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THE RICHARD STOCKTON COLLEGE OF NEW JERSEY

Related to FEMA DR-NJ 4086 Declared for Hurricane Sandy

Beach-Dune Performance Assessment of

New Jersey Beach Profile Network (NJBPN) Sites

Between Deal and Sea Bright, New Jersey

Related to FEMA DR-NJ 4086 Declared for Hurricane Sandy

December 12, 2012

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. The analysis for the northern 15 survey sites starting at Roosevelt Avenue in Deal moving north to Via Ripa Street in the Borough of Sea Bright, NJ. The three Sandy Hook National Seashore sites were not included because the beaches were closed due to finding old military ordinance items on the beach following Sandy. Survey work along the three Raritan Bay survey sites remains to be completed, but will all be included in the final report on Raritan and Delaware Bay sites plus all the oceanfront natural areas such as Sandy Hook, Island Beach State Park, and other Cape May County sites. The field work was completed November 26, 2012 as clean-up work continued to remove debris. Any sand excavated from roadways was being returned to the beach and is included in the survey cross section since it is now part of the post-Sandy beach. This initial report is focused on the impact to municipal dunes and beaches from Hurricane Sandy. The damage details have been organized specific to each municipal segment of the county shoreline starting at Roosevelt Avenue in Deal and ending at the northern profile site in Sea Bright, NJ before entering Sandy Hook National Seashore. The coastal segment between Long Branch to Sandy Hook was the shoreline where the New York District Army Corps of Engineers conducted its Phase I Shore Protection Project between 1994-1996 (initial contract for Monmouth Beach to Sea Bright) and 1997-1999 (for Monmouth Beach to Long Branch). There have been several maintenance contracts conducted in this reach to address erosional "hotspots" (1997, 1999, 2002, 2010 and currently in Monmouth Beach December 2012). The 2011 Coastal Center 25-year report evaluated the sand quantity remaining within this reach at the 12 sites within the project extent at between 14% and 116% of the initial placement volume. The phase I reach between Sandy Hook National Seashore and the Elberon/Long Branch border did have several maintenance fills (1997, 1999, 2002, 2009, a minor addition in 2010 and the current project underway in late 2012). However, there are two significant points of erosion that have hampered the overall project success. There is a large rock groin at the Cottage Road site (#179) that blocks sand movement along the beach. Since sand moves north, this site is perpetually starved for sand moving into the area from the south. The second location is #173 at West End in Long Branch where the project ends moving south. Elberon and Deal did not participate in the initial project, so sand leaves West End moving north leaving

erosion the only avenue open. No sand arrives from the south. The best evidence for this was the limited success for the 2009 maintenance project focused on the West End site that declined by over 50% between 2009 and 2011. The Morris Avenue location 5,000 feet north benefited within 6 months however.

Another issue with the Long Branch to Sea Bright segment of the Army project was the failure to include a significant dune system in the original plan. The presence of the 28-foot high Sea Bright seawall and a 20+foot high natural bluff in Long Branch armored with rock and steel allowed the dune to become more or less an after thought to the project's effectiveness. Initially, two lines of sand fence were erected in Sea Bright with grass planted between them. No initial ridge of sand was designed or built, so the dune system evolved naturally as grass spread and the wind transported material toward the fencing. As a result after 12 years, the dune was irregular, varied greatly in width and elevation and was positioned a considerable distance from the rock wall. There was no dune system in Long Branch due to a very high tourism usage. Grass plants did colonize at the toe of the rock revetment, but no consequential dunes developed.

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. The Pullman Avenue site saw two homes with foundation elevations at +28 feet destroyed and a third of the lot transformed into empty space where the land once stood. The Lake Tackanassee site was obliterated and the entire Long Branch boardwalk on the top of the bluff was destroyed.

These huge breakers essentially bulldozed the berm, beach and irregular dune system to the base of the massive Sea Bright seawall, and then ramped up that slope, over the wall and slammed down onto the space between the highway and the wall. The gaps in the seawall were exploited in a devastating manner in the Borough of Sea Bright especially in the town center where the municipal public beach is located in a gap in the rock seawall. Sandy just blasted through this gap with awful consequences.

Beach/Dune Damage Assessment by Municipal Island Segment:

To measure the erosion, pre-existing New Jersey Beach Profile Network (NJBPN) monitoring sites were used to provide an accurate comparison and assessment of storm related shoreline and beach volume changes. Using the data from those sites surveyed for fall 2012 NJBPN survey, completed in Monmouth County by October 12, 2012, provides a good baseline for damages that occurred during the hurricane. For those sites not yet surveyed, data from spring 2012 was used for comparison. Data collected at the 15 oceanfront beach profile locations was done November 12-26, 2012 using RTK GPS and extending from the reference location, across the dunes, beach and into the surf to wader depth and by traditional survey methods (swimmers going to -16 feet of water) at those sites not yet surveyed during NJBPN fall 2012 survey. By the 12th, it was clear that sand recovery was well under way as a berm had been deposited on the erosional surface generated by Sandy with a substantial offshore bar present in water less than 5 feet deep offshore. However, in some locations massive amounts of sand had been transported inland and were being returned to the beach. Very little sand was transported over the bluff or steel wall in Long Branch, but wave damage was evident from moving water. Substantial sand volumes were moved over the Sea Bright seawall and through the gaps in the rock wall. This was being hauled back to the beach.

Profile Locations: Site locations in Deal, Elberon, Monmouth Beach and Sea Bright were not surveyed during fall 2012 prior to the arrival of Sandy, the Long Branch sites were surveyed on October 5 & 8, 2012 and all sites again post-Sandy through November 26, 2012 (Figure 1). This report covers the New York District Corps of Engineers Monmouth County Shore Protection project's initial Phase I where sand was placed from the border with the National Sea Shore, south through Sea Bright, Monmouth Beach, and Long Branch, NJ late in the 20th Century into the first two years of the 21st

Century. Maintenance work was done on Phase I beaches in places, but none has been performed on the southern segment (Phase II) between Asbury Park and Manasquan Inlet. Based on the performance of the fill project, clearly the dune system’s design needs to be evaluated and a new approach implemented along this pair of Monmouth County reaches as the post-storm data is processed and analyzed.

*Below is a map showing the location of each profile.

NJBPN 170	Roosevelt Ave.	Deal	NJBPN 177	404 Ocean Ave.	Long Branch
NJBPN 171	Pullman Ave.	Elberon	NJBPN 178	Beach Club	Monmouth Beach
NJBPN 272	805 Ocean Ave.	Long Branch	NJBPN 179	Cottage Ave.	Monmouth Beach
NJBPN 173	West End Ave.	Long Branch	NJBPN 180	Sunset Court	Sea Bright
NJBPN 174	Morris Ave.	Long Branch	NJBPN 181	Municipal Beach	Sea Bright
NJBPN 175	N.Broadway Ave.	Long Branch	NJBPN 182	Public Beach	Sea Bright
NJBPN 176	7-Presidents Park	Long Branch	NJBPN 282	Shrewsbury Way	Sea Bright
			NJBPN 183	Via Ripa St.	Sea Bright

