STOCKTON UNIVERSITY
COASTAL RESEARCH CENTER

This view is of New Jersey's coastline from mid-Long Beach Island to Cape May Point from the International Space Station taken July 17, 2019 and provided to the Coastal Center by Christina Hammock-Koch, NASA astronaut.

New Jersey Beach Profile Network 2018 Annual Report on Shoreline Changes in New Jersey's Four Coastal Counties Raritan Bay to Delaware Bay Spring of 2017 Through Fall of 2018

Prepared for:
New Jersey Department of Environmental Protection
Division of Construction and Engineering
1510 Hooper Avenue, Toms River, New Jersey 08753

Prepared by:
The Stockton Coastal Research Center
Stockton University
30 Wilson Avenue, Port Republic, NJ 08241

March 15, 2020

The Stockton University
Coastal Research Center

New Jersey Beach Profile Network
2018 Annual Report
On
Shoreline Changes In New Jersey
In the Four Coastal Counties
Raritan Bay to Delaware Bay

Prepared for:
New Jersey Department of Environmental Protection
Division of Construction and Engineering
1510 Hooper Avenue

Prepared by:
Dr. Stewart C. Farrell
Kimberly McKenna, Steven Hafner
Crist Robine, Holly Pimpinelli, Alex Ferencz, Mathew Suran, Mathew Deibert, Brad Smith, Sami Doganay, Evan D'Ambrosio and Frances Deibert

March 15, 2020

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The New Jersey Department of Environmental Protection (NJDEP) collaborated with the Stockton University Coastal Research Center (CRC) in 1986 to create the New Jersey Beach Profile Network (NJBPN). This project commenced as an annual oceanfront and Raritan and Delaware Bay shoreline survey in the fall between 1986 and 1993, then switched to a spring and a fall survey at each site in 1994. This allowed the CRC to summarize winter storm damage each spring and review beach accretion following the summer season. The 2018 report is divided into four coastal county segments and gives a summary of beach changes in each county.

The US Army Corps of Engineers (USACE) has established coastal shore protection projects along 100% of the 97 miles of New Jersey's oceanfront shoreline with the NY District responsible for Raritan Bay efforts and the oceanfront from Sandy Hook National Seashore, south to Manasquan Inlet. The Philadelphia District manages from Manasquan Inlet south to Cape May Point and into Delaware Bay. Currently, the only segment where construction of the selected shore protection effort has yet to be constructed encompasses North Wildwood to Lower Township (The Wildwoods). Here, a project is under final implementation processes at the District to complete work along the NJ shoreline.

2018 Shoreline Management:

The post Hurricane Sandy USACE work on authorized coastal storm damage reduction projects was completed by the end of 2015. By the fall of 2017 the USACE Absecon Island project, initially completed for Atlantic City and Ventnor in 2003, was extended through Margate and Longport. Work continued in Margate with the construction of a stormwater management/ocean drainage system to replace the existing process of ocean street-end discharge onto the beach landward of the dunes.

In 2017, work commenced on the Manasquan Inlet to Barnegat Inlet project for the developed portion of Northern Ocean County. Multiple dredges have operated since spring 2017 to carry sand from the offshore borrow sites and place the material on the beach to build the design beach/dune cross section. The project stops at the Island Beach State Park northern boundary in the south and tapers off to no added material in the northernmost third of Point Pleasant Beach Borough located just south of Manasquan Inlet. As of the fall of 2018, the project was complete across much of northern Ocean County with Bay Head and Point Pleasant Beach Boroughs still to be completed. Litigation continues in both communities as oceanfront owners object to the easement requirement needed to legally have the federal government's contractors place sand above the mean high-water line on private land.

The USACE continues its evaluation of the proposed Wildwoods coastal storm damage reduction project where sand derived from the excess material accumulating on the Wildwood and Wildwood Crest municipal beaches will be excavated and used to restore the losses on the northernmost North Wildwood oceanfront. Again, private ownership to the mean high-water line in the City of Wildwood is delaying the start of construction, perhaps until 2022.

At the request of the New York District US Army Corps of Engineers (NY District), the NJDEP Division of Coastal Engineering (NJDEP DCE) and the CRC, surveyed 65 new profile locations in the fall of 2017. These

were selected from existing NY District survey sites between the present NJBPN survey locations. The CRC installed or upgraded survey markers and backup monumentation at the new locations. These sites are distributed among the original 34 oceanfront locations. Including the three Raritan Bay sites, the number of NJBPN sites for Monmouth County is 102 (Figure 1a-d). The 2018 contract included surveys completed at the old and new Monmouth County locations in the spring and fall of 2018. The Monmouth County section of this report contains comparisons among the three existing surveys to show changes to the NY District's Monmouth County coastal storm damage reduction effort between Sandy Hook National Seashore and Manasquan Borough. The number of NJBPN locations now totals 171 coast-wide.

All NJBPN survey data were analyzed to show changes in shoreline position and sand volume in each coastal county for an 18-month study interval. The seasonal, annual, and 18-month summaries are provided as county-wide averages in the tables below and in expanded tables for each site and each survey at the end of the report.

All four counties maintained a positive sand volume gain during the study interval at double digit values for the 18-month evaluation. Two counties lost minor amounts of sand volume during the winter (F 2016 to S 2017 surveys). In the summer of 2017e protection project (Table 1a).

Sand Volume Changes at the NJ Oceanfront

	S 17 – F 17 Cu. yds./ft.	F 17 – S 18 Cu. yds./ft.	S 18 – F 18 Cu. yds./ft.	S 17 – F 18 Cu. yds./ft.
Monmouth County	**2.62**	**-5.69**	**-5.07**	**-2.48**
Ocean County	**8.21**	**6.34**	**33.81**	**46.56**
Atlantic County	**35.30**	**18.99**	**-7.79**	**48.78**
Cape May County	**2.87**	**1.82**	**-9.50**	**-5.87**

The shoreline change values represent the difference in horizontal distance of the zero elevation position (0.0 ft. NAVD88) from the reference monument on the two profiles being compared. Advances seaward are presented as positive integers and retreat landward are negative. Each number shown in the table below is the average change for all the sites in each county. Ocean and Atlantic County shoreline positions averaged double digit advances seaward over the 18-month period. This is directly related to the USACE's ongoing beach projects. Monmouth and Cape May County averaged minor shoreline retreat values (Table 1b).

Shoreline Position Shifts Landward (-) or Seaward (+) at the NJ Oceanfront

	S 17 – F 17 Feet	F 17 – S 18 Feet	S 18 – F 18 Feet	S 17 – F 18 Feet
Monmouth County	**9.77**	**-10.02**	**-7.08**	**-6.67**
Ocean County	**32.31**	**-7.16**	**34.73**	**59.88**
Atlantic County	**42.26**	**19.43**	**4.87**	**66.56**
Cape May County	**4.58**	**1.04**	**-11.48**	**-5.87**

ACKNOWLEDGEMENTS

This research was funded by the State of New Jersey Department of Environmental Protection, Division of Construction and Engineering under the New Jersey Shore Protection Fund (N.J.S.A. 13:19-16.1). This is the final report under contract #4294-18.

INTRODUCTION:

The New Jersey Beach Profile Network (NJBPN) project provides site-specific information that can be expanded into a regional assessment of NJ coastal zone changes. It is designed to document seasonal and storm-related damage assessments of the New Jersey shoreline. Each of the original sites has been visited annually in the fall since 1986. Semi-annual visits, each spring and fall, began in 1994 following the passage of Public Law 93. The program was expanded to take surveys every spring following the winter northeasters and in the fall following summer beach accretion. During the first decade of work, new sites were established in the gaps of coverage and at all shorelines adjacent to tidal inlets. The information collected consists of photographs of the beach/dune system at each site, a topographic profile of the dune, beach and seafloor to a minimum depth of 15-18 feet, and field notes on significant geomorphic changes. Also, construction activity is noted and necessary information regarding quantity and duration of such activity is gathered. The field data are used to generate graphical cross section plots, which can be used for comparison across the width of the active coastal zone. The direct comparison of any two cross sections can be used to calculate sand volume and shoreline position changes during the time interval between the two surveys.

The major innovation in recent years has been the CRC, NJDEP DCE, and the USACE-New York District coordinated efforts to add 65 new profile sites to Monmouth County that were distributed along the oceanfront coastline south from Sandy Hook National Seashore. The USACE sites were added to provide more continuous coverage of shoreline changes within the recently renourished Sea Bright to Manasquan coastal segment. Each of the USACE sites was initially surveyed during the fall of 2017. Each was included in the 2018 contract work, which will allow individual site change calculations to be completed for the 2018 annual report. Ground photographs at each of the new sites replace the Google Earth views used last year to show site locations. The tables of computed shoreline and sand volume changes among the four seasonal survey dates do not include values for these new locations in Monmouth County for the spring of 2017 because the fall 2017 data reflects the initial survey of these new sites.

A series of mild to moderate northeast storms did have an impact between early March and just prior to Memorial Day in 2018, but serious storm events were absent including Atlantic hurricane tracks in proximity to the NJ coastline during the 2018 hurricane season. The tables of beach volume and shoreline change data are found after the county site descriptions for Cape May County in the appendix. A summary of each county's coastal zone activities follows the county profile site location diagram at the start of each county discussion. Conclusions based on the study data for this time interval appear at the end of each county section.

STORM RECOVERY AND BEACH PROJECT EFFECTIVENESS:

It is now over 6 years since Hurricane Sandy, and based on both the recovery rates observed following the 1992 northeast storm and recovery since Sandy, the vast majority of natural sand migration back to the NJ beachfront has occurred. The massive effort by the NJ DCE and the two Army Corps Districts was critical in instituting a significant recovery in the level of beachfront storm protection for NJ coastal communities. It is a testimony to the efforts of local leaders, the NJDEP DCE staff and leadership, the federal planners and engineers, and the interest by local citizens that New Jersey is the only US state with 100% of its developed oceanfront shoreline under federal jurisdiction with either completed projects or one final project about ready to be built. In addition, work has been completed or in final planning along the NJ Raritan Bay at three sites (Port Monmouth, Keansburg, and Union Beach). The Philadelphia District has completed projects along the Delaware Bay shoreline in NJ with several in the design stages for Fortescue, Money Island, and Villas.

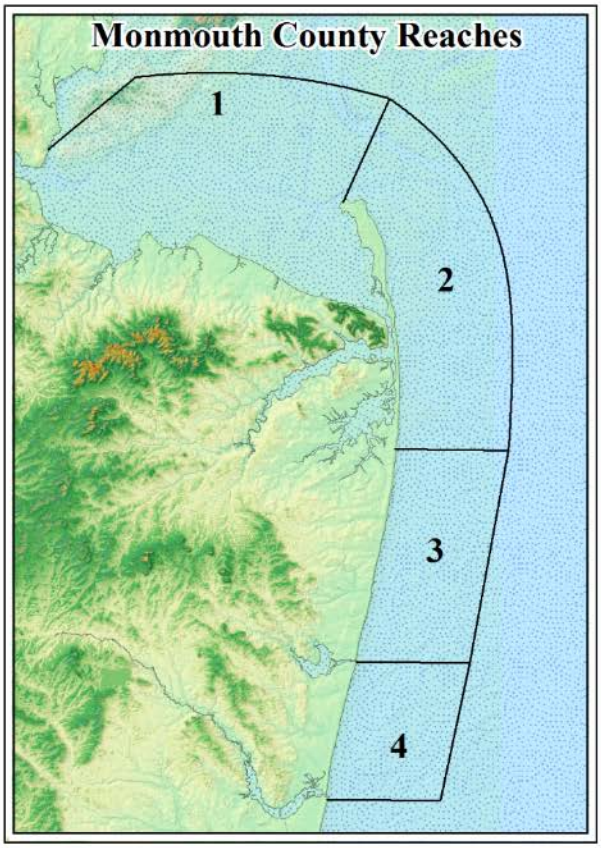
New Jersey Beach Profile Network

Monmouth County

Raritan Bay and Sandy Hook to Manasquan Inlet

NJBPN Profile #'s 187 - 256

New Jersey Beach Profile Network
Monmouth County Site Locations - Overview and Reach 1



The 102 NJBPN shoreline monitoring sites in Monmouth County extend from three sites along the eastern beaches of the Raritan Bay, to the oceanfront shoreline of Sandy Hook, then south to Manasquan Inlet. Profile sites are located in: Cliffwood Beach in Aberdeen Township, the Borough of Union Beach, Port Monmouth in Middletown Township, Gateway National Seashore, the Borough of Sea Bright, the Borough of Monmouth Beach, the City of Long Branch, the Borough of Deal, the Borough of Allenhurst, the City of Asbury Park, Ocean Grove in Neptune Township, the Borough of Bradley Beach, the Borough of Avon-by-the-Sea, the Borough of Belmar, the Borough of Spring Lake, the Borough of Sea Girt, and the Borough of Manasquan. Monmouth County has the greatest number of beach profile sites due to the complexity of its shoreline. A combination of man-made structures, the natural variety of beach widths and distinct erosional and/or accretional areas made careful site selection a necessity. In the fall of 2017, monitoring efforts were expanded to more fully document current conditions and seasonal changes. This expansion involved adding 65 new monitoring sites throughout the county. Locations of new sites were selected to match those previously occupied by the Army Corps of Engineers.

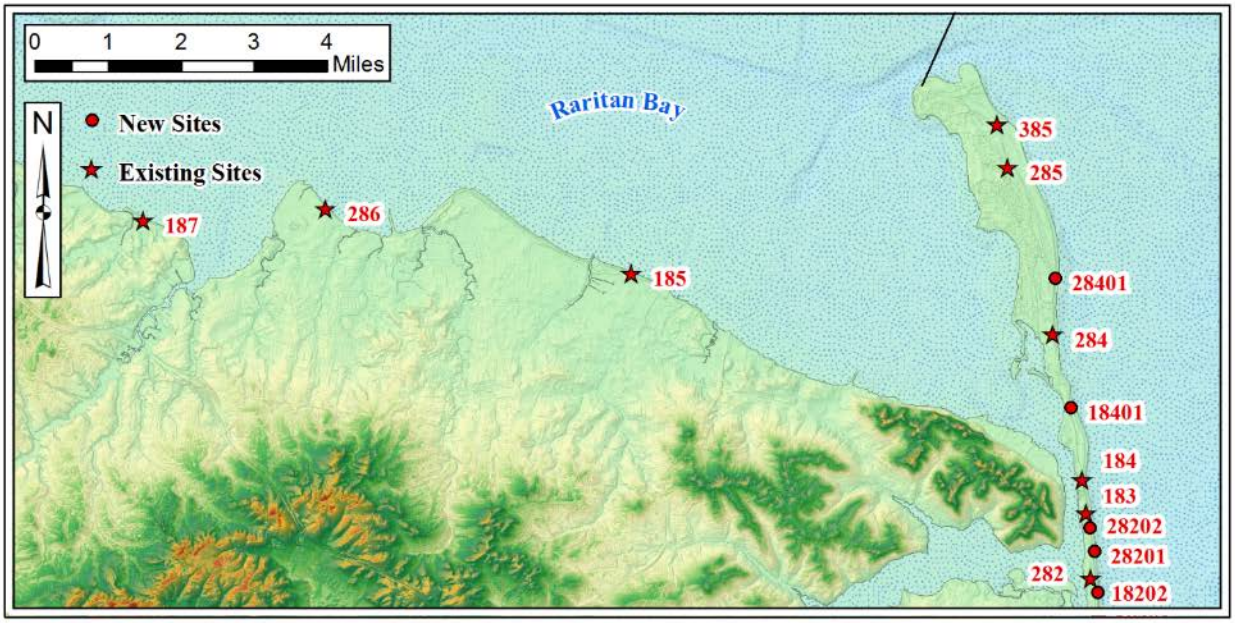


Figure 1a. Location Map for the four Monmouth County coastal reaches where the original and new survey sites are positioned along the Raritan Bay and oceanfront shorelines. The new sites have 5 diget ID numbers with the first three digits representing the original site immediately to the south, and the second two indicating the number of the site added. Site #286 was relocated in 2009 to the middle of a public bathing beach to document changes at a non-structural shoreline.

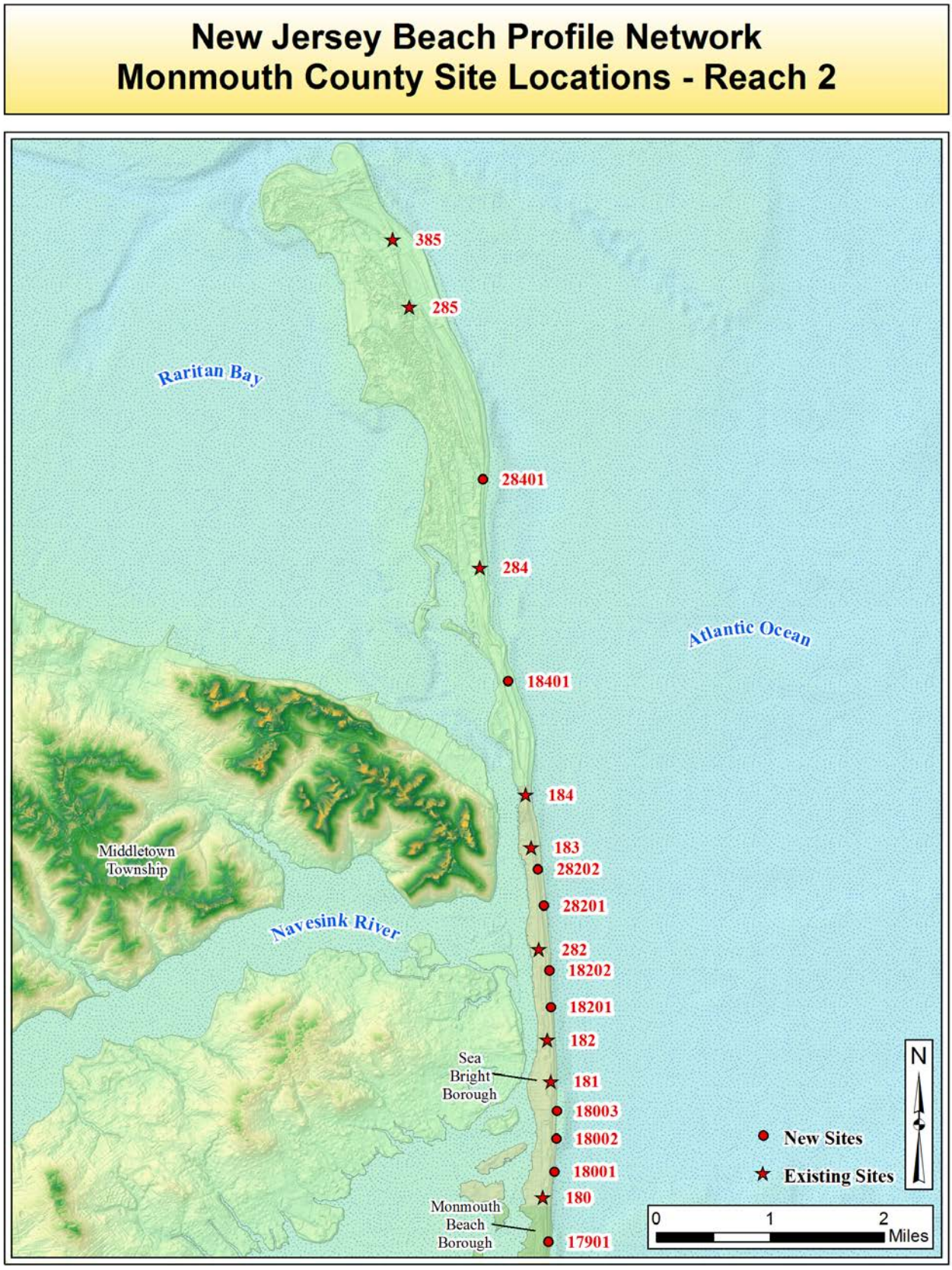


Figure 1b. Reach 2 showing Sandy Hook and Sea Bright survey site locations. The USACE NY District sites added in the fall of 2017 have 5 digits as location numbers. Site #385 was added spring 2017 to extend the Sandy Hook oceanfront beach coverage closer to the tip of the spit to gain better information on sand volumes moving north from the federal project.

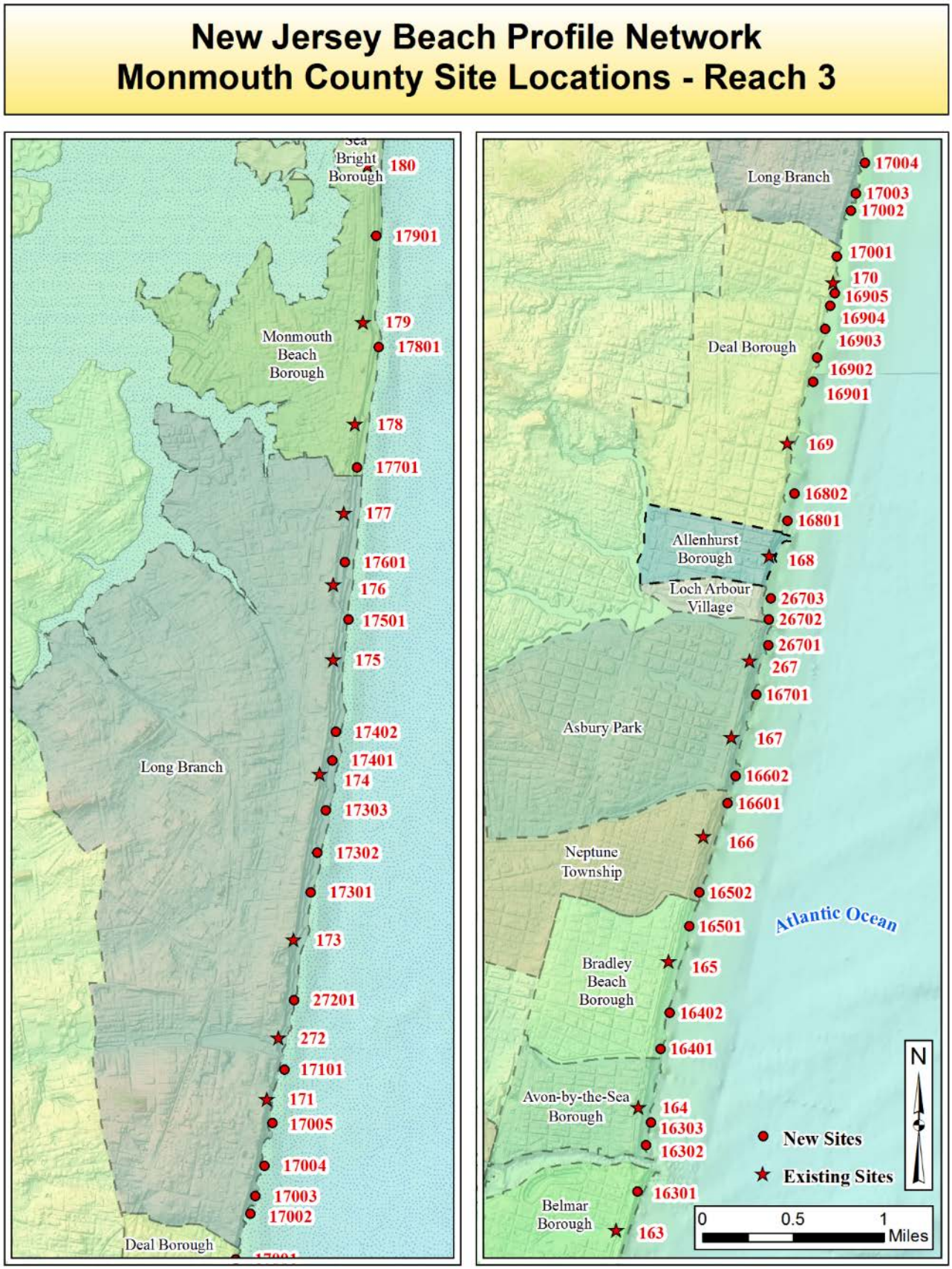


Figure 1c. Reach Three extends from Monmouth Beach south to Belmar Borough along the Monmouth County shoreline. A new location just north of Lake Takanassee was added (#272) in 2010 as Phase III of the federal beach project went to construction to better document the transition between the Phase I and Phase III projects.

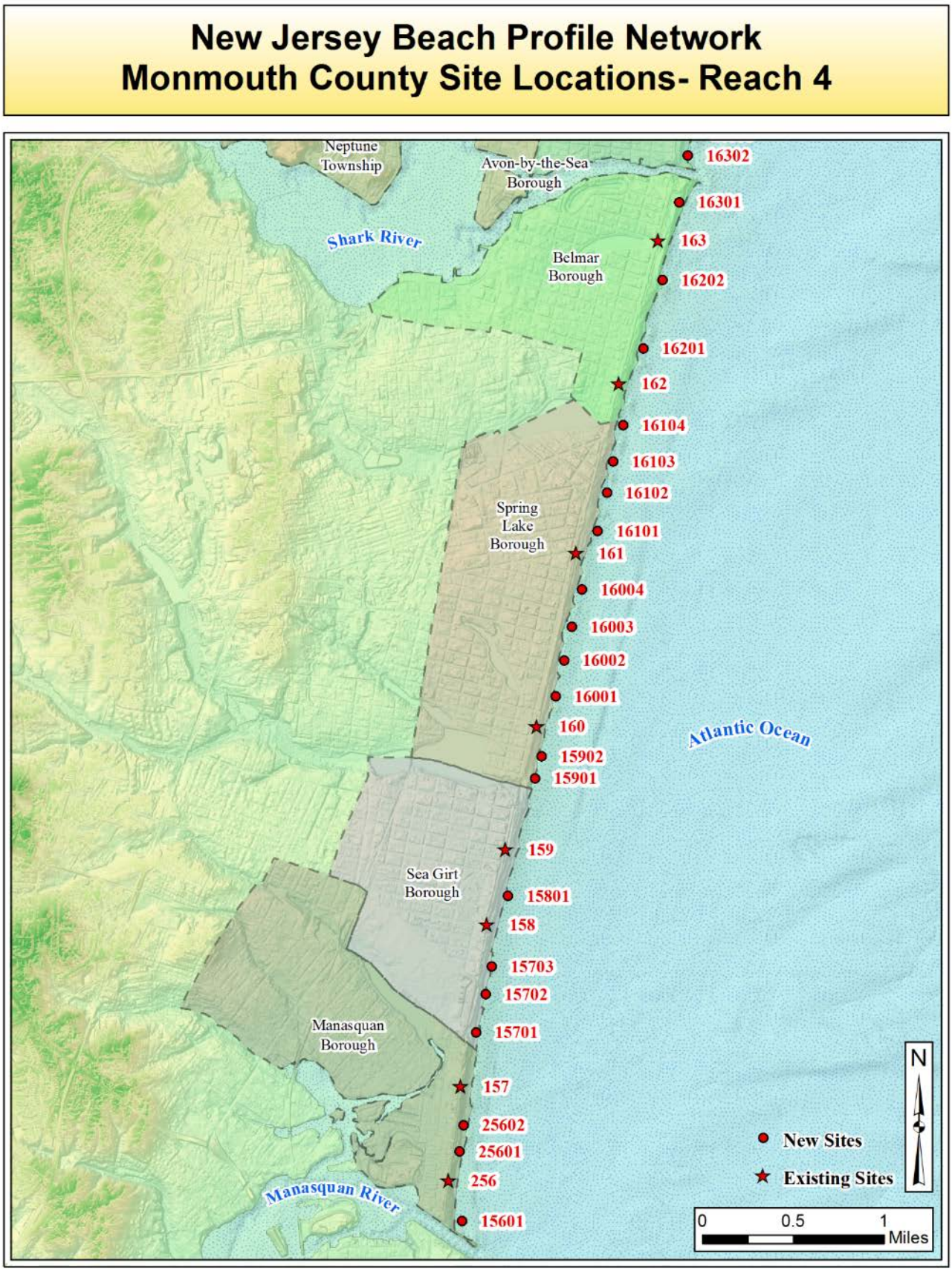


Figure 1d. The fourth reach extends to the Manasquan Inlet, the southern limit of the Monmouth County oceanfront and the NY Corps District project jurisdiction.

Individual Site Descriptions:

Following Congressional funding in early 2013, all public governing bodies affected by Hurricane Sandy worked diligently to restore the Monmouth County shoreline. The impact fell hardest on the beachfront communities (Sea Bright to Manasquan), but both the State and USACE came in to restore the damage. Work continued in 2013 and 2014 to bring all federal segments originally constructed back to design specifications. (2.1 million cu. yds. ($25.6 million) was placed between Sea Bright and Monmouth Beach. Long Branch received 3.3 million cu. yds. ($40.1 million), Asbury Park to Manasquan was enhanced with the placement of 2.3 million cu. yds. ($43.6 million). During 2015 the final phase of the Monmouth County shore protection project got underway with the placement of sand along the Loch Arbor, Allenhurst and Deal shoreline. Work was completed into Long Branch through the Elberon section (3.5 miles) leading to Lake Takanassee and the initial project beaches beginning at West End Avenue (4.45 million cu. yds., $38 million dollars). Work is scheduled to be complete with groin modifications plus storm water system changes by 2018, all funded under PL 113-2 (Disaster Relief Appropriations Act of January 2013). The NY District is evaluating beach conditions using the three CRC surveys completed, with the raw point data transferred to the District as of January 2019.

The beaches along Raritan Bay were badly eroded following Hurricane Sandy, but some recovery was documented since that time. The NY District undertook multiple efforts in restoration, spending $36.9 million placing 875,000 cu. yds. of new sand along the Keansburg Raritan Bay shoreline in 2014. The 2014 Port Monmouth work involved 3,000 feet of shoreline and about a half-million cubic yards of new sand plus a western groin to hold in the sand and a new, longer fishing pier at the Spy House Museum location. In Union Beach, work in the design phases was reevaluated following Hurricane Sandy via the Limited Re-evaluation Report (HSLRR) that was conducted with non-federal partners, NJDEP and Borough of Union Beach, NJ and published in June 2017. This project includes levees, floodwalls, tide gates, pump stations, and a dune and beach program. All these efforts are 100% federally funded under Public Law 113-2.

The 65 new profile sites, added to the Monmouth County NJBPN dataset, are identified by 5-digit numbers (Figure 1a-d). These sites were added to provide more continuous coverage of shoreline changes within the US Army Corps of Engineers, NY District's recently completed Sea Bright to Manasquan coastal segment.

Cliffwood Park, Aberdeen; #187

This site is located in a small county park that was established shortly before surveying commenced in 1986. The shoreline faces north-northeast into Raritan Bay and is subject to a significant wave fetch across the bay. Hurricane Sandy transported the entire dune landward into the parking and access areas for the park. During the most recent study period (spring 2017 to fall 2018), minimal changes occurred (sand volume declined just -1.26 yds^3/ft. as the shoreline retreated 8 feet). No specific sediment addition was attempted and the natural changes were very modest.

Union Beach; #286

The Union Beach site is now located in the middle of the municipal bathing beach on Raritan Bay. The site was moved to provide more meaningful data on bay beach changes. Hurricane Sandy pushed sand landward beyond the parking lot, but did not severely affect the shoreline position. During 2013, Union Beach funded sand placement from Amboy Aggregates in the amount of 14,000 cubic yards by truck. On January 3, 2018 a NJ State partnership agreement was signed by the NJDEP and the Corps. Plans and specifications for Phase I, the shoreline component are in development (sand placement, terminal groins, dune cross overs, and outfall extensions). Between spring 2017 and fall 2018, the sand volume decreased by 2.20 yds^3/ft. as the shoreline retreated 5 feet. At both these first two sites, bay floor changes have remained essentially zero in spite of an average depth less than 5 feet over a 500-foot distance offshore.

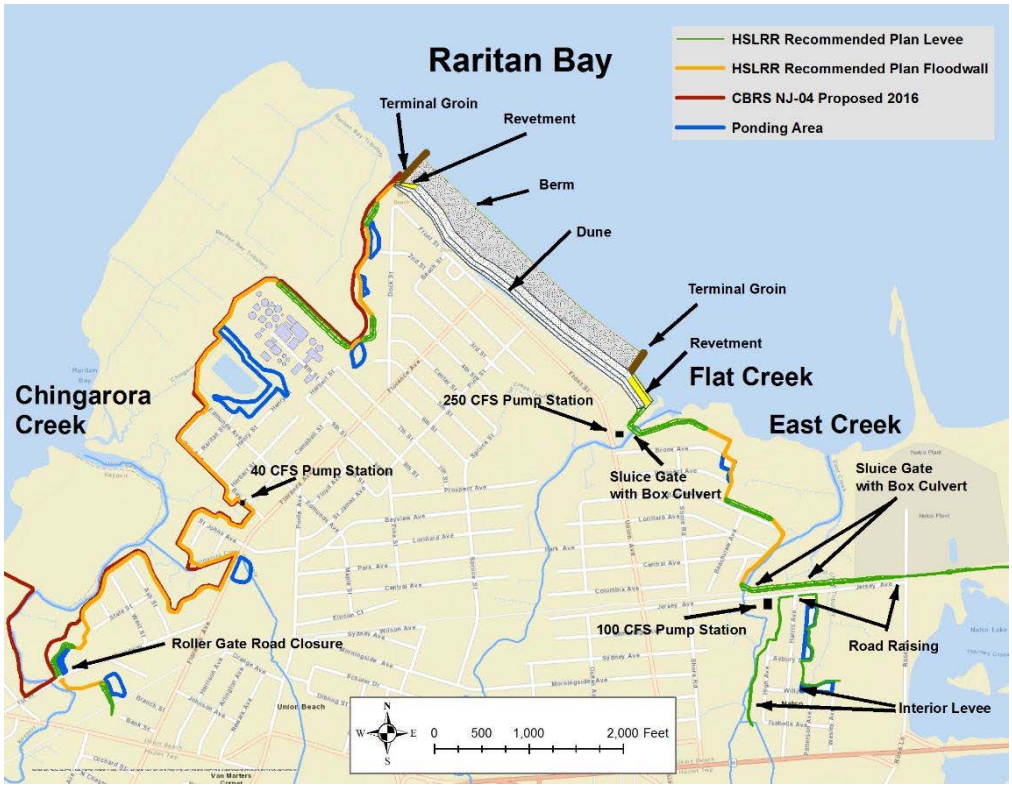


Figure 2. Design plan for Union Beach coastal resilience features reproduced from the January 2017 USACE Union Beach, NJ Hurricane Sandy Limited Reevaluation Report for Coastal Risk Management (retained from the 2017 report).

Bay Shore Waterfront Park, Port Monmouth; #185

The easternmost site along the Monmouth County Raritan Bay shoreline is positioned west of Highlands and Atlantic Highlands at a Monmouth County Park site dedicated to an historic building dating to the revolution. Significant shore rehabilitation work preceded Hurricane Sandy and served to absorb some of the impact. The New York District Corps of Engineers concluded pumping approximately a half-million cubic yards of sand onto 3,000 feet of the Port Monmouth shoreline adding a 150 yds^3/ft. sand volume addition to the beach in 2014. This project includes a new, longer fishing pier and a rock groin on the west end to retain the bulge in the sand shoreline now present. The 142.11 yds^3/ft. sand volume reported as a result of the spring 2014 to fall 2014 survey reflects this project. The site has lost 4.79 yds^3/ft. by spring 2015 and 16.67 yds^3/ft. by fall 2015. The project shoreline advance of 261 feet saw a 1.7-foot and a 3.7-foot retreat over the next two surveys. Between the spring of 2016 to fall 2017 the site lost 5.07 yds^3/ft. as the shoreline retreated 14.34 feet. The spring 2017 to fall 2018 change was a sand volume loss of 1.16 yds^3/ft. and a shoreline retreat of 7 feet. Since completion in 2015, the sand loss amounts to 27.69 yds^3/ft. in four years (19.5%) accompanied by a shoreline retreat of 26.7 feet. Offshore, this location had no change in the bay floor over a distance of 1,000 feet.

North Beach, Sandy Hook National Seashore; #385

This site was added to NJBPN in 2016 to gain information on the sand volumes accumulating along the National Seashore oceanfront to the northernmost vehicular access location. This included an additional 3,500 feet of beach to that previously analyzed between the park entrance (#184) and Gunnison Beach (#285). The tip of the Sandy Hook spit extends an additional 4,000 feet of curving shoreline into Raritan Bay, but profile maintenance and access is difficult. This study interval saw 42.67 yds^3/ft. in added sand volume along with a 115-foot shoreline advance.

Gunnison Beach, Sandy Hook National Seashore; #285

Gunnison Beach, originally the northernmost site on Sandy Hook National Seashore actually lost sand volume during the past 18 months (-11.74 yds^3/ft.) accompanied by a 54-foot shoreline retreat.

Area F Road, Sandy Hook National Seashore; #28401

This site is the northernmost of the newly added 65 profiles to the original series of 37 NJBPN locations in Monmouth County. The new sites were established in 2017 for the NY District Corps of Engineers to provide greater shoreline coverage density throughout the Monmouth County project. This new profile site was positioned between Gunnison Beach and Parking lot E in the Sandy Hook National Seashore. There is a wide dune with an extended slope seaward to the beach and a significant offshore bar. The coordinates given for the cross section's starting point and alignment put a large concrete relic directly on the survey line. The ruin lies in the intertidal surf zone and presents a danger to the survey crew trying to include it in the profile. Therefore this line was moved 70.2 feet south of the given coordinates for the start point to avoid the obstacle. The ruins are likely related to WW I or WW II military defense installations. The site gained sand during the fall 2017 to spring 2018 interval (6.74 yds^3/ft.) and gained material between the spring 2018 and fall 2018 period (-11.85 yds^3/ft.). The shoreline changes for each interval were -24 and -32 feet respectively.

Parking Lot E, Sandy Hook National Seashore; #284

This public bathing beach was selected because it was located in the middle of Sandy Hook and represented both a public use area and an easy access point to conduct surveys. Growth in the beach and berm width occurred as the site gained 39.89 yds^3/ft. in new sand producing a 50.8-foot shoreline advance (spring 2017 to fall 2018).

Parking Lot C, Sandy Hook National Seashore; #18401

A second new site on the Sandy Hook National Seashore oceanfront. There is a 22-foot elevation dune located 225 feet landward of the berm crest on the beach. The profile is quite steep, but offshore there is a bar system extending 350 feet seaward at 7-foot depths prior to dropping into deeper water. Both seasonal surveys saw sand volume losses (-2.24 yds^3/ft. and -26.47 yds^3/ft.). Shoreline changes were zero in the winter of 2017-8 and -14.5 feet of retreat during the summer of 2018.

Highlands Beach, Sandy Hook National Seashore; #184

This was initially the northern coastal site, but data supported the need to add sites on Sandy Hook since it was clear that losses south of #184 were being deposited along the National Seashore beaches. Extensive deposition occurred on this site during the past 18 months, (22.59 yds^3/ft. in sand volume gain, accompanied by a 33-foot shoreline advance) as the berm and beach extended seaward over the summer and fall of 2018.

Via Ripa, Sea Bright; #183

This northern Sea Bright location lies just south of the bridge to Atlantic Highlands across the entrance into the Shrewsbury and Navesink Estuaries. In 2015, the Army Corps project added 43.1 yds^3/ft. to the beach producing a shoreline position almost equal to pre-Sandy conditions. A substantial sand volume was added between February 2016 and December 2016 (52.51 yds^3/ft. and a 159-foot shoreline advance seaward). The 18-month (S16 to F17) change was a gain in sand of 43.56 yds^3/ft. and a 102.5-foot shoreline advance. The 19 month interval from spring 2017 to fall 2018 saw reversals in depositional trends with a 1.49 yds^3/ft. sand volume increase and a 75-foot shoreline retreat as the beachface retreated substantially. Sand moved up to the dune toe and offshore balancing the sediment budget for the interval.

300 Ocean Avenue, Sea Bright; #28202

Positioned along the Sea Bright seawall, this site is similar to #183 above with a wide beach, but no dune, a steep berm and a modest offshore bar. The net seasonal change was a loss of 37.50 yds^3/ft. during the summer of 2018 accompanied by a 54-foot shoreline retreat.

436 Ocean Avenue, Sea Bright; #28201

This new Sea Bright seawall site includes a dune seaward of the wall and a wide beach and a minor offshore bar system. This site's shoreline advanced 8 feet in 2018, but the site lost 7.15 yds^3/ft. in sand volume.

Shrewsbury Way, Sea Bright; #282

This site was the only northern Monmouth County site along Phase I Federal project that had exceeded the initial sand volume placed on the beach (116%). The Army Corps project restored sand to the beach, but the shoreline fell 156 feet short of the pre-Sandy conditions as of April 2013. This site continued to gain sand since the Corps project concluded by adding 36.20 yds^3/ft. with an outstanding 154-foot shoreline advance. This took the site to a position where the shoreline was 96 feet further seaward than prior to Hurricane Sandy. There exists a certain stability to this site that differs from most other Sea Bright locations. During the past 18 months an additional 5.93 yds^3/ft. in sand volume was added, but the shoreline retreated (-22 feet). The recent 18 months of data show that the sand volume decreased by 12.38 yds^3/ft. along with a 16-foot shoreline retreat.

678 Ocean Avenue, Sea Bright; #18202

This new site includes a small dune at the base of the seawall, but a 250-foot wide dry beach seaward of the dune. Little material lies offshore as a bar however. Since the initial survey in early January 2018, the site initially gained substantially across the entire profile adding 18.48 yds^3/ft. during the winter, however the 2018 summer season the shoreline retreated 32 feet as the site lost 25.12 yds^3/ft. during the summer. The annual loss was less at 6.64 yds^3/ft., which is unusual to see high summer sand losses exceed the winter gains (18.48 yds^3/ft.).

801 Ocean Avenue, Sea Bright; #18201

There is no seawall at this new profile site located between two beach clubs. There is a wide beach rising about 2 feet higher at the berm crest on a multiple ridge beachfront that is 540 feet wide to the water's edge. No offshore bar system is present. Very pronounced berm ridges seem to appear with the October 2018 representative having 4 feet of relief on the landward slope. This site gained sand during the summer season, but lost material during the winter and spring of 2018. The net change was -7.76 yds^3/ft. with a 42-foot shoreline retreat.

Sea Bright Public Beach, Sea Bright; #182

The next location south was obtained by NJ State purchase 30 years ago and converted into a public bathing area with some off-street parking. There was a modest dune at the toe of the rocks, but the waves ramped up and over the rocks using that sand as a deposit forming the ramp. This beach contained 98% of the initial Federal project's fill material as of fall 2011. No dune existed other than grass growing at the toe of the rock seawall. In 2013 the beach was restored and a new small dune has appeared along with a wide beach that, between spring 2016 and fall 2017, gained 21.13 yds^3/ft. in new sand generating a 96-foot shoreline advance. There is no significant offshore bar system. During 2018, sand migrated onto the shoreline forming a distinct ridge, but absent the traditional offshore bar. The sand volume decreased by 10.63 over 18 months with a 21-foot shoreline retreat.

Sea Bright Municipal Beach; #181

The peninsula widens here to include commercial businesses on both sides of Ocean Avenue plus parking for the beach. However, no rock seawall extended across a gap at the municipal beach. The federal project showed dramatically as a 76.32 yds^3/ft. wedge of sand added to the beach by October 2013 advanced the shoreline 104 feet beyond that present prior to Sandy. Following Hurricane Sandy a new hard structure was installed at the seaward edge of the parking lot. Since April 2017 a very large new dune was built on the beach to elevation 19 feet. The beach seaward of the dune lost 10.63 yds^3/ft. as the shoreline advanced 47 feet.

1201 Ocean Avenue, Sea Bright; #18003

This new profile location includes a pair of dune ridges seaward of the seawall but no horizontal dry beach, just a slope to the water's edge. The dune continued to develop with added sand. The first survey found a pushed up ridge of sand, not repeated subsequently. The summer of 2018 resulted in a very large berm ridge generating a decent beach area. No distinct offshore bar features have developed.

15 Tradewinds Lane, Sea Bright; #18002

This new profile site has two dune ridges with the larger one seaward, and a similar structure to the beach seaward as seen at site 18003. The larger "dune" was pushed up that winter, and was not repeated. The beach has retreated in both sand volume and shoreline position since Jan 2018 (-19.96 yds^3/ft. and -9 feet for the year).

1485 Ocean Avenue, Sea Bright; #18001

Positioned at the base of the seawall, this new profile site shows a narrow beach, a developed berm, but no offshore bar system on the initial survey completed in February 2018 due to site access difficulties with private owners. Subsequently, the site lost sand volume and the shoreline retreated somewhat as the beach became lower in elevation at the seawall by 5 feet. The sand loss was -14.76 yds^3/ft. with a 31-foot shoreline retreat.

Sunset Court, Sea Bright; #180

The location north of Cottage Road maintained 45% of the initial sand volume placed in 1999. The repeated deposition of maintenance material at Cottage Road moved north through this location. There was no dune, other than grass here and there among the rocks of the seawall. Sand appeared offshore in quantity as material was pumped onto the beach by the Federal project (82.94 yds^3/ft.). Over the past 18 months the sand volume decreased (-12.65 yds^3/ft.) and the shoreline retreated 42 feet.

122 Ocean Avenue, Monmouth Beach; #17901

This NY USACE site is located north of Cottage Road and contains no dune at the seawall, but a relatively decent width beach sloping into the sea without an offshore bar system. During 2018, the site lost sand volume during the winter, then regained some material during the summer. At the end of the study interval, the sand volume declined by 4.90 yds^3/ft. and the shoreline retreated 31 feet.

Cottage Road, Monmouth Beach; #179

The Cottage Road location has been the "Hot Spot" erosion area in an otherwise very successful Federal beach restoration project. Immediately south of this site a massive stone groin was privately built decades ago and acts to restrict sand movement north from the beach fronting a 19th Century private beach club. The groin obviously serves its intended purpose, but to the detriment of the Federal beach project's durability just north of the groin. The Cottage Road site commenced losing sand as soon as it was completed. Losses were replaced in

1997, 1999, 2001, and a modest sand volume was added in 2010 from Shrewsbury River dredging. There was only a narrow, dry beach that gets wet to the rocks under normal wave action at high tide. Just prior to Sandy the construction of a 2012 restoration had started here and was moving northward. The post-storm survey in late March 2013 showed even more loss at the low tide line. By October 2013, restoration had occurred where the berm was regenerated at elevation 10.0 feet and extended 500 feet from the seawall at that elevation. There is no dune at the seawall, but a narrow berm remains in place. Retreat has been consistent starting with the May 2016 survey. The net loss in 2017 was -70.31 yds^3/ft. accompanied by a 73-foot shoreline retreat at the site. The loss rate in 2018 continued at a similar rate (-42.13 yds^3/ft. in sand loss and a 78-foot shoreline retreat).

65 Ocean Avenue, Monmouth Beach; #17801

This new profile location includes a 14-foot elevation dune that lies at the landward edge. The beach is about 150 feet wide to the second berm crest and then slopes into the water without any bar system present. This site is on the up-drift side of the groin producing the serious erosion hot spot at Cottage Road (site #179). During 2018 this location lost 3.89 yds^3/ft. along with a 31-foot shoreline retreat.

Monmouth Beach Club, Monmouth Beach; #178

The Valentine Street site is located on the premises of the venerable Monmouth Beach Club with the survey starting point in the landward segment of the timber deck overlooking the seawall. Destroyed by Sandy, this site has been rebuilt and the sand replaced to the initial federal project specifications. The dimensions of sand placement between March and October of 2013 is an impressive 181.20 yds^3/ft. with a 231-foot shoreline advance seaward. Sand accumulation added to the berm elevation and beach width between April 2016 and January 2018 surveys. During 2018 the berm was cut back and lowered in elevation. The shoreline remained relatively constant however. The sand volume increased by 21.89 yds^3/ft., but the shoreline advanced just one foot. There was a very large ridge of sand pushed up on the beach that also generated a deep trough immediately landward. This activity was as a result of the NJDEP working on the rock seawall and excavating material for access. The site also developed a significant offshore bar and trough by Jan. 2, 2019.

9 Ocean Avenue, Monmouth Beach; #17701

Positioned half way between #178 and #177, this new profile site includes a seawall with a sand ridge immediately seaward of it, followed by a 270-foot wide dry beach. The beach slope is steep and ends at a very small offshore bar system, which became much more pronounced at each of the two subsequent surveys. The sand volume decreased by 23.87 yds^3/ft. as the shoreline position retreated 29 feet by May 2018 and then 26 feet by December 2018.

Ocean Avenue Long Branch; #177

This site was once a USO non-commissioned officer's beach recreation area for Fort Monmouth personnel. Presently part of the Seven-Presidents Park system belonging to Monmouth County, this site saw severe erosion during Sandy, followed by further losses offshore as some sand moved landward by March 2013. The federal sand placement project eventually put 123.04 yds^3/ft. in new sand at the site producing a shoreline advance of 185 feet. The recent study interval produced a shoreline change of -40 feet with a -35.82 yds^3/ft. loss in sand volume.

300 Ocean Avenue, North Long Branch; #17601

This new profile location includes a long slope up to the dune crest, a straight line drawn between the reference mark 400 feet landward of the crest and the top of the dune. The beach is about 220 feet wide, but slopes steeply into a trough present during the initial survey. This trough represents a bar system approaching the base

of the beachface. This bar deposit was added to the beachface by March 2018, but erosion has taken a toll since because the November 2018 survey shows berm retreat. Sand volume declined by 58.14 yds^3/ft. following a 36.55 yds^3/ft. increase in March. The shoreline retreated 60 feet after a 35-foot advance in March 2018.

Seven Presidents Park, Long Branch; #176

This site was converted into open parkland space 35 years ago with the purchase of all commercial and private buildings near the waterfront. The area has 25 foot dunes with several prominent gaps to allow public easy access to the beach. The Federal project was completed here in 1999 and 74% of the initial sand placed was still present in October 2011. The restoration effort provided 98.24 yds^3/ft. and a 131-foot shoreline advance. The last 18 months of surveys show that the sand volume decreased by 38.91 yds^3/ft. in a series of three steps between April 2017, December 2017 and March 2018, followed by a summer increase in beach width as of November 2018. The shoreline retreated 45 feet, again with the summer 2018 period seeing 24 feet of recovery from previous (-69 feet) erosional events.

Ocean Terrace, Long Branch; #17501

Starting at a bulkhead, this new profile site shows a beach with a high seaward berm and a steep slope into the water. A very minor offshore bar existed without a ridge between December 2017 and March 2018. In the March 2018 cross section, sand had shifted landward building a significant berm, but not at the expense of offshore deposits. However, during the 2018 summer season, the berm remained present, but a deep trough developed at the base of the beachface and an offshore bar appeared. The study interval produced a -6.96 yds^3/ft. sand volume change with a 13-foot shoreline retreat.

Broadway Avenue, Long Branch; #175

At this site the Corps project beach was at 79% of the as-built sand volume in the fall of 2011. The storm transferred sand offshore between the early October 2012 and March 2013 surveys with 22.72 yds^3/ft. deposited on the beach from a loss seen offshore of 28.68 yds^3/ft. by the time of the October 2013 survey. The USACE provided 95.55 yds^3/ft. in new sand causing a 103-foot shoreline advance here. During this study interval, the beach accumulated sand during the 2017 summer season, losing some of it over the winter, plus an increased amount during the summer of 2018. The changes occurred in the beachface and nearby offshore regions. The two earlier seasonal gains in sand volume were offset by the 2018 summer loss leaving the site with a -3.70 yds^3/ft. sand volume change and a 15-foot shoreline advance.

45 Ocean Avenue, Long Branch; #17402

The bluff at this new profile location lies protected behind a decades old vertical steel sheet pile wall. The beach is 175 feet wide with a milder slope into the ocean. No offshore bar system is present. Minor losses were documented at the base of the beachface and immediately offshore. The net change was a sand volume loss of 2.11 yds^3/ft. for the year and a 12-foot shoreline retreat.

North Morris Avenue, Long Branch; #17401

At this new profile site the old steel sheet pile wall has a rock revetment protecting it. The beach is about 300 feet wide with a strong break in slope to a more gentle gradient out to sea from the base of the beachface. The 2017 to 2018 winter season saw significant beachface and nearshore erosion (-20.49 yds^3/ft. and -43 feet of shoreline retreat). The November 2018 survey saw sand deposited up at the bluff, but the loss of the earlier offshore bar material.

Morris Avenue, Long Branch; #174

This site is positioned along the old Long Branch beachfront along the former Ocean Avenue now reduced to a pedestrian walk. Sandy removed the boardwalk from the top of the bluff above the rock seawall. Since then, sand moved landward from offshore regenerated the beach to the position just prior to the hurricane. As of the fall 2014 survey it appeared that the City moved the pedestrian walkway onto the eastern half of the remaining southbound road that once was Ocean Avenue. The boardwalk was rebuilt at the bluff's edge. The USACE work completed by May 2014 placed 167.25 yds^3/ft. in new sand at the site and generated a 200-foot shoreline advance as of fall 2014. In the recent survey interval, the site lost -9.83 yds^3/ft. in sand volume with a 15-foot shoreline retreat.

276 Ocean Avenue, Long Branch; #17303

This new profile starts at the top of the bluff and crosses the rock revetment that protects Ocean Avenue in Long Branch. This site saw few changes since the initial profile survey in December 2017. A bar developed offshore and the beachface retreated a few feet. The sand volume change was -2.09 yds^3/ft. with a 16-foot shoreline retreat.

378 Ocean Avenue, Long Branch; #17302

This new profile location was established along the uplands bluff, crossing the rock revetment, this site has a similar beach width to site #17303 to the north, with an offshore bar deposit. Few changes occurred at the site yielding a small shoreline retreat (9.0 feet) and a -1.85 yds^3/ft. loss in sand volume.

Wooley Court, Long Branch; #17301

This is the third new site between Morris Avenue and West End Avenue, which starts on the top of the sedimentary bluff, crosses the rock revetment to the beach. The initial survey shows a near identical cross section to the other two new sites in this segment of the Long Branch shoreline. However, here the winter season produced a substantial beach retreat and sand volume loss (-31 feet, -16.04 yds^3/ft.) that was followed by recovery in sand volume (+29.06 yds^3/ft.) and a 34-foot shoreline advance by December 2018.

West End Avenue, Long Branch; #173

Located near the southern end of Phase I within the NY District Corps of Engineers Monmouth County beach restoration project, this site has a rock revetment protecting the base of the bluff, with the boardwalk positioned at the edge of the bluff some 15 feet above the revetment. In 1999 the initial beach replenishment was completed giving this location a 250-foot wide beach, but no dune was included. This site recovered in a similar pattern to the other Long Branch sites. The USACE placed 385.38 yds^3/ft. in new sand that generated a 436-foot shoreline advance at the site as of spring 2014. This work suffered 47% loss rates into the fall of 2015, that was followed by restoration work in 2016 and 2017 as the third phase of the Monmouth County project was completed through Deal and Elberon into Long Branch. The past 18 months documented 20.44 yds^3/ft. in sand volume increases mostly on the beach as the elevation reached 10.0 feet NAVD 1988. The shoreline advanced 14 feet in the process.

717 Ocean Avenue, Long Branch; #27201

This new profile site is positioned just south of the end of the rock revetment protecting the old Ocean Avenue in Long Branch. There is a bulkhead at the property line and a 300-foot wide beach seaward of the bulkhead. No dune exists at the site, but there is an offshore terrace at the -4-foot elevation of about 200 feet in width. No bar exists on the initial survey. This site replaced a site originally established in 1986 (#172) and abandoned

due to development. The year since the first survey saw -8.35 yds^3/ft. in sand volume loss combined with a -35-foot shoreline retreat. The beachface retreat was constant among the three surveys thus far, but the summer 2018 season saw a large wedge of sand accumulate just offshore mitigating the total site sand loss.

Lake Takanassee, 805 Ocean Avenue, Long Branch; #272

This profile location was established a few years ago to replace original site #172 abandoned years ago. Lake Takanassee is the northernmost "estuary lake" along the Monmouth County shoreline and, like the others, has a fresh water drainage system constricted at the shoreline by a bay-mouth barrier. It was necessary to relocate the profile to the south, further from the condominium's parking lot retaining bulkhead. All changes since Hurricane Sandy were variations in cross shore sediment transfers leading to some beach accumulation as of the fall of 2013. The USACE placed sand to this point adding 102.66 yds^3/ft. and a shoreline advance of 79 feet. The major sand placement took place between May and December of 2016 as the Phase III portion of the USACE project was completed. That sand volume was 217.10 yds^3/ft. with a 322-foot shoreline advance seaward. Steady erosion has marked this site since the US Army project was completed. The past 18 months has seen -25.41 yds^3/ft. in sand volume loss combined with a 67-foot shoreline retreat. A new freshwater drainage system was completed to allow lake water to discharge into the ocean without the need to breach the beach deposit at random times and points along the shoreline proximal to Lake Takanassee.

Plaza Court, Long Branch; #17101

Located south of Lake Takanassee, this new site was completed under Phase III of the NY District USACE beach nourishment project in 2016. The initial cross section shows a 180-foot wide beach at elevation 10.0 ft. (NAVD88) as built by the Corps. The initial berm and beach as eroded back substantially, mostly between May and December 2018. The sand volume loss is -39.20 yds^3/ft. with a 27-foot shoreline retreat. The beach now slopes seaward from the bluff bulkhead, decreasing in slope offshore to a point 600 feet seaward of the reference where a small offshore bar has developed.

Pullman Avenue, Elberon; #171

The cross section located in Elberon at Pullman Avenue demonstrated the susceptibility of even the high bluff located here (28 feet NAVD88) to major erosion from the storm surge and waves generated by Hurricane Sandy. The rock revetment and timber wall account for about 40% of the bluff height and were unaffected. Deposition during Sandy occurred offshore where 24.40 yds^3/ft. of beach and bluff material was deposited. The scour at the base of the rock revetment protecting this coast was extensive taking sand to -10-foot elevations (as recorded with the Jan 13, 2013 survey 2.5 months later). Since then sand moved back landward, first by the spring 2013 survey back to the pre-Sandy elevations, then by the fall 2013 survey, depositing a dry sand beach over half way up the revetment adding 17.14 yds^3/ft. of new material and creating the best "beach" ever recorded at this location since 1986. The May 2016 survey was the last of pre-project cross sections and is the basis for a dramatic comparison with the Phase III sand placement (271.99 yds^3/ft., with a 418-foot shoreline advance). Losses were substantial by May 2017 (-100.86 yds^3/ft., and -189 feet of shoreline retreat). Loss continued during the summer of 2017 (-40.66 yds^3/ft., and -57 feet of additional retreat). The net change since May 2016 was a loss of 137.40 yds^3/ft. and a shoreline retreat of 173 feet (41.4% of the placement shoreline advance). Conditions at this site have not improved between May 2017 and December 2018. Beach retreat rates have consumed the remainder of the USACE deposit (-57; -46; and -48 feet between the three surveys totaling 150.5 feet of retreat). Sand volume losses were almost as consistent totaling -98.02 yds^3/ft. Thus far the site retains just 13.4% of the sand initially placed here in 2016. However, the Sandy erosion above the bulkhead and revetment has been restored with slope fill completed in stages between May 2017 and May 2018.

981 Ocean Avenue, Long Branch; #17005

This new profile is situated along the high bluff on private property and starts at the toe of the dune at the bluff. The beach extends seaward at elevation 10.0 for 100 feet before descending on a steep slope to an offshore trough. A substantial offshore bar system was present in the initial survey which disappeared by May 2018. This was followed by beach losses during the summer of 2018. Sand loss was 56.17 yds^3/ft. and the shoreline retreated 56 feet during the first year of the new site surveys.

1115 Ocean Avenue, Long Branch; #17004

The second of the five new profile locations moving south from Pullman Avenue and initially displayed a 90-foot wide beach at elevation 10.0 feet, but a very small bar system that is more of a flat terrace offshore. The terrace has become an offshore trough without the material being transferred to the beach. The sand volume loss was 33.92 yds^3/ft. with a shoreline retreat of 8 feet.

Ocean Court, Long Branch; #17003

This new profile starts at the toe of either bluff sediments or a small dune. There was a pronounced berm on the beachface crest initially, different from the two northern sites above. The size of the offshore bar decreased substantially over the next year, but sand loss was smaller than sites immediately to the north (-16.06 yds^3/ft. and a 17-foot shoreline retreat).

