The Coastal Research Center

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NEW JERSEY'S DISTINCTIVE PUBLIC UNIVERSITY

Mayor Palombo and Township Committee
Township of Upper
P.O. Box 205
Tuckahoe, New Jersey 08250

May 18, 2018

Dear Mayor Palombo and Committee Members:

The Stockton University Coastal Research Center (CRC) surveyed the municipal shoreline March 16, 2018 to document changes for the first quarter of 2018. This analysis compares the recently collected data with the data from December and September of 2017. The survey comparisons provide data to evaluate seasonal shoreline and sand volume changes, current beach conditions and engineered beach performance. Data collected at the six-oceanfront beach profile locations cover the municipal beaches from Seaview Avenue to 1st Street. This coverage includes the changes in the US Army Corps of Engineers (USACE) engineered beach in Upper Township but not those occurring on State property at Corson's Inlet.

The 2018 winter quarter followed a relatively benign summer and early fall 2017 hurricane season with no passage of hurricanes of significance offshore the NJ coast. This pattern began to change in December as a few small storm systems brought rain and snow to areas of NJ. The Jersey shore took its first large storm event of 2018 in early January. By January 5, the region's first blizzard of 2018 had dropped up to 17 inches of snow across regions of South Jersey and caused beach erosion and coastal flooding at the shore. Winter Storm Grayson, referred to as a "bomb cyclone", a rapidly intensified low-pressure system that packed winds similar to a category 1 hurricane as it moved along the Mid-Atlantic coast. Along the Jersey shore, winds were over 50 mph and the snowfall rate was 1-2 inches per hour ringing in the New Year with a significant storm event.

After a relatively benign February for coastal storms, a series of northeasters then struck the Jersey shore in rapid sequence in March through early April. The first in this series on March 2-3, 2018, also labeled a second "bomb cyclone" of 2018, because of its rapid intensification off the New Jersey coast. Strong winds, coastal flooding and beach erosion resulted along the Jersey coast with rain and heavy wet snow and wind gusts reaching 80-90 mph in some areas. On March 7-8, 2018, a second less powerful northeaster followed rapidly behind causing additional coastal flooding, beach erosion and snowfall along the Jersey shore. This event was followed by yet a third storm that developed off the coast of Carolina on March 12-13, 2018. The storm ramped up in intensity as it moved up the coast dumping over 2 feet of snow in Northern NJ while South Jersey escaped with mostly rain and light snow. Damages from this third storm prompted Governor Murphy to ask for federal assistance to help the state clean up after the storm. Strong winds from the storm again caused coastal flooding, beach erosion and widespread power outages across the state.

As the storm moved offshore, the Coastal Research Center conducted its first quarter survey of the Upper Township beaches to quantify beach changes from December 2017 to March 16, 2018. Seasonal beach surveys conducted at the six monitoring sites allows the Township to monitor changes to USACE project beaches over time, quantify beach changes following storm events and short and long-term changes to the Strathmere beaches, independent of the USACE monitoring schedule. These six quarterly monitoring sites are as follows:

UT-1	First Street at the border with Sea Isle City (NJBPN site #120)
UT-2	2400 Commonwealth Avenue
UT-3	Jasper Avenue
UT-4	Tecumseh Avenue
UT-5	Williams Avenue (NJBPN site #121)
UT-6	Seaview Avenue at Corson's Inlet

Following the first quarter survey two additional northeast storms occurred on March 20-21, 2018 and April 6, 2018. The survey data displayed within this report does not show the impact of these storms. Included in this report is a series of recent aerial photographs (below) taken by Mr. Ted Kingston for the CRC. The series of photos displayed cover the winter 2017-2018 storm season. The first photo (figure 1) taken in mid-December shows conditions at the northeast corner of Strahmere and along Corson's Inlet prior to the onset of the winter storm season. Typical winter storm conditions shown in the second photo (figure 2) taken March 6, 2018, immediately following the first of a series of northeast storms that struck New Jersey in March and as a second rapidly approached. The third photo (figure 3), taken on April 21, 2018, shows the post-winter beach conditions following the final storm event in this series of four northeasters that began March 2-3, 2018 and continued until April 6, 2018.

Figure 1. Above is an aerial view of Strathmere, taken December 18, 2017, it shows the close proximity of the shoal and bar system to the beach as its welds onto the northeast shoreline. There is little evidence of significant offshore deposits beyond the emergent bar system given by the lack of breaking waves seaward of the Strathmere beach. (Photo by Ted Kingston).

In the December 18, 2017 photograph above, there's a large emergent sand ridge separated from the beach by a narrow trough or runnel. This feature extends from south of Williams Avenue to the northeast corner of the beach at Corson's Inlet. The wave climate during the fall allowed the shoal and offshore bar system to migrate landward to where it nearly welded to the shoreline in mid-December. The cross-shore movement of sand from the offshore towards the beach also shows on the cross-sections for the December survey at both the Williams

and East Seaview Avenue profiles (figures 8 & 9). The wedge of sand shown above in December is in a favorable position prior to the winter storm season to add significantly to the onshore sand volume, extend the beach width and restore the project beach berm eroded at the northeast corner of the Strathmere beach.

The view below in figure 2 below shows conditions on March 6, 2018, following the first in a series of late winter storms that struck the Jersey shore on March 3 & 4 and just prior to the March 7-8 storm.

Figure 2. This second aerial photo shows conditions on March 6, 2018, immediately following the first of a series of winter storm events in March 2018 and just prior to the arrival of a second storm on March 7-8, 2018. On the front-beach, the berm top ponding provides evidence that storm waves reached the federal project dune toe that remained intact and prevented wave breaching and overwash. Tidal flooding was still extensive, the back-bay marshes and landward island marsh bank remained inundated in this photo (Photo by Ted Kingston).

In the photo above, the approaching and remnant storm swell is evident with significant white water on the shoal and nearshore absorbing breaking wave energy as the waves approach the beach. The previous storm surge inundated the beach allowing the wave surge to reach the federal dune toe, the flooding left berm top ponds on the upper beaches, still evident in this photo. Although the flooding and wave surge reached the seaward dune toe, the wave energy was absorbed by the wide beaches preventing any significant erosion along the seaward dune slope. Tidal flooding persisted in the back bays leaving a thin layer of water across most of the marsh, although the deeper channels and marsh feature remain visible in the aerial. A few high points including the dredge material holding site along the Intracoastal Waterway and roadways remained dry at this phase of the storm flooding as the onshore winds continued to feed and hold water in the back bays. Over the next two days, the flooding and wave assault on this region intensified as the second storm in the series struck the Jersey shore from March 7-8, 2018.