**New Jersey Beach Profile Network Locations,
Northern Monmouth County**

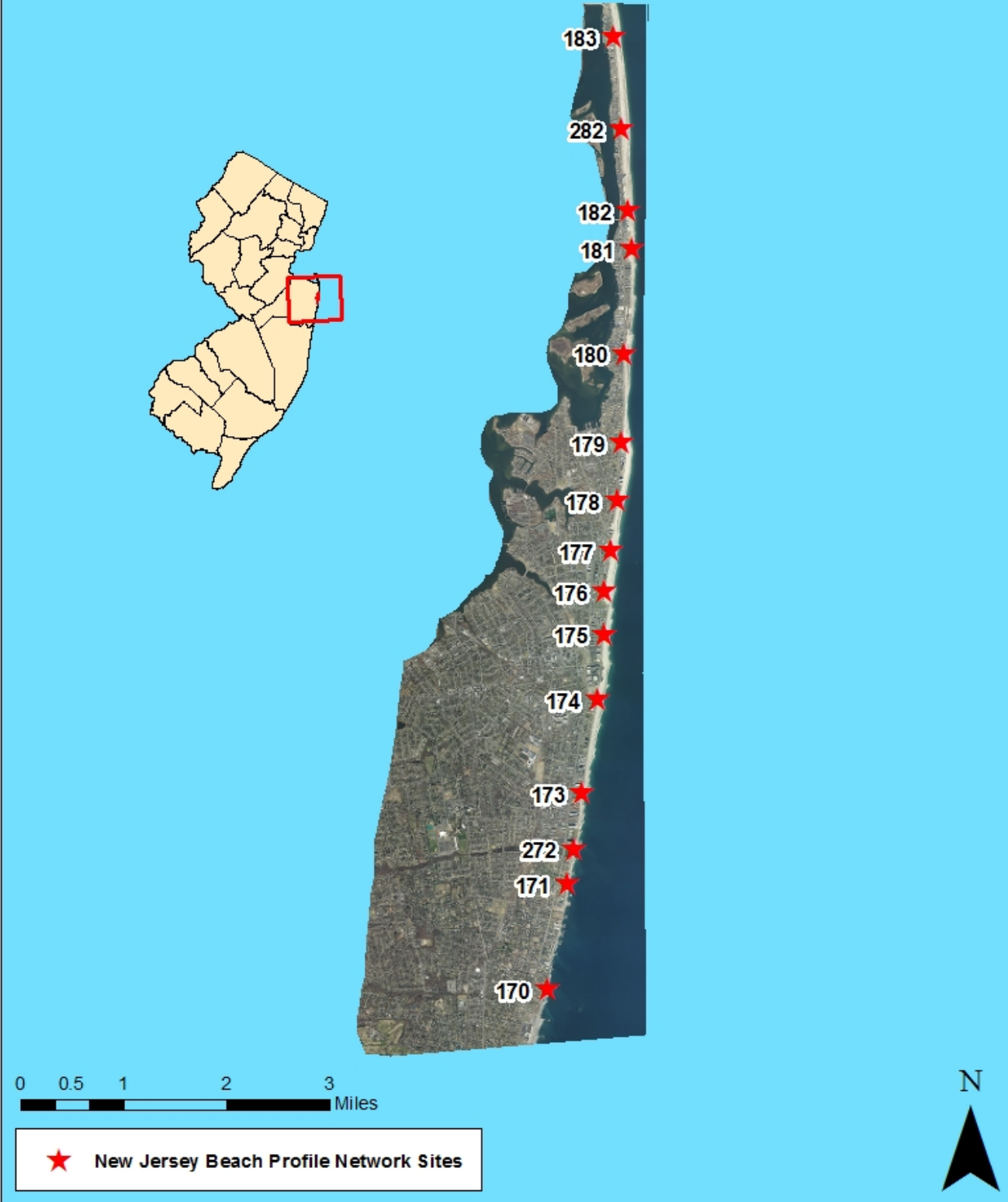


Figure 1. NJBPN Profile Locations, between Roosevelt Avenue, Deal and Sandy Hook National Seashore, Monmouth County, New Jersey

Roosevelt Avenue, Deal;

The Roosevelt Avenue site is located north of the Deal sewage pumping station built in 1906 at the base of the sedimentary bluff. It is essentially a three-story building with just the top story presented at the end of Roosevelt Avenue. South of this street is a series of private homes built on the bluff with a decent sand beach seaward of the dune-mantled bluff edge. Phillips Avenue is the location of a public bathing complex that was totally destroyed by the loss of the Phillips Avenue fishing pier built decades ago over the rock groin at the end of Phillips Avenue. North of Roosevelt Avenue there is essentially no dry beach between closely-spaced groins. Site #170 has a 26-year history of a wet beach against the rocks. Occasional offshore bars have migrated to the shoreline yielding a temporary dry beach less than 25 feet in width. Sandy's waves over-topped the rock wall and scoured deeply into the soil, fill debris (bricks etc.) and bluff sediments. Water poured landward flooding both Roosevelt and Ocean Avenues to 3-foot depths as seen in debris lines on nearby properties. The tile roof was torn off the seaward side of the sewer plant pumping station and all three floors of the facility were filled with seawater. Deal's \$650,000 investment in rehabilitation of the facility last year was in ruins.

Pullman Avenue, Elberon;

The single cross section located in Elberon at Pullman Avenue demonstrated the susceptibility of even the high bluff located here (28 feet NAVD88) to major erosion from the storm surge and waves generated by Hurricane Sandy. Homes built at the bluff edge were destroyed by waves with about a third of each lot's width inland gone. The rock revetment and timber wall account for about 40% of the bluff height and were unaffected. Apparently waves broke on the revetment with crests at least 35 feet high because both homes were smashed in on the seaward side. This was not from wave spray on impact with the fortifications. The end of Pullman Avenue was eroded landward by about 50 feet.

Lake Tackanasee, Long Branch;

This new cross section designed to replace original site #172 abandoned years ago was positioned just south of a series of major condominium complexes between West End Avenue and the Lake. This is the northernmost "estuary lake" along the Monmouth County shoreline and, like the others has a fresh water drainage system buried under a bay-mouth barrier. There is no bluff here, so the storm waves simply rolled over everything in their path to the lake where Ocean Avenue crosses it on a bridge structure. An historic life-saving station converted to a bathing complex was utterly destroyed. All traces of the beach survey established two years ago were gone, so the site was navigated to using the GPS coordinates for the reference monuments. The profile ran up-grade to a point where the slope reversed down-grade seaward into the water. An offshore bar was present as well. Multiple individuals with metal detectors were busy finding coins long buried by sand now washed landward toward the lake. The abundance of metal artifacts was such that this author picked up two 25¢ coins on the beach surface while doing the post-storm survey. The sand loss was extensive and the structural damage was total.

West End Avenue, Long Branch;

Located near the southern end of Phase I within the NY District Corps of Engineers Monmouth County beach restoration project, this site has a rock revetment protecting the base of the bluff, with the boardwalk positioned at the edge of the bluff some 15 feet above the revetment. The former Ocean Avenue was a four-lane highway with a grass median and a grass strip between the roads and the bluff edge before the boardwalk that was located on the beach perched on concrete supports. During the 1950's hurricanes and northeasters carved away at the bluff, destroyed the old boardwalk and reduced Ocean Avenue to the southbound two lane roadway with a tiny grass plot seaward of it. Long Branch abandoned the old Ocean Avenue in the 1970's; locating a modern highway a block inland and parallel with Ocean Avenue extending south into Elberon. The rock revetment was built and the boardwalk was placed on the narrow

remnant of grass east of the southbound roadway. In 1999 the initial beach replenishment was completed giving this location a 250-foot wide beach, but no dune was included. Sandy rolled over the beach and struck the revetment with massive force tearing out the bluff under and the boardwalk over the grass strip. The erosion extended to the concrete curbing bordering the old roadway. Water damage existed on properties landward of the roadway as evidenced by debris and sand deposits. The City was in the process of hauling sand to Morris Avenue where it was being sieved to remove debris and returned to the beach. The beach was reduced in elevation, width and ramped up against the revetment somewhat. There was a significant offshore bar moving landward that almost reached the low tide position and was included in the wading survey.

Broadway Avenue, Long Branch;

Here the Corps project beach was at 79% of the as-built sand volume in the fall of 2011. Sandy's waves rolled across this beach as well and impacted the steel wall protecting the bluff. Water crashed down on the paved promenade without incident and cascaded into the new development causing minor flooding and damage. The high-grade railing along the edge of the promenade was bent landward and would need replacing along much of the distance. The beach was lower and narrower, but still in place with a sizable offshore bar just offshore.

Seven Presidents Park, Long Branch;

This site was converted into open parkland space 20 years ago with the purchase of all commercial and private buildings near the waterfront. The area has 25 foot dunes with several prominent gaps to allow public easy access to the beach. The Federal project was completed here in 1999 and 74% of the initial sand placed was still present in October 2011. The cross section is located at the southern gap in the dunes, so storm damage in the form of abundant sand washed landward into the parking lot was evident. Park employees were busy scraping up the sand and returning it to the beach to clean up. The park public use buildings were inundated, but built to take impacts, so remained standing, if wet. The remarkable event was the discovery that wave run-up on the immediately adjacent dunes went to their crest. The GPS elevation of the dune crest was 24.6 feet NAVD88, so Sandy's waves registered over 10 vertical feet more run-up elevation than measured in Avalon or Atlantic City south of the hurricane eye. This is strong evidence of the massive difference in storm damage seen in Ocean, Monmouth Counties in NJ (plus NY) as compared to Cape May and Atlantic Counties south of the landfall point for the center of storm rotation.

177 Ocean Avenue Long Branch;

This site was once a USO non-commissioned officer's beach recreation area for Fort Monmouth personnel. Presently part of the Seven-Presidents Park system belonging to Monmouth County, this site was part of the Federal Project and retained 72% of the initial fill sand volume. However, Sandy rolled across the beach to Ocean Avenue and transported abundant sand into the roadway. Clearing was nearly complete so traffic was moving slowly by, but more work needed to be completed. Nearby businesses were flooded by the combination of storm surge and wave overwash.

Monmouth Beach Club & Cottage Road, Monmouth Beach;

Monmouth Beach has two survey sites, one at the Beach Club along Ocean Avenue between Vista Court and Valentine Street and the second located at Cottage Avenue near an offset in the seawall and extended groin that protects the Private Beach Club located along Ocean Avenue between Beach Road and Cottage Avenue.

The Valentine Street site is located on the premises of the venerable Monmouth Beach Club with the survey starting point in the landward segment of the timber deck overlooking the seawall. On the day of the post-Sandy visit, three excavators were picking apart the ruins of the entire facility and transferring the debris into huge dumpster vehicles for

transport to the staging area. The beach was much lower and narrower because only 53% of the initial sand volume was still present from the Federal project. In addition, no dune had been designed into the project, but irregular sand dunes had appeared over time by natural growth processes. These dunes failed to stop the wave attack.

The Cottage Road location has been the poster for “Hot Spot” erosion in an otherwise very successful Federal beach restoration project. Here a massive stone groin was privately built decades ago to restrict sand movement north from the beach fronting an equally venerable coastal recreational edifice from the 19th Century. The groin obviously serves its intended purpose, but to the detriment of the Federal beach project’s durability just north of the groin. The Cottage Road site commenced losing sand as soon as it was completed. Losses were replaced in 1997, 1999, 2001, and modest sand volume was added in 2010 from Shrewsbury River dredging. Currently a contractor has the site closed to anyone not involved in the construction project as a 2012 restoration starting here and moving northward is underway. There is only a narrow, dry beach that gets wet to the rocks under normal wave action at high tide. Sandy barreled over the seawall, dumping many thousands of tons of seawater into the highway making storm surge flooding worse. The beach is in the process of being replaced by sand dredged from the approved borrow sites as this is being written.