Garfield Road, Long Branch; #17002

This new profile site has a vertical bulkhead as its starting point and sand was placed to the 10.0-foot beach elevation. A substantial berm initially deposited higher in elevation than the 10.0 foot placement elevation. The beachface sloped steeply into the ocean with a small terrace deposited offshore. This terrace became lower in elevation as sand moved further offshore during the winter of 2017. Change was minimal over the summer of 2018. The site shed 11.38 yds^3/ft. in sand volume over the first year of study, which included a -17-foot shoreline retreat.

Jerome Avenue, Deal; #17001

Located just south of the Deal municipal boundary, this new profile starts at a vertical bulkhead and initially extended for 160 feet at elevation 10.0 to the berm crest. Shoreline erosion took a few feet from the project beach width, but sand accumulated offshore as a substantial bar system that appeared ready to migrate onto the beach by December 2018. The shoreline retreat was 30 feet during the year, with a -14.53 yds^3/ft. sand volume loss.

Roosevelt Avenue, Deal #170;

The Roosevelt Avenue site is located north of the Deal sewage pumping station built in 1906 at the base of the sedimentary bluff. South of this street is a series of private homes built on the bluff with a decent sand beach seaward of the dune-mantled bluff edge. North of Roosevelt Avenue there was essentially no dry beach between closely-spaced groins. Between here and Pullman Avenue, 5 former USACE sites were added to NJBPN to follow changes to the 2016 beach nourishment work completed along the Deal/Long Branch shoreline. Site #170 had a 26-year history of a wet beach against the rocks. Occasional offshore bars migrated to the shoreline yielding a temporary dry beach less than 25 feet in width. Sandy's waves over-topped the rock wall and scoured deeply into the soil, fill debris (bricks etc.) and bluff sediments. Since Sandy, the beach sand excavated at the base of the rock revetment and carried offshore has slowly returned so that the spring 2013 survey found that the sand profile closely matched the pre-Sandy condition. However, more material moved

landward so that by October 2013 a dry beach was present at the base of the rocks as sand added to that deposited during the first few months following Hurricane Sandy. By November 2016 the Phase III deposition amounted to 189.96 yds^3/ft. and a 311-foot shoreline advance. This site saw modest adjustments over the next two surveys as the berm retreated providing sand offshore as a terrace by December 2017. The recent study interval showed that the sand volume decreased by 21.28 yds^3/ft. mostly from the retreat in the beachface. This generated a 22-foot shoreline retreat as well. The project beach remains far beyond that present prior to the project.

South Roosevelt Avenue, Deal; #16905

This new profile site is just situated south of the Roosevelt Avenue street end, but north of Poplar Brook, a unique freshwater stream that still flows across the beach into the sea from headwaters to the west of the Borough of Deal in Monmouth County. This stream channel apparently never achieved an "estuary lake" status at the coastline, but has been flowing across the beach for a long, long time. The new beach is 200 feet wide at elevation 10.0 with a steep beachface and no offshore bar present in the initial survey. This stream has been put into an underground culvert extending from Ocean Avenue into the sea, so no longer flows at the surface directly into the ocean. Over the past year the shoreline remained very stable (-12 feet) while the sand volume grew by 14.95 yds^3/ft. largely offshore as the bar that appeared by May 2018 migrated almost to the shoreline.

71 Ocean Avenue, Deal; #16904

Starting at a vertical bulkhead, this new profile location shows an initial trough below elevation 10.0, which rose to elevation 10.0 at the berm crest about 370 feet from the bulkhead. This back-beach trough filled in over the summer of 2018, while the berm maintained its configuration. The beach became steeper producing a shoreline retreat of 39 feet. The sand volume loss was 15.72 yds^3/ft.

Ocean Lane, Deal; #16903

This new profile starts at a rock revetment and reaches the beach at elevation 10.0, which extends seaward for 350 feet to the berm crest. Sand moved offshore further, reducing the elevation close to the beach. The shoreline retreated 43 feet as the sand volume decreased by 57.56 yds^3/ft.

Brighton Avenue, Deal; #16902

This new profile location is situated directly in front of a major beach club in Deal and has a new dune between the property development and the open beach. This dune is narrow with a summit elevation of 20 ft. (NAVD88). The beach seaward is about 100 feet wider at elevation 9.0 descending steeply to a lower slope gradient terrace offshore. Since the initial survey this terrace remained at the same slope, but became deeper as the beachface extended into deeper water immediately offshore. The shoreline retreated 17 feet as the sand volume decreased by 26.97 yds^3/ft.

Wallace Road, Deal; #16901

Positioned at a tall bulkhead and rock revetment that reaches the bluff crest at 30 feet elevation, this new profile location includes a beach that is 200 feet wide at elevation 10.0. The beach slopes to the ocean at similar gradients to others in the area, but has a wide low-gradient terrace offshore. No bar system was present on any of the three surveys. Following a major sand loss offshore, this site remained stable with little other change. The first comparison between December 2017 and May 2018 saw 30.35 yds^3/ft. in sand volume loss in the change in depth on the offshore terrace. Subsequently, a 1.15 yds^3/ft. gain in sand volume occurred by fall 2018. The shoreline retreated just 2 feet during this initial year of survey.

Southern Deal, Darlington Avenue #169

The Darlington Avenue site is about a mile north into Deal from Allenhurst and was picked because there was a pocket beach centered at Darlington Avenue extending several blocks in either direction. The sediment bluff, once exposed 25 years ago had been armored by individual property owners over time with timber bulkhead "seawalls". The beach varied little over time. Individual owners repaired the extensive damage to their bluff protection once again concealing the sedimentary deposits from inspection. This site did gain sand as the federal project got underway with 241.39 yds^3/ft. added during the spring to fall 2015 interval. The net change was a sand volume gain of 231.44 yds^3/ft. accompanied by a 350-foot shoreline advance. The recent study interval produced a 3.99 yds^3/ft. sand volume loss accompanied by a 23-foot shoreline retreat. These changes were accumulative across the active part of the beach and offshore region with no one area impacted significantly. The street end slope remains a thin veneer of waste rock and brick debris covering the sediments comprising the bluff.

Monmouth Drive, Deal; #16802

This new profile site has a 160-foot wide beach at elevation 10.0 with a steep slope on the beachface to the zero datum elevation. Substantial erosion plus sand transfer offshore occurred the first winter of study at this site. The 2018 summer saw more sand extracted from the beachface and from the bar trough offshore. The sand volume decreased by 30.11 yds^3/ft. as the shoreline retreated 31 feet.

Neptune Avenue, Deal; #16801

From the bluff elevation, this new profile descends to the beach at the 10.0-foot elevation. The initial cross section did not display any offshore bar deposit, but the next survey in May 2018 found that the nearshore trough had developed and sand moved seaward generating a bar system. The sand volume decreased by 12.27 yds^3/ft. and the shoreline retreated 18 feet during the initial year of study.

Corlies Avenue, Allenhurst; #168

The site #168 at Allenhurst sits on top of an old concrete wall that drops vertically to the sand beach. There is a wooden walk elevated above the road just landward of the concrete wall. The boardwalk is 20 feet above sea level, behind a vertical concrete wall. No Phase II Federal Project sand was deposited along this short segment, but over 13 years some Phase II material has bypassed the large terminal groin in Asbury Park enhancing this small reach. The site gained 89.54 yds^3/ft. as the USACE project got underway in 2015. Completed earliest in the Phase III project, this site now has a 225-foot wide beach. The three spikes on the cross sections are sand ridges pushed up by the beach owners as added storm protection. The initial survey of this 18 month series shows the widest beach that was cut back during the winter of 2018. Recovery was close to 100% of the initial survey by December 2018. The sand volume change was -3.97 yds^3/ft. following a 37.71 yds^3/ft. winter loss. Shoreline changes were likewise similar with a 42-foot retreat in the winter and a 32-foot advance over the summer of 2018.

Euclid Avenue, Loch Arbor; #26703

This new profile site is located at a public beach at the north limit of this tiny community's shoreline. The initial survey showed a tall spike of a dune that was not present in May 2018, but reappeared in exactly the same position by December 2018. The narrow beach slopes steeply into the ocean. The low-gradient terrace offshore initially has been replaced by a bar and trough system with the bar approaching the land by December 2018. The sand volume change was a gain of 15.21 yds^3/ft. over the year of study. The shoreline advanced 33 feet.

Edgemont Avenue, Loch Arbor; #26702

This new profile site is situated directly at Deal Lake, the boundary between Loch Arbor and Asbury Park. The Deal Lake flume is the boundary as Loch Arbor has only a two-block shoreline with half a public beach and half in private ownership. There has been a long history of storm waves washing through the private beach club into Deal Lake. This clearly had occurred as the road across the "estuary lake" bay mouth barrier was still closed months after Sandy. Deal Lake is the largest of the now-closed stream estuaries along the Monmouth County shoreline. It was mapped as open to tidal flow repeatedly between 1867 up to as late as 1880, but mapped as closed by 1889. The initial survey showed a profile with a dune and a 120-foot wide beach at elevation 6.0 feet. Offshore there was a terrace extending at a gentle slope for another 220 feet seaward. Subsequently, this beach eroded substantially shedding the volume and area where the "dune" was located. This was most likely a man-made ridge of sand put in place as added storm protection. The December 2018 survey shows a smaller feature in a more landward location on the cross section. The sand volume loss was 105.30 yds^3/ft. as the shoreline retreated 50 feet.

1740 Ocean Avenue, Asbury Park; #26701

Positioned on the Asbury Park side of Deal Lake at the north end of the boardwalk, this new profile site has a tiny dune seaward of the boardwalk and a 240-foot wide beach at elevation 10.0 feet. The beachface slope is steep with a lower gradient terrace offshore. This terrace became a trough and bar system by May 2018 and grew more pronounced by December 2018. The sand volume change was smaller than site #26702 above at -14.28 yds^3/ft. and a shoreline shift of 21 feet seaward as a result of berm width enhancement over the summer.

Seventh Avenue, Asbury Park; #267

The Federal project beach in Asbury Park had no dune, but the sand was ramped up to the elevation of the boardwalk. In 2014, the USACE provided an additional 92.68 yds^3/ft. generating a 115-foot shoreline advance. In the past study interval, the site gained 14.45 yds^3/ft. as the shoreline advanced 17 feet. The May 2018 profile had the most sand present on the beach with the widest cross section, but the December survey was in better condition. The "dune" is a man-made ridge pushed up for added storm protection. It also appears that extensive beachfront construction has removed the boardwalk at this site and for 4-5 blocks to the south.

Sunset Avenue, Asbury Park; #16701

This new profile location starts at the boardwalk and the beach extends 135 feet seaward at a 10.0-foot elevation descending into the ocean at a steep slope. The flat terrace at -3.0 feet elevation has been superseded with a large bar system. The May 2018 profile showed a very large beachface deposit that has been redistributed back to the bar, the crest of which mimics the November 2017 terrace elevation. The sand volume change was -17.15 yds^3/ft. as the shoreline retreated 33 feet from the initial position surveyed in 2017.

Third Avenue, Asbury Park; #167

At site #167 on Third Avenue, there was a storm loss of 29.66 yds^3/ft. from the beach, an 84-foot shoreline retreat and sand moved well offshore beyond 17.6-foot depths (NAVD88). By the fall of 2014 the added sand amounted to 60.39 yds^3/ft. and the shoreline advanced 35 feet seaward as a result of the USACE restoration project. Over the past 18 months, the site gained 11.23 yds^3/ft. as the sand moved onto the beachface from offshore. There is a man-made dune ridge pushed up in the late November 2018 profile.

Asbury Avenue, Asbury Park; #16602

Located at the southern limit of Asbury Park, this new profile site also starts at the boardwalk with the beach extending 270 feet seaward at a 10.0-foot elevation. The April 2018 beachface matched the previous fall survey for slope and position, but retreat occurred by December 2018. The sand volume decreased by 5.30 yds^3/ft. as the shoreline retreated 30 feet. The dune ridge was man-made for the winter season's storms.

Spray Avenue, Ocean Grove; #16601

There is a minor dune present seaward of the boardwalk sloping down to the elevation 10.0-foot beach. The steep beachface slope ends at -2.0-foot elevations in the water. The low-gradient terrace, present in the initial survey remains at a foot lower elevation. The April 2018 survey displayed the widest beach, with the fall 2018 survey equal to that surveyed in the fall of 2017. The sand volume declined by 6.33 yds^3/ft. and the shoreline advanced 3 feet after advancing 26 by April, then retreating 23 feet by fall 2018.

Ocean Grove, Ocean Pathway; #166

Ocean Grove had severe damage to the beach and boardwalk focused to the south of Main Street following Hurricane Sandy. At Ocean Pathway the dune remained as did the large, open, but roofed seating area seaward of the boardwalk. The 2014 restoration activity added 35.79 yds^3/ft. in new sand producing a 13-foot shoreline advance. The recent study interval produced a sand volume gain of 29.97 yds^3/ft. with a 5-foot shoreline advance. Ocean Grove added a man-made beach ridge for winter storm protection in both 2017 and 2018 with the 2018 version larger and more seaward on the beach.

Broadway, Ocean Grove; #16502

This new site has a boardwalk, a dune and a 175-foot wide dry beach seaward of the dune at a 10-foot elevation. Sand was pushed up for added storm protection in 2018, but the beachface retreated from the initial position in 2017. The sand volume essentially remained the same (-0.64 yds^3/ft.) with the shoreline retreating 21 feet.

Cliff Avenue, Bradley Beach; #16501

At this new profile location, there is a promenade on the bluff edge followed by a dune on the beach. This condition was established prior to the USACE project that followed the 1992 northeast storm when the community elected to abandon the boardwalk over the beach and moved it onto the bluff, thus gaining about 40 feet of badly needed beach space. Today, the beach at elevation 10 continues about 160 feet seaward of the dune before descending into the water at elevation -3.0. The terrace present in the fall of 2017 has been replaced by an offshore bar system that added sand volume to the distal portion of the profile line. The beach/dune portion changed very little over the study interval. The sand volume decreased by 1.32 yds^3/ft. while the shoreline position retreated 12 feet.

McCabe Avenue, Bradley Beach; #165

Following Hurricane Sandy, the McCabe Avenue site had some damage, but fared better than most locations. Following the USACE work in 2014, the site gained 75.40 yds^3/ft. and the shoreline advanced 34 feet. During the past 18 months of study, this site saw fluctuations in the beachface, sand added to the back beach and dune and sizable changes offshore as bar migration was extensive. The sand volume increased by 9.58 yds^3/ft. and the shoreline advanced by 14 feet during the past 18 months.

4th Avenue, Bradley Beach; #16402

This new profile site is situated at the Bradley Beach bluff promenade and dune complex, initially with a 170-foot wide beach seaward of the dune. This berm disappeared by April 2018 and was replaced by a seaward slope from the seaward dune toe to the water's edge. A small offshore bar was present all during 2018. The sand volume declined by 4.37 yds^3/ft., but the shoreline advanced 7 feet seaward.

2nd Avenue, Bradley Beach; #16401

The new profile at 2nd Avenue begins at the boardwalk that lies landward of the dune by approximately 100 feet. The beach is 200 feet wide at elevation 10.0 feet. Sand on the berm eroded after the fall 2017 survey, but returned for the fall 2018 survey at essentially the same position it had at the initial survey. The dune gained sand and minor fluctuations occurred in the offshore. The sand volume increased by 3.67 yds^3/ft. as the shoreline advanced 23 feet seaward.

Sylvania Avenue, Avon-by-the-Sea; #164

The Sylvania Avenue boardwalk and adjacent structures suffered extensive damages during Hurricane Sandy. Sand lost from the beach was carried inland, not deposited offshore. The USACE effort added 99.16 yds^3/ft. and a 108-foot shoreline advance seaward. The beach extends 220 feet from the boardwalk at a 10-foot elevation before sloping into the water. There are bars present following the fall 2017 survey. Beachface erosion took place, but a flatter slope to the beach produced a 20-foot shoreline advance. The sand volume decreased by 9.97 yds^3/ft.

Garfield Avenue, Avon-By-The-Sea; #16303

This new profile site includes a tiny dune seaward of the boardwalk with the beach extending about 100 feet further seaward at a 10-foot elevation. The bar terrace offshore in the initial profile became much deeper as a trough and bar system took its place by spring 2018. The beach retreated slightly as well. The sand volume decreased 34.36 yds^3/ft. largely offshore as the shallow terrace eroded. The shoreline change was minimal at 14 feet.

Washington, Avenue, Avon-By-The-Sea; #16302

Located just north of Shark River Inlet, this new profile site has a 160-foot wide beach without a dune seaward of the boardwalk. The beach slope and offshore gradient is more gentle than most Monmouth County sites and initially had a bar on the offshore which became almost non-existent as far as a feature of influence is concerned. The beach developed a distinct berm by the fall of 2018, but the offshore sand loss tipped the net change for the year to -11.06 yds^3/ft. and a 12-foot shoreline retreat entirely due to the steeper beachface slope by the fall of 2018.

2nd Avenue, Belmar; #16301

Positioned 3 blocks closer to Shark River Inlet on the Belmar side from site #163, this new location has the wide beach retained by the inlet jetty (420 feet wide). The steeply sloping beachface was retained during 2018 with the seasonal retreat documented in April 2018 reversed by fall 2018 with a net shoreline change of -9 feet. The sand volume decreased by -16.36 yds^3/ft. due to the losses offshore.

5th Avenue, Belmar; #163

Belmar has an original survey site at 5th Avenue near Shark River Inlet. The Belmar beach has a boardwalk between it and Ocean Avenue that suffered damages during Hurricane Sandy but was still largely present. Sand was washed into Ocean Avenue during the storm. Since the 5th Ave. beach is extra wide due to the south jetty to Shark River Inlet, the USACE does not add significant sand to this site. The majority of the changes in the past 18 months have been offshore with bar migrations. The beach, by fall 2018, had returned almost exactly to the May 2017 position. The sand volume change was a loss of 6.37 yds^3/ft. with a shoreline change of just -2 feet.

8th Avenue, Belmar; #16202

At this new profile site, the boardwalk is just seaward of Ocean Avenue and the beach extends 210 feet further seaward at the 10.0-foot elevation. The steep beachface that continues offshore abruptly transitioning into a bar system has remained almost static since fall 2017. The bar system has eroded vertically downward by 3 to 6 feet generating a loss in sand volume (-76.16 yds^3/ft.), but the shoreline only retreated 3 feet.

14th Avenue, Belmar; #16201

At this new profile location, the boardwalk appears to have a tiny dune at its seaward base. The 10-foot elevation beach extends 240 feet seaward with a man-made ridge of sand pushed up in both fall surveys. A generous berm developed by fall 2018 with offshore bar migrations creating some diversity in configuration. The sand volume increased by 20.63 yds^3/ft. as the shoreline retreated 3 feet.

18th Avenue, Belmar; #162

The sand volume added was 66.17 yds^3/ft. producing a 76-foot shoreline advance following Hurricane Sandy. The City generates a sand ridge on the beach to protect against northeast storms because there is no dune system. A substantial berm developed by fall 2018 with modest changes in the offshore bar system. The sand volume increased by 3.15 yds^3/ft. and the shoreline retreated 8 feet.

North Boulevard, Belmar; #16104

This new profile site is south of the municipal boardwalk seaward of Lake Como, another of the Monmouth County "estuary lakes". While, historically, not known to have been open to the sea, there is no reason to believe that it never was. Sub-bottom studies for an offshore breakwater system installed in the 1990's found lagoonal sediments under a 3-foot thick sand layer approximately at the 600-foot horizontal distance seaward. This deposition was residual from past conditions where the shoreline was significantly seaward of today's location. This beach dramatically shifted landward between the fall of 2017 to April 2018, then again accreting back to slightly beyond the fall 2017 position by fall 2018. The seasonal sand volume loss was -16.68 yds^3/ft. followed by an increase of 37.62 yds^3/ft. The shoreline position shifted landward by 35 feet, then advanced seaward by 49 feet between spring and fall 2018.

Remsen Avenue, Spring Lake; #16103

The new profile at the Spring Lake boardwalk lies seaward of the dune system with a 210-foot wide beach at elevation 10.0 feet. Two of the three surveys found the man-made sand ridge pushed up, and the fall 2018 survey captured a pronounced berm deposit as sand moved onto the shoreline from the bars offshore. The sand volume change was 13.38 yds^3/ft. with a 15-foot shoreline advance.

Lorraine Avenue, Spring Lake; #16102

A similar situation exists at the next new site south where the dune exists landward of the boardwalk. The practice of pushing up a ridge of sand each winter stems from multiple past losses of the boardwalk, most recently in Hurricane Sandy. The spring survey of 2018 saw considerable beach erosion that recovered by the fall of 2018. No ridge of sand had been pushed up as of October 2018. The sand volume declined by 1.62 yds^3/ft. with just a 2-foot shoreline retreat.

Tuttle Avenue, Spring Lake; #16101

This fourth new profile site in Spring Lake maintains the same configuration as the northern three with the pushed up ridge on the beach, an elevation of the beach of 10.0 feet (NAVD88), and a generous berm deposit by fall 2018. Bar migration was the cause of the berm development as the sand volume increased by 9.38 yds^3/ft. and the shoreline advanced a foot seaward.

Brighton Avenue, Spring Lake; #161

Hurricane Sandy relocated sand along this profile with a volume loss (-36.15 yds^3/ft.) from the beach but volume gain (25.40 yds^3/ft.) offshore to a point 857 feet from the reference (elevation -16.63 ft. NAVD88). By the end of 2014, the boardwalk was rebuilt on its original concrete supports and the USACE provided 40.47 yds^3/ft. in new sand at Brighton Ave. with a 76-foot shoreline advance seaward. Man-made storm ridges are the rule in Spring Lake, but the fall 2018 survey preceded sand pushing. Sand appeared as a generous berm and offshore as a broad, low elevation bar providing the 19.58 yds^3/ft. in added sand volume. The shoreline advanced 30 feet as well.

Madison Avenue, Spring Lake; #16004

This new profile site includes a dune, then the boardwalk, followed by a pushed up ridge of sand. The offshore contains a significant bar system with a well-defined trough at the 300-foot distance on the initial survey that was nearly perfectly replicated by the fall 2018. The sand volume added was 5.47 yds^3/ft. and the shoreline advanced 20 feet.

Morris Avenue, Spring Lake; #16003

This new profile location includes a dune, boardwalk, and a pushed up sand ridge, but has little horizontal beach remaining seaward of the boardwalk. Offshore, there is a shallow terrace system, which has low distant bars by spring 2018. A sand volume loss of 31.96 yds^3/ft. was accompanied by a 5-foot shoreline retreat.

Mercer Avenue, Spring Lake; #16002

This new profile location closely resembles #16003 with sand ridges and a fairly wide offshore terrace. The sand volume change was -4.08 yds^3/ft. with a 3-foot shoreline advance.

Essex Avenue, Spring Lake; #16001

This fourth new site between the two original NJBPN locations in Spring Lake more closely resembles the northern site #16004 with a 100 feet of beach seaward of the pushed up sand ridge. There is a bar offshore on the terrace distant from the base of the beachface by fall 2018. Sand volume loss was 11.65 yds^3/ft. with a -1-foot shoreline retreat.

Salem Avenue, Spring Lake; #160

The site was restored with just 32.29 yds^3/ft. in new sand after Sandy causing the shoreline to advance 42 feet. For some reason, Salem Avenue did not see sand ridges pushed up. The berm is fairly wide at 150 feet with the fall 2018 configuration better than the spring conditions but lower in elevation from those surveys in 2017. The sand volume change was -6.27 yds^3/ft. with a 28-foot shoreline advance.

Union Avenue, Spring Lake; #15902

At this new profile location, the dune is quite a bit higher than the boardwalk with a 140-foot wide, 10-foot elevation beach. No sand ridges have been present. The initial larger offshore bar has become more distant and smaller. The site lost 32.40 yds^3/ft. in sand volume with a 4-foot shoreline advance.

Brown Avenue, Spring Lake; #15901

At this new profile site, there is a boardwalk and a dune that is approximately equal to the elevation of the boardwalk. The pushed up sand ridge is present here only on the initial survey with about 100 feet of dry beach seaward at elevation 10 feet. This site lies just north of Wreck Pond, recently the site of extensive reconstruction of the flume box guiding freshwater from this "estuary lake" to the sea. Sandy opened up Wreck Pond to tidal flow for several years. Sand was lost in minor quantity (-2.24 yds^3/ft.) as the shoreline retreated 16 feet landward.

New York Avenue, Sea Girt; #159;

Sea Girt is divided into two parts, each with an original profile site. The New York Avenue site #159, represents northern Sea Girt where a shore-parallel Ocean Avenue allows vehicles to park at the boardwalk with easy public access to the beach. By the April 2013 a new dune had been placed on the beach using sand recovered from inland with a wider base, but about the same height (17.5 feet). During 2014 the USACE provided 23.81 yds^3/ft. advancing the shoreline 107 feet as of fall 2014. Change since the spring of 2017 has been relatively minor with a pronounced berm and offshore trough by fall 2018. The sand volume amounted to a gain of 14.51 yds^3/ft. and a shoreline advance of 13 feet in the past 18 months.

Crescent Park, Sea Girt; #15801

Crescent Park is an enclave of expensive single family homes located starting south of New York Avenue and extending to Trenton Avenue. At this new profile location, there is a dune deposited on top of the sedimentary bluff seaward of the homes, followed by a boardwalk with the post-federal project dune established seaward of the boardwalk. The dry beach accumulated a large berm by fall 2018 with a near identical bar system to that present at the fall 2017 initial survey. The sand volume was a loss of 7.91 yds^3/ft. with a 15-foot shoreline retreat.

Trenton Avenue, Sea Girt; #158

The southern Sea Girt site at Trenton Avenue typifies the coastal bluff with single family homes and a wide, reasonably high dune landward of the boardwalk deposited on the bluff that minimized Sandy erosion and kept the overwash out of the street ends. The 2014 USACE effort added 94.20 yds^3/ft. and pushed the zero elevation shoreline 121 feet further seaward as the shore protection project was restored. A variety of berm and offshore configurations occurred in the past 18 months all with nearly the same exact shoreline position. The net sand volume change was -1.30 yds^3/ft. and the shoreline variation was from -6 to +3 feet of no change. The net difference was -3.5 feet over 18 months.

Seaside Place, Sea Girt; #15703

This new site starts at the street end and goes directly to the landward base of the bulkhead defending the street. Seaward lies a dune, the beach with a steep beachface. Offshore is a terrace with a low amplitude bar system present on the initial survey. This beach retreated between the spring and fall surveys of 2018 and the offshore region became much deeper with the terrace shifted seaward as a small bar system. The net sand volume loss was 31.69 yds^3/ft. and a 21-foot shoreline retreat.

National Guard Training Center, North, Sea Girt; #15702

This new profile site is one of two within the oceanfront segment long devoted to NJ State Police and National Guard training. Off limits to the public on the beach, the very impressive dune is also part of the shooting range back stop for bullets. There is a 150-foot wide beach at 10.0-foot elevation leading to an offshore terrace with a bar present on the initial survey. Subsequently the beach retreated somewhat and the offshore bar system became more pronounced with a deeper trough and higher bar. The sand volume change was -9.14 yds^3/ft. with a 38-foot shoreline retreat.

National Guard Training Center, South, Sea Girt; #15701

This new profile location is situated at the south end of the NGTC beach segment with a tall dune, a small foredune leading into a 220-foot wide beach at 10.0-foot elevation. There was no significant offshore bar present on the terrace initially, but one subsequently developed by spring 2018. This profile site gained 22.76 yds^3/ft. and the shoreline advanced 7 feet seaward over the past 12 months.

Riddle Way, Manasquan; #157;

Manasquan is located at the southern limit of the NY District's massive Monmouth County beach restoration project and positioned just north of the Manasquan Inlet. Prior to the USACE project, the Borough had established a small dune system seaward of the paved promenade that is in front of the oceanfront homes This was primarily in response to the December 1992 northeast storm that damaged the community. Following Sandy, there were tiny remnant dunes present seaward of the asphalt promenade at Riddle Way (site #157). At Riddle Way the dune was all but removed, but the promenade surface remained intact. By the fall of 2014 the USACE had added 94.17 yds^3/ft. in new sand advancing the shoreline 92 feet seaward. Over the 5-6 years since Hurricane Sandy, this community has not developed a dune to replace that one lost to the storm. Instead they depend on sand ridges pushed up each fall with considerable variation in width and elevation. The fall 2018 ridge was present by the November survey. Here the sand volume increased by 16.62 yds^3/ft. and the shoreline advanced 13 feet. However, the December 2017 survey found the most sand above the zero datum of the entire set of recent profiles.

Main Street, Manasquan; #25602

This new profile extends across the beach from the asphalt promenade. A small dune lies seaward of the promenade as well as a 270-foot wide sloping beach with a fairly consistent gradient all the way into 17 feet of water on the initial survey here. Since the fall of 2017 the beach became steeper as the shoreline retreated and a significant bar trough developed immediately seaward. The bar as of fall 2018 was quite insignificant. No sand ridges appear on the three surveys. The sand volume declined by 27.40 yds^3/ft. and the shoreline retreated 88 feet due to the bar trough and steeper beach.

Brielle Road, Manasquan; #25601

Positioned closer to Manasquan Inlet, this new site also consists of a wide beach extending from the asphalt promenade into the water without significant depositional features such as a berm, dunes or an offshore bar on the initial survey. This changed with significant beach berm loss and offshore deepening at the toe of the beachface by fall 2018. The sand volume amounted to -4.23 yds^3/ft. with the bar shifting farther seaward offsetting the beach sand loss over the past 12 months. The shoreline shift shows the magnitude of the landward movement in the zero elevation position of 65 feet.

Pompano Avenue, Manasquan; #256

At the Pompano Avenue site (#256) the dune was removed by Sandy as well as the entire promenade with most of the sand transported inland. The Army Corps placed 82.26 yds^3/ft. at this site generating a 113-foot shoreline advance, but there is no significant dune present along the rebuilt promenade. A similar retreat in the beachface position along with the shifting of the bar system seaward over the past 12 months following the December 2017 profile survey follows the pattern seen to the north. The sand volume declined by 6.70 yds^3/ft. but the shoreline shifted landward by 20 feet since spring 2017 while the fall 2017 position was 40 feet further seaward of the spring 2017 position.

Riverside Drive, Manasquan; #15601

The southernmost new profile site in Monmouth County is positioned just north of the north jetty to Manasquan Inlet. The initial survey reproduces a similar pattern to the other December 2017 Manasquan surveys. The minimal dune at the promenade, followed by a wide beach (200 feet) and a relatively uniform slope seaward without an offshore terrace or bar system. A large deposit of sand occurred by spring 2018 pushing the zero elevation position 80 feet seaward, but it eroded back landward of the initial position by fall 2018. The 12 month condition changes for sand volume were not so large because the accretion was followed by erosion yielding a change of 17.48 yds^3/ft. in sand added due to shifts from the beach to the offshore (90.54 yds^3/ft. was added by spring 2018, but 71.07 yds^3/ft. eroded away by fall 2018). The shoreline position moved 14 feet landward after 12 months (+61 feet by spring 2018, -75 feet by fall 2018).

NJBPN 187 – Beach Park, Cliffwood Beach

This is the westernmost NJBPN site located on Raritan Bay. The photograph on the left shows the shoreline on September 29, 2017 and shows the beach, the replaced fence and modest dune grass recovery. The right hand view, taken on October 5, 2018, at a very low tide shows extensive gravel on the beach, the contrasting fine sediment on the bay floor, and erosion damage to the dune fencing.

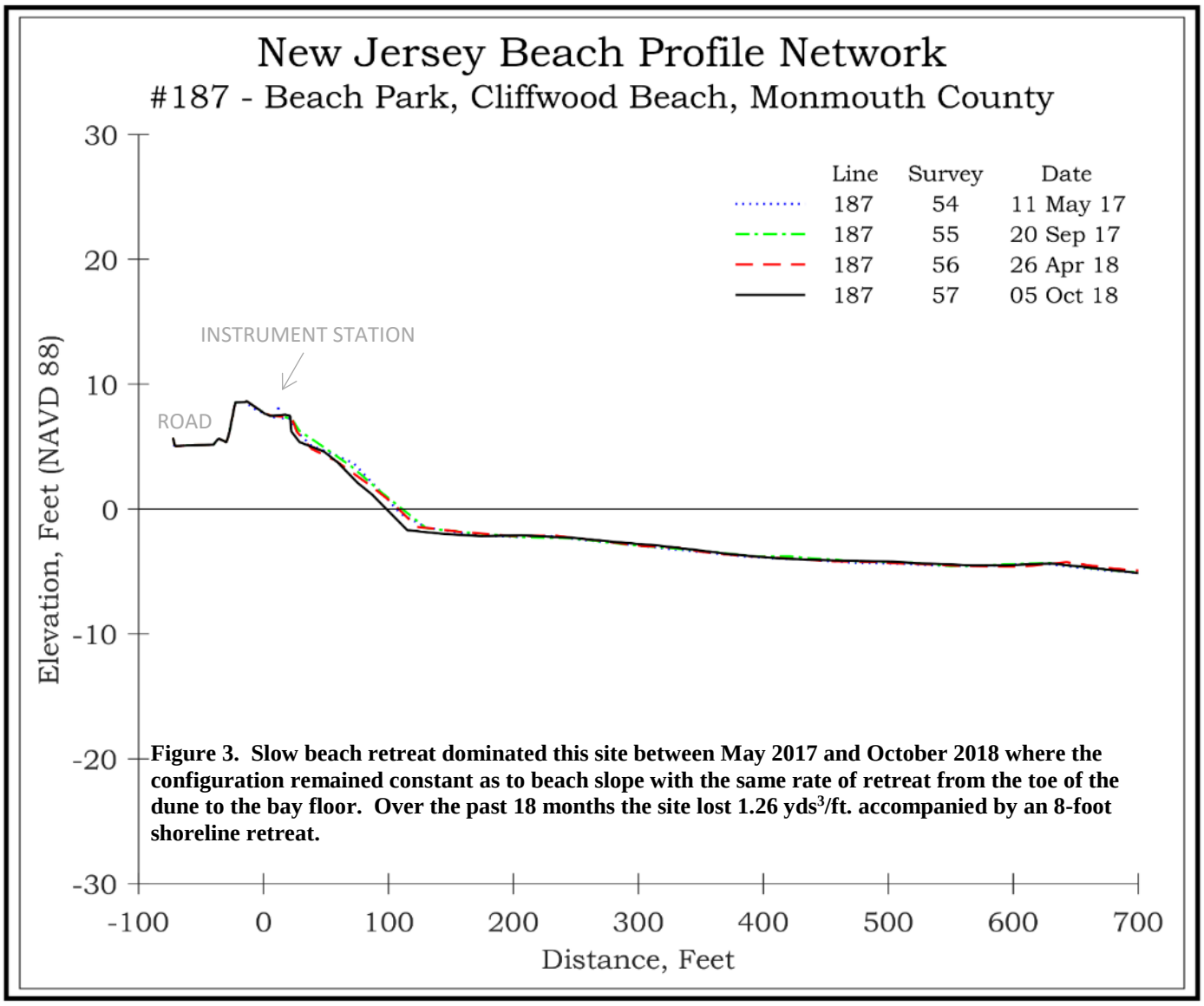
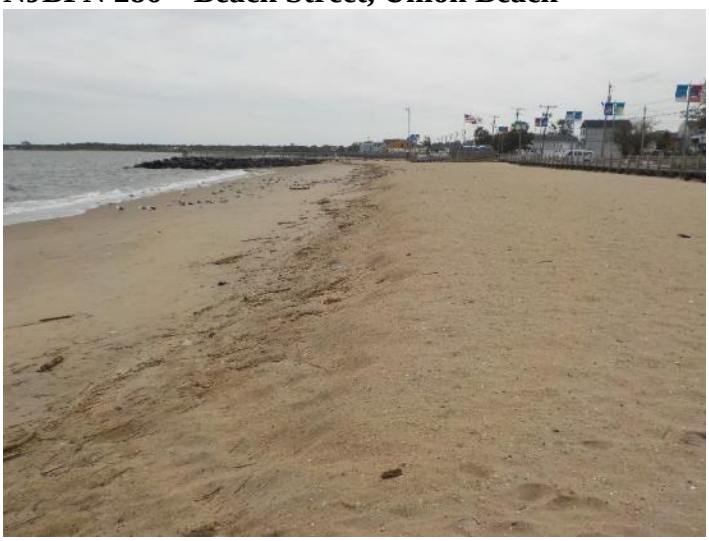


Figure 3. Slow beach retreat dominated this site between May 2017 and October 2018 where the configuration remained constant as to beach slope with the same rate of retreat from the toe of the dune to the bay floor. Over the past 18 months the site lost 1.26 yds^3/ft. accompanied by an 8-foot shoreline retreat.

NJBPN 286 – Beach Street, Union Beach



This site was moved to the public bathing beach in 2009. The photograph on the left shows the shoreline on September 20, 2017 with a small storm barrier pushed up onto the berm. A truck fill project in 2013 added 14,000 cu. yds. of sand. The photo on the right shows the beach width and berm on October 5, 2018, again with the ridge pushed up as of early-October.

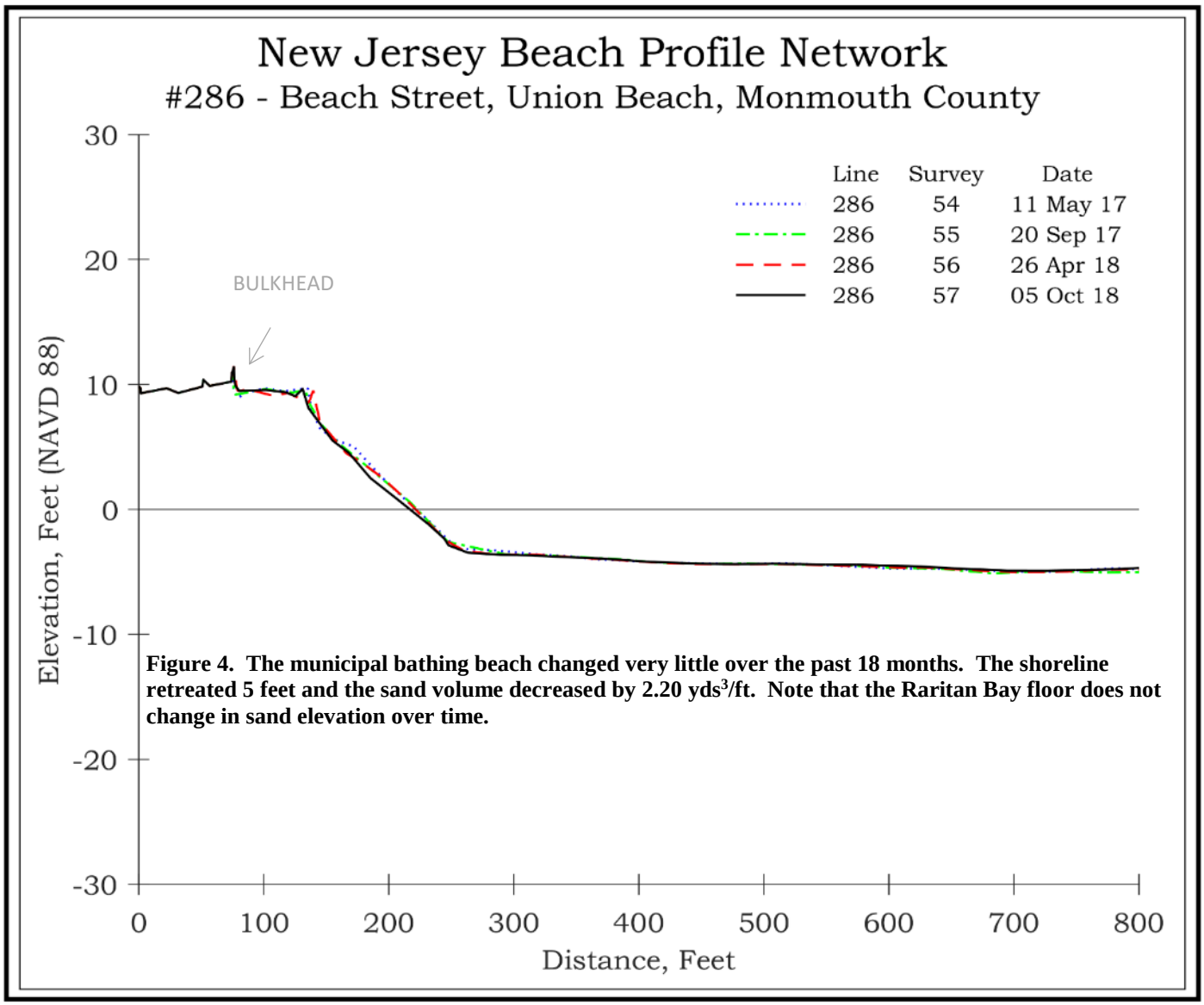


Figure 4. The municipal bathing beach changed very little over the past 18 months. The shoreline retreated 5 feet and the sand volume decreased by 2.20 yds^3/ft. Note that the Raritan Bay floor does not change in sand elevation over time.

NJBPN 185 – Bay Shore Waterfront Park, Port Monmouth

This site was greatly enhanced during 2014 by the NY USACE. The September 18, 2017 view on the left along the beach to the east shows the established profile. The right picture was taken September 18, 2018 confirming the minimal changes documented by the surveys.

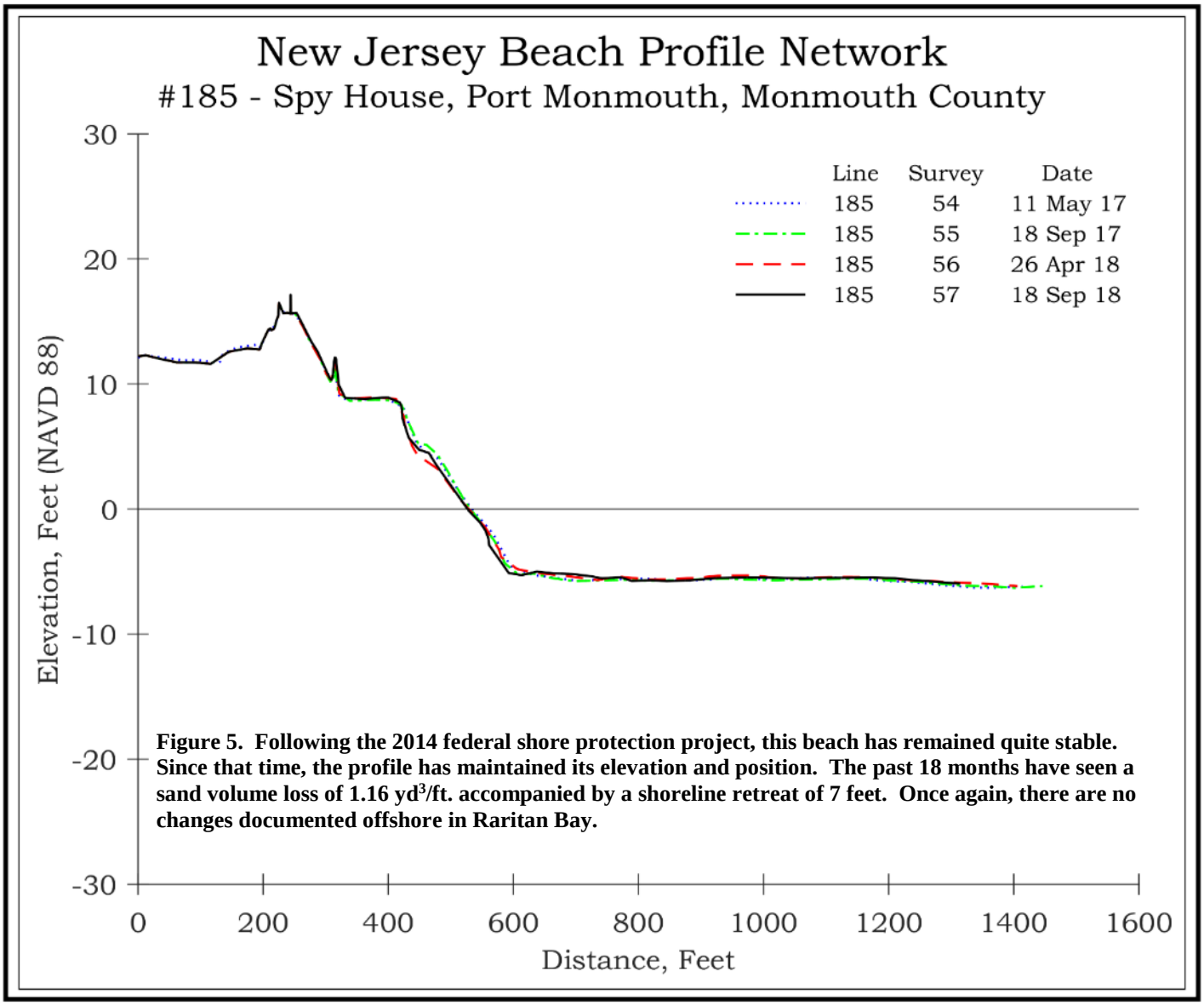


Figure 5. Following the 2014 federal shore protection project, this beach has remained quite stable. Since that time, the profile has maintained its elevation and position. The past 18 months have seen a sand volume loss of 1.16 $yd^3/ft.$ accompanied by a shoreline retreat of 7 feet. Once again, there are no changes documented offshore in Raritan Bay.

NJBPN 385 - North Beach, Sandy Hook National Seashore

This Sandy Hook location was established in December 2016. The expanse of beach with the view to the left 1/11/2018 looking to the east, displays the beach as viewed from the dunes. On the right is a view to the south along the dune toe on December 20, 2018 showing the width of this beach.

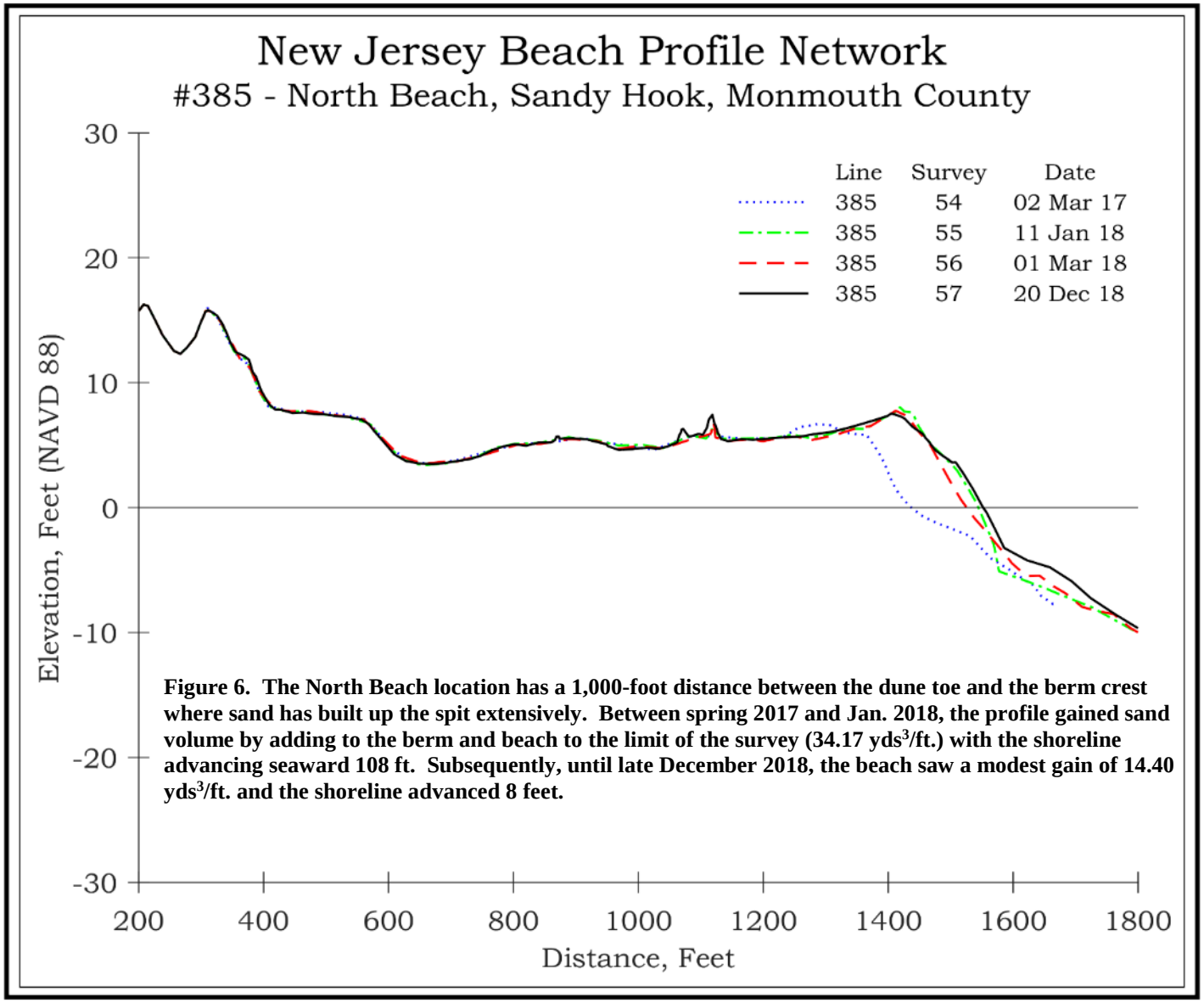


Figure 6. The North Beach location has a 1,000-foot distance between the dune toe and the berm crest where sand has built up the spit extensively. Between spring 2017 and Jan. 2018, the profile gained sand volume by adding to the berm and beach to the limit of the survey (34.17 yds^3/ft.) with the shoreline advancing seaward 108 ft. Subsequently, until late December 2018, the beach saw a modest gain of 14.40 yds^3/ft. and the shoreline advanced 8 feet.

NJBPN 285 – Gunnison Beach, Sandy Hook National Seashore

The photograph on the left shows the January 11, 2018 beach looking east toward the water's edge from the toe of the primary dune. On December 20, 2018 the berm presented a sharp ridge with wave debris in a very uniform line from the previous high tide. The expanse of beach to the right is enormous.

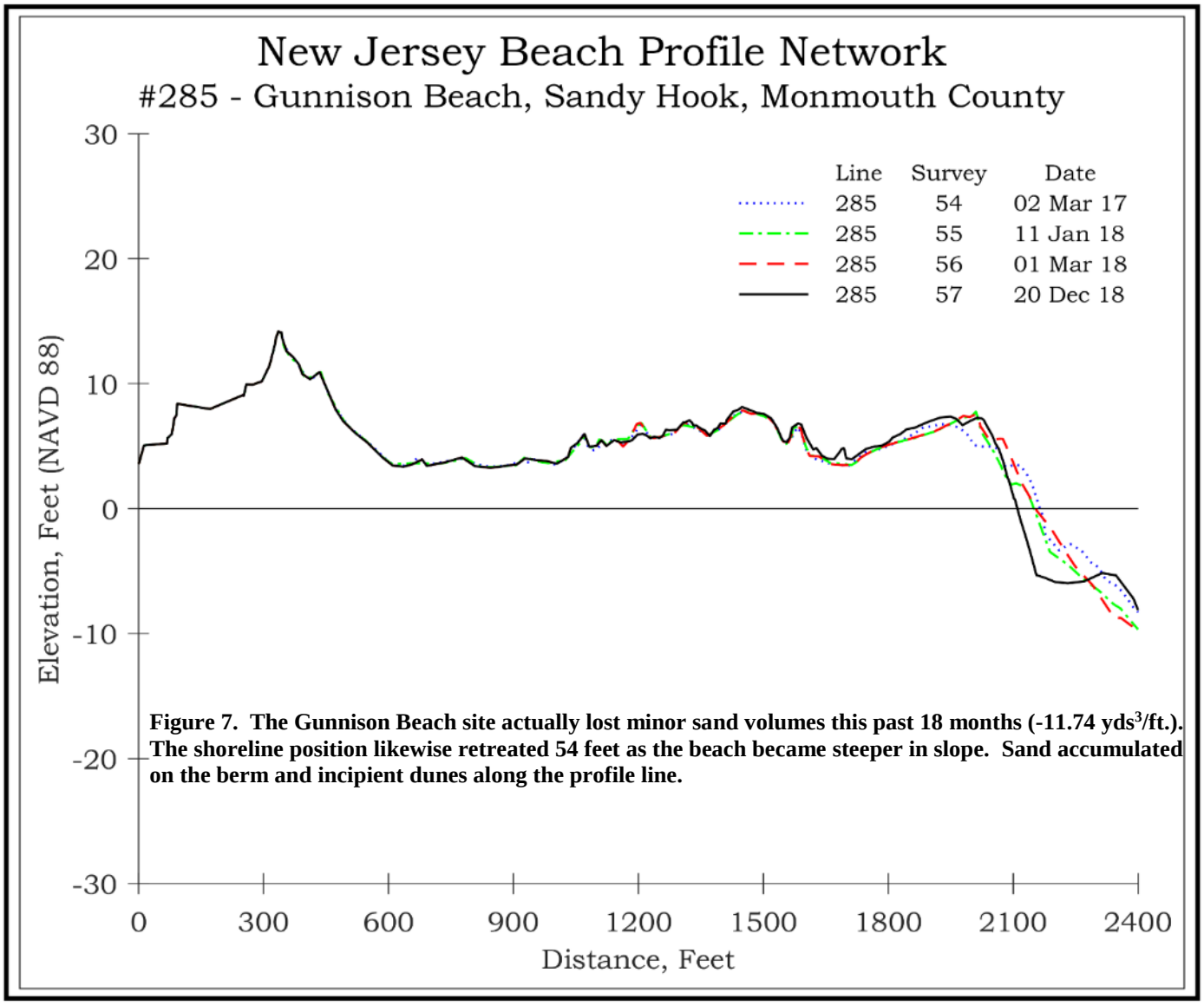


Figure 7. The Gunnison Beach site actually lost minor sand volumes this past 18 months (-11.74 yds^3/ft.). The shoreline position likewise retreated 54 feet as the beach became steeper in slope. Sand accumulated on the berm and incipient dunes along the profile line.

NJBPN 28401 - Area F Road, Sandy Hook National Sea Shore

This December 20, 2018 view to the south along the dune crest shows vegetation on the dunes near the beach. The beach extent seaward of the dunes is limited and quite steep. Changes in one year of surveys amount to 56 feet of shoreline retreat and a loss of 5.83 yds^3/ft.

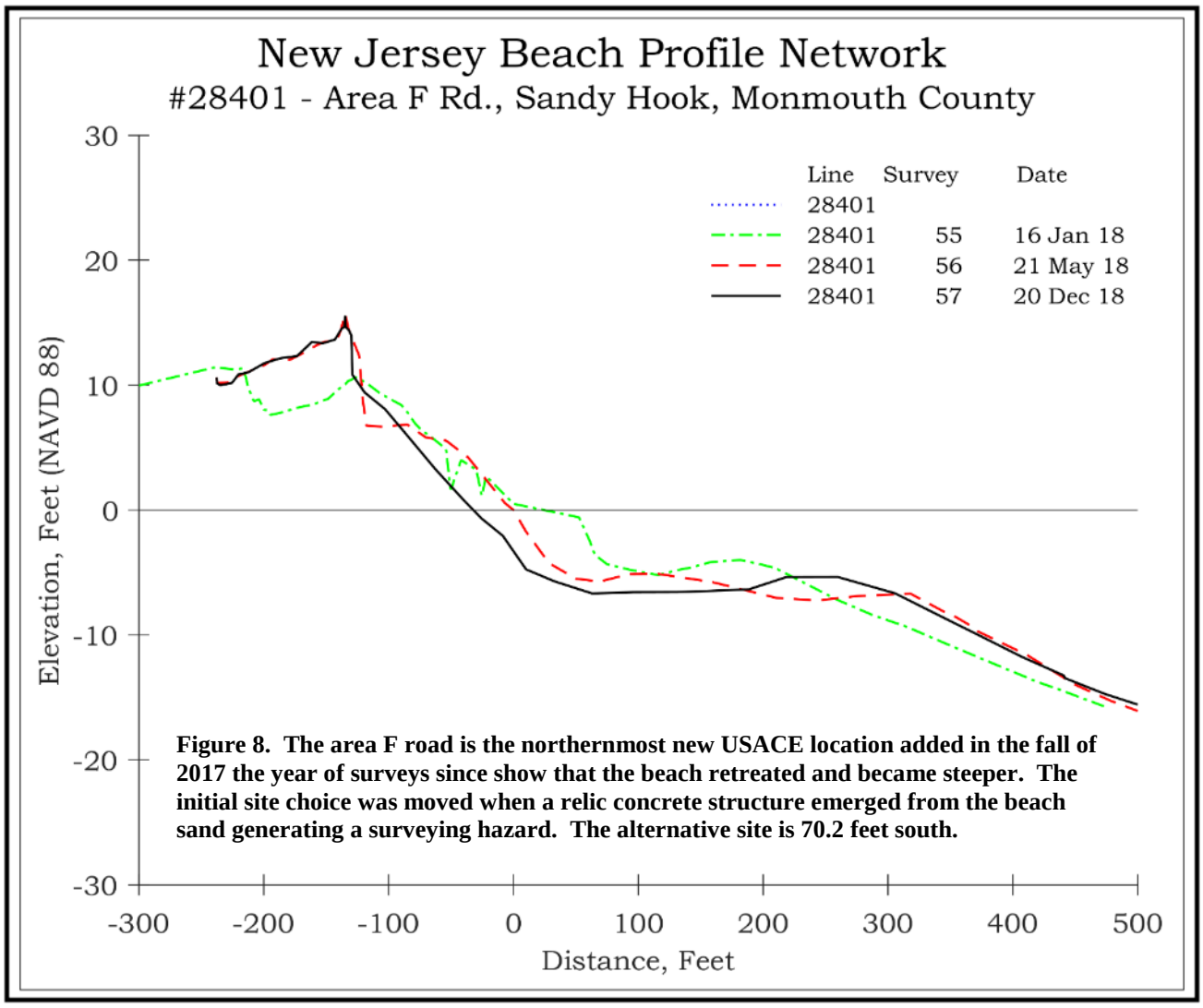


Figure 8. The area F road is the northernmost new USACE location added in the fall of 2017 the year of surveys since show that the beach retreated and became steeper. The initial site choice was moved when a relic concrete structure emerged from the beach sand generating a surveying hazard. The alternative site is 70.2 feet south.

NJBPN 284 – Parking Lot E, Sandy Hook National Seashore

On the left is a beach picture from January 11, 2018 looking south along the dune toe. A similar perspective on October 2, 2018 shows the dunes accumulating seaward of the primary dune on the cross section.