The aerial photo (figure 3) on the following page taken on April 21, 2018, two weeks following the fourth storm in the series. View is looking south from above the Ocean City southern spit towards Strathmere and shows Corson's Inlet as well as the oceanfront beaches extending south to near the Sea Isle City border. Water levels

in the back bays had returned to normal with the marsh islands exposed while the ocean wave climate is calmer as the transition from the winter storm season to the spring-summer beach building period was under way.

Figure 3. This third aerial photo in the series shows conditions on April 21, 2018, following the last of the winter storm series. This photo shows the tip of the southern Strathmere spit truncated after the storms but new sand has already welded to the beach along both the Ocean City and Strathmere shorelines (Photo by Ted Kingston).

Although the winter storms had truncated the northern and southern spits at Corson's Inlet, by April 21st both sides of the inlet showed early signs of natural sand recovery as emergent sand ridges were in various stages of attaching to the beaches. On the Ocean City side, additional sand was nearshore on a wide shoal with breaking waves while on the Strathmere side a nearshore bar positioned to add sand to the beach from the inlet south along the oceanfront beaches. A well-developed main channel remained from the maintenance dredging separating Ludlam Island from Pecks Beach that directed tidal flow seaward towards the east northeast, away from the Strathmere shoreline. The federal project's dune system remained intact following the series of northeast storms, and continued to provide storm protection to the community.

On the following page, tables 1 & 2 show the sand volume and shoreline change values calculated for each of the six monitoring sites. Table 1 shows the values for the period from December 2017 to March 2018 while table 2 shows the changes for the six-month interval from September 2017 to Match 2018. Individual shoreline (feet) and sand volume (yds^3/ft.) changes displayed along with an average volume change between sites. The average volume change multiplied by the distance between sites determines a net cell volume change. Summation of the net cell volume changes produces a total net sand volume change for the Strathmere oceanfront beaches.

Table 1.
Sand Volume and Shoreline Position Changes at Six Strathmere Survey Sites
December 2017 to March 2018

Profile	Shoreline Change (feet)	Volume Change (yds^3/ft)	Avg.Volume Change (yds^3/ft)	Distance Between (feet)	Net Volume Change (yds^3)
Southern Township Boundary					
UT-1	-25	4.5			
			3.2	1,410	4,442
UT-2	20	1.8			
			-0.6	2,938	-1,763
UT-3	66	-3.0			
			-22.3	2,297	-51,108
UT-4	-62	-41.5			
			-46.5	1,323	-61,453
UT-5	51	-51.4			
			-32.2	911	-29,289
UT-6	11	-12.9			
				0	
Northern Township Boundary					
			Total Volume Change =		**-139,172**

Table 1 above shows, a cumulative sand volume loss of -139,172 cubic yards for the winter season. The southern two sites showed modest sand volume gains while the northern sites suffered moderate to significant sand volume losses, ranging from -3.0 yds^3/ft. at UT-3 to -51.4 yds^3/ft. of sand at UT-5. From Jasper Avenue north the Strathmere shoreline lost -141,850 cubic yards of sand. The southern two sites gained 2,679 cubic yards of sand. The general trend appears to have been a north to south and offshore transfer of sand during the winter months. Shoreline changes were variable with the largest retreat (-62 feet) occurring at Tecumseh Avenue and the largest advance at Jasper (66 feet). Locations that showed shoreline advances occurred due to sand eroded from the beach being transferred nearshore onto the lower beachface raising the slope elevation and forming a shallow platform above the zero datum. At all sites, the berm width eroded due to the storm waves and tidal surge.

Table 2.
Sand Volume and Shoreline Position Changes at Six Strathmere Survey Sites
September 2017 to March 2018

Profile	Shoreline Change (feet)	Volume Change (yds^3/ft)	Avg.Volume Change (yds^3/ft)	Distance Between (feet)	Net Volume Change (yds^3)
Southern Township Boundary					
UT-1	-33	8.2			
			9.3	1,410	13,131
UT-2	25	10.4			
			-2.6	2,938	-7,576
UT-3	11	-15.6			
			-25.2	2,297	-57,895
UT-4	-24	-34.8			
			-43.6	1,323	-57,693
UT-5	65	-52.4			
			-33.4	911	-30,426
UT-6	156	-14.4			
				0	
Northern Township Boundary					
			Total Volume Change =		**-140,458**

Table 2 shows the six month cumulative sand volume loss was heavily influenced by the winter losses, the net change was a loss of -140,458 cubic yards of sand of which nearly 99% resulted from the winter storm season. Not surprisingly, the sand losses focused on the shoreline north of UT-2 with gains on the southern beaches, following the winter pattern. The biggest variation was in shoreline position changes. At East Seaview Avenue, the shoreline position advanced 156 feet as the nearshore bar welded to the beach in late fall, as seen in the December 2017 aerial photo (figure 1).

The six municipal selected beach profile sites cover the Strathmere beach from the northern limit of development, south to the border with Sea Isle City. These individual beach profile cross-sections appear on the following pages in order from south to north along the Strathmere shoreline and display the results from the last three surveys. Included is a site description and photographs taken for visual comparison between surveys.

UT-1, First Avenue (NJBPN #120).

This site positioned near the boundary between Sea Isle City and Strathmere, has a 30-year survey history making it essential to incorporate into the Township study. The region has a history of frequent storm breaches and overwash across Commonwealth Avenue prior to the state and local beach nourishment project. Following the federal project the dune crest height is 15 feet NAVD88, while width at the toe is approximately 160 feet. The beach width extends another 300 feet seaward to the MHW line with a berm crest height of approximately 6 feet NAVD88.

By September 2017, a substantial typical summer berm crest had developed that persisted through December 1, 2017. Winter storm waves eroded the beachface slope and flattened the summer berm cutting the berm crest position landward approximately 120 feet and the shoreline position retreated -25-feet. The beach absorbed the wave energy and prevented loss of sand from the upper beach and seaward dune slope where modest aeolian accumulations occurred over the winter season. Net loss above the zero datum from December 2017 to March 2018 was -12.58 yds^3/ft. of sand. Winter storm waves scoured, then deposited sand cross-shore, forming both a nearshore ridge and further offshore a shore parallel sand bar. The net sand volume below datum increased by 17.10 yds^3/ft. of sand for a net profile gain of 4.53 yds^3/ft. of sand. This sand positioned nearshore should return to the beach and restore the berm losses through natural processes once the calmer summer wave climate prevails.

Photo above taken on December 1, 2017 shows a view looking north along the seaward dune slope. The seaward slope is well vegetated with American Beach grass, planted as part of the federal project.

Photo on right taken on March 16, 2018 shows a similar view looking north. A new foredune ridge is developing and the seaward dune fence nearly buried from aeolian sand accumulation.

