2015 ANNUAL REPORT ON
THE CONDITION OF THE MUNICIPAL BEACHES FOR
THE BOROUGH OF STONE HARBOR, CAPE MAY COUNTY, NEW JERSEY

View to the Borough of Stone Harbor on Seven Mile Island. The photo shows the condition of the municipal shoreline two days following northeast storm Jonas on January 24, 2016. The beach and dune were impacted with erosion generating a scarp here between 95th (right) and 101st (left) Streets in the Borough.
(Photo by Ted Kingston, January 26, 2016)

PREPARED FOR: **THE BOROUGH OF STONE HARBOR**
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Introduction:

A little over three years since Hurricane Sandy, the NJ coast is being negatively impacted by an El Nino winter where northeast storms are occurring with regularity and some degree of intensity. Although the 100% Federally-funded project that commenced within six months following Hurricane Sandy was completed by August 2013, these storms have depleted the beach sand volume by 73.4% as of the fall survey. Storm data was limited to a long duration event just prior to the final survey in 2015. This early October event was followed by an extended period of mild, even warm weather until the New Year. January brought northeast storm Jonas followed by two days of northeast winds February 7th and 8th. Loss to beach elevation, scarps cut into dunes extended the entire length of the Stone Harbor coastline. The worst dune loss was seen at the 123rd Street site where a 15-foot high scarp left no easy access to the beach with the high tide washing right to the scarp's toe.

In January 2013, Congress passed Public Law 113-2 (Disaster Relief Appropriations Act of 2013) to restore all Federal shore protection projects (including beaches and dunes) within the impacted area. In Stone Harbor those efforts included a major beach nourishment project to restore the municipal shoreline to the original full design template with the placement of 674,224 CY (USACE reported pay volume) of sand on the beaches and dunes between 80th Street and 123rd Street.

Annual shoreline and sand volume changes between Surveys #43 and #45 are presented in Table 1 and semi-annual changes (Surveys #44 to #45) are presented in Table 2.

2015 Weather Events;

The spring of 2015 was unsettled with no major storms. There was a beneficial summer season of beach berm and dune building. There were no near miss hurricanes in 2015 with all east coast storms moving well offshore and out into the Atlantic. The first northeast event commenced in early October and lasted three days with 25 to 30 MPH wind gusts. The seas built to erosional levels and confined their damage to berm erosion. Following this event the weather turned warm, lasting through December. December has since been labeled the warmest December ever recorded. The winter began in mid-January with cold and northeast winds culminating in NE Storm Jonas January 23 and 24, 2016. Labeled a 10-year storm, this event cut into the dunes and stripped the beach elevation so that subsequent high tides still reached the dune scarp. A lesser storm occurred February 7th and continued the erosion of the dune toe, easily done because the berm was still reduced in elevation. Both storms occurred in coincidence with a spring tide, so tidal surge flooding was significant and impacted bayside residents still recovering from Sandy.

This is an El Nino winter and the temperature increases in the central Pacific are some of the most extreme ever recorded. Expect the storm pattern to continue.

Beach Monitoring Program Methodology

The CRC established the Borough's beach monitoring program in June of 1996 to address the shoreline changes along the 13,077 feet of municipal oceanfront beaches. Eight permanent beach profile-monitoring sites were established to gather data on a quarterly basis. Each profile starts at a fixed reference position behind the dunes, crosses the dunes, beach and extends over 600 feet into the water, ending at a depth of 12-16 feet. Each of the groin compartments or cells along the Borough beachfront contains one profile line. Work continues on a semi-annual monitoring schedule.

The following is a list of the profile locations:

♦ **SH-82**	82nd Street	Border with Avalon – 84th St. groin
♦ **SH-90**	90th Street	84th St. groin – 92nd St. groin

♦ **SH-95**	95th Street	92nd St. groin – 98th St. groin
♦ **SH-103**	103rd Street	98th St. groin – 106th St. groin
♦ **SH-108**	108th Street	106th St. groin – 111th St. groin
♦ **SH-112**	112th Street (paper street)	111th St. groin – 114th St. groin
♦ **SH-116**	116th Street	114th St. groin – 122nd St. groin
♦ **SH-123**	123rd Street (paper street)	122nd St. groin – terminal groin

Surveys Completed

The CRC completed four surveys between October 2014 and February 2016

- **Survey 43** represents a full dune, beach, and nearshore survey at all sites and is considered the Fall 2014 survey for measuring annual changes.
- **Survey 44** represents a full dune, beach and nearshore survey at all sites for the Spring 2015 semi-annual survey.
- **Survey 45** represents a full dune, beach and nearshore survey at all sites for the Fall of 2015 semi-annual survey.
- **Survey 46** represents an emergency survey of the dune and beach at all sites following northeast storm Jonas on January 24, 2016.

Stone Harbor Engineered Beach Performance

Initial construction of the Federal shore protection project began in 2002 and was completed in the Borough in 2003. Since placement, the USACE engineered beach sustained several significant storm events but maintained its storm protection value to the community during Hurricanes Irene and Sandy by preventing major added flooding by storm waves and dune breaches.

Hurricane Sandy (landfall on October 29, 2012) severely eroded the Borough's beaches and the dunes scarped but maintained their stability and were able to protect oceanfront properties from storm surge. Damage to beach access crossovers, ramps and pavilions was extensive but the public infrastructure inland was largely protected from storm waves.

In April 2013, the emergency beach fill commenced and added 674,224 CY (USACE reported pay volume) of sand to the Borough's 13,077 feet of oceanfront shoreline. This was an average gain of 54.70 yds^3/ft. Fill volumes tapered to the south as net sand transport along the Borough's shoreline is to the south and required less sand to restore the template. The total net sand volume changes over late summer and early fall of 2013 was a modest loss of 22,287 CY of sand from across the entire Stone Harbor oceanfront including the dunes, beaches and offshore seafloor (CRC, 2014).

Tables 1 through 3 provide shoreline and volume change information for each of the ocean beach profile locations within the Borough of Stone Harbor. Shoreline changes were calculated by comparing the zero datum positions for the 2014-2015 monitoring period. Sand volume changes across the length of the survey line were calculated for each individual profile site by computing the cut and fill cell changes in the profile with the previous survey or, were calculated from the annual surveys. These values are expressed in cubic yards of sand per linear foot of beachfront (yds^3/ft.) the total beach volume change is calculated using this value. The distance (cell width) between groins along the beachfront of Stone Harbor was measured between the centerlines of adjacent groins. Each cell's net sand volume change is computed by multiplying each cross section volume change by its corresponding groin cell width.

Table 1 represents the annual changes in shoreline position and across profile volume changes (from Fall 2014 [Survey 43] to Fall 2015 [Survey 45]).

Table 1
Stone Harbor 2014-2015
Fall 2014 (#43) to Fall 2015 (#45)
Annual Shoreline and Profile Sand Volume Changes

Profile Number	Shoreline Change (feet)	Volume Change (yds^3/ft)	Cell Distance (feet)	Cell Volume Change (yds^3)
SH-82	1	-81.78	1,381	-112,941
SH-90	-7	-15.90	2,240	-35,620
SH-95	-83	-21.13	1,680	-35,503
SH-103	-49	-4.73	2,208	-10,444
SH-108	-60	-27.75	1,433	-39,767
SH-112	-66	-14.29	804	-11,490
SH-116	-29	-6.80	2,273	-15,454
SH-123	-17	-42.02	1,058	-44,452
		Total Volume Change =		**-305,672**

Since the completion of the federal project in 2013 the annual sand volume losses the first year were 188,886 cubic yards for the Borough's ocean beaches and nearshore. The second year 305,672 cubic yards of sand were lost from the Borough beaches. This volume approximates ¾'s of the pay volume placed on the beaches following Sandy in 2013 (674,224 cubic yards placed vs. 494,558 lost since). This sum does not include the Jonas damage done in January 2016.

Table 2, below shows the winter impact on the Borough beaches as multiple minor events during a cold early part of the new year impacted the coast.

Table 2
Stone Harbor Semi-Annual Survey
Spring 2015 (#44) to Fall 2015 (#45)
Shoreline and Total Sand Volume Changes

Profile Number	Shoreline Change (feet)	Volume Change (yds^3/ft)	Cell Distance (feet)	Cell Volume Change (yds^3)
SH-82	-25	-93.17	1,381	-128,665
SH-90	-11	-12.21	2,240	-27,344
SH-95	-67	-24.02	1,680	-40,345
SH-103	-39	-12.81	2,208	-28,284
SH-108	-52	-27.81	1,433	-39,853
SH-112	-47	-15.03	804	-12,084
SH-116	-56	-12.28	2,273	-27,906
SH-123	-62	-20.96	1,058	-22,173
		Total Volume Change =		**-326,654**

The semi-annual comparison (Table 2) shows that the shoreline retreated at all of the Borough's profile locations driven by spring storms. The sand loss volume is slightly greater than the annual change and indicates that there was limited summer accretion on the beaches or offshore during the summer. The vast majority of the sand erosion occurred in the winter of 2014 into 2015.

Table 3 was created to display the Jonas losses since October 2015 that impacted the Borough shoreline. This erosion was universal along the dunes, taking up to a third of the dune volume present (123rd Street site). The sand loss volume declined toward the north as did the height of the scarp in the dunes.

Table 3
Stone Harbor Emergency Survey Following Jonas NE Storm
Fall 2015 (#45) to Jonas 2016 (#46)
Shoreline and Total Sand Volume Changes

Profile Number	Shoreline Change (feet)	Volume Change (yds^3/ft)	Avg.Volume Change (yds^3/ft)	Cell Distance (feet)	Cell Volume Change (yds^3)
			-18.24	540	-9847.98
SH-82	-49	-18.24			
			-14.04	2,254	-31649.54
SH-90	-46	-9.85			
			-8.20	1,397	-11449.81
SH-95	-12	-6.55			
			-10.92	2,237	-24422.45
SH-103	-32	-15.29			
			-12.57	1,423	-17891.38
SH-108	-16	-9.86			
			-8.90	1,468	-13071.81
SH-112	-16	-7.95			
			-4.98	998	-4969.04
SH-116	-5	-2.01			
			-6.63	2,508	-16638.07
SH-123	-31	-11.26			
			-11.3	600	-6757.20
		Total Volume Change =			**-136,697**

The post-Jonas northeast storm survey was conducted at the southern four sites on January 25, 2016 using RTK-GPS equipment that allows data collection to about -3.0 NAVD 1988 depending on the stage of the tide. Before the remaining sites could be visited, another NE storm occurred February 7 and 8, 2016 causing additional erosion. The remaining sites were surveyed February 10, 2016 and include the second storm's losses. The four post-Jonas sites were re-surveyed for data points at the top of the dune scarp, the base and a point out on the beach to gage the dune loss to be added to the initial post-storm review. The evaluation based on the eight locations in the Borough shows that Jonas and the February 7-8, 2016 storms removed 136,697 cubic yards of sand from the seaward slope of the primary dune in 6 of 8 locations and excavated sand from the berm at all sites. The cross-shore transport of sand is indicated in at least 4 locations where there had been a nearshore bar as a result of the early October 2015 multi-day NE event that impacted beaches in spite of low wind velocities because of the 4 day duration of the event. The October 2015 survey took place on the 12th, 6 days later allowing the development of the nearshore bar deposits that were planed off and mixed with beach sand eroded by Jonas. Stone Harbor's oceanfront shoreline has a history of developing massive offshore sand bars during storms that transfer beach sand over 1,000 feet seaward of the tide zone on the beach making post-storm recovery difficult. Sand preferentially moves south building South Point.

Individual Site Descriptions:

This section describes the changes documented at each of the beach profile locations from May 2014 to January 2016. All of the sites are located within the Federal shore protection project limits and all received sand to return the sites to the 2002-2003 original design template. The spring 2013 post-Hurricane Sandy restoration project commenced in April and worked from south to north to repair storm damages. The project finished its northern section in late July.