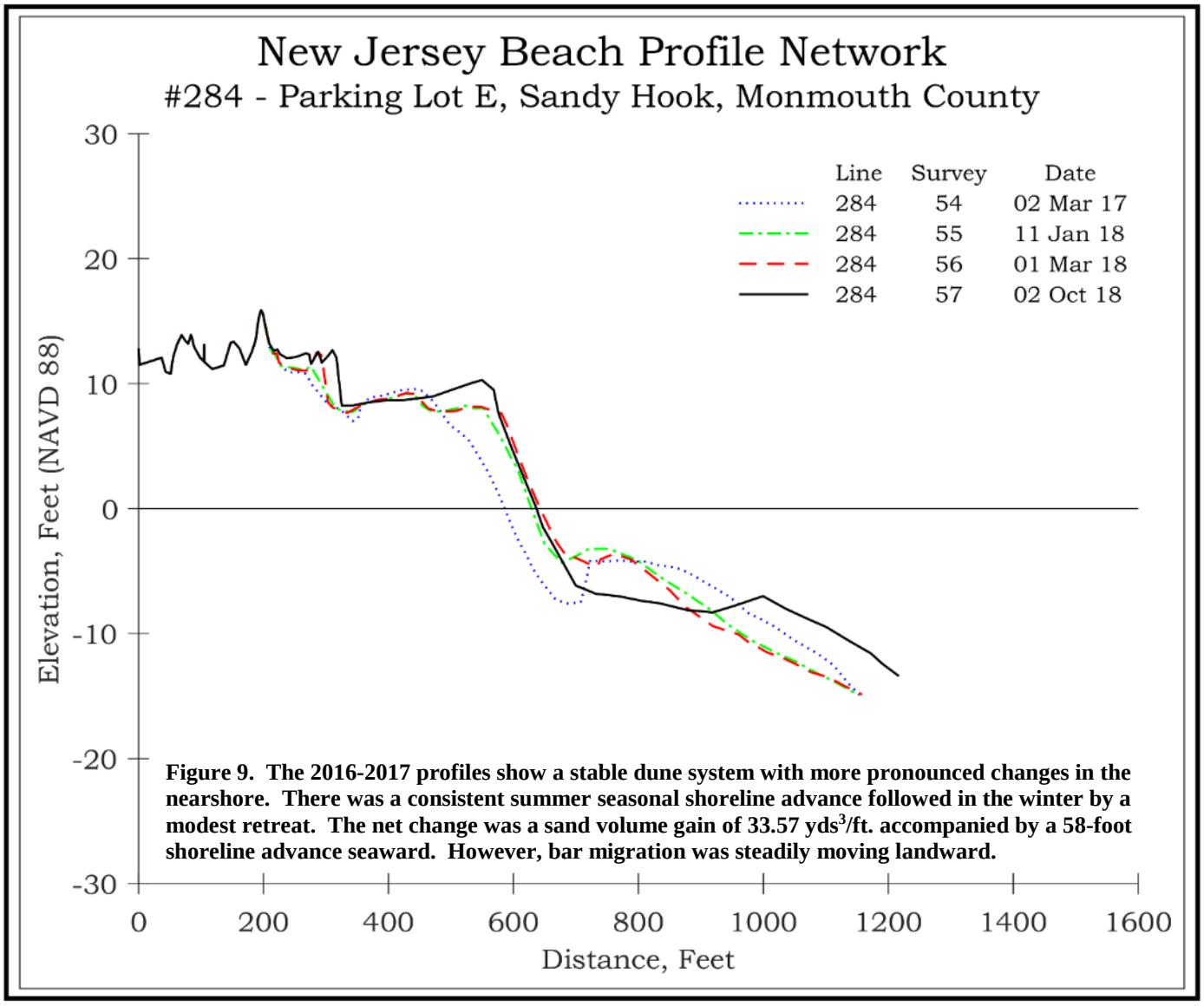


Figure 9. The 2016-2017 profiles show a stable dune system with more pronounced changes in the nearshore. There was a consistent summer seasonal shoreline advance followed in the winter by a modest retreat. The net change was a sand volume gain of 33.57 yds^3/ft. accompanied by a 58-foot shoreline advance seaward. However, bar migration was steadily moving landward.

NJBPN 18401 - Parking Lot C, Sandy Hook National Sea Shore

This new USACE site shows a wide area of new dune growth moving out onto the wider beach. The site is located at parking lot C along the National Seashore.

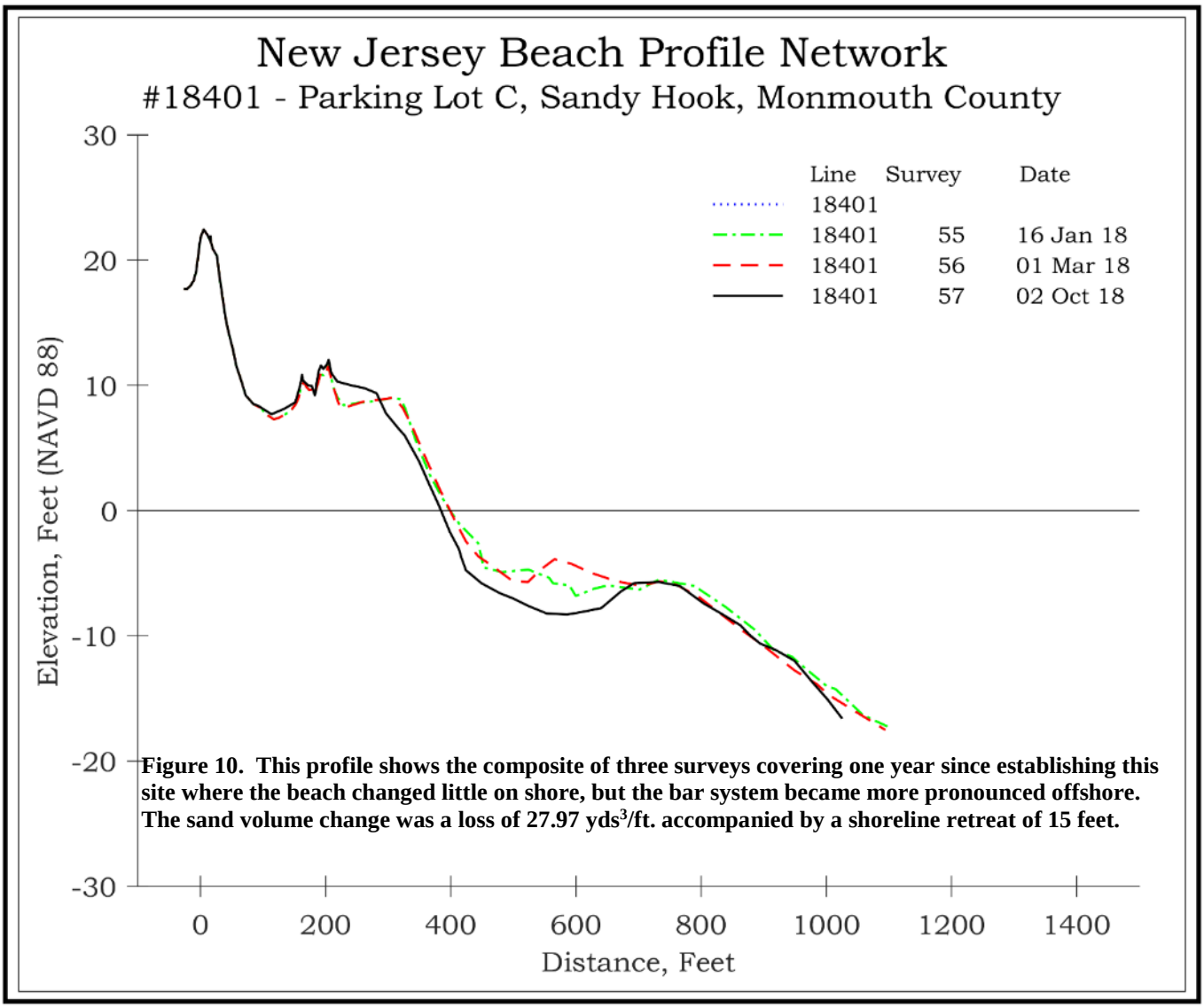


Figure 10. This profile shows the composite of three surveys covering one year since establishing this site where the beach changed little on shore, but the bar system became more pronounced offshore. The sand volume change was a loss of 27.97 yds^3/ft. accompanied by a shoreline retreat of 15 feet.

NJBPN 184 – Highlands Beach, Sandy Hook National Seashore

This southern Sandy Hook site is located near the entrance to the park. The left view was taken Jan. 16, 2018. Sand built into this site since Feb. 2017 maintaining a better beach width. As of October 1, 2018 the beach and bar system were separated by over 100 feet.

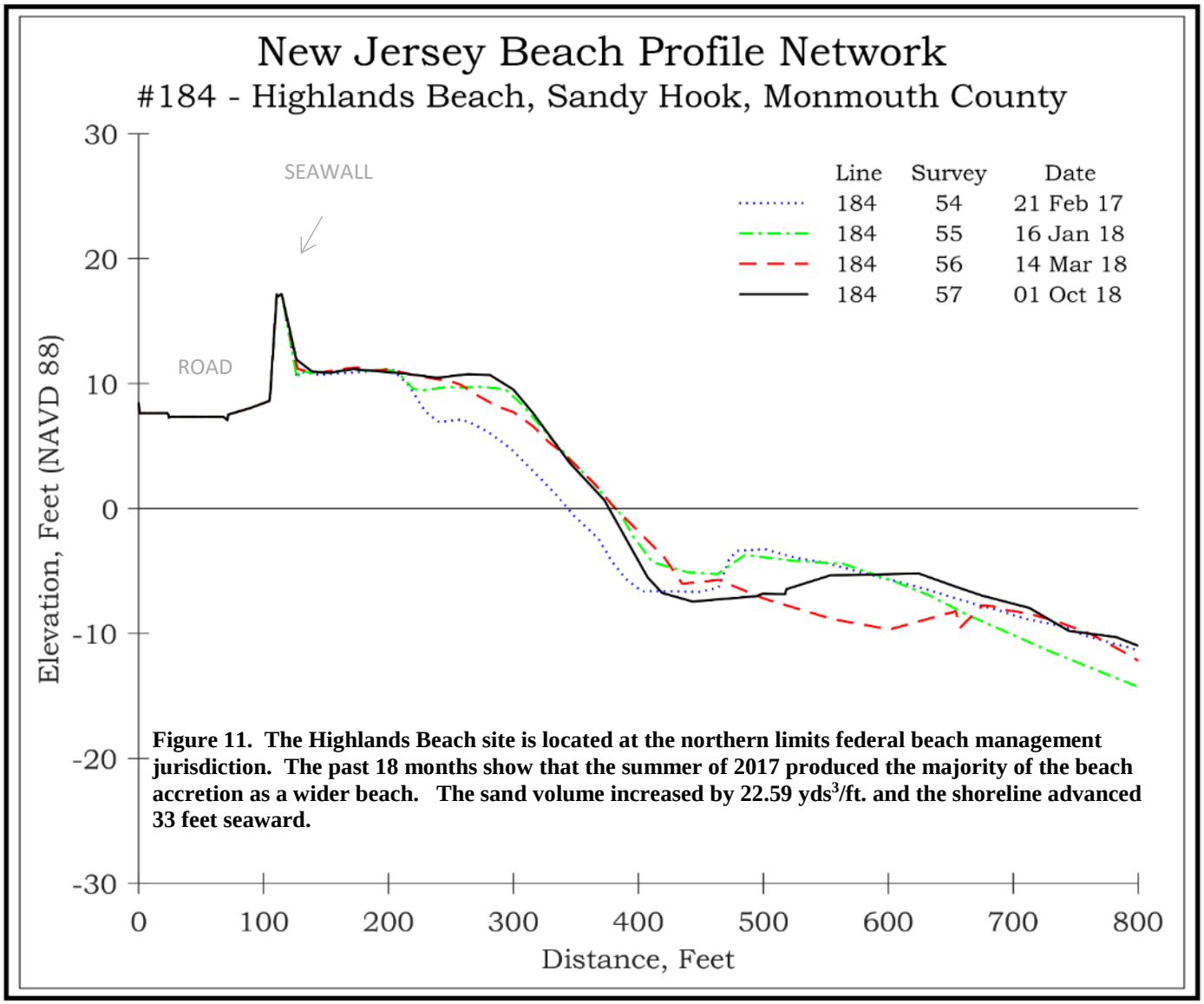


Figure 11. The Highlands Beach site is located at the northern limits federal beach management jurisdiction. The past 18 months show that the summer of 2017 produced the majority of the beach accretion as a wider beach. The sand volume increased by 22.59 yds^3/ft. and the shoreline advanced 33 feet seaward.

NJBPN 183 – Via Ripa Street, Sea Bright

This site is near the northern limit of the initial Federal shore protection project. The left photo shows the seawall and the line of dunes looking south on Jan. 10, 2018, while the right photo (Oct. 1, 2018) shows a southerly view from the dune crest. This dune was not built as part of the project, but has developed as time passed around one line of fencing.

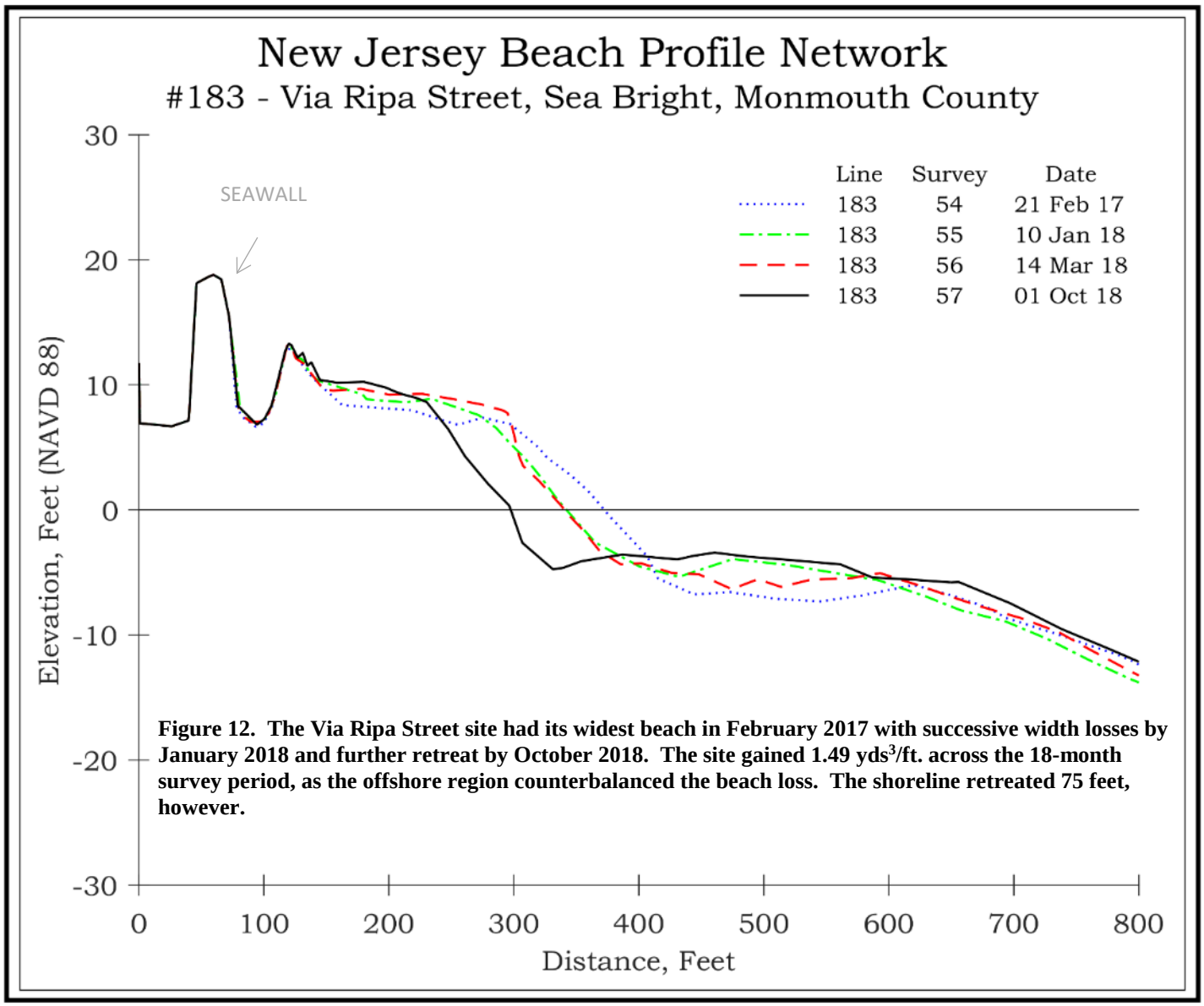


Figure 12. The Via Ripa Street site had its widest beach in February 2017 with successive width losses by January 2018 and further retreat by October 2018. The site gained 1.49 yds^3/ft. across the 18-month survey period, as the offshore region counterbalanced the beach loss. The shoreline retreated 75 feet, however.

NJBPN 28202 - 300 Ocean Avenue, Sea Bright

This new site has beach grass established along the toe of the rock seawall, but no dune exists yet. The beach width decreased over the past year.

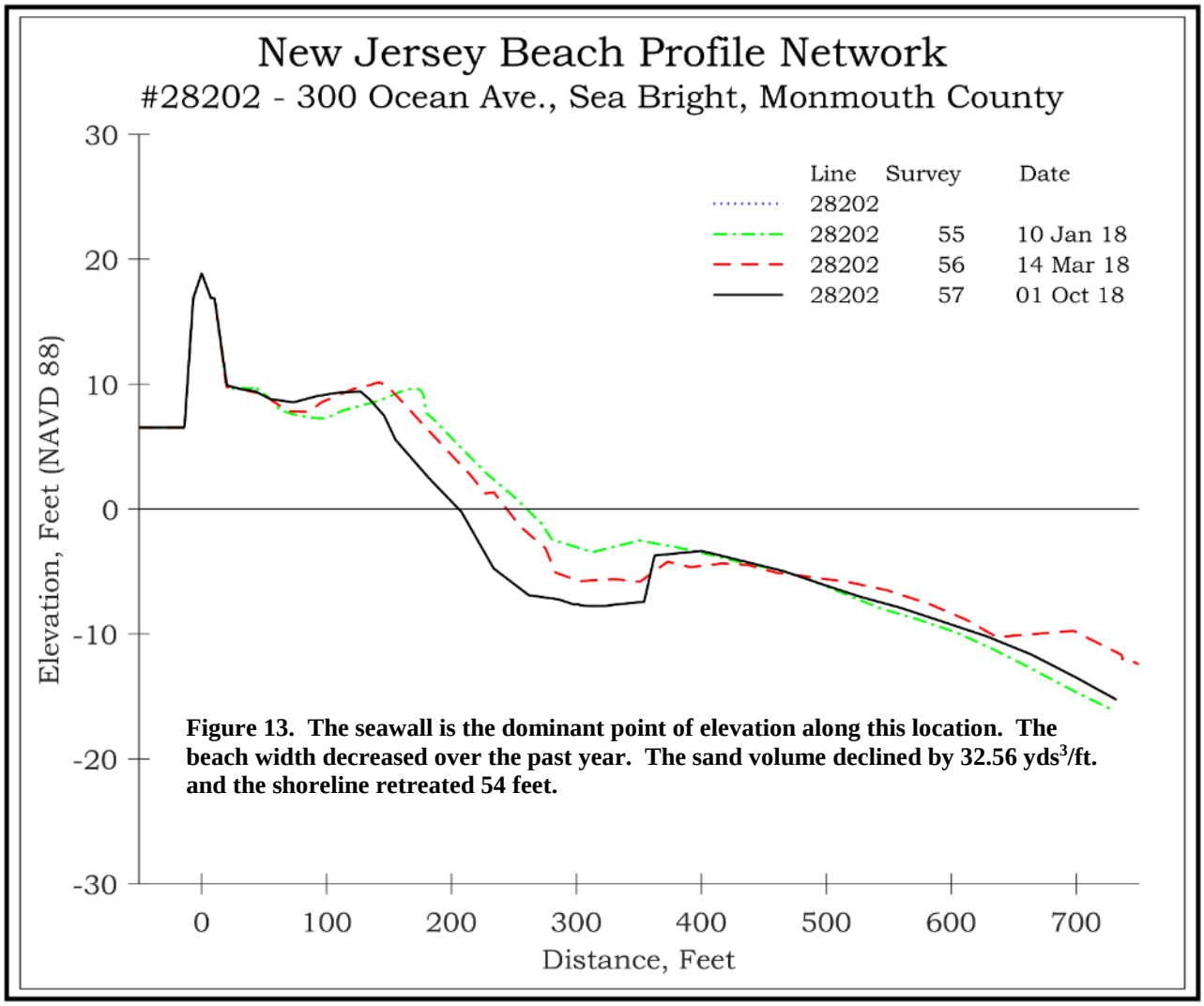


Figure 13. The seawall is the dominant point of elevation along this location. The beach width decreased over the past year. The sand volume declined by 32.56 yds^3/ft. and the shoreline retreated 54 feet.

NJBPN 28201 - 436 Ocean Avenue, Sea Bright

This location has a substantial dune developed seaward of the seawall with a wider beach and dune grass extending onto the sand flats near the dune.

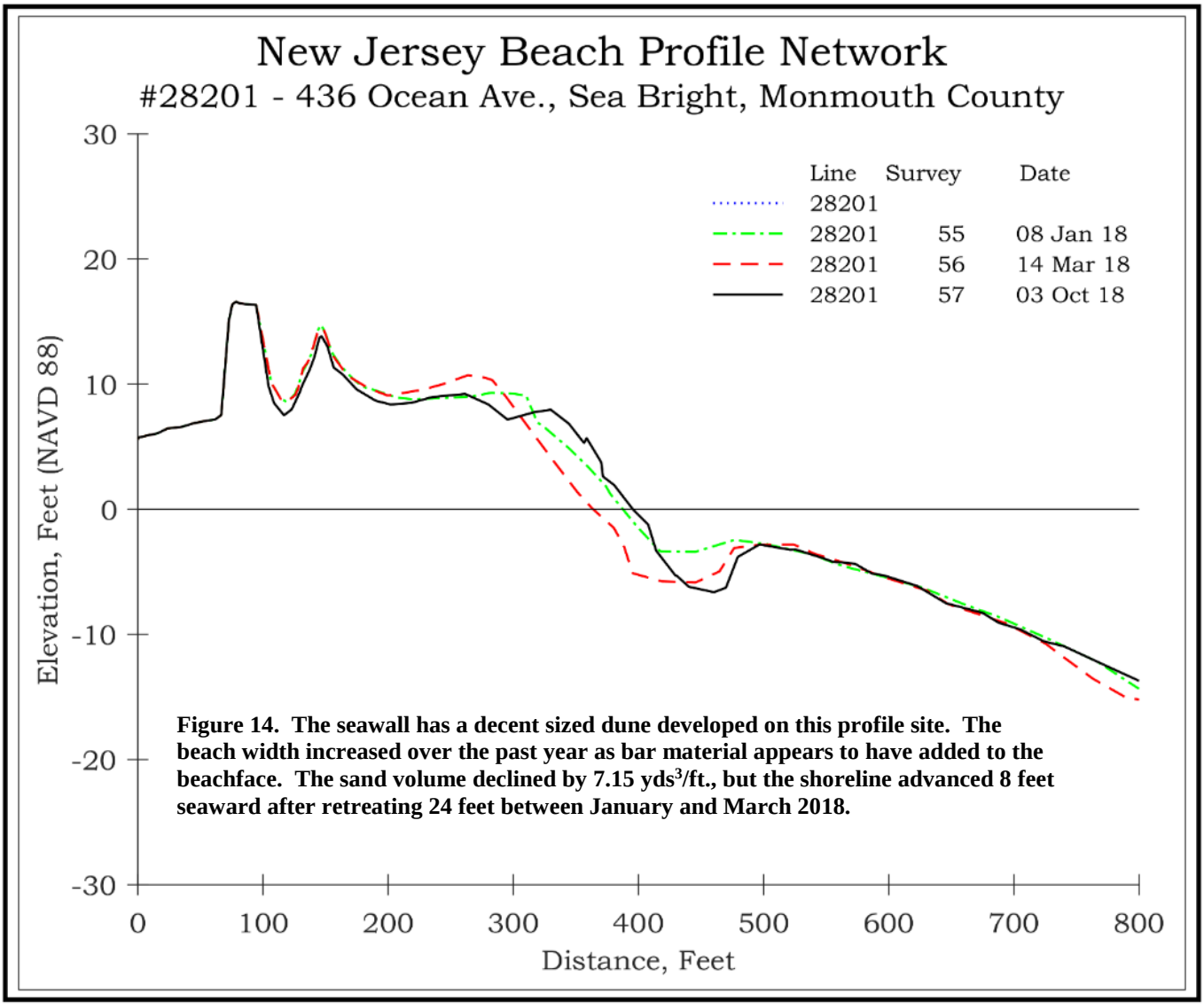


Figure 14. The seawall has a decent sized dune developed on this profile site. The beach width increased over the past year as bar material appears to have added to the beachface. The sand volume declined by 7.15 yds^3/ft., but the shoreline advanced 8 feet seaward after retreating 24 feet between January and March 2018.

NJBPN 282 – Shrewsbury Way, Sea Bright

The left view shows the federal project from the crest of the dune on Jan. 10, 2018 (view to north). The right photo, from the seawall looking north, shows the dune and beach seaward of the rock seawall on October 3, 2018.

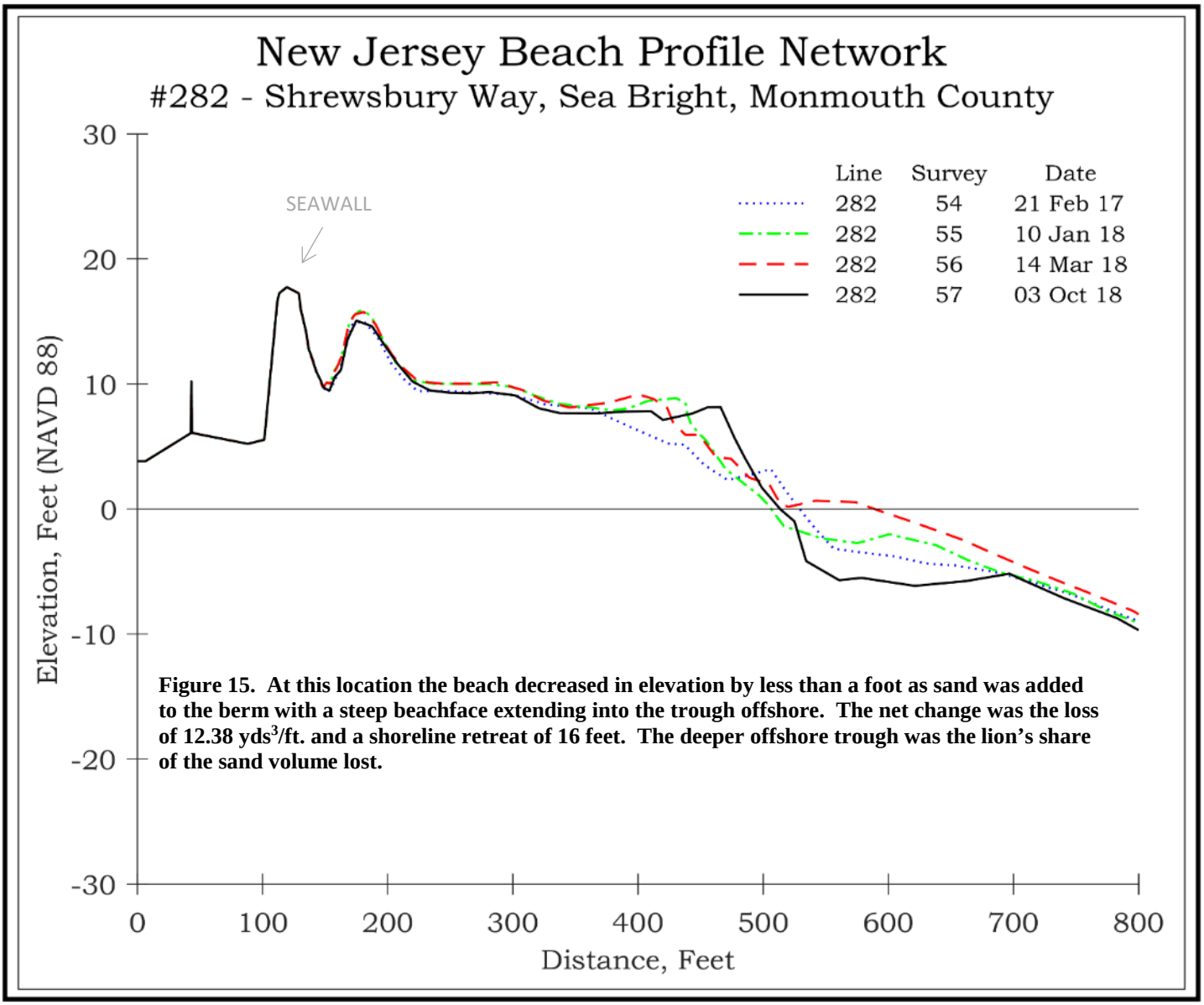


Figure 15. At this location the beach decreased in elevation by less than a foot as sand was added to the berm with a steep beachface extending into the trough offshore. The net change was the loss of 12.38 yds^3/ft. and a shoreline retreat of 16 feet. The deeper offshore trough was the lion's share of the sand volume lost.

NJBPN 18202 - 678 Ocean Avenue, Sea Bright

This site along the Sea Bright seawall shows the dune and wind deposited sand among the seaward facing rocks. The fence line showing in the photograph is the alignment that initiated sand deposition to create the dune system. Grasses propagate seaward across the dry beach because of the low pedestrian traffic and absence of any beach raking maintenance.

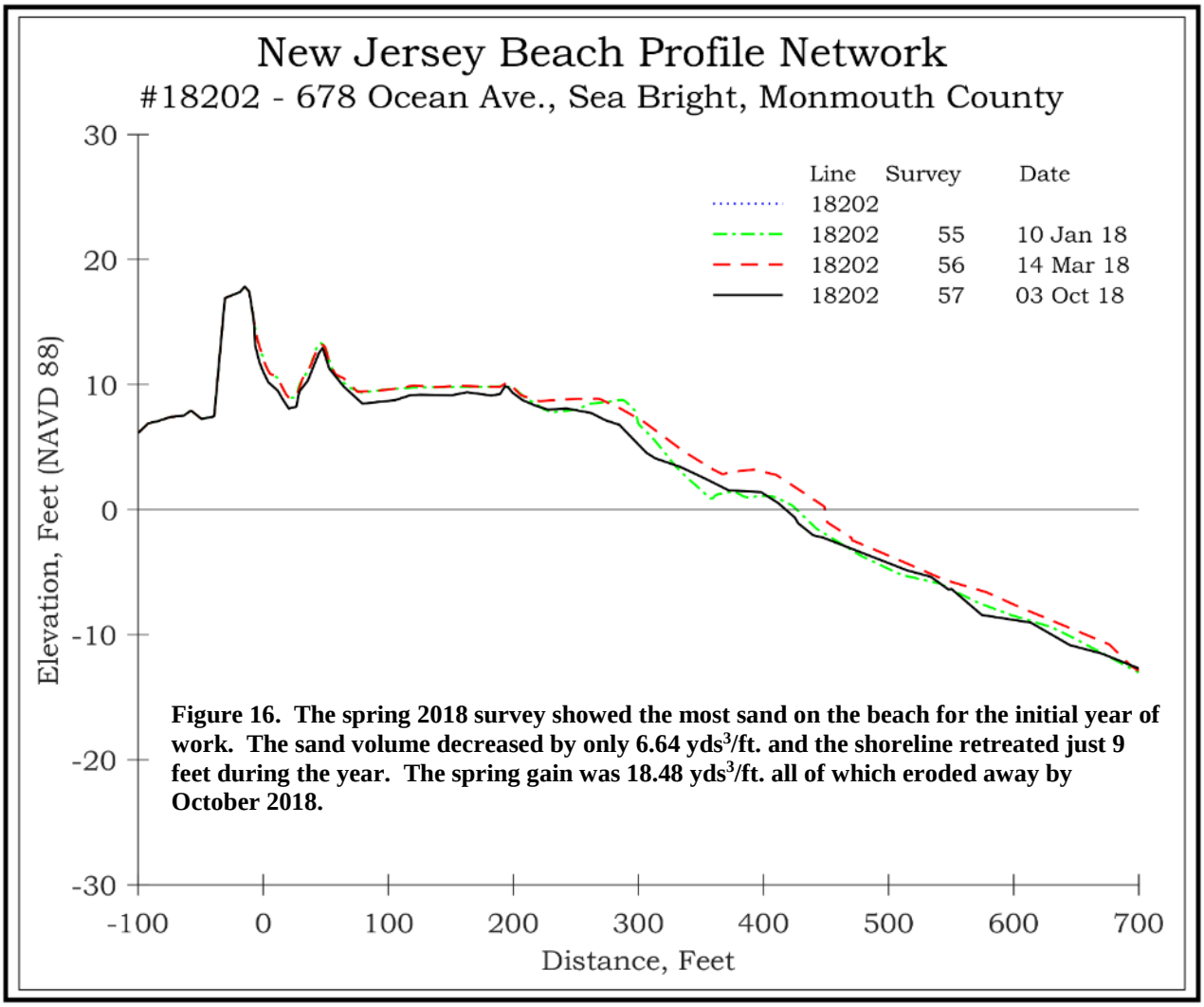


Figure 16. The spring 2018 survey showed the most sand on the beach for the initial year of work. The sand volume decreased by only 6.64 yds^3/ft. and the shoreline retreated just 9 feet during the year. The spring gain was 18.48 yds^3/ft. all of which eroded away by October 2018.

NJBPN 28201 - 801 Ocean Avenue, Sea Bright

Positioned between two beach clubs, this line starts at the parking lot, ramps up to the dry beach without any dune present. The beach extends 500 feet seaward of the parking lot where a steep beachface drops into the water. There is no terrace or bar system present.

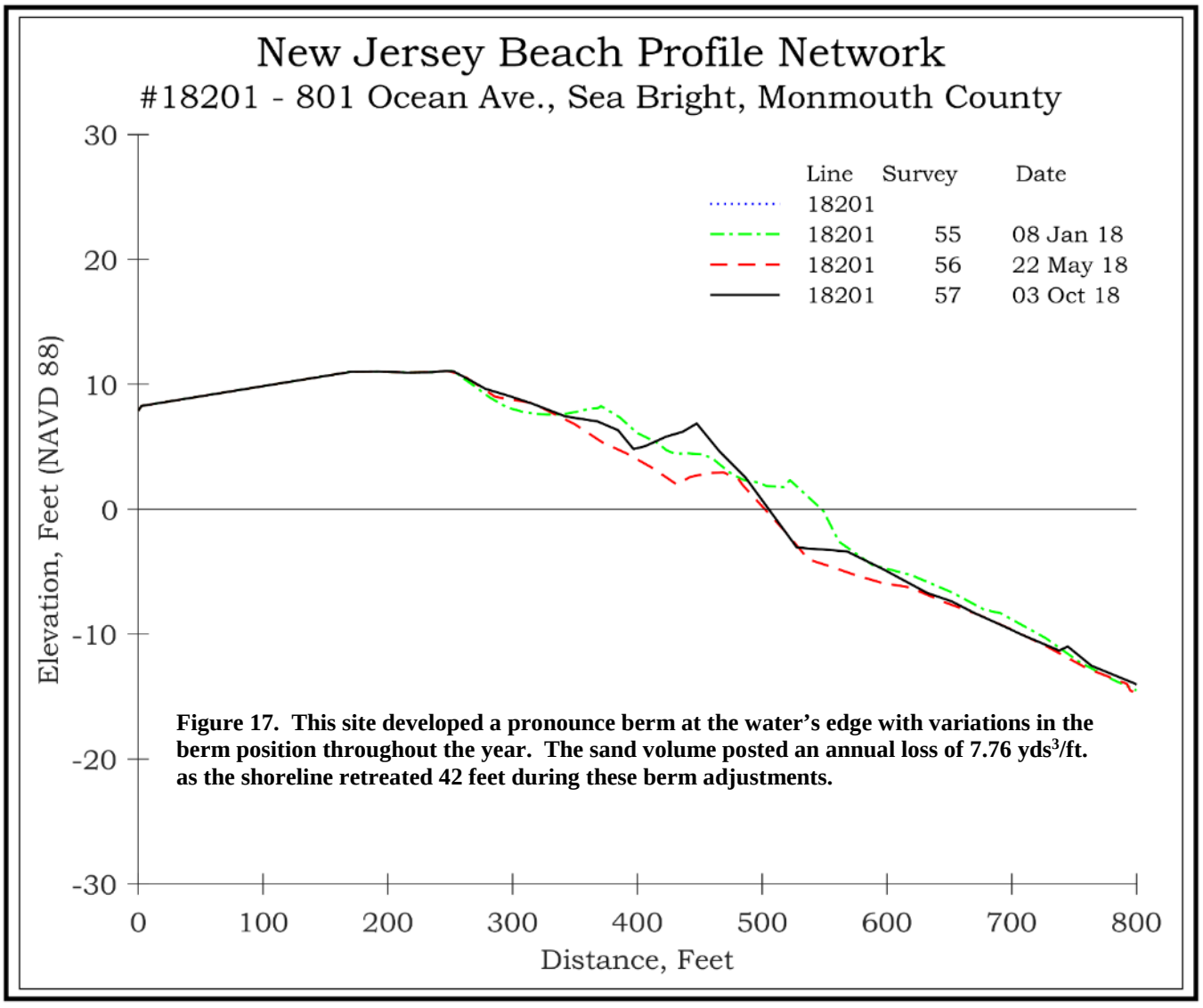


Figure 17. This site developed a pronounce berm at the water's edge with variations in the berm position throughout the year. The sand volume posted an annual loss of 7.76 yds^3/ft. as the shoreline retreated 42 feet during these berm adjustments.

NJBPN 182 – Public Beach, Sea Bright

The Jan. 9, 2018 view on the left shows The berm developed on the beach in early 2018. The right view taken October 1, 2018 shows the berm sloping into a large runnel trough as the offshore bar migrated onto the beach at this site. The dunes exist to either side of the club, but not at the pedestrian entry paths.

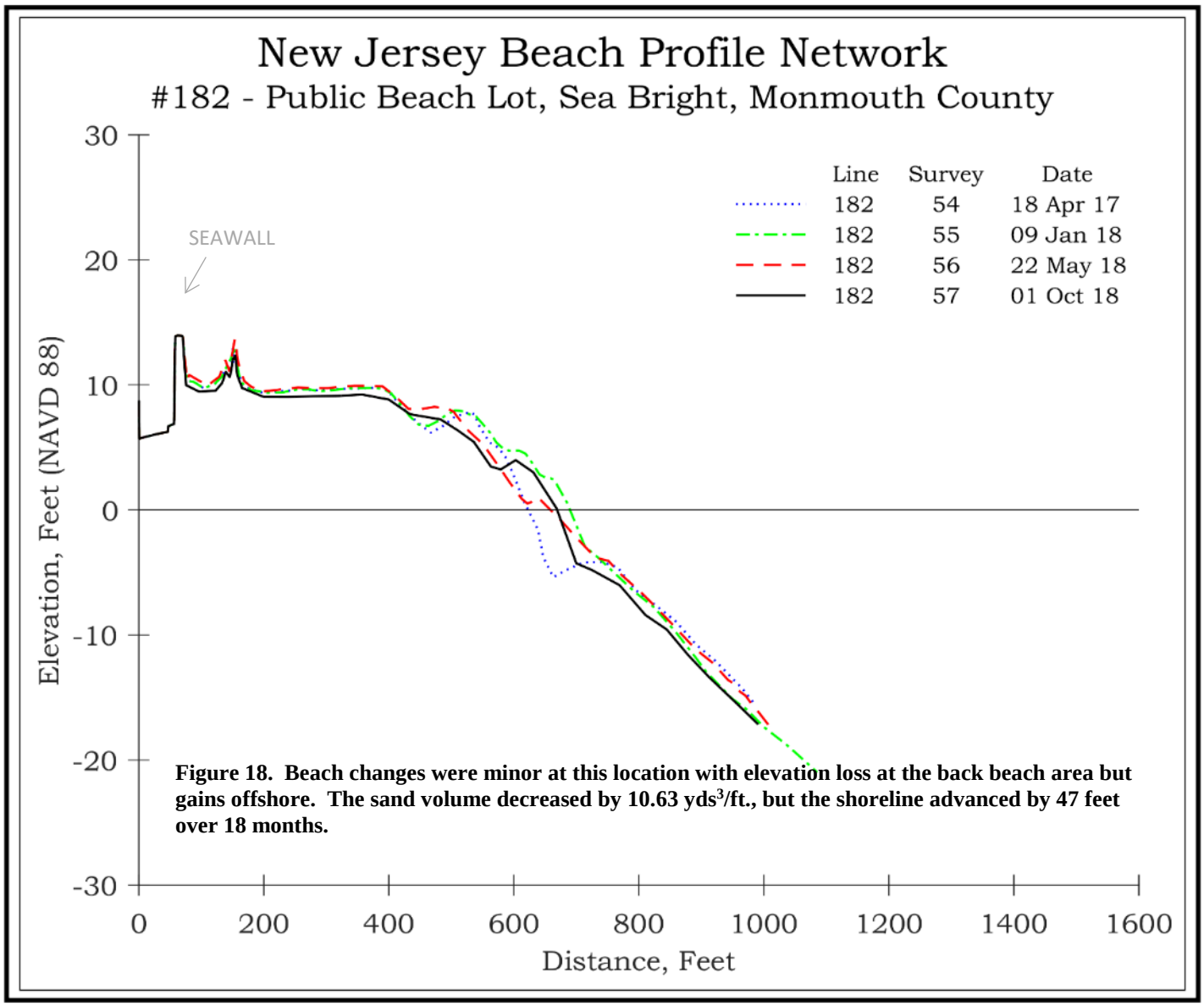


Figure 18. Beach changes were minor at this location with elevation loss at the back beach area but gains offshore. The sand volume decreased by 10.63 yds^3/ft., but the shoreline advanced by 47 feet over 18 months.

NJBPN 181 – Municipal Beach, Sea Bright

The January 9, 2018 view on the left side shows a huge "dune" placed as an added storm barrier on the site. This was graded out onto the beach by May 2018 adding to the berm. By December 2018 the berm had eroded.

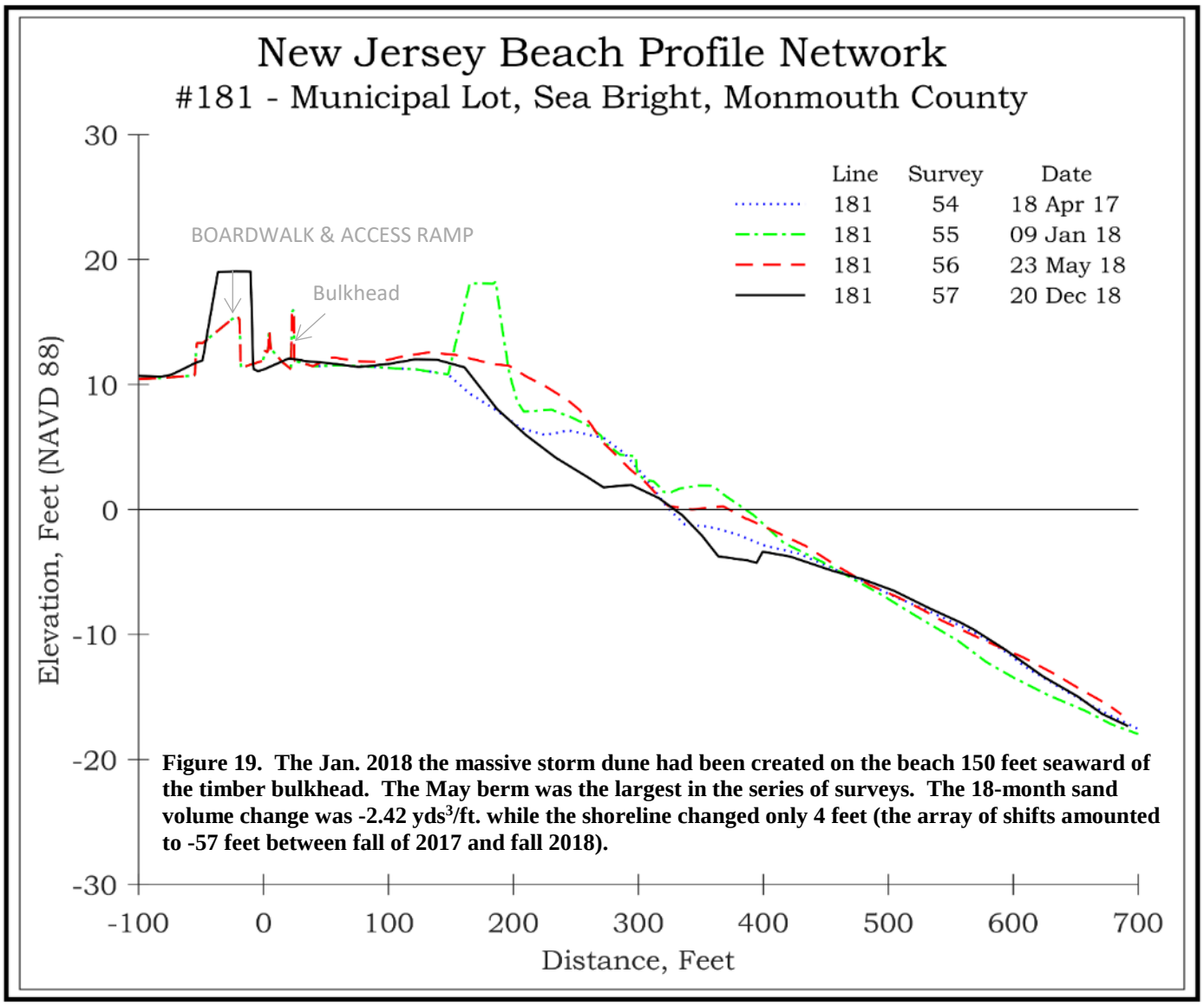
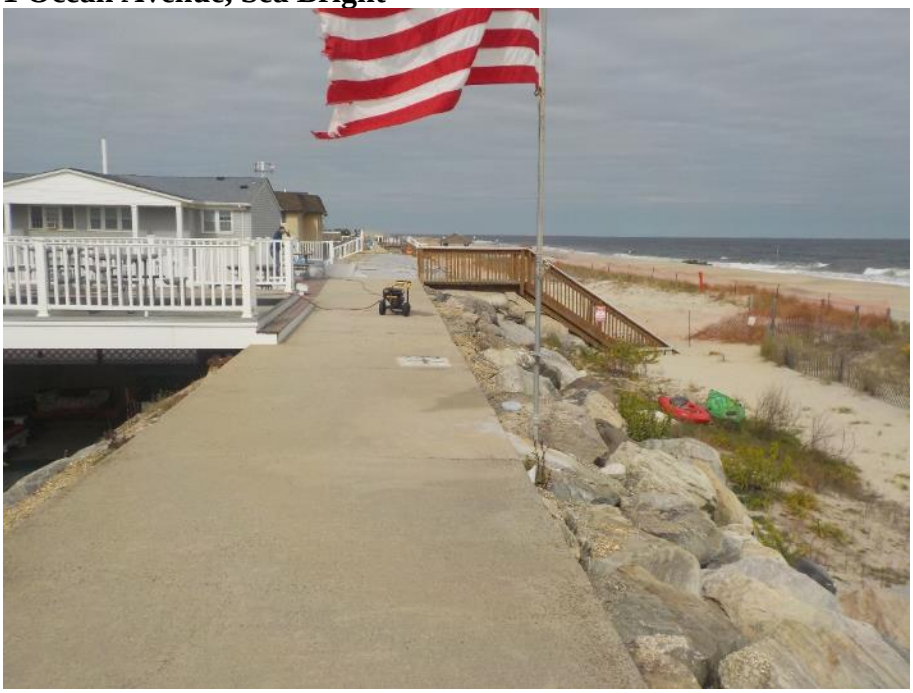


Figure 19. The Jan. 2018 the massive storm dune had been created on the beach 150 feet seaward of the timber bulkhead. The May berm was the largest in the series of surveys. The 18-month sand volume change was -2.42 yds^3/ft. while the shoreline changed only 4 feet (the array of shifts amounted to -57 feet between fall of 2017 and fall 2018).

NJBPN 28003 - 1201 Ocean Avenue, Sea Bright



This site starts at the rock seawall with a dune present on the landward beach's first 100 feet of width. The second ridge seen in January 2018 may be a seasonal barrier to storm waves. It was not present in subsequent surveys.

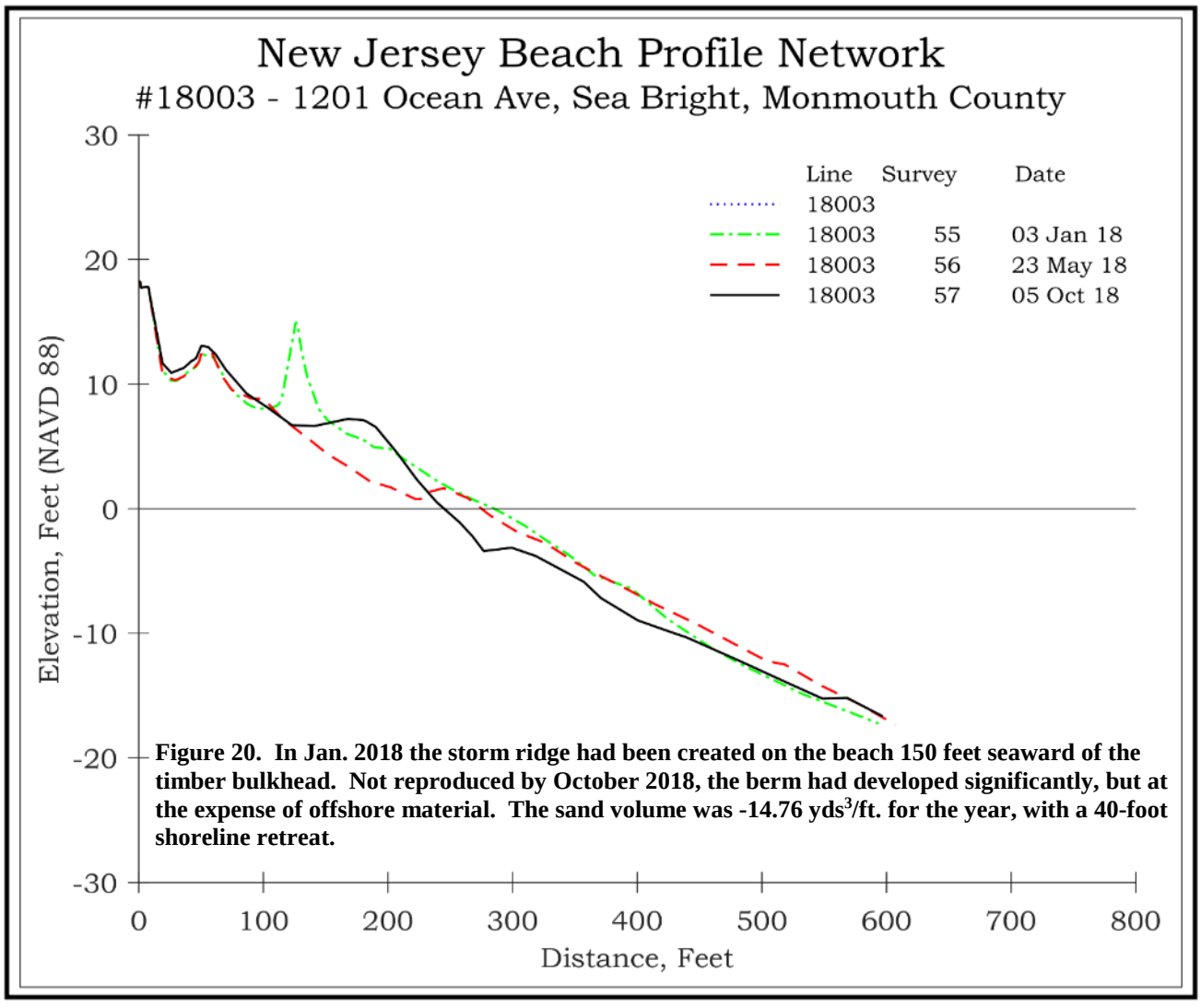


Figure 20. In Jan. 2018 the storm ridge had been created on the beach 150 feet seaward of the timber bulkhead. Not reproduced by October 2018, the berm had developed significantly, but at the expense of offshore material. The sand volume was -14.76 yds^3/ft. for the year, with a 40-foot shoreline retreat.

NJBPN 18002 - 15 Tradewinds Ln., Sea Bright

The dune at this location has developed along the single row of fencing. The beach width here is not excessive since the year since the initial survey shows considerable loss in berm sand.

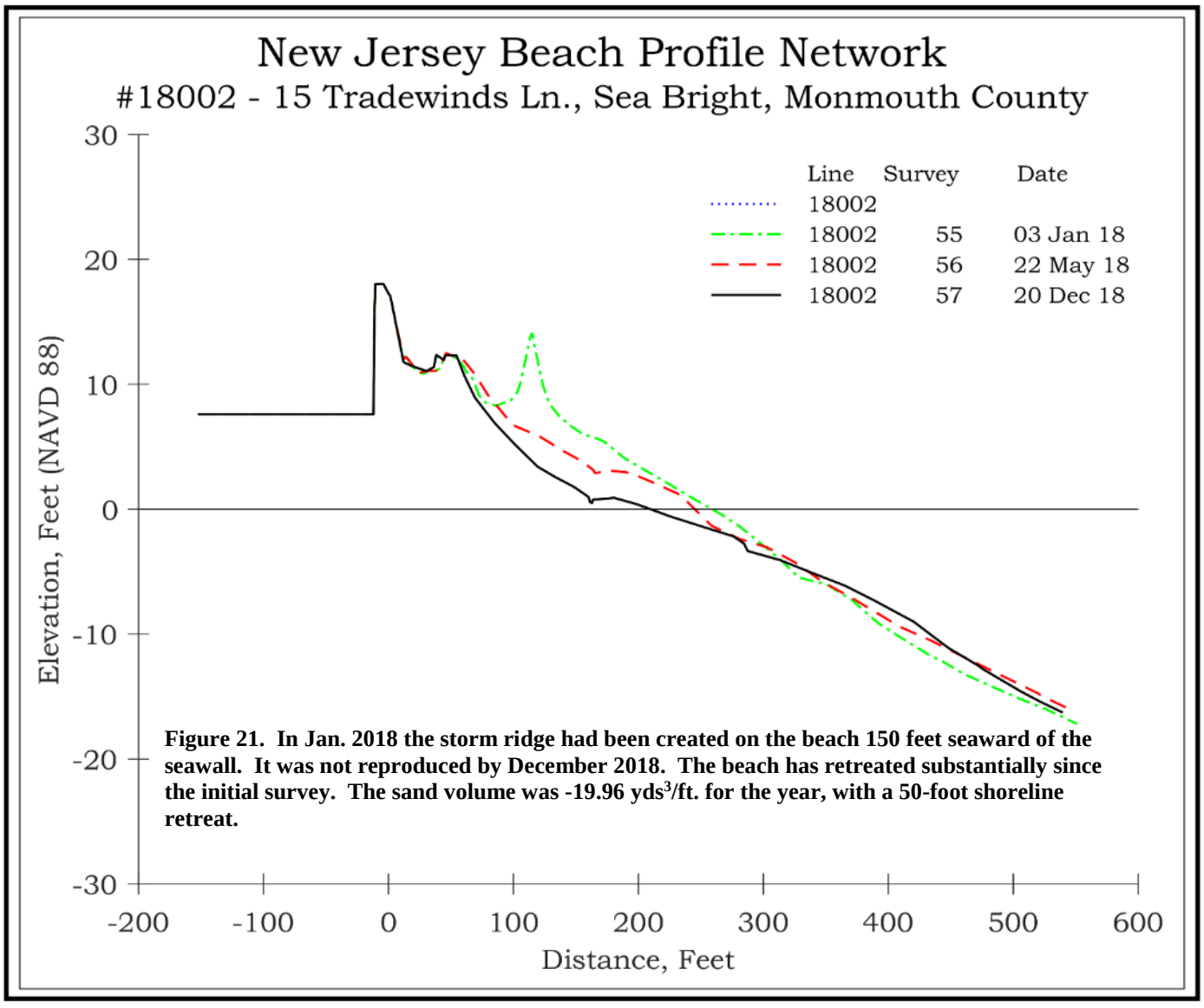


Figure 21. In Jan. 2018 the storm ridge had been created on the beach 150 feet seaward of the seawall. It was not reproduced by December 2018. The beach has retreated substantially since the initial survey. The sand volume was -19.96 yds^3/ft. for the year, with a 50-foot shoreline retreat.

NJBPN 28001 - 1485 Ocean Avenue, Sea Bright

This site starts at a bulkhead and rocks considerably seaward of Ocean Avenue because the structures have been built seaward of the highway. There are no dunes, a fairly narrow beach that is losing sand. Offshore there is no terrace or bar system present.

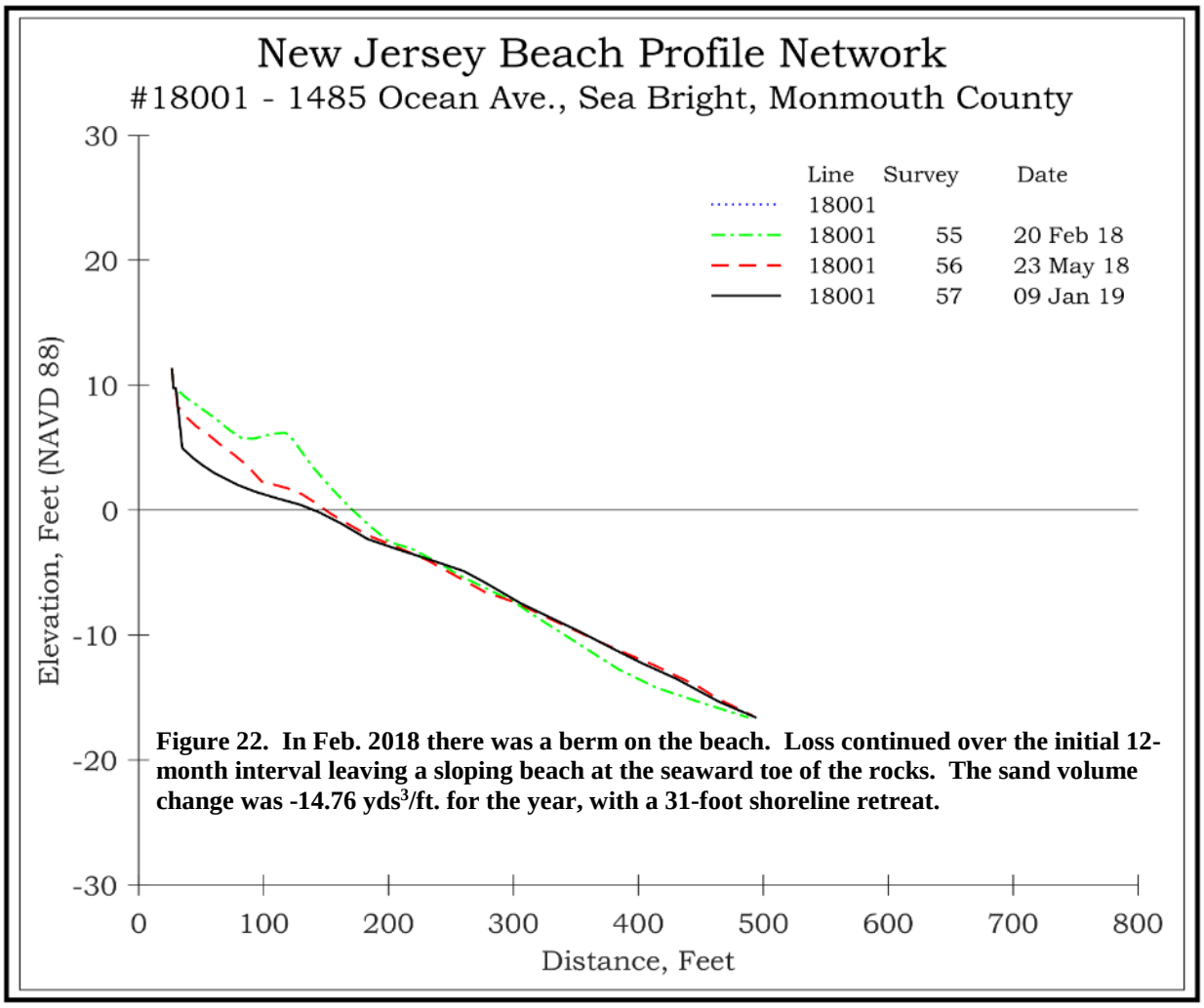


Figure 22. In Feb. 2018 there was a berm on the beach. Loss continued over the initial 12-month interval leaving a sloping beach at the seaward toe of the rocks. The sand volume change was -14.76 yds^3/ft. for the year, with a 31-foot shoreline retreat.

NJBPN 180 – Sunset Court, Sea Bright

The view on the left taken Jan. 3, 2018 shows the sand build-up on the dune at the seaward slope. By December 18, 2018 the fence was nearly covered. The site started and finished this series of surveys from essentially the same beach cross section.