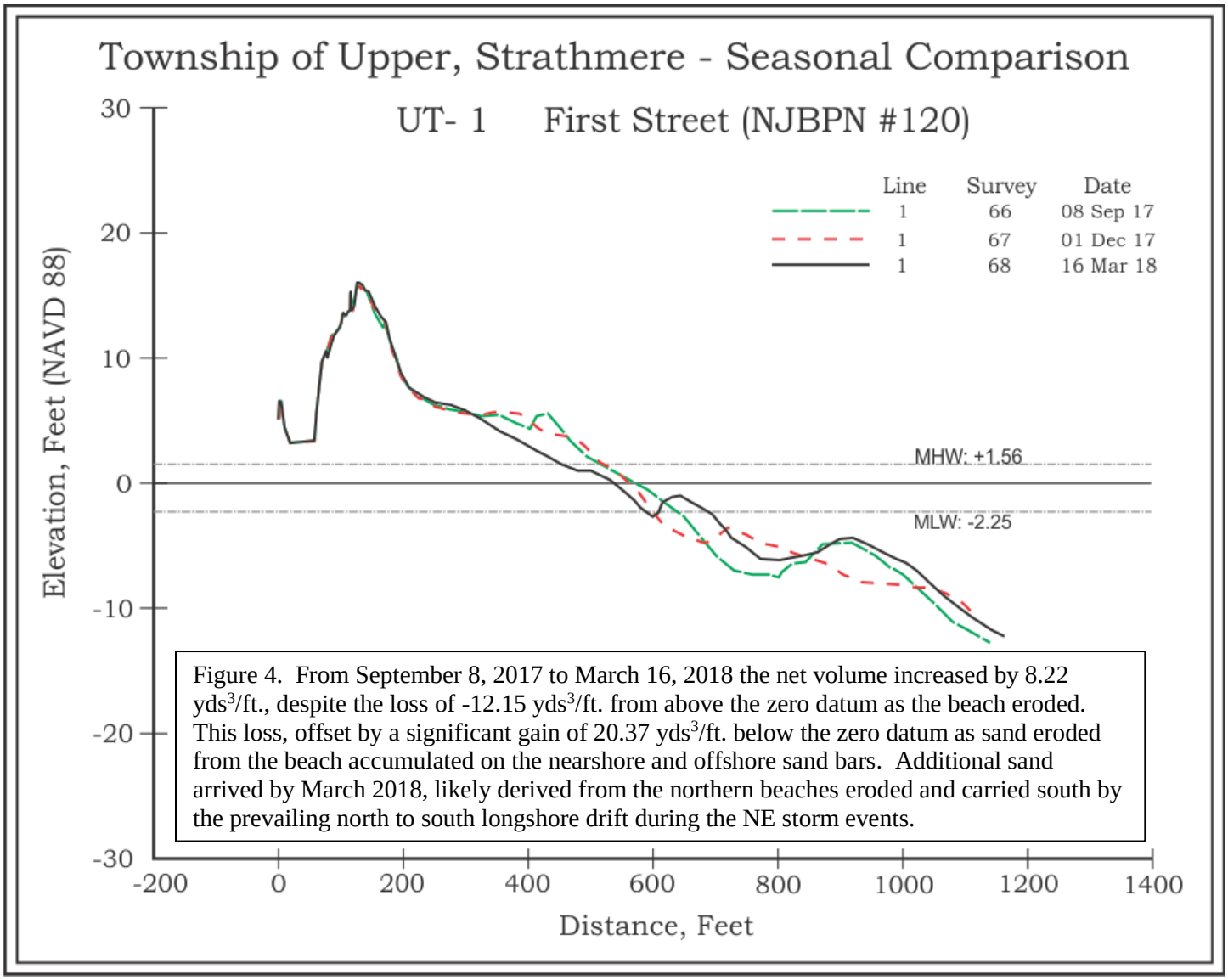


Figure 4. From September 8, 2017 to March 16, 2018 the net volume increased by 8.22 yds^3/ft., despite the loss of -12.15 yds^3/ft. from above the zero datum as the beach eroded. This loss, offset by a significant gain of 20.37 yds^3/ft. below the zero datum as sand eroded from the beach accumulated on the nearshore and offshore sand bars. Additional sand arrived by March 2018, likely derived from the northern beaches eroded and carried south by the prevailing north to south longshore drift during the NE storm events.

UT-2, Located at 2400 Commonwealth Avenue.

The site is located along the southern undeveloped eastern strip of Commonwealth Avenue across the road from 2400 Commonwealth Avenue. This region has been more resilient than First Avenue with no documented episodes of dune breaching or overwash during the CRC monitoring for the Township. The state, local and federal beach nourishment efforts have significantly enhanced the beach and dune. Current dune crest elevation is 15 feet NAVD 88 and 160 feet in width at the toe. The beach extended an additional 300 feet seaward from the dune toe to the MHW line while the beach berm crest remained at 6 feet NAVD 88 as of December 2017.

The wider beach berm crest persisted from September through December 2017. Winter storm waves once again cut into the beachface slope and beach berm pushing the crest landward over 100 feet, while the shoreline position actually advanced 20 feet as eroded beach sand accumulated nearshore forming an emergent ridge. From December 2017 to March 2018, the beach lost -13.29 yds^3/ft. of sand, above the zero datum. The sand eroded from onshore moved to the nearshore, deposited on the lower beachface slope and further offshore forming two distinct features, a nearshore ridge and a shore parallel bar. Below the zero datum 15.14 yds^3/ft. of sand accumulated by March 2018. The gain offshore offset the onshore loss resulting in a modest net volume accumulation of 1.84 yds^3/ft. of sand over the winter season.

Photo on the left taken on December 1, 2017 looking north shows the seaward dune slope, toe and beach berm. An extended period of relatively calm weather resulted in the wider dry beach berm.

Photo on the right taken March 16, 2018 followed closely behind the third consecutive northeaster to strike in March. There is evidence of ponding during recent storms with modest beach erosion but sand accumulated on the dune.