Sunset Court, Sea Bright;

The next location north of Cottage Road maintained 45% of the initial sand volume placed in 1999. The repeated deposition of maintenance material at Cottage Road moved north through this location. There was no dune, other than grass here and there among the rocks of the seawall. Storm waves over-topped the wall in quantity and caused flooding and debris damage that kept the highway closed for weeks to general traffic. A lower, narrower beach remains, but the restoration process is underway just to the south.

Sea Bright Municipal Beach;

The peninsula widens here to include commercial businesses on both sides of Ocean Avenue plus parking for the beach. However, no rock seawall extended across a several hundred foot gap at the municipal beach. An ancient timber bulkhead was the back shot position for the survey and it had gaps cut in it to allow easy public access to the beach. The resulting storm wave damage and tidal flooding was intense and destruction was wide spread and devastating. The situation was made worse because both the fire company and the police station were located between the municipal beach and Ocean Avenue. Both were gutted by waves. Debris impacted businesses on the west side of Ocean Avenue while the storm surge flooding into Raritan Bay flowed up the Shrewsbury and Navesink River Estuaries compounding the disaster. While the beach is still present, it is narrower and lower in elevation with a massive amount of sand moved landward into Sea Bright Borough.

Sea Bright Public Beach, Sea Bright;

The next location north was obtained by NJ State purchase 25 years ago and converted into a public bathing area with some off-street parking. There was a modest dune at the toe of the rocks, but the waves ramped up and over the rocks using that sand as a deposit forming the ramp. In addition there was a timber bulkhead protecting a 20-foot wide gap in the rock seawall at this location. Sandy blew through the timber section and poured into Ocean Avenue with sand, debris and lots of salt water. This compounded the water coming in from Raritan Bay making flooding the worst ever recorded. This beach contained 98% if the initial Federal project’s fill material as of fall 2011. No dune existed other than grass growing at the toe of the rock seawall. The post-Sandy survey showed a narrower and lower elevation beach with an as yet unknown ratio of sand lost offshore versus sand transported through the gap or over the seawall.

Shrewsbury Way, Sea Bright;

This site was the only northern Monmouth County site along Phase I Federal project that had exceeded the initial sand volume placed on the beach (116%). Even so, the storm waves broke over the Sea Bright seawall as they ramped up the sand against the rocks allowing wave run-up to crest the 28-foot wall. The beach profile was reduced in elevation and width.

Via Ripa, Sea Bright;

This northern location lies just south of the bridge to Atlantic Highlands across the entrance into the Shrewsbury and Navesink Estuaries. The beach was at 74% of the initial Federal project placement sand volume and waves ran up and over the wall, but in a lower magnitude based on the sand found landward of the wall. Also, there was a much smaller ramp leading to the top of the wall on the sea side. Located closer to the fetch limit produced by Long Island, perhaps the waves were simply smaller.

Individual Site Descriptions:

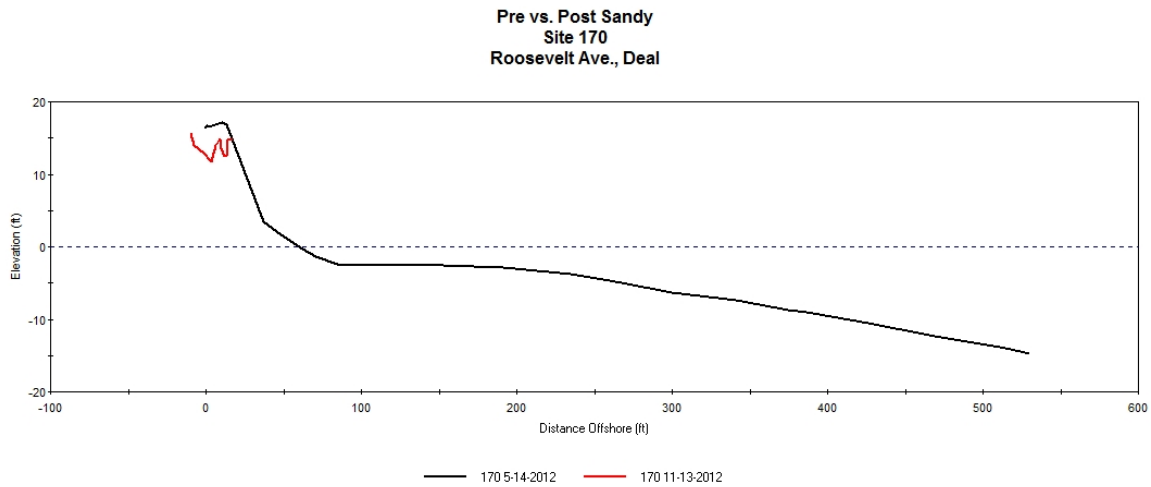
Each location was surveyed following Hurricane Sandy between November 12 and 26, 2012. The profile lines were surveyed using RTK-GPS with data points on the dune, beach and shallow offshore regions or using a total station electronic transit at sites where the fall 2012 surveys were not completed prior to Sandy (Sites #177 to 183). Because not all sites were surveyed to closure depth following Sandy, all sand loss figures apply to the dune/beach system only and do not account for a percentage of sand dragged offshore by Sandy's waves, to return later in time. This recovery process was clearly already underway at all locations as of November 12th.

NJBPN 170 – Roosevelt Avenue, Deal



The photographs above were taken on May 13, 2012 (left) and November 13, 2012 (right).

Figure 2. This profile is located between two rock groins that limit sediment movement. This area has never received sand during beach nourishment and has never benefited from the addition of sand from the littoral system derived from the Federal beach fills. Here the bluff is 20 feet higher than the beach, armored with rocks, yet waves crashed over the rocks and dug deeply into the area just landward of the rock revetment. Water poured across the private property and flooded Ocean Avenue at least 3 feet deep. The seaside private patio was destroyed as was the Deal sewage pumping station at the seaward end of Roosevelt Avenue.

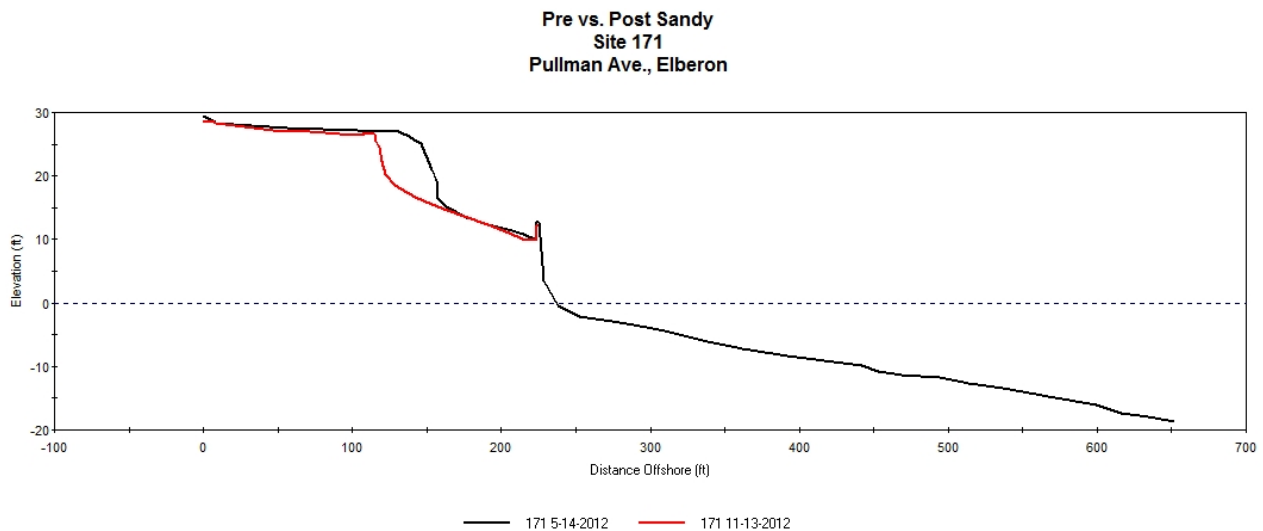


NJBPN 171 – Pullman Avenue, Elberon



The photographs above were taken on May 13, 2012 (left) and November 13, 2012 (right).

Figure 3. This site is located on the highest point along the bluff shoreline and in the past, has had very little sub-aerial beach as this community was not included in the Federal beach nourishment projects. Prior to Hurricane Sandy, the private properties were separated from the shoreline by a bulkhead and rock revetment which rises 12 feet in elevation and was un-damaged. However, waves apparently broke over the rock revetment, attacked upper un-armored bluff sediments and pushed the edge back 40 feet. The waves reached both homes either side of the street destroying both and removing a third of the building lot in the process. A small wedge of sand was observed in the corner created between the revetment and the south groin in this cell. The beach in front of the profile was virtually unchanged.