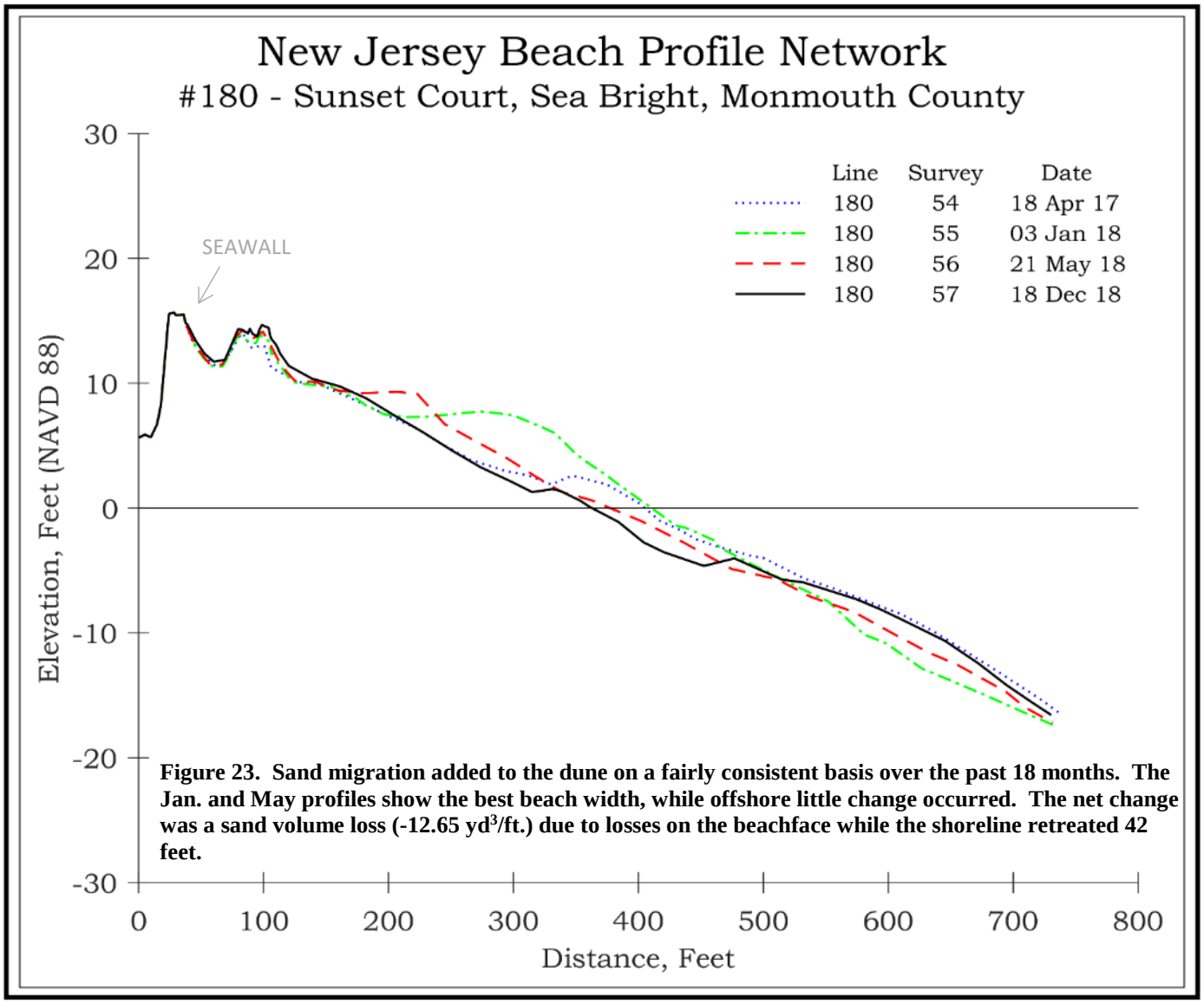


Figure 23. Sand migration added to the dune on a fairly consistent basis over the past 18 months. The Jan. and May profiles show the best beach width, while offshore little change occurred. The net change was a sand volume loss (-12.65 yd^3/ft.) due to losses on the beachface while the shoreline retreated 42 feet.

NJBPN 17901 - 122 Ocean Avenue, Monmouth Beach

This site shows sand blown up into the seaward face of the seawall filling in among the rocks, but no dune is present. The beach width is more extensive than site 180 to the north.

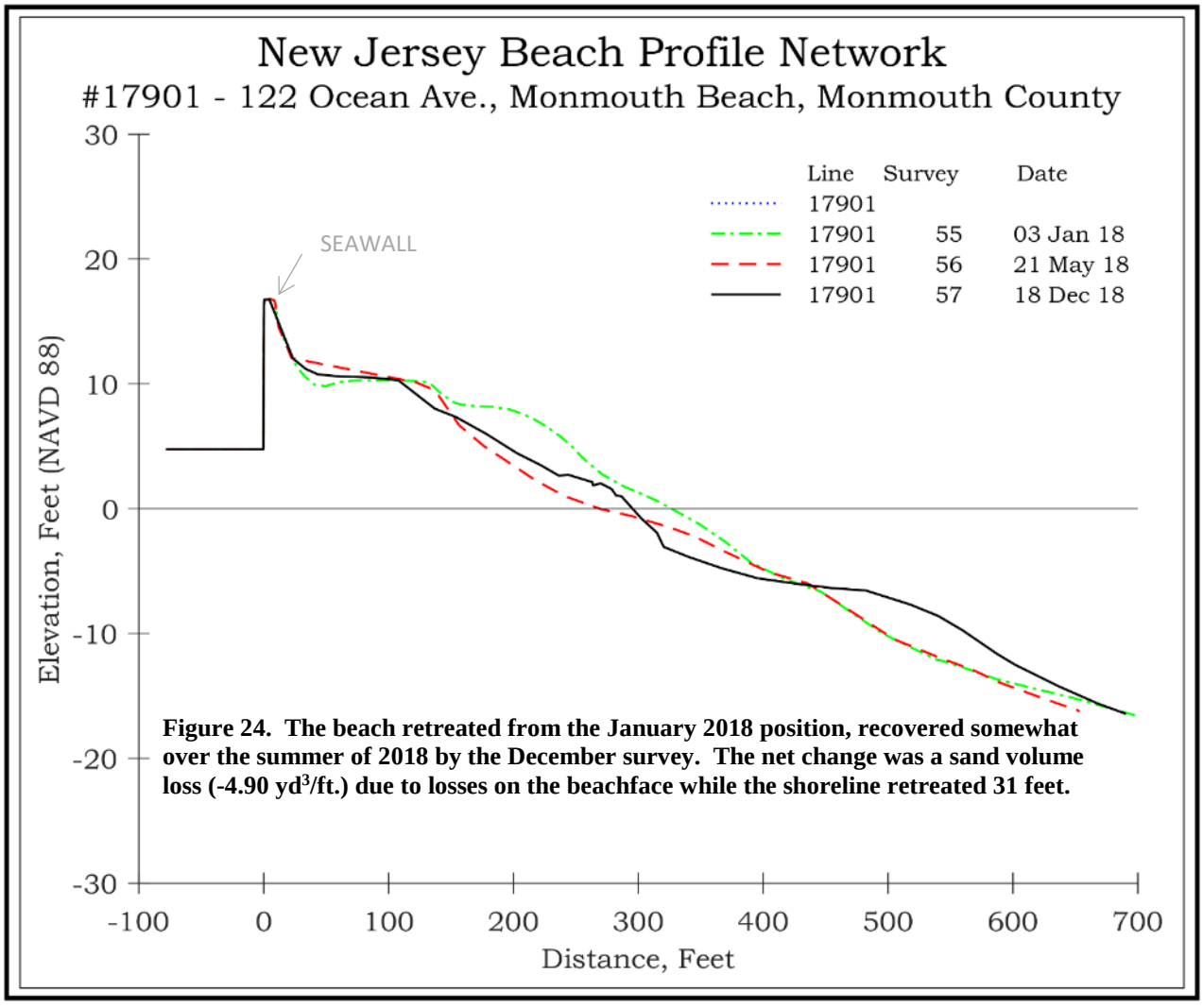


Figure 24. The beach retreated from the January 2018 position, recovered somewhat over the summer of 2018 by the December survey. The net change was a sand volume loss (-4.90 $yd^3/ft.$) due to losses on the beachface while the shoreline retreated 31 feet.

NJBPN 179 – Cottage Road, Monmouth Beach

This site has been where the worst erosion occurs in Monmouth County. The left photograph December 21, 2017 shows the newly planted dune from the seaward side of the seawall. On the right the existing beach has narrowed the point where the dune is in jeopardy as of December 20, 2018.

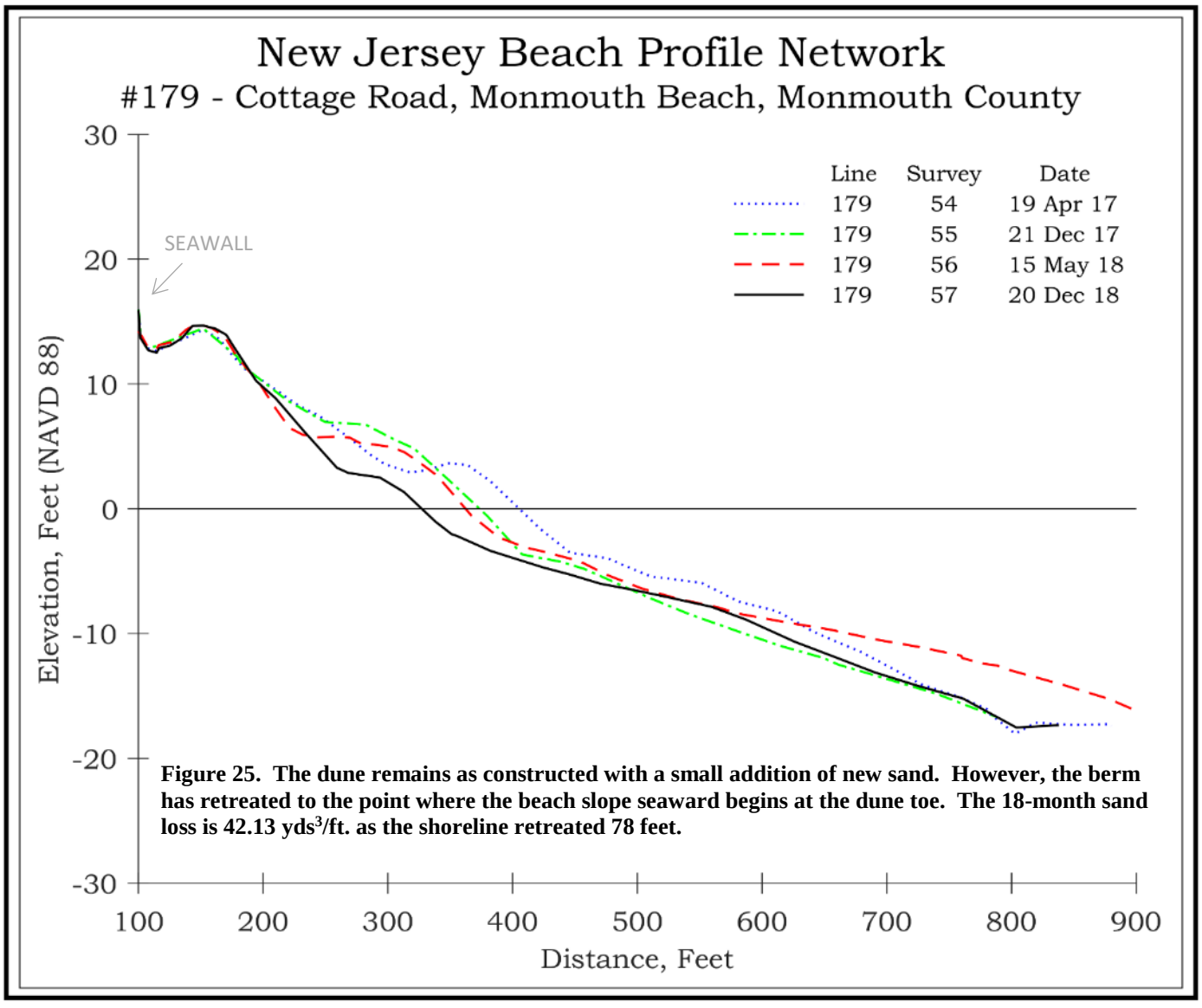


Figure 25. The dune remains as constructed with a small addition of new sand. However, the berm has retreated to the point where the beach slope seaward begins at the dune toe. The 18-month sand loss is 42.13 yds^3/ft. as the shoreline retreated 78 feet.

NJBPN 17801 - 65 Ocean Avenue, Monmouth Beach

This new site is south of the groin at Cottage Road site and the beach reflects the impoundment factor as a low gradient beachface.

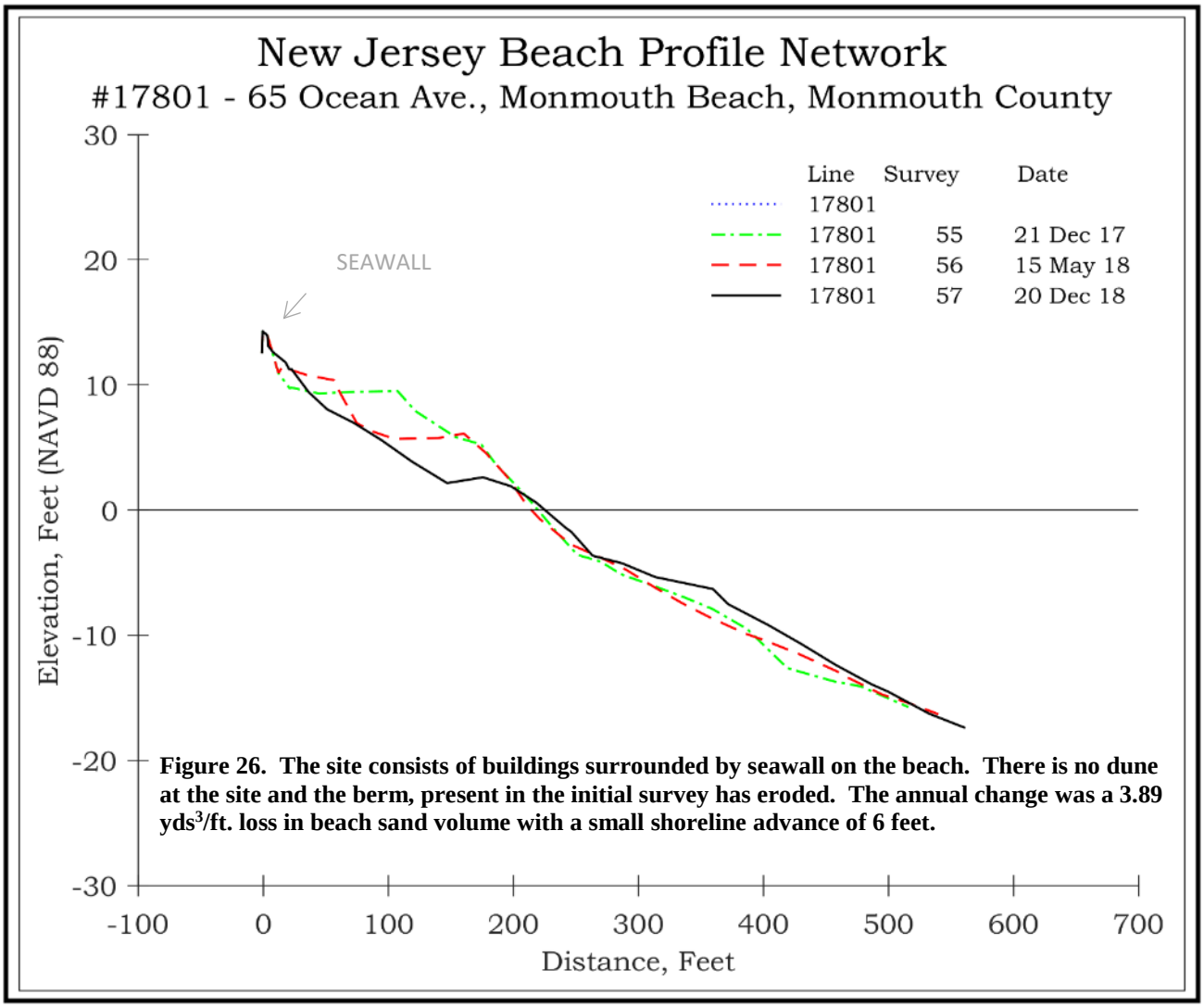


Figure 26. The site consists of buildings surrounded by seawall on the beach. There is no dune at the site and the berm, present in the initial survey has eroded. The annual change was a 3.89 yds^3/ft. loss in beach sand volume with a small shoreline advance of 6 feet.

NJBPN 178 – Monmouth Beach Club, Monmouth Beach

The left photo taken January 19, 2018 was taken at the sand fence line looking north across the beach berm. The right picture shows the extensive seawall construction going on at the site January 2, 2019 establishing the rock barrier to the interior.

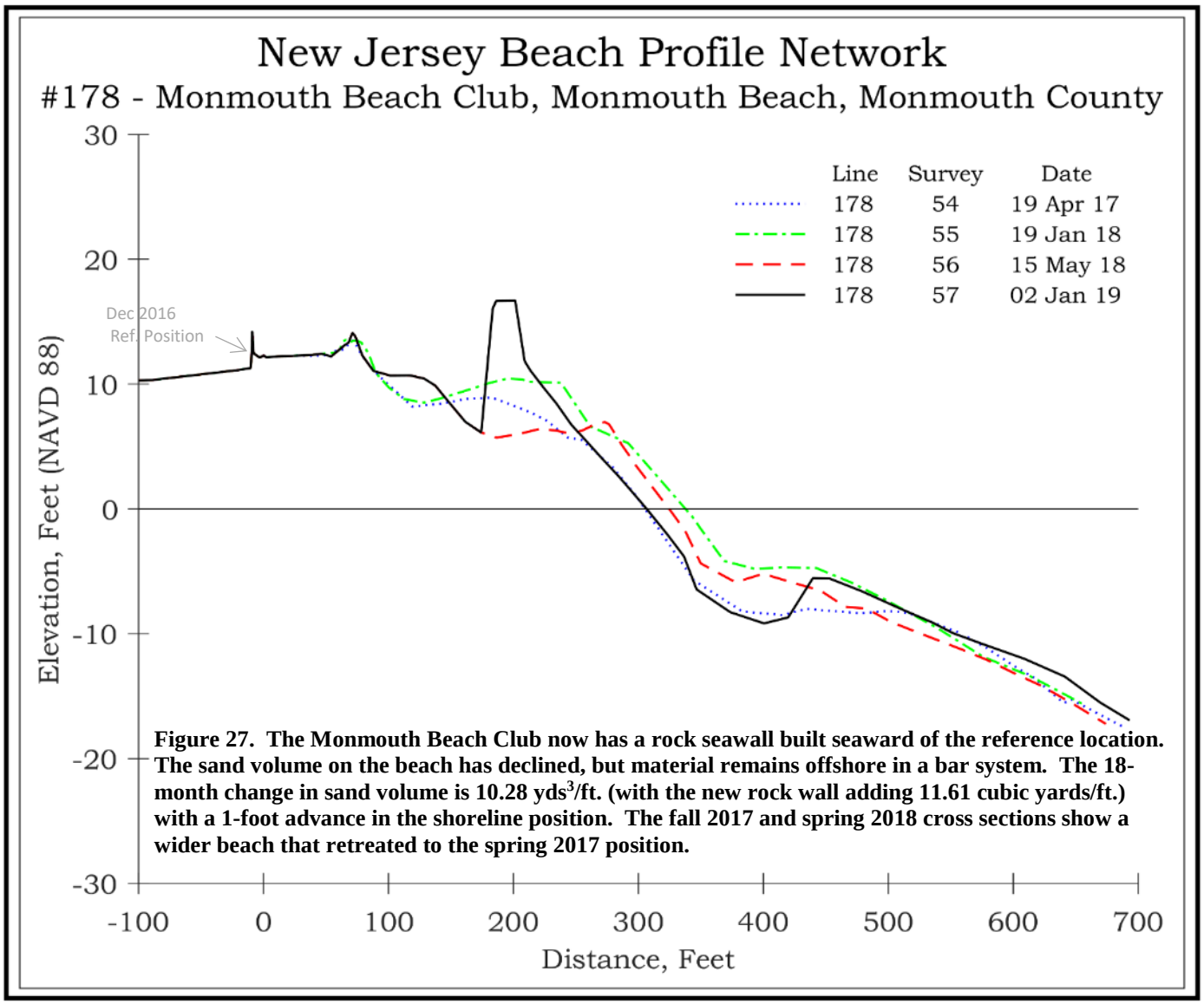


Figure 27. The Monmouth Beach Club now has a rock seawall built seaward of the reference location. The sand volume on the beach has declined, but material remains offshore in a bar system. The 18-month change in sand volume is 10.28 yds^3/ft. (with the new rock wall adding 11.61 cubic yards/ft.) with a 1-foot advance in the shoreline position. The fall 2017 and spring 2018 cross sections show a wider beach that retreated to the spring 2017 position.

NJBPN 17701 - 9 Ocean Avenue, Monmouth Beach

This location has the seawall as the ultimate backstop, with a 270-foot wide beach seaward. The initial survey did not have an offshore bar system, but one developed by May 2018 which has remained in place.

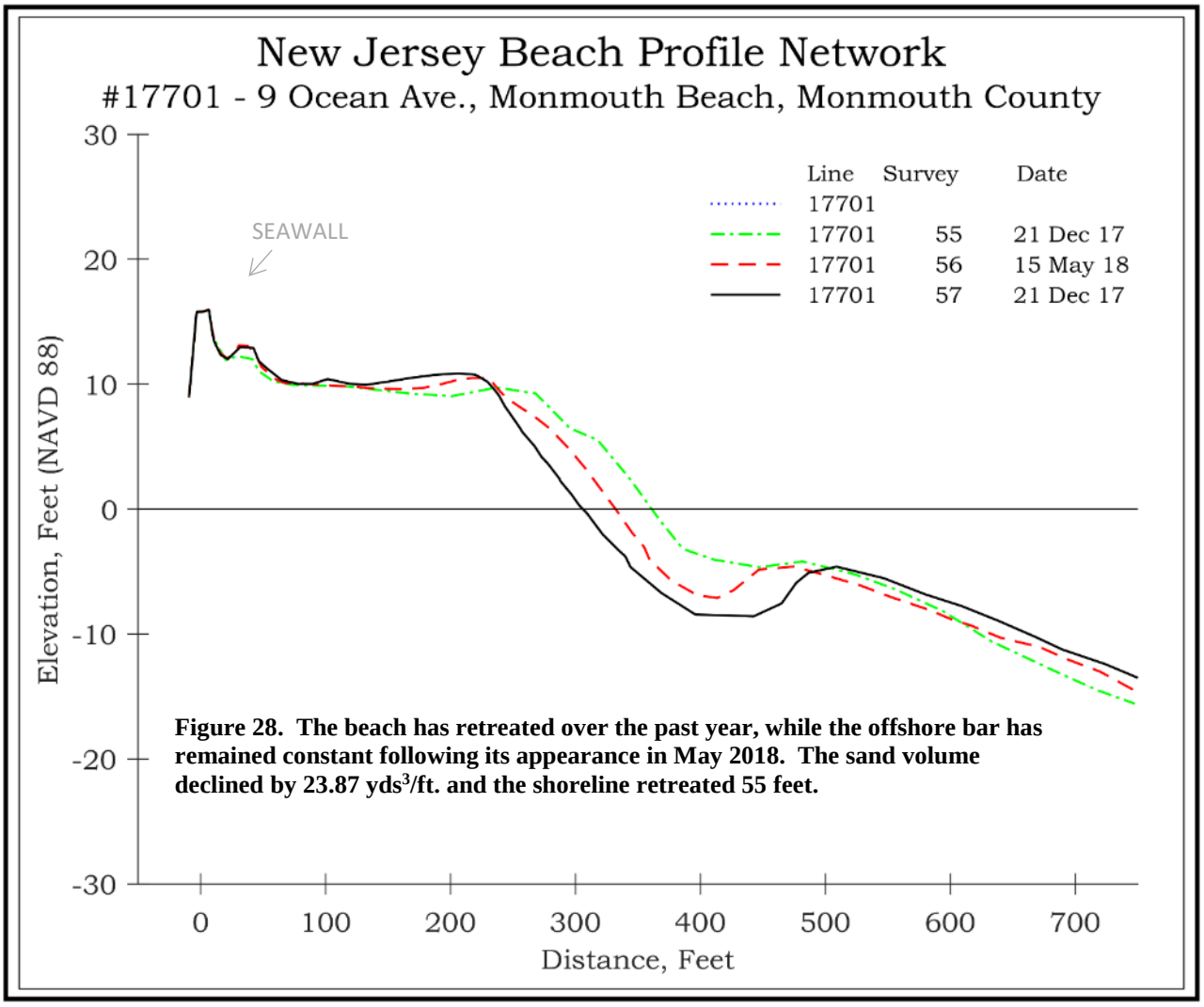
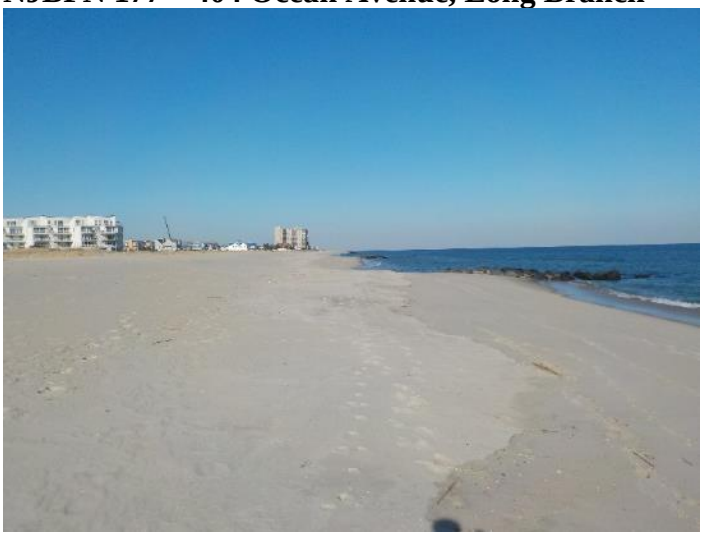


Figure 28. The beach has retreated over the past year, while the offshore bar has remained constant following its appearance in May 2018. The sand volume declined by 23.87 yds^3/ft. and the shoreline retreated 55 feet.

NJBPN 177 – 404 Ocean Avenue, Long Branch



The left photo was taken December 21, 2017. By November 2018 the beach had retreated following stability during 2017. The dune and back beach did accumulate some sand.

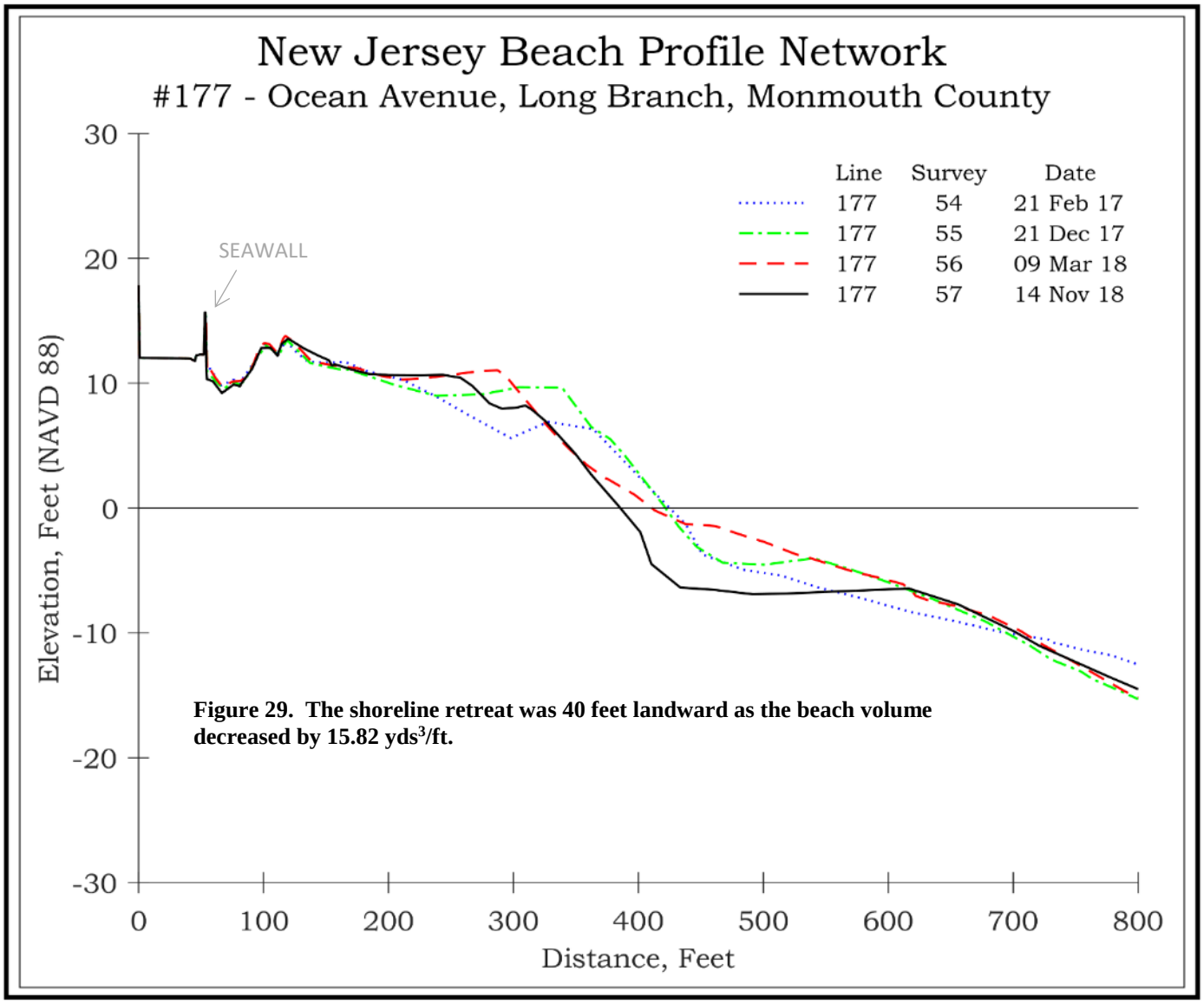
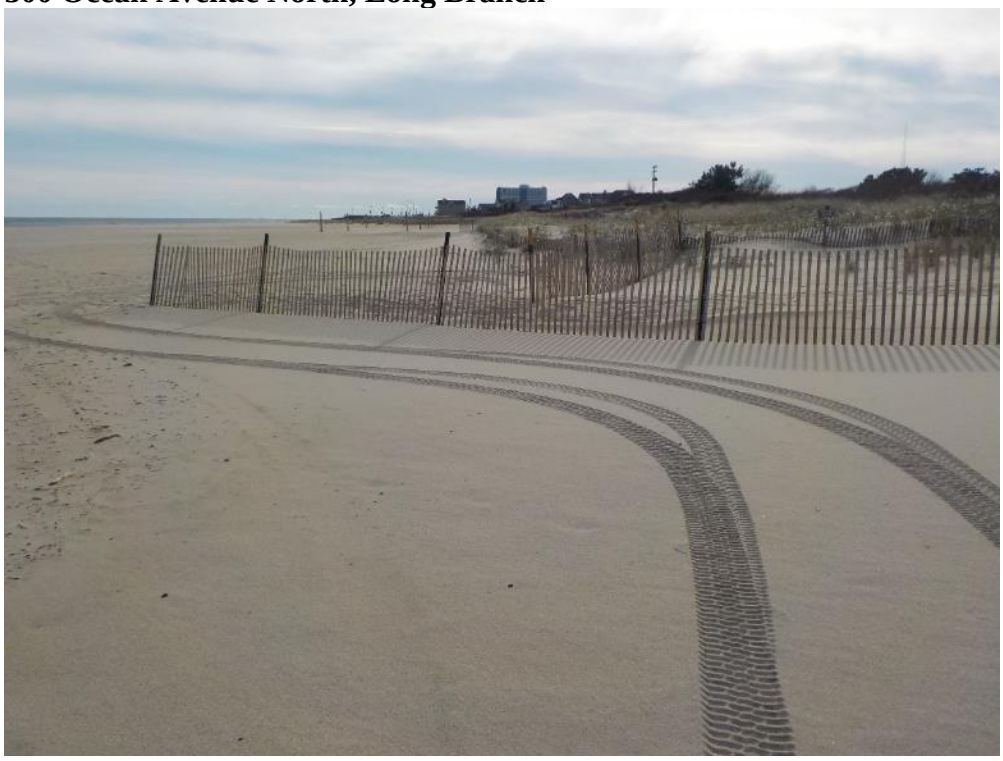


Figure 29. The shoreline retreat was 40 feet landward as the beach volume decreased by 15.82 yds^3/ft.

NJBPN 17601 – 300 Ocean Avenue North, Long Branch



The dune is back toward the roadway and the beach is reasonably wide. There was retreat this year, but no dune loss.

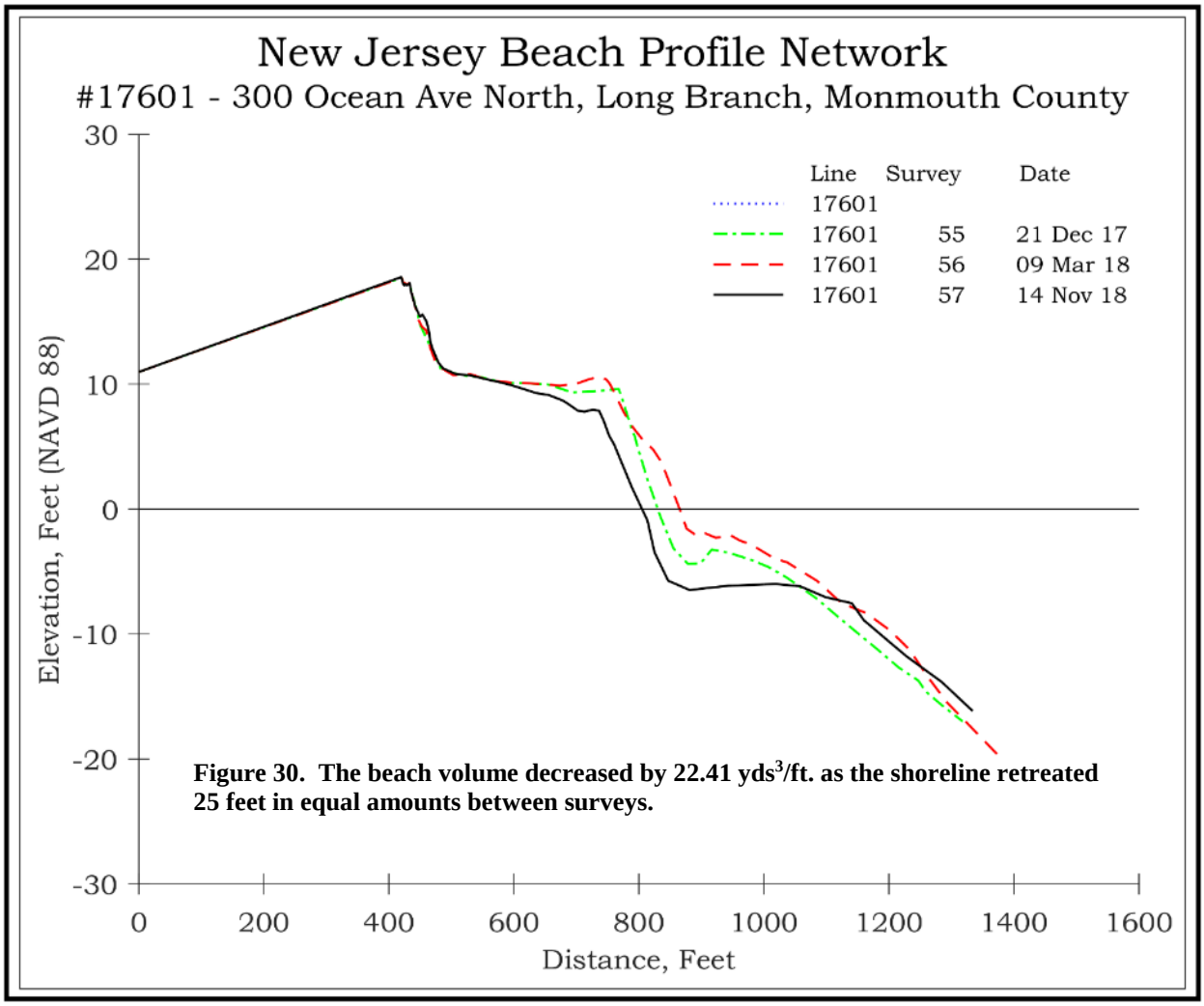


Figure 30. The beach volume decreased by 22.41 yds^3/ft. as the shoreline retreated 25 feet in equal amounts between surveys.

NJBPN 176 – Seven President's Park, Long Branch

This December 19, 2017 (left) photo shows the groin rocks were covered in sand as the summer berm remained in place. The right photo from November 14, 2018 was taken from the same perspective a year later and shows a bit more rock showing.

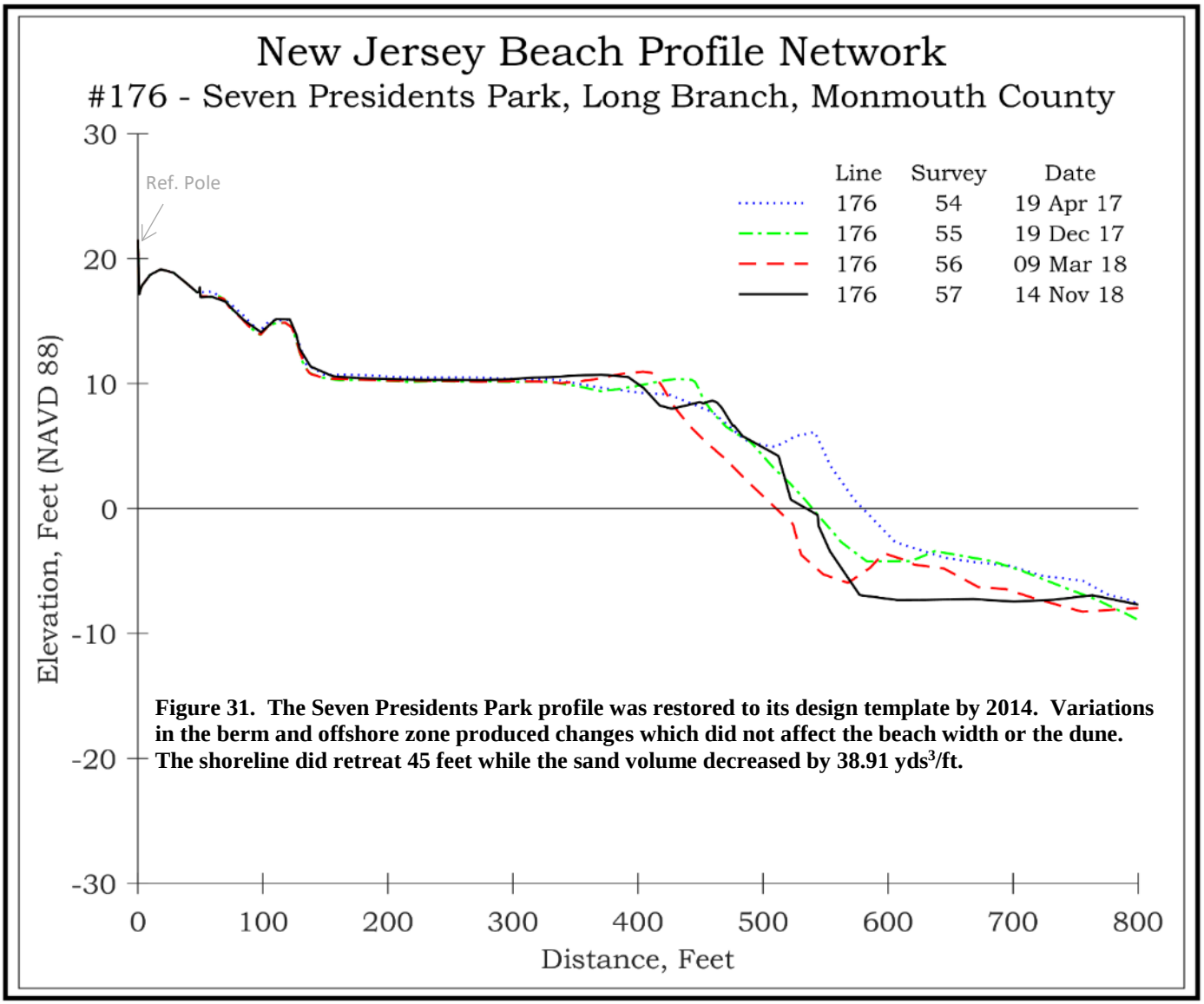


Figure 31. The Seven Presidents Park profile was restored to its design template by 2014. Variations in the berm and offshore zone produced changes which did not affect the beach width or the dune. The shoreline did retreat 45 feet while the sand volume decreased by 38.91 yds^3/ft.

NJBPN 17501 – Ocean Terrace, Long Branch

This location is at the very northern end of the old steel sheet pile wall at the Long Branch uplands bluff edge. There is no dune established here, but sand is ramped up against the wall. There is a 120-foot wide beach, a uniform beach slope and a narrow offshore terrace, which remained in place until the fall of 2018 when an offshore bar appeared.

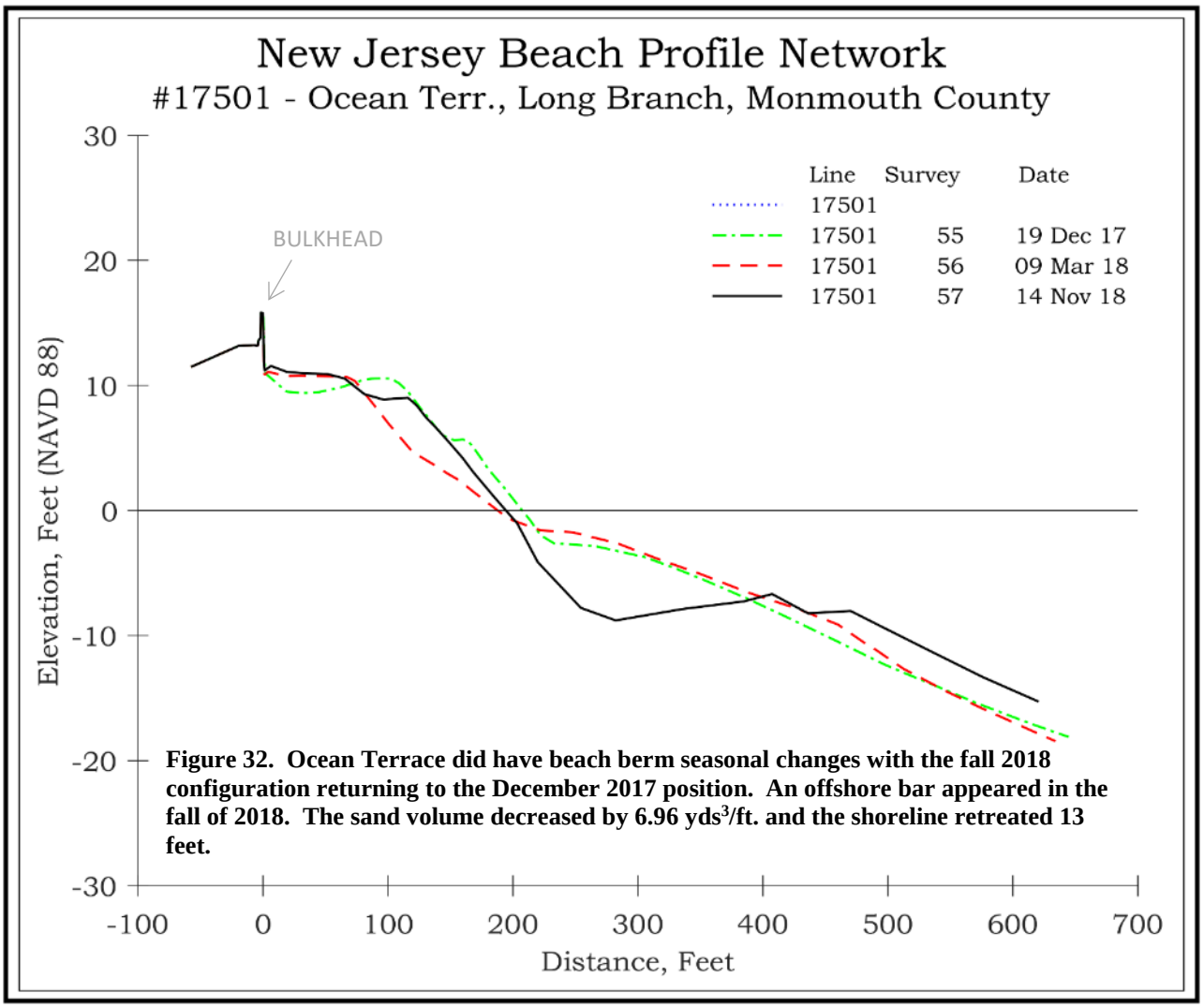


Figure 32. Ocean Terrace did have beach berm seasonal changes with the fall 2018 configuration returning to the December 2017 position. An offshore bar appeared in the fall of 2018. The sand volume decreased by 6.96 yds^3/ft. and the shoreline retreated 13 feet.

NJBPN 175 – Broadway Avenue, Long Branch

The left photograph taken December 19, 2017 shows that the beach was a little flatter. A significant berm had appeared by May 2018 as seasonal growth commenced.

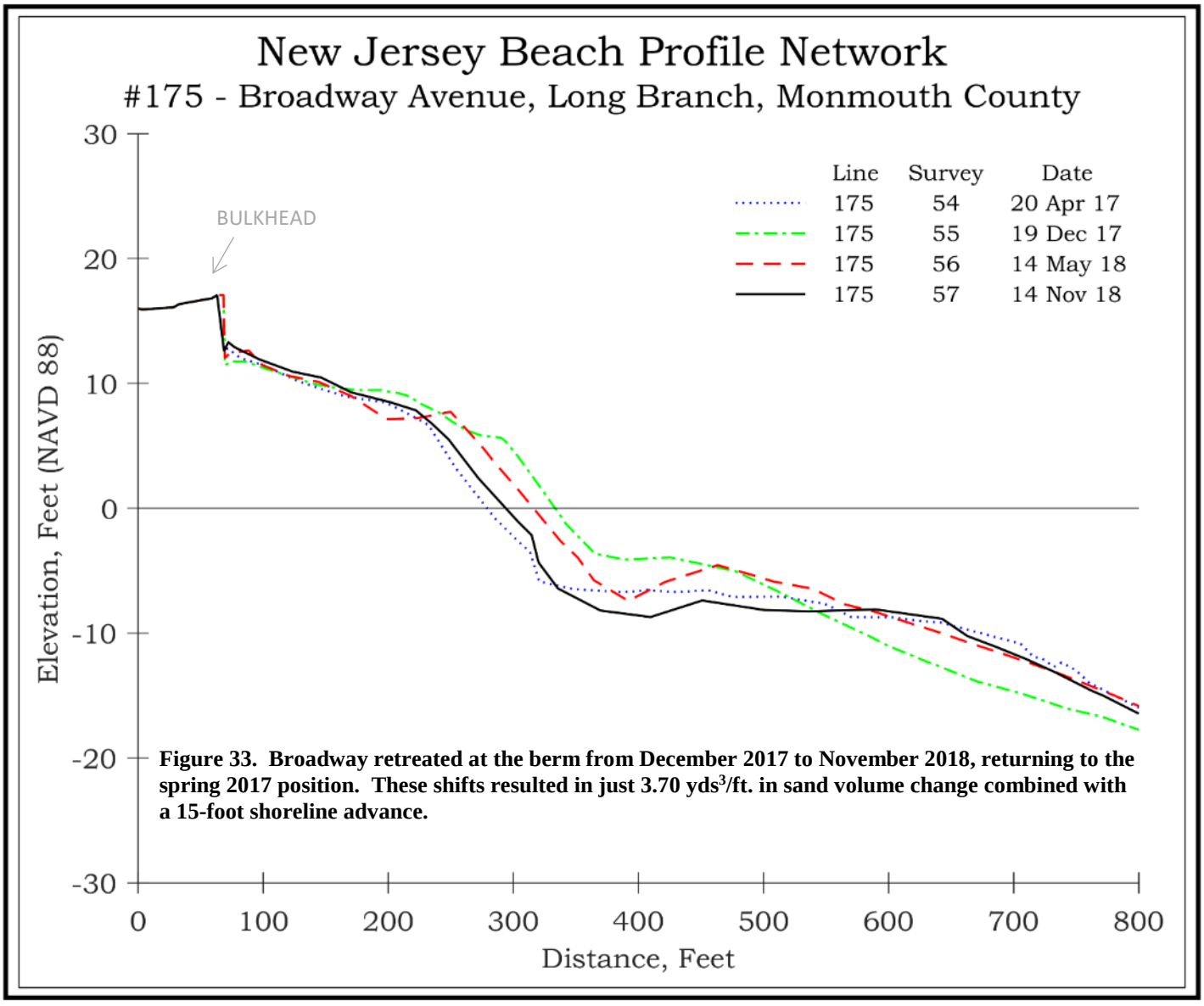


Figure 33. Broadway retreated at the berm from December 2017 to November 2018, returning to the spring 2017 position. These shifts resulted in just 3.70 yds^3/ft. in sand volume change combined with a 15-foot shoreline advance.

NJBPN 17402 – 45 Ocean Avenue, Long Branch

The beach narrows to 150 feet with a uniform beachface and offshore slope without any bar system present by the fall of 2018. There is a hint of one forming, but as yet, still a fairly minimal feature.

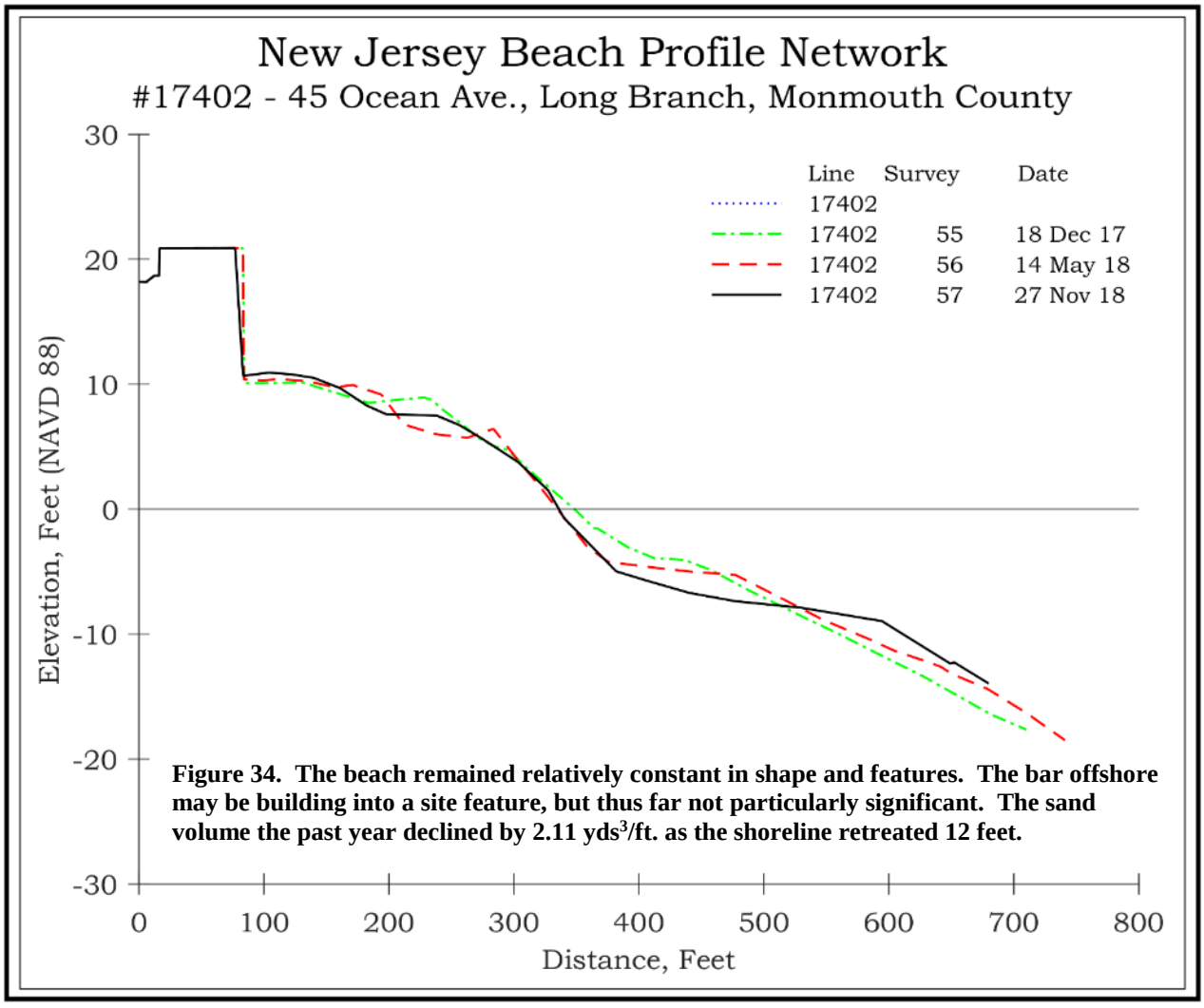


Figure 34. The beach remained relatively constant in shape and features. The bar offshore may be building into a site feature, but thus far not particularly significant. The sand volume the past year declined by 2.11 yds^3/ft. as the shoreline retreated 12 feet.

NJBPN 17401 – North Morris Avenue, Long Branch

The steel wall was augmented a decade or two ago with a rock revetment because of deterioration. The beach extends 250 feet further seaward to a beachface slope ending in 5 feet of water. There is a flatter terrace offshore without a bar present as of the fall of 2018.

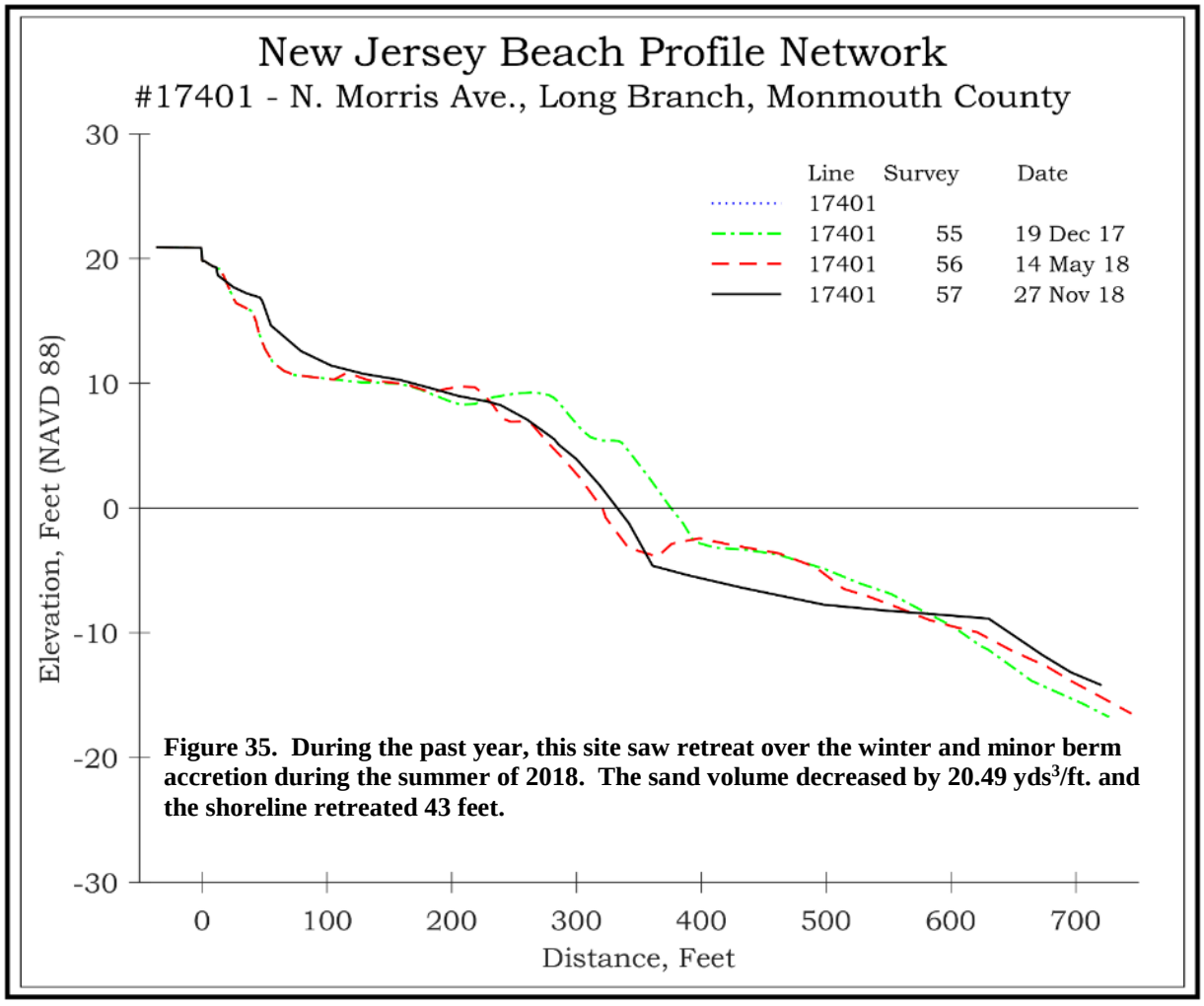


Figure 35. During the past year, this site saw retreat over the winter and minor berm accretion during the summer of 2018. The sand volume decreased by 20.49 yds^3/ft. and the shoreline retreated 43 feet.

NJBPN 174 – Morris Avenue, Long Branch

The right side view, taken December 19, 2017 shows some grass growth and a 200-foot wide beach 18 months after restoration work was complete. The summer accretion of 2017 was removed by the fall of 2018.