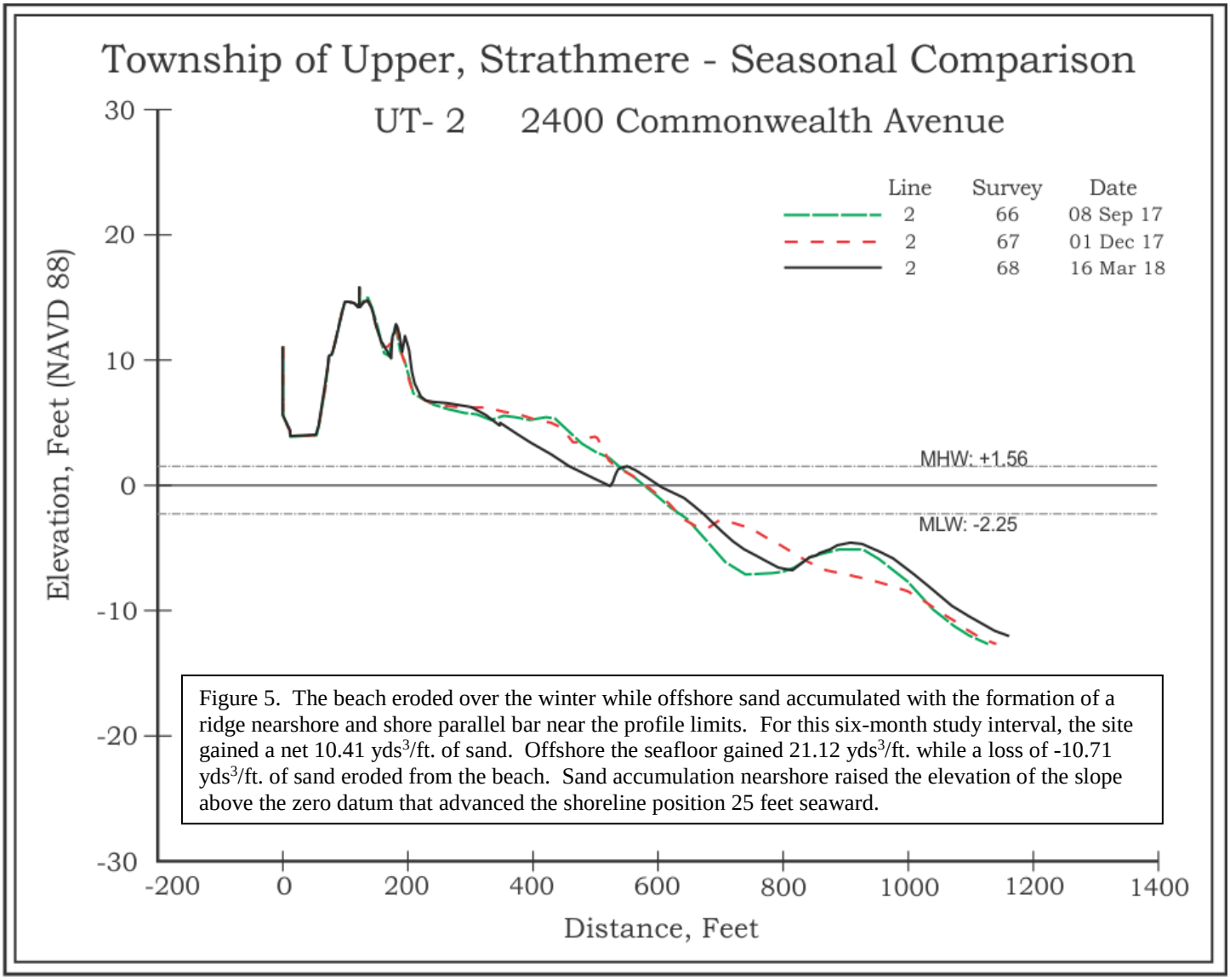


Figure 5. The beach eroded over the winter while offshore sand accumulated with the formation of a ridge nearshore and shore parallel bar near the profile limits. For this six-month study interval, the site gained a net 10.41 yds^3/ft. of sand. Offshore the seafloor gained 21.12 yds^3/ft. while a loss of -10.71 yds^3/ft. of sand eroded from the beach. Sand accumulation nearshore raised the elevation of the slope above the zero datum that advanced the shoreline position 25 feet seaward.

UT – 3, Jasper Avenue.

This site is located at Jasper Avenue near the southern extent of the RV Park in Strathmere, where development of the properties on the eastern side of Commonwealth Avenue extends. Perhaps because of this property development intrusion reducing the dune width at Jasper Avenue this region has suffered several episodes of storm breaches and overwash in the past. The first event was a northeast storm in 1984, which led to the very first NJ State co-sponsored beach restoration in Strathmere. In 1998, three homes suffered serious damage in a pair of NE storms that breached the street end. Dune restoration work seaward of the homes did reduce further damages leading into the 2001 NJ State project. Following the federal project, the dune elevation crest was at 14 feet NAVD88 with a toe width of approximately 200 feet. In September 2017, the beach extended 440 feet seaward from the dune toe to the MHW line.

Despite the series of winter storms Jasper Avenue remained relatively stable. The storm waves did erode the upper beachface slope and berm crest, scouring away about 80 feet of the upper berm, but the sand moved to the lower slope and raised the elevation above the MHW line. This resulted in a seaward shoreline advancement of 66 feet with 3.13 yds^3/ft. of sand added above the datum from December 2017 to March 2018. Completely opposite from UT-1 and UT-2 here the site lost sand below the zero datum (-6.10 yds^3/ft.) as wave scouring cut a deeper nearshore trough offsetting the accumulation of sand on the bar ridges. The overall net change was a modest loss of -2.97 yds^3/ft. of sand at this winter's transitional site between accretive beaches to the south and an erosional shoreline to the north.

Photo above taken on December 1, 2017 looking north along the seaward dune slope shows sand has accumulated along the toe burying the fence. The wide beach provides a source of aeolian sand for continued dune growth and expansion seaward. New fencing placed a third of the way up the new foredune slope will encourage vertical growth rather than expansion across the upper beach.

Photo on the right taken March 16, 2018 three days after a northeast storm shows the dune remained intact and continued to accumulate sand. The wet sand is evidence of recent berm top ponding created as the storm surge and waves overtopped the beach berm ridge reaching landward to the seaward dune toe. Although the beach suffered erosion, the berm was still 400 feet wide from the dune toe to the MHW line.

