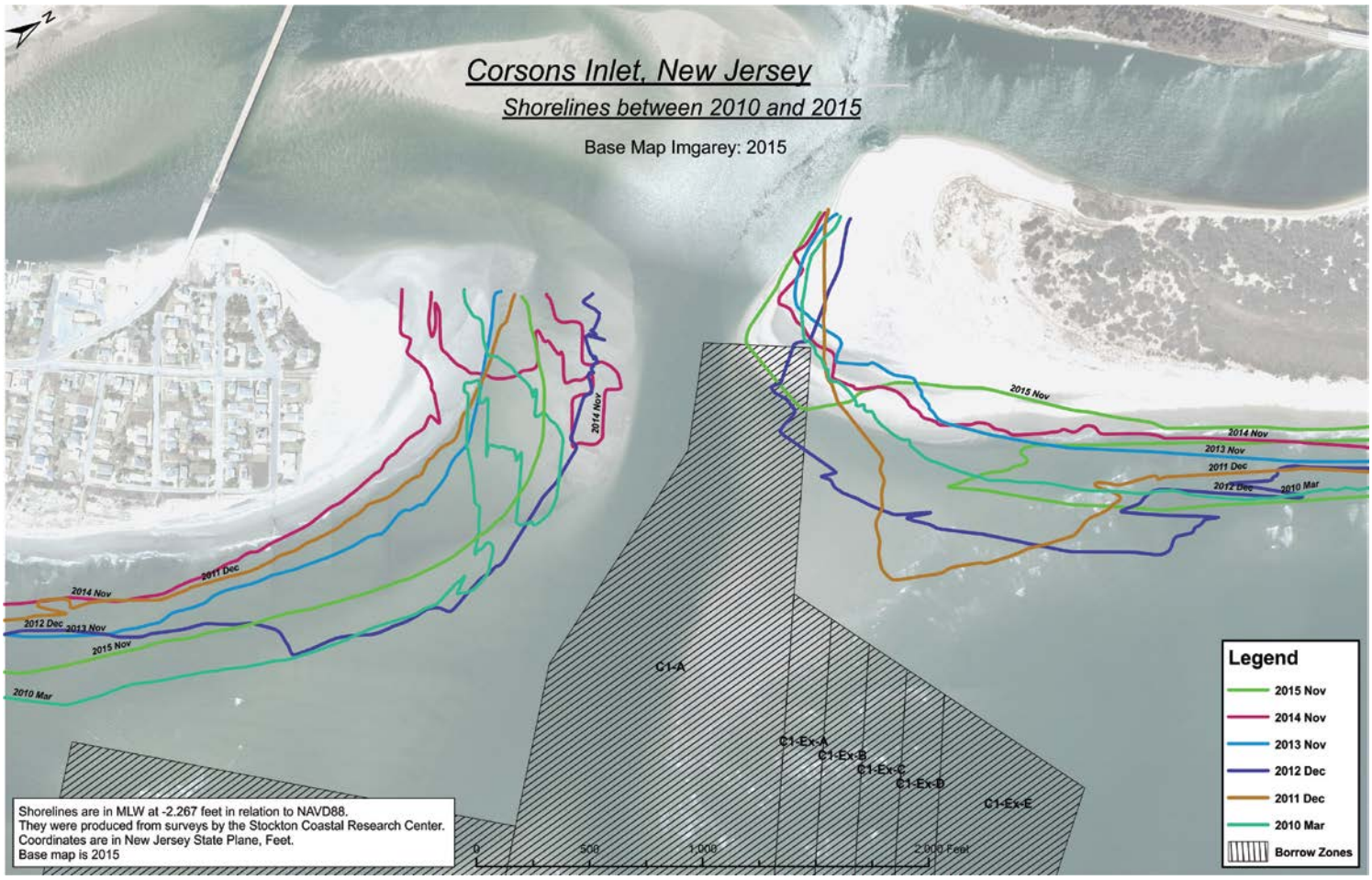
FINAL REPORT FOR 2015
ON THE CONDITION OF THE MUNICIPAL BEACHES
IN
THE TOWNSHIP OF UPPER, CAPE MAY COUNTY, NEW JERSEY



Aerial photograph at Corson's Inlet depicting the annual shoreline positions of the southern end of Ocean City, NJ and the northern portion of the Strathmere beaches. By design, the main tidal channel flows through the borrow zone (diagonally-hatched lines). The shoreline retreat in northern sections of Strathmere's municipal beaches and the State Park regions that existed in 2014 has since reversed this position seaward as displayed in the November 2015 shoreline. On the Ocean City side, the shoreline advanced into portions of the borrow zone by November 2015.

PREPARED FOR: THE TOWNSHIP OF UPPER
PO BOX 205
TUCKAHOE, NEW JERSEY 08250

PREPARED BY: THE STOCKTON UNIVERSITY COASTAL RESEARCH CENTER
30 WILSON AVENUE
PORT REPUBLIC, NJ 08241
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Annual Report for 2015
To
The Township of Upper On the
Condition of the Municipal Beaches

Introduction

This annual report presents the status of the beaches and inlet (Corson's) within the Township of Upper for 2015. Hurricane Sandy pulled substantial quantities of sand from the beaches and dunes north of Corson's Inlet in Ocean City. This material partially returned to the beach, but much of it migrated south on prevailing littoral currents to the ebb-tidal shoals of Corson's Inlet, where deposition of that sand along the northern channel margin produced migration of the tidal channel to the southwest toward both the NJ State Park at Corson's Inlet and the municipal oceanfront between Seacliff and Seaview Avenues along the beach. This subsidiary channel had migrated close to the northeast corner of the Township municipal beach generating an erosional scarp that had re-exposed the steel sheet piling and revetment rocks installed under emergency events in 2008 prior to the 2009 NJ State and locally sponsored beach restoration project. This erosional sequence paralleled conditions observed between late 2007 into 2008 that lead to the 2009 restoration. In Upper Township an erosional zone north of Winthrop extending into the NJ State Park began in January 2014 and progressively became worse, reaching critical concern in early July 2014. The elevations on the large armor stones at the steel wall had dropped several feet due to the combination of settling under wave action and the lack of a supporting foundation under the placed rocks. Favorable winds from the northwest becoming southeast dominated much of December, allowing sand to be transported to the vulnerable areas at the northern beaches (Seaview Avenue). The result, as seen in the cover photograph taken December 28, 2014, is a dry beach at the foot of the armored rocks in front of the steel wall as well as a significant lobe of sand protruding north towards Corson's Inlet.

Over the course of the last six years there has been five Presidential disaster declarations made for New Jersey's coast in response to three northeast storms and two hurricanes, starting with a strong northeaster November 11-13, 2009 to most recently Hurricane Sandy on October 29, 2012. A Presidential disaster declaration was not issued for the offshore passage of Hurricane Arthur on July 4, 2014. However, the dune at the northern end of the island retreated about 100 feet and exposed the Seaview and shore-parallel Neptune Avenue to direct erosion. Each of the previous Presidential declarations has allowed the Township to be eligible for FEMA reimbursement under Category "G" losses to an engineered beach project to share the cost of sand replacement following each storm event. The Township of Upper oceanfront shoreline and nearshore bathymetry were surveyed by Stockton University Coastal Research Center (CRC) to document changes in shoreline position and volume from these storms and over the past year. This annual report presents a discussion of shoreline changes and performance of the engineered beach and surrounding areas.

The overall trend, as depicted in the Elevation Change Maps for the time periods from October 2014 to July 2015 and July 2015 to October 2015, was that of an accreational zone at both the northern State Park region and Township Municipal oceanfront beaches during the first half of 2015 directly due to the USACE funded beachfill, and an erosional zone along the Townships oceanfront beaches as well as the State Park region for the second half of 2015. Between October 2014 and July 2015, cumulative volume gains between the two regions amounted to 1,473,740 cu. yds. The vast majority of the gain took place on the Townships beaches (1,108,010 cu. yds.), while 52,770 cu. yds. were gained in the State Park. Erosion had taken place following the beachfill project, with total losses amounting to 551,540 cu. yds. recorded between July 2015 and October 2015 (431,600 cu. yds. Township beaches).