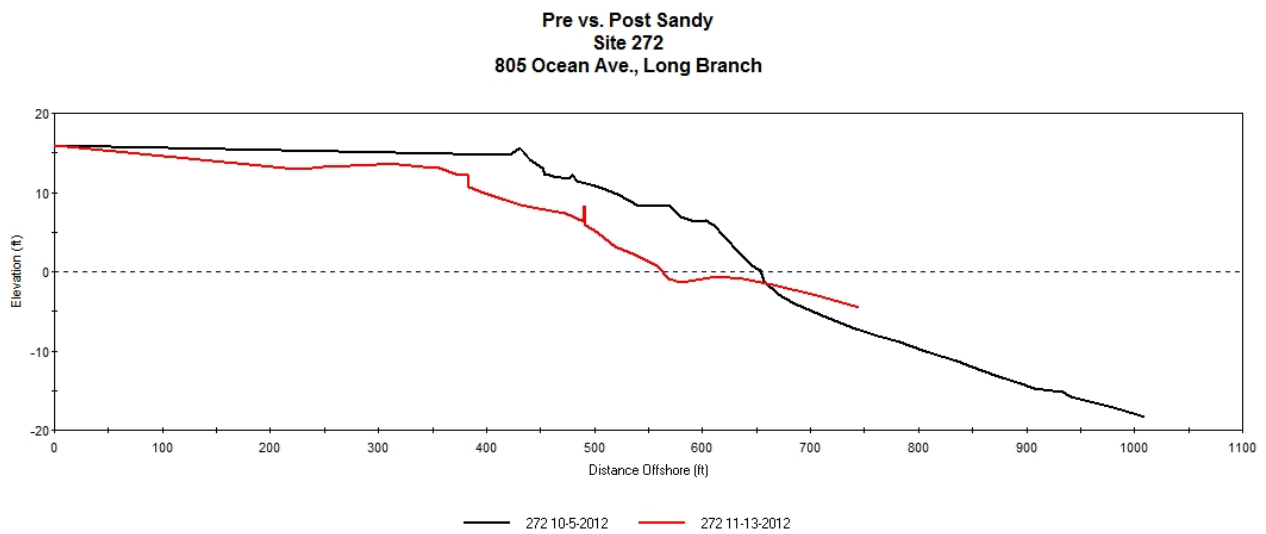


NJBPN 272 – 805 Ocean Ave, Long Branch



The photographs above were taken on October 5, 2012 (left) and November 13, 2012 (right).

Figure 4. This site was established in 2010 and has gained in sand volume over the past two years. Unfortunately, Hurricane Sandy stripped sand from the beach and pushed the berm landward. All structures landward of the original dune crest were erased and reduced to rubble. Sand was pushed landward or washed back out to sea.

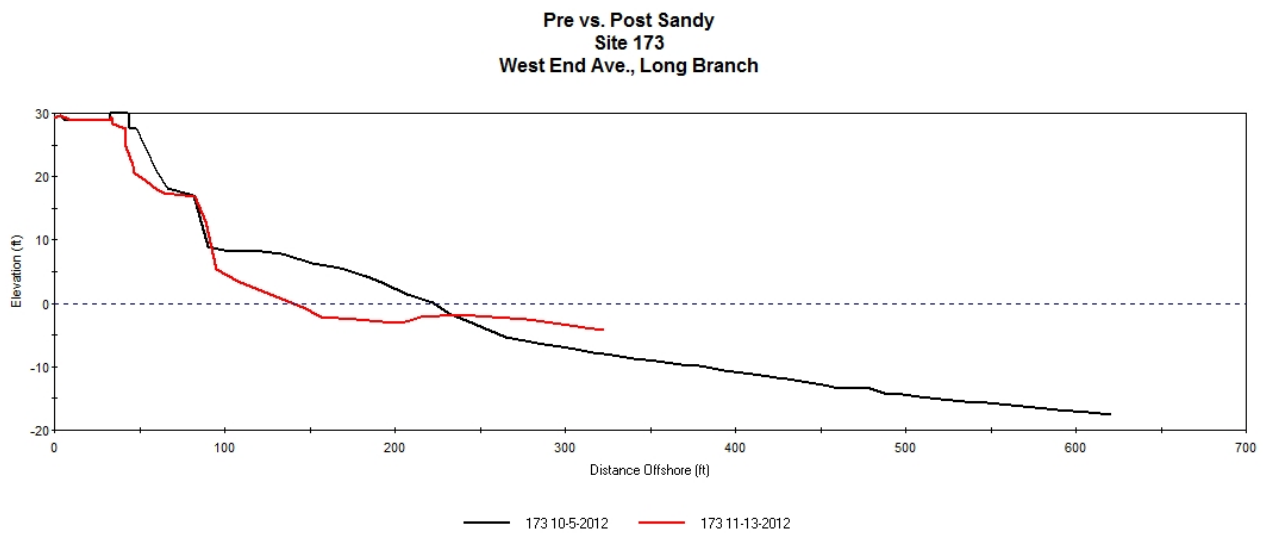


NJBPN 173 – West End Avenue, Long Branch



The photographs above were taken on October 5, 2012 (left) and November 13, 2012 (right).

Figure 5. This site is located near the southern limit of the Federal beach nourishment project. Long Branch did not include the construction of a protective dune. It was decided at the time of planning the project that the bluff elevation and the presence of the rock revetment was enough protection for landward properties and the sand was put into the berm. While the revetment held in place during Hurricane Sandy, the boardwalk built on the upper bluff sediments was destroyed with bluff retreat to the edge of the old southbound Ocean Avenue roadway. Much of the berm sand was moved to the nearshore bar. This was the site of the 2010 experimental “bump-out” replenishment designed in part to answer surfing related issues with the beach restoration work.

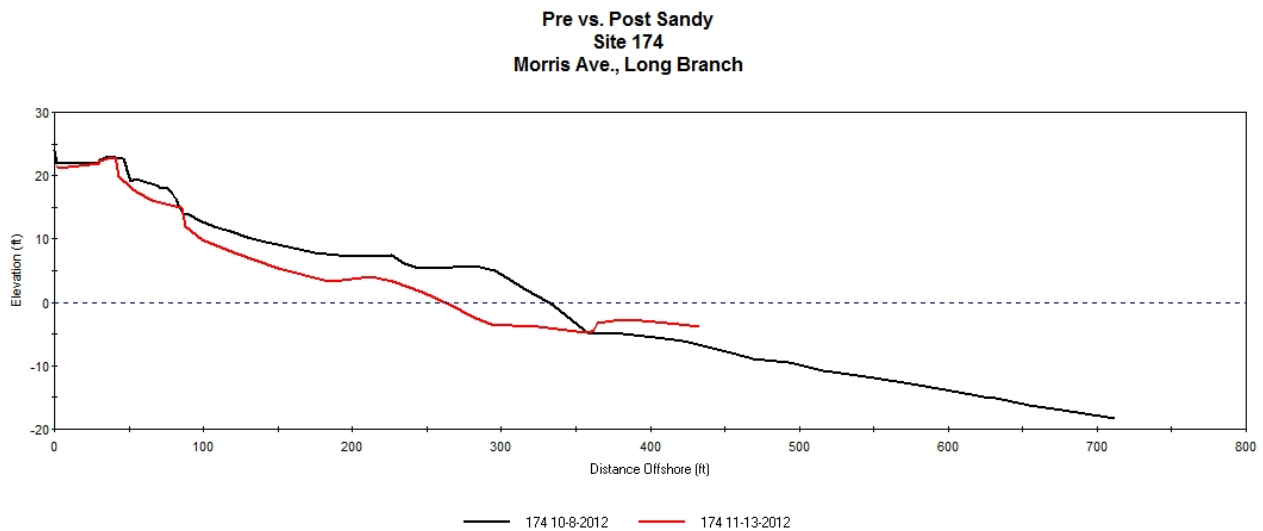


NJBPN 174 – Morris Avenue, Long Branch



The photographs above were taken on October 8, 2012 (left) and November 13, 2012 (right).

Figure 6. This site also was the recipient of the Federal beach nourishment project and was a direct beneficiary from the 2010 maintenance fill completed to the south. Strong northerly littoral sand transport moved abundant sand from that project into this segment. Hurricane Sandy removed the sand from on top of the seawall, eroded into the upper bluff sediments and destroyed the boardwalk. The beach was reduced in elevation and width with sand deposited offshore. The recovery berm and a small offshore bar are indicated on the survey from 11/13/2012.

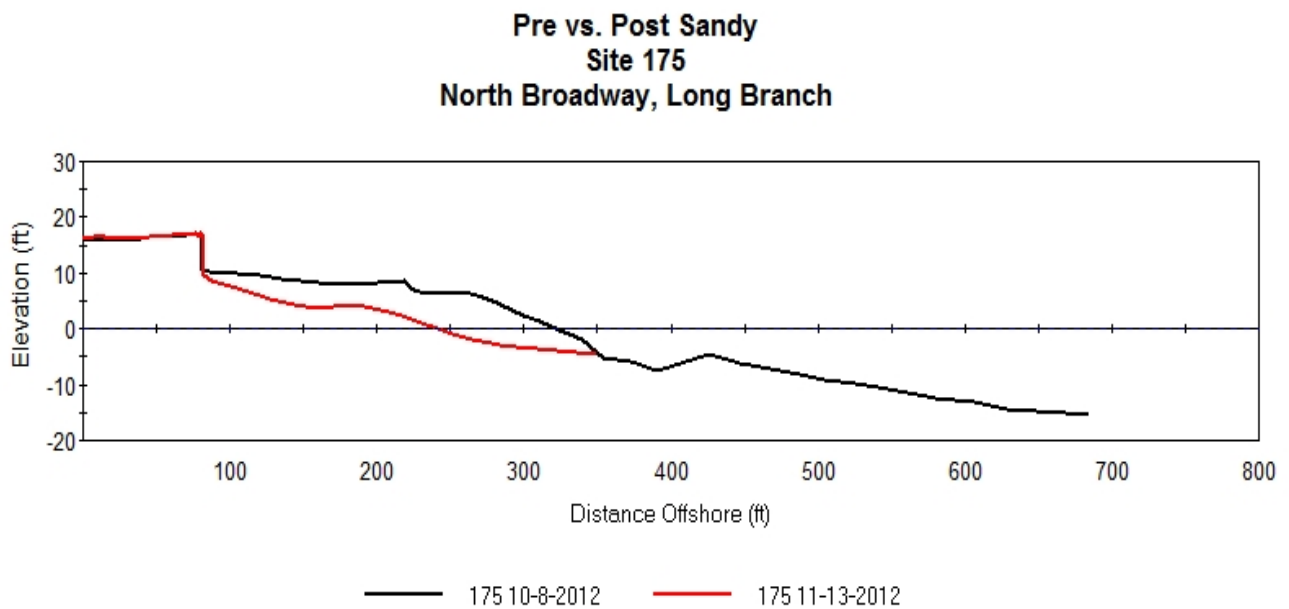


NJBPN 175 – Broadway Avenue, Long Branch



The photographs above were taken on October 8, 2012 (left) and November 13, 2012 (right).