SH-82 is located at 82nd Street along 1st Avenue and seaward of the 82nd Street recreation area. The profile line is set approximately midway between the Avalon border and the groin at 84th Street. This site is included in the Borough's monitoring program to represent typical beach conditions on the Borough's only stretch of beach without a groin (in the northern section of the community). The profile is located about 800 feet south of the Avalon border and the USACE federal project taper. This site consists of 200 feet of primary dune width seaward of the asphalt promenade that is set on top of the revetment from its landward offset at 83rd Street to 80th Street.

The dune remained unaffected by storm events, but lost the protection of the berm seaward of the toe during the early October 2014 long-duration northeast storm that generated substantial early seasonal erosion in spite of a lower wind velocity. The event lasted for at least 5 high tide cycles with a fully developed sea state for 25 to 30 MPH winds.

Site SH-82 – 82nd Street (Photoplates 1a-1b)

Photoplate 1a - Photo taken May 15, 2015. View to south along the dune toe from 82nd Street. The dune fence installed after the ACOE project to capture aeolian sand had almost filled, but the beach remained relatively narrow.

Photoplate 1b - Photo taken February 11, 2016 following both Jonas and a more minor event February 7, 2016. The dune was eroded into the seaward slope removing about half the toe slope. The beach was flat and low enough such that high tide was easily able to reach the dune scarp. All fencing was destroyed.

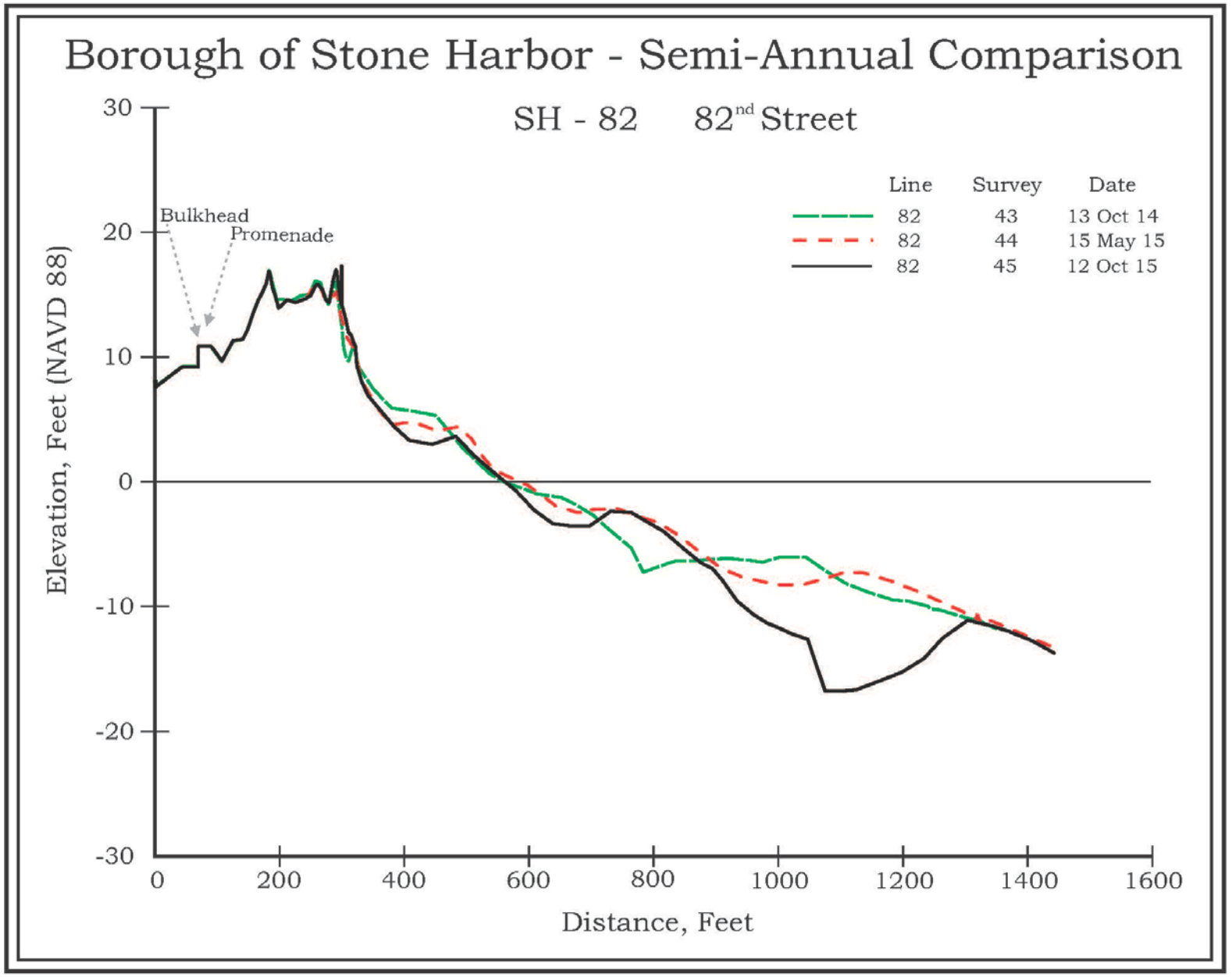

Figure 1a. The post-initial northeast storm of 2015's winter months contributed to the loss in berm elevation shown on the plot for Oct. 12, 2015 above. Waves also generated a deep trough offshore that contributed the lion's share of the seasonal loss recorded (-93.17 $yds^3/ft.$). Stone Harbor has a long history of major offshore troughs that follow storms where the sand is moved over 1,000 feet from the reference position. The dunes remained undamaged until Jonas in late January 2016.

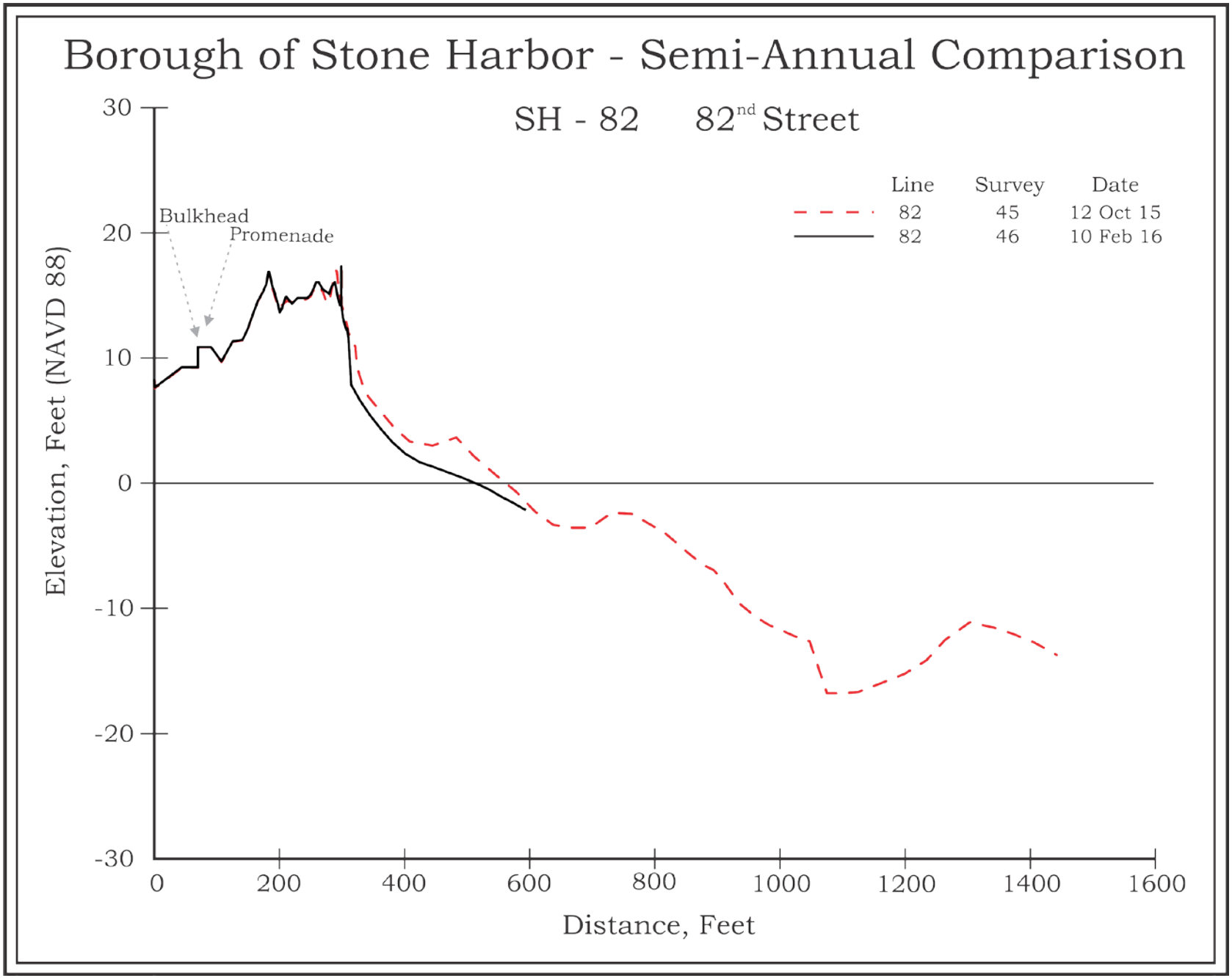

Figure 1b. Post-Jonas erosion at the dune's seaward slope and on the beach compared to conditions from October 12, 2015, which followed 3-4 days of northeast winds. The storm related loss was 15.99 yds^3/ft. from the dune to the zero elevation datum (NAVD 1988); followed by a 2.24 yds^3/ft. loss below the datum to the end of the survey.

SH-90, is located at 90th Street and was originally established in 1986 as a survey site for the New Jersey Beach Profile Network (NJBPN). The profile line is set north of the public beach access path to provide a typical cross-sectional representation of the dune and beach that is bounded by groins at 84th Street and 92rd Street. The dune system consists of two ridges approximately 150 feet wide extending from the street end revetment to the seaward dune toe.

The beach remained at a constant width between the dune toe and the zero elevation location, but lost elevation during early seasonal northeast storms. The situation stabilized, but that ended with NE storm Jonas in late January 2016.

Site SH-90 – 90th Street (Photoplates 2a-2b)

Photoplate 2a - Photo taken May 15, 2015. View to south along the row of dune fence from 90th Street. Aeolian sand had begun to accumulate around the base of the fence, filling in to expand the seaward dune slope.

Photoplate 2b - Photo taken February 11, 2016 following Jonas and a second event two weeks later. The wrack line reached the beach entrance at the dune toe making a small scarp in places. The dune fence was still unaffected at this location.