2015 Storm Activity

In early 2015 a winter storm brought snow, tidal flooding, and beach erosion to portions of the oceanfront beaches. The spring season was free of any significant storm events but there were periods of northeast wind conditions that moved sand along the shoreline. On October 2, 2015 a three-day northeast episode commenced that never exceeded a 25 MPH wind speed, but remained constant until the 5th. No other storm events were recorded for the remainder of 2015. In fact, December was the warmest December on record with over 70 degree temperature days.

Engineered Beach Overview

To review, an initial beach nourishment project co-sponsored by the Township and the New Jersey Department of Environmental Protection (NJDEP) was completed in October 2001 that placed 461,000 cubic yards of sand on the beach. This initial project was followed by a more comprehensive joint project in August of 2009. The extent of the work ran from the municipal boundary at Corson's Inlet State Park (100 feet north of Seaview Avenue) and extended south to the boundary with Sea Isle City. A total of 688,000 cubic yards (CY) of sand was used to construct dunes and berm on approximately 9,000 feet of Ludlam Island's shoreline. Since completion of the 2009 project, there have been five Federal disaster declarations. The declarations include: November 2009 Northeast Storm (DR-NJ 1867); the March 2010 Northeast Storm (DR-NJ 1897); and a December 26, 2010 Northeast Storm (DR-NJ 1954). Following Hurricane Irene (DR-NJ 4021), there was yet another loss of 106,949 CY of sand from the Upper Township beaches. All individual disaster assessments were combined in 2011 and maintenance nourishment conducted in late fall of 2011 and completed in winter 2012. Weeks Marine Inc. was the contractor for the 2011 beach restoration project and utilized the designated Corson's Inlet borrow area as a sand source, work commenced in November 2011. Sand was placed on the beach, surf zone and nearshore on northern Ludlam Island both in the Corson's Inlet State Park and from the Township boundary, south to Williams Road. The mid-section was deemed to be at the original design width and elevation, so sand was added south of Tecumseh Avenue from approximately Survey Line -12+00 to the municipal boundary with Sea Isle City. The restoration project was completed in January 2012.

Within this report the Elevation Change Maps created from the surveyed topography and volume calculations are separated into two regions (Figures 12 & 13). The State Park, extending from the northwest portion of Corson's Inlet around to the bulkhead located just north of East Seaview Avenue, and the Township beaches, extending from East Seaview Avenue to a point just north of First Street in Sea Isle City.

Beach Monitoring Program Methodology

The beach monitoring program extends back to June 1995 when the Township of Upper requested that the CRC design and establish a means to provide information on coastal zone management issues within the municipality. Initially, six sites were selected to survey and allow calculations to provide information on beach behavior. In 2009, three additional beach profile stations (UT-21, UT-31, and UT-7) were established in sections that did not have profiles to monitor sediment movement within groin compartments and along Corson's Inlet. A decision was made in 2009 to discontinue the 9 traditional sites and instead monitor the 200-foot spaced baseline cross sections used during construction of the 2009 Upper Township beach nourishment project to quantify sand volumes required and placed and meet monitoring requirements for FEMA category G beach. The time interval between surveys was increased to six months from the quarterly interval previously used.

The data presented in this report evaluates the performance of the engineered beach over the 2014 to 2015 year. Each profile survey (cross section) includes the dunes, beach and nearshore to approximately -12 feet (NAVD88). The profile locations are spaced 200 feet apart along the inlet and oceanfront south to the Sea Isle

City boundary with Strathmere. The fact that sand volume changes often occurs further seaward than effectively reached by swimming from shore, a vessel was used to survey the outermost 1,500 feet of each cross section at the same time the beach work occurred during the fall 2015 survey effort. The vessel employs RTK-GPS technology linked to a digital depth recorder through "Hypack" software to generate bathymetric data along the traverse line with a tidally-corrected NAVD88 elevation and NAD 83 horizontal control NJ State Plane Coordinate value for each point. All the data were transferred to Arc GIS software and a series of Digital Elevation Models were created and superimposed on the latest available digital aerial imagery to show the scope and nature of the changes recorded between surveys. In addition cross-sectional plots were provided to show two dimensional changes to the dune, beach and nearshore at select sites along the engineered beach that best represent regional changes in those areas. The following is a list of the surveys that are included in this report and the dates they were completed:

- Survey 20 March 2014
- Survey 22 October 2014
- Survey 22.5 July 2015
- Survey 23 November 2015

Note: *Survey 22.5 was a partial study done at the request of the municipal engineer in August of 2015.

Specific Profile Site Descriptions

Figure 1 located below shows the locations of all 58 beach profile stations on the inlet and ocean coast. Five sites are selected (in red 36+00, 22+00, 02+00, -20+00 and -46+00) to show changes in the beach throughout 2015, photographs and cross sections are presented later in this report.

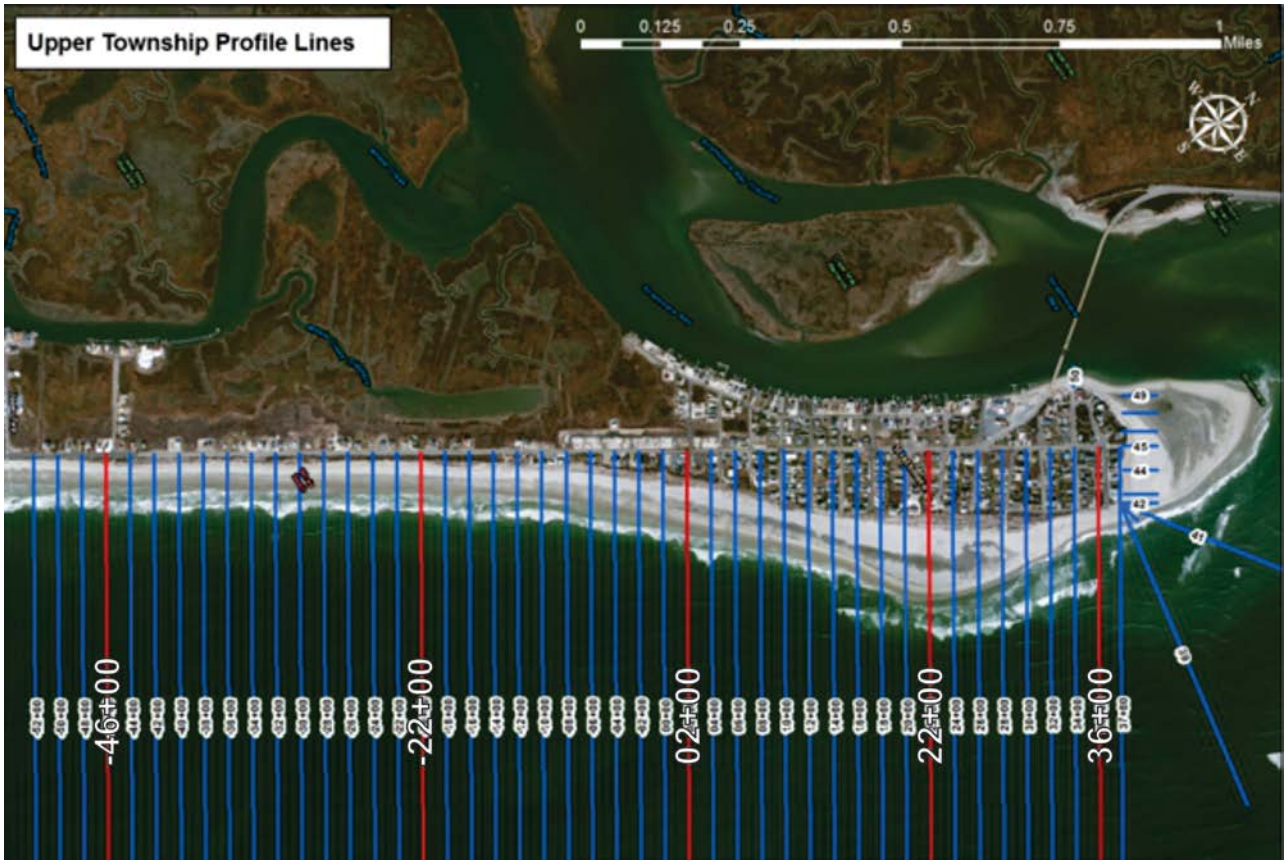

Figure 1. Locations of all 58 200-foot spaced beach profile stations for the engineered beach in Upper Township. The map includes both the Township and Corson's State Park project areas and the respective monitoring locations. Shoreline conditions at select representative locations highlighted in red are described in the following pages.