Figure 7. This site lost a huge amount of sand from the berm with some moved over the vertical steel wall, but the vast majority deposited offshore beyond the reach of the wading profile survey. The railing on the right photograph was bent landward by wave action 17 feet above the zero datum elevation.

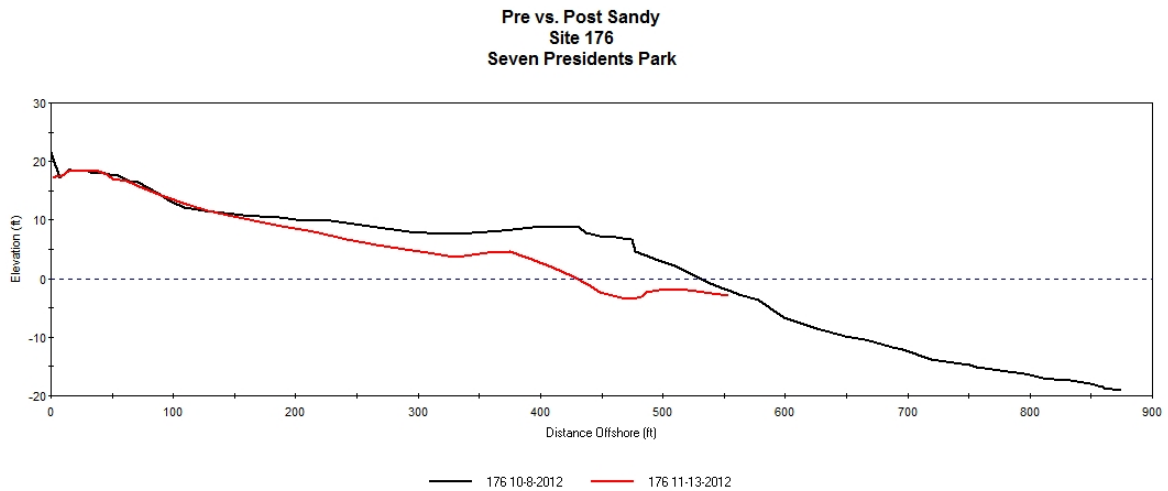


NJBPN 176 – Seven President’s Park, Long Branch



The photographs above were taken on October 8, 2012 (left) and November 13, 2012 (right).

Figure 8. This site is a popular recreational park with a partial ridge of 25-foot elevation dunes and an expansive berm that has undergone variable volume changes through the years. During Hurricane Sandy, the grade-level public access points created channeled flow from the storm waves and washed sand landward into the parking lots. Measurements of wave run-up on the dune’s seaward slope north of the profile line found debris at 24.6 feet NAVD88 indicating a massive surge of wave power during the storm.



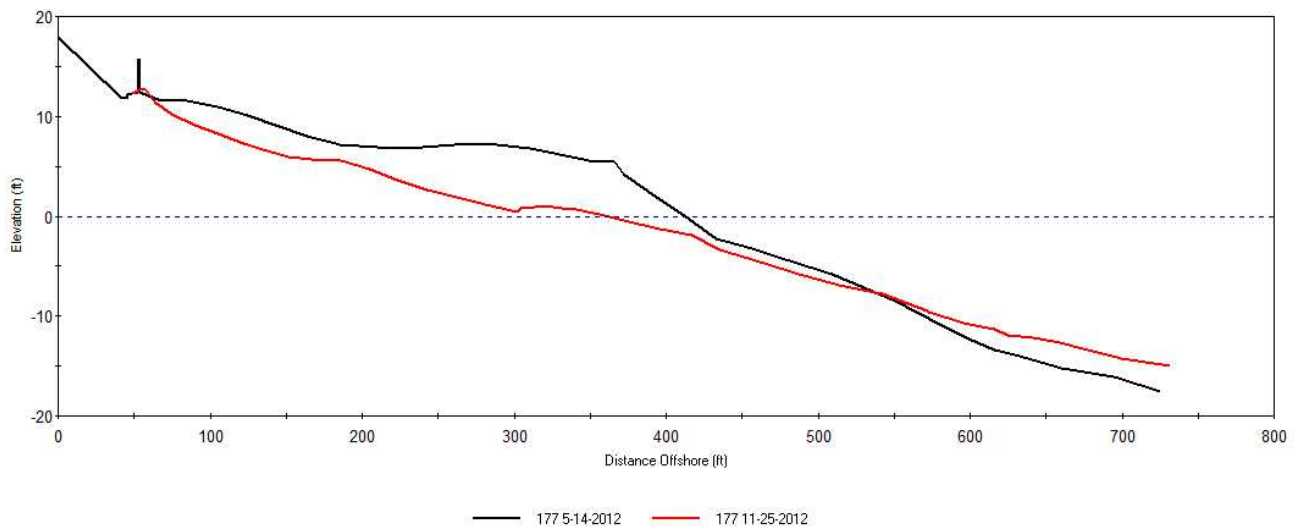
NJBPN 177 – 404 Ocean Avenue, Long Branch



The photographs above were taken on May 14, 2012 (left) and November 25, 2012 (right).

Figure 9. This site was the recipient of sand from the initial Federal beach nourishment project. The beach here has remained relatively constant in width and volume due to the presence of the large rock groin which slows the littoral flow and allows for sand deposition. Waves washed sand into Ocean Avenue and associated businesses. The berm was reduced in elevation and pushed landward, with sand deposited offshore as well. This cross section was the southernmost one NOT surveyed prior to Sandy, so the pre-storm profile is from the spring of 2012 and shows that sand was carried seaward beyond the normal 16-foot ending depth for NJBPN surveys. The normal survey procedure was used from this point north and serves to additionally document offshore transport of sand volumes that indicate either a major transport further landward into the community or a reflection seaward where the deposit offshore approximates the loss to the beach above the zero elevation. At this site, the offshore sand movement was to a greater distance than the 16-foot depths the CRC normally surveys using swimmers.

**Pre vs. Post Sandy
Site 177
404 Ocean Ave, Long Branch**



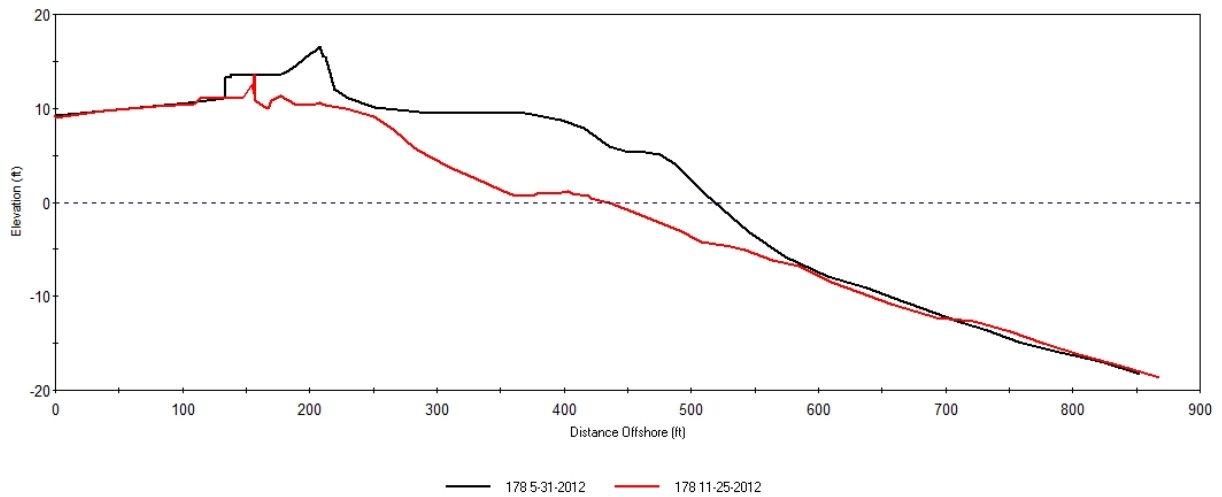
NJBPN 178 – Monmouth Beach Club, Monmouth Beach



The photographs above were taken on May 31, 2012 (left) and November 25, 2012 (right).

Figure 10. This profile was the recipient of the initial Federal beach nourishment project and since that time, shoreline and volume changes have been relatively stable. Hurricane Sandy removed significant amounts of sand from the berm, destroyed a moderate-sized dune and utterly destroyed the buildings associated with the facility. Sand was not carried offshore because much of the loss was moved either landward or to the immediate south of this profile.