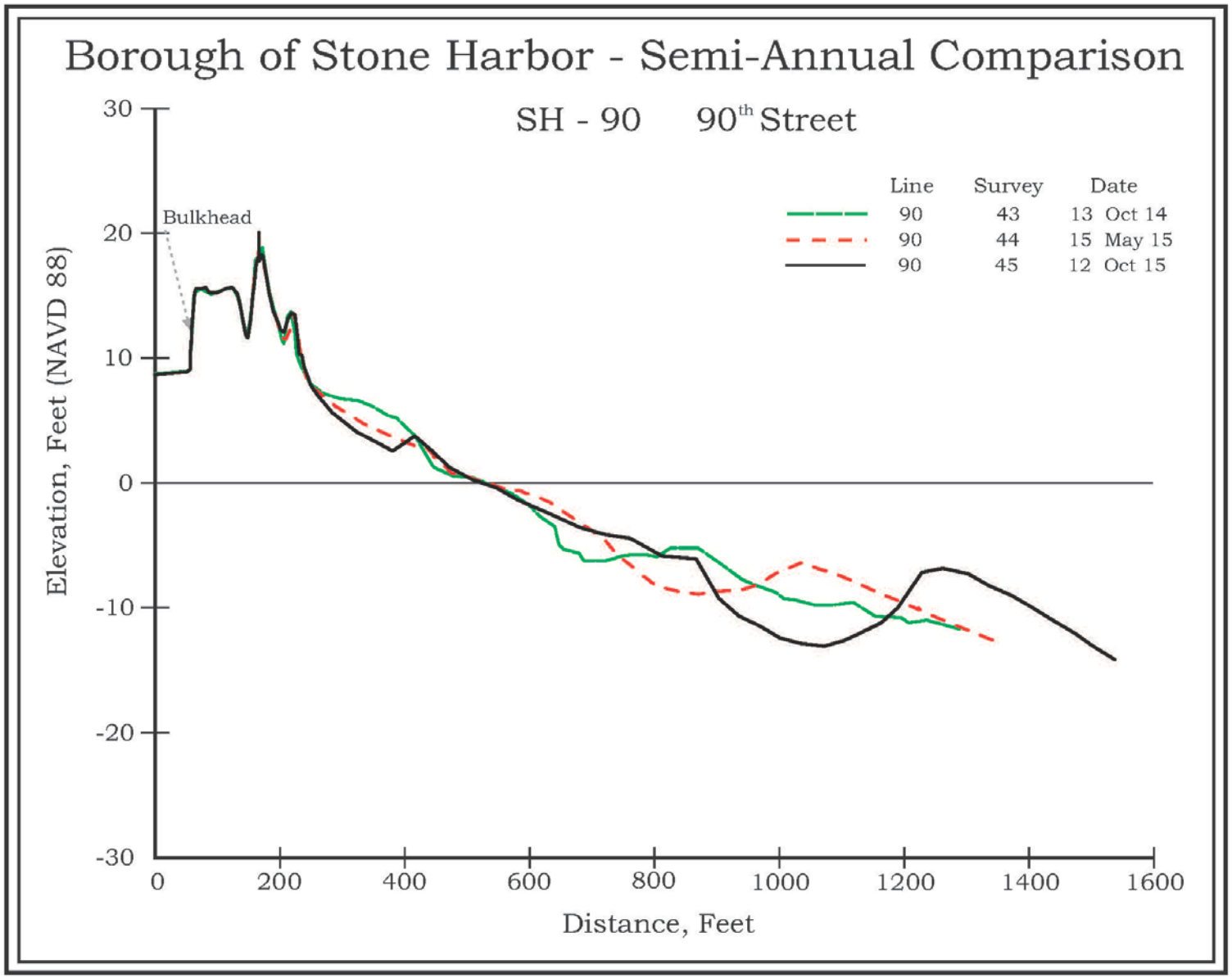

Figure 2a. The beach lost elevation, but remained the same width to the zero elevation datum. The early October 2015 northeast storm flattened the berm, but left the dune untouched until Jonas in January 2016. Note that the bar and trough offshore responded to the October storm by switching between a relatively gentle gradient between zero elevation and the end of the survey to one where there was a deep trough followed by a bar 4 feet higher than previously. The site saw a -12.21 yds^3/ft. sand volume change that did not reflect the entire bar deposit due to the length of earlier profiles.

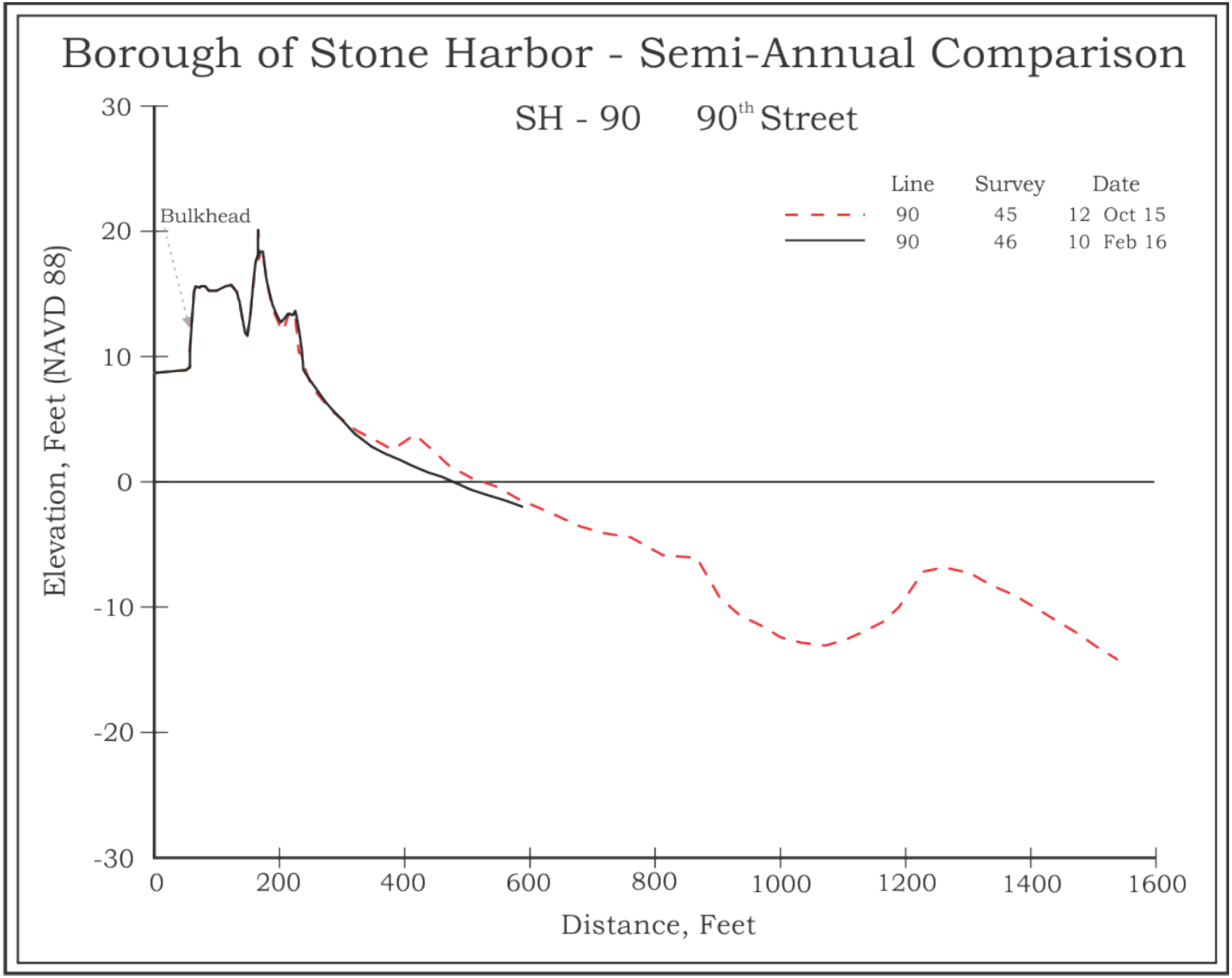

Figure 2b. Post-Jonas erosion on the beach compared to conditions from October 12, 2015, which followed 3-4 days of northeast winds. The storm related loss was 7.20 yds^3/ft. above the zero datum and 2.65 yds^3/ft. below the datum to the end of the survey line. This site suffered little dune loss.

SH-95, is located at 95th Street site was established along the north side of 95th Street and the beach access path. The profile line crosses the municipal parking lot, a wooden bulkhead, access ramp and dune located just north of the municipal beach observation platform. The dune system is essentially a single ridge that extends seaward 140 feet from the street end revetment to the seaward dune toe with a crest elevation of 15 feet NAVD88.

Site SH-95 – 95th Street (Photoplates 3a-3b)

Photoplate 3a - Photo taken May 15, 2015. View to south along the dune toe from 95th Street. A new access ramp featuring ADA access was built and withstood the Jonas storm. The erosion into the dune approximates where the individual standing at the edge of the grass is positioned in the photograph.

Photoplate 3b - Photo taken January 25, 2016 following Jonas. The access ramp was undercut and exposed. The last segment of the railing was gone, otherwise the structure was fine. The dune fencing was destroyed in both directions with 25 feet of seaward slope erosion beyond the fencing position.

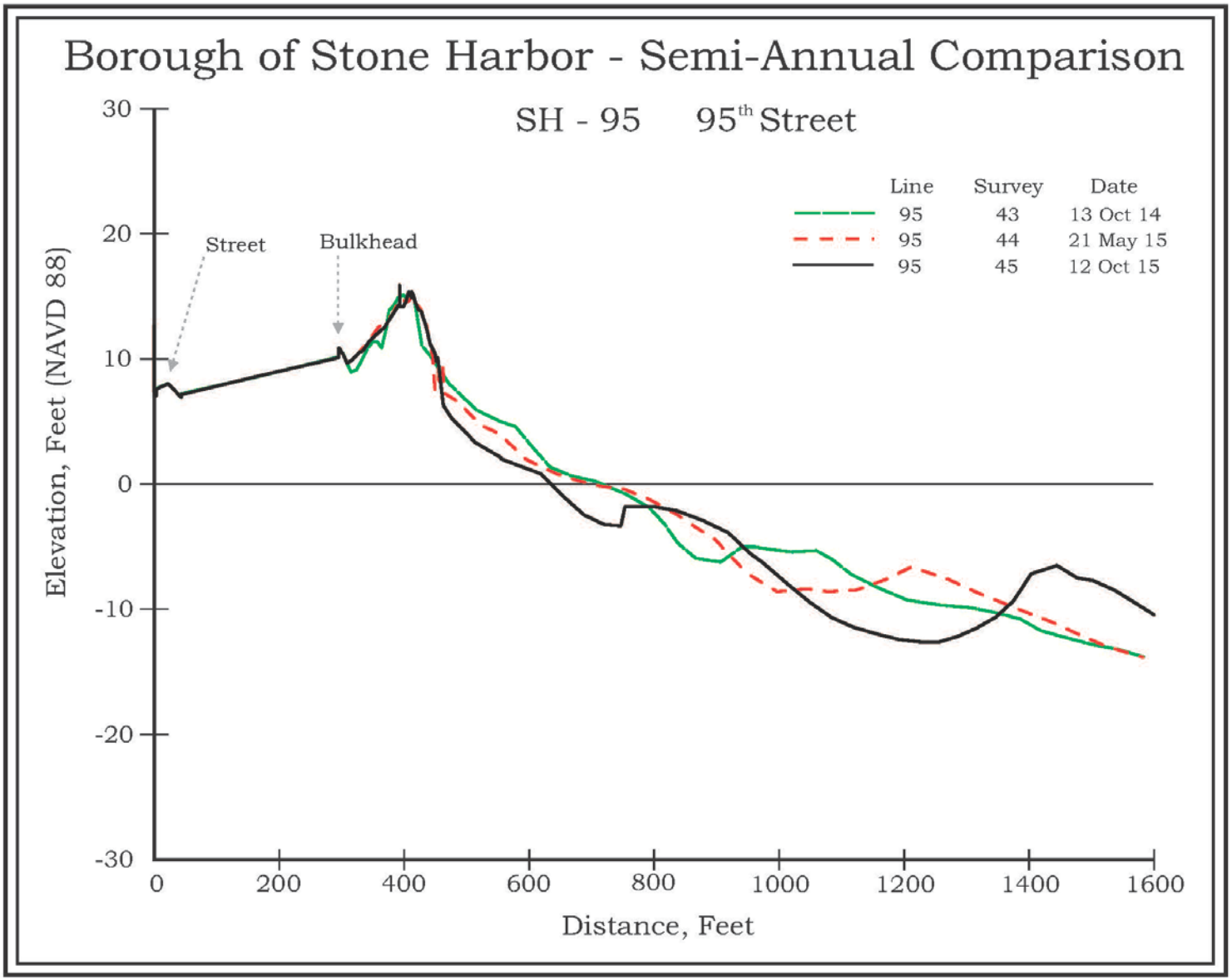

Figure 3a. At 95th Street the storm impact shows as dune erosion into the seaward toe as well as significant berm elevation loss. The shoreline retreated 67 feet (largest value documented) and the profile lost 24.02 yds^3/ft. The offshore region also developed a major trough over 400 feet wide with a 4.5-foot higher bar developed further offshore. This bar substantially reduced the net loss to the system, but recovery will require extended periods of calm wave conditions.