Individual Site Review

This section describes the shoreline and volume changes documented at selected profile locations to show general trends in sediment movement along the Township's engineered beaches for 2015. Beach volume and shoreline changes were calculated from October 2014 to November 2015. Profile plots included show survey results from March 2014, October 2014, July 2015 (survey data provided by township engineer Paul Dietrich, P.E.), and November 2015. Photos for each site are included to show the beach conditions during specific time frames throughout the year.

- **Survey Line 36+00 located near Seaview Avenue**

This ocean-front profile station is located on the northeast corner of the island. This region has been the focus point of erosion along the Township's engineered beach. Following construction of the engineered beach in 2009, the dune remained relatively stable but the beach was subject to episodes of storm related erosion. Prior to construction in 2009, inlet dynamics and wave erosion eliminated the State Park beach along the inlet and cut into the Township beach near Seaview Avenue back to private oceanfront properties prompting emergency installation of a steel sheet bulkhead starting late in 2008. This was later reinforced prior to the beach fill, with a rock revetment to stabilize the bulkhead and prevent further scouring of sand along the base of the steel sheets. The 2009 beach nourishment restored the dune and beach along the Township shoreline and State Park.

From November 2013 through October 2014 the survey line at 36+00 and its surrounding areas lost significant sand volume in the seaward dune slope, beachface, and nearshore regions. The shoreline eroded over 90 feet and volume losses for the profile amounted to 52.93 yds^3/ft. The natural repositioning of the well-developed ebb shoal reduced the wave shelter effect afforded to this beach, exposing the beach to northeast wave attack. The rapid rate of erosion continued as the nearshore trough formed a tidal channel that allowed tidal currents to rapidly move sand from the area around this profile site.

The USACE sponsored beachfill was completed by July 2015 which extended and elevated the dune and beachface seaward significantly. By the final survey in November, erosion to the beachface of the engineered beach had already taken place. The annual comparison from October 2014 to November 2015 revealed a shoreline advance of 378 feet with a gain of 261.67 yds^3/ft. of sand.

2a. March 5, 2014

2b. October 24, 2014

2c. November 5, 2015

Figures 2a to 2c. Close proximity to survey line 36+00 near Seaview Avenue. View to the north.

Photograph 2a shows that the extent of the winter erosion suffered in this area. The old timber pilings are exposed as well as the dune scarp and low elevation of the beach.

Photograph 2b was taken on October 24, 2014 a couple hundred feet south of photographs 7a and 7b. The dune scarp is visible in the distance as well as the exposed timber pilings. Note the low elevation of the beachface.

Photograph 2c was taken on November 5, 2015 shows the newly constructed USACE dune system. The old timber pilings are now buried.

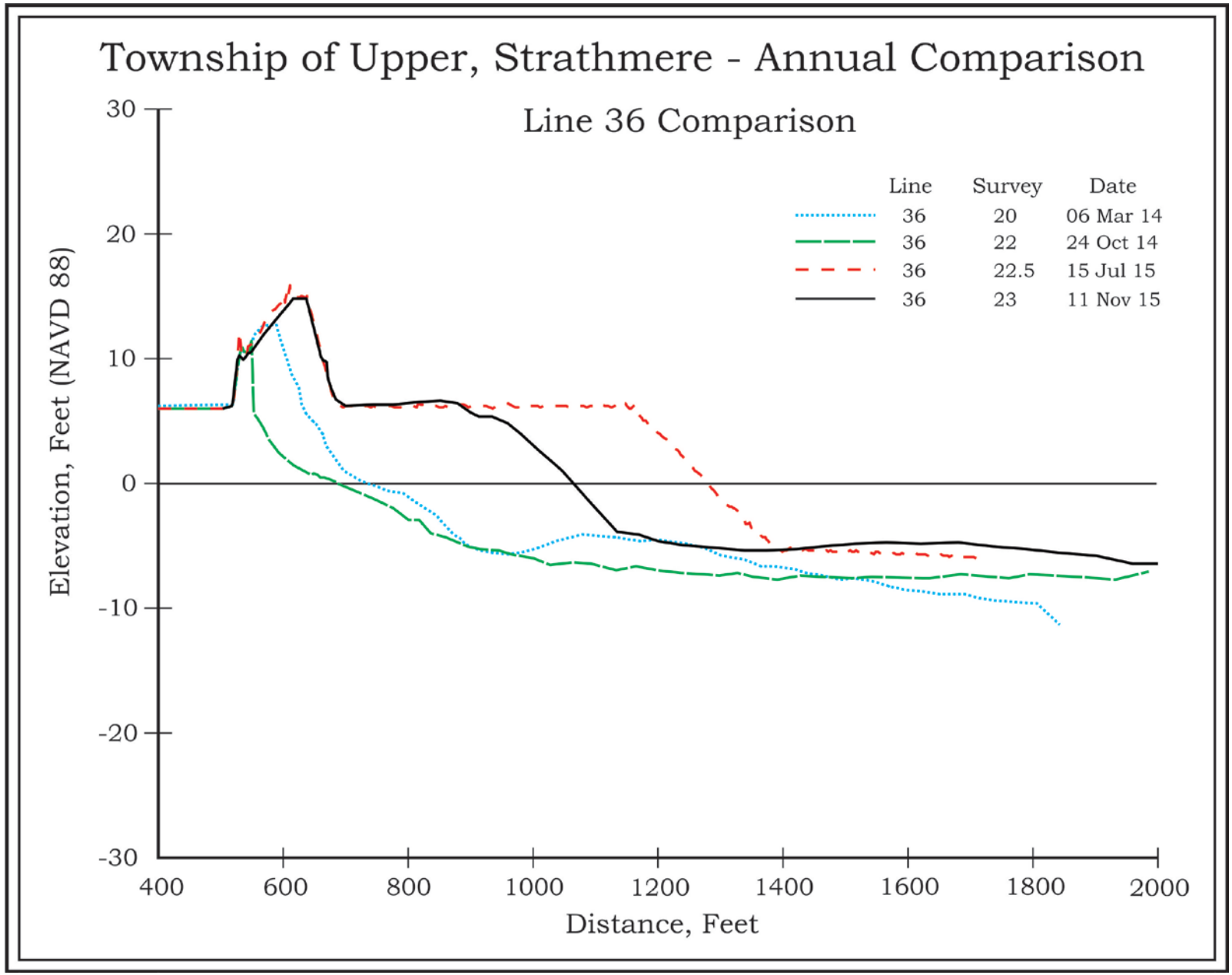

Figure 3. Significant erosion to the seaward dune and beachface can be seen prior to the USACE beachfill project. By Survey 22.5, the extent of the nourishment project is displayed in this area by the extended beachface and dune width. Erosion of the beachface by an October northeast weather event had taken place and is shown by Survey 23. For the year, from October 2014 to November 2015, the shoreline position advanced 378 feet with a gain of 261.67 yds^3/ft. of sand.

- **Survey Line 22+00, Whittier Avenue, Strathmere**

In the past, this profile location has demonstrated an accretionary trend due to beach fill activities and natural patterns of sand migration. Northeast storms and ebb tidal flow moves sand from the inlet shoals, south, depositing the majority of sand between Williams and Tecumseh Avenues with a gradual taper further south to approximately Prescott Avenue. Little to no sand was added directly to this region during the 2009 beach restoration project or needed in the 2011 maintenance project since these locations were at or above the design specification for beach width and dune elevation.