**Pre vs. Post Sandy
Site 178
Beach Club, Monmouth Beach**



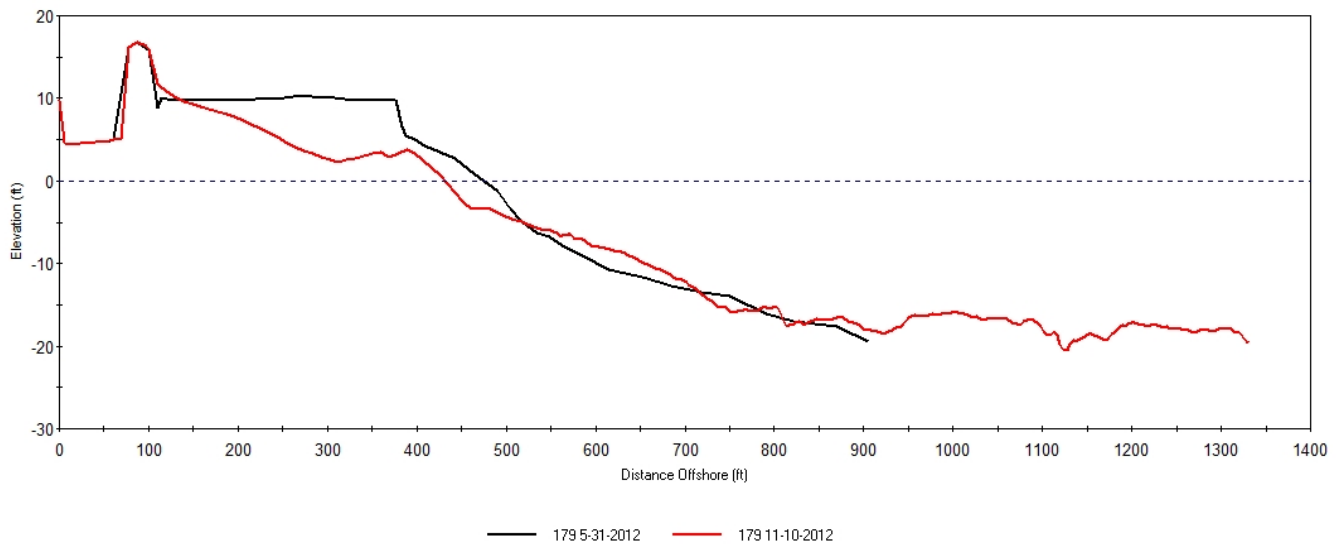
NJBPN 179 – Cottage Road, Monmouth Beach



The photographs above were taken on May 31, 2012 (left) and November 21, 2012 (right).

Figure 11. This site has the worst erosion history of any site in Monmouth County. It was the recipient of sand from the initial Federal beach nourishment project, though no dunes were constructed due to the presence of the seawall and rock revetment. Chronic volume losses have been recorded over the years because the rock groins adjacent to the site block sand transport from the south. The spring 2012 survey recorded a high 300-ft wide berm and most of that sand was moved to the nearshore or over the seawall during Hurricane Sandy's waves. There is a current maintenance project underway with the post-Sandy data supplied by the contractor who had closed the beach segment as construction was underway.

**Pre vs. Post Sandy
Site 179
Cottage Rd, Monmouth Beach**

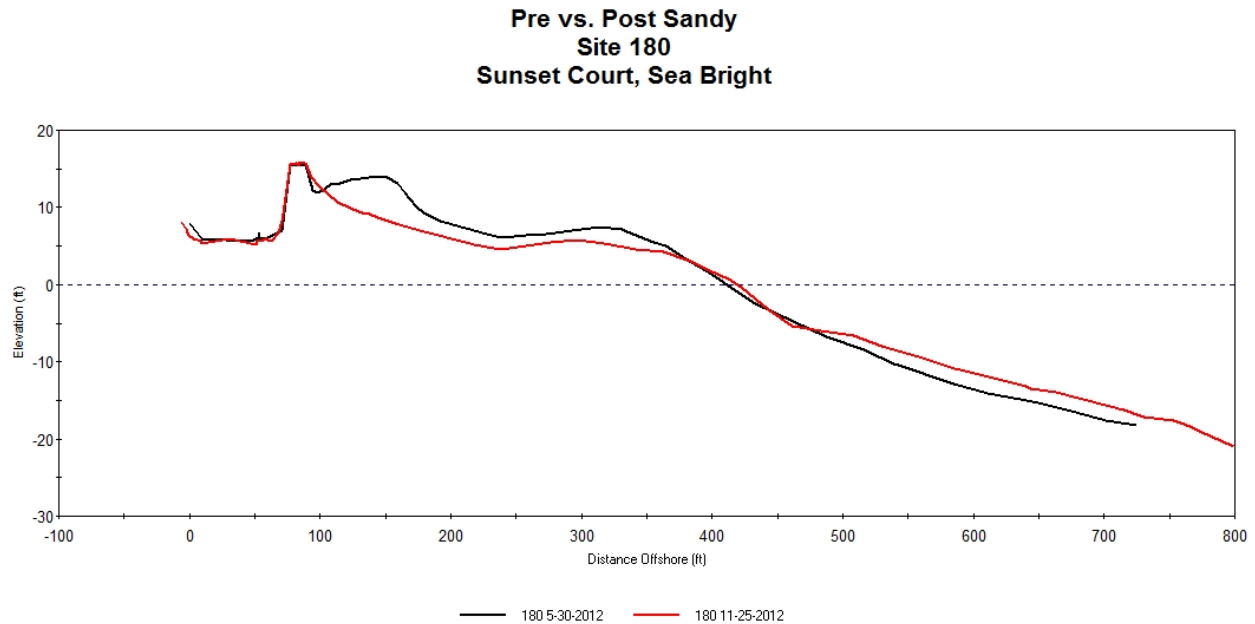


NJBPN 180 – Sunset Court, Sea Bright



The photographs above were taken on May 30, 2012 (left) and November 21, 2012 (right).

Figure 12. This site was the recipient of sand from the initial Federal beach nourishment project. The left photograph shows the variety in height, width and vegetation density associated with the naturally developed dunes seaward of the seawall along the Sea Bright shoreline. Sandy's waves pushed sand into a gentle ramp up the seaward rock slope and allowed the wave bores to pour over the wall into Ocean Avenue and associated properties with a vengeance. Sand was also transported well seaward as the post-storm survey shows.

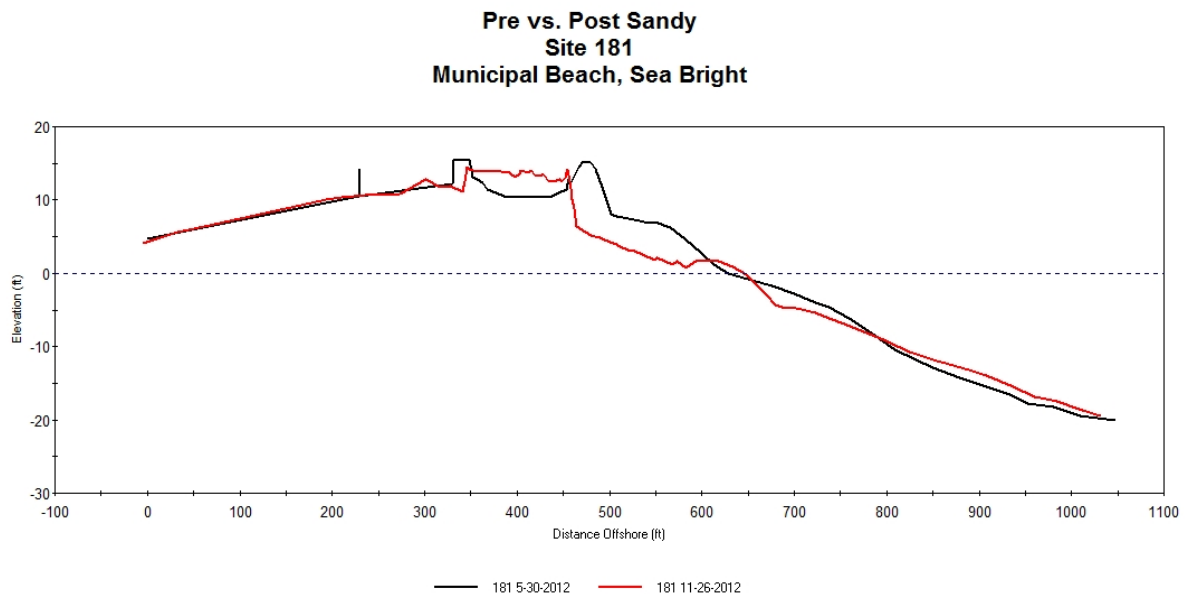


NJBPN 181 – Municipal Beach, Sea Bright



The photographs above were taken on May 30, 2012 (left) and November 21, 2012 (right).

Figure 13. This site was the most heavily damaged along the northern Monmouth County shoreline because there was a gap in the rock seawall at the municipal beach protected by dunes (but with large grade-level pedestrian gaps) and an aging, low bulkhead separating the beach from the municipal services landward. Sandy blasted through these defenses and wrecked the fire and police departments plus extensively damaged the businesses on both sides of Ocean Avenue. The wave surge added to the tidal flooding coming in from Raritan Bay up the Navesink and Shrewsbury Rivers, so Sea Bright was battered from both directions, especially right here. The irregular high zone landward of the dune and seaward of the timber boardwalk is sand gathered from the streets and hauled back to the beach to act as a temporary barrier. The cross section appears to show the transfer of sand landward into Sea Bright because this location does not have a significant volume deposited offshore as compared to the others where longer profiles were taken.