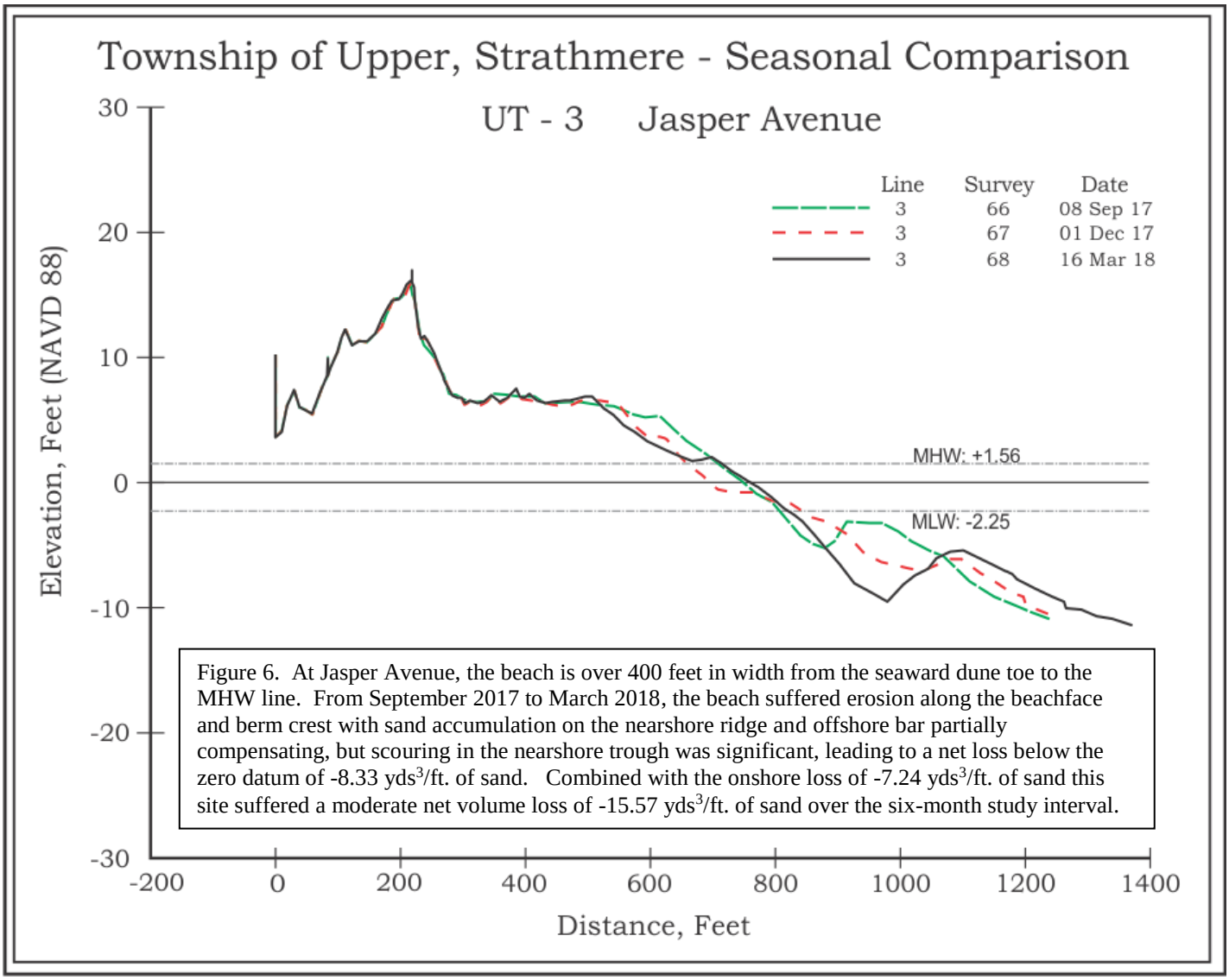


Figure 6. At Jasper Avenue, the beach is over 400 feet in width from the seaward dune toe to the MHW line. From September 2017 to March 2018, the beach suffered erosion along the beachface and berm crest with sand accumulation on the nearshore ridge and offshore bar partially compensating, but scouring in the nearshore trough was significant, leading to a net loss below the zero datum of -8.33 yds^3/ft. of sand. Combined with the onshore loss of -7.24 yds^3/ft. of sand this site suffered a moderate net volume loss of -15.57 yds^3/ft. of sand over the six-month study interval.

UT – 4, Tecumseh Avenue.

This site, set one block north of the Sumner Avenue groin to measure its impact. The timber bulkhead jogs landward south of Sherman Avenue one block south of Sumner Avenue, because of a natural setback in the shoreline. Prior to initial beach nourishment storm surge and waves would reach and frequently overtop the exposed bulkhead at Tecumseh Avenue. Sand added during the state project restored a small dune, widened and elevated the beach burying the majority of the structures and limiting their impact. The federal project further enhanced the dune system and beach improving storm protection in this region. The dune crest elevation, established by the project at 14 feet NAVD88 and 200-feet wide between the landward and seaward dune toe provides enhanced storm protection. By the end of 2017, the beach width extended another 440 feet seaward of the dune toe to the MHW line with a beach berm elevation ranging from 5-6 feet NAVD88.

Over the winter, the beachface slope and berm eroded at Tecumseh Avenue for a loss of -13.56 yds^3/ft. above the zero datum. The beach berm crest retreated nearly 100 feet while the shoreline position retreated -62-feet. The beach absorbed the winter's storm wave energy protecting the dune system, which remained stable to slightly accretive from December 2017 to March 2018. In addition to eroding the beach, the storm waves scoured into the lower beachface and created a 6 foot-deep nearshore trough. The erosion continued offshore with little accumulation within the survey envelope. Net loss from offshore below the zero datum was -27.95 yds^3/ft. of sand. A nearshore bar developed by March 16, 2018 in a position in close proximity to the shoreline to supply sand for natural beach building to occur once a calmer wave climate prevails. Because of the larger offshore loss not seen at the southern Strathmere beaches combined with the onshore storm erosion, the net volume change was a loss of -41.52yds^3/ft. of sand for the first quarter of 2018. Despite this significant loss of sand at this site, there was still 390 feet of beach width between the seaward dune toe and the MHW line.

Photo on the left taken on December 1, 2017 looking north along the seaward dune toe. The wide dune and beach provides extensive storm protection for the seaward properties and community. This dry beach provides a source of sand for aeolian accretion along the seaward dune slope. By December 2017, a new foredune ridge buries the seaward dune fence.

Photo above shows the same view on March 16, 2018 after a series of winter storms. The seaward dune slope and toe remained intact and continued to accumulate sand. The feature provided community protection during the winter storms. The wave surge reached the seaward toe evident by the still damp beach (darker color).