The width of the dry recreational beach berm here extended seaward from the dune toe by 300 feet when Hurricane Sandy struck the New Jersey coast on October 29, 2012. Following winter NE Storm Saturn, the beachface was flattened and the sand eroded from the lower berm was dragged to the nearshore forming a shallow platform along the shoreline. This result is seen in the June 2013 profile. Offshore the sand bar was diminished as sand moved onshore or away from the profile. The fall wave climate caused additional erosion and by November 2013 a deep trough was scoured nearshore, the beachface flattened and the shoreline position retreated. Sand was carried cross-shore where a shore parallel bar reformed in nearly the identical position following Sandy.

From November 2013 through October 2014 the survey line at 22+00 and its surrounding areas lost significant sand volume in the seaward beachface and nearshore regions. The shoreline eroded over 131 feet and volume losses for the profile amounted to 30.89 yds^3/ft. The seaward foredune and offshore bar grew by survey 20 (March 2014) but the continued losses incurred at the recreational beach and nearshore regions are documented through the final survey conducted October 2014.

By July 2015, the USACE sponsored beachfill was completed which elevated the primary dune and extended the beachface seaward nearly 350 feet. By the final survey in November, erosion to the beachface of the engineered beach had already taken place. The annual comparison from October 2014 to November 2015 revealed a shoreline advance of 260 feet with a gain of 120.99 yds^3/ft. of sand.

4a. March 27, 2014

4b. October 27, 2014

4c. November 6, 2015

Figures 4a to 4c. Survey line 22+00 located between Whittier and Sumner Avenues. 9a & 9c view to the south, 9b view to the north.

Figure 4a taken just north of Tecumseh Avenue, begins to display an erosional beachface. Shoreline retreat amounted to 79 feet from the November 2013 survey.

Figure 4b taken around Sumner Avenue shows the stable dune system but an erosion of the beachface amounting to an additional shoreline retreat of 52 feet.

Figure 4c taken around Tecumseh Avenue shows the reconstructed USACE dune and beach width.

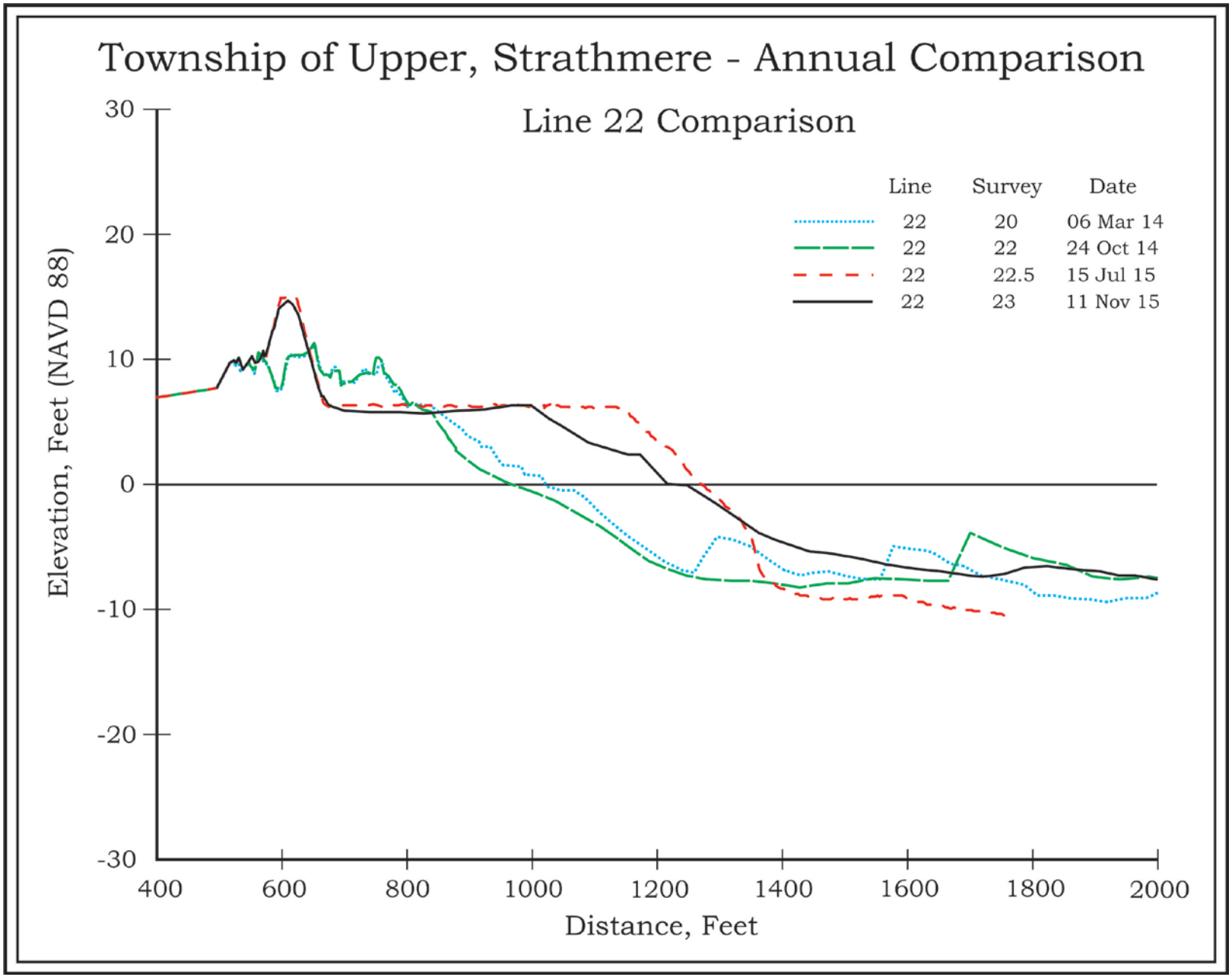

Figure 5. By Survey 22.5, the extent of the nourishment project is displayed in this area by the extended beachface and dune height. Erosion of the beachface by an October northeast weather event had taken place and is shown by Survey 23. For the year, from October 2014 to November 2015, the shoreline position advanced nearly 260 feet with a gain of 120.99 yds^3/ft. of sand.

- **Survey Line 02+00, Prescott Terrace, Strathmere;**

This profile location is positioned near the only recreational vehicle park on the ocean beaches of New Jersey in the Township's central oceanfront section. There is a continuous dune adjacent to the beach that runs along Commonwealth Avenue approximately 100 feet wide with a crest elevation of 14-15 feet NAVD88. The 2009 beach nourishment added a 100-foot wide dry beach berm here seaward of the dune. This beach has provided a source of aeolian sand that has feed development of a foredune ridge at the seaward toe. This section of the engineered beach has remained relatively stable during recent storm events since initial construction. The 2011 project taper for the south end began in this region and required only a modest sand volume added to restore the design template.

Prior to Hurricane Sandy the beachface and beach berm extended nearly 300 feet seaward of the dune. Following Sandy the berm crest and beachface slope was flattened but the shoreline position was stable as sand was carried nearshore forming a shallow platform along the shoreline. Sand was pushed higher up the beach to the seaward dune slope and upper beach additional sand was deposited offshore forming a shore parallel bar. As a result the net sand volume loss was limited as again the Upper Township shoreline fared much better than much of the jersey shore during Sandy. Winter storm Saturn and the winter wave climate caused additional erosion and by June 2013 the nearshore was scoured and the beachface and berm flattened pushing the shoreline position over 100 feet landward. By November 2013, the beach berm still 200 feet wide provided ample storm protection and source of aeolian sand for continued foredune development.

The net change from November 2013 to October 2014 was a loss of 14.08 yds^3/ft. of sand again derived mostly from landward movement of the nearshore bar and wave scouring. Losses along the beachface caused the shoreline position to retreat minimally (8feet) in 2014.

The USACE sponsored beachfill was completed by July 2015 which significantly extended and elevated the dune and beachface seaward. The berm and upper beachface began to show signs of erosion by November 2015. The shoreline advanced 265 feet from October 2014 to November 2015, coupled with a gain of 129.65 yds^3/ft. of sand.