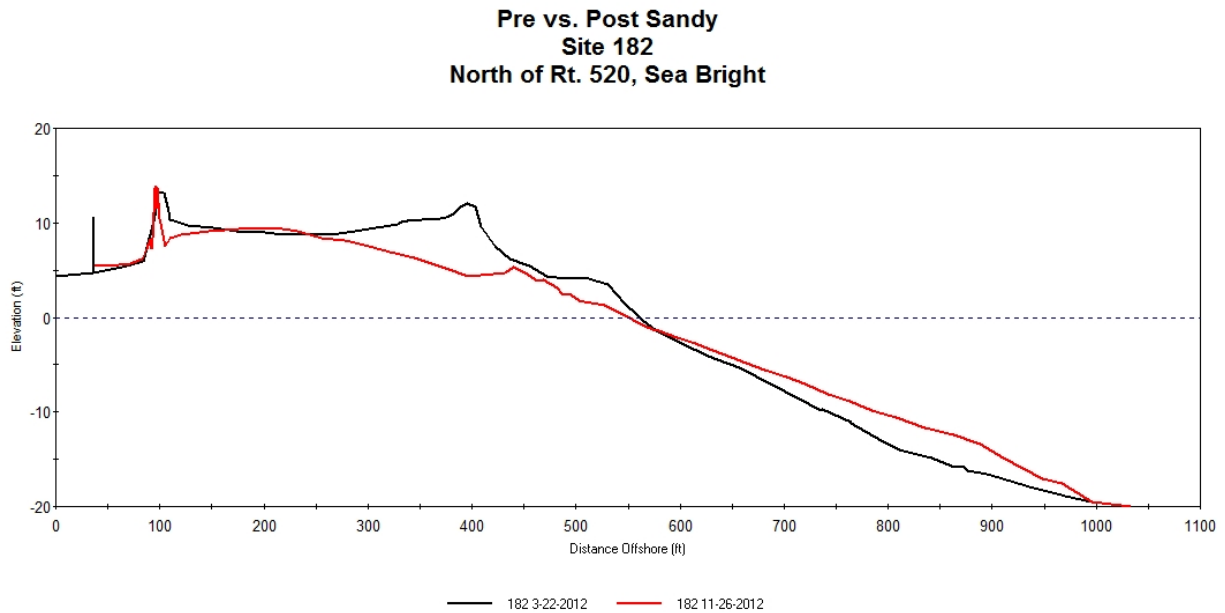


NJBPN 182 – Public Beach, Sea Bright



The photographs above were taken on March 22, 2012 (left) and November 21, 2012 (right).

Figure 14. At this location, low, wide dunes established naturally following the initial Federal beach nourishment project did not stop the wave damage. Sand volumes have been relatively stable since that time. Hurricane Sandy's storm surge and waves relocated sand from the dune and berm both landward to the rocks, over the rocks and to the nearshore. A second gap was a 20-foot wide break in the rock seawall that had a timber barrier. This failed allowing torrents of sea water into the Sea Bright business area at the north end. The deposition of sand offshore was less than the quantity removed from the beach/dune system, but it appears as if closure was achieved including sand lost except for the quantity transported landward into the community.

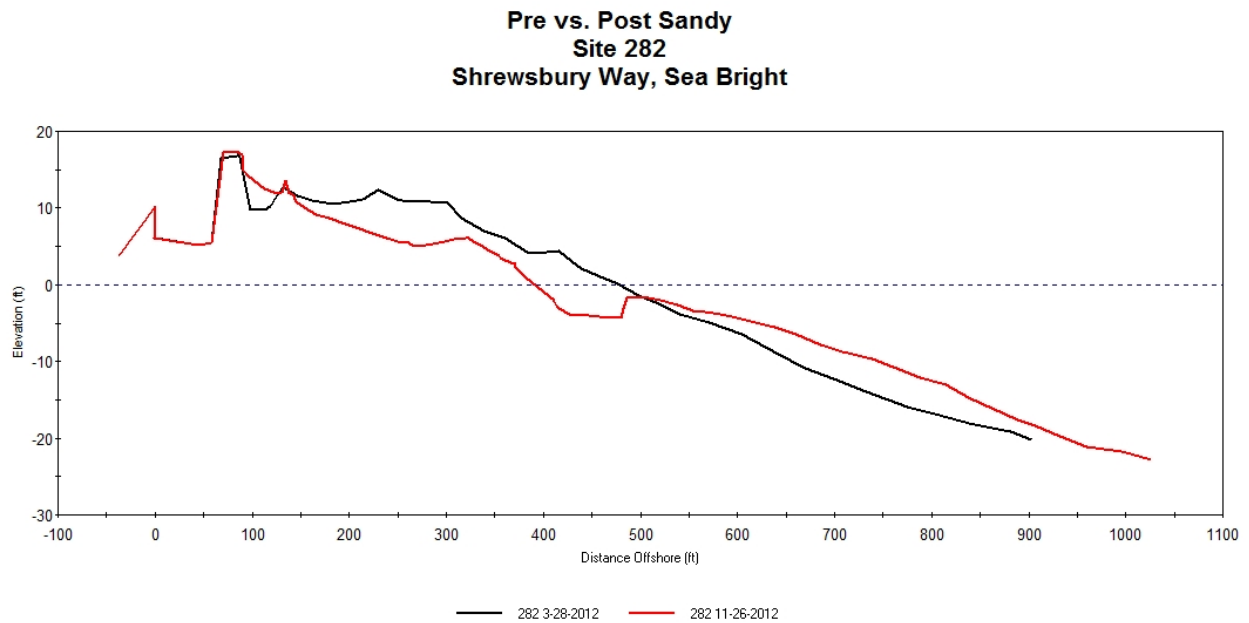


NJBPN 282 – Shrewsbury Way, Sea Bright



The photographs above were taken on March 28, 2012 (left) and November 26, 2012 (right).

Figure 15. This site was included in the initial Federal beach nourishment project but did not include an engineered dune. A low, wide dune field was established surrounding a pair of fence rows built immediately following beach restoration and planted with grass between them. The left photograph shows the natural development of the dune system over the past 12 years. The site has gained in sand volume since the project (116% of the initial sand volume placed by 2011). Hurricane Sandy's storm surge and waves created a ramp of sand adjacent to the seawall and transported sand both further landward with back-rush carried to the nearshore bar. Substantial sand volume was deposited offshore below the zero elevation datum. The normal length surveys here documented this process.



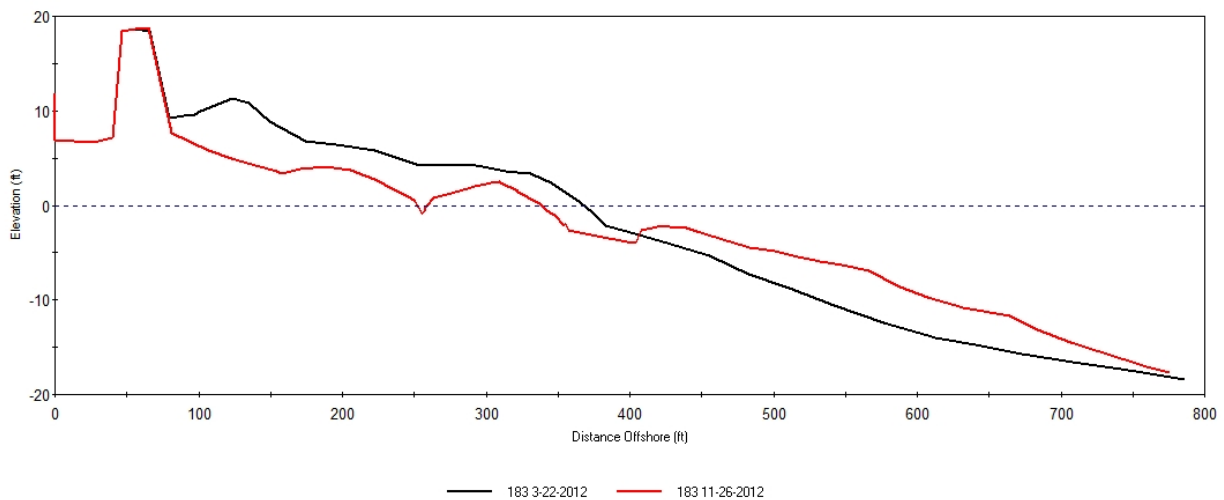
NJBPN 183 – Via Ripa Street, Sea Bright



The photographs above were taken on March 21, 2012 (left) and November 26, 2012 (right).

Figure 16. This site was near the northern limit of the initial Federal beach nourishment project and has experienced only moderate sand losses since that time. An engineered dune was not constructed due to the presence of the seawall with the sand placed in the berm. A low dune established naturally between two parallel rows of sand fence. Hurricane Sandy’s storm surge and waves moved sand to the nearshore bar, most of which is post-storm recovery as seen in the right photograph’s right edge. This location was surveyed to the normal distance offshore following Sandy and as can be seen, the sand deposited offshore approximates the volume lost above the crossing point on the two surveys. Above Datum: the loss amounted to -34.101 cu. yd/ft, while below the datum; the gain was 35.500 cu. yd/ft. Since this site did not see extensive over-topping of the seawall, the net change to a depth of -18.11 feet NAVD88 actually was a gain of 1.40 yds³/ft. Therefore, in spite of huge waves, a massive storm surge, and a strong southerly littoral drift current during Hurricane Sandy, the beach at this site has been shown to have had nearly a zero change in net sand volume.