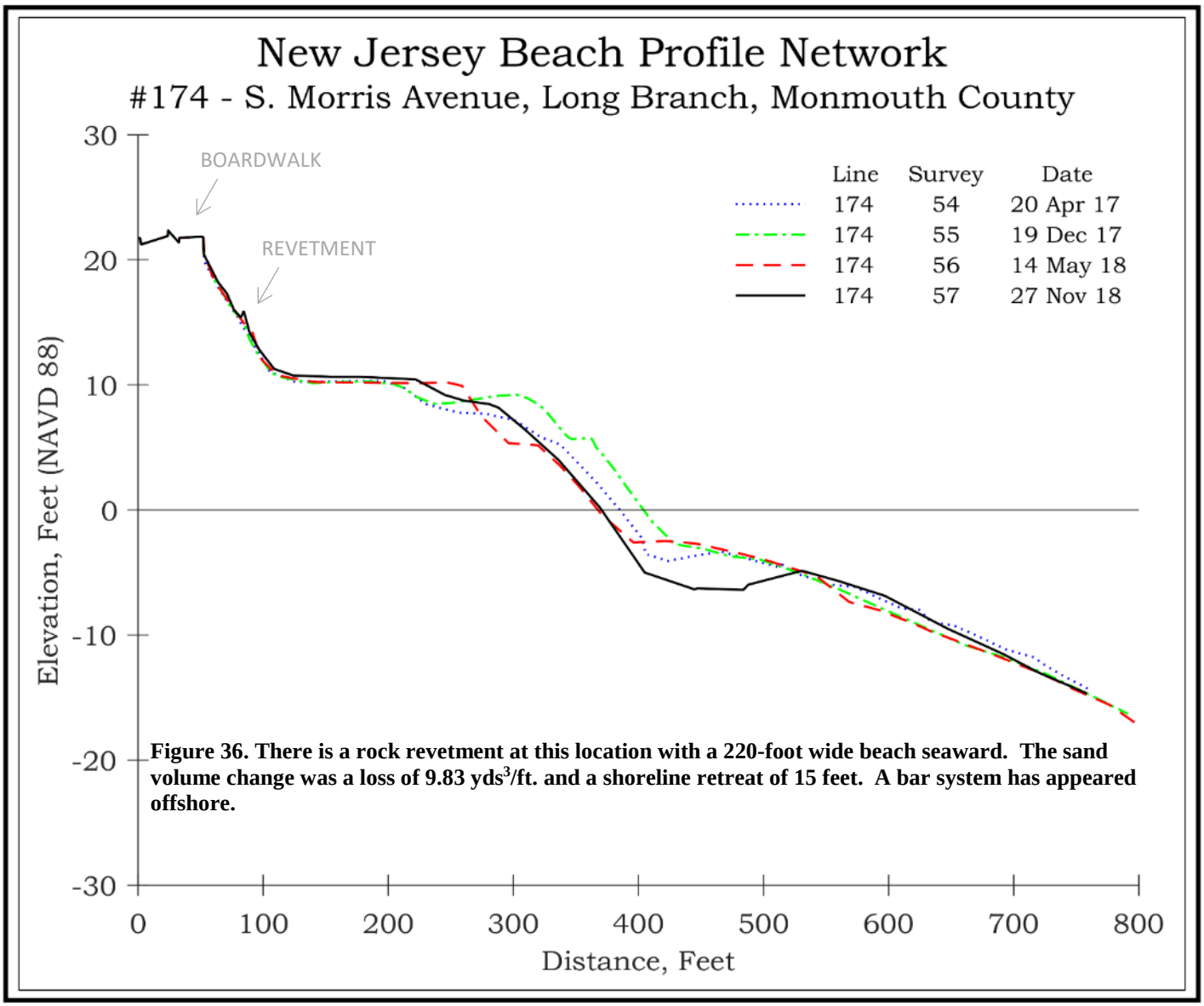
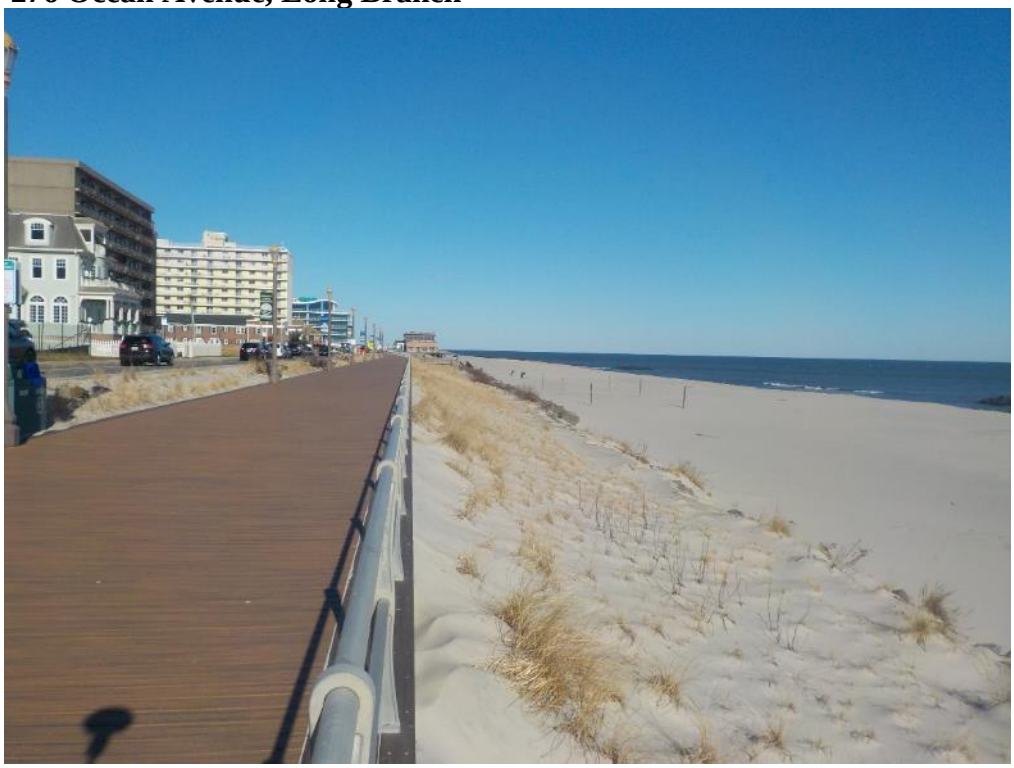


Figure 36. There is a rock revetment at this location with a 220-foot wide beach seaward. The sand volume change was a loss of 9.83 yds^3/ft. and a shoreline retreat of 15 feet. A bar system has appeared offshore.

NJBPN 17303 – 276 Ocean Avenue, Long Branch



South of Morris Avenue the rock revetment continues with a 240-foot wide beach, no dune system and a horizontal terrace about 75 feet wide offshore which converted into a bar system.

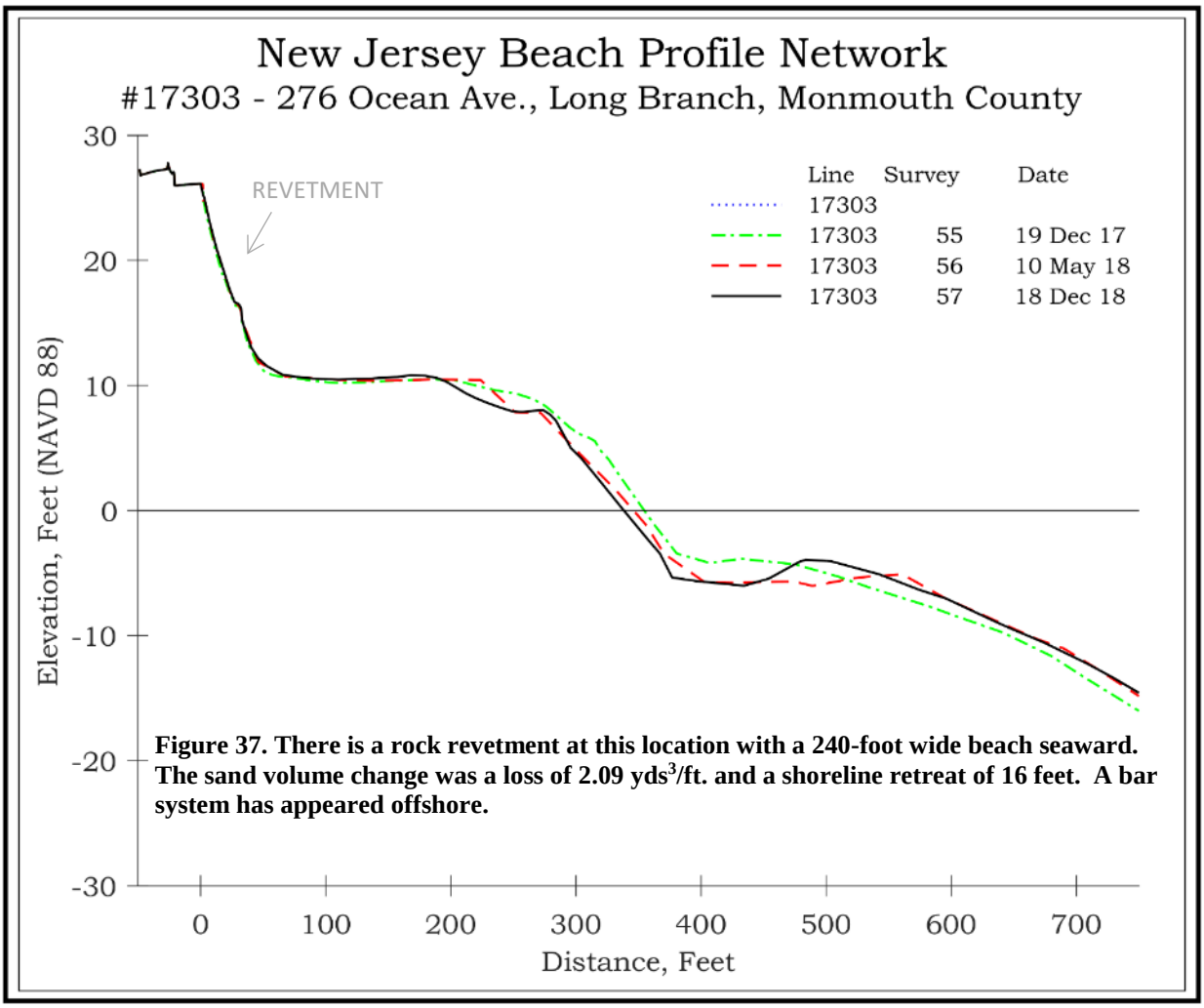


Figure 37. There is a rock revetment at this location with a 240-foot wide beach seaward. The sand volume change was a loss of 2.09 yds^3/ft. and a shoreline retreat of 16 feet. A bar system has appeared offshore.

NJBPN 17302 – 378 Ocean Avenue, Long Branch

The bluff revetment is the first element in the survey with a 230-foot wide beach to the berm. Here there is an offshore bar present on the terrace about 3 feet below the zero datum that grew larger over the past year.

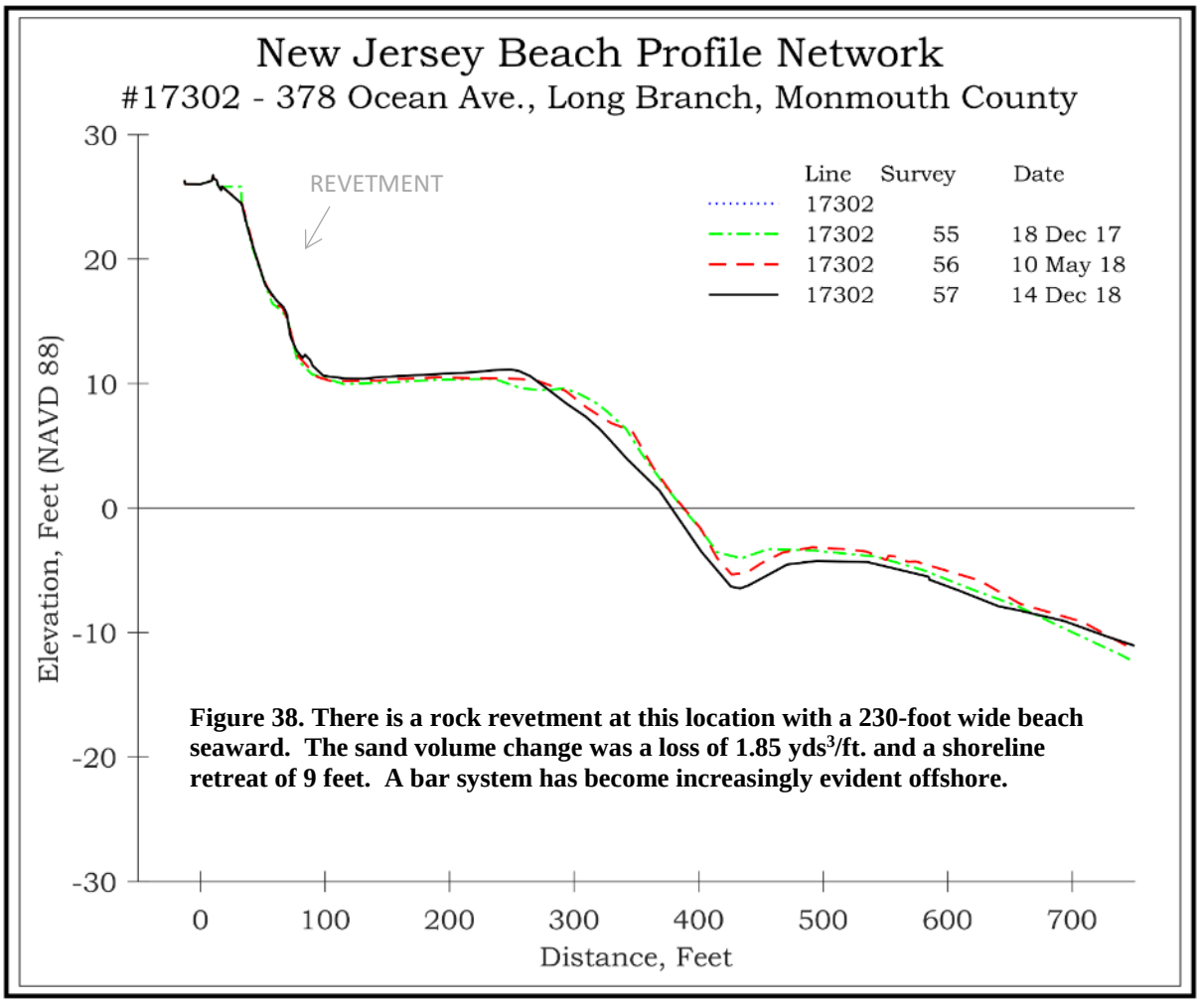


Figure 38. There is a rock revetment at this location with a 230-foot wide beach seaward. The sand volume change was a loss of 1.85 yds^3/ft. and a shoreline retreat of 9 feet. A bar system has become increasingly evident offshore.

NJBPN 17301 – Wooley Court, Long Branch

The rock revetment is followed by a 170-foot wide beach to the berm and a beachface slope to a terrace about 4 feet below the datum with a small bar present. Over the past year, this bar has grown larger.

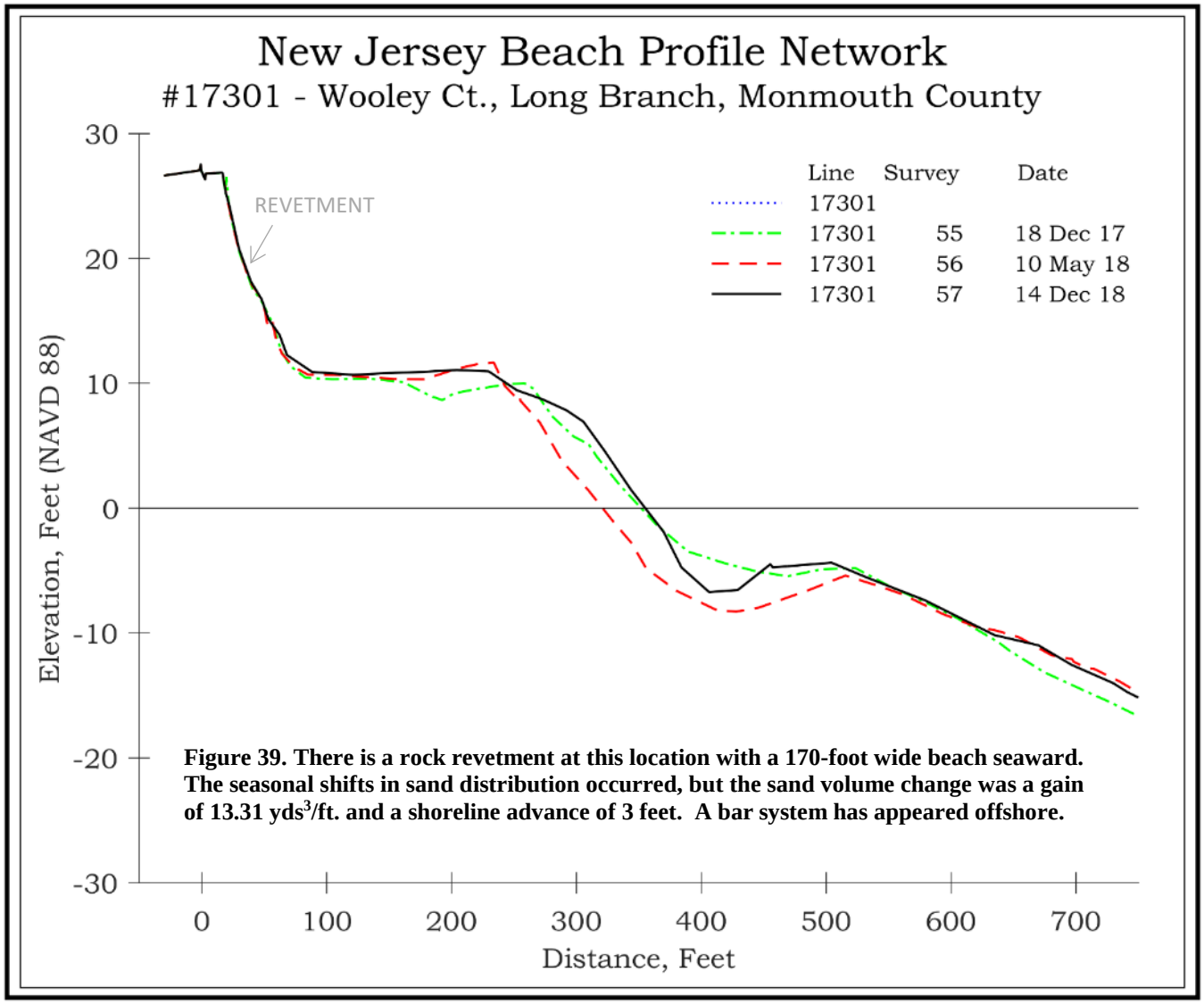


Figure 39. There is a rock revetment at this location with a 170-foot wide beach seaward. The seasonal shifts in sand distribution occurred, but the sand volume change was a gain of 13.31 yds^3/ft. and a shoreline advance of 3 feet. A bar system has appeared offshore.

NJBPN 173 – West End Avenue, Long Branch

This site was the southern location within Phase I of the federal project. By December 18, 2017 the scope of the additional sand placed as the third phase was completed is quite dramatic on the left. A year later on the right, the rock wall was partially buried in wind-transported sand and the beach remained at a 200-foot width.

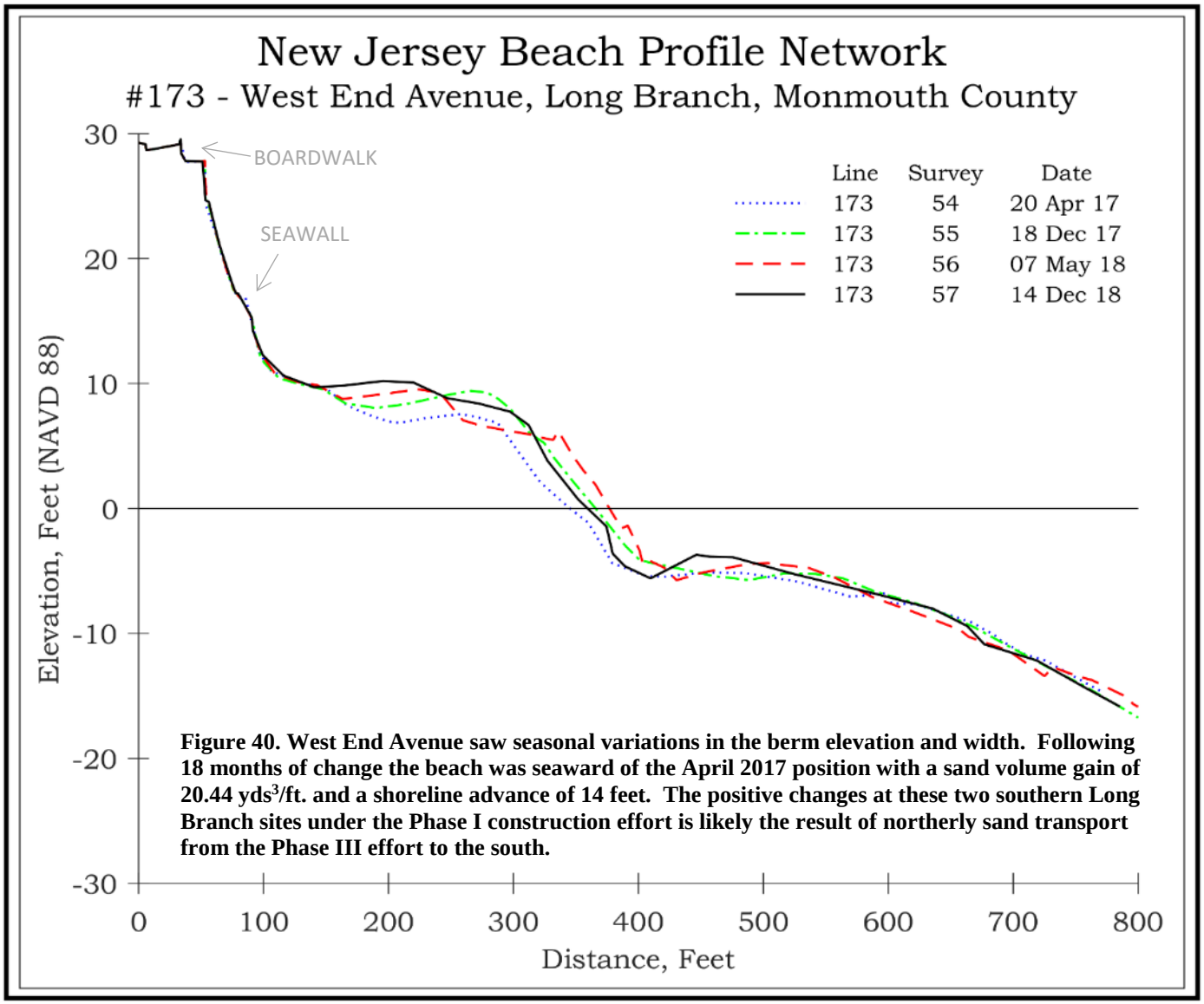


Figure 40. West End Avenue saw seasonal variations in the berm elevation and width. Following 18 months of change the beach was seaward of the April 2017 position with a sand volume gain of 20.44 yds^3/ft. and a shoreline advance of 14 feet. The positive changes at these two southern Long Branch sites under the Phase I construction effort is likely the result of northerly sand transport from the Phase III effort to the south.

NJBPN 27201 – 717 Ocean Avenue, Long Branch

Located in the northern limit for the Phase III USACE beach restoration project, this location starts at a bulkhead, then extends across 250 feet of elevation 10.0 beach to the berm crest. The 10.0-foot elevation represents the project design elevation for the berm. Berm retreat did occur as sand moved offshore to start a bar system.

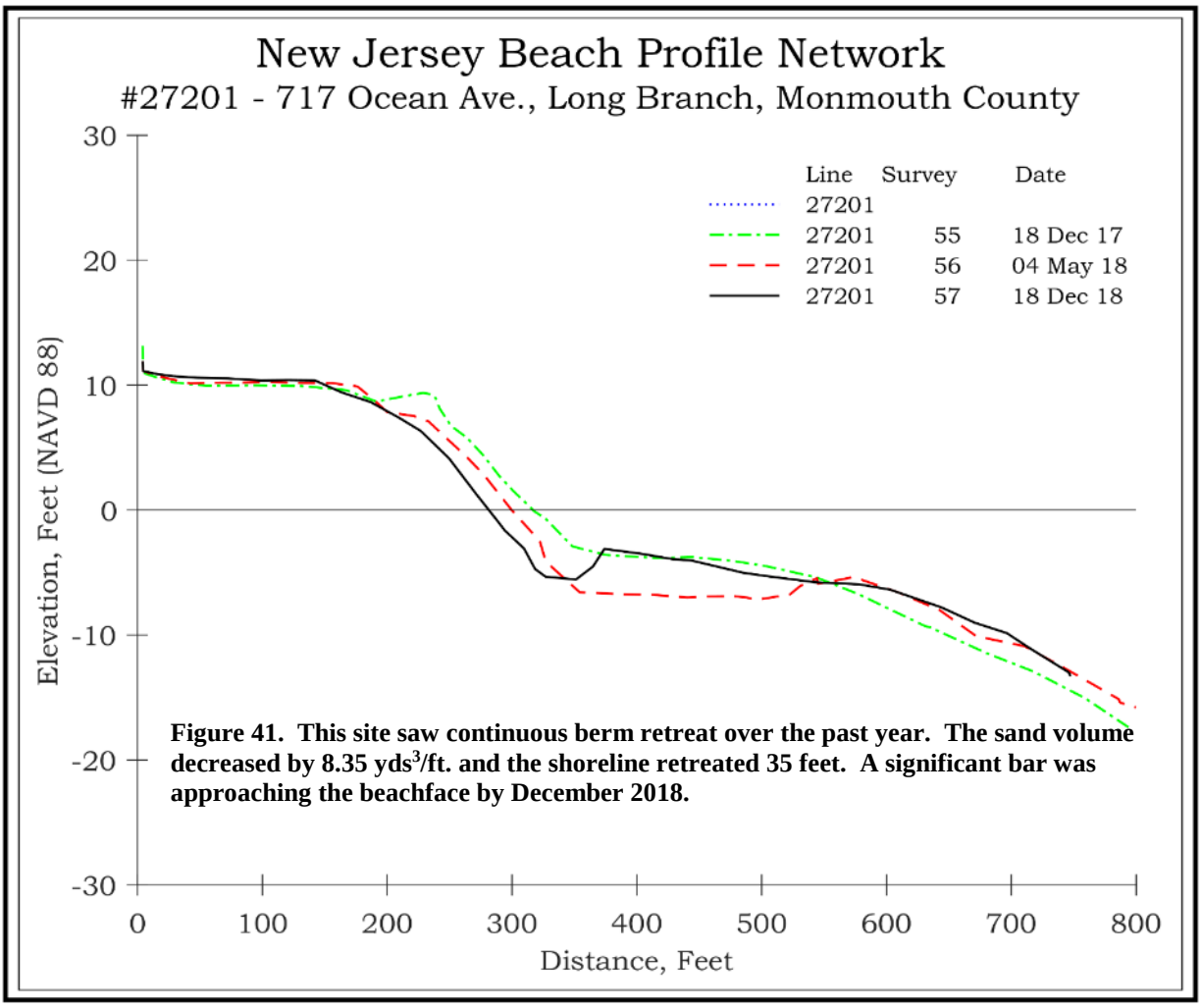


Figure 41. This site saw continuous berm retreat over the past year. The sand volume decreased by 8.35 yds^3/ft. and the shoreline retreated 35 feet. A significant bar was approaching the beachface by December 2018.

NJBPN 272 – 805 Ocean Ave, Long Branch

This site, established in 2010, is located on the northeastern edge of Lake Takanassee. The view to the left, taken December 12, 2017, shows the Phase III project as complete and the rock groin was buried in new material from offshore. Retreat at the berm was slow, but steady.

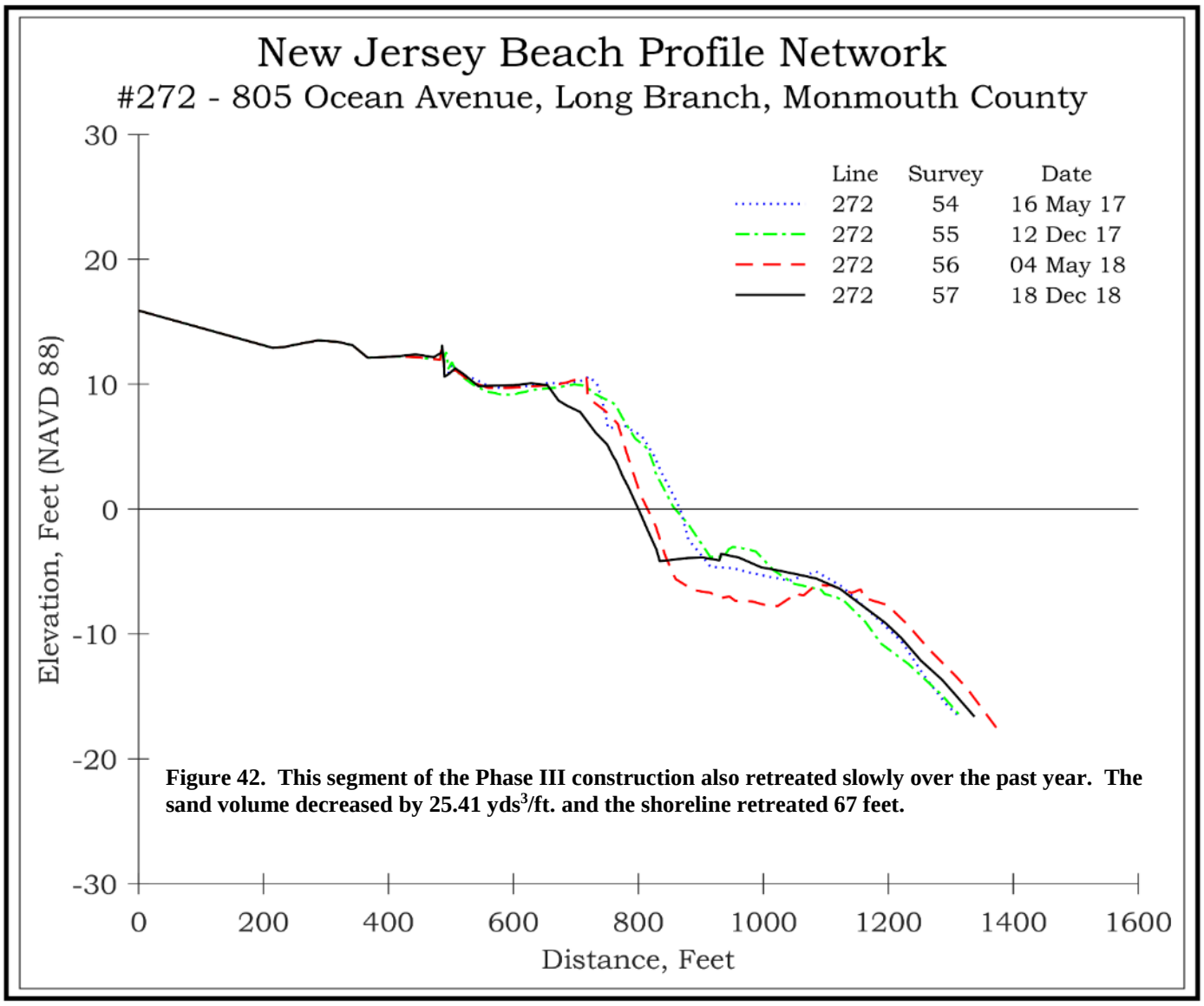


Figure 42. This segment of the Phase III construction also retreated slowly over the past year. The sand volume decreased by 25.41 yds^3/ft. and the shoreline retreated 67 feet.

NJBPN 17101 – Plaza Court, Long Branch

This site is located south of Lake Takanassee at a wide beach position south of the lake's freshwater exit flume structure. The beach was 190 feet wide at elevation 10.0 to the berm crest. A year later the beach slope starts at the bulkhead and drops into the water with the 10-foot elevation berm gone.

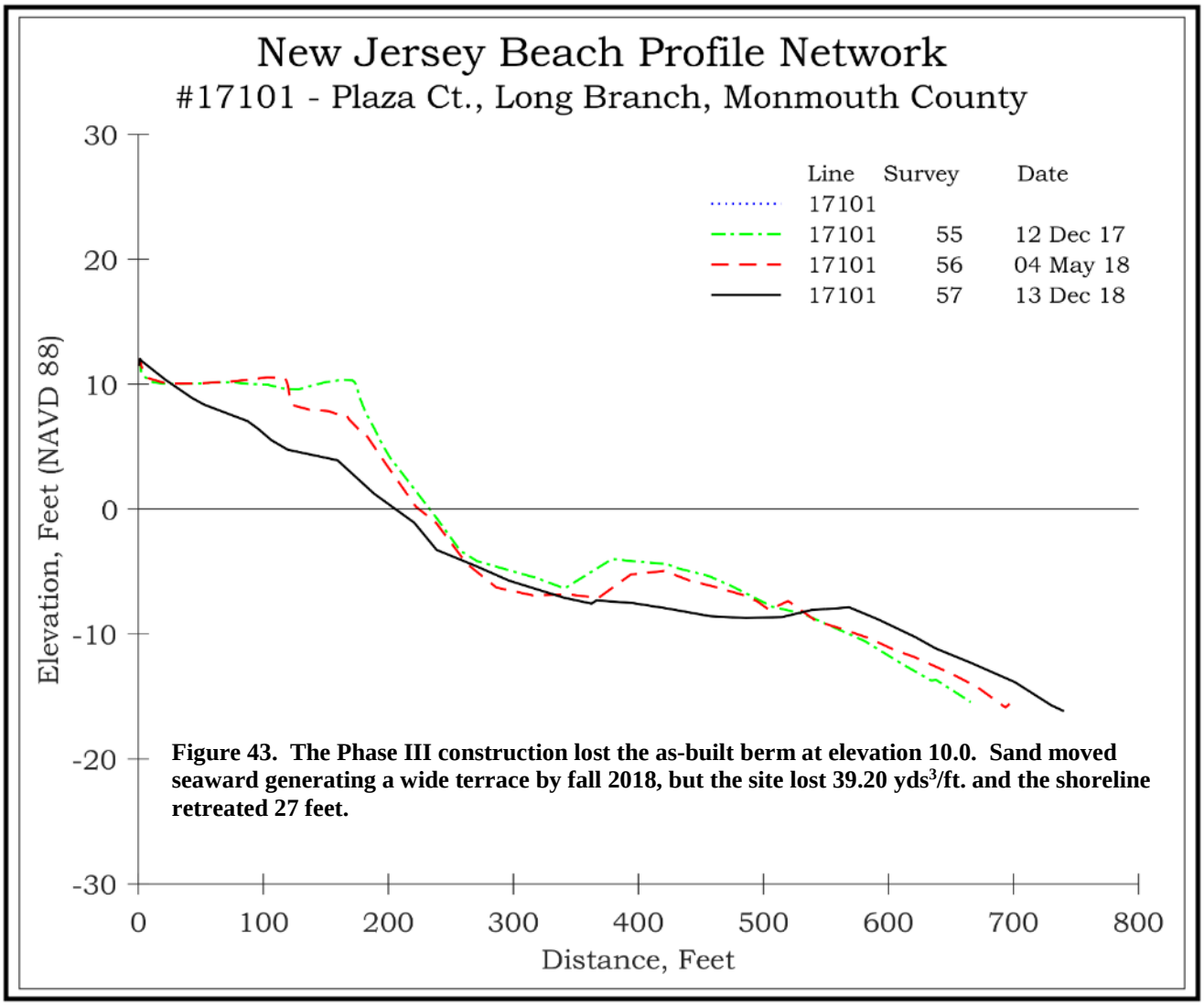


Figure 43. The Phase III construction lost the as-built berm at elevation 10.0. Sand moved seaward generating a wide terrace by fall 2018, but the site lost 39.20 yds^3/ft. and the shoreline retreated 27 feet.

NJBPN 171 – Pullman Avenue, Elberon

This site is located on the highest point along the bluff shoreline. The photo on the left (taken December 12, 2017) shows the new beach after some adjustment. The vertical bulkhead just shows to the right side. By December 2018 the four pilings and a rock that show on the left are part of a fully exposed groin with the bulkhead more extensively exposed as well.

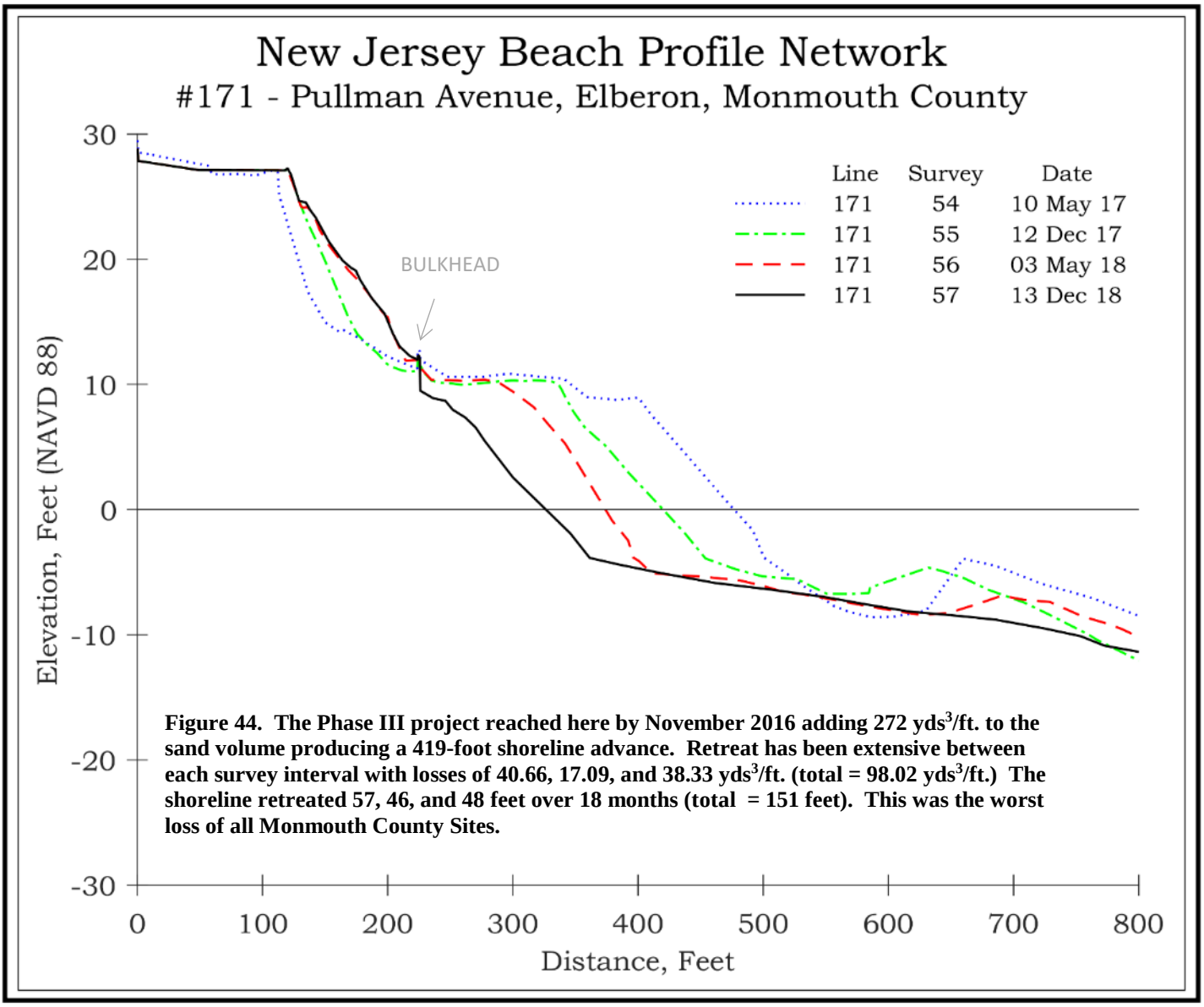


Figure 44. The Phase III project reached here by November 2016 adding 272 yds^3/ft. to the sand volume producing a 419-foot shoreline advance. Retreat has been extensive between each survey interval with losses of 40.66, 17.09, and 38.33 yds^3/ft. (total = 98.02 yds^3/ft.) The shoreline retreated 57, 46, and 48 feet over 18 months (total = 151 feet). This was the worst loss of all Monmouth County Sites.

NJBPN 177 – 981 Ocean Avenue, Long Branch

Located in the Elberon groin field, this location was completed during 2016 and clearly has adjusted with beach width reduction and sand deposited offshore in a very large bar system. The rocks above are now exposed.

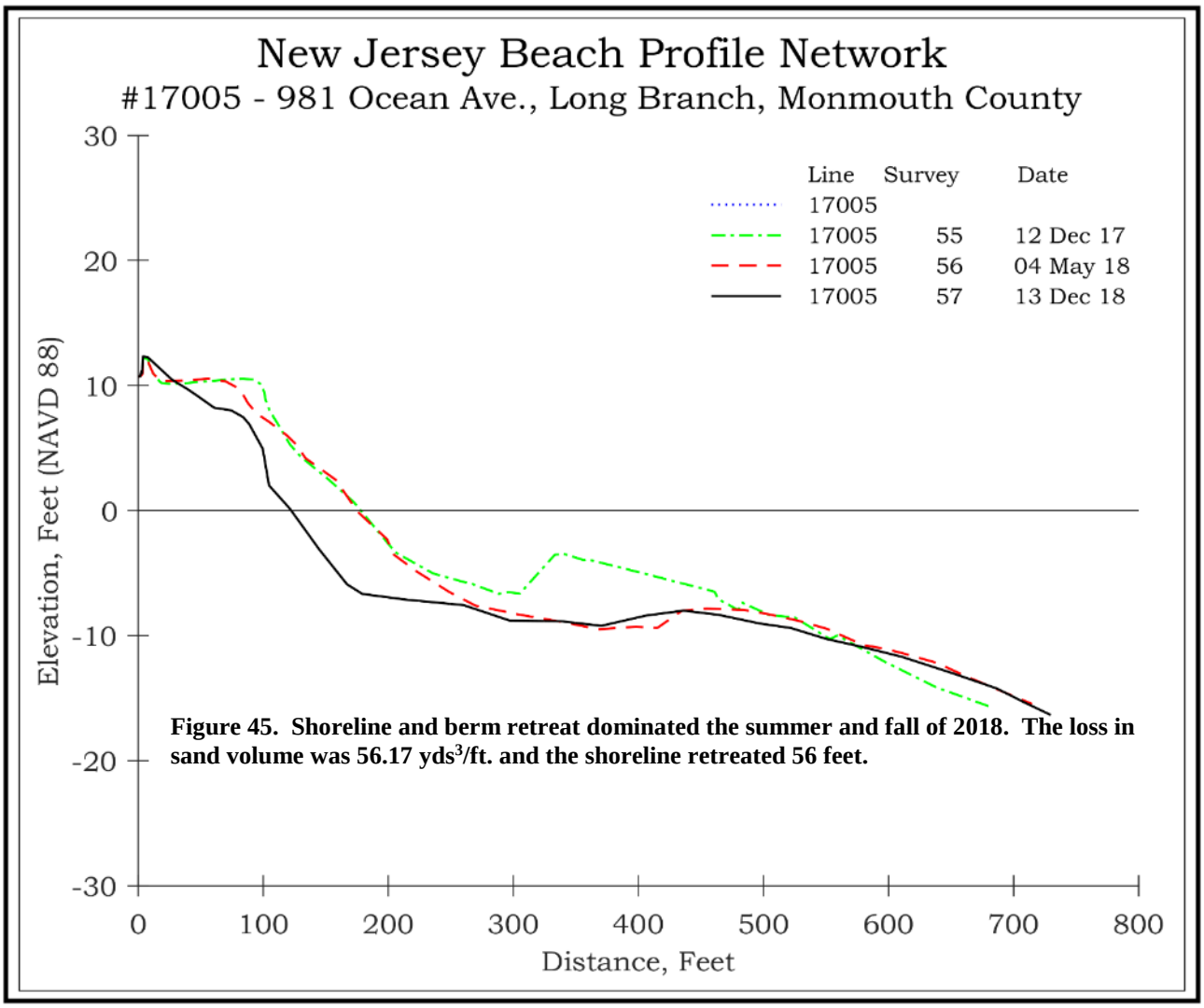


Figure 45. Shoreline and berm retreat dominated the summer and fall of 2018. The loss in sand volume was 56.17 yds^3/ft. and the shoreline retreated 56 feet.

NJBPN 17004 – 1115 Ocean Avenue, Long Branch

This location is also within the Elberon groin field. The beach is under 100 feet wide to the berm crest. The offshore terrace is 200 feet wide indicating considerable profile adjustment since 2016.

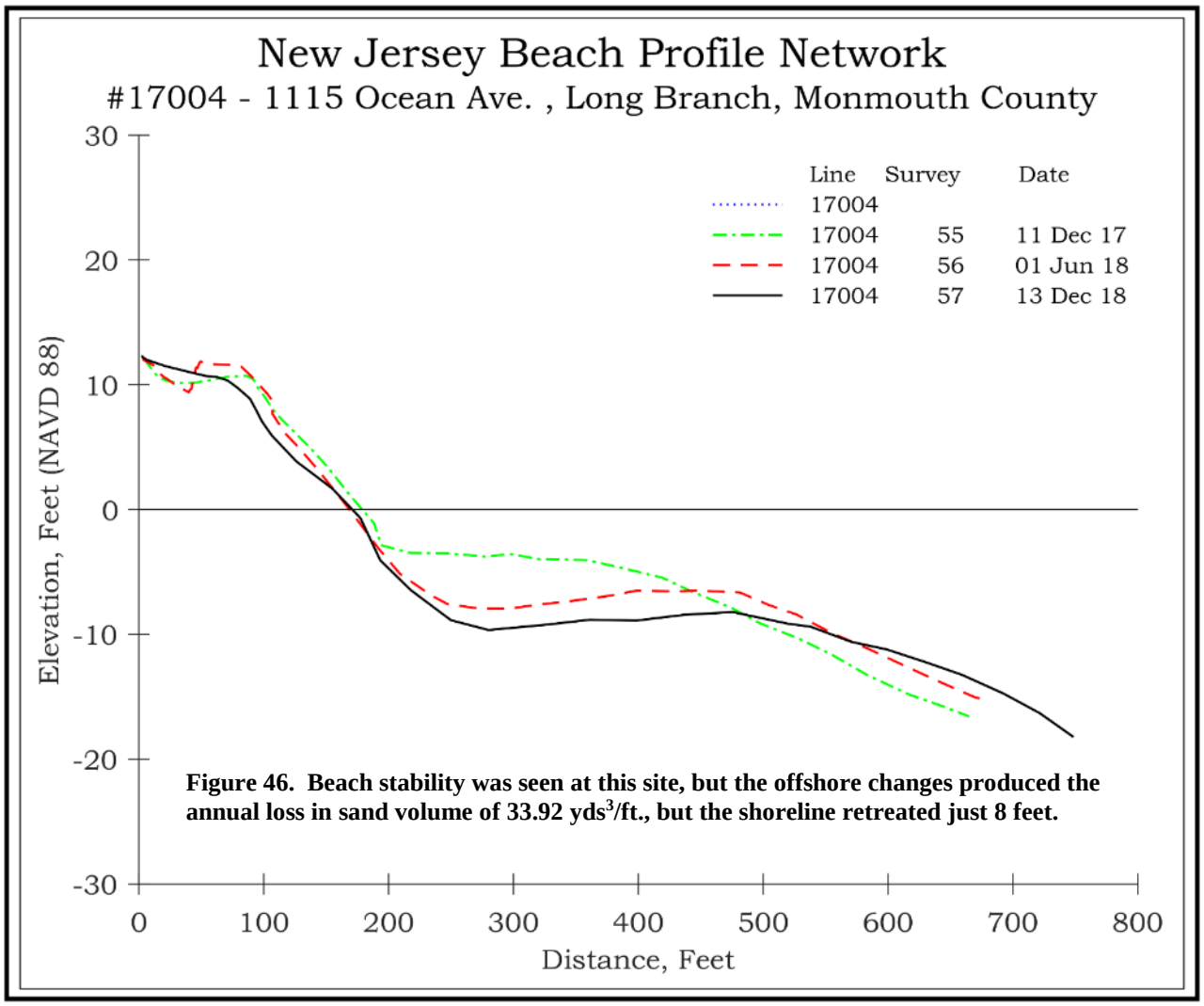


Figure 46. Beach stability was seen at this site, but the offshore changes produced the annual loss in sand volume of 33.92 yds^3/ft., but the shoreline retreated just 8 feet.

NJBPN 17003 – Ocean Court, Long Branch

This site retains a wide beach with a significantly built up berm leaving 260 feet of elevation 10.0-foot beach remaining. The bar system offshore has been present since the initial survey. There are no dunes along this Elberon bluff segment.

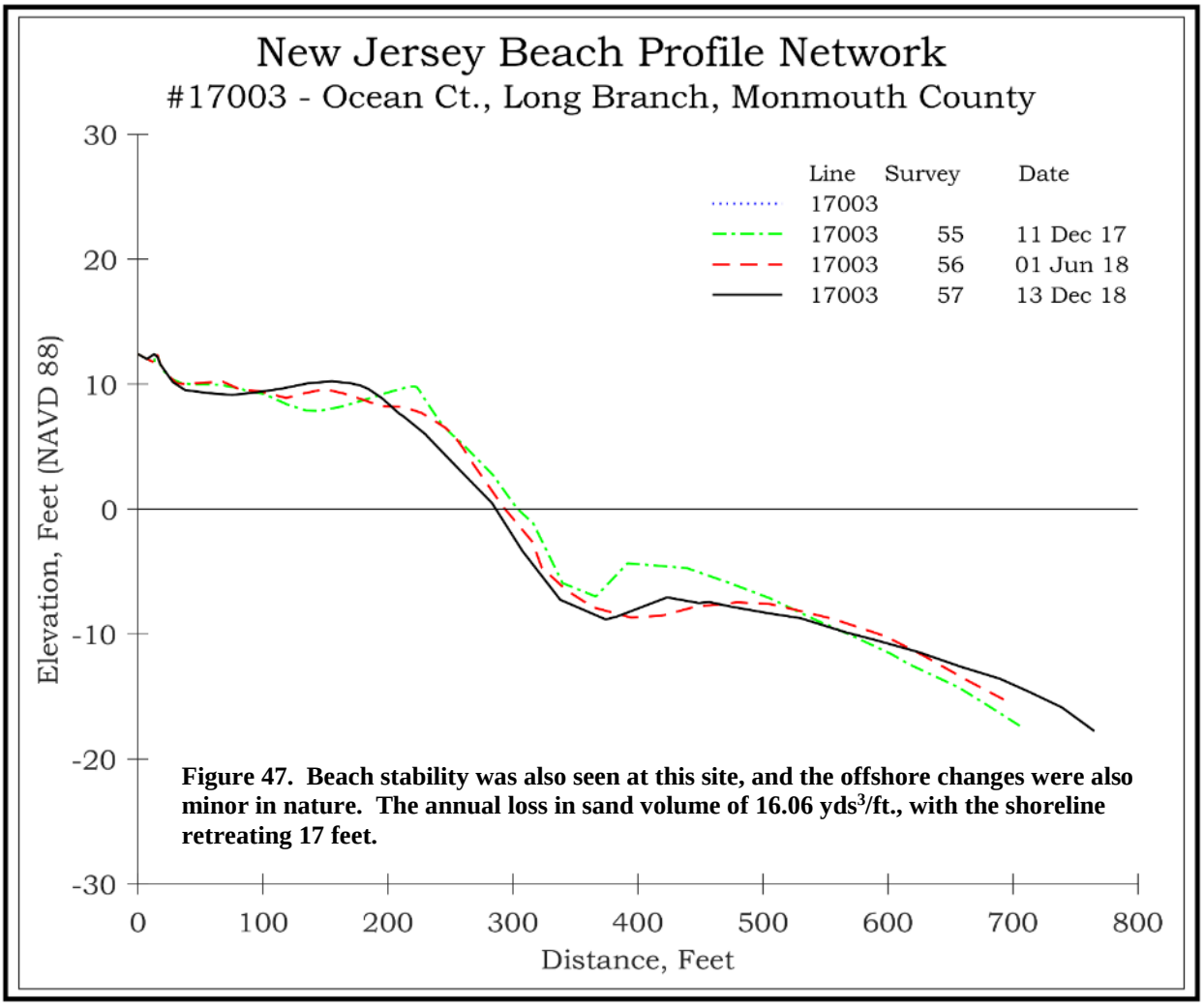


Figure 47. Beach stability was also seen at this site, and the offshore changes were also minor in nature. The annual loss in sand volume of 16.06 yds^3/ft., with the shoreline retreating 17 feet.

NJBPN 17002 – Garfield Road, Long Branch

The beach width is just over 200 feet at elevation 10.0 with a build up on the berm crest from wave up-rush. Offshore a terrace with a small bar present deepened into a trough with a wider bar system by fall 2018.

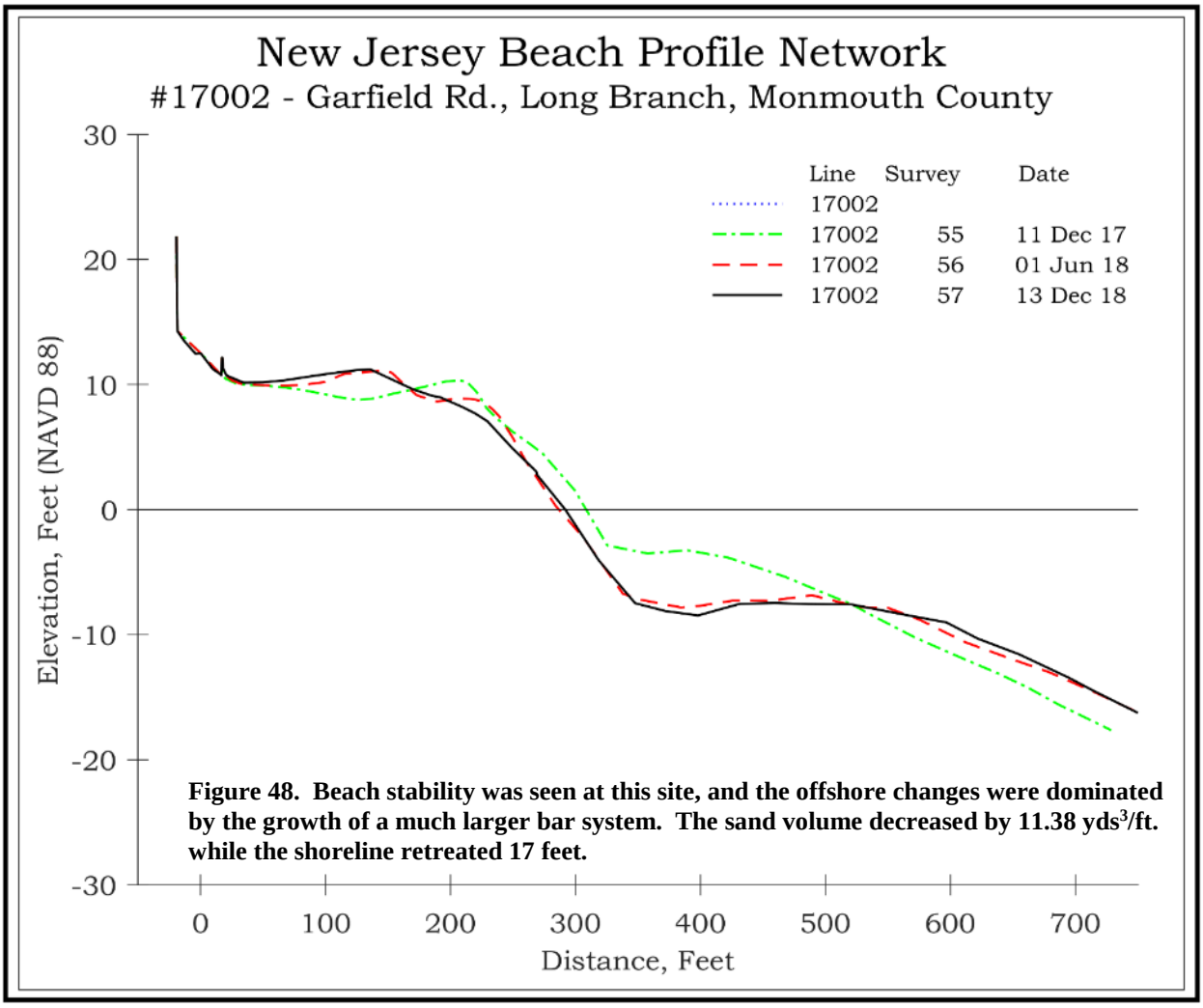
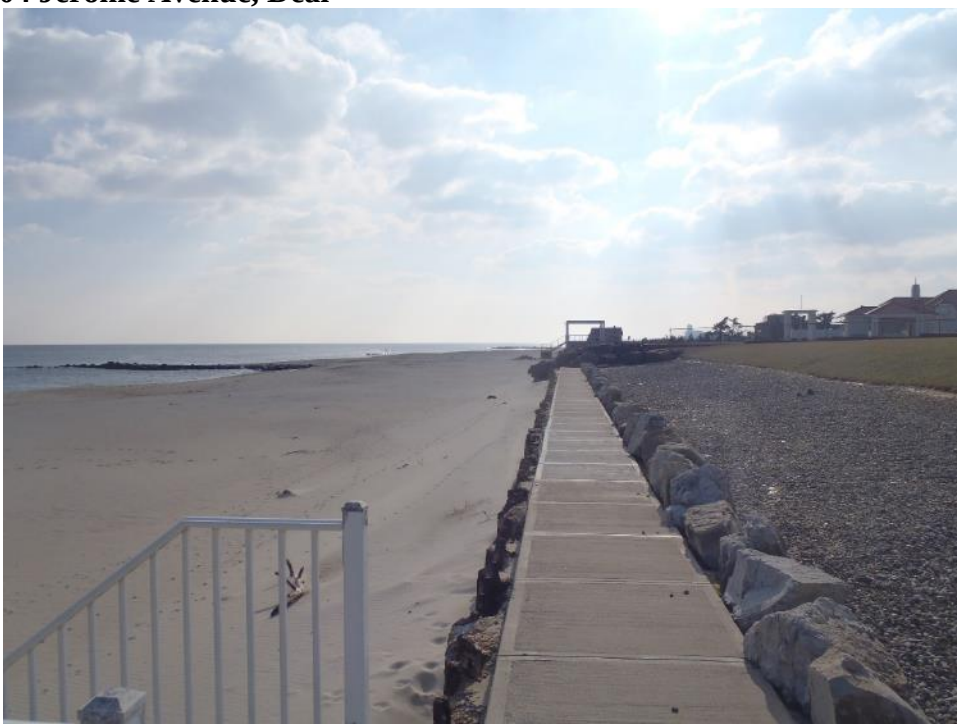


Figure 48. Beach stability was seen at this site, and the offshore changes were dominated by the growth of a much larger bar system. The sand volume decreased by 11.38 yds^3/ft. while the shoreline retreated 17 feet.

NJBPN 17001 – 404 Jerome Avenue, Deal



The survey shows a 200-foot wide beach with a small terrace offshore, no dune and some readjustment in the cross section since the fill was complete. Most change occurred in the berm and with bar migration offshore.

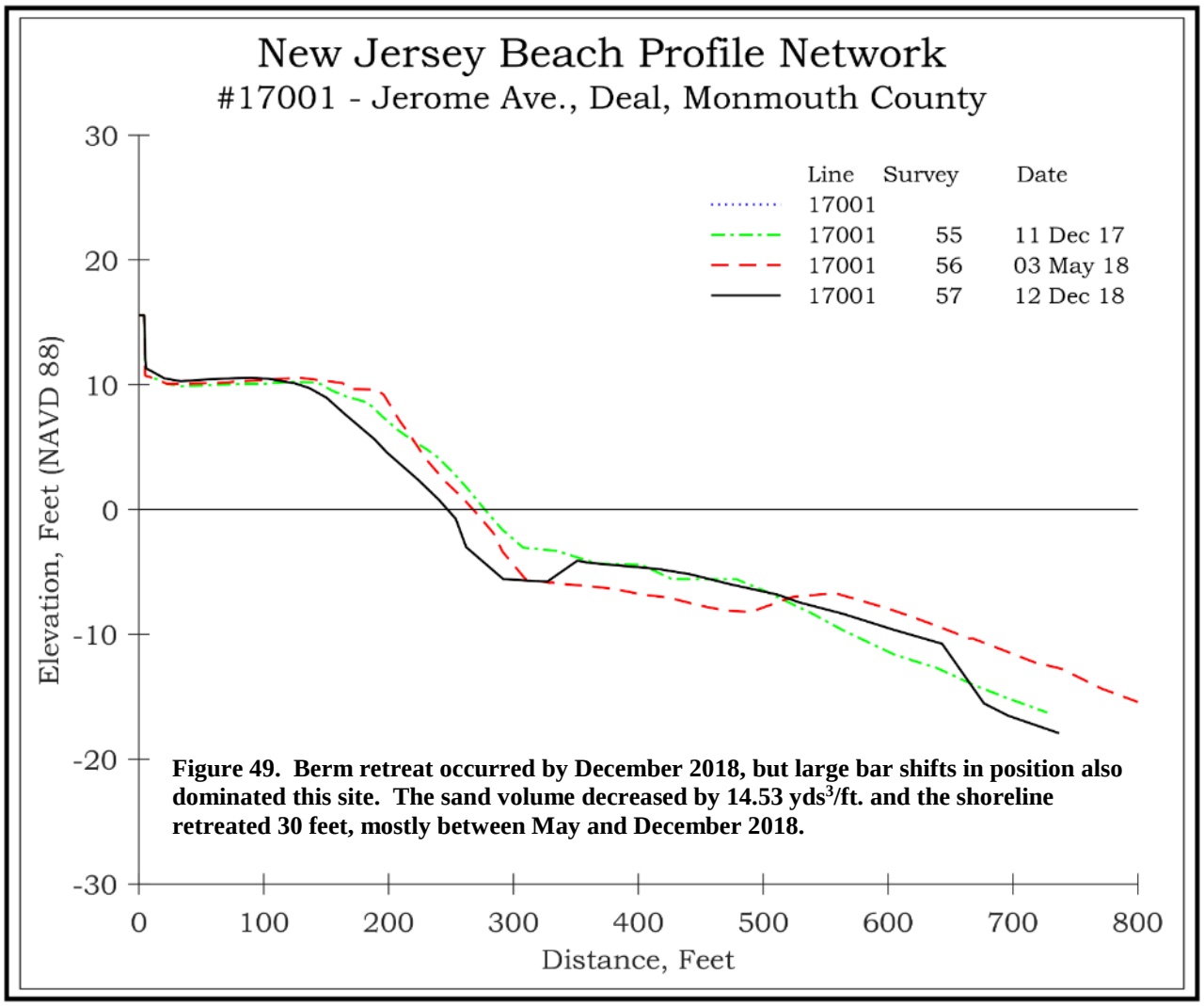


Figure 49. Berm retreat occurred by December 2018, but large bar shifts in position also dominated this site. The sand volume decreased by 14.53 yds^3/ft. and the shoreline retreated 30 feet, mostly between May and December 2018.