Figure 6a. March 28, 2014

Figure 6b. October 28, 2014

Figures 6a and 6b taken looking north.

Figure 6a South of Putnam Ave. shows the extent of the wide beach. The wide beach provides an excellent source of aeolian sand to continue development of the new foredune here.

Figure 6b South of Prescott Terrace shows aeolian sand has accumulated along the seaward dune toe and plants have colonized the region a new foredune feature has developed.

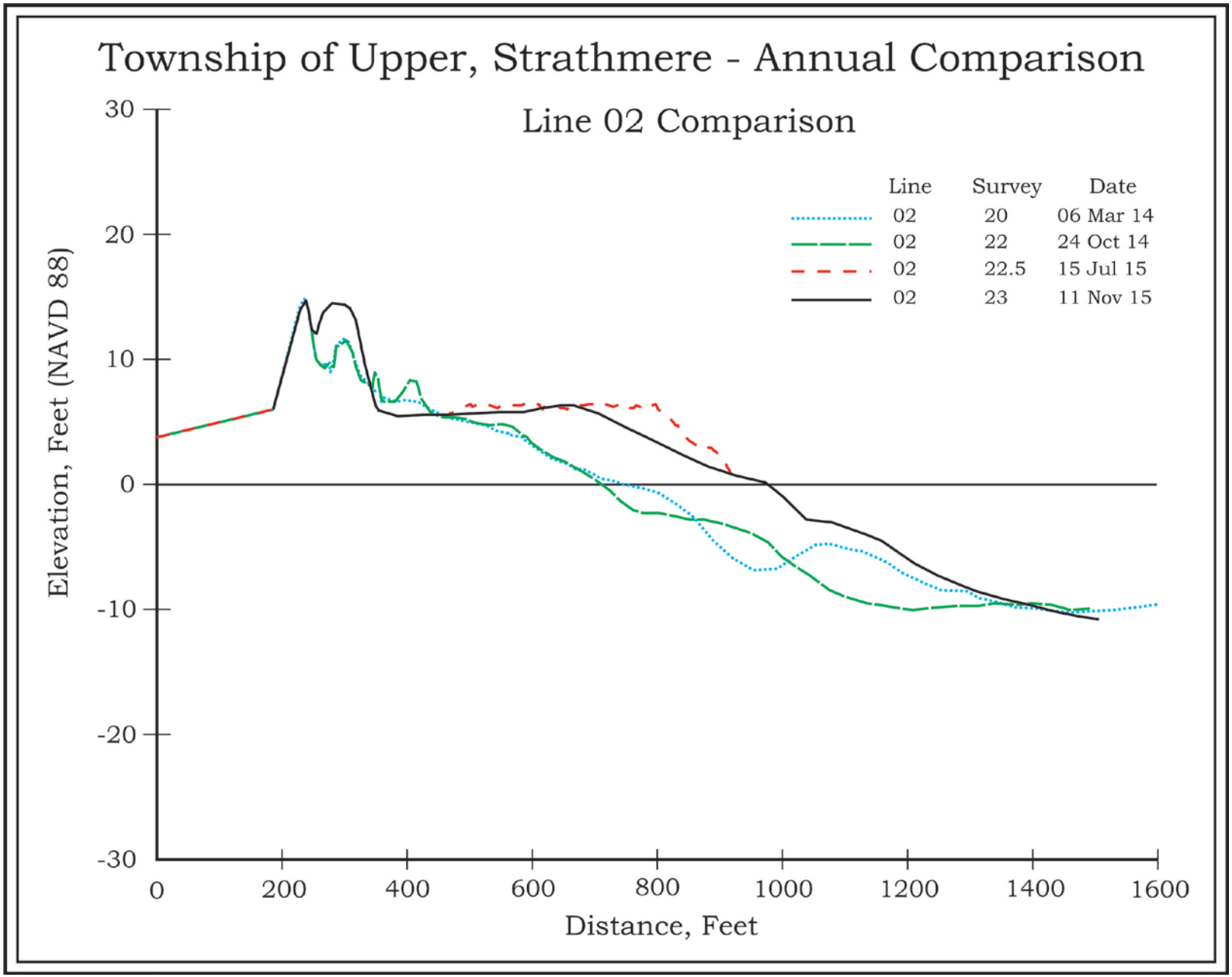

Figure 7. By Survey 22.5, the extent of the nourishment project is displayed in this area by the extended beachface and dune width/height. Erosion of the berm by an October northeast weather event had taken place and is shown by Survey 23. For the year, from October 2014 to November 2015, the shoreline position advanced nearly 265 feet with a gain of 129.65 yds^3/ft. of sand.

- **Survey Line -20+00, 1200 feet South of the RV Park, Strathmere;**

This profile station is located in the central section of the Township's oceanfront. In the mid 1980's the State shared in the construction of three timber and rock toe groins in this reach in an attempt to slow the loss of sand south. The groins are located at survey lines -16+00, -32+00 and -46+00 on the site location map (Figure 6). The beaches were low and narrow with the dune essentially the only protection for the road and homes west of the highway. Further south in Sea Isle City, storm activity produced breaching and overwash again and again starting in 1984, continuing in 1991, 1992, 1994 and 1998. After the 1998 events, the dune was re-built with a geo-textile core and quarry sand was piled on top to generate a tougher barrier. In 2009 this region was addressed during the beach restoration project expanding the dune and building a wider beach berm to prevent further overwash and protect shorefront homes and infrastructure from repeat damages.

The region fared well during Hurricane Sandy compared to Ocean and Monmouth County beaches. Here again erosion was limited to the beachface and beach berm the dune system remained intact. Waves and storm surge flattened the beachface slope and berm here the elevation was reduced across the entire 200 foot-wide beach berm and increased onshore losses compared to the previous sites.

By the spring 2013 survey the beach had seen modest recovery onshore as the weather and wave climate became favorable for natural beach building processes to push sand higher up the beachface slope to form a berm ridge. Landward cross-shore transport moved sand from the offshore bar closer to the beach. The bar continued to move landward over the summer and by the fall survey it had moved nearly 200 feet landward from its November 2012 position still separated from the beach by a nearshore trough.

By July 2015, the USACE sponsored beachfill was completed which elevated and extended the berm position seaward nearly 250 feet. By the final survey in November, erosion to the beachface of the engineered beach had already taken place. The annual comparison from October 2014 to November 2015 revealed a minimal shoreline advance of 3 feet with a gain of 24.133 yds^3/ft. of sand.

8a. April 7, 2014

8b. October 30, 2014

Figures 8a to 8b at Line -20+00 at the Southern Strathmere Beach. View to the south.

Photograph 8a by late spring losses to the recreational beach are observed with a shoreline retreat of 42 feet recorded between November 2013 and April 2014.

Photograph 8b taken in October 2014 the beach having accumulated sand over the summer appears to have significant growth in the foredune area.