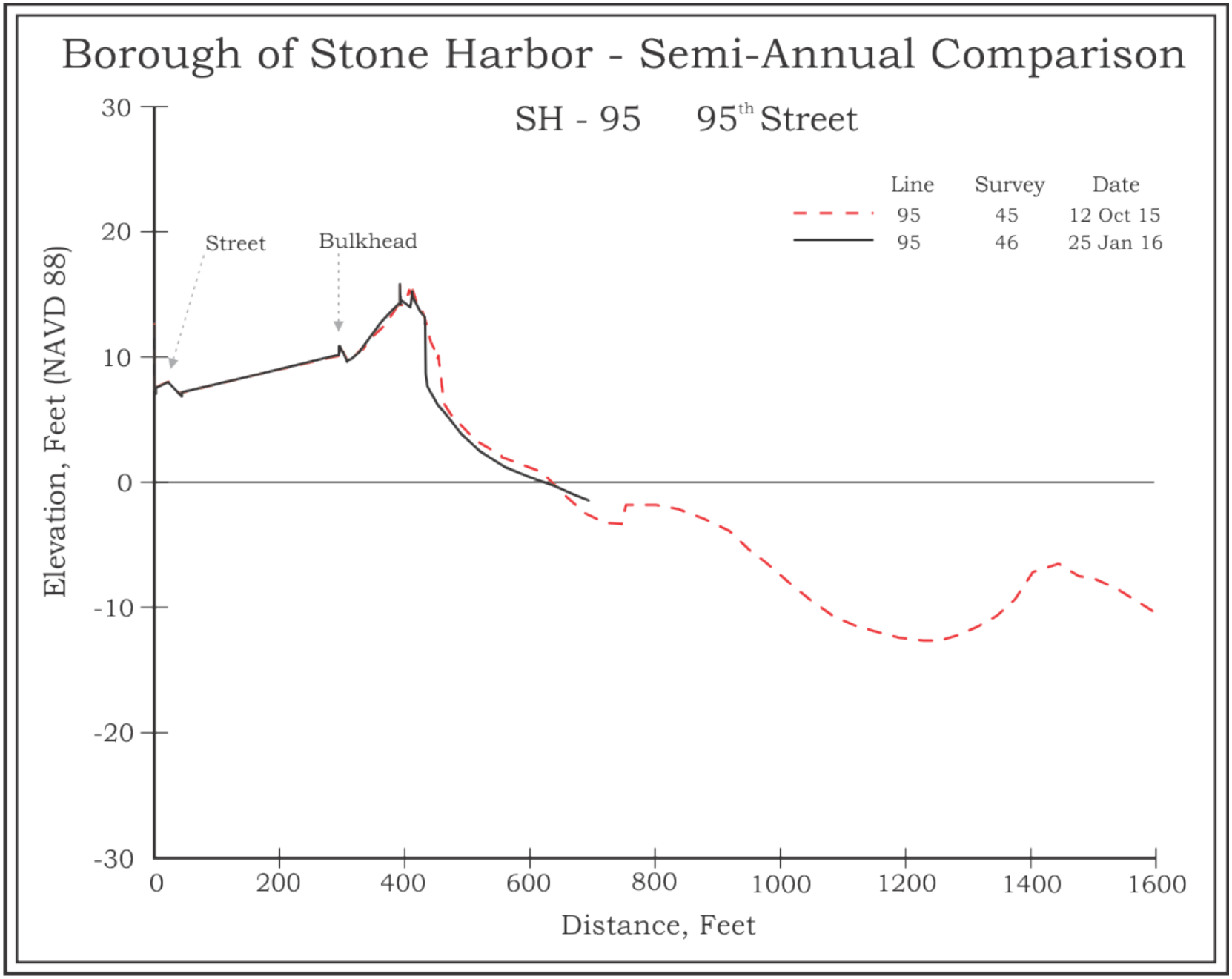

Figure 3b. Post-Jonas erosion at the dune's seaward slope and on the beach compared to conditions from October 12, 2015, which followed 3-4 days of northeast winds. The storm related loss was 7.82 yds^3/ft. above the zero elevation datum, and a small gain of 1.27 yds^3/ft. below the datum as the nearshore bar trough filled in with sand.

SH-103, is located at 103rd Street and was established for the Borough's beach monitoring program at the seaward end of 103rd Street along the north sidewalk. When the site was originally established in 1996, the profile crossed the bulkhead and dropped to the rock revetment at the toe of the bulkhead. An extremely narrow beach just seaward of the rocks provided limited recreational area for beach patrons. Storm waves and surge would overtop the revetment and cause local flooding. This beach continued to erode until by 1998 no dry beach existed seaward of the rock revetment. Sand was placed here during the 1998 municipal beach fill re-establishing a dry beach berm and dune ridge. In 2003 the initial Federal project enhanced the width of both the dune and beach. Several subsequent projects have been required to provide periodic beach maintenance that included the 2009 state/municipal project, the spring/summer 2011 federal project, and the summer 2013 H. Sandy emergency beach fill.

The early October storm severely reduced the elevation on the berm, cutting a minor scarp in the toe of the dune made significantly worse by Jonas in January 2016. The massive bar build-up continued with the deposit over 4 feet higher at the bar crest than the seafloor was previously.

Site SH-103 – 103rd Street (Photoplates 4a-4b)

Photoplate 4a - Photo taken May 21, 2015. View to the south along the dune toe from 103rd Street access pathway. The beach remained narrow from the previous fall survey. Wind-blown sand accumulated on the seaward dune slope that reduced the steep scarp and restored a gentler uniform slope.

Photoplate 4b - Photo taken August 6, 2013 (spring 2013 survey [40]). View to the south along the dune toe from 103rd Street. The 2013 USACE beach maintenance project restored the beach width and elevation to the original design template. Sand was placed on the seaward dune slope and a row of dune fence was installed to trap windblown sand.

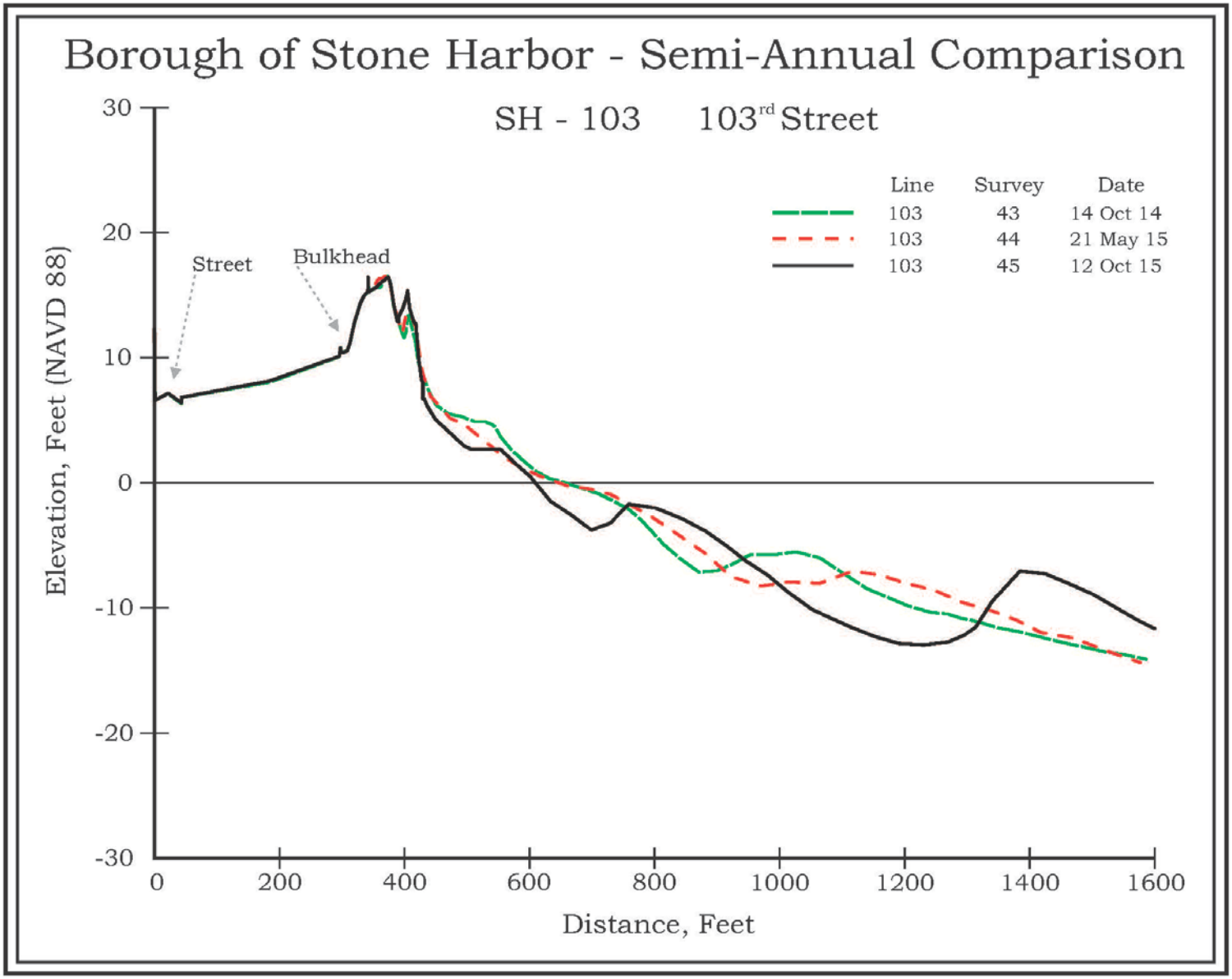

Figure 4a. Dune toe losses continued south into this groin cell as well leaving a minor scarp and a 39-foot shoreline retreat. The berm elevation was reduced similar to elsewhere and the offshore trough developed to a 400-foot wide area between 1,000 and 1,400 feet seaward of the reference location. The sand deposited in the offshore bar balanced the beach and nearshore losses yielding a -12.81 yds^3/ft. net loss, a volume easily present in the bar beyond the point 1,600 feet seaward of the street end.

