Figure 10.** This beach has benefited from the nourishment projects that were constructed to the north. No dunes exist, but there is a wide berm that has remained relatively stable. Following Hurricane Sandy, sand was transported to the bulkhead filling the swale immediately seaward and continuing landward to Ocean Avenue. The ridge at the bulkhead was sand from the streets deposited back on the beach to be spread back toward the ocean.



Pre vs. Post Sandy  
Site 127  
Benson Ave., Margate

Volume Change = 2.647 cu.yd/ft



— 127 4-13-2012    — 127 11-6-2012

## NJBPN 126 – 17<sup>th</sup> Street, Longport



The photographs above were taken on April 11, 2012 (left) and November 6, 2012 (right). The narrow beach allowed wave energy to explode on the seawall. The water bounced over it and crashed into the homes built at the base of the wall. Street end flooding, sand deposition to Atlantic Avenue and structural damage was spread along the shoreline.

Pre vs. Post Sandy  
Site 126  
17th St, Longport

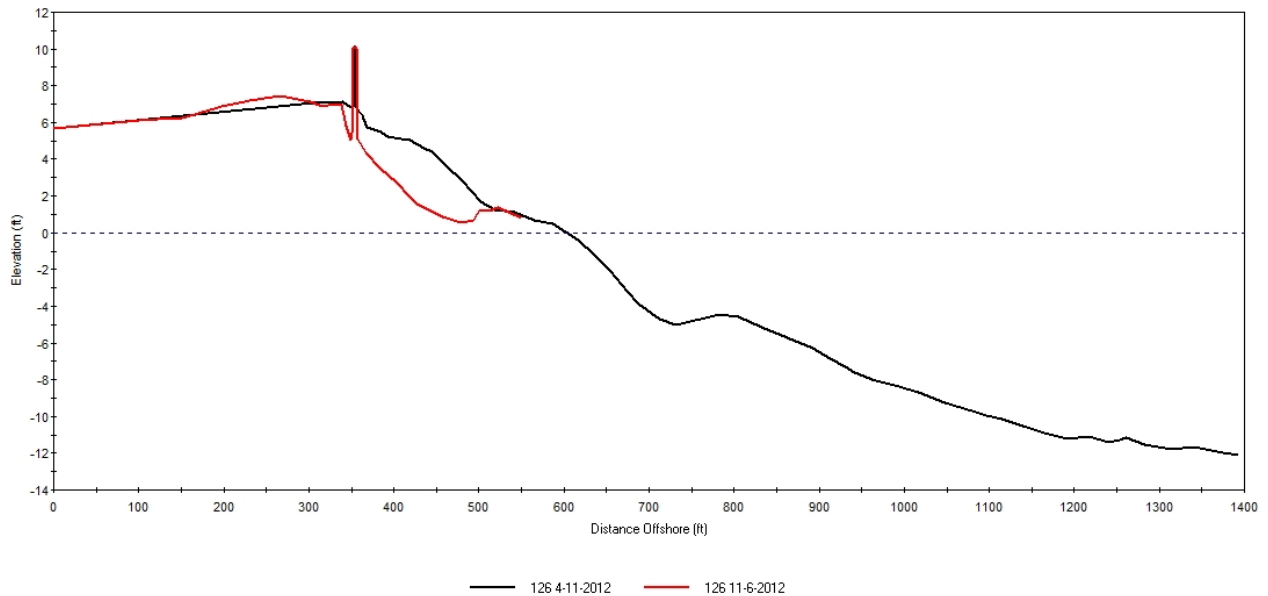


Figure 11. The concrete seawall stands in place of a dune system along this section of Longport. Hurricane Sandy's waves relocated the berm sand landward of the seawall and steepened the berm slope. Trucks were unloading material in piles over the wall back to the beach on November 6<sup>th</sup>.