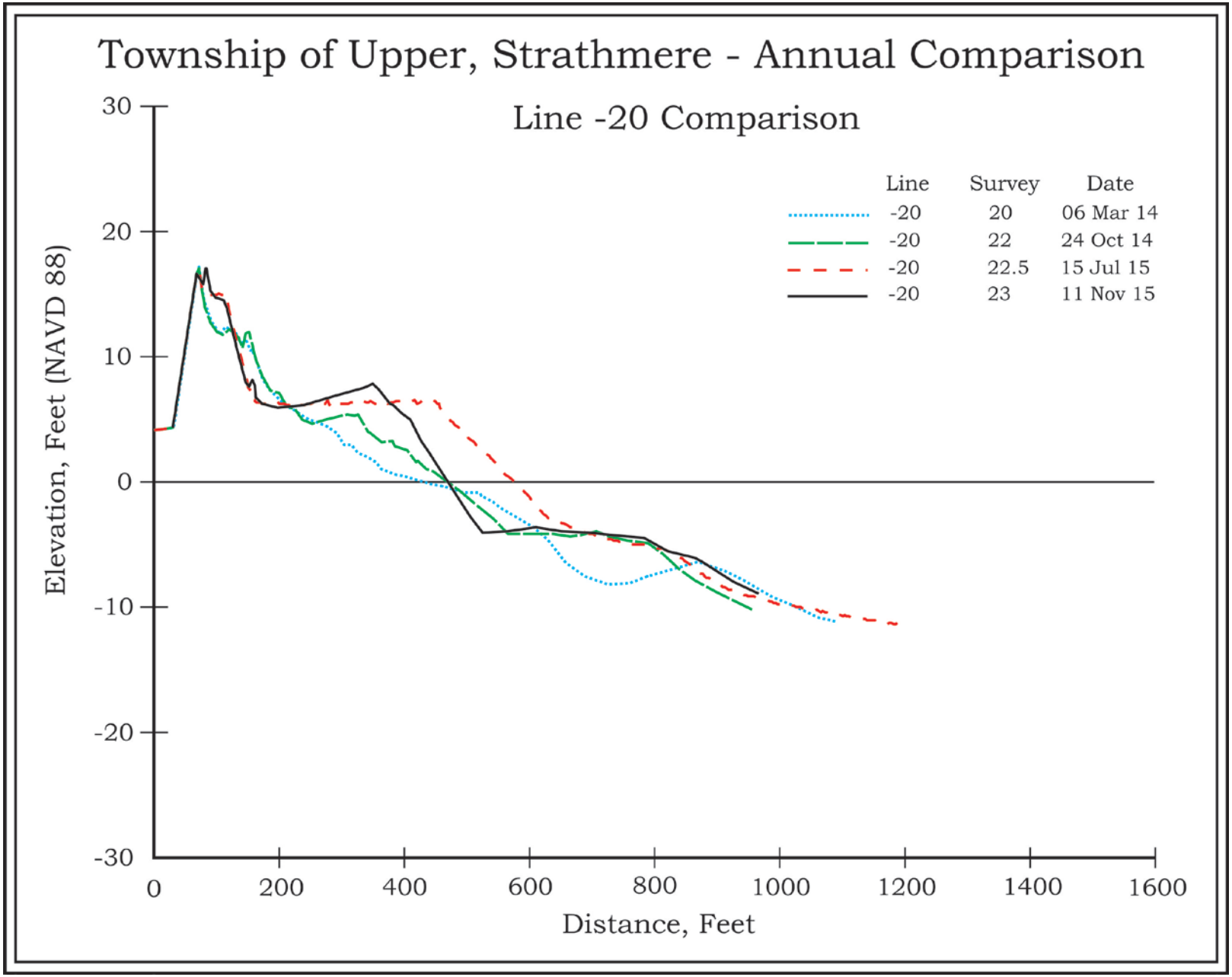

Figure 9. The 2015 USACE renourishement project widened the beachface seaward 109 feet (survey 22.5). Almost immediately, erosion of the beachface and nearshore had taken place. The net effect of the nourishment and erosional processes amounted to a net effect of a 3 foot shoreline advance for the annual comparison.

- **Survey Line -46+00, Southern Strathmere Beach (Taylor Avenue)**

This profile station is located in the southern section of the Township's oceanfront shoreline just north of the Township border at the third and final rock groin on the Strathmere beach. As discussed for survey line -20+00 this section of shoreline prior to the 2009 project was a region subject to frequent storm overwash and extensive dune erosion due to narrow low profile beaches and a narrow dune. In 2009 this region was also addressed during the beach restoration project again expanding the dune and building a wider beach berm to prevent further overwash and protect shorefront homes and infrastructure from repeat damages.

This section was hit hardest during Hurricane Sandy the beachface and berm were flattened to the seaward dune toe where wave run up scoured the seaward slope and pushed the seaward slope 20 feet landward. The elevation of the beach was reduced up to 3 feet significantly reducing the overall sand volume and storm protection afforded the dune in future events. A deeper nearshore scour trough developed and some sand was deposited on an offshore bar. Some sand was carried cross-shore to the offshore bar. Little or no sand was added updrift on the Township beaches so the majority of eroded sand appears to have been swept away from the site to the south or transferred well offshore beyond the survey limits. The June 2013 survey showed only modest changes onshore. Wave scour occurred along the shoreline position while offshore cross-shore transport moved sand landward partially filling the nearshore trough.

From November 2013 through October 2014 the survey line at -46+00 and its surrounding areas remained relatively stable absent of any significant storm activity. An elevated beach and foredune growth can be seen by the fall 2014 survey but the narrow beach width still renders this area of the island vulnerable to wave activity. For the annual comparison, the shoreline position advanced 27 feet and cumulative volume gains amounted to 19.77 yds^3/ft. (6.89 yds^3/ft. above the datum).

The USACE sponsored beachfill was completed by July 2015 which significantly extended and elevated the dune and beachface seaward. The berm and upper beachface began to show signs of erosion by November 2015. By the November survey a pronounced nearshore trough had formed as material shifted to the offshore bar. The shoreline advanced 42 feet from October 2014 to November 2015, coupled with a gain of 24.74 yds^3/ft. of sand.

10a. April 4, 2014

10b. November 9, 2015

Figure 10b. October 30, 2014

View to the north and south.

Photograph 10a. The April photograph reveals minimal changes to the recreational beach area from the previous survey.

Photograph 10b. Again, following the typical summer beach building pattern, sand has pushed up onto the upper beach forming a wider more elevated dry beach seaward of the dune system.

Photograph 10c. Following the USACE beachfill, the wider and higher dune system and beachface are shown in this photograph.