**Pre vs. Post Sandy
Site 183
Via Ripa St, Sea Bright**



Summary & Conclusions

<i>Roosevelt Ave. Deal to Via Ripa St. Sea Bright Post-Sandy Site Volume Changes</i>				
Site Location and Number	Site Sand Volume Change (cu yds/ft)	Dune Failure (Y or N)	Date of Recent Beach Fill	
Deal	170	No Data Yet	Bluff Retreat	Never
Elberon	171	-13.60	Bluff Retreat	Never
Long Branch	272	-71.38	Y	Never
Long Branch	173	-23.97	Bluff Retreat	1999
Long Branch	174	-40.72	Bluff Retreat	1999
Long Branch	175	-46.76	No Dune	1998
Long Branch	176	-62.07	No Dune	1998
Long Branch	177	-45.87	No Dune	1997
Monmouth Beach	178	-69.38	Y	1994
Monmouth Beach	179	-48.83	No Dune	1994
Sea Bright	180	-22.60	Y	1995
Sea Bright	181	-16.70	Y	1995
Sea Bright	182	-31.20	Y	1995
Sea Bright	282	-37.13	Partial	1996
Sea Bright	183	-34.10	Y	1996

Figure 17 shows a table of sand loss volumes per foot of shoreline at each of the Northern Monmouth County sites. No beach nourishment was done at the three southern sites because Allenhurst/Loch Arbor, Deal and Elberon declined to participate in the project. The hightide ownership issues were the major stumbling block. Because there was a high sediment bluff in Long Branch fronted with a rock revetment and a very high bathing use demand on the beach space, no dune was designed into this project. Sea Bright's shoreline was defended solely by a 28-foot rock wall that had served as the only form of shore protection during the decades prior to the NY District Corps Project, and this zone was not designated as needing dunes. Fencing was installed along the Sea Bright section and planted between the rows of fence. Natural processes served to allow dunes to develop over 12 years, but with no general design specifications, the process was pretty random. A significant recommendation would be to re-assess the view on creating a wide, double ridge of sand to provide a higher level of storm protection to serve as a blocker for wave run-up that went over the seawall. More importantly, efforts must be made to close the two gaps in the rock wall in the central section of Sea Bright with huge dunes or extend the wall with a serious barrier to seal these two entry points from future waves.

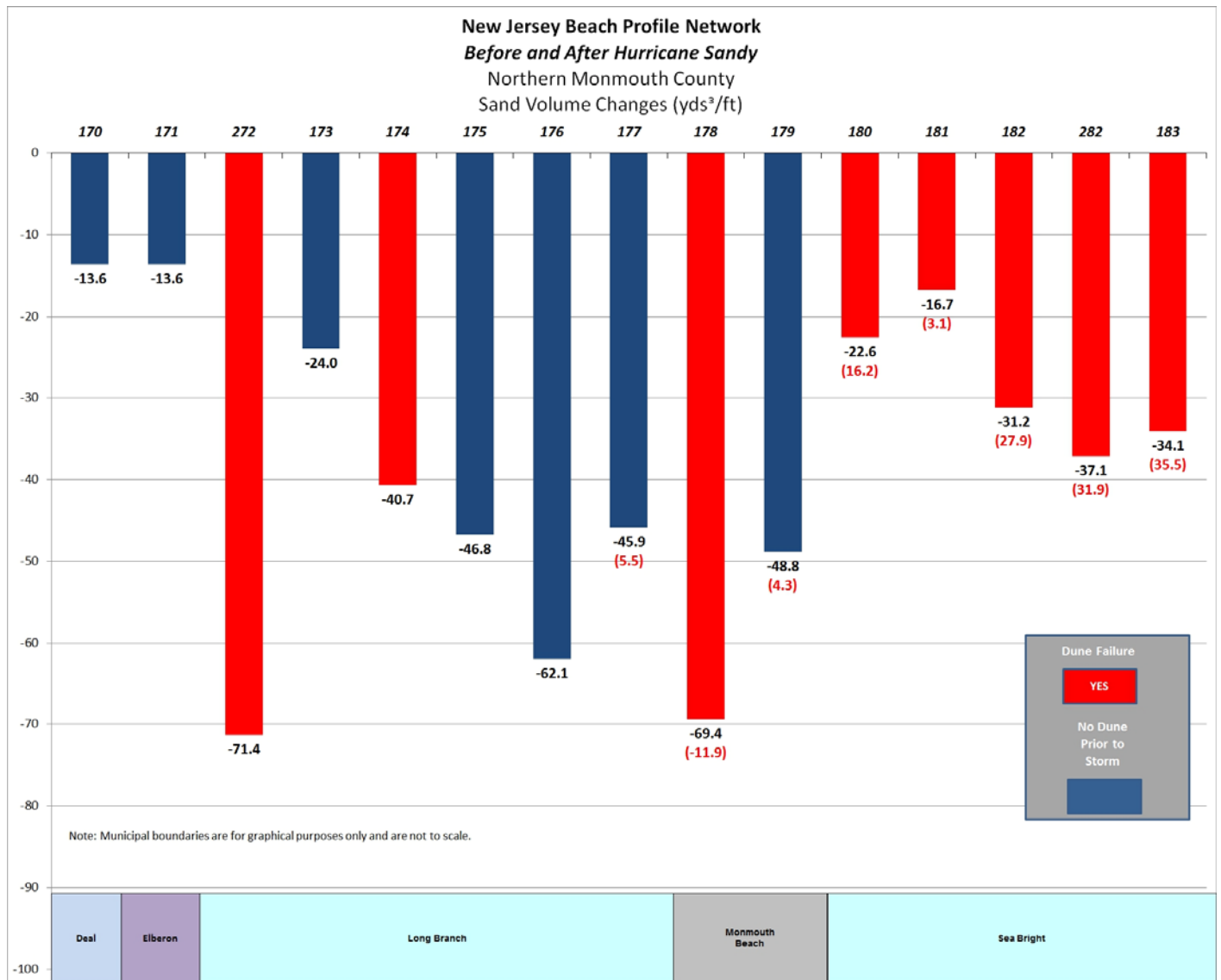


Figure 18. This is a graphical display of the sand volume lost at each site combined with an indication of the presence, absence or failure of the dune system along the Northern Monmouth County shoreline. The natural area north of Sea Bright (Sandy Hook National Seashore) has three cross sections that will be surveyed before December 21, 2012. The sand volume losses are expressed in cubic yards of sand per foot of shoreline. For comparison, the Federal placement volumes were between 225 and 300 cubic yards of sand per foot of shoreline.

All the sand volumes above and in the other two tables reflect loss within the dune, beach and shallow offshore reached by wading with a GPS unit. From site 177 north to #183, each location had not been surveyed prior to Sandy, so the regular fall survey was conducted that goes well offshore to 16 to 18-foot depths (NAVD88). On those 8 sites, the deposition of sand offshore is readily apparent. The quantity of sand deposited offshore for those sites is shown in (red) below the loss number for the beach/dune system. For the two northern profiles, the offshore volume nearly equals the loss on the beach. The final depth reached appears to contain the envelope of change termed “closure”.

Northern Monmouth County Post Sandy Volume Changes

MUNICIPALITY	NJBPN Site#	Shoreline Change in the Zero Elev. Position Since Initial Fill	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 (South to North)	Cumulative Volume Change Cubic Yards (South to North)	
Deal	*No Survey Yet*	170	no project	-13.60	-17.23	Seawall	Never	4868	-66,207	-66,207
Elberon	171	no project	-13.60	-13.60	Bluff Retreat	Never	5527	-75,172	-141,379	
Long Branch	272	no project	-71.38	-42.29	Failed	Never	1418	-101,185	-242,564	
Long Branch	173	-362	-23.97	-47.68	Bluff Retreat	1999	3283	-78,695	-321,259	
Long Branch	174	-216	-40.72	-32.35	Bluff Retreat	1999	4886	-198,973	-520,232	
Long Branch	175	-97	-46.76	-43.74	No Dune	1998	3353	-156,767	-676,999	
Long Branch	176	-83	-62.07	-54.42	No Dune	1998	2192	-136,066	-813,065	
Long Branch	177	7	-45.87	-51.25	No Dune	1997	2096	-96,130	-909,194	
Monmouth Beach	178	-198	-69.38	-59.87	Failed	1994	2647	-183,648	-1,092,842	
Monmouth Beach	179	-309	-48.83	-61.92	No Dune	1994	2949	-143,976	-1,236,818	
Sea Bright	180	-124	-22.60	-25.48	Failed	1995	4559	-103,044	-1,339,863	
Sea Bright	181	-111	-16.70	-10.03	Failed	1995	5382	-89,873	-1,429,735	
Sea Bright	182	-106	-31.20	-8.47	Failed	1995	1937	-60,437	-1,490,172	
Sea Bright	282	-95	-37.13	-4.28	Partial	1996	4206	-156,159	-1,646,331	
Sea Bright	183	-86	-34.10	-1.93	Failed	1996	4742	-161,702	-1,808,032	

Figure 19. 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 shoreline change data is the distance in feet that the zero elevation position has moved landward since the Federal project was completed (1994 to 1999). This coastal segment contains the northern phase of the NY District Corps of Engineers massive Monmouth County Shore Protection Project with the exception of the Deal and Elberon sites (#170, 171 & 272) where no sand was ever placed. The totals for sand loss is derived by adding the 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 in the form of growing offshore sand bars, 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. In this report, the sites north of #176 were surveyed to the normal -16-foot elevations because these sites were not surveyed in the fall of 2012 prior to Sandy. These were compared to the spring 2012 surveys done earlier in the year. It is also acknowledged that the large distances between sites limits the precision of the sand loss total volume for restoration purposes, but it gives a decent approximation. Longer surveys will be repeated 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.