NJBPN 170 – Roosevelt Avenue, Deal

By December 11, 2017 (left), the project was complete and the beach had adjusted to the configuration shown below in the plots. The berm at elevation 10.0 remained close to the May 2017 position, but large changes took place offshore.

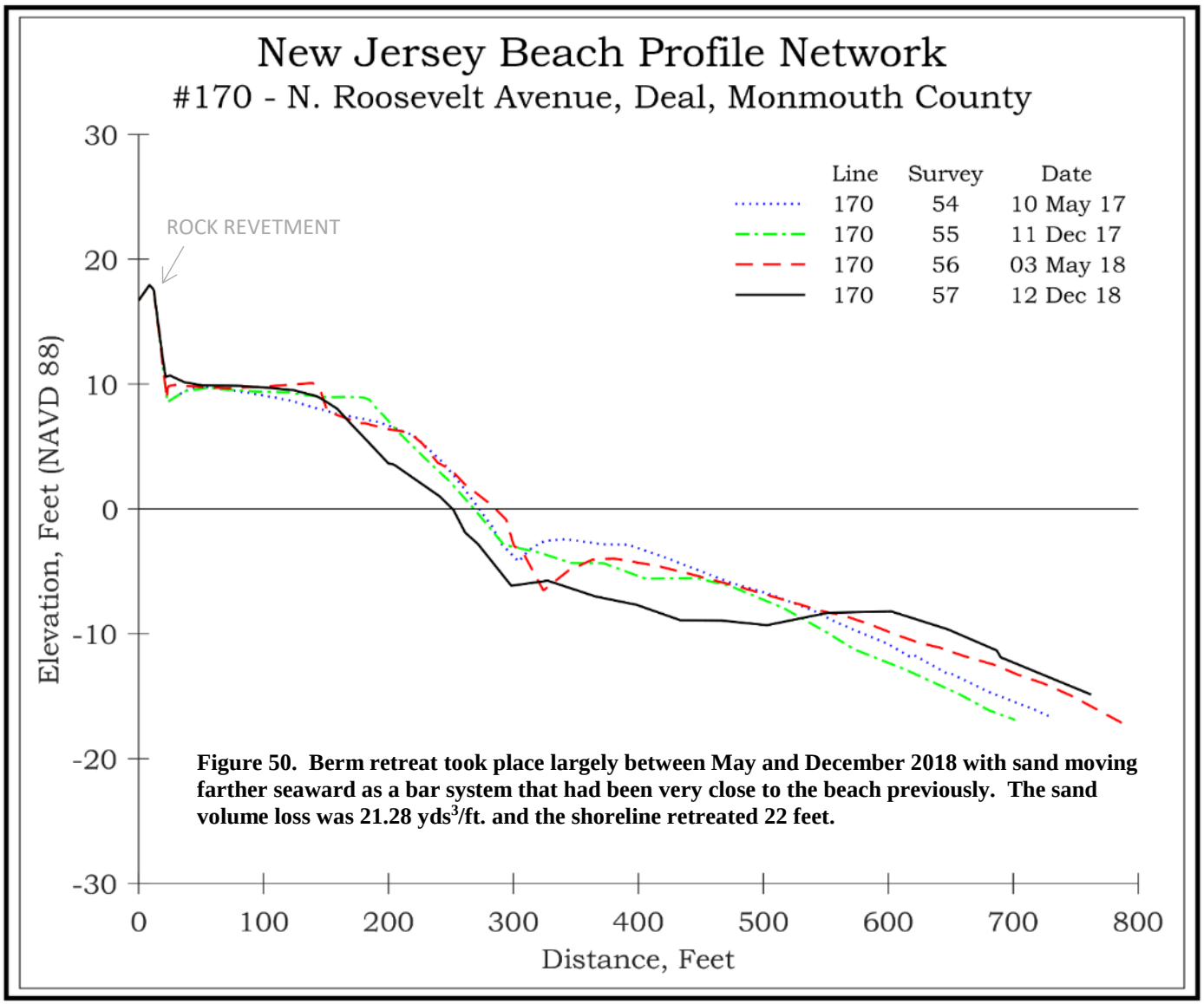
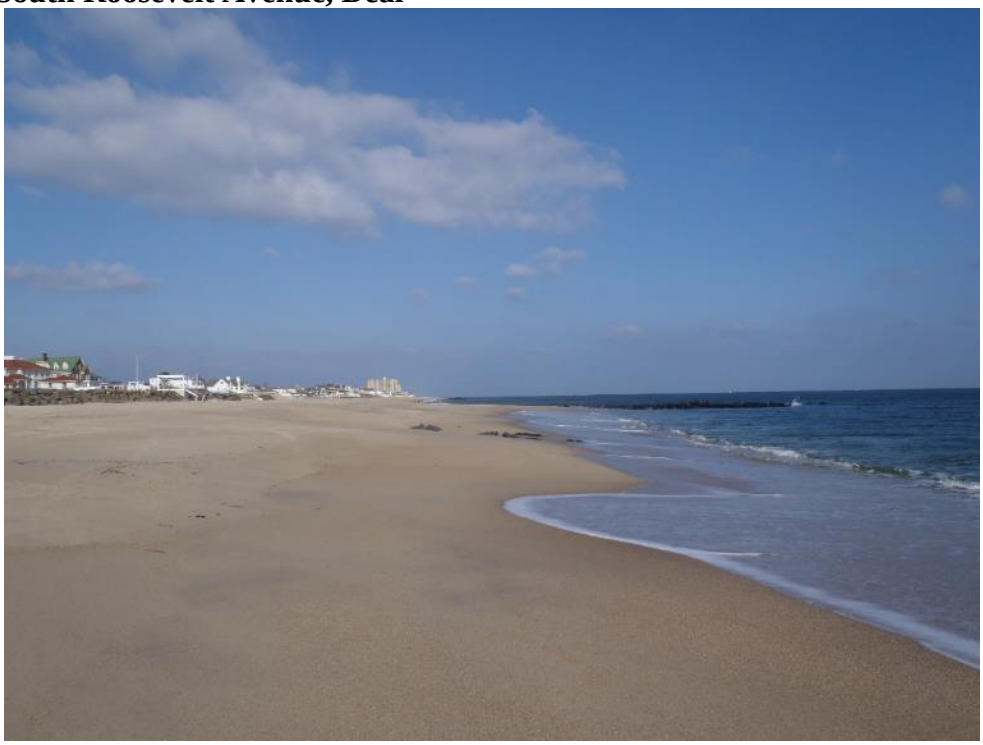


Figure 50. Berm retreat took place largely between May and December 2018 with sand moving farther seaward as a bar system that had been very close to the beach previously. The sand volume loss was 21.28 yds^3/ft. and the shoreline retreated 22 feet.

NJBPN 16905 – South Roosevelt Avenue, Deal



This new site is just south of Roosevelt Avenue in Deal. The beach is 200 feet wide without any offshore terrace or bar system. There is an old dune ridge present that extends south from the Roosevelt Avenue pumping station.

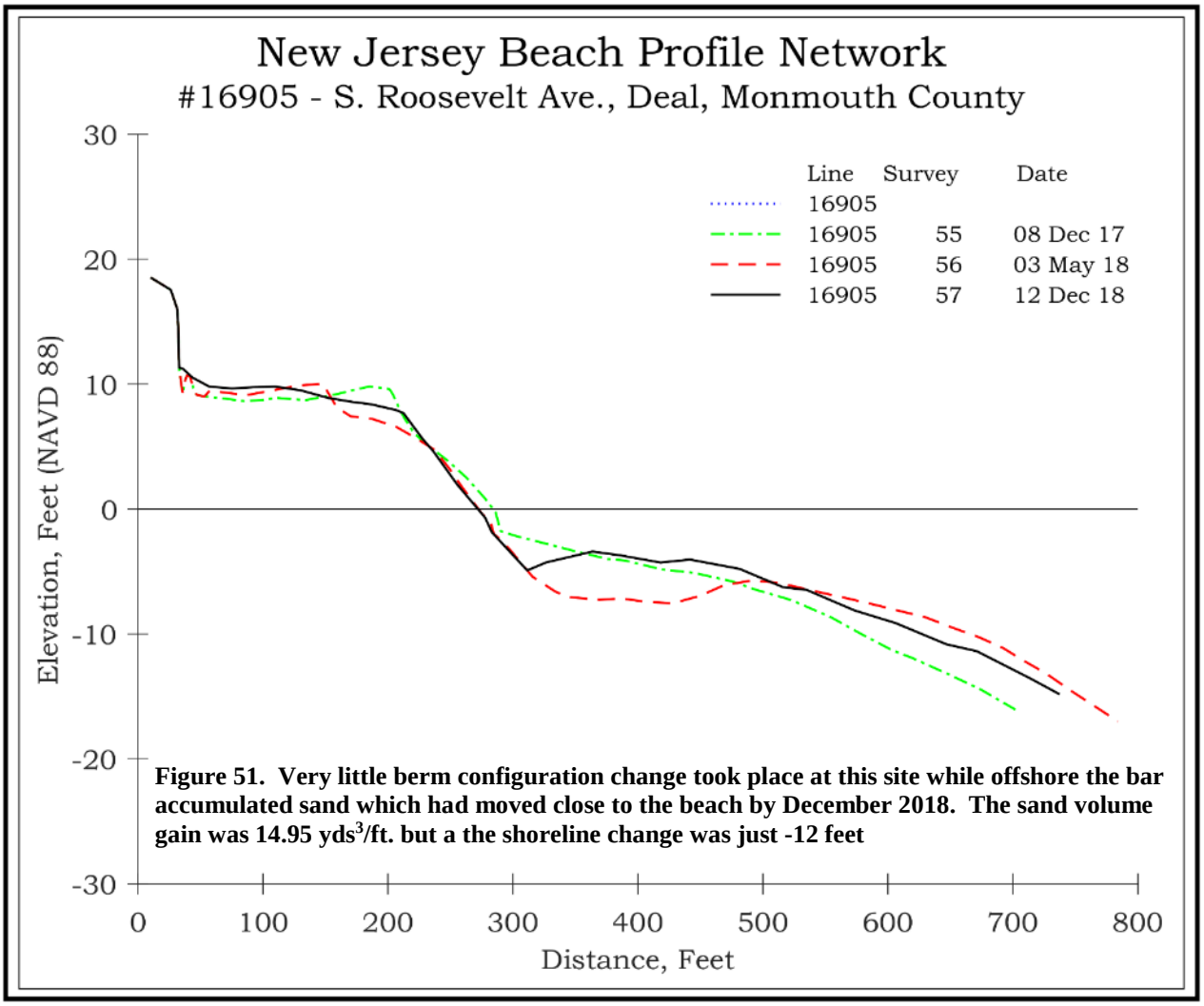


Figure 51. Very little berm configuration change took place at this site while offshore the bar accumulated sand which had moved close to the beach by December 2018. The sand volume gain was 14.95 yds^3/ft. but a the shoreline change was just -12 feet

NJBPN 16904 – 71 Ocean Avenue, Deal

Located south of Poplar Brook, this site has a mounded berm indicating post-construction adjustment. The offshore section has a very small bar system, but little accumulation of material

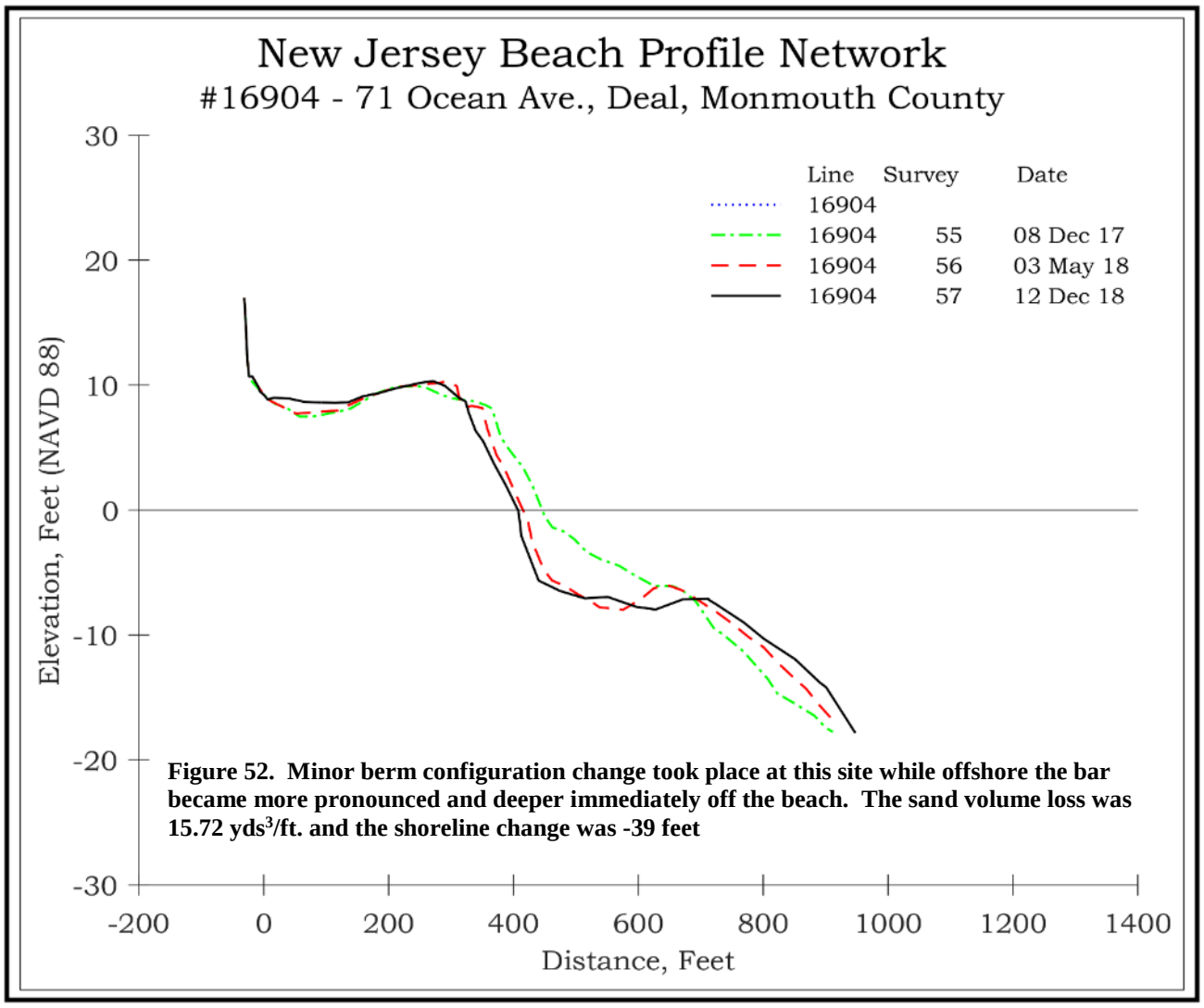


Figure 52. Minor berm configuration change took place at this site while offshore the bar became more pronounced and deeper immediately off the beach. The sand volume loss was 15.72 yds^3/ft. and the shoreline change was -39 feet

NJBPN 16903 – Ocean Lane, Deal

This site is in proximity to Phillips Avenue bathing pavillion, severely damaged by Hurricane Sandy. The site has a 220-foot wide beach and a minor bar system offshore. An old dune system dating back to the 19th Century is the profile starting point. The sand ridge was pushed up to protect the new Phillips Ave. pavillion.

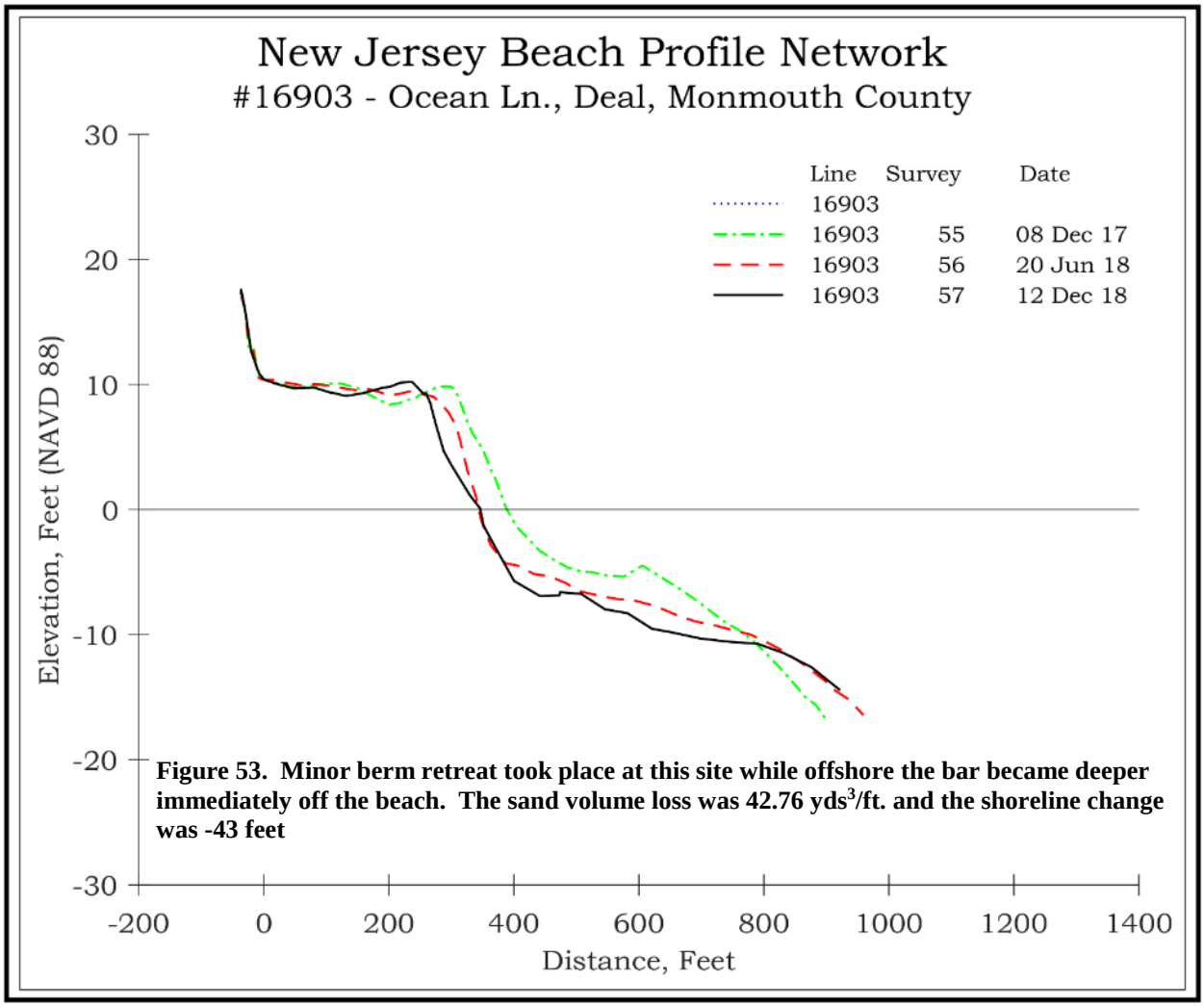


Figure 53. Minor berm retreat took place at this site while offshore the bar became deeper immediately off the beach. The sand volume loss was 42.76 yds^3/ft. and the shoreline change was -43 feet

NJBPN 16902 – Brighton Avenue, Deal

The Deal Casino bathing complex is the site of this cross section. The extensive disturbance seen December 2018 was to create a sand ridge on the beach for storm defense this winter. A small dune is present near the property fenceline as well as an offshore bar as a minor feature.

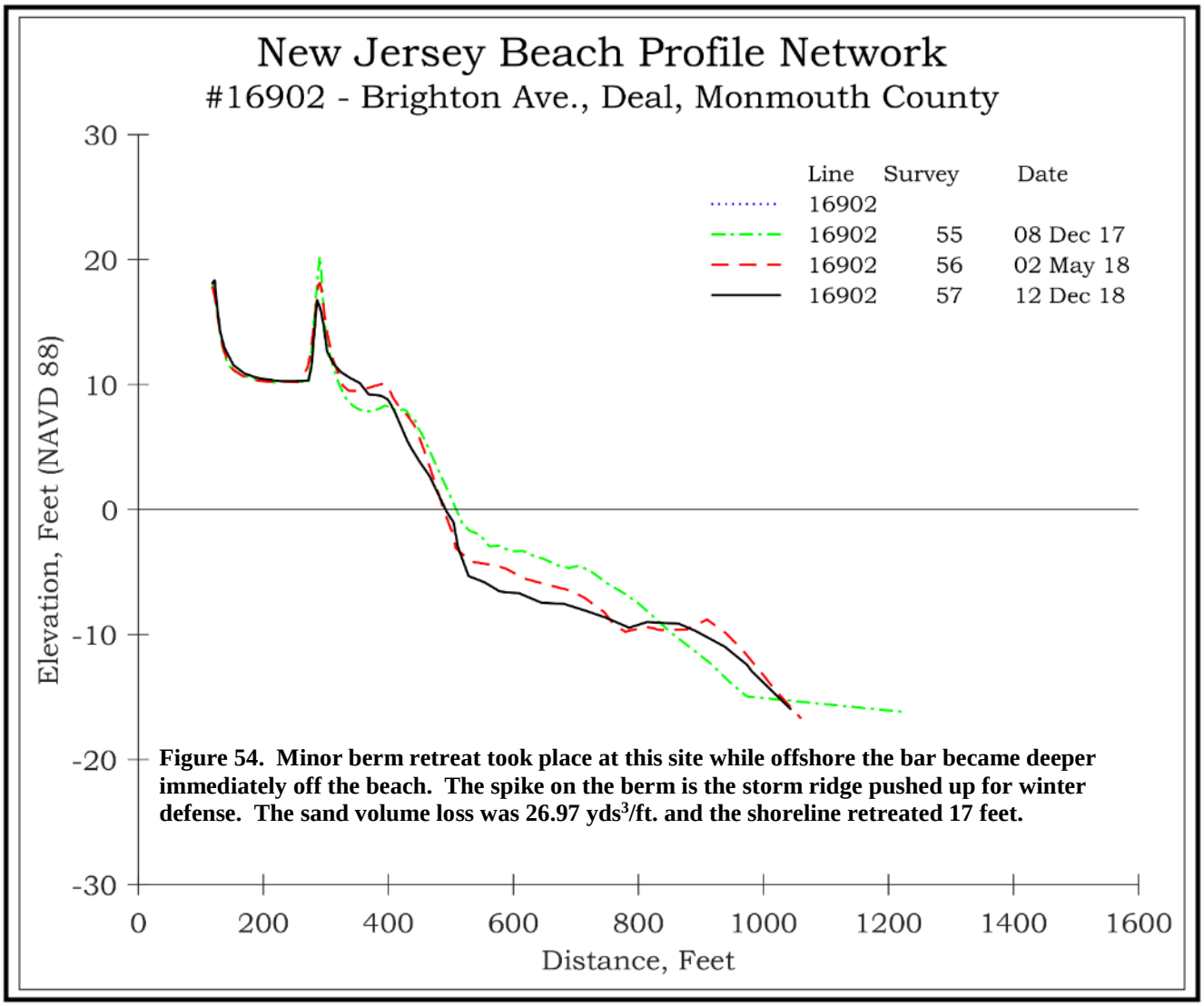


Figure 54. Minor berm retreat took place at this site while offshore the bar became deeper immediately off the beach. The spike on the berm is the storm ridge pushed up for winter defense. The sand volume loss was 26.97 yds^3/ft. and the shoreline retreated 17 feet.

NJBPN 16901 – Wallace Road, Deal

This site is located on the boundary between the bathing complex and private homes which extend south of the location. This beach abuts the sedimentary bluff without a dune present. The Phase III beach remains 200 feet wide with a terrace offshore, but no bar complex present as of December 2018.

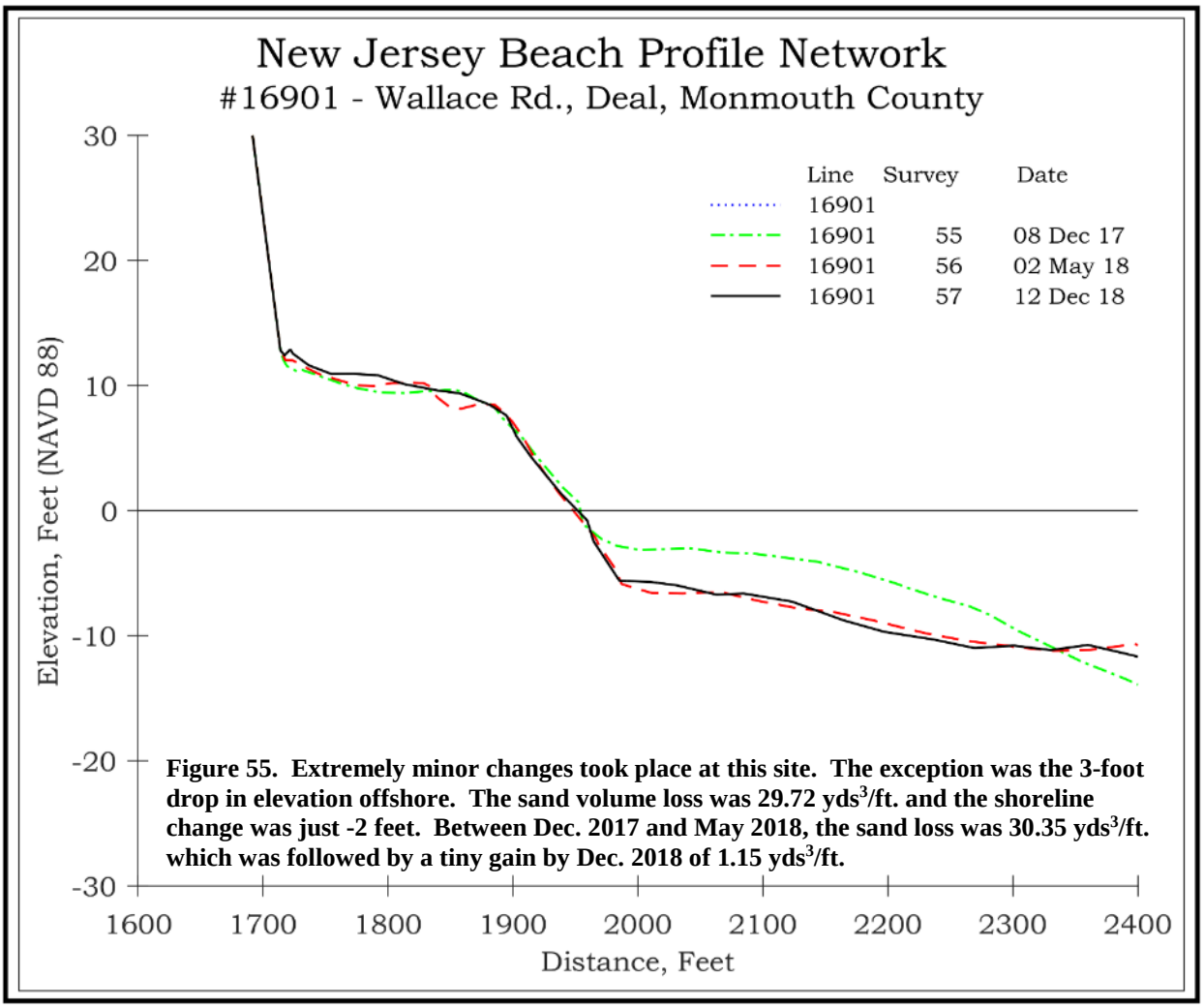
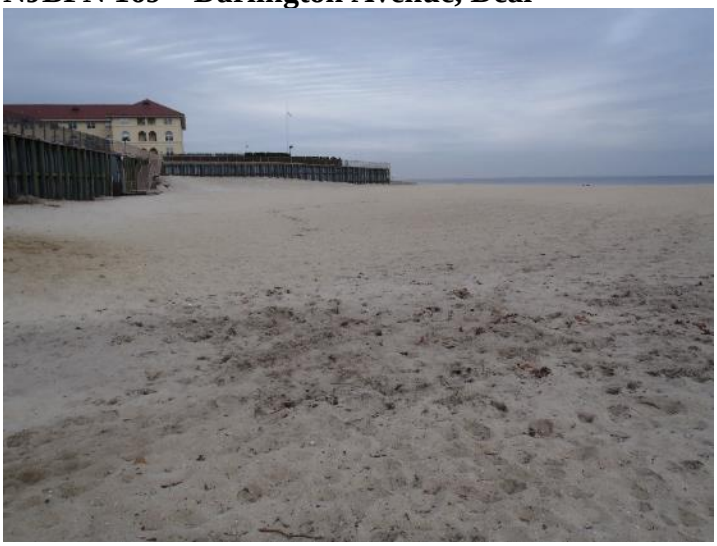


Figure 55. Extremely minor changes took place at this site. The exception was the 3-foot drop in elevation offshore. The sand volume loss was 29.72 yds^3/ft. and the shoreline change was just -2 feet. Between Dec. 2017 and May 2018, the sand loss was 30.35 yds^3/ft. which was followed by a tiny gain by Dec. 2018 of 1.15 yds^3/ft.

NJBPN 169 – Darlington Avenue, Deal



The Darlington site has maintained the as-built width quite well. Completed early during Phase III, there is a wide beach with a berm extending 340 feet beyond the bluff. The bluff is once again protected behind new timber bulkheads.

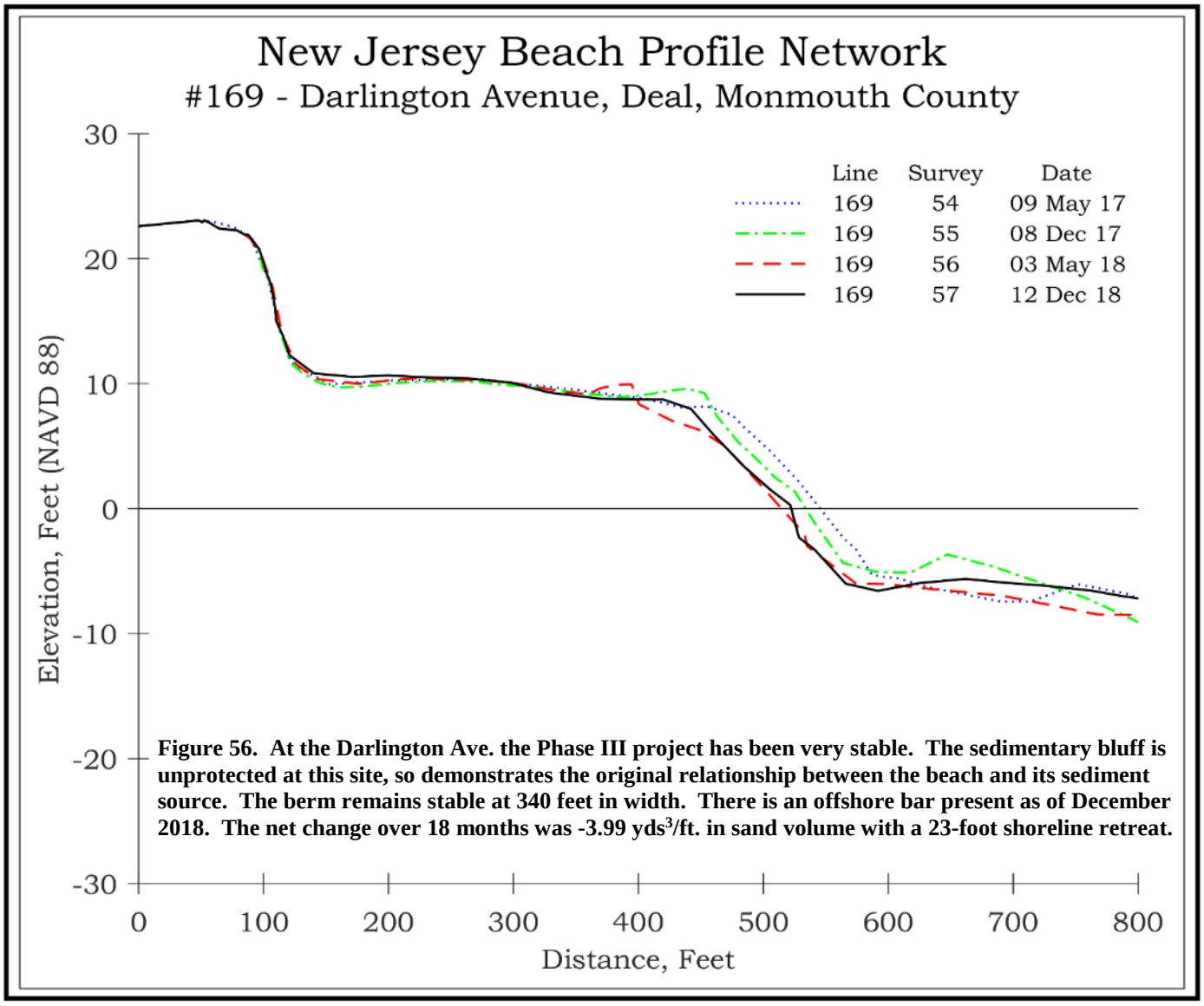


Figure 56. At the Darlington Ave. the Phase III project has been very stable. The sedimentary bluff is unprotected at this site, so demonstrates the original relationship between the beach and its sediment source. The berm remains stable at 340 feet in width. There is an offshore bar present as of December 2018. The net change over 18 months was -3.99 yds^3/ft. in sand volume with a 23-foot shoreline retreat.

NJBPN 16802 – Monmouth Drive, Deal

This site fronts a private home at the bluff. No dune exists and the beach measured 150 feet wide. There was no offshore terrace or bar system developed until December 2018.

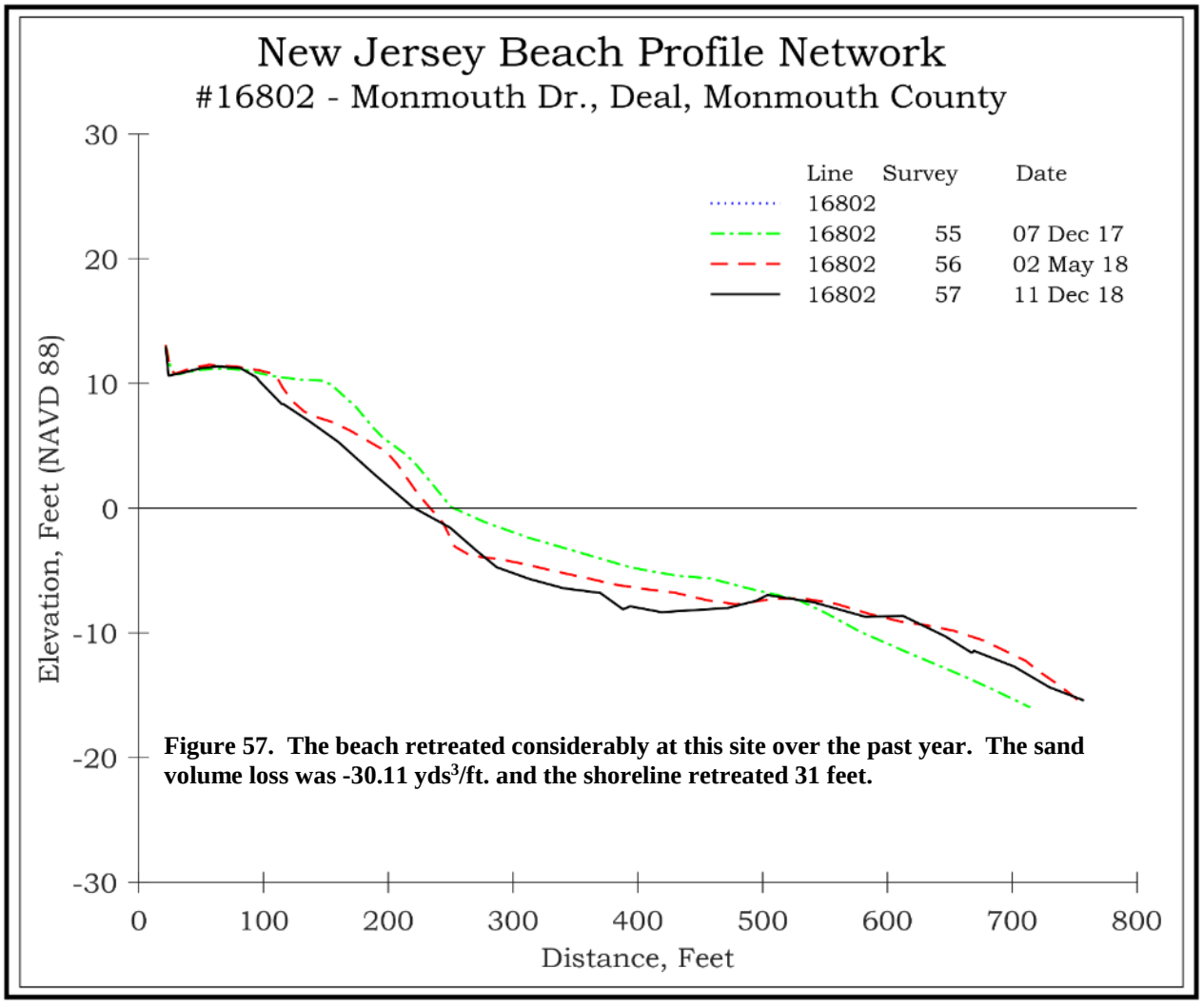


Figure 57. The beach retreated considerably at this site over the past year. The sand volume loss was -30.11 yds^3/ft. and the shoreline retreated 31 feet.

NJBPN 16801 – Neptune Avenue, Deal

This is the southernmost site in Deal with the bluff protected by armor stone. The beach has retreated this year, post project with about 70 feet of the 10.0-foot elevation berm remaining. The beachface slopes seaward and intersects a low gradient terrace offshore.

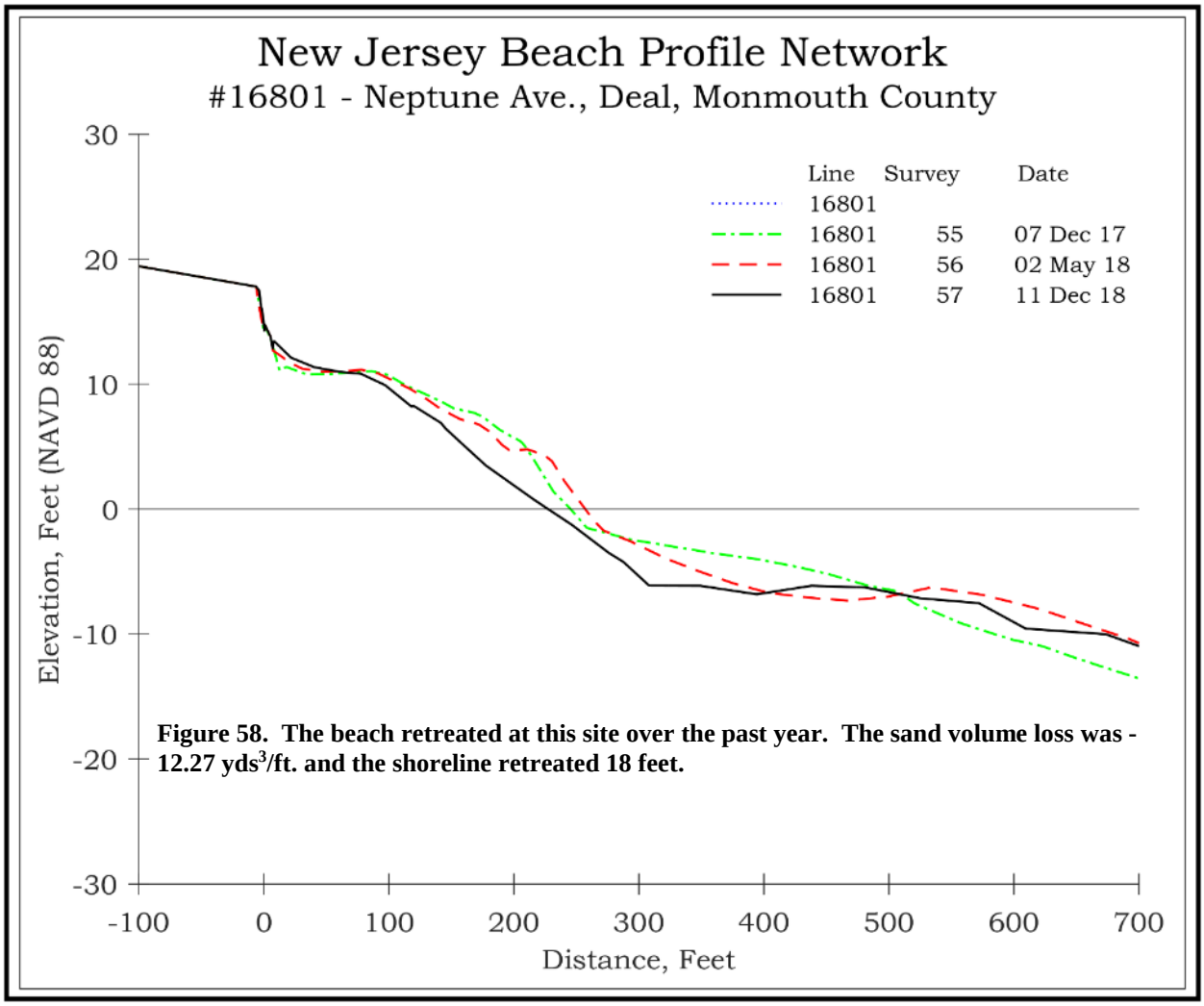


Figure 58. The beach retreated at this site over the past year. The sand volume loss was -12.27 yds^3/ft. and the shoreline retreated 18 feet.

NJBPN 168 – Corlies Avenue, Allenhurst

This site in Allenhurst was the starting point for Phase III USACE work in 2015. The left side view (Dec. 7, 2017) to the south includes Loch Arbor and in the distance, Asbury Park. Both views from the top of the old concrete seawall show the storm ridge pushed up to mitigate wave damage as of December 11, 2018.

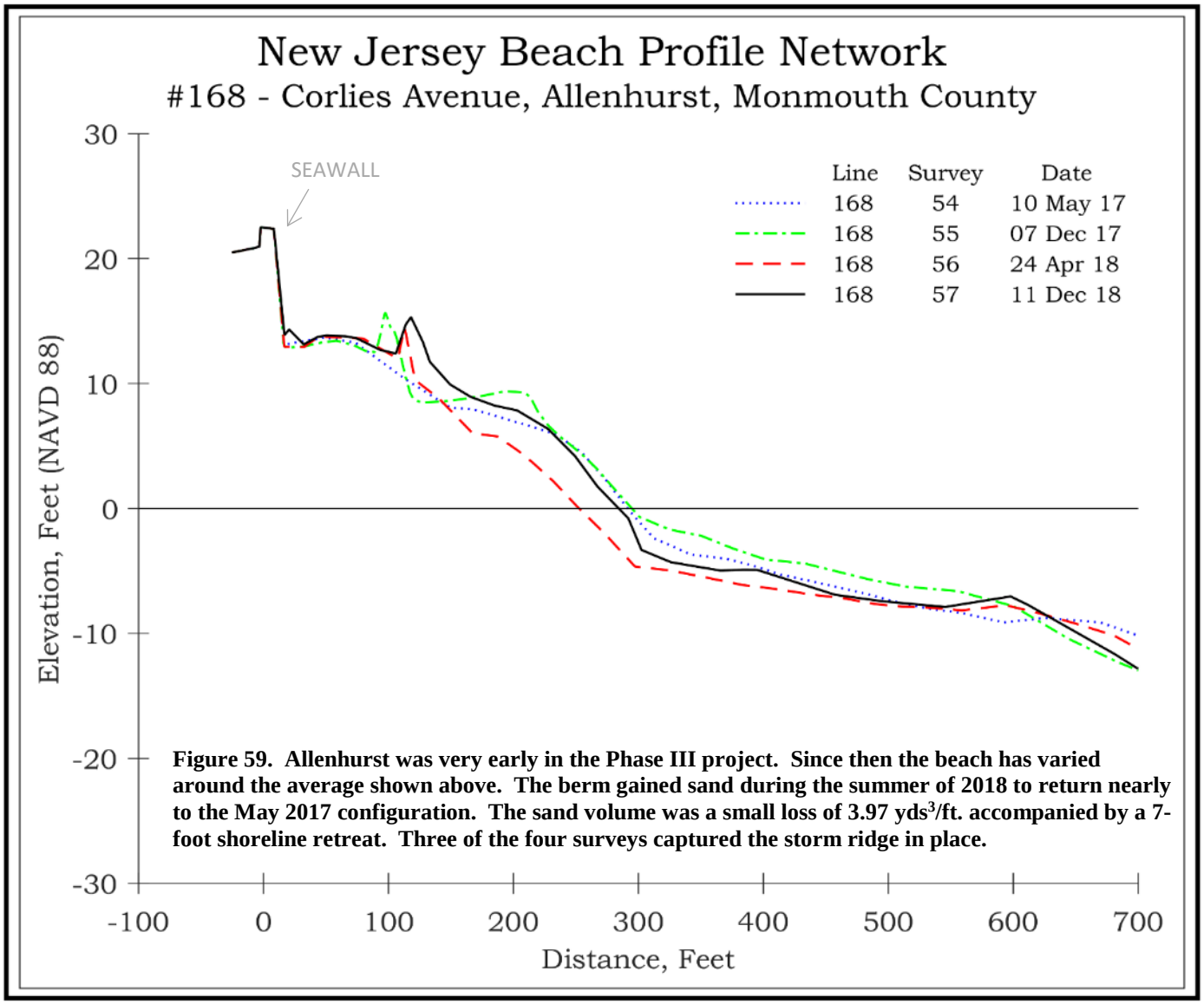


Figure 59. Allenhurst was very early in the Phase III project. Since then the beach has varied around the average shown above. The berm gained sand during the summer of 2018 to return nearly to the May 2017 configuration. The sand volume was a small loss of 3.97 yds^3/ft. accompanied by a 7-foot shoreline retreat. Three of the four surveys captured the storm ridge in place.

NJBPN 26703 – Euclid Avenue, Loch Arbor

This site is located on the public half of the Loch Arbor shoreline with a beach that has narrowed considerably since the Phase III construction project started in the spring of 2016. The low gradient terrace offshore evolved into a bar system by Dec. 2018.

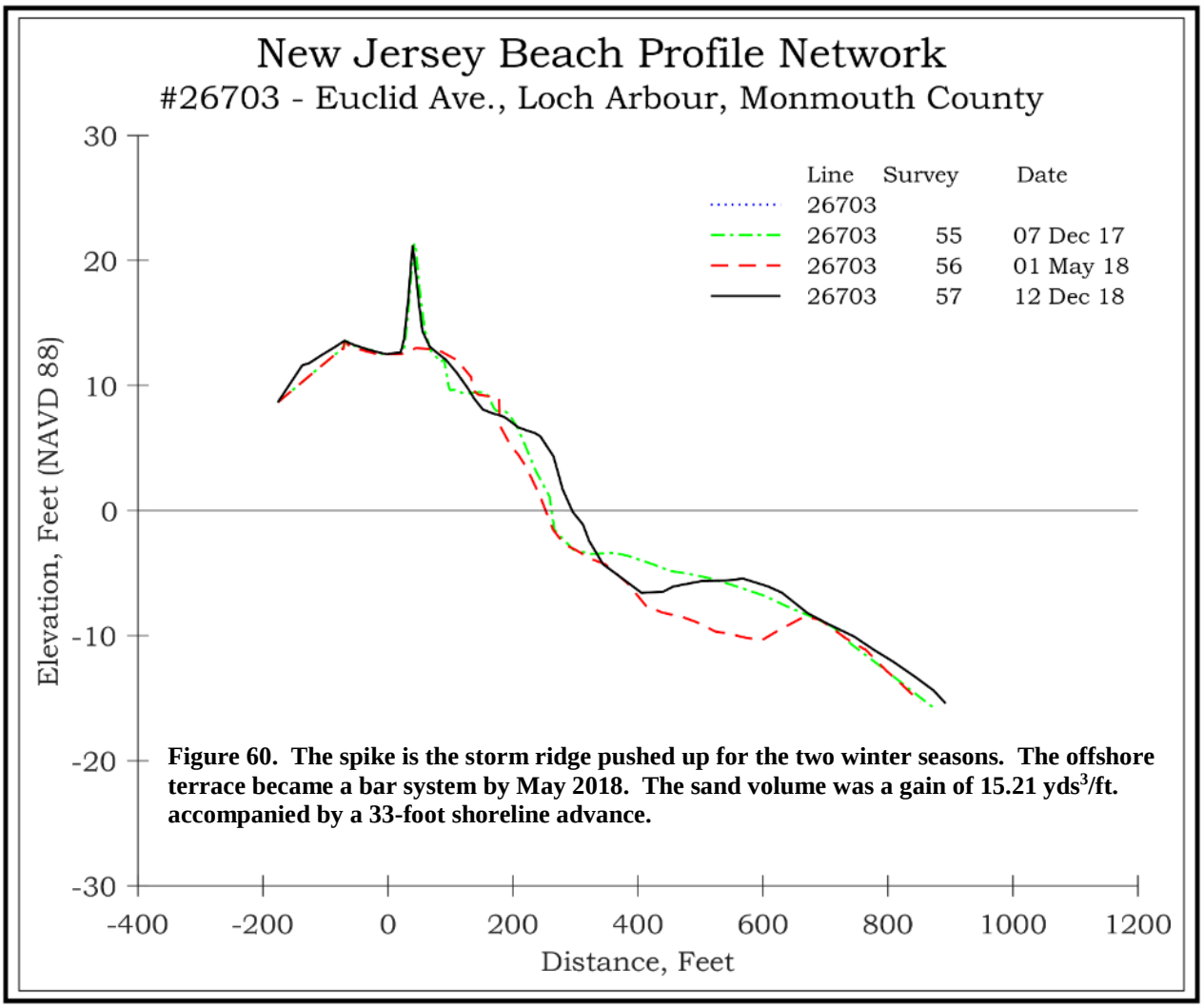


Figure 60. The spike is the storm ridge pushed up for the two winter seasons. The offshore terrace became a bar system by May 2018. The sand volume was a gain of 15.21 yds^3/ft. accompanied by a 33-foot shoreline advance.

NJBPN 26702 – Edgemont Avenue, Loch Arbor

This site is located on the private half of the Loch Arbor shoreline, adjacent to the Deal Lake exit flume. This lake is the largest of the now-closed estuary lakes in Monmouth County. The sand ridge represents a winter season push-up storm protection. There is a minor dune, with a small offshore bar that disappeared by December 2018.

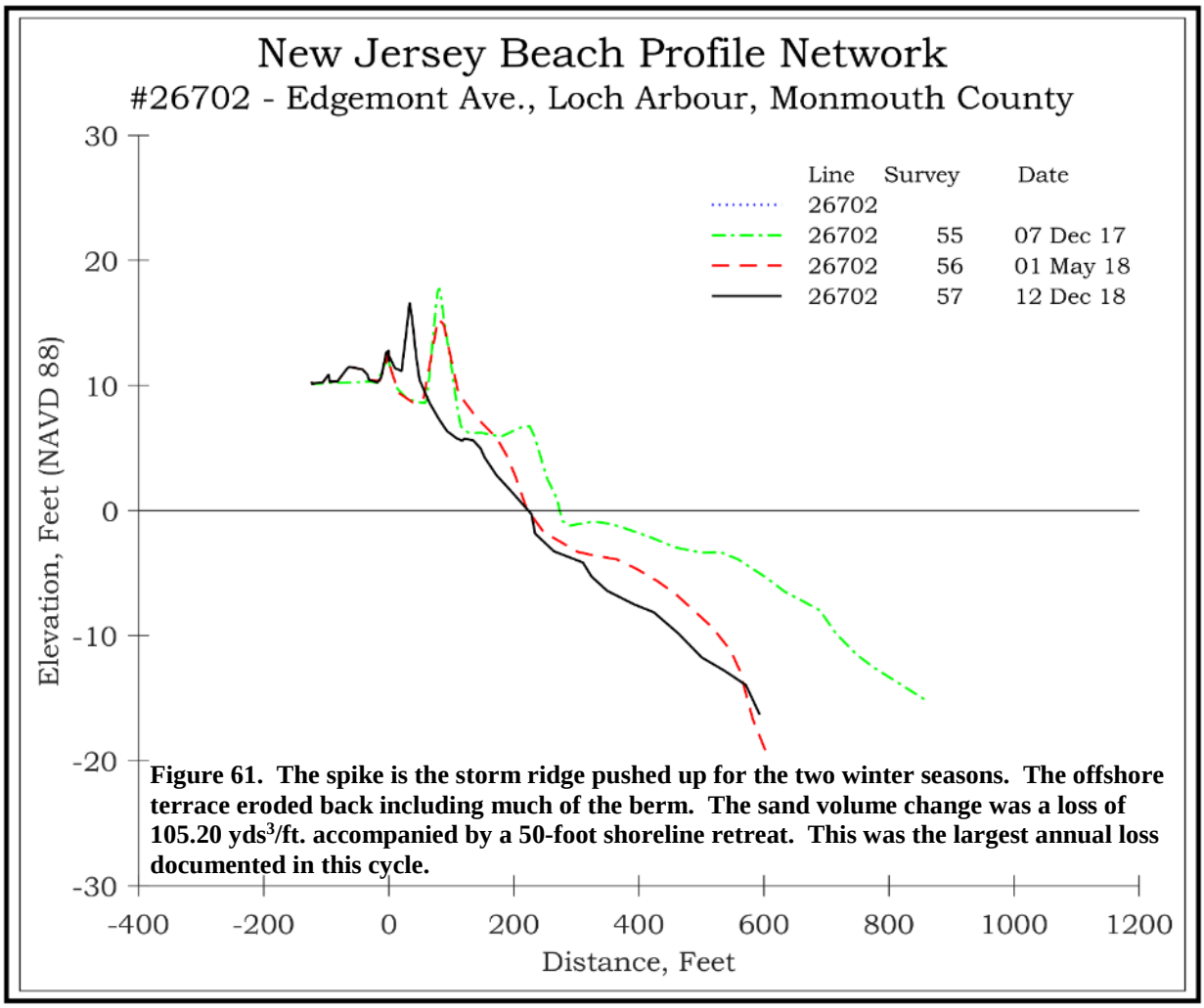


Figure 61. The spike is the storm ridge pushed up for the two winter seasons. The offshore terrace eroded back including much of the berm. The sand volume change was a loss of 105.20 yds^3/ft. accompanied by a 50-foot shoreline retreat. This was the largest annual loss documented in this cycle.

NJBPN 26701 – 1740 Ocean Avenue, Asbury Park

Positioned at the northern limit of the Asbury Park shoreline, this site sits at the boardwalk with a tiny dune seaward of the walk. The beach is about 200 feet wide following Sandy restoration of Phase II from Asbury south to the Manasquan Inlet. There is a terrace offshore that has become a bar system by December 2018.

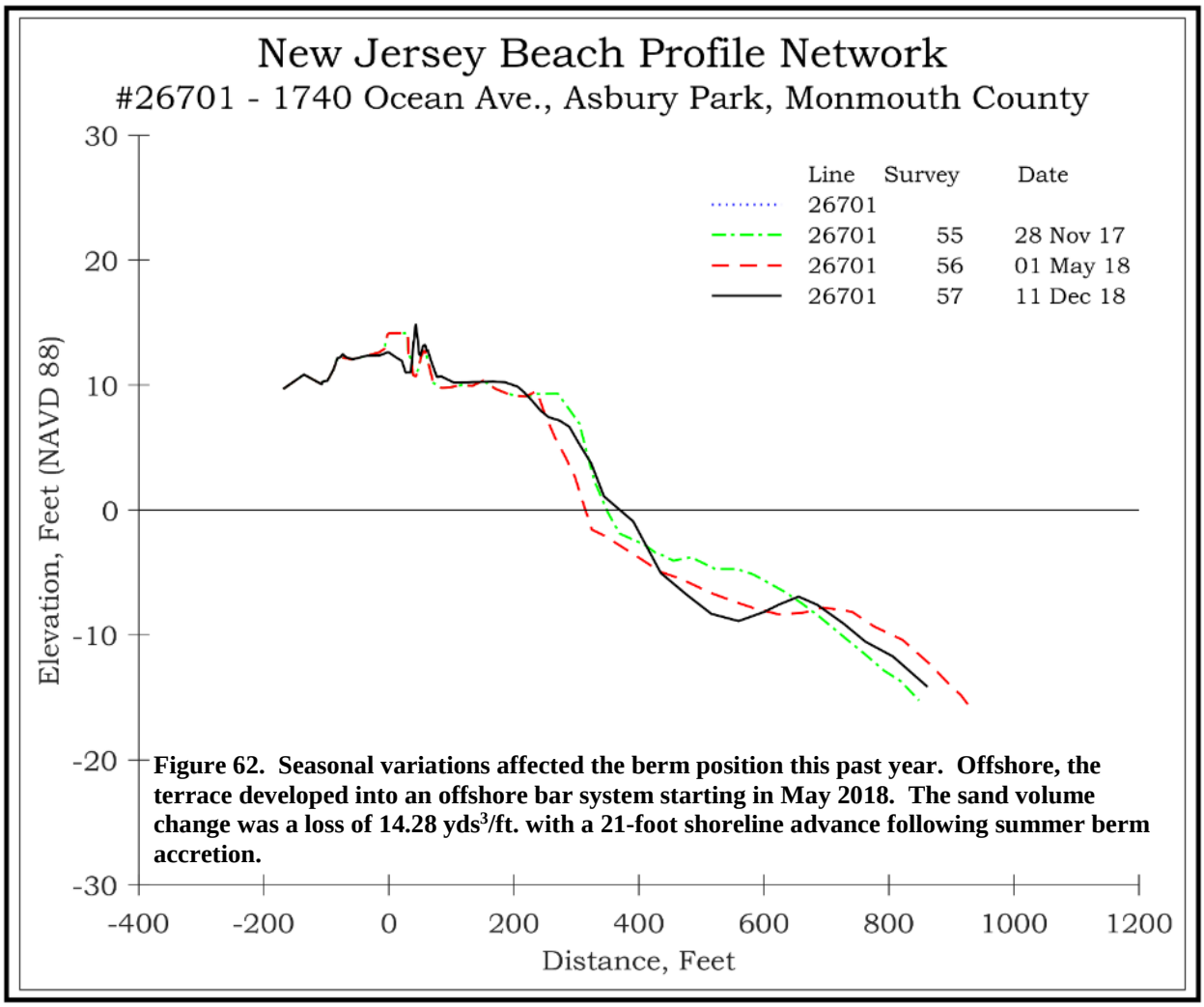
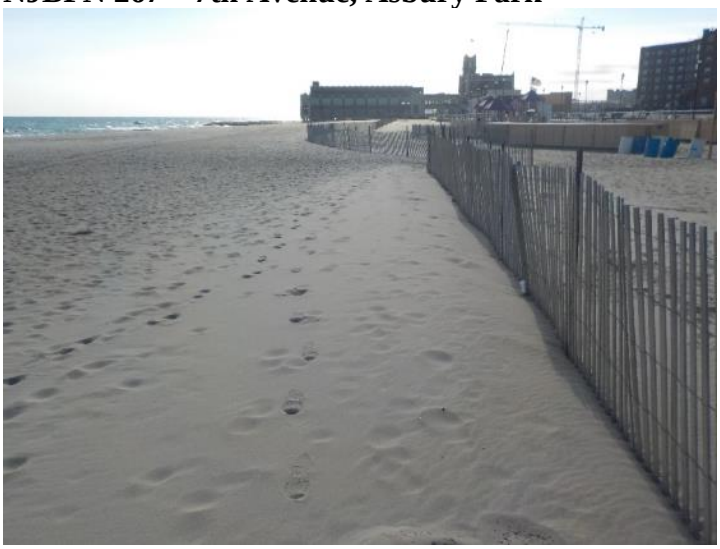


Figure 62. Seasonal variations affected the berm position this past year. Offshore, the terrace developed into an offshore bar system starting in May 2018. The sand volume change was a loss of 14.28 yds^3/ft. with a 21-foot shoreline advance following summer berm accretion.