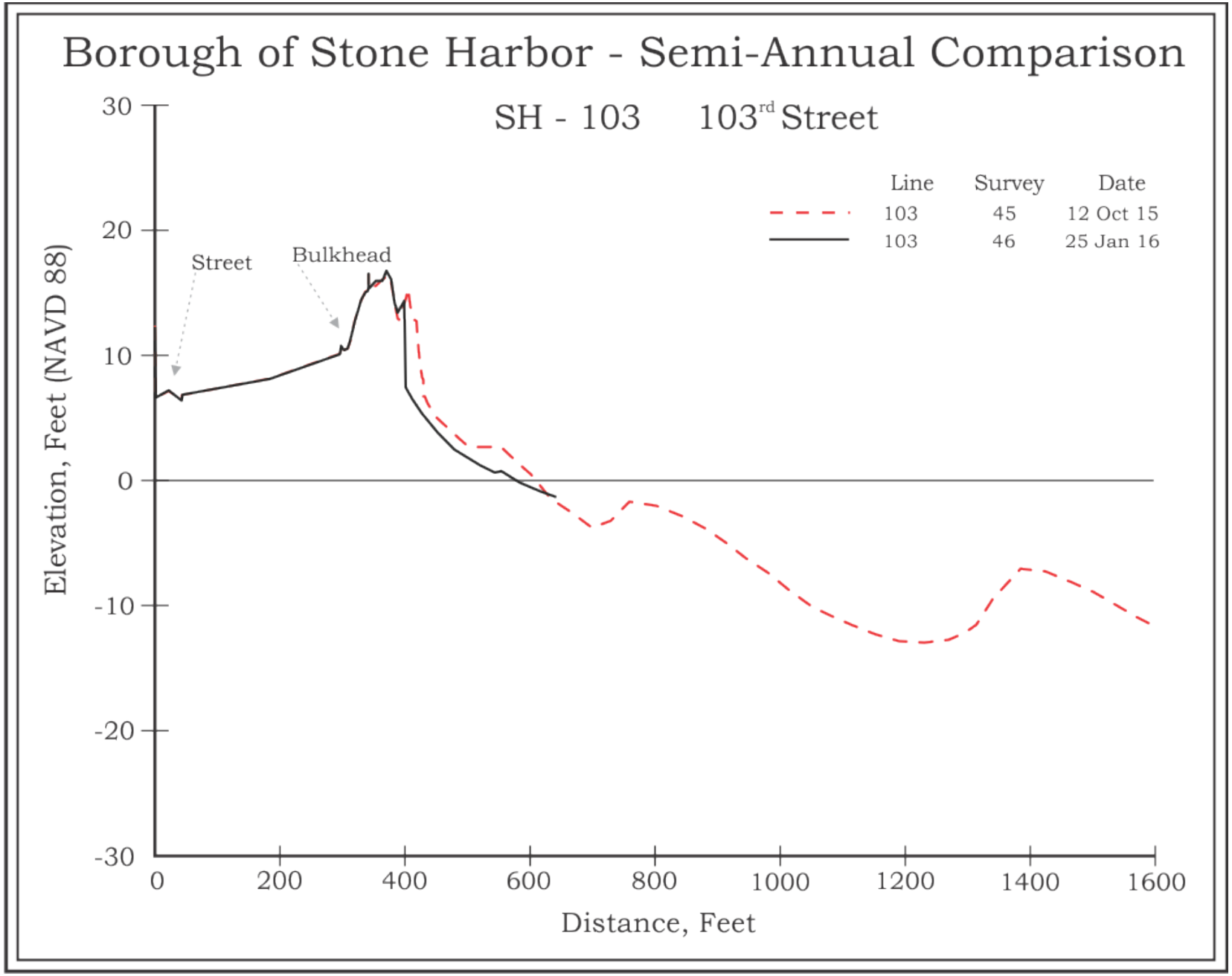

Figure 4b. Post-Jonas erosion at the dune's seaward slope and on the beach compared to conditions from October 12, 2015, which followed 3-4 days of northeast winds. The storm related loss was 14.83 yds^3/ft. above the zero elevation datum, with an additional loss of 0.46 yds^3/ft. below the datum to the end of the survey line. This dune was cut back to the landward slope of the foredune added since the ACOE project was completed in 2004.

SH-108, is located at the end of 108th Street and was placed near the middle of this groin cell. The history here is similar to site SH-103. When the site was originally established in 1996, the profile crossed the bulkhead and dropped to the rock revetment at the toe of the bulkhead. An extremely narrow beach just seaward of the rocks provided limited recreational area for beach patrons. Exposure of the rocks accelerated the beach erosion as waves refracted off the hard structure and scoured the sandy beach. Larger storm waves and surge would overtop the revetment and cause local flooding. Sand was also placed here during the 1998 municipal beach fill re-establishing a dry beach berm and dune ridge. In 2003 the initial Federal project enhanced the width of both the dune and beach. Several severe storms have impacted the Stone Harbor beaches since 2009 including Hurricanes Irene in 2011 and Sandy in 2012. Storm erosion has required subsequent periodic beach maintenance that included the 2009 State/municipal project, the 2011 Federal project and the 2013 USACE emergency project.

Berm erosion and the cutting of a scarp into the dunes by the relatively minor event in early October left the site vulnerable to larger losses during the January event (Jonas). Similar bar and trough development produced a minor net loss, but more than likely the majority if not all that volume of sand loss is to be found beyond the 1,600 foot survey distance (-27.81 yds^3/ft.).

Site SH-108 – 108th Street (Photoplates 5a-5b)

Photoplate 5a - Photo taken May 21, 2015. View to south along the dune toe from 108th Street. Wind-blown sand accumulated on the seaward dune slope.

Photoplate 5b - Photo taken January 25, 2016 showing the dune scarp at 108th Street looking south along the cut. The beach was wet to the toe of the scarp from the last high tide. Two weeks later addition erosion took place. All the dune fencing was destroyed with the storm taking all the recent deposition as well.

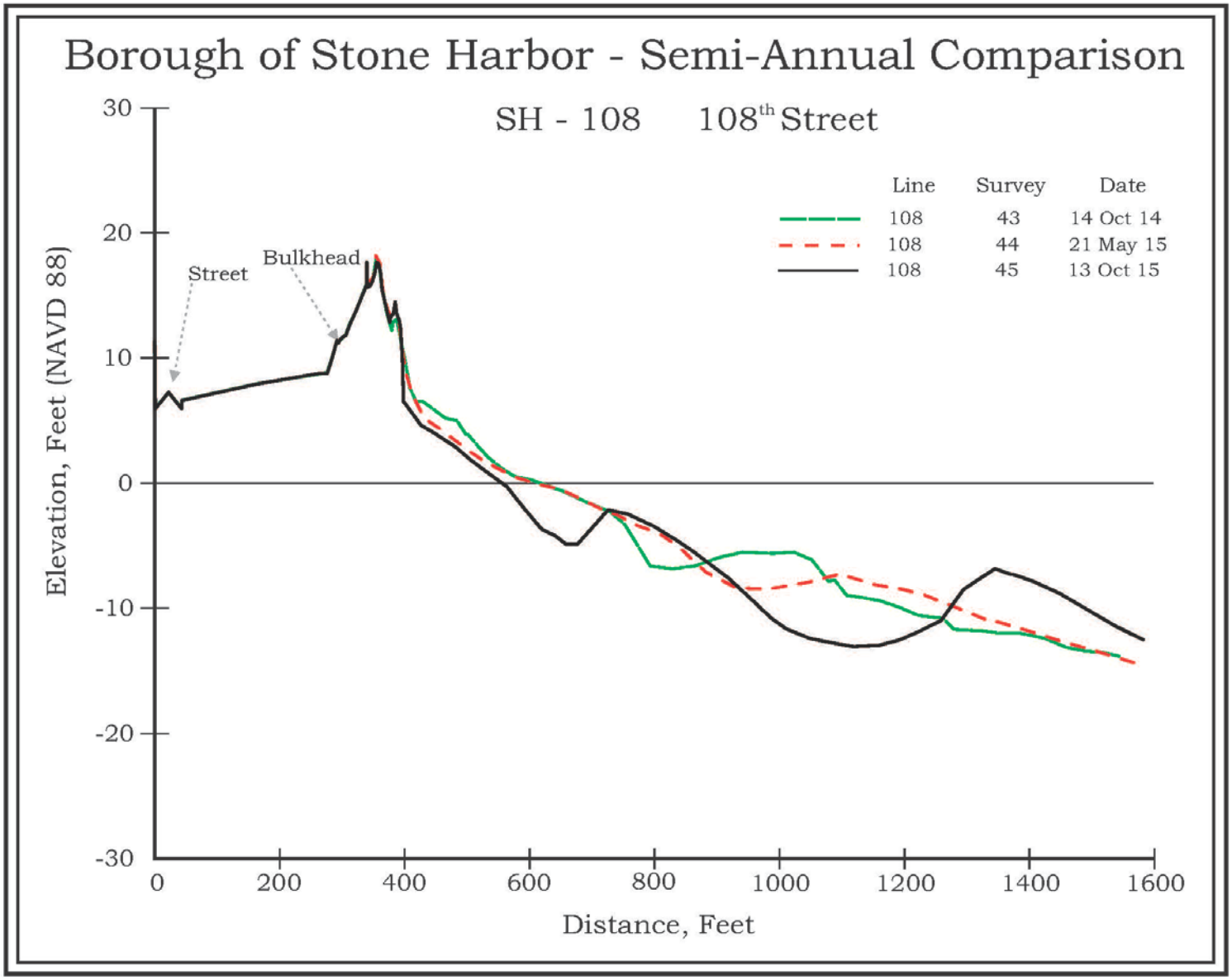

Figure 5a. Beach and shoreline retreat was 52 feet at this site. Berm elevation loss was substantial as was the scarp cut into the dunes. Jones made the situation worse, creating over a 6-foot scarp and causing additional retreat. Offshore the bar and trough situation was identical to northern sites where the sand lost from the beach was deposited offshore 800 feet seaward. The bar compensated for much of the loss leaving the net change as -27.81 yds^3/ft.

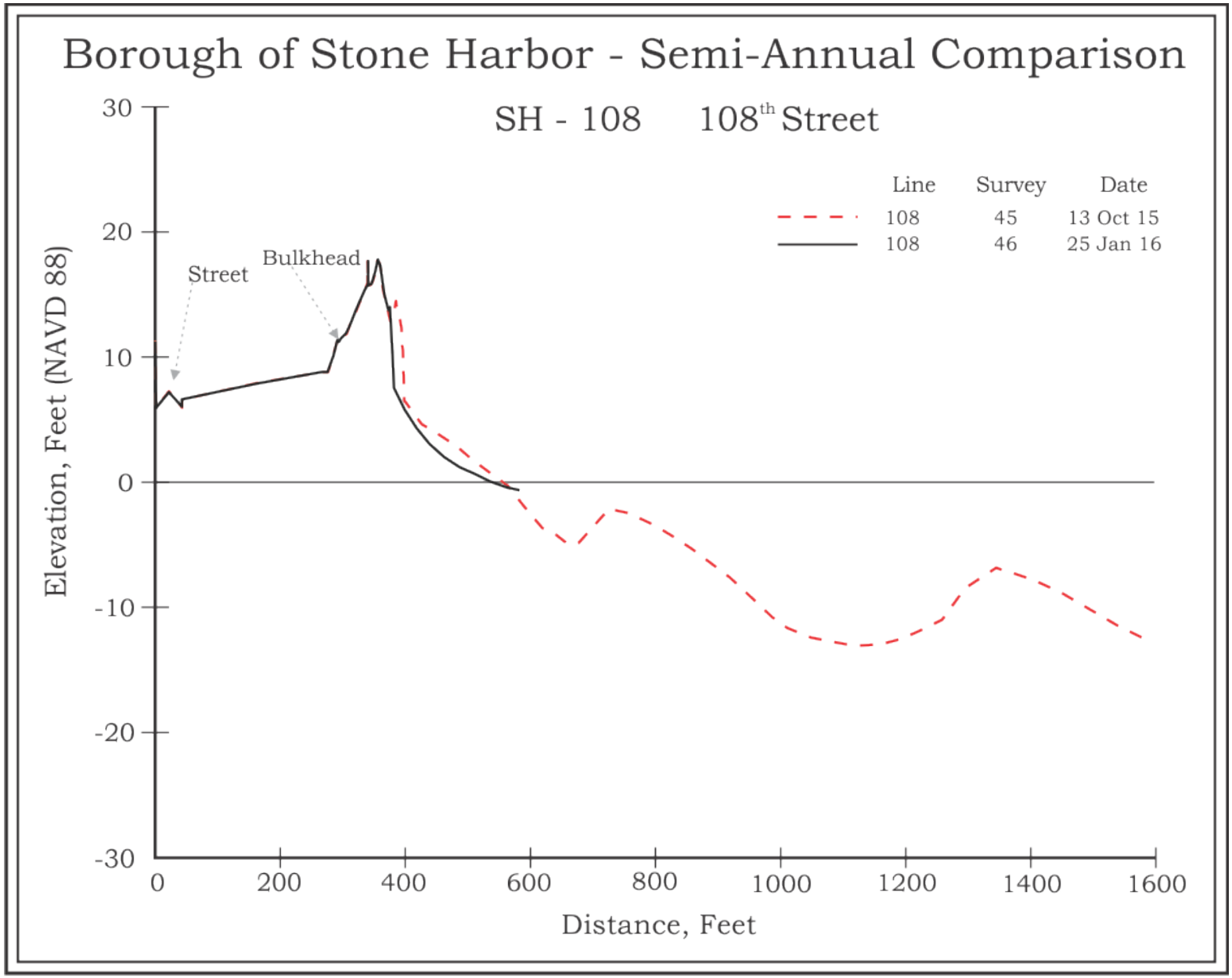

Figure 5b. Post-Jonas erosion at the dune's seaward slope and on the beach compared to conditions from October 12, 2015, which followed 3-4 days of northeast winds. The storm related loss was 9.93 yds^3/ft. from the dune's seaward slope and beach with minimal data determined below the datum (0.072 yds^3/ft.).