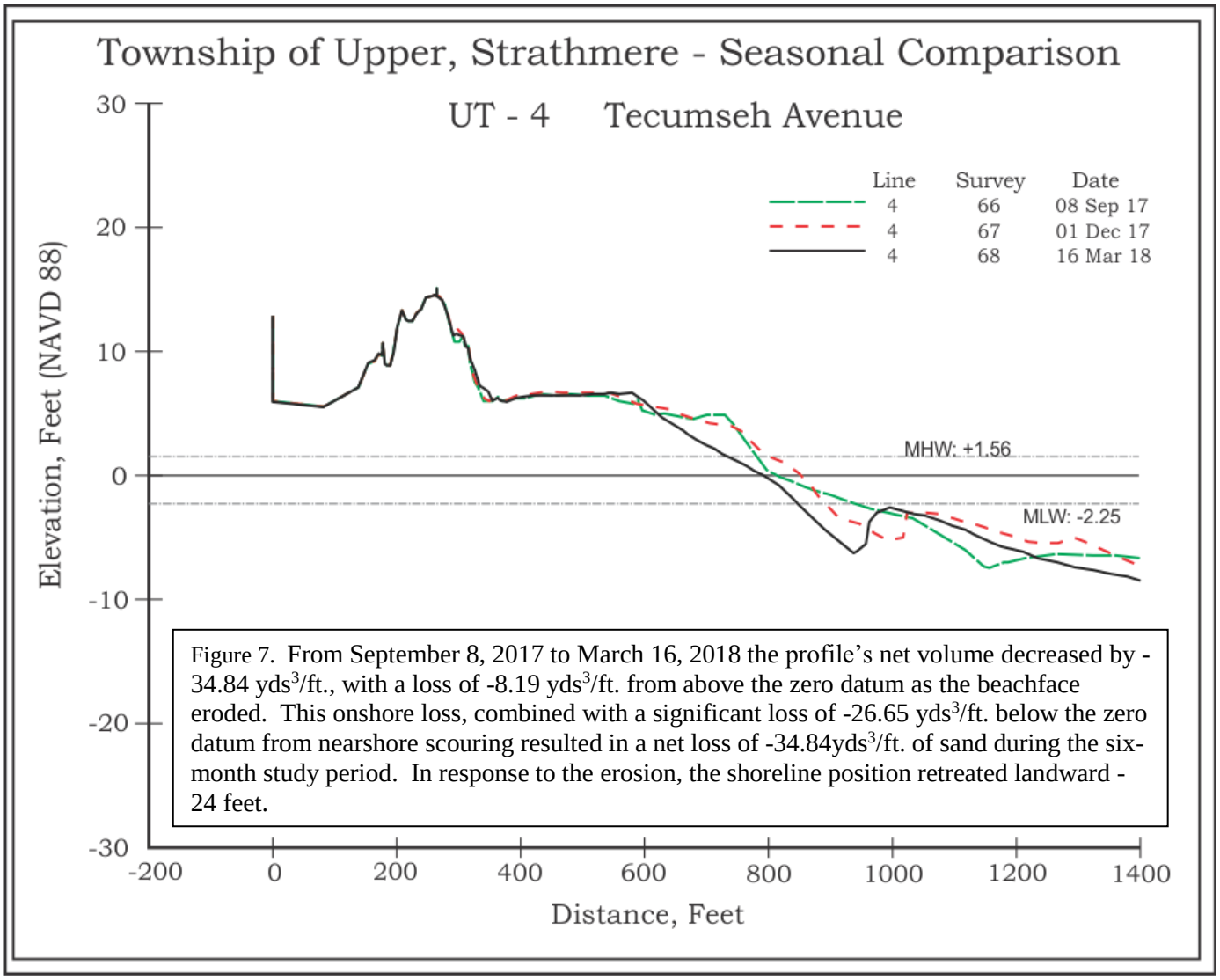


Figure 7. From September 8, 2017 to March 16, 2018 the profile's net volume decreased by -34.84 yds^3/ft., with a loss of -8.19 yds^3/ft. from above the zero datum as the beachface eroded. This onshore loss, combined with a significant loss of -26.65 yds^3/ft. below the zero datum from nearshore scouring resulted in a net loss of -34.84yds^3/ft. of sand during the six-month study period. In response to the erosion, the shoreline position retreated landward -24 feet.

UT – 5, Williams Avenue (NJBPN #121).

Monitoring started here in 1986 as part of the NJBPN program, now included in the municipal monitoring project. This site is located near the southern limit for direct inlet influences. Sand intermittently accumulates on this beach naturally as tidal delta bars shed off adjacent ebb shoals migrate landward under favorable conditions and attach to the shoreline. This provides periodic influxes of sand through natural processes to this region. As a result, the beach is typically wider, supports modest natural dune growth and received limited fill volumes during beach nourishment.

Despite little direct sand placement the beach width has remained relatively consistent. As of December 1, 2017, the beach extended 520 feet seaward of the dune toe to the MHW line with a dry recreational beach berm width of 480 feet. The dune crest was at 14.5 feet NAVD88 and approximately 160 feet wide at the dune toe. Although the seaward dune slope is steeper than the landward slope it has remained relatively intact protected by the wider beach from storm waves.

From September 2017 to December 2017, changes onshore were modest variations in the berm crest position and elevation while nearshore a large wedge of sand moved towards the beach forming a shallow platform that extended seaward just below the zero datum over 200 feet, then gently sloped offshore. Following the winter storm season the beach berm had retreated a little further as the beachface slope eroded but the wide beach protected the dune from any storm damage. Net change from December 2017 to March 2018 onshore was a modest loss of -5.38 yds^3/ft. of sand. Below the zero datum, wave scouring was significant removing over half of the shallow platform. Less than 100 feet of the shallow platform remained but a portion was slightly elevated just above the zero datum resulting in an advancement in the shoreline position of 51 feet. Just offshore, the seafloor depth increased up to 5 feet, from -2.5 ft. NAVD88 to -8 ft. NAVD88 from the scouring without any significant accumulation of sand out the seaward survey limits. As a result, -46 yds^3/ft. of sand was lost from below the zero datum for a net volume loss of -51.38 yds^3/ft. of sand at this site during the winter quarter. The majority of the sand was lost from between -0.3 to -9 feet NAVD88 (-53.40yds^3/ft.) partially offset by a gain of 5.98yds^3/ft. of sand at the limit of the survey. Although it is very likely much of the lost sand transfer was via longshore currents and storm waves to the south and north towards the inlet on tidal currents, a portion of the sand was also carried cross-shore to the limits of the survey (1700 feet) and beyond. Summer wave climate should start to move any sand deposited beyond the survey limits landward over the next few months but it will take a while to accumulate nearshore where it was in December 2017.

Above photo, taken December 1, 2017 shows the wide dune and beach at Williams Avenue. The beach supplies sand for foredune growth at the toe.

Photo on the right taken March 15, 2018 a few days after the third NE storm in March shows a damp beach from the surge but no dune damage.