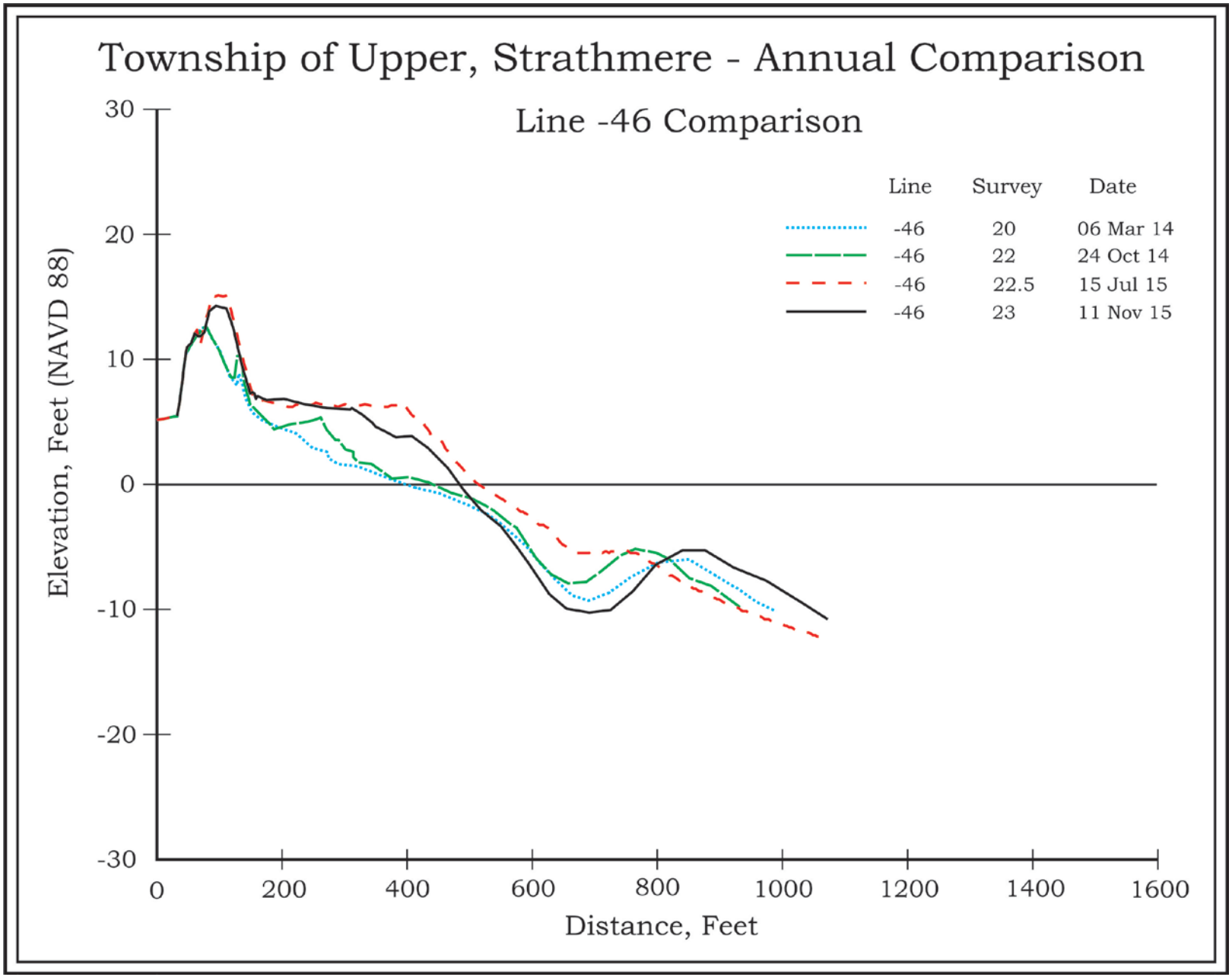

Figure 11. The dune and recreational beach height/width were enhanced during the 2015 beachfill project. By November 2015, the berm and beachface had eroded while the nearshore scour trough deepened as material moved seaward to the offshore bar. From October 2014 to November 2015 the shoreline advanced 42 feet and volume gains of 24.74 yds^3/ft. were recorded.

Geographical Information System (GIS) Calculating Volume Changes

Data collected by the CRC's beach survey team (elevations of the dune, beach, and nearshore) and the CRC's research vessel team (bathymetric data beyond the range of the swimmers to a depth of approximately -20 feet NAVD88) was integrated into a geographical information system (ESRI ArcGIS) software Digital elevation modeling was used to compute changes in elevation and sand volume for the Township's beaches and nearshore areas. The ArcGIS software incorporates all the elevation data points, interpolates elevations through triangular areas among groups of three near-by points, and lastly establishes change in elevation (the vertical difference between the two surfaces being compared). These vertical measurements were converted into a specific area (square feet). Then, the resulting volume is divided by 27 cubic feet per cubic yard to get a volume comparison difference. Each zone, block, region or area of the beach can be defined to arrive at a volume change or elevation difference desired by the operator. The data density was set at cross sections every 200 feet along both the inlet and oceanfront shorelines.

Elevation Change Maps

The maps provided in figures 12 &13 below show the elevation changes between October 2014 to July 2015 (immediately following the USACE beach nourishment project) and changes between July 2015 and October 2015 for the dune, beach, and nearshore/offshore areas. Each color classification represents a two-foot elevation change. Positive elevation changes (green hues) indicate sediment gain. Negative elevation changes (orange-red hues) indicate sediment loss. Yellow areas are zones of no change.

The maps show the inlet and northern beaches down through the southern municipal beaches suffered losses of sediment, focused heavily in the nearshore regions, following the USACE beachfill in July 2015. The northeast facing corner of the engineered beach in the State Park and near Seaview Avenue continued to be the erosional "hotspot". Annual volume calculations that compare the surface elevation changes between surveys showed a total net loss of 551,440 cubic yards (CY) of sand during the July 2015 to October 2015 timeframe. Breaking the losses down between project regions showed 119,840 CY was lost from the State Park while 431,600 CY sand loss occurred in the Township beaches.

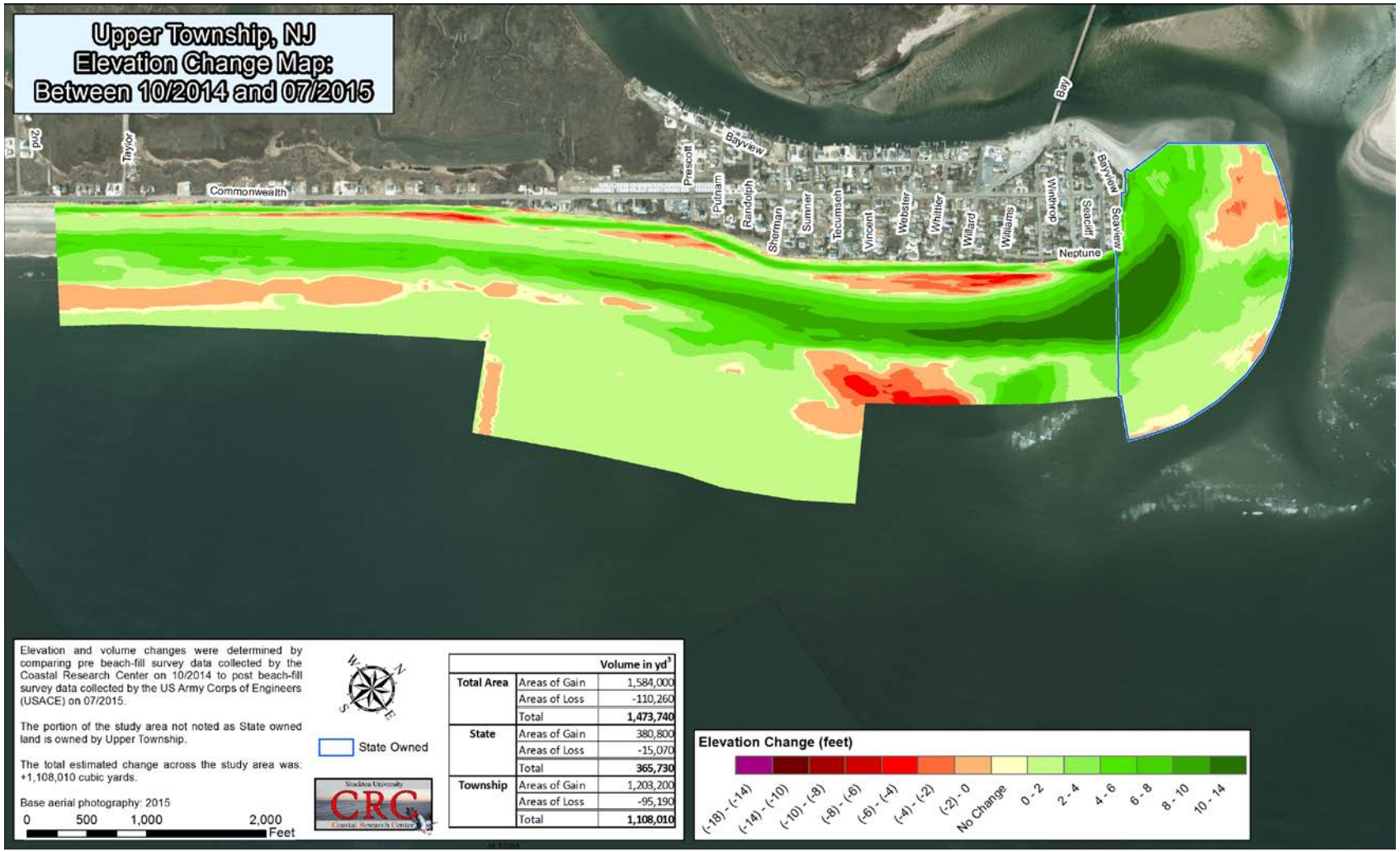

Figure 12. The elevation change map above for October 2014 to July 2015 shows elevation and volume changes on the beach, nearshore and offshore (to approximately -20 feet NAVD88) in Upper Township. Red colors show areas of elevation loss while green regions are elevation gains. Annual Volume calculations that compare the surface elevation changes between surveys showed a total net gain of 1,473,740 cubic yards (CY) of sand during the time frame. Breaking the volume changes down between project regions showed 365,730 CY gain from the State Park while 1,108,010 CY had gained to the Township beaches. The USACE beachfill in the summer 2015 accounted for the large gains displayed.