NJBPN 267 – 7th Avenue, Asbury Park



This site is the northernmost location in the Phase II part of the Monmouth County project. The left photo was taken Nov. 28, 2017 and shows the sand fence placed primarily to restrict access to the boardwalk reconstruction. Sand did accumulate at the toe of the fence as the boardwalk work continued. No storm ridge was pushed up as of mid-December 2018.

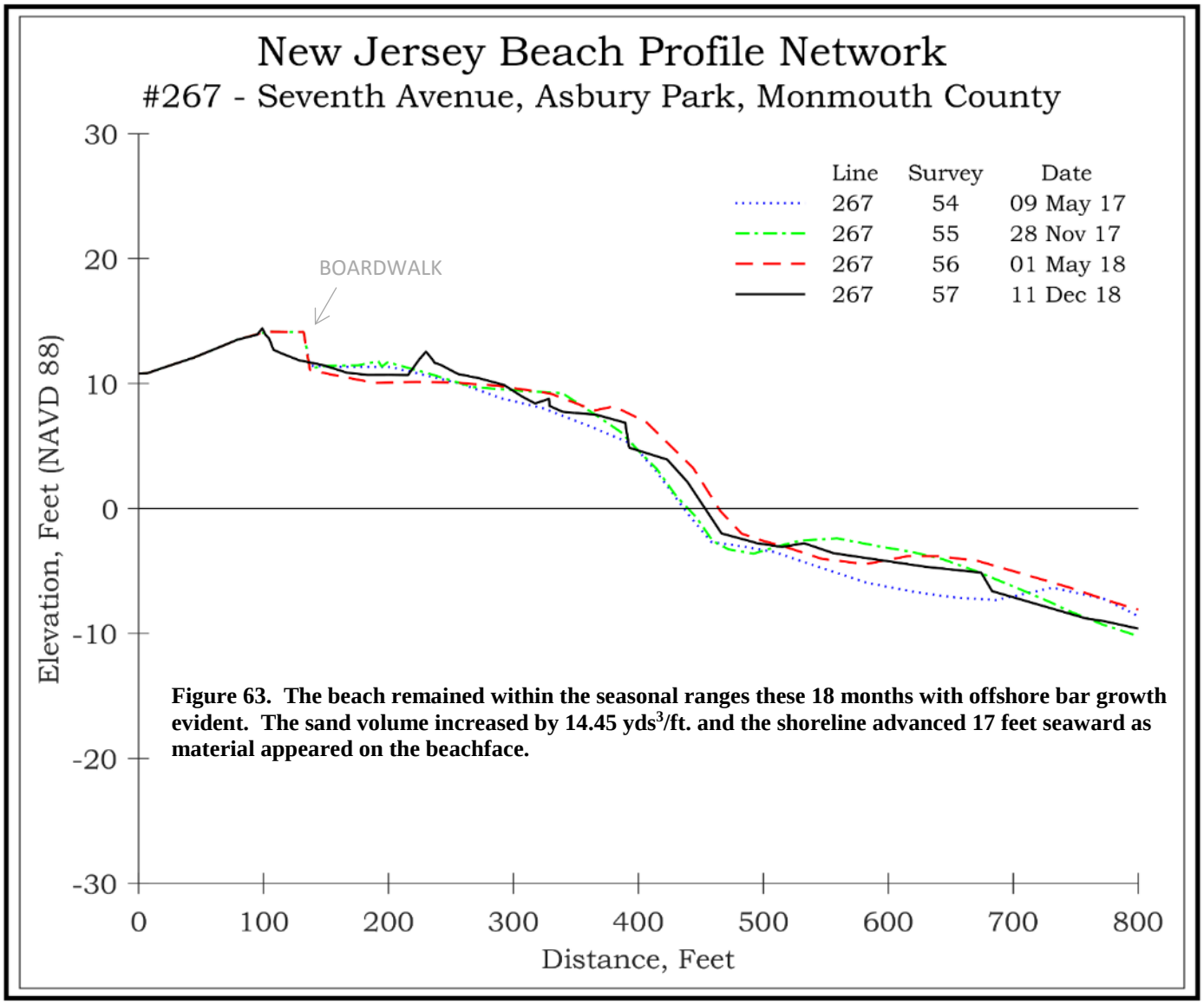
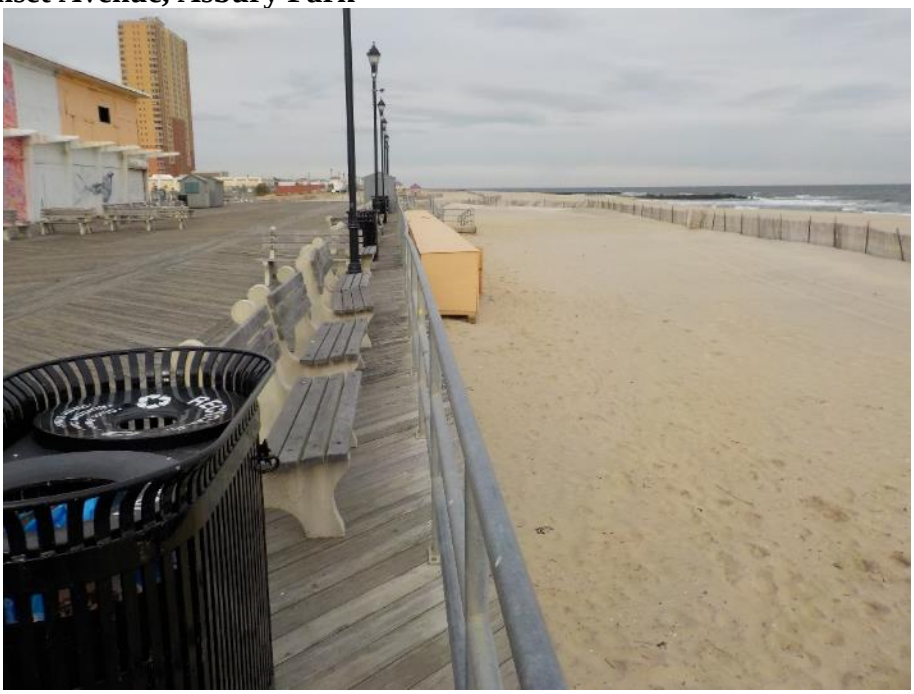


Figure 63. The beach remained within the seasonal ranges these 18 months with offshore bar growth evident. The sand volume increased by 14.45 yds^3/ft. and the shoreline advanced 17 feet seaward as material appeared on the beachface.

NJBPN 16701 – Sunset Avenue, Asbury Park



This site starts at the boardwalk and extends across 150 feet of dry beach largely remaining at the 10.0-foot elevation. There was a wide terrace offshore without a bar present until the December 2018 survey. The new feature appears ready to weld back onto the beachface as of the most recent survey.

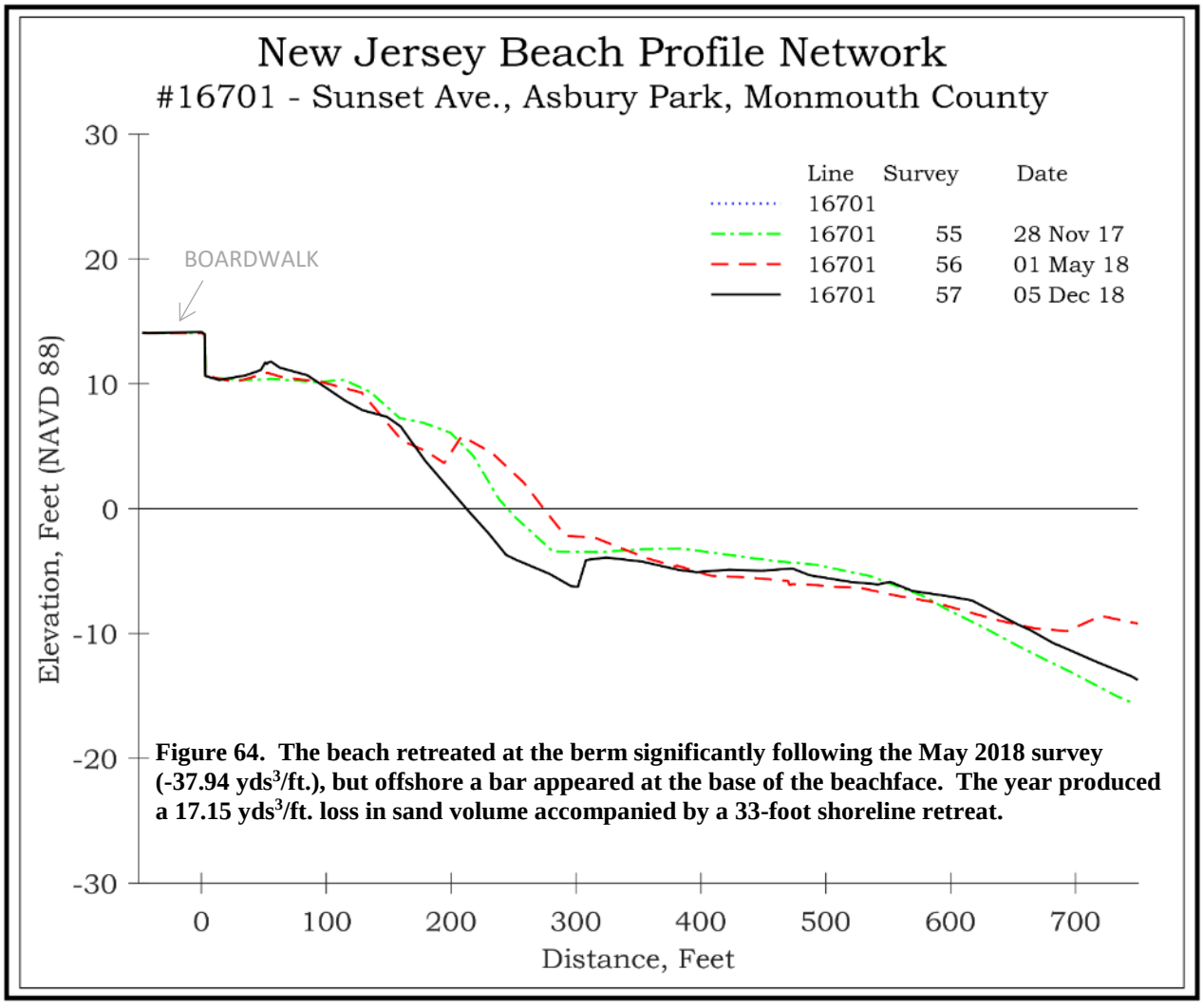


Figure 64. The beach retreated at the berm significantly following the May 2018 survey (-37.94 yds^3/ft.), but offshore a bar appeared at the base of the beachface. The year produced a 17.15 yds^3/ft. loss in sand volume accompanied by a 33-foot shoreline retreat.

NJBPN 167 – 3rd Avenue, Asbury Park

The site remained in good shape with the Nov. 21, 2017 view (left), not significantly different from that (right) taken November 30, 2018. The berm has advanced somewhat by accretion. There is a small "dune" present in Nov. 2018 confined between two rows of sand fence.

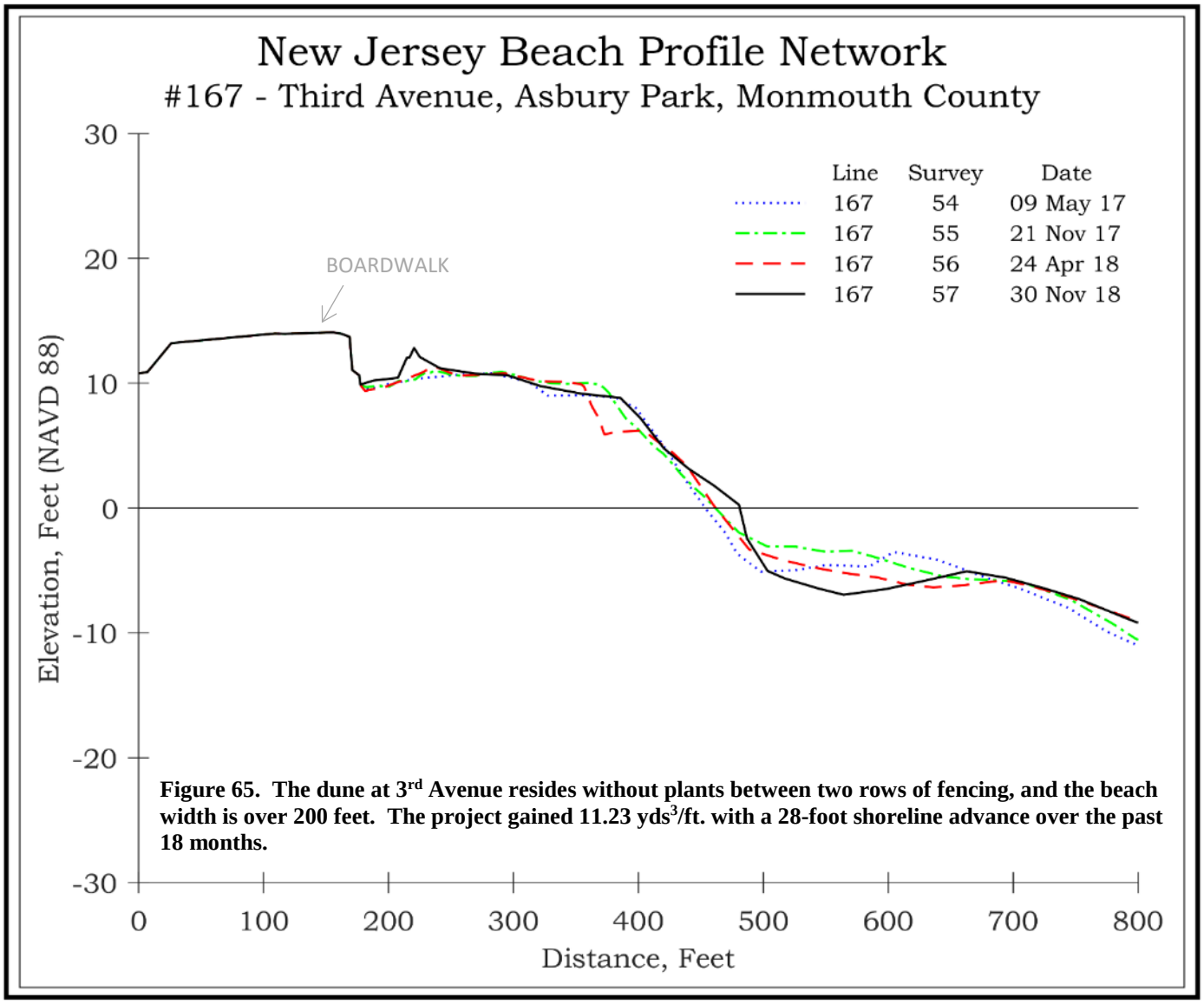
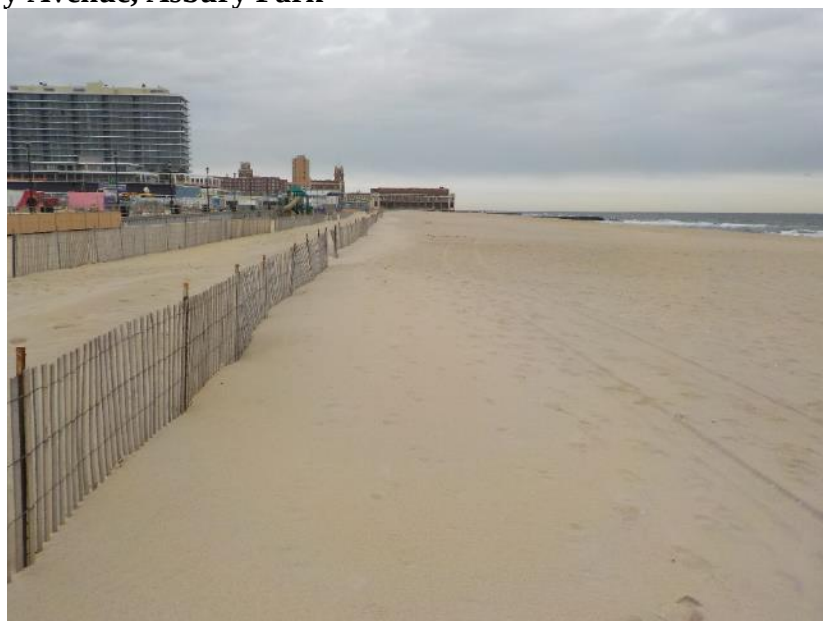


Figure 65. The dune at 3rd Avenue resides without plants between two rows of fencing, and the beach width is over 200 feet. The project gained 11.23 yds^3/ft. with a 28-foot shoreline advance over the past 18 months.

NJBPN 16602 – Asbury Avenue, Asbury Park



The beach remains at a decent width with minor berm retreat. There is no bar offshore as of the end of the initial year of surveying. A small, unvegetated "dune" is now present between two rows of fencing.

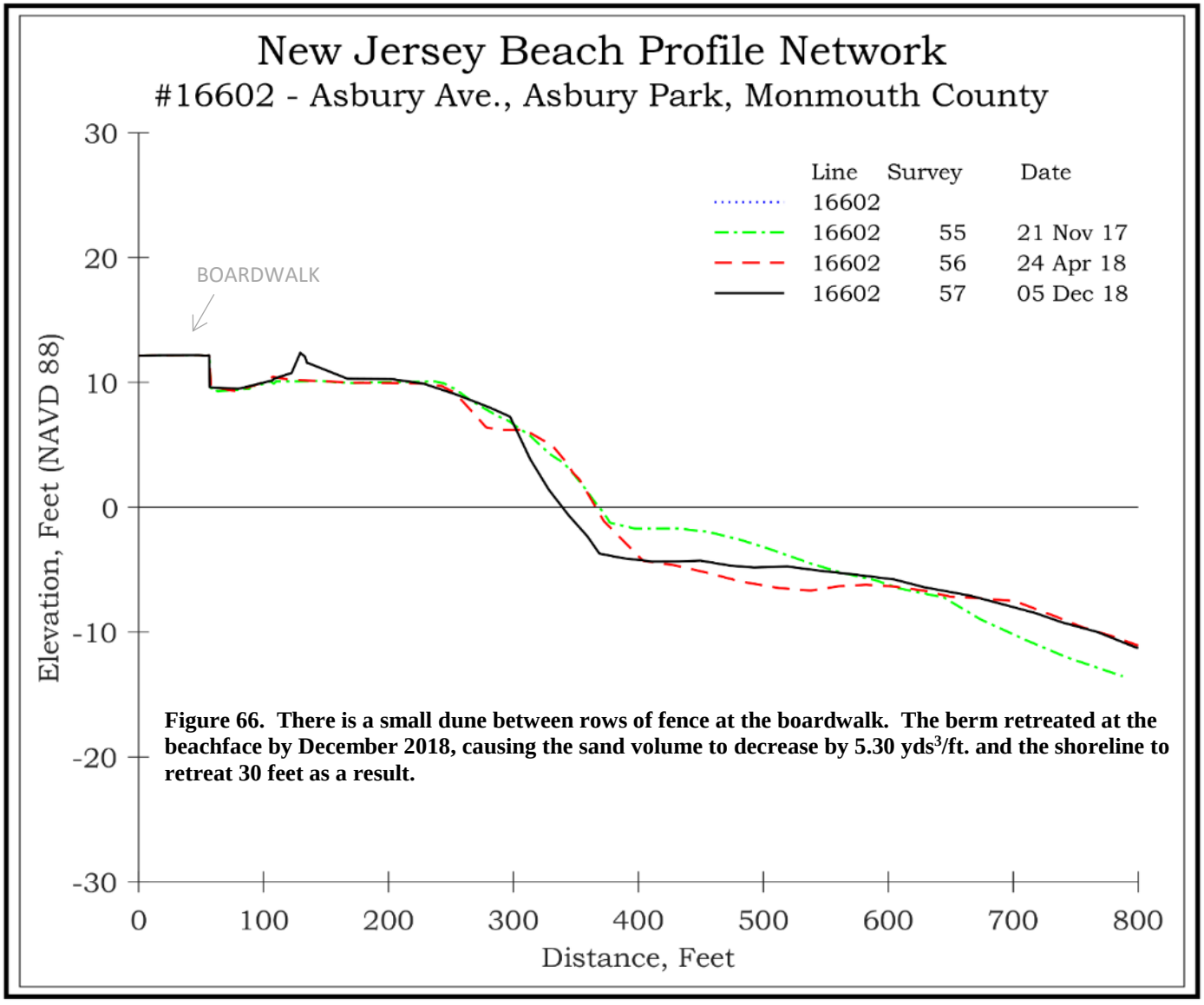


Figure 66. There is a small dune between rows of fence at the boardwalk. The berm retreated at the beachface by December 2018, causing the sand volume to decrease by 5.30 yds^3/ft. and the shoreline to retreat 30 feet as a result.

NJBPN 16601 – Spray Avenue, Ocean Grove

The northern Ocean Grove cross section starts at the boardwalk, with a small dune immediately seaward. The beach is 210 feet wide with a generously wide terrace offshore, but no bar system present.

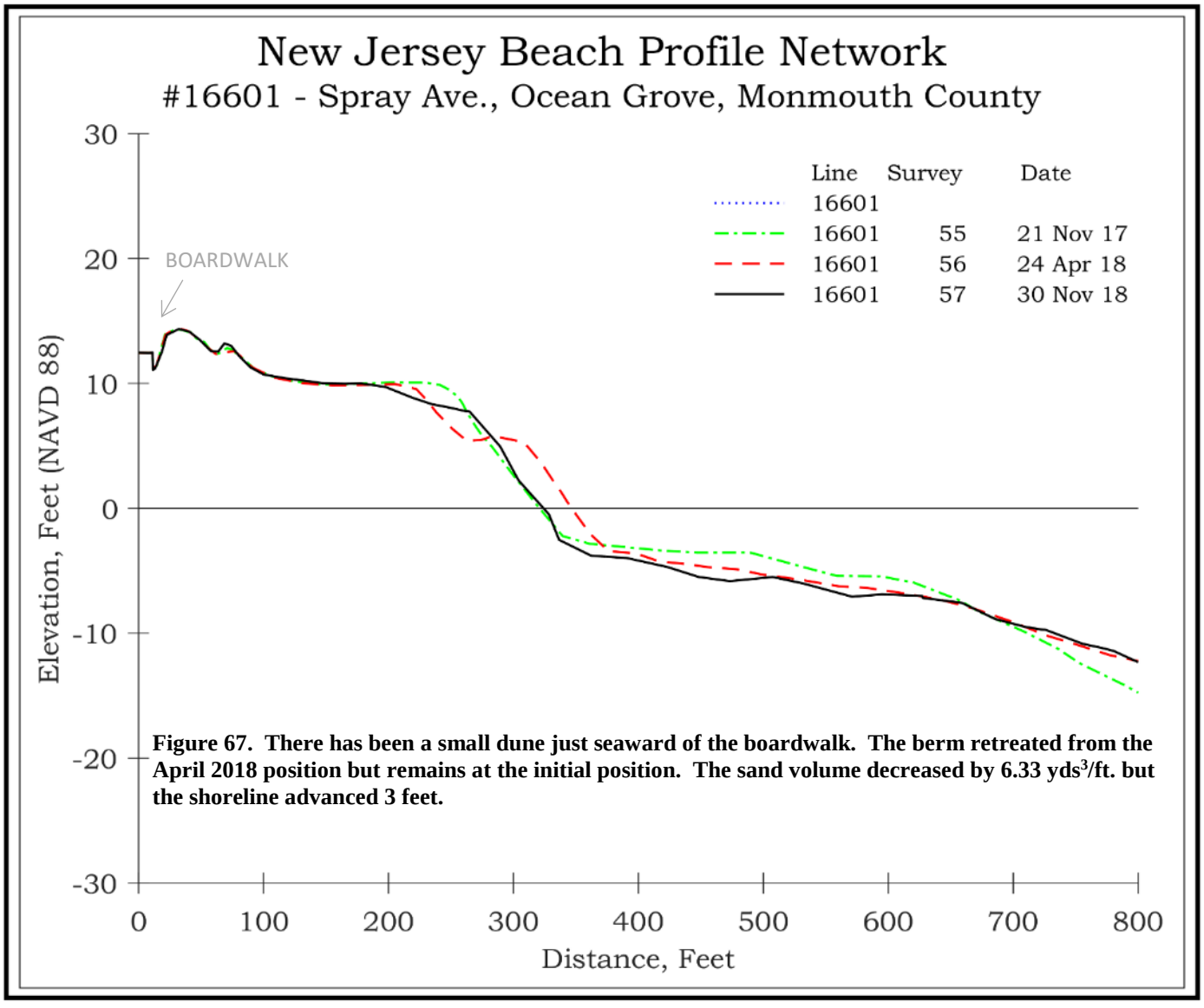


Figure 67. There has been a small dune just seaward of the boardwalk. The berm retreated from the April 2018 position but remains at the initial position. The sand volume decreased by 6.33 yds^3/ft. but the shoreline advanced 3 feet.

NJBPN 166 – Ocean Pathway, Ocean Grove

sand volume added during 2014 remains in place (Nov. 21, 2017) with minor variations leaving the berm virtually unchanged on November 30, 2018 (right). There was a storm ridge pushed up by Nov. 2018.

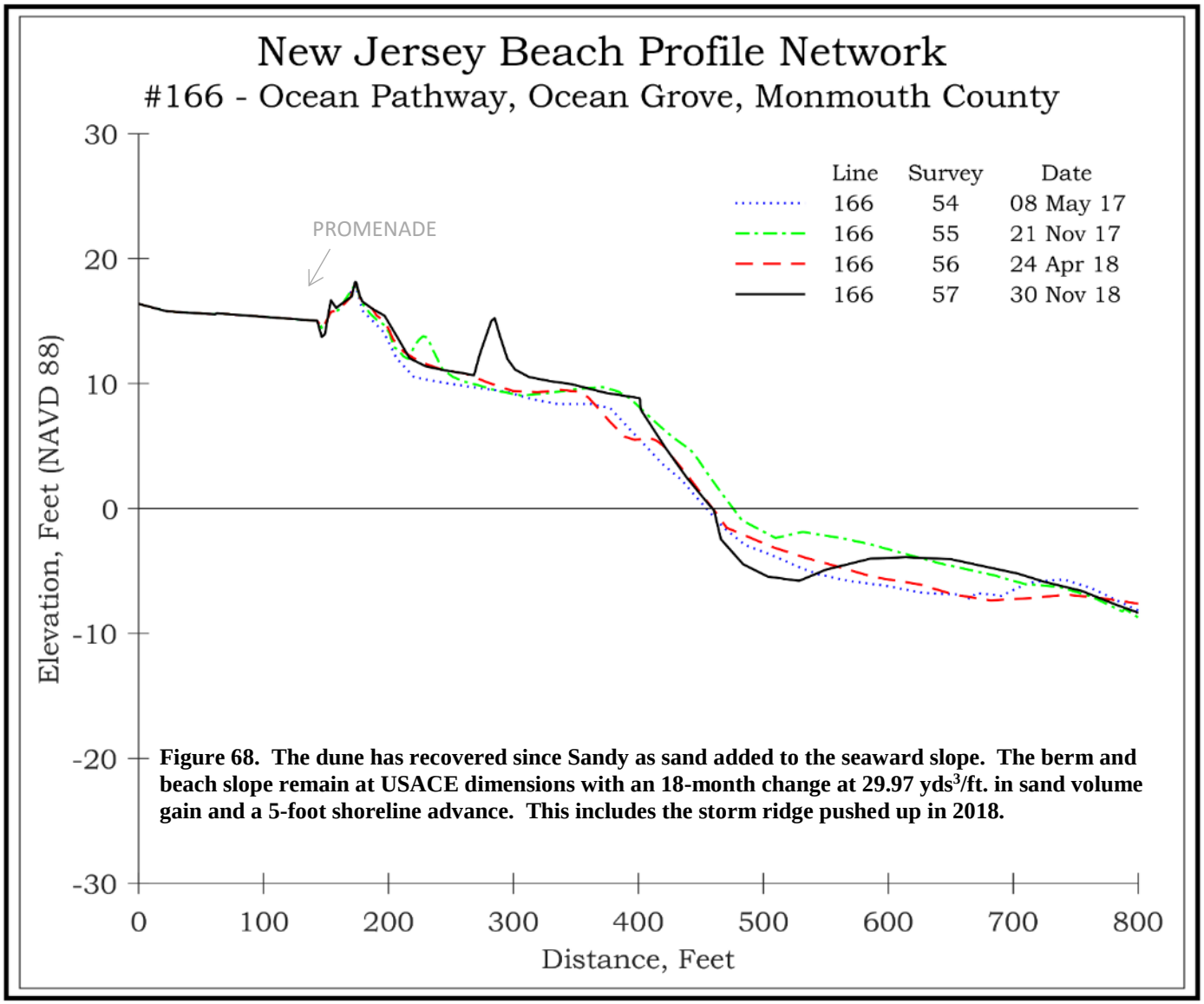


Figure 68. The dune has recovered since Sandy as sand added to the seaward slope. The berm and beach slope remain at USACE dimensions with an 18-month change at 29.97 yds^3/ft. in sand volume gain and a 5-foot shoreline advance. This includes the storm ridge pushed up in 2018.

NJBPN 16502 – Broadway, Ocean Grove

Positioned at the south end of Ocean Grove, this site has a low dune seaward of the boardwalk with 150 feet of 10.0-foot elevation beach beyond that. The offshore has a tiny bar on the shallow gradient terrace seaward of the beachface and an emergency storm ridge pushed up for the winter.

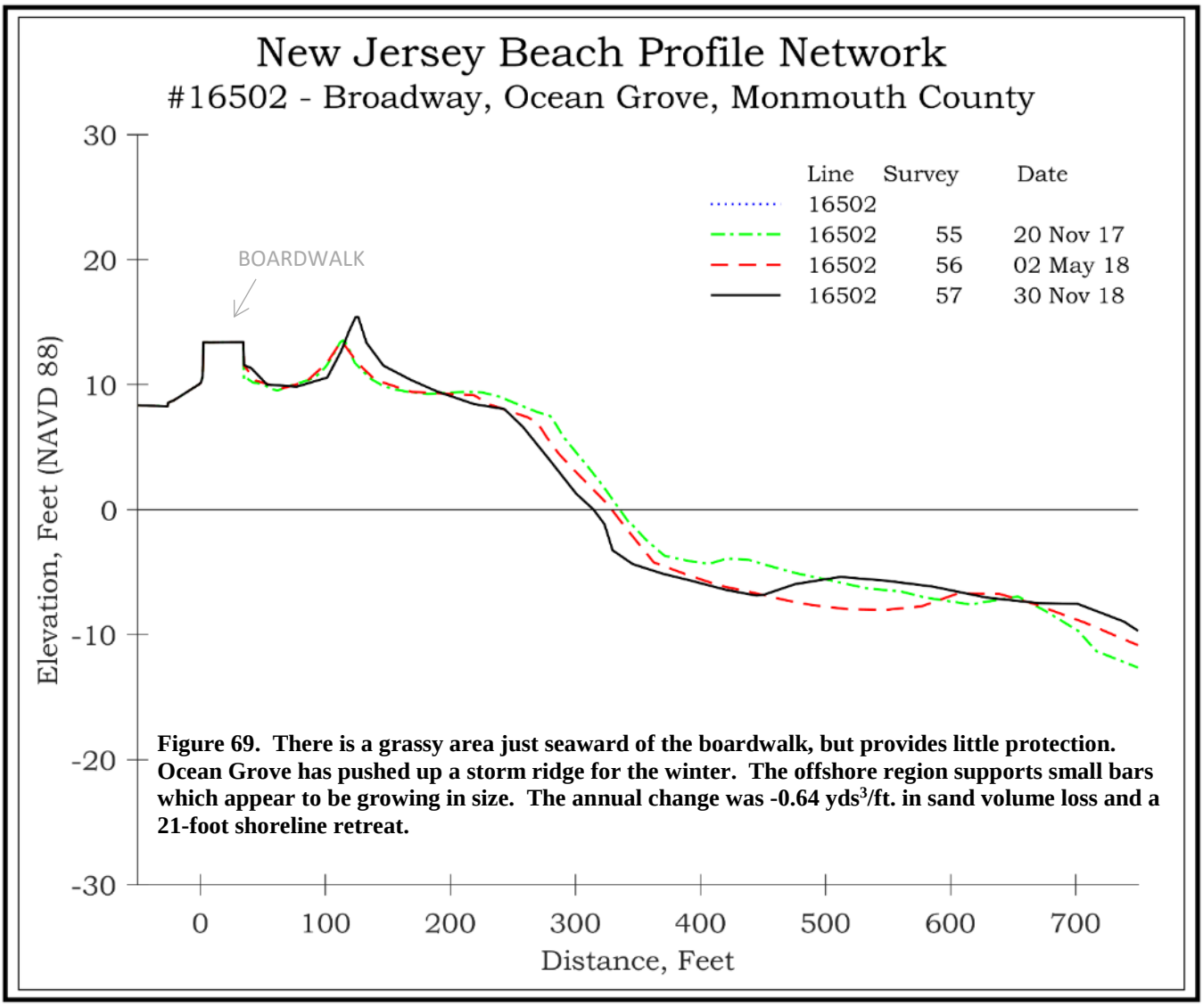


Figure 69. There is a grassy area just seaward of the boardwalk, but provides little protection. Ocean Grove has pushed up a storm ridge for the winter. The offshore region supports small bars which appear to be growing in size. The annual change was -0.64 yds^3/ft. in sand volume loss and a 21-foot shoreline retreat.

NJBPN 16501 – Cliff Avenue, Bradley Beach

There is a dune between the boardwalk and the beachfront with about 200 feet of dry beach seaward at the USACE design elevation. There is a terrace offshore with a bar present as of November 2018.

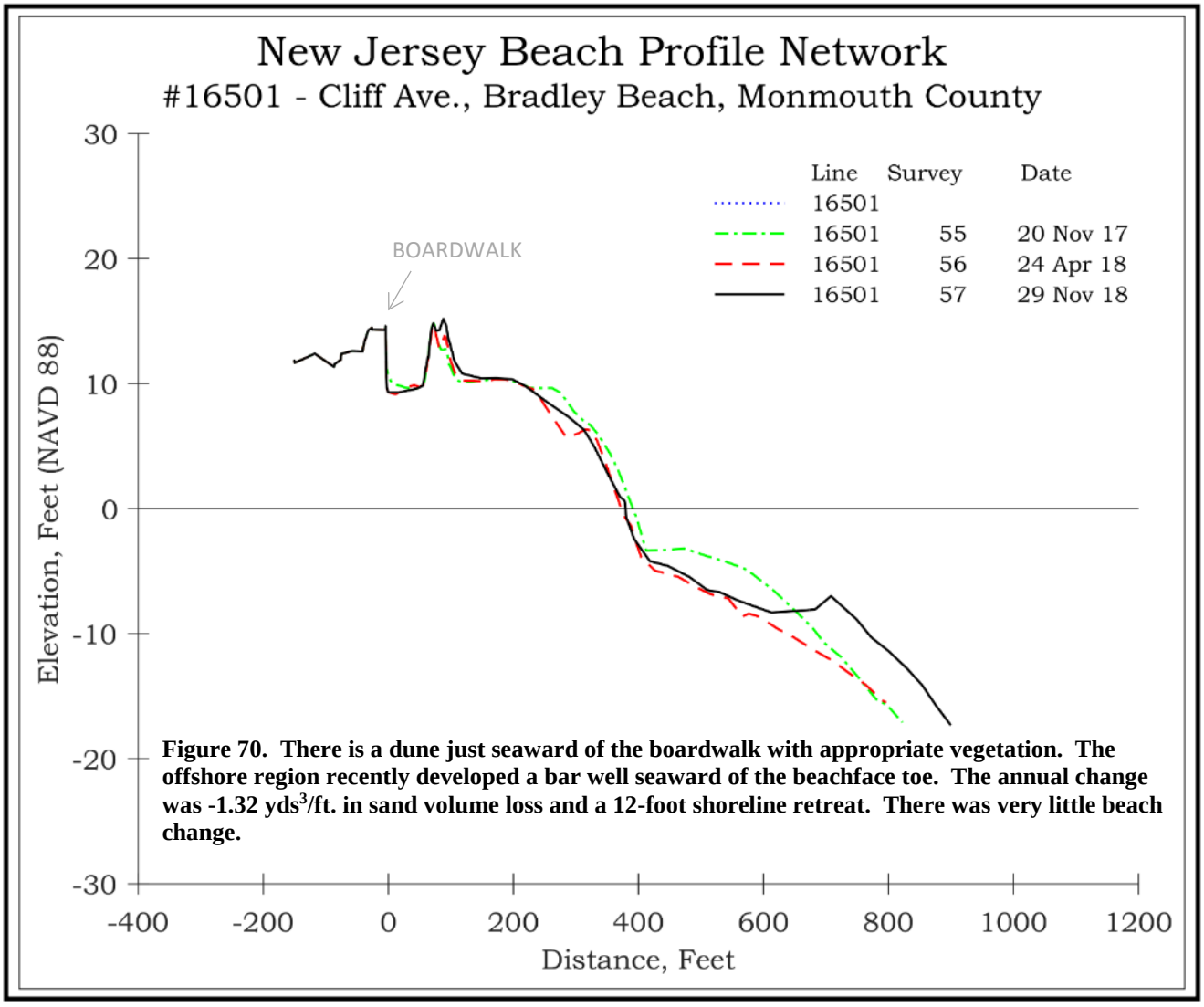


Figure 70. There is a dune just seaward of the boardwalk with appropriate vegetation. The offshore region recently developed a bar well seaward of the beachface toe. The annual change was -1.32 yds^3/ft. in sand volume loss and a 12-foot shoreline retreat. There was very little beach change.

NJBPN 165 – McCabe Avenue, Bradley Beach

The November 20, 2017 view to the south shows the beach width (left photo) and dune crest with excellent grass growth. On the right, the wind had deposited abundant sand on the plants enhancing the dune by November 2018. The fence is nearly buried.

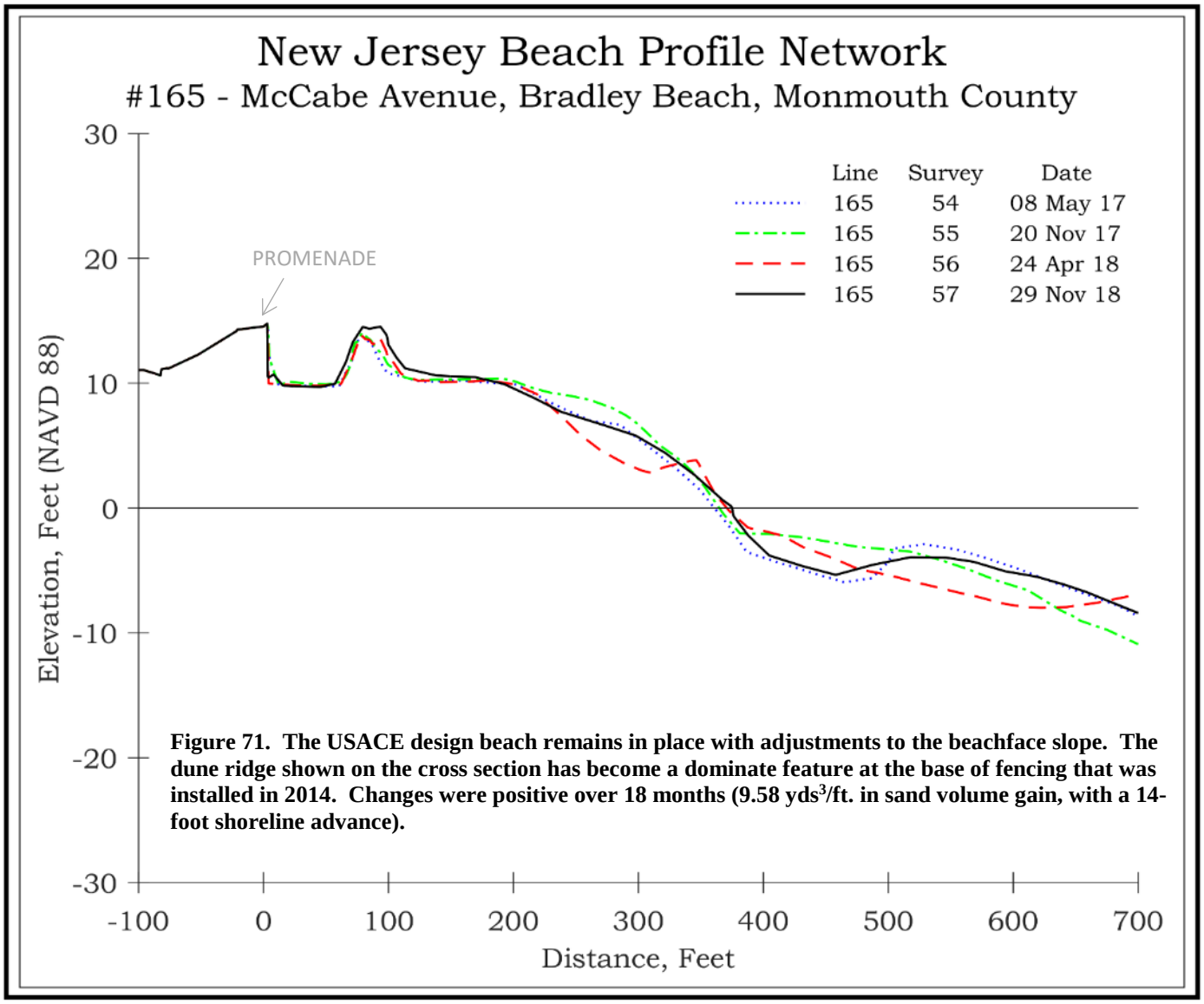


Figure 71. The USACE design beach remains in place with adjustments to the beachface slope. The dune ridge shown on the cross section has become a dominate feature at the base of fencing that was installed in 2014. Changes were positive over 18 months (9.58 yds^3/ft. in sand volume gain, with a 14-foot shoreline advance).

NJBPN 16402 – 4th Avenue, Bradley Beach

A dune lies seaward of the promenade with a 160-foot wide beach seaward from it. Offshore the terrace has a modest bar system present that grew larger over the past year.

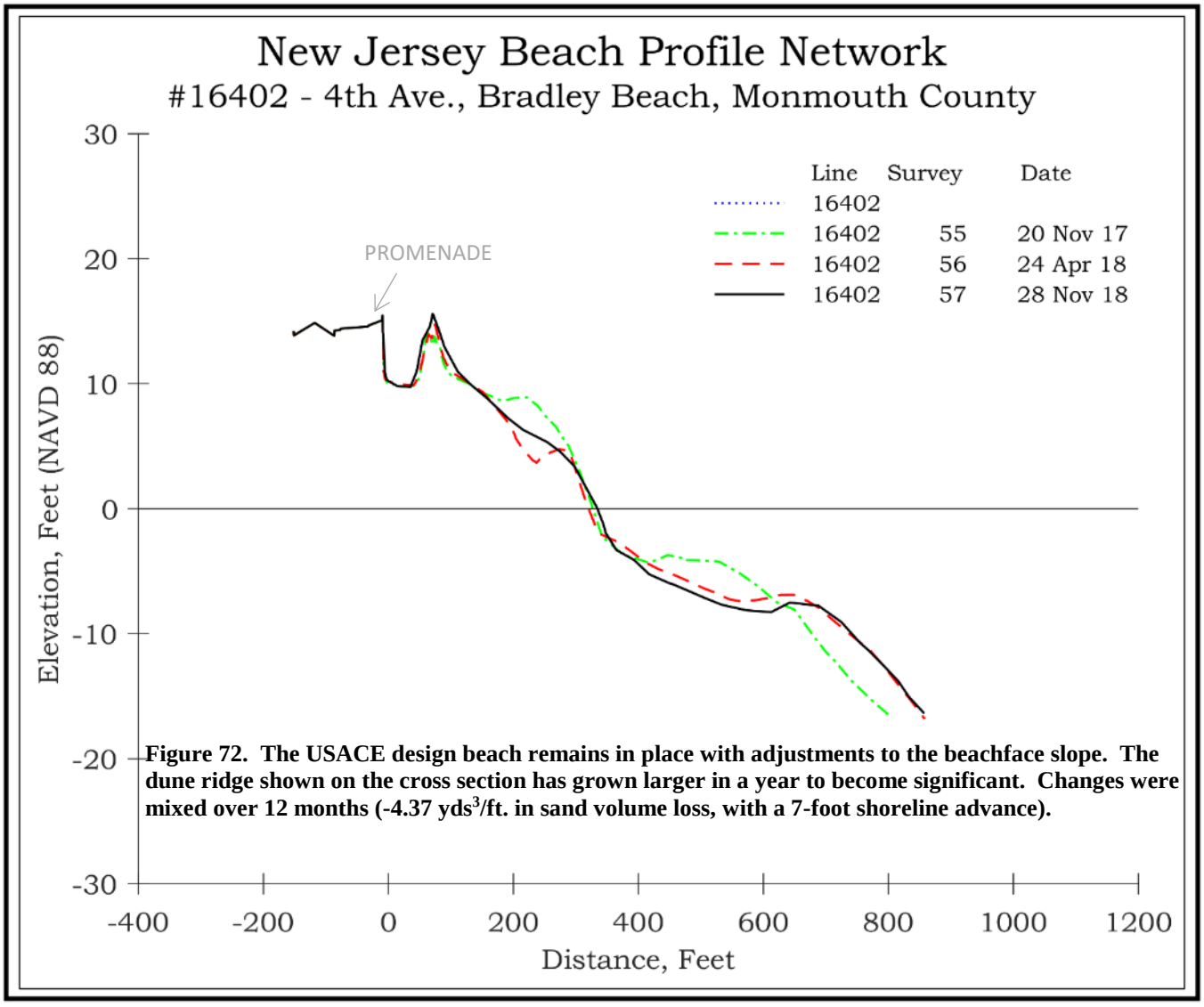
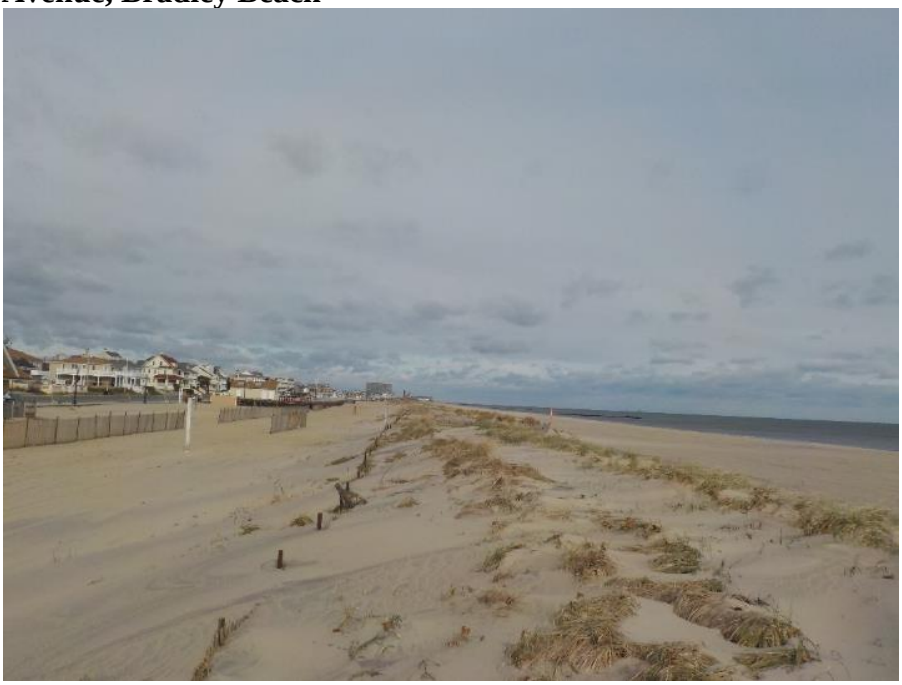


Figure 72. The USACE design beach remains in place with adjustments to the beachface slope. The dune ridge shown on the cross section has grown larger in a year to become significant. Changes were mixed over 12 months (-4.37 yds^3/ft. in sand volume loss, with a 7-foot shoreline advance).

NJBPN 16401 – 2nd Avenue, Bradley Beach



There is a dune present seaward of the walkway and a 270-foot wide beach leading offshore to a small bar system present on the terrace

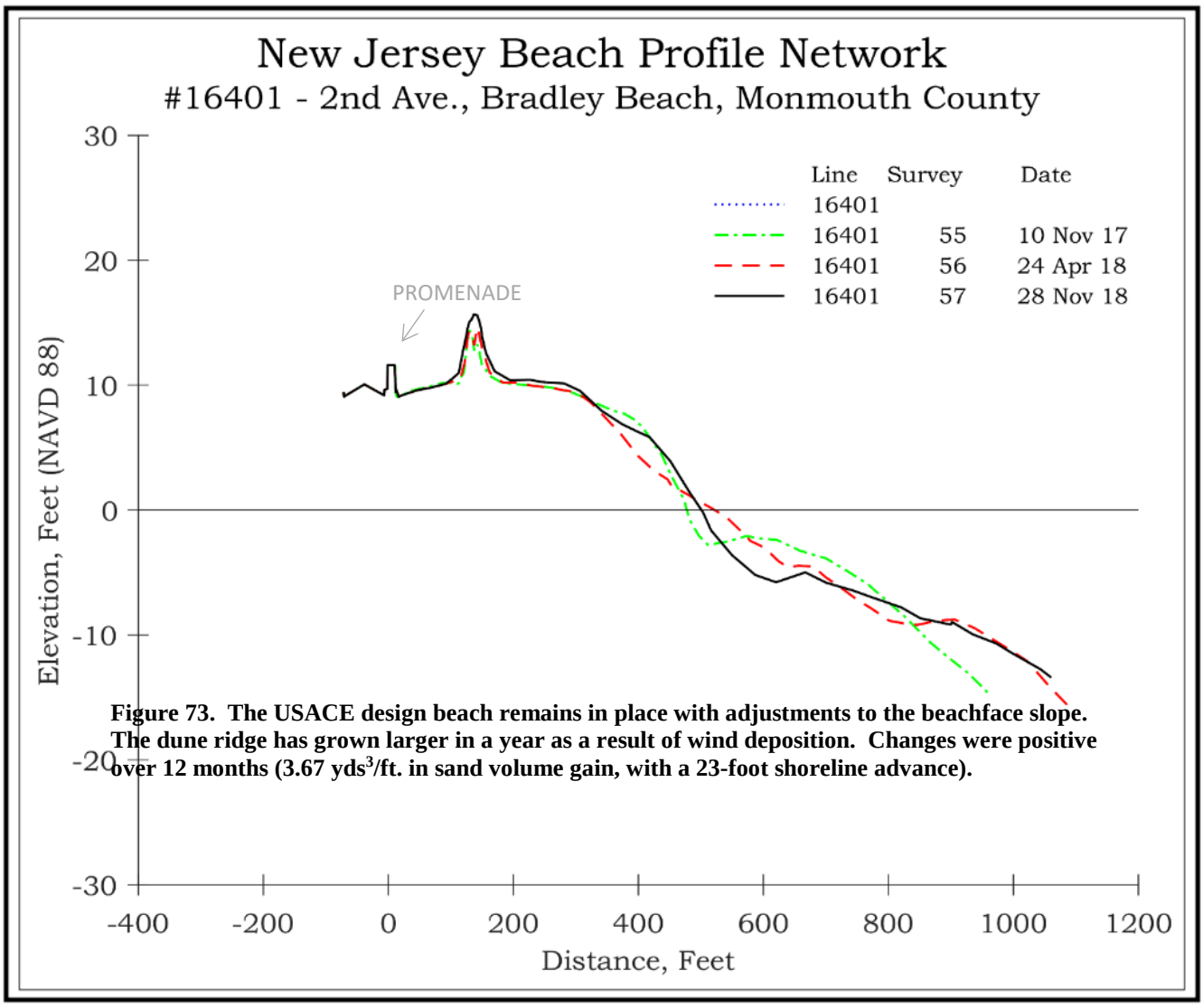
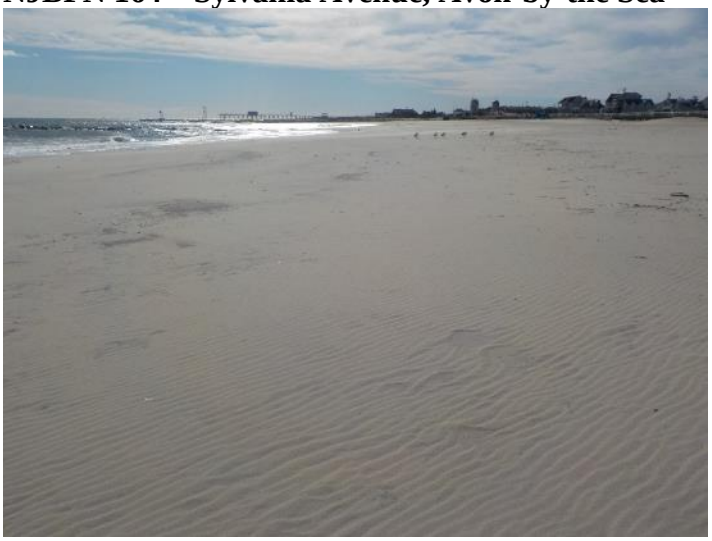


Figure 73. The USACE design beach remains in place with adjustments to the beachface slope. The dune ridge has grown larger in a year as a result of wind deposition. Changes were positive over 12 months (3.67 yds^3/ft. in sand volume gain, with a 23-foot shoreline advance).

NJBPN 164 – Sylvania Avenue, Avon-by-the Sea



This site is located north of the Shark River Inlet. The left view shows the beach looking south toward the inlet on November 10, 2017. On September 18, 2018 (right photo), the beach was about the same with berm elevation variations over the 18-month period.

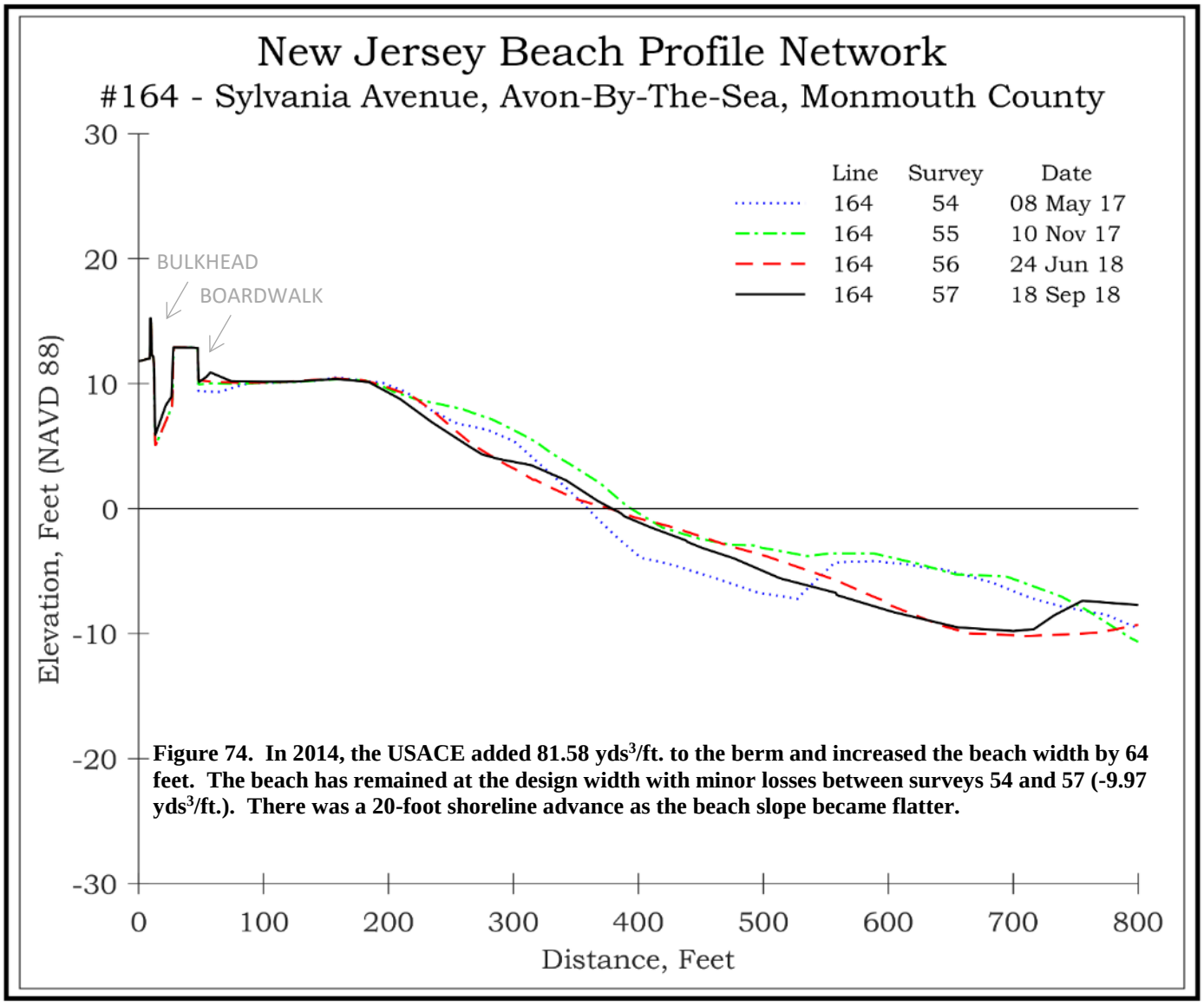


Figure 74. In 2014, the USACE added 81.58 yds^3/ft. to the berm and increased the beach width by 64 feet. The beach has remained at the design width with minor losses between surveys 54 and 57 (-9.97 yds^3/ft.). There was a 20-foot shoreline advance as the beach slope became flatter.

NJBPN 16303 – Garfield Avenue, Avon-by-the Sea

Seaward of the boardwalk, sand accumulated at the base of the sand fence and a 200-foot wide beach. The site is north of the Shark River Inlet entrance. Offshore shows a terrace and bar that moved seaward over the past 12 months.