SH-112 is located on the open lot adjacent to the Villa Maria Catholic retreat that occupies the paper location of 112th Street. The profile line extends landward to a reference location along 2nd Avenue. An open grass lot occupies the city block between 2nd Avenue and the wooden bulkhead revetment. The wooden revetment runs parallel to the beach the entire length of the Borough along the oceanfront property lines and seaward street ends. The bulkhead is significantly offset landward at 111th Street, providing additional area for dune development to occur naturally. As a result, the width of the primary dune was nearly 200 feet from the bulkhead to the seaward dune toe.

This location has a very significant primary dune largely due to the limited oceanfront development on this parcel. Occupied by the Catholic Church as a retreat for over a century, the site has no structures directly at the landward dune toe. The dunes spill over the bulkhead and occupy most of the original dry beach that existed prior to the USACE project in 2004. The beach became steeper with the berm lowered at the seaward end, while multiple offshore bars created a wide and complex zone offshore.

Site SH-112 – 112th Street (Photoplates 6a-6b)

Photoplate 6a - Photo taken May 21, 2015. View to north along the dune toe from 112th Street. The beach was narrow but wind-blown sand accumulated on the seaward dune slope.

Photoplate 6b - Photo taken February 11. 2016 following Jonas and a second storm February 7, 2016. Note the 3 to 4-foot scarp cut into the seaward dune toe slope and the flat beach showing high tide wave activity nearly to the scarp days later. The newly accumulated foredune was removed back into the established grasses.

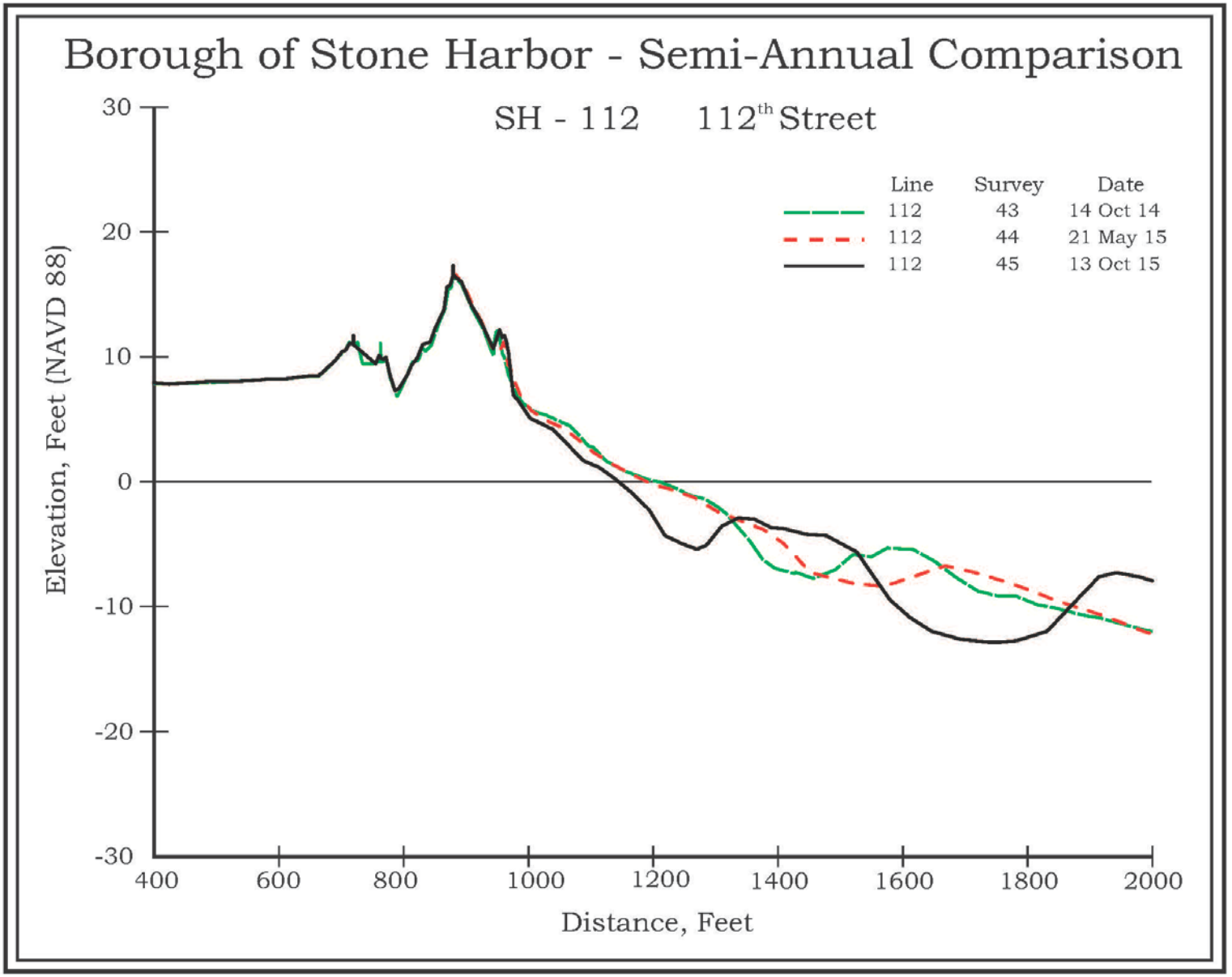

Figure 6a. The pattern of storm damage changed slightly at 112th Street where the dune remained untouched, while the berm was lowered in its gradient and the shoreline retreated 47 feet as the consequence of the early October storm. Two offshore troughs developed, the inner one at the base of the beachface with a 200-foot wide bar seaward of that trough. The deepest trough was positioned further seaward with a large bar extending beyond the 2,000-foot mark from the reference location. The site lost 15.03 yds^3/ft., but most of that sand lies further seaward than the 2000-foot marker.

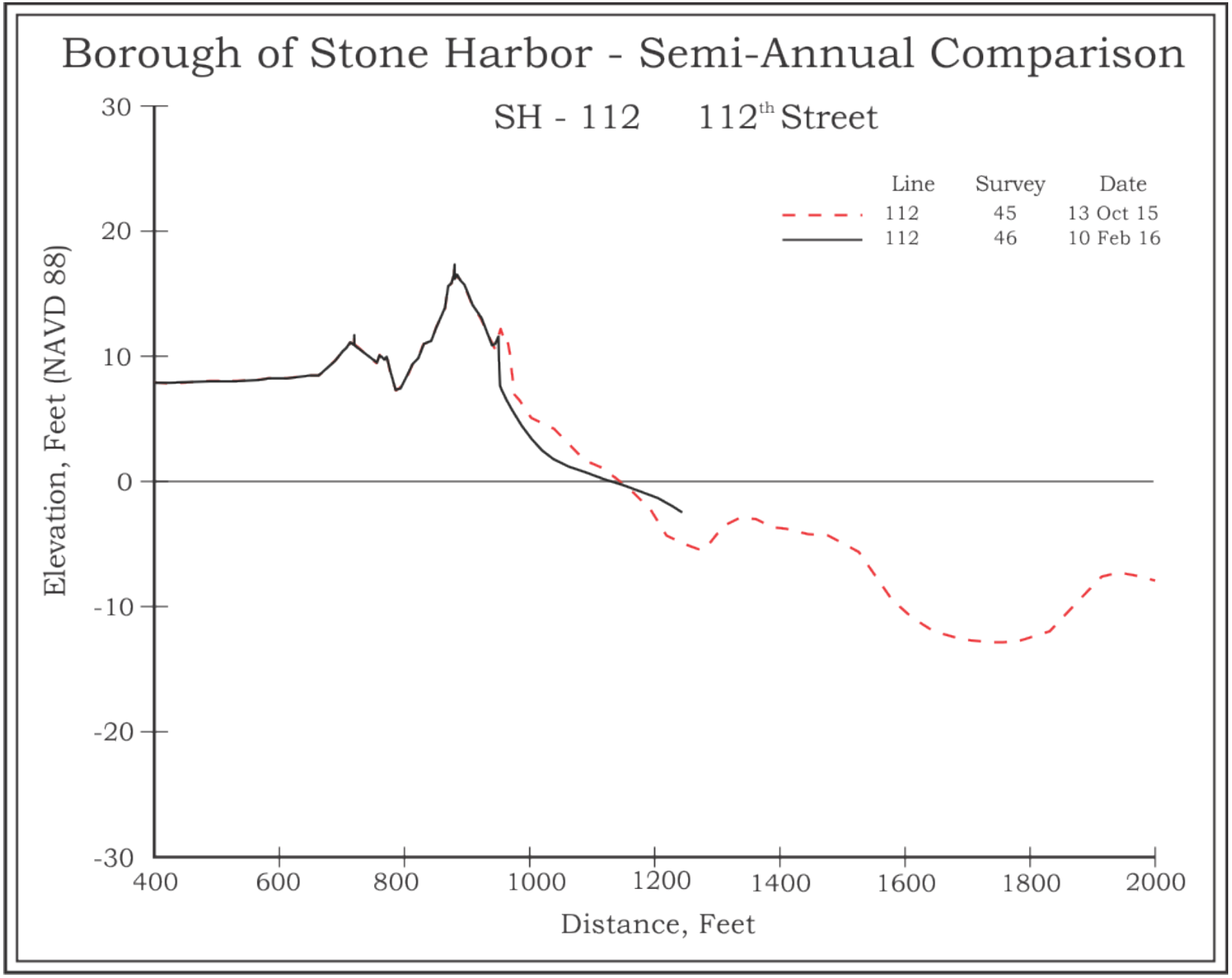

Figure 6b. Post-Jonas erosion at the dune's seaward slope and on the beach compared to conditions from October 12, 2015, which followed 3-4 days of northeast winds. The storm related loss was 12.83 yds^3/ft. from the foredune area and the beach with a 4.88 yds^3/ft. sand volume gain in the nearshore trough below the datum.

SH-116 is located along the west side of 2nd Avenue and 116th Street. Seaward of the bulkhead at 116th Street is the best-established natural dune system in the Borough. A landward offset in the bulkhead just north of this site produced the area on which this dune developed, sheltered from storm overwash by the 114th Street groin and the bulkhead offset to the west. The dune system consists of two distinct ridges with a combined width of nearly 300 feet from the street end bulkhead to the seaward dune toe with a crest elevation of 16.5 feet NAVD88.

This location did not suffer severe berm erosion, in spite of a 56-foot shoreline retreat since May 2015. There were two offshore bars that developed with the outer one containing the most sand. The net sand loss was relatively minor at 12.28 (yds^3/ft.) largely due to sand located 800 to a 1,000 feet offshore.

Site SH-116 – 116th Street (Photoplate 7a-7b)

Photoplate 7a - Photo taken May 22, 2015. View to south along the dune toe from 116th Street. Wind-blown sand accumulated on the seaward dune slope and plants began to colonize the new slope. The beach is significantly wider, a fact that benefitted the location thus far this winter.