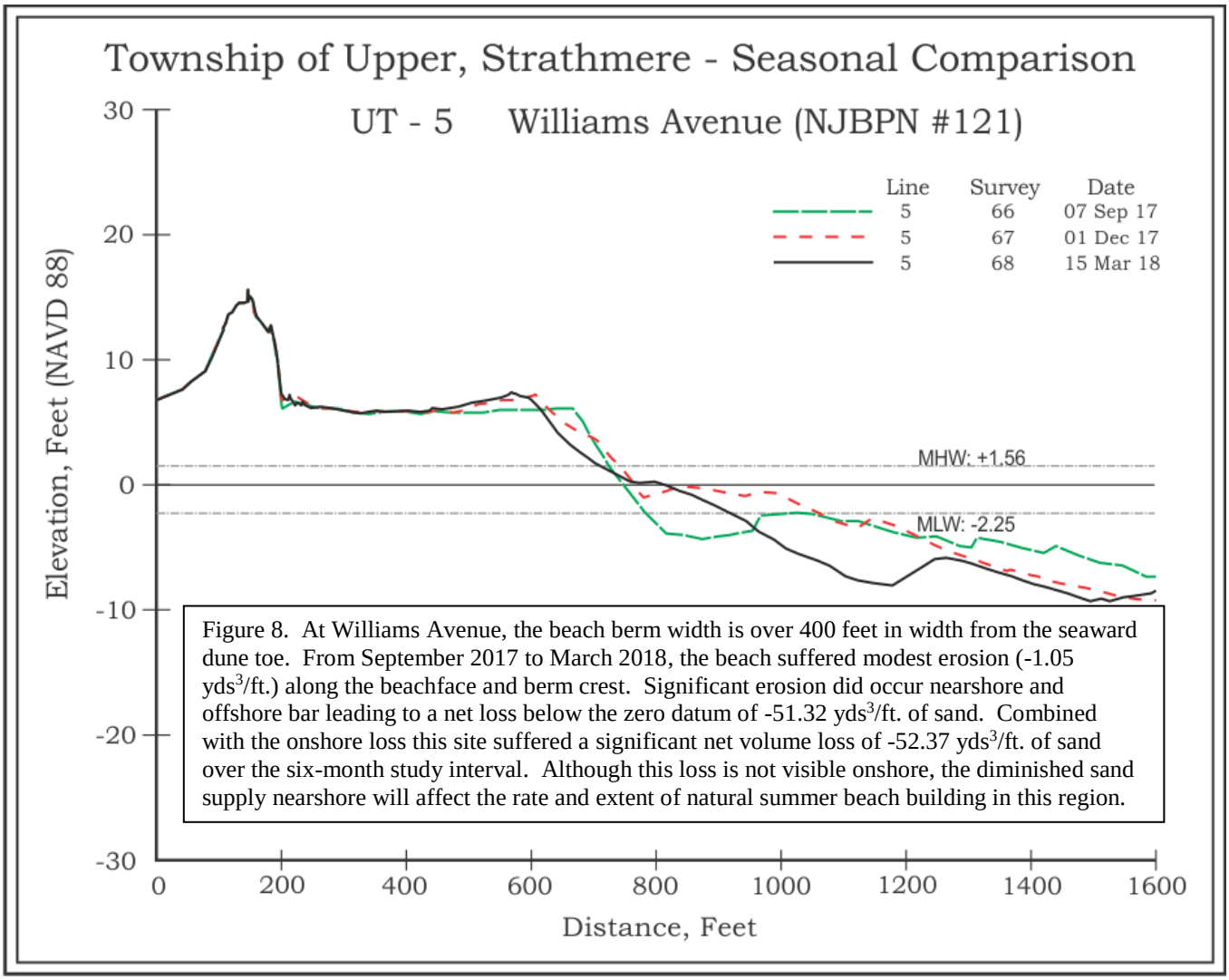


Figure 8. At Williams Avenue, the beach berm width is over 400 feet in width from the seaward dune toe. From September 2017 to March 2018, the beach suffered modest erosion (-1.05 yds^3/ft.) along the beachface and berm crest. Significant erosion did occur nearshore and offshore bar leading to a net loss below the zero datum of -51.32 yds^3/ft. of sand. Combined with the onshore loss this site suffered a significant net volume loss of -52.37 yds^3/ft. of sand over the six-month study interval. Although this loss is not visible onshore, the diminished sand supply nearshore will affect the rate and extent of natural summer beach building in this region.

UT – 6, Seaview Avenue near the Park Boundary.

This site, located adjacent to Corson's Inlet makes it vulnerable to rapid beach changes from inlet dynamics and northeast storms. To mitigate these losses, the State project created a wide bump out in the beach width here. The recently completed federal project dune and beach system template was narrower. The project beach continues to provide storm protection for inlet and oceanfront facing properties. As of September 2017, the dune crest elevation was at 15 feet NAVD88 and approximately 200 feet wide at the toe. However, the dry beach width eroded to just 50-feet from the dune toe to the MHW line. Over the fall, the seaward dune toe eroded leaving a 2-3-foot scarp, the nearshore shoal moved towards the beach and by December 2017, sand had welded to the beachface slope. The sand filled a trough along the shoreline present in September as it moved landward forming a wide shallow platform at the zero datum. The platform extended 140 feet, while a secondary sand ridge positioned about 200 feet from the shoreline contained more sand moved landward.

At East Seaview Avenue, the beach gained sand over the winter, despite the series of northeast storms. A modest 5.33 yds^3/ft. of sand accumulated on the beachface slope adding width and raised the elevation up to 1 foot from December 2017 to March 2018. By March 15, 2018, the beach width expanded from 140 feet in December 2017 to 300 feet between the dune toe and the MHW line. Although 150 feet of new width was at or just above the MHW elevation, subjecting it to storm waves and surge. The shoreline position advanced 11 feet in this same period. Storm waves scoured the nearshore bar transferring material seaward across the offshore region, deposited as a thin layer across the seaward 550 feet of the profile. This loss offset any accumulation below the datum resulting in an offshore loss of -18.21 yds^3/ft. of sand. Net volume loss for the winter was -12.88 yds^3/ft. of sand. Loss of the nearshore shoal/bar, left a shallow platform that extended at approximately elevation -6 feet NAVD88 over 800 feet seaward. This diminished the sand volume readily available for natural beach building once a calmer wave climate prevails in spring/summer.

Photo on the left taken December 1, 2017, shows fall erosion had cut into the dune toe but sand was moving towards the beach adding width, the emergent sand ridge is visible along the shoreline at low tide. The dune fence partially damaged by the storm marks a small scarp line that continues around the tip but the crest of the dune is still intact. A thin dry beach separated the dune from the inlet shoreline.

Photo above taken on March 15, 2018, shows the sand moving towards the shoreline in fall had welded to the beach by March, forming a wide emergent platform extending hundreds of feet seaward of the dune. Higher tides and storm surge still flood much of this low elevation beach but it helps to dissipate wave energy during storms, protecting the dune from additional erosion.