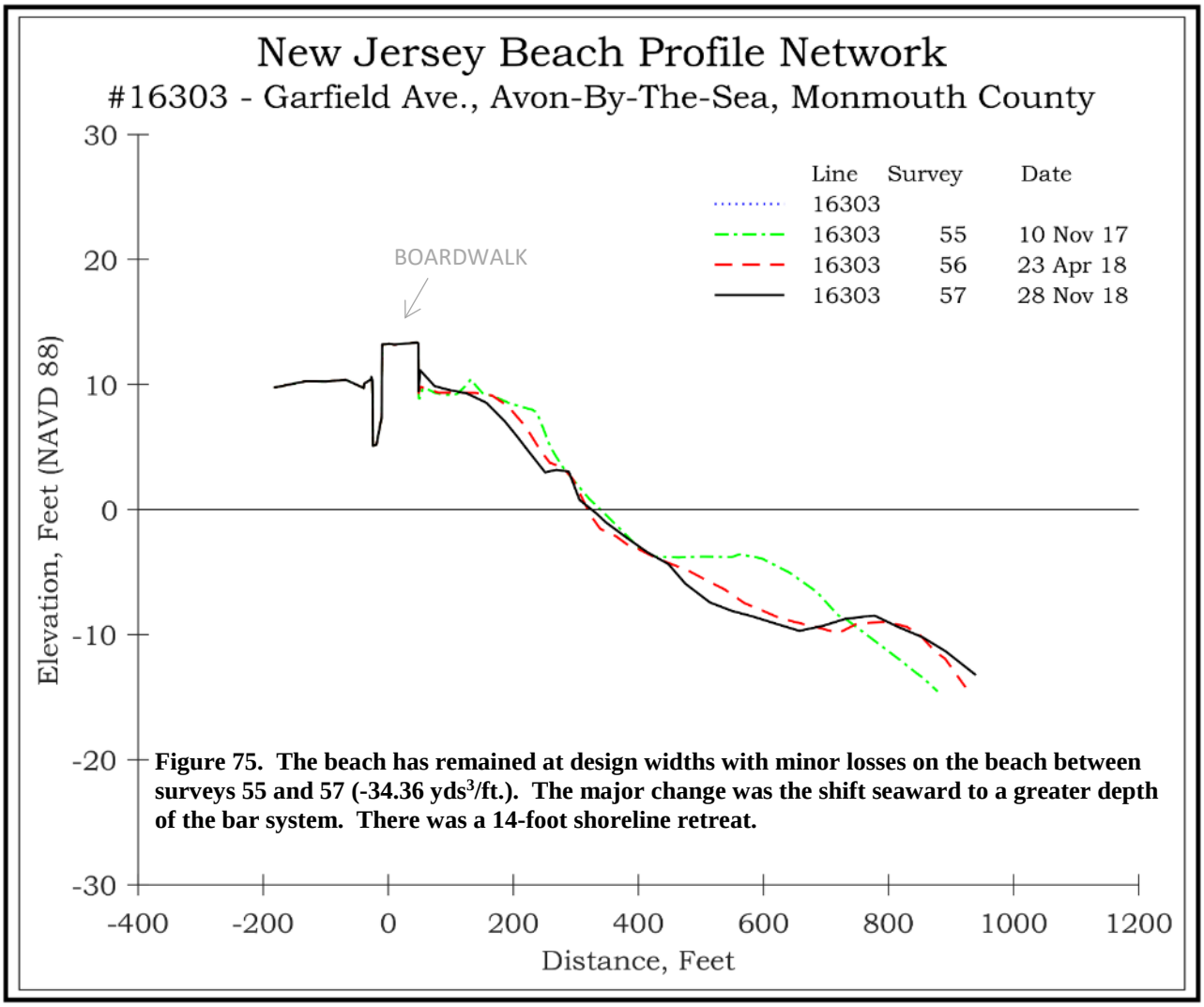
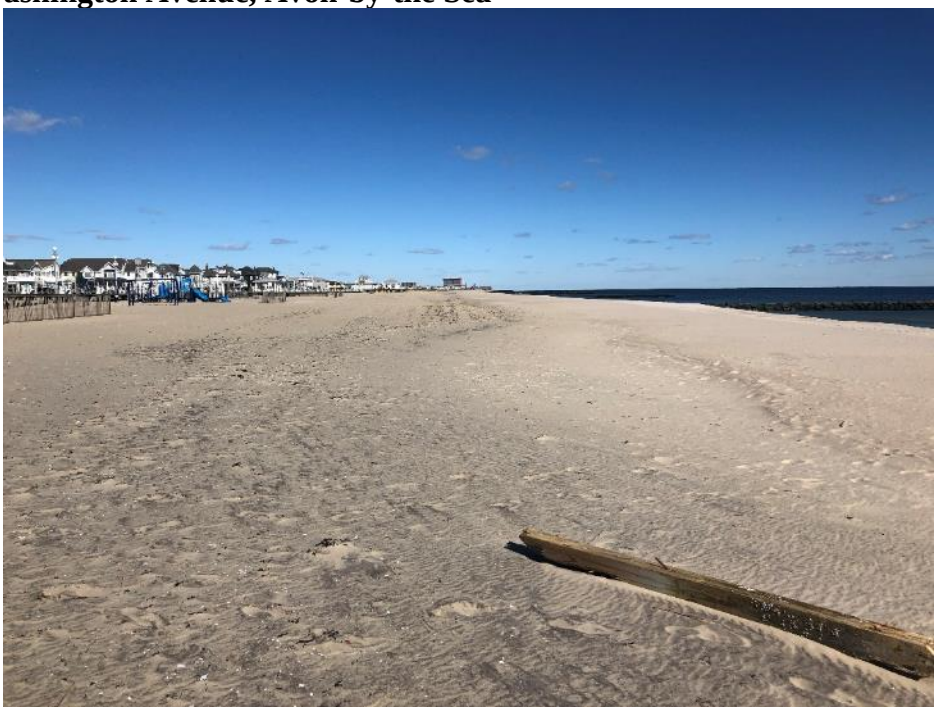


Figure 75. The beach has remained at design widths with minor losses on the beach between surveys 55 and 57 (-34.36 yds^3/ft.). The major change was the shift seaward to a greater depth of the bar system. There was a 14-foot shoreline retreat.

NJBPN 16302 – Washington Avenue, Avon-by-the Sea



This new site is located approximately 300 ft. north of the Shark River Inlet north jetty. The elevation 10-ft berm extends seaward from the boardwalk by 180 feet. The 2017 offshore bar vanished in 2018, but the elevation of the surface decreased.

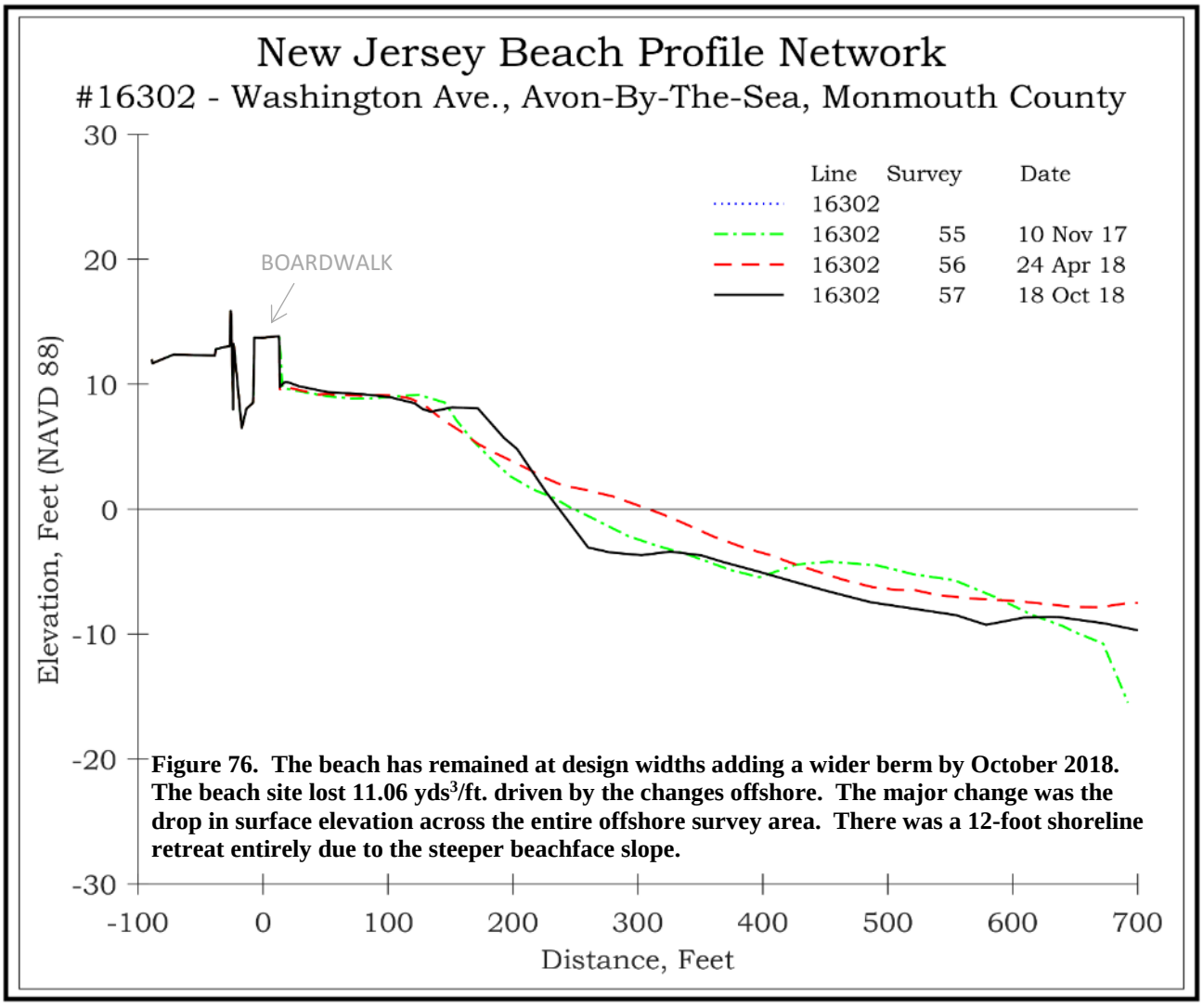


Figure 76. The beach has remained at design widths adding a wider berm by October 2018. The beach site lost 11.06 yds^3/ft. driven by the changes offshore. The major change was the drop in surface elevation across the entire offshore survey area. There was a 12-foot shoreline retreat entirely due to the steeper beachface slope.

NJBPN 16301 – 2nd Avenue, Belmar

The new site in Belmar includes a 450-ft wide beach with no dune. The Shark River Inlet jetty can be seen behind the pier supports north of this site.

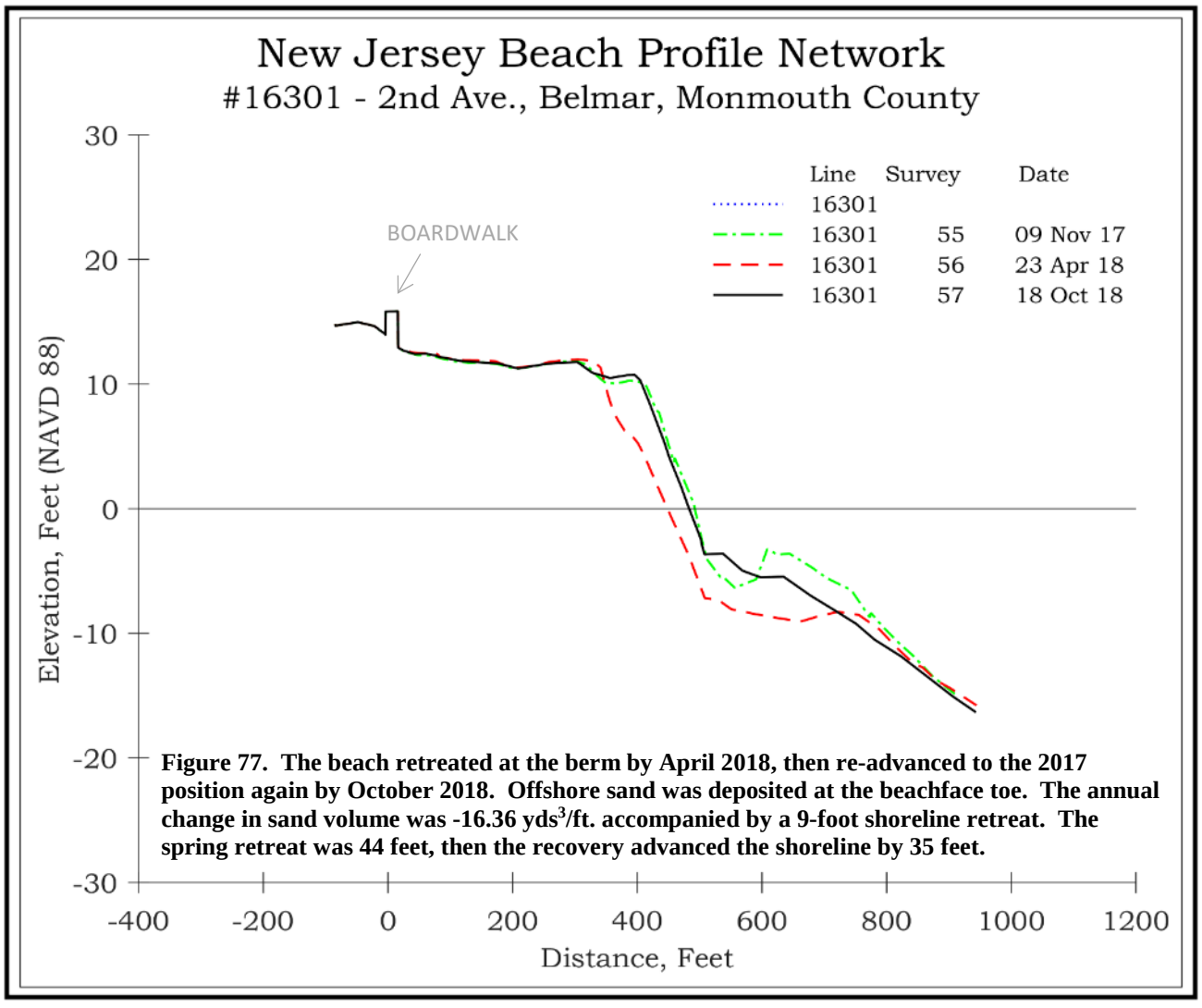
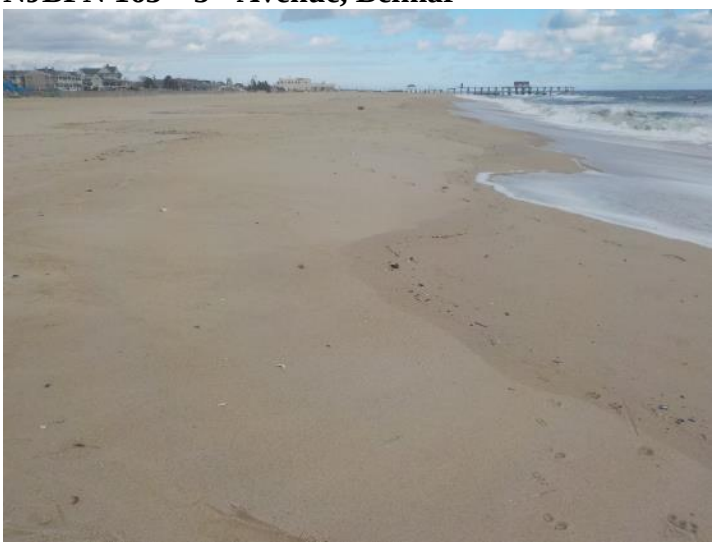


Figure 77. The beach retreated at the berm by April 2018, then re-advanced to the 2017 position again by October 2018. Offshore sand was deposited at the beachface toe. The annual change in sand volume was -16.36 yds^3/ft. accompanied by a 9-foot shoreline retreat. The spring retreat was 44 feet, then the recovery advanced the shoreline by 35 feet.

NJBPN 163 – 5th Avenue, Belmar



This site did not have a dune prior to Sandy but had a wide, dry beach. The north view on November 9, 2017 (left photo) shows this wider than normal beach due to sand trapping by the Shark River Inlet jetty. By October 17, 2018 (right photo) the position of the shoreline was located near the May 2017 position.

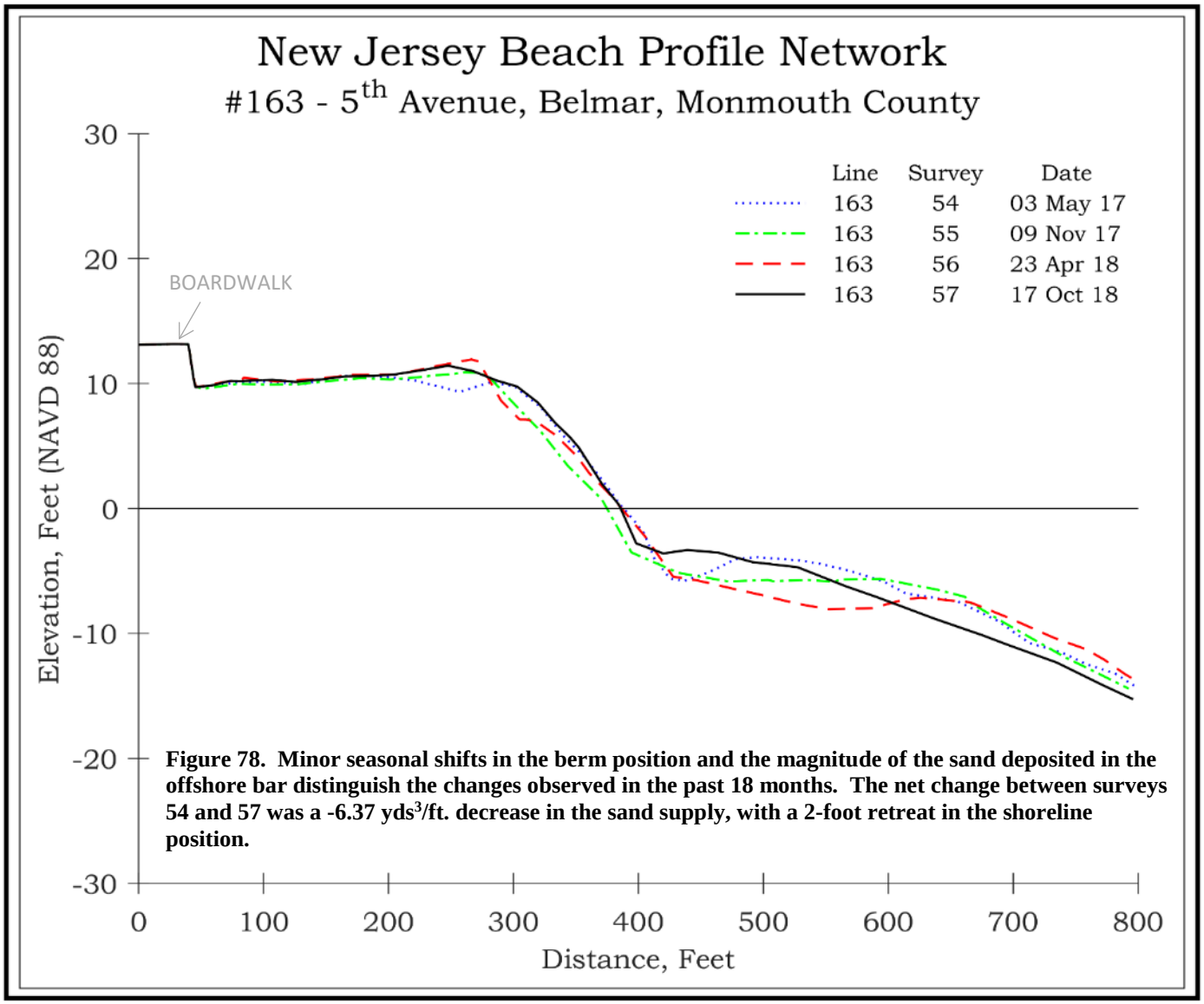


Figure 78. Minor seasonal shifts in the berm position and the magnitude of the sand deposited in the offshore bar distinguish the changes observed in the past 18 months. The net change between surveys 54 and 57 was a -6.37 yds^3/ft. decrease in the sand supply, with a 2-foot retreat in the shoreline position.

NJBPN 16202 – 8th Avenue, Belmar

The boardwalk is the backstop for the beach, since there is no dune system. The beach is over 200 feet wide at elevation 10.0 feet leading into a steep beachface and a significant offshore bar, the crest of which reaches nearly to the zero elevation datum

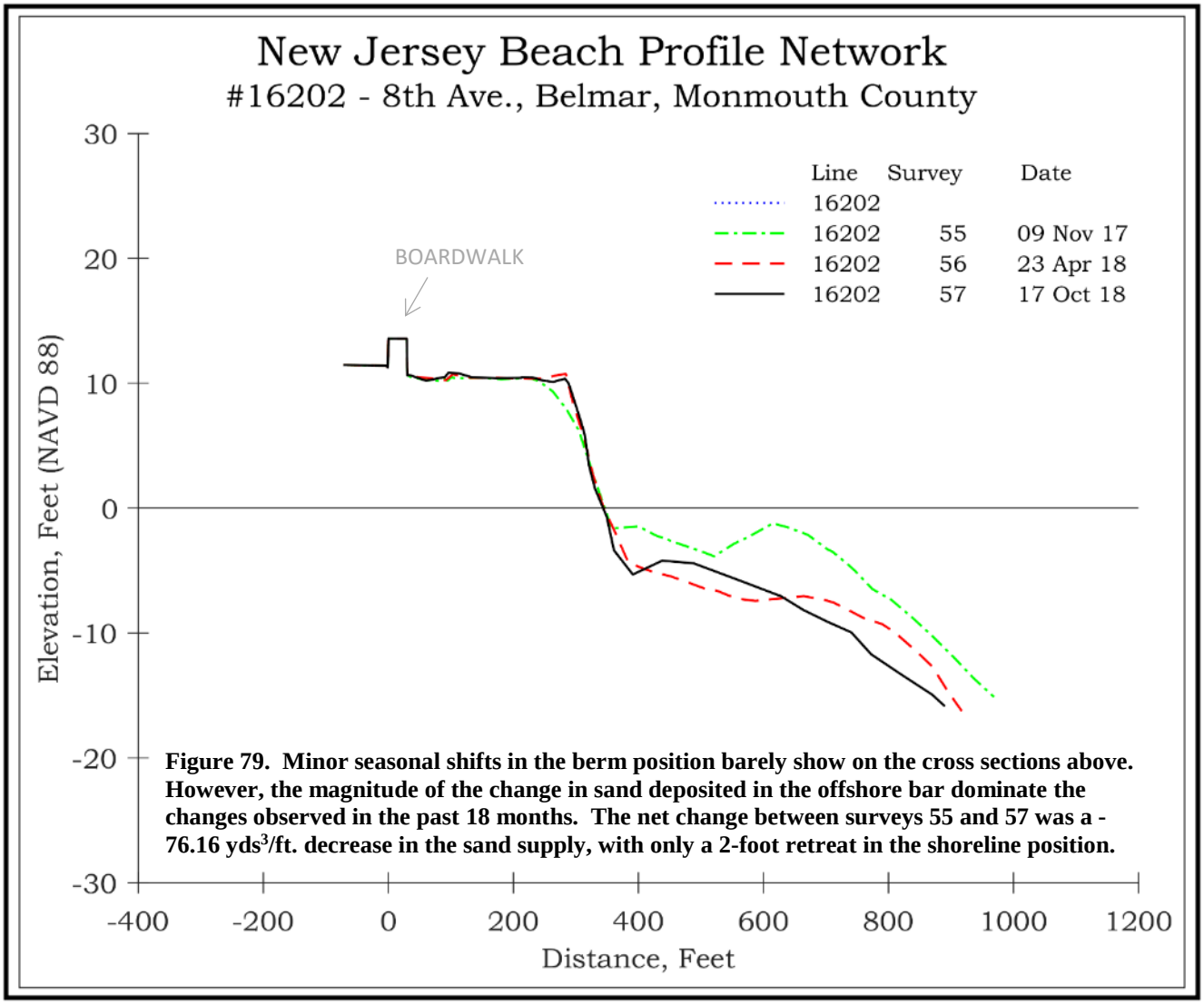


Figure 79. Minor seasonal shifts in the berm position barely show on the cross sections above. However, the magnitude of the change in sand deposited in the offshore bar dominate the changes observed in the past 18 months. The net change between surveys 55 and 57 was a -76.16 yds^3/ft. decrease in the sand supply, with only a 2-foot retreat in the shoreline position.

NJBPN 16201 – 14th Avenue, Belmar

The 14th Avenue site does have a tiny dune feature immediately seaward of the boardwalk. The beach extends 125 feet to a ridge of sand pushed up as a seasonal barrier to storm waves. Not present further north up the beach, these features are not uniformly created in the southern Monmouth County communities. Offshore, a tiny bar on a terrace is present

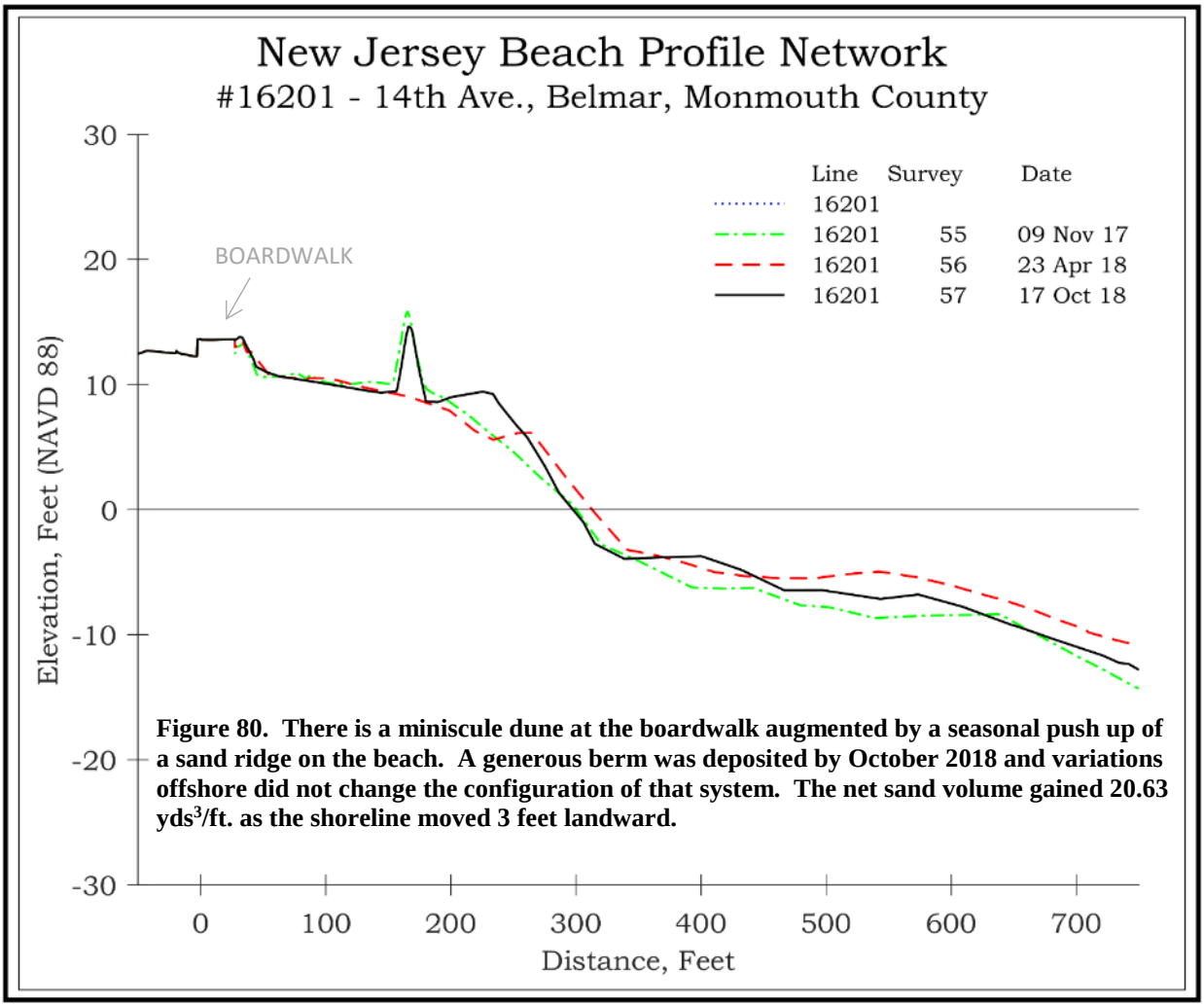
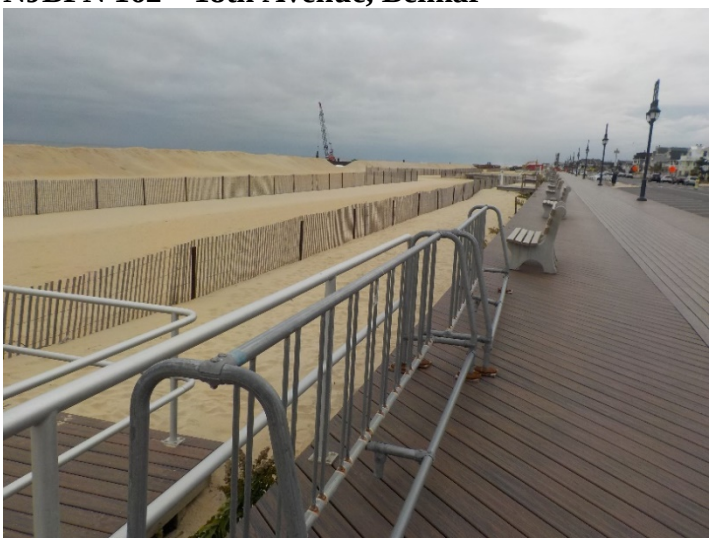


Figure 80. There is a miniscule dune at the boardwalk augmented by a seasonal push up of a sand ridge on the beach. A generous berm was deposited by October 2018 and variations offshore did not change the configuration of that system. The net sand volume gained 20.63 yds^3/ft. as the shoreline moved 3 feet landward.

NJBPN 162 – 18th Avenue, Belmar



The November 7, 2017 view on the left shows the new boardwalk and facilities built since Sandy with the storm ridge pushed up for the winter. The right photo is taken from the crest of the 2018 storm barrier pushed up by October 17, 2018 to help defend the boardwalk from winter events. No significant dune has been created along the Belmar waterfront.

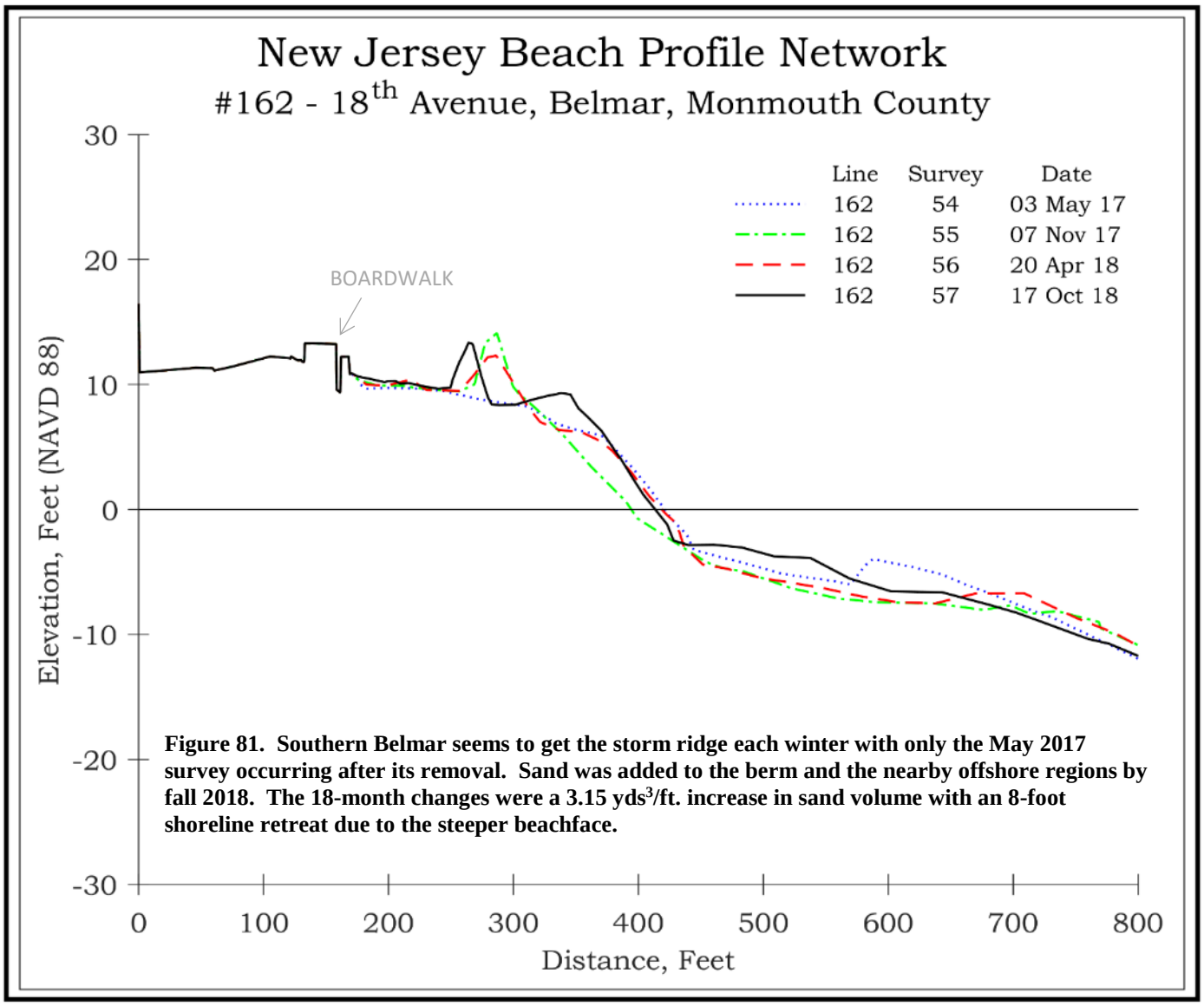
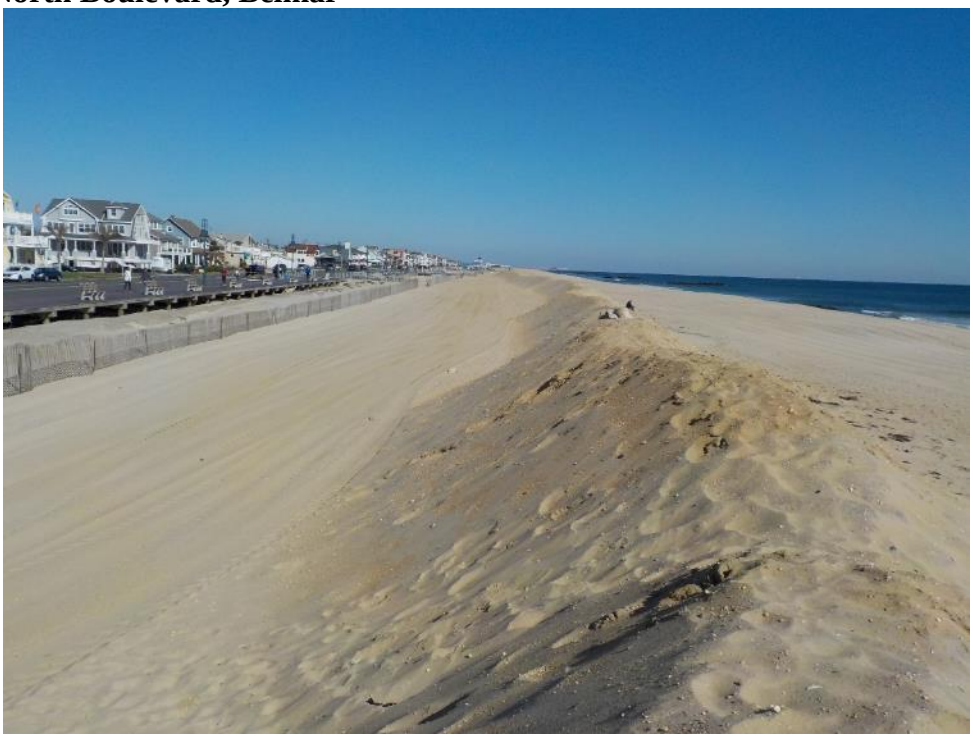


Figure 81. Southern Belmar seems to get the storm ridge each winter with only the May 2017 survey occurring after its removal. Sand was added to the berm and the nearby offshore regions by fall 2018. The 18-month changes were a 3.15 $yds^3/ft.$ increase in sand volume with an 8-foot shoreline retreat due to the steeper beachface.

NJBPN 16104 – North Boulevard, Belmar



This site is located on the north side of Lake Como, the estuary lake between Belmar and Spring Lake. The beach is 300 feet wide without a dune system present. Belmar continued the emergency sand ridge south to this position.

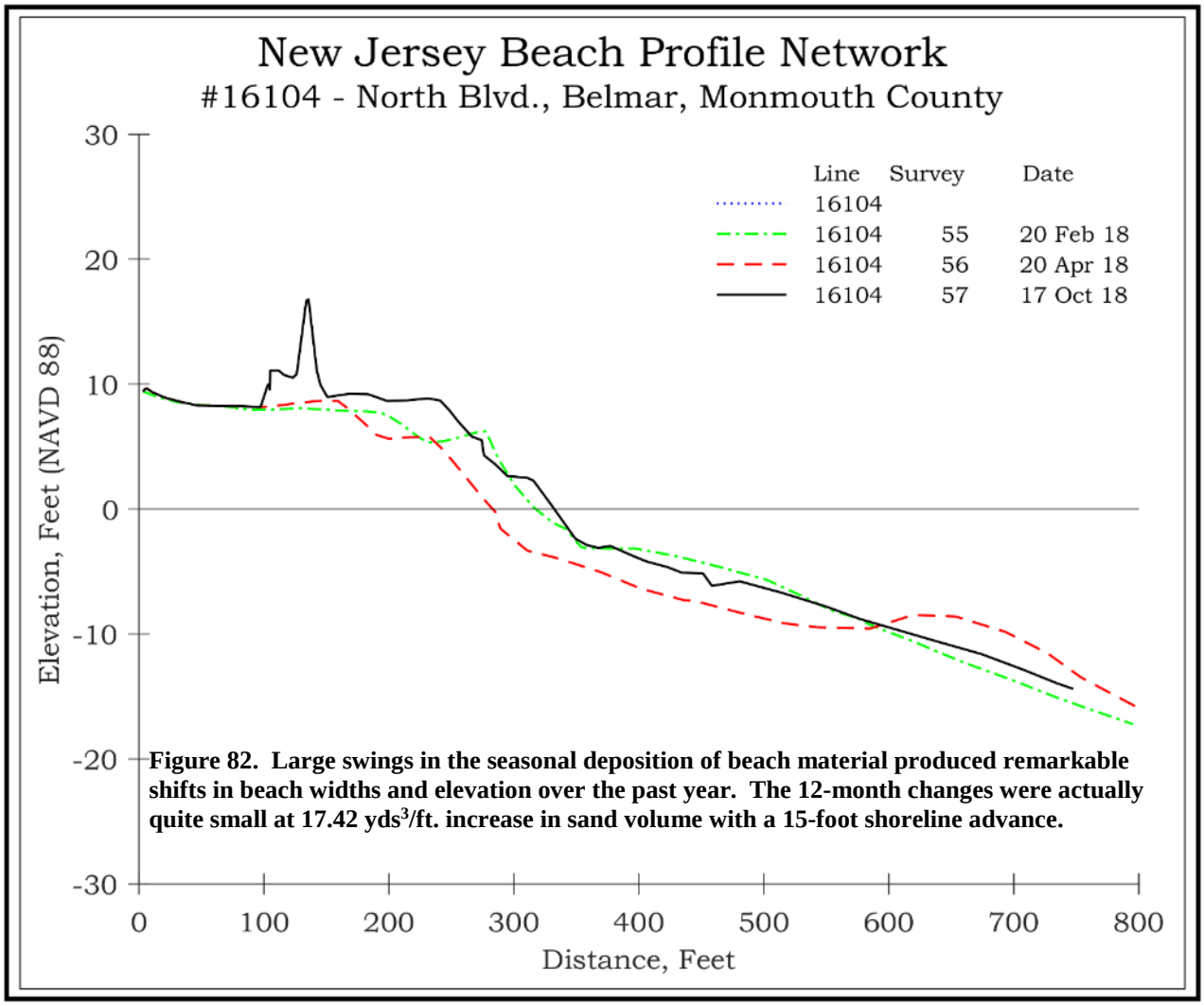
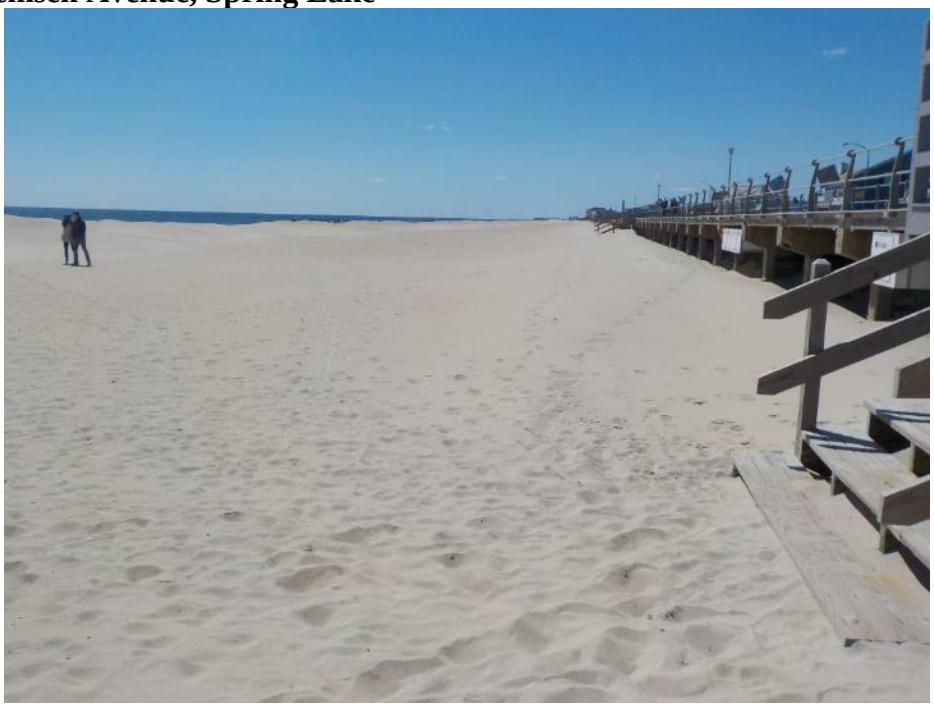


Figure 82. Large swings in the seasonal deposition of beach material produced remarkable shifts in beach widths and elevation over the past year. The 12-month changes were actually quite small at 17.42 yds^3/ft. increase in sand volume with a 15-foot shoreline advance.

NJBPN 16103 – Remsen Avenue, Spring Lake



A grass strip separates Ocean Avenue and the boardwalk. The municipality pushed up a storm wave barrier on the outer dry beach on the USACE fill in 2017, but not as of Oct. 2018. The beachface slope is quite uniform and leads to a gently sloped terrace with one small bar deposited on it.

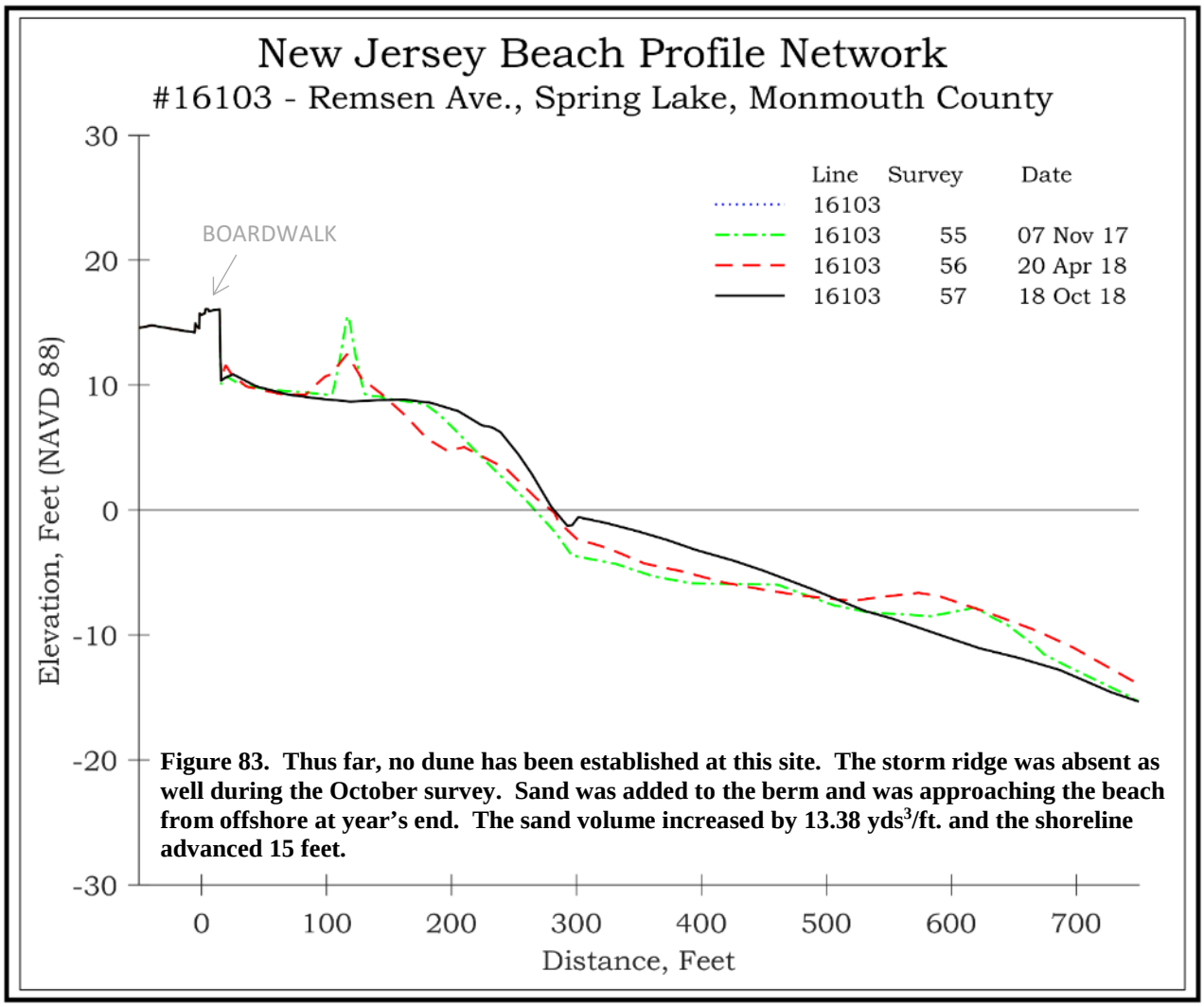


Figure 83. Thus far, no dune has been established at this site. The storm ridge was absent as well during the October survey. Sand was added to the berm and was approaching the beach from offshore at year's end. The sand volume increased by 13.38 yds^3/ft. and the shoreline advanced 15 feet.

NJBPN 16102 – Lorraine Avenue, Spring Lake

This site follows the same pattern as the site to the north with a boardwalk fronted by a 250-foot wide beach. There is a grass strip between the boardwalk and Ocean Avenue. In 2017 there was a winter emergency sand ridge, not present for the fall 2018 survey.

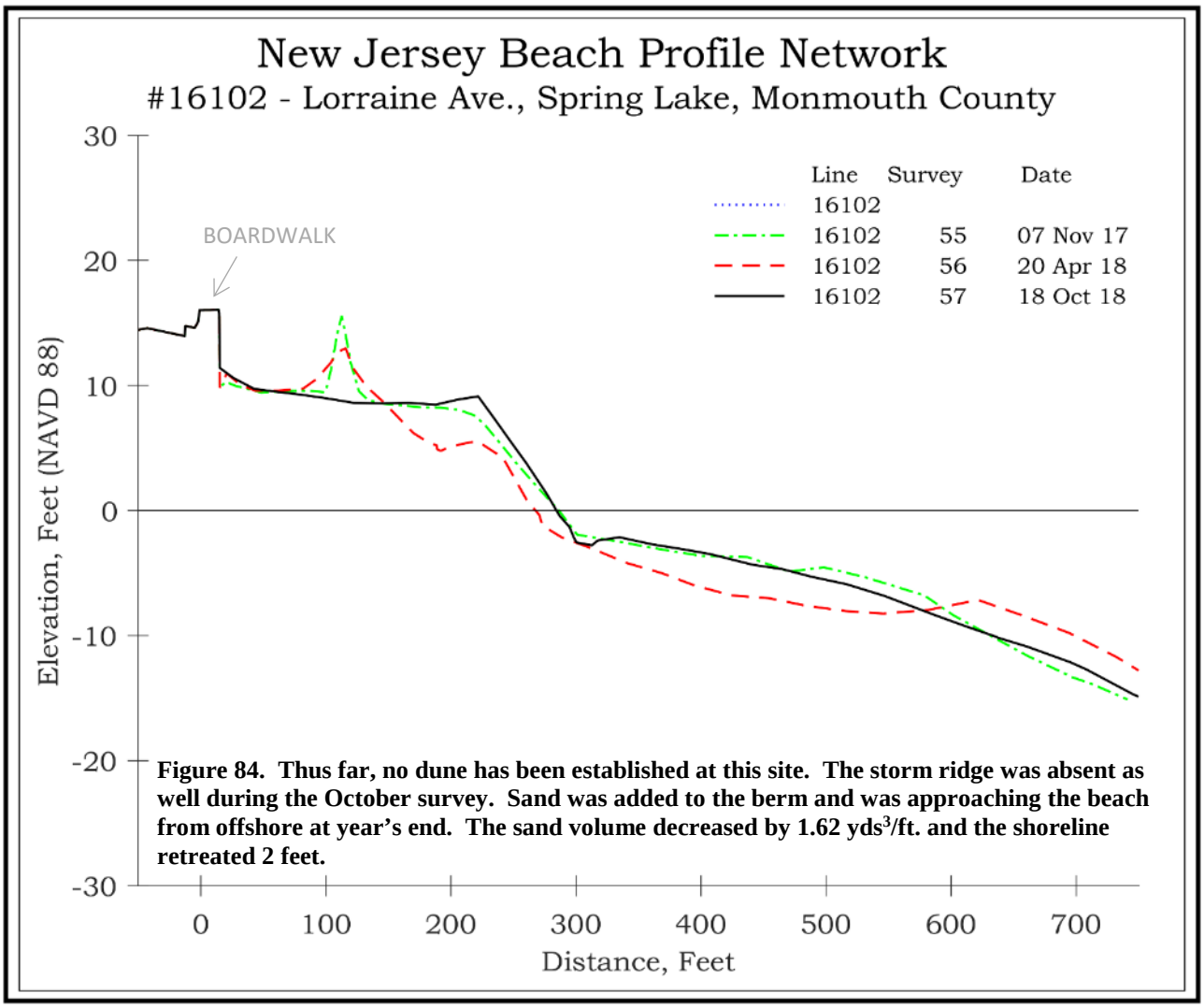


Figure 84. Thus far, no dune has been established at this site. The storm ridge was absent as well during the October survey. Sand was added to the berm and was approaching the beach from offshore at year's end. The sand volume decreased by 1.62 yds^3/ft. and the shoreline retreated 2 feet.

NJBPN 16101 – Tuttle Avenue, Spring Lake

At this site the dune deposit has appeared seaward of the boardwalk installation and the storm wave barrier lies just 60 feet from the boardwalk. There is another 100 feet of beach nearly at elevation 10.0 seaward of the sand ridge. Offshore there is a modest bar which appears to have moved toward the beach in the past year.

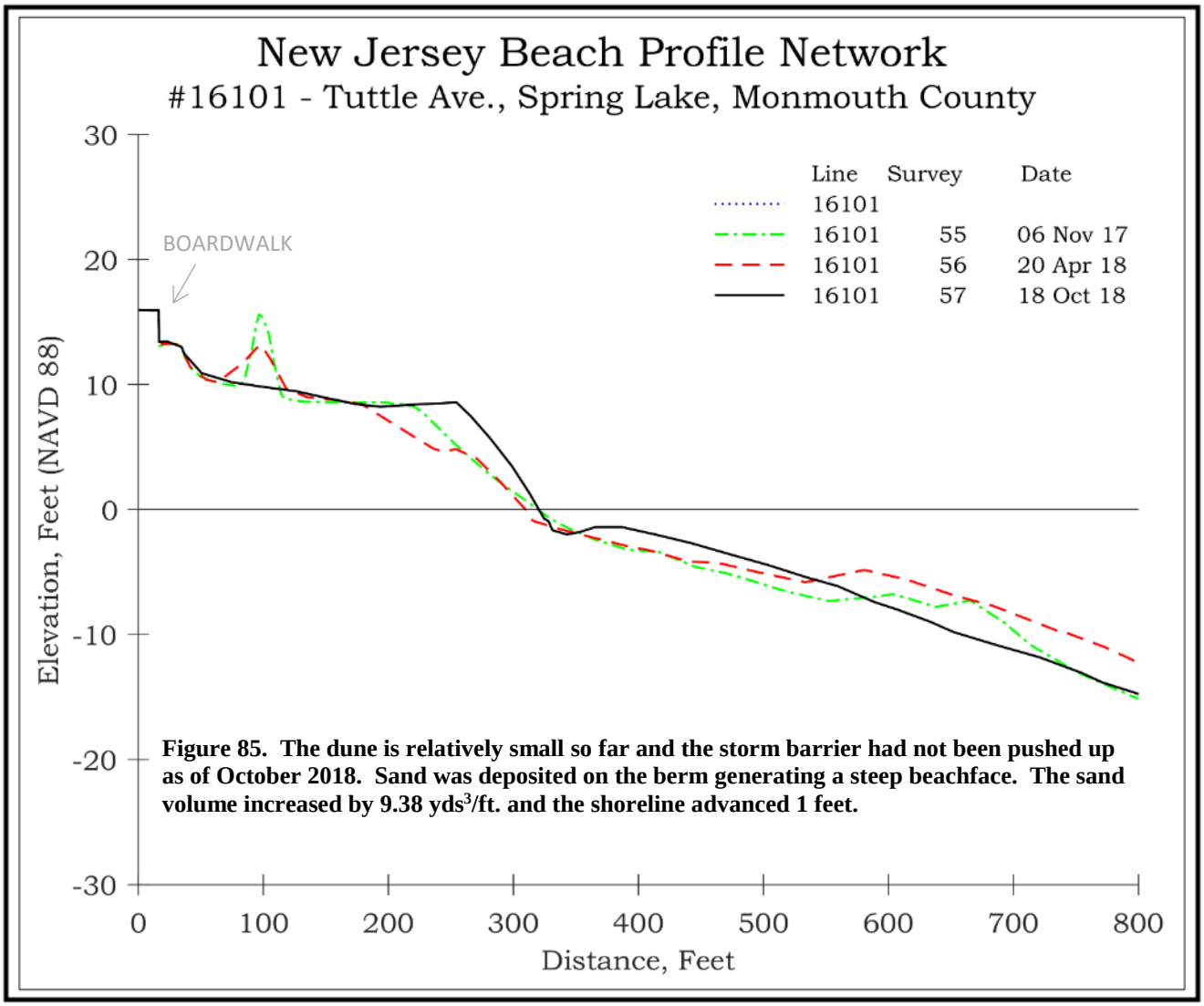
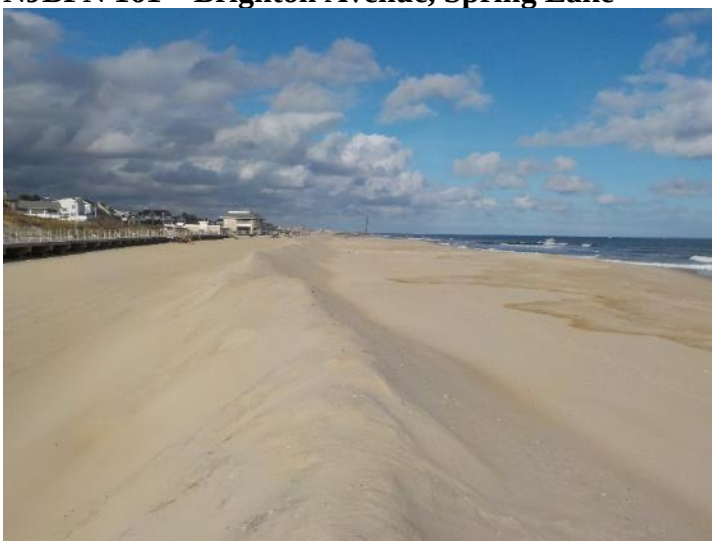


Figure 85. The dune is relatively small so far and the storm barrier had not been pushed up as of October 2018. Sand was deposited on the berm generating a steep beachface. The sand volume increased by 9.38 yds^3/ft. and the shoreline advanced 1 feet.

NJBPN 161 – Brighton Avenue, Spring Lake



The left photo shows the beach as of Nov. 6, 2017 looking north in Spring Lake from the crest of the storm ridge. The right photo was taken from where the storm ridge would be placed (Nov. 14, 2018).

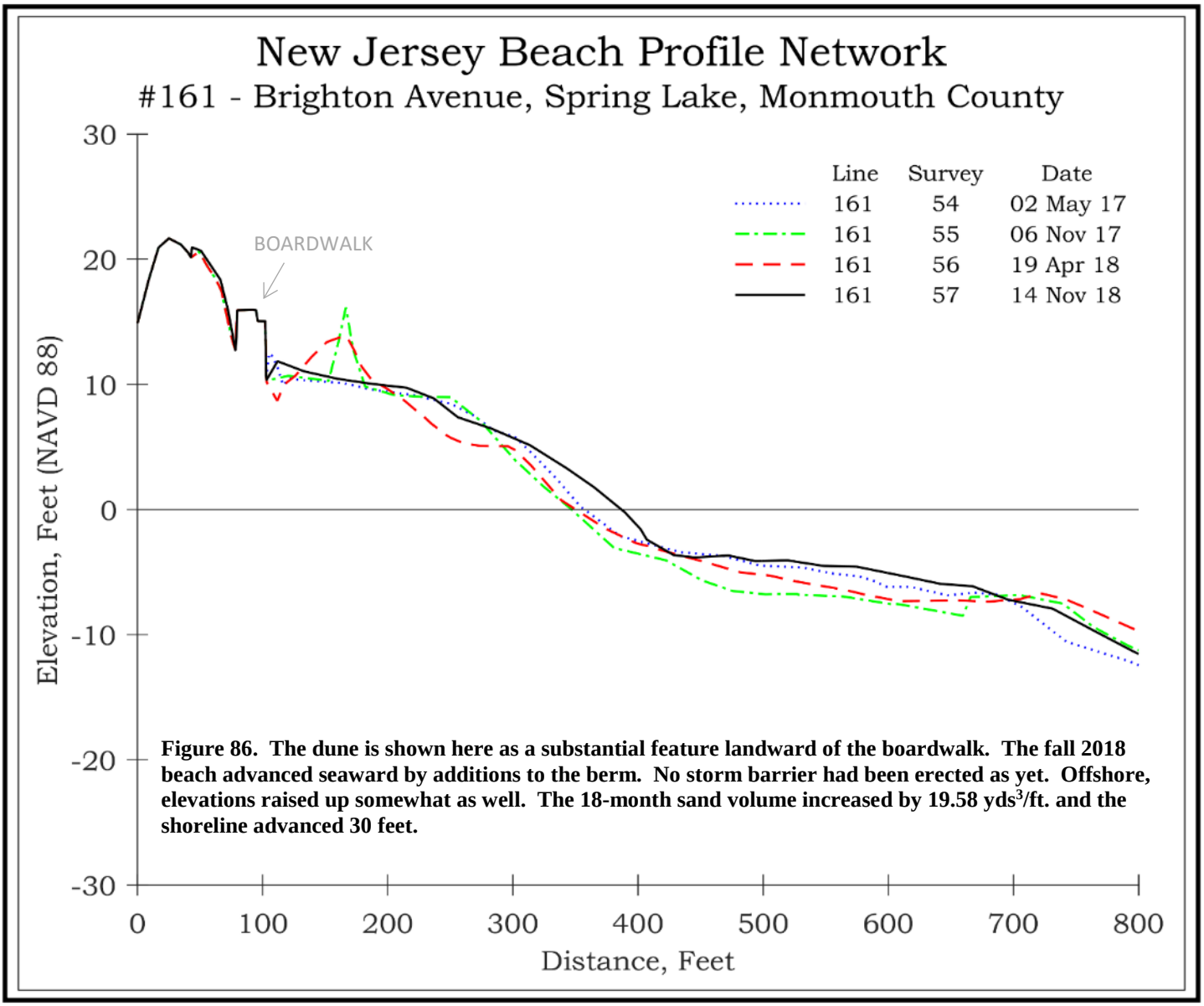


Figure 86. The dune is shown here as a substantial feature landward of the boardwalk. The fall 2018 beach advanced seaward by additions to the berm. No storm barrier had been erected as yet. Offshore, elevations raised up somewhat as well. The 18-month sand volume increased by 19.58 yds^3/ft. and the shoreline advanced 30 feet.

NJBPN 16004 – Madison Avenue, Spring Lake

The dune is robust between Ocean Avenue and the boardwalk. The fall 2017 storm barrier was not replicated by the time of the fall 2018 survey. Offshore the bar system increased in size and moved landward.