Photoplate 7b - Photo taken February 1, 2016 following Jonas and a second, smaller northeast storm two weeks later. Note the wrack line at the toe of the dunes making the beach wet to the toe following the storms. The dune damage was relatively minor at this site

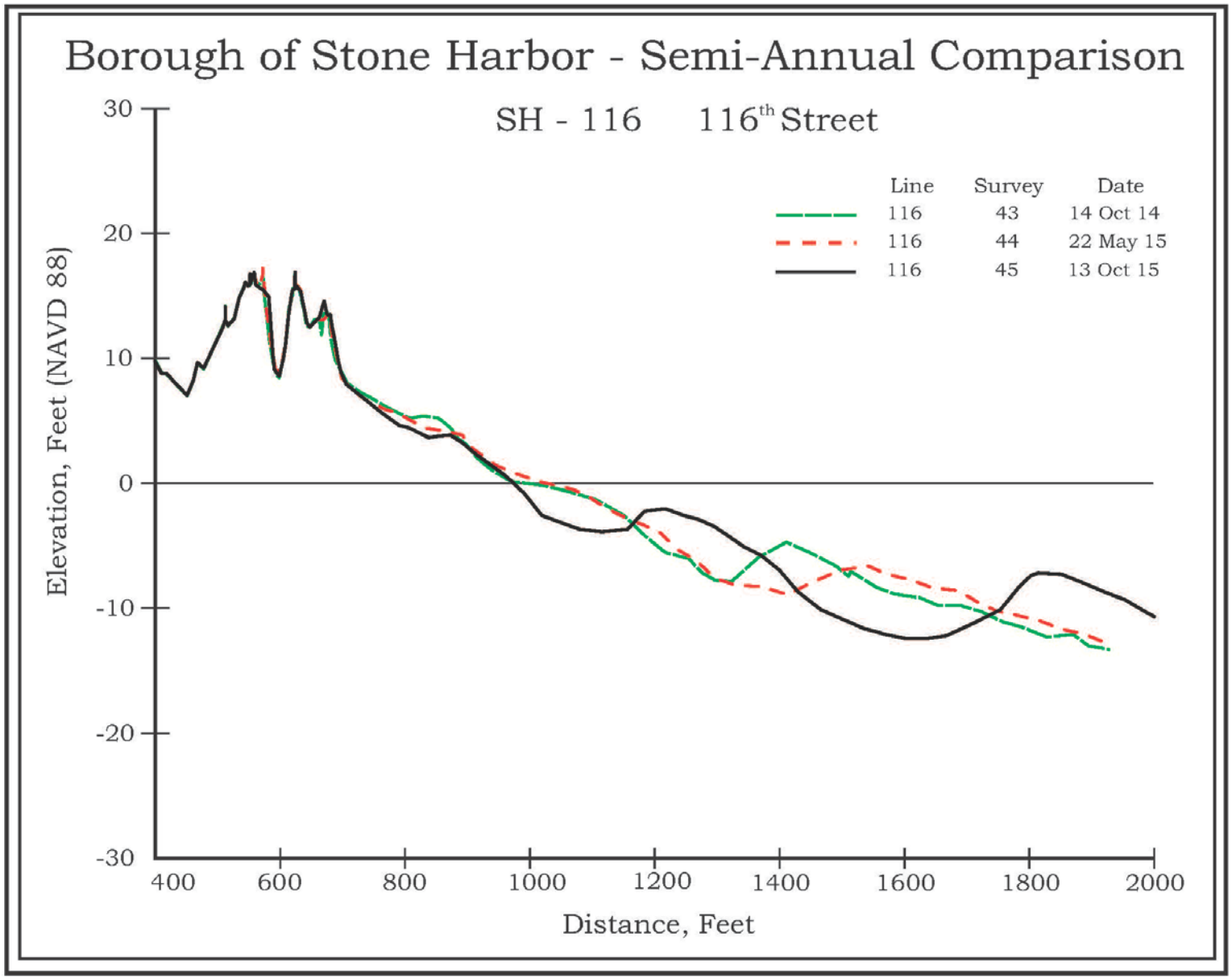

Figure 7a. 116th Street was one of three sites with low net berm losses combined with a double offshore bar system. The berm was a little lower, but the beach retreated 56 feet from the May 2015 location. The distant offshore bar reflected the sand redistribution seaward as a minor net loss (-12.28 yds^3/ft.) because the bar was still 3 feet higher than the seafloor was previously at the 2,000-foot distance.

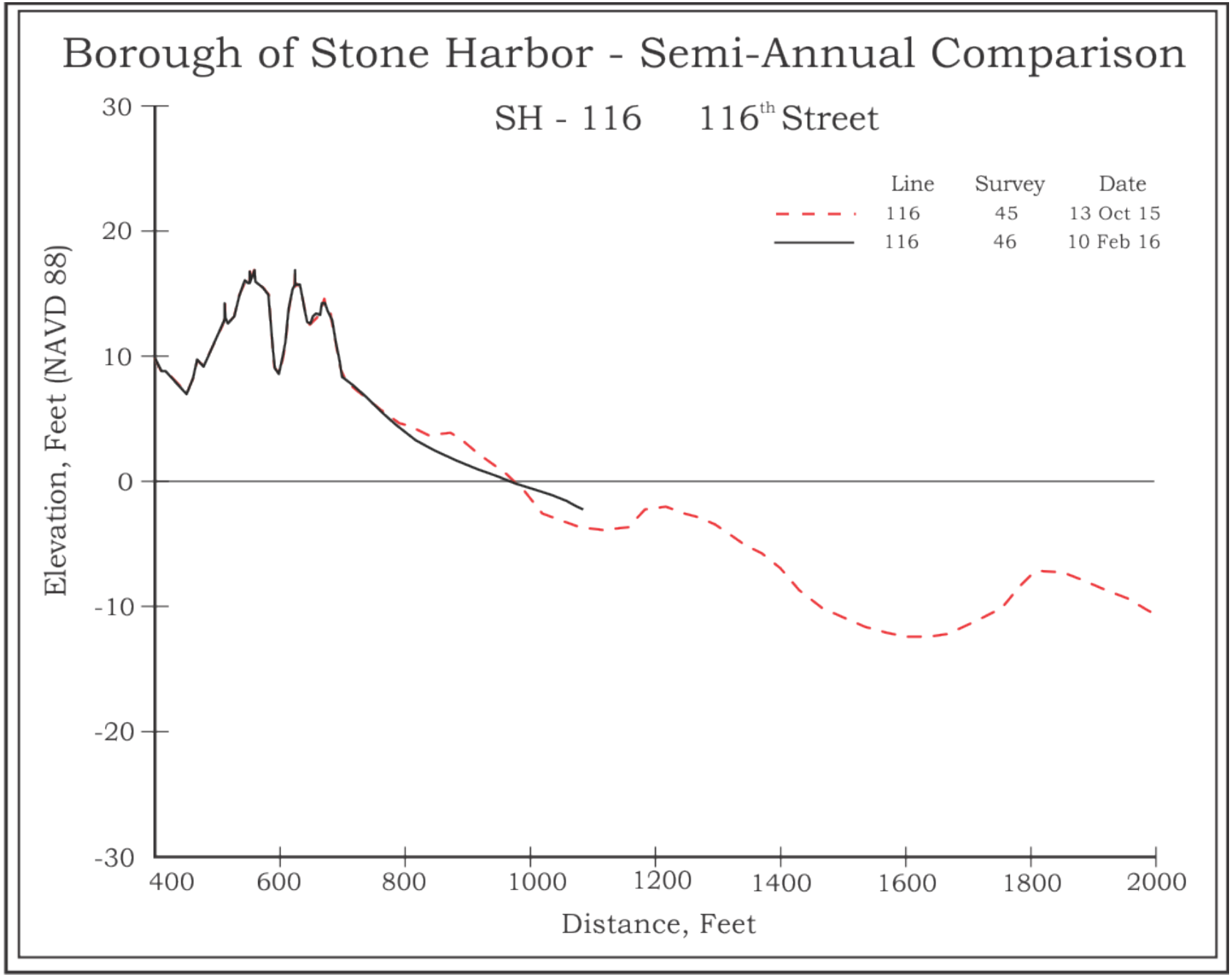

Figure 7b. Post-Jonas erosion on the beach compared to conditions from October 12, 2015, which followed 3-4 days of northeast winds. The storm related loss was 7.28 yds^3/ft. eroded from the beach above the zero datum elevation. The deposit offshore filled a nearshore trough yielding a 5.27 yds^3/ft. sand volume gain to the end of the survey line.

SH-123 is located at 123rd Street south of the developed part of town and just north of the terminal groin originally constructed by the Philadelphia District of the U.S. Army Corps of Engineers (USACE). In 1994, the site was added to the NJBPN as part of an expansion of the State's monitoring project and as a replacement cross section for former site #112 that was erased from South Pointe by weather events in 1990 where the entire natural zone south of the terminal groin was eroded to a shoal below low tide. Because of this prior history of data collection and its proximity to Hereford Inlet, this site was included in the Borough's beach monitoring project. The profile reference marker is located in a dense stand of bayberry west of a vehicle access path to the Hereford Inlet terminal groin.

This region has benefited tremendously since the completion of the initial USACE project both from direct sand placement and from longshore currents that have carried a substantial volume of sand shed from the northern project beaches south toward South Pointe. The result has been a larger dune system that now completely buries the revetment once exposed along this beach and the formation of an expansive point that stretches over a mile from the terminal groin into Hereford Inlet. However, like the other Borough project beaches this location suffered significant erosion of the dry beach berm and dune during Hurricanes Irene and Sandy and several northeasters.

This problem continued in 2015 into 2016 as two northeast storms acting to cut a steep scarp into the dune, and remove the berm elevation leaving a broad, flat beach instead. Sand was transferred offshore into multiple bars and produced a net loss of 20.96 yds^3/ft. The 62-foot shoreline retreat was the second highest value after the 95th Street loss of 67 feet. The storm damage has been substantial with 6 weeks of winter yet to go.

Site SH-123 – 123rd Street (Photoplate 8a-8e)

Photoplate 8a - Photo taken May 22, 2015. View to northeast across the dune crest from 123rd Street. Note the catamaran poles and the newer dune fencing on the foredune slope. The bench to the crest elevation is to the left in the picture.

Photoplate 8b – Photo taken January 25, 2016 following Jonas. The scarp was 8 to 10 feet high and the seaward dune toe was cut back to within 20 feet of the bench up to the crest. The beach was flat and wet to the toe on the last high tide.