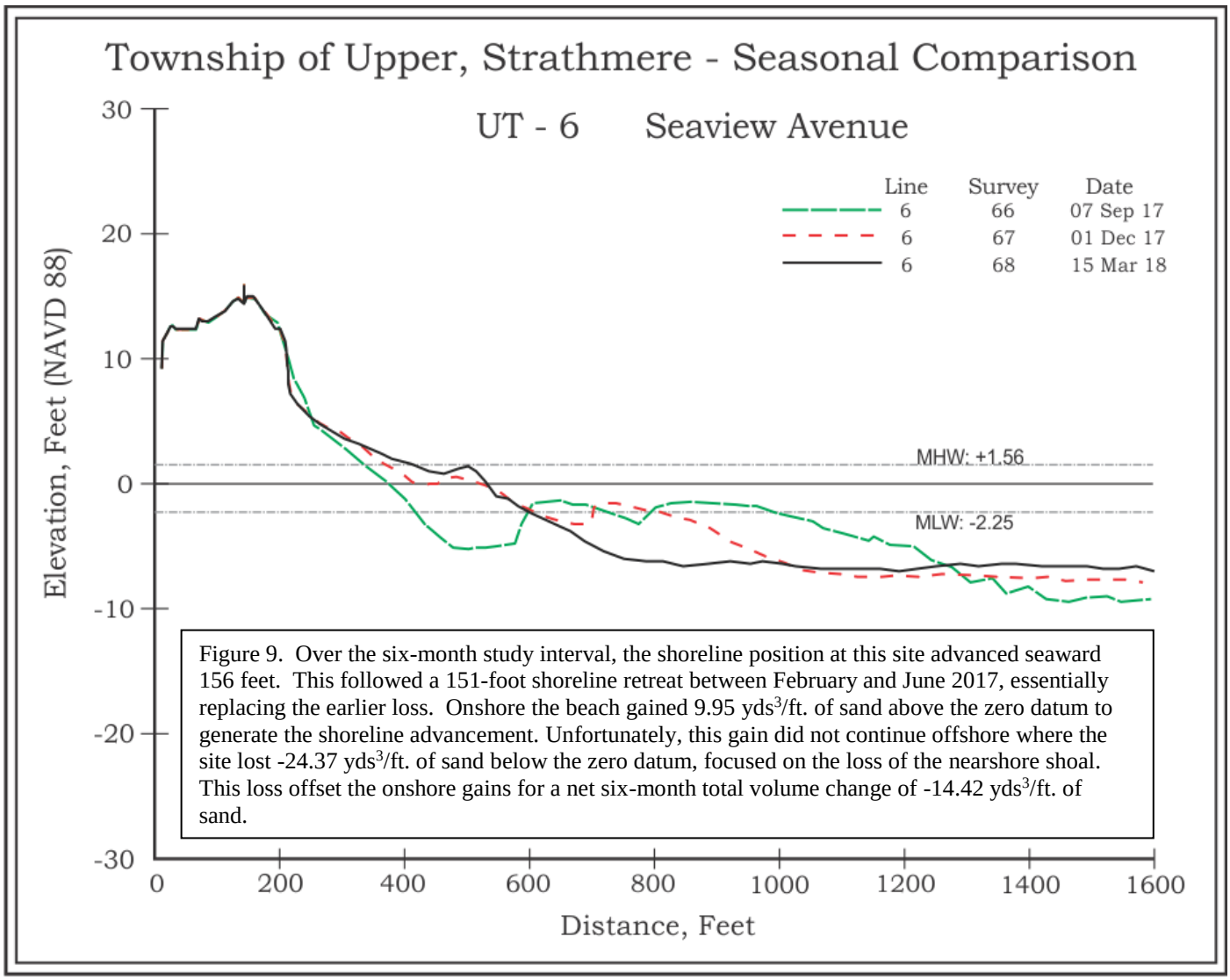


Figure 9. Over the six-month study interval, the shoreline position at this site advanced seaward 156 feet. This followed a 151-foot shoreline retreat between February and June 2017, essentially replacing the earlier loss. Onshore the beach gained 9.95 yds^3/ft. of sand above the zero datum to generate the shoreline advancement. Unfortunately, this gain did not continue offshore where the site lost -24.37 yds^3/ft. of sand below the zero datum, focused on the loss of the nearshore shoal. This loss offset the onshore gains for a net six-month total volume change of -14.42 yds^3/ft. of sand.

Conclusions:

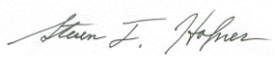
The Jersey shore suffered tidal flooding and beach erosion from multiple moderate to modest northeast storm events this winter, from December 1, 2017 to March 16, 2018. The first significant event occurred January 4-5, 2018, followed by a series of back-to-back storms on March 2-3, March 7-8 and March 12-13, 2018. With no time between events for natural sand recovery to occur these storms caused extensive erosion along the shoreline, but the dunes in Strathmere remained intact. The wide federal project beach berm absorbed the majority of the storm wave energy while the storm surge flooded the beach, leaving berm top ponds the diminished wave energy only caused minor erosion on the upper beach. The beachface and berm crest retreated at five of the six locations, only Seaview Avenue showed a gain in the berm width over the winter. Four of the six sites showed an advance in the zero datum shoreline position but this was a result of sand accumulation on the lower beachface slope, eroded then dragged seaward from the berm.

Along the southern Strathmere shoreline from First Avenue north to Jasper Avenue there was significant sand accumulation nearshore forming shore parallel bars, offsetting the onshore erosion resulting in modest volume changes ranging from a gain of 4.5 yds^3/ft. of sand at First Avenue to a loss of -3.0 yds^3/ft. of sand at Jasper Avenue. Net losses increased moving south to north where offshore losses were greater than onshore, resulting in significant diminished profile volumes at Tecumseh Avenue (-41.5yds^3/ft.) and Williams Avenue (-51.4yds^3/ft.). The site at Seaview Avenue benefited from shoal material welding to the beach for a modest onshore gain (5.33yds^3/ft.). Unfortunately, offset by the shoal loss for a net profile volume reduction of -12.88yds^3/ft. of sand. Overall, the Strathmere oceanfront beaches lost -138,982 cubic yards of sand over the winter months or approximately 9% of the sand placed during the federal project.

The modest volume changes on the southern shoreline indicates predominant cross-shore sand movement with a modest influx of sand carried longshore from the northern beaches during the winter storm season. More significant sand volume losses at the northend, indicates the storms either transferred sand cross-shore beyond the offshore limits of the survey methodology, or carried it away from these beaches through longshore transfer. There is an indication in the southern sites that a modest sand volume transferred longshore to those beaches but not in sufficient quantity to account for all the northend loss. Another possibility is that sand moved towards the inlet. Aerial photographs and photos taken looking towards the inlet from Seaview Avenue all suggest a significant accumulation of sand on the inlet shoreline. However, as this is part of the State Park the current Township monitoring program does not include this section. No quantitative confirmation of sand volume added to this shoreline over the winter is possible.

The CRC will conduct the spring quarterly survey in early June. This survey should provide an indication as to the redistribution of sand after the wave climate transitioned from the winter storm season to the gentler summer pattern. Please contact the Coastal Research Center with any questions or comments. Thank you for allowing the CRC to provide assistance with the Township's coastal zone management issues.

Sincerely,



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