**NJBPN Site 126**  
**17th Street, Longport**  
**Before & After Hurricane Sandy**

0 0.125 0.25 0.5 Miles



**Legend**

- NJ Beach Profile Reference Sites
- NJ Beach Profile Locations

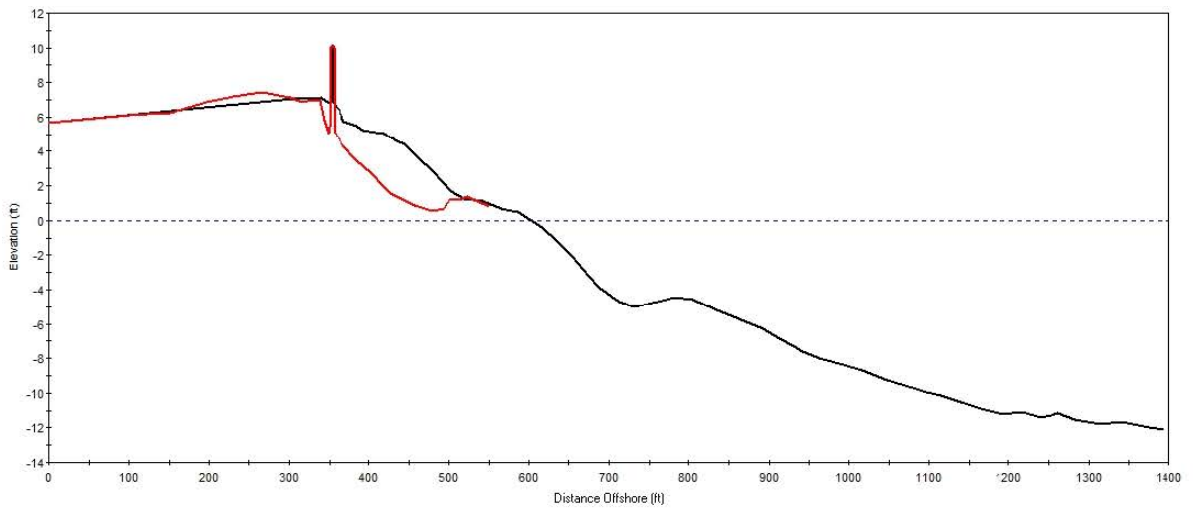
**Beach-Dune Sus ceptibility Assessment Results**  
**50-year Storm Sus ceptibility**

- Inundated
- >90% Removed
- 75% - 90%
- 50% - 75%
- 25% - 50%
- 10% - 25%
- 0% - 10%
- Not Inundated



**Pre vs. Post Sandy**  
**Site 126**  
**17th St., Longport**

Volume Change = -12.169 cu.yd/ft



### Summary & Conclusions

<i>Atlantic County Post Sandy Volume Changes</i>				
Site	Volume Change (cu yds/ft)	Dates for Comparison	Dune Failure	Recent Beach Fill
134	-39.77	Oct 26, 2012 to Nov 11, 2012	Y	Never
133	-17.72	Oct 26, 2012 to Nov 3, 2012	N	2006 & 2011
132	-0.40	Oct 26, 2012 to Nov 3, 2012	No Dune	Never
131	-23.93	Oct 26, 2012 to Nov 3, 2012	N	Never
230	-30.27	Sep 18, 2012 to Nov 6, 2012	N	2011
130	-25.13	June 4, 2012 to Nov 6, 2012	N	2011
129	-15.36	Apr 13, 2012 to Nov 6, 2012	N	2004
128	-1.18	Apr 13, 2012 to Nov 6, 2012	N	2004
127	2.65	Apr 13, 2012 to Nov 6, 2012	No Dune	Never
126	-12.17	Apr 11, 2012 to Nov 6, 2012	No Dune	1990

Figure 12 shows a table of values for the 10 shoreline profile site locations in Atlantic County. The sand volume lost per foot of shoreline represents loss from the dune and the beach and does not include changes in the offshore region. These surveys were completed as rapidly as possible so no swimmers were brought to these sites. Dunes were damaged at some points, but performed in an excellent manner at sites numbered 131, 230, 130, 129 and 128.