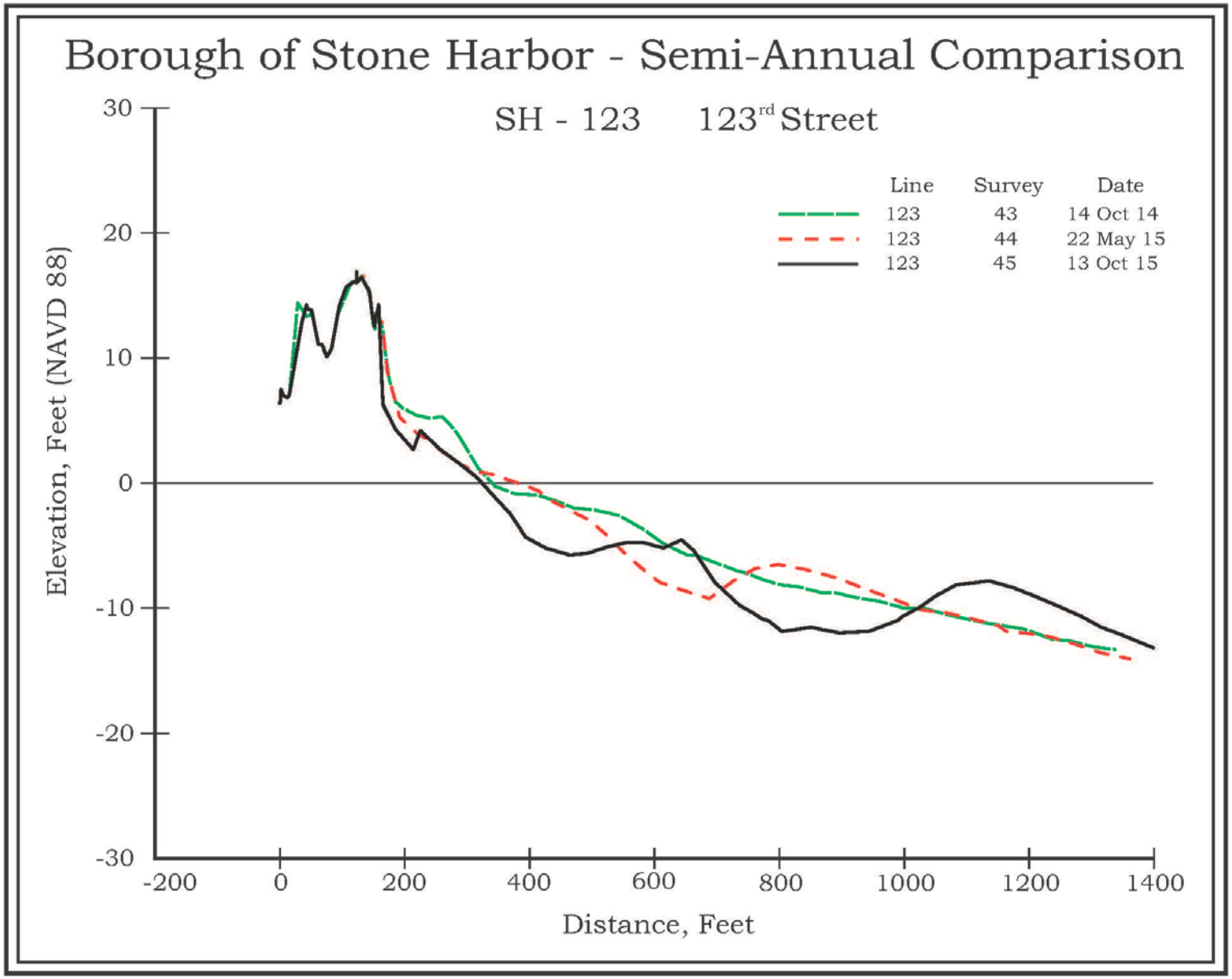

Figure 8a. 123rd Street suffered dune toe erosion and the loss of the summer berm during the early October 2015 northeast storm. Sand was moved offshore forming two bars, one at 600 feet seaward and the second at 1,200 feet seaward of the reference position. In late January the dune scarp became worse with elevations approaching 15 vertical feet and retreat into the upper seaward slope. The beach was flat and wet to the dune toe following Jonas.

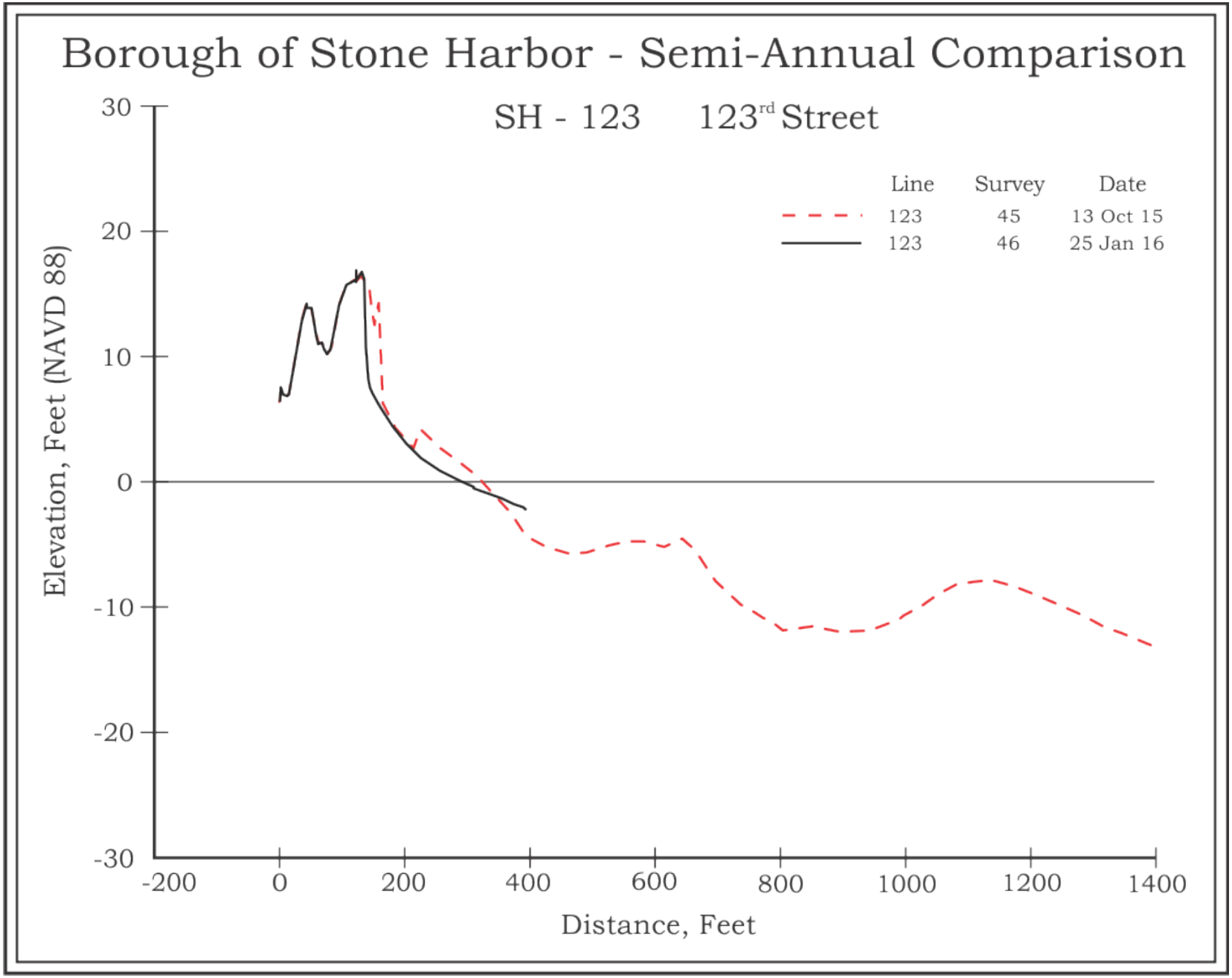

Figure 8b. Post-Jonas erosion at the dune's seaward slope and on the beach compared to conditions from October 12, 2015, which followed 3-4 days of northeast winds. The storm related loss was 12.37 yds^3/ft. from the dune's seaward slope and the beach with a 1.11 yds^3/ft. sand volume gain below the datum to the limit of the survey line. This location suffered the most dune erosion with the highest scarps in the Borough, but the sand volume taken was not the most extensive.

Summary

This monitoring report documents the changes to the Stone Harbor municipal beaches from October 2014 to October 2015. The beaches suffered from what has been determined to be a 10-year event in late January 2016 named Jonas. Jonas had 65 MPH winds and occurred during a spring tide producing the worst tidal flooding since Hurricane Sandy. Hurricane Sandy accounted for the removal of 380,859 cubic yards of sand from just the dune and beach not including nearshore losses. Much of the eroded sand has moved south to Hereford Inlet extending the South Pointe beaches into the inlet to a point just 450 feet from the revetment rocks in North Wildwood's side of Hereford Inlet.

Loss rates continued to be storm-generated up to and including NE storm Jonas and a subsequent storm of less intensity two weeks later. Emergency surveys provide data showing 136,697 cubic yards of sand lost from the dune's seaward slope as compared to conditions present October 12, 2015 (largely from the foredune developed since the ACOE project was initially completed in 2004). The remainder of the sand was eroded from the beach berm and distributed seaward and to the south. Sand was washed over the 123rd Street groin in a wave-generated "river" created as the waves hit the groin and the dune scarp combining where the groin intersects the beach to rush over the structure transporting large sand volumes seen as a spit deposit on South Point. Jonas completely over-washed bird nesting elevation sand pads built last season to try and limit tidal flooding of the nests. Work is currently in progress to re-establish similar pads a foot or so above mean high tide to increase nesting success.

The emergency re-nourishment effort by the USACE for Stone Harbor was initially authorized following Irene then expanded to include damages suffered during Hurricane Sandy. Work to restore the project to its original template design commenced within six months of Sandy. During late spring and summer 2013, Norfolk Dredging Company contracted by the USACE completed work on the municipal beaches. Surveys conducted by the CRC before and after the project show a placement volume of 715,346 CY of sand (211,850 CY of sand above the pre-Sandy conditions). Beach berm elevations were raised to 7.5 feet NAVD88 and extended seaward from the dune toe by up to 220 feet. Public Law 113-2 (June 2013) allowed the USACE to fully fund the re-nourishment with federal dollars saving the state and local governments from covering the project cost. The emergency funding also financed planting dune grass, installing sand fencing, and beach crossover work in the project area.

Effort is in progress to provide restoration funding related to northeast storm Jonas and its aftermath because the dunes end at a beach elevation barely above normal high tide. The goal is to build a berm that will protect the dune into the future.

Conclusions & Recommendations:

Although the area of South Pointe is a valued natural area and shore bird habitat, the region represents a vast source of potential sand to harvest in a sustainable manner to mitigate the annual losses within the developed section of Stone Harbor. As more sand is placed into the system on the northern beaches, erosion and littoral currents combine to transport the sand shed from these beaches south toward the South Pointe spit resulting in its continued growth.

This winter's storm erosion of the federal project demonstrates the need to provide regular maintenance of beach nourishment projects to maintain a higher level of storm preparedness. The recommendation from previous years to recycle the sand from South Pointe remains valid and is the best alternative to continued reliance on large scale nourishment projects triggered only after the beaches degrade to a critical level to warrant federal (USACE) maintenance projects.

The CRC conducts annual surveys of Hereford Inlet and the surrounding shoreline as part of an ongoing monitoring program for the State of NJDEP BCE (Bureau of Coastal Engineering). These surveys have

revealed that the South Pointe spit continues to grow in width, elevation and length as additional sand shed from project beaches in the north moves south carried by the dominant direction of littoral currents. The point has continued to grow at a rate of about 500 feet a year accumulating in an advance of 7,200 feet since 2006, and is now well over a mile long stretching from the terminal groin south of 123rd Street to the tip of the point.

Recommendations as result of recent events have not changed significantly from previous reports.

- Minimal dune slope losses at two sites are offset by moderate loss from the remaining six sites to the accumulated dune sand transported into the dunes following beach restoration. The storm-generated losses can be replaced with berm construction followed by either toe fencing or a round of bulldozing berm sand into a restored seaward slope.
- The zigzag pattern of the installed fence forced deposition of the wind-transported sand seaward and lower in elevation on the upper seaward toe slope of the dunes. This pattern prevents excessive elevation to the primary dune. Fence installation should follow recommendations summarized in past CRC reports as obtained from the USDA circular defining the installation of fence and planting of American beach grass. CRC could provide additional copies if needed.
- New regular interval maintenance efforts including sand harvesting and transfer from South Pointe to the project area should be considered to maintain the beach near its full design template through recycling longshore erosional losses to reduce the frequency of large scale beach nourishment projects and increase the resiliency of Stone Harbor's dune and beaches in future storm events.
    - Issues would be: Determining the regions on South Point least likely to impact the bird habitat.
    - Depths of excavation into the beachface allowed.
    - Sand volume extracted from each excavation zone on the beach.
    - Extent along the beachface for each excavation zone.
    - Timing of the work to allow natural shoreline adjustment to erase the impacts before March 1st.
    - Designing a project palatable to both the NJ Endangered Species Program and the US Fish & Wildlife Service.
    - We do not expect enthusiastic support from the USF&WS or NJ Endangered Species program staff for any South Point sand harvesting, but it might be worth the effort to make an initial request.
- It is recommended to deposit all maintenance sand on the northern portion of groin cells because sand tends to move south between the cells fairly quickly.
- This year sand augmentation is possible as the bayside lagoon dredging proceeds using hydro-cyclones to separate sand from silt in the lagoon sediment being removed, cycling the sand obtained this way out to the oceanfront beaches. The sand volume will be far less than the quantity needed to restore the design template, but will provide modest input. The CRC is tasked with monitoring this effort.