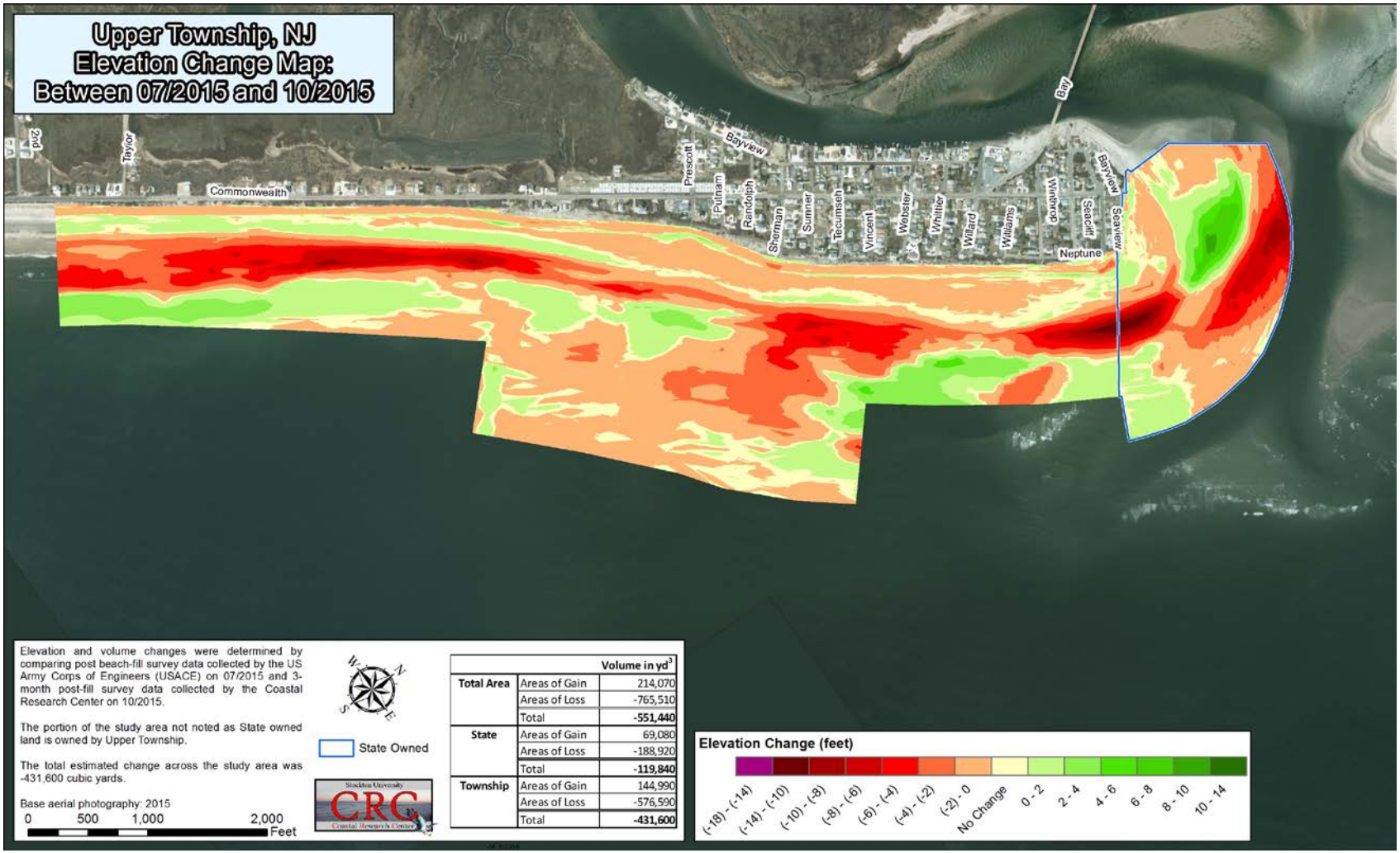

Figure 13. The elevation change map above for July 2015 to October 2015 shows elevation and volume changes on the beach, nearshore and offshore (to approximately -20 feet NAVD88) in Upper Township. Red colors show areas of elevation loss while green regions are elevation gains. Volume calculations that compare the surface elevation changes between surveys showed a total net loss of 551,440 cubic yards (CY) of sand during the time frame. Breaking the losses down between project regions showed 119,840 CY was lost from the State Park while 431,600 CY eroded from the Township beaches. Greatest losses were again focused on the nearshore towards the north end of the project area as well as the southern extents of the project.

Summary & Conclusions

Upper Township Municipal Township beaches experienced the full range of transgressive (beachfill) and regressive shoreline positions throughout 2015. The first half of the year was capped with the federally sponsored US Army Corps of Engineers beach nourishment projects completion in July (Great Egg Harbor to Townsends Inlet). The source material for this project came from an offshore borrow zone and was funded under Public Law 113-2, the Disaster Relief Appropriations Act following Hurricane Sandy. Under this project, Ludlum Island and portions of Ocean City are eligible to be completed at 100% Federal expense with no sponsor payback initially. The elevation change map generated by the CRC between October 2014 and July 2015 calculated a gain of 1,473,740 cubic yards of sand, the vast majority came from the Township beaches. The second half of 2015 displayed a reversal of fortune as it was marked by an erosional trend intensified by an October weather event. The elevation change map from July 2015 to October 2015 revealed a 551,440 cubic yard loss of material with 431,600 cubic yards of that amount being lost from the Township oceanfront beaches.

Impact of Winter Storm Jonas

Winter storm Jonas struck the New Jersey coast starting on January 22 through January 24, 2016. The storm arrived at a time where astronomical tides enhanced the impact of the storm surge resulting in record flooding throughout many locations in New Jersey. In addition to the flooding wind speeds were sustained at over 50 mph with gust reached over 70 mph recorded. The extremely strong northeast winds generated turbulent sea conditions and storm waves on top of the surge. Wind direction, speed, duration and length of wind fetch over the water created extreme conditions along the Jersey shore for 24-36 hours with strong onshore flow and waves battering the coast. Southern New Jersey was especially hit hard by the storm surge flooding and waves leading to significant damage in many coastal communities. In addition to property and infrastructure damage the beaches and dunes along the coastal towns suffered significant erosion.

Jonas combined with the October Nor'easter event resulted in significant erosion to the 2015 USACE beach renourishment project on Ludlum Island. Strathmeres dune system remained intact as the beaches absorbed most of the wave energy causing beach berm erosion and flattening the beach face slope. The extent of the damage reached the degree of severity that the Cutter Suction Dredge Illinois repumped and repaired the beaches back to the USACE design template. This repair work began January 3, 2016 and was completed April 21, 2016 this time utilizing the Corson's Inlet Borrow zone as the sand source.

The following observations were made for 2014 to 2015:

- Inlet dynamics in Corson's Inlet accelerated erosion to the northend of Ludlam Island.
- A significant influx of sand into Corson's inlet has resulted in over 3.14 million cubic yards of sand available within the defined borrow zones prior to the 2016 beach renourishment repair work. This influx of sand was likely derived from severe erosion of the Ocean City southend beaches during Hurricane Sandy. Prevailing longshore drift along southern Peck's Beach is towards the south and Corson's Inlet. The influx of sand onto the northern channel margin shoal and ebb shoal has recharged the borrow zone and reduced the tidal flow through the main tidal channel created by dredging in the defined borrow zone. As sand build up occurs on the north side of the inlet pressure is placed on the tidal channel to move towards the southern shoreline.
- The recent and future USACE maintenance projects to dredge sand from the borrow zone for use in restoring the engineered beach would also deepen the northern tidal channel. Dredging from the borrow zone to the allowed depth of -20 feet NAVD88 would enhance tidal flow through the northern channel and remove the pressure on the inlet channel to swing south in response to the build-up of sand on the northern shoals. In the absence of an inlet dredging project, tidal flow along the southern inlet shoreline will continue to accelerate erosion at the north end of Ludlam Island. The CRC suggests keeping close

contact with the Philadelphia District office, either Keith Watson, project manager, 215-656-6287 or Chief of Coastal Planning Division, Brian Bogle, 215-656-6585.

- Due to the rapid changes that occur in Corson's Inlet and the adjacent shoreline, the CRC suggests providing our regularly monitoring results to supplement the USACE monitoring efforts, to prevent the shoreline from reaching a critical point before responding.