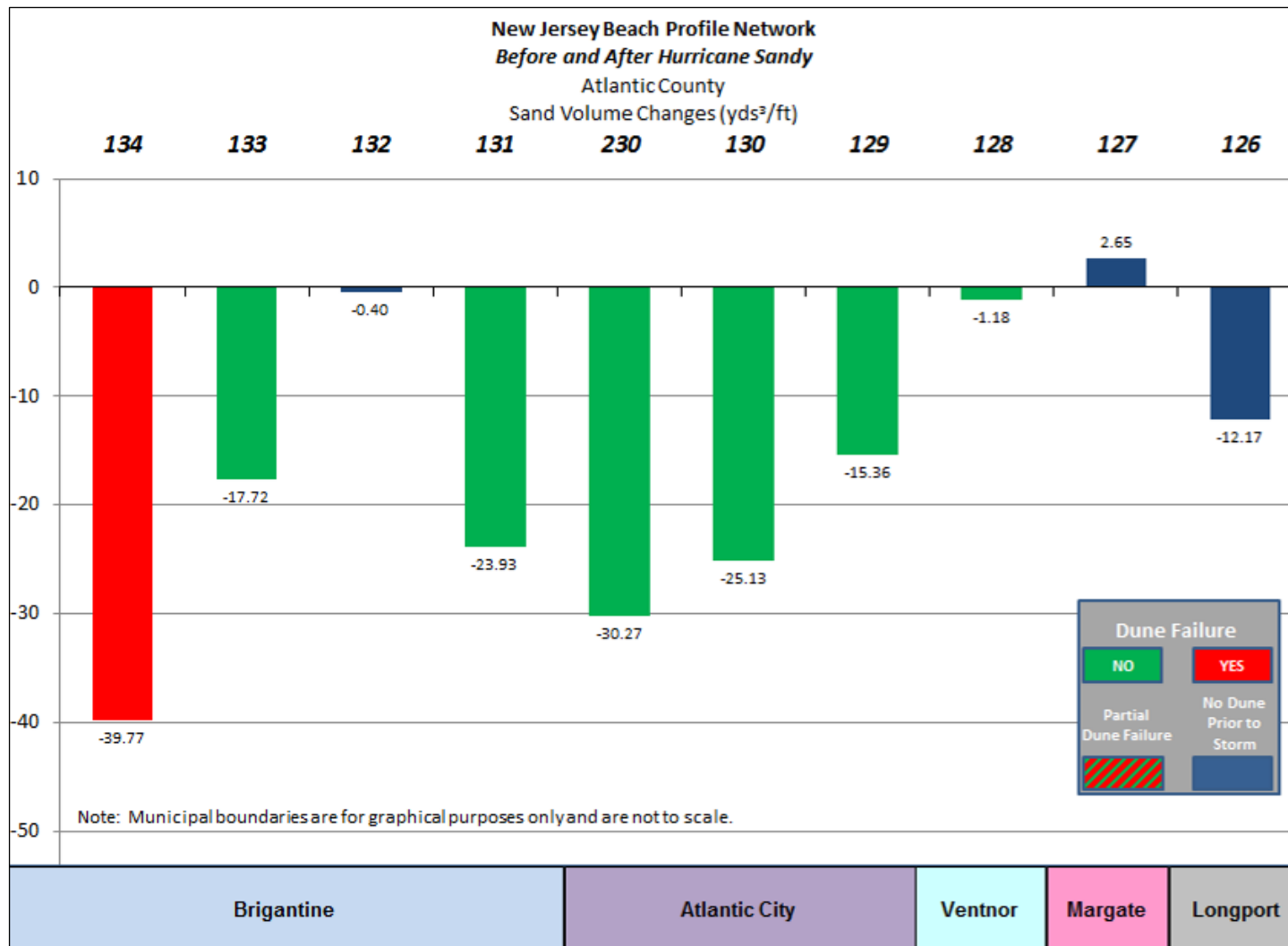


Figure 13. This graphic shows the sand volume loss figures for each of the communities within the developed sections of the Atlantic County shoreline. Federal shore protection projects have occurred along this portion of the New Jersey shoreline in Brigantine (northern portion), Atlantic City, and Ventnor. In Brigantine, prior to the storm the engineered beach had been eroded away. Atlantic City and Ventnor’s engineered beach and dune systems have been maintained by the USACE recently and withheld the storm generated waves from breaching the dunes. All sites experienced berm erosion and dune losses except for site 127 in Margate, where sand had accumulated in front of the bulkhead adjacent to the street end (No dune at this location). The only true dune failure occurred in the national area on the north end of Brigantine (site 134), however sites 132 (Brigantine), 127 (Margate) and 126 (Longport) did not have dune systems in place prior to the storm and all experienced overwash of waves with sand being transported landward of the beach.

*Atlantic County Post Sandy Volume Changes*

MUNICIPALITY	NJBPN Site#	Shoreline Change in the Zero Elev. Position Since Sandy	Vol Change cu yds per ft	Average of Sand Loss Between Adjacent Sites (cy/ft)	Dune Failure	Recent Beach Fill	Distance Between Sites (FEET)	Vol Change - Cubic Yards Between Profiles (North to South)	Cumulative Volume Change - Cubic Yards (North to South)
North Brigantine Natural Area	134	-25	-39.77	-39.77	Y	Never	2,000	-79,540	-79,540
4th St. No. Brigantine	133	-18	-17.72	-28.75	N	2006 & 2011	7,554	-217,128	-296,668
15th St. So. Brigantine	132	0	-0.40	-9.06	No Dune	Never	4,762	-43,145	-339,813
43rd St. So. Brigantine	131	-10	-23.93	-12.17	N	Never	7,042	-85,661	-425,474
Rhode Is. Ave. Atlantic City	230	-65	-30.27	-30.27	N	2011	850	-25,730	-451,203
No. Carolina Ave. Atlantic City	130	47	-25.13	-27.70	N	2011	3,265	-90,454	-541,657
Raleigh Ave. Atlantic City	129	58	-15.36	-20.25	N	2004	11,384	-230,468	-772,125
Dorset Ave. Ventnor	128	73	-1.18	-8.27	N	2004	5,419	-44,816	-816,941
Benson Ave. Margate	127	-92	2.65	0.74	No Dune	Never	11,753	8,639	-808,302
17th St. Longport	126	-31	-12.17	-4.76	No Dune	1990	7,737	-36,830	-845,132
<b>Total Volume Loss for Atlantic County =</b>									<b>-845,132</b>

Figure 14. This table provides a summary of all the individual site sand volume losses from the dune and beach to the limit of the post-Sandy survey. The total is derived by adding two adjacent site losses and dividing by two, then multiplying by the distance in feet between the two sites. This is known in the dredging industry as “closed-end averaging” to obtain dredged volume along a channel. It is acknowledged that sand resources reside seaward of the short post-storm surveys, but the need for speed dictated that taking additional time to survey to 15-16 feet of water offshore would not add significantly to the losses seen within the beach/dune system. These longer surveys will be completed in due course however. A percentage of the sand carried offshore by Sandy will move back toward the beach over time in the absence of future storms. All sand lost from the dunes will require human intervention to replace, groom and re-vegetate in order to have the protection in place quickly. A natural dune system developing from scratch would require 15 to 20 years to re-establish close to what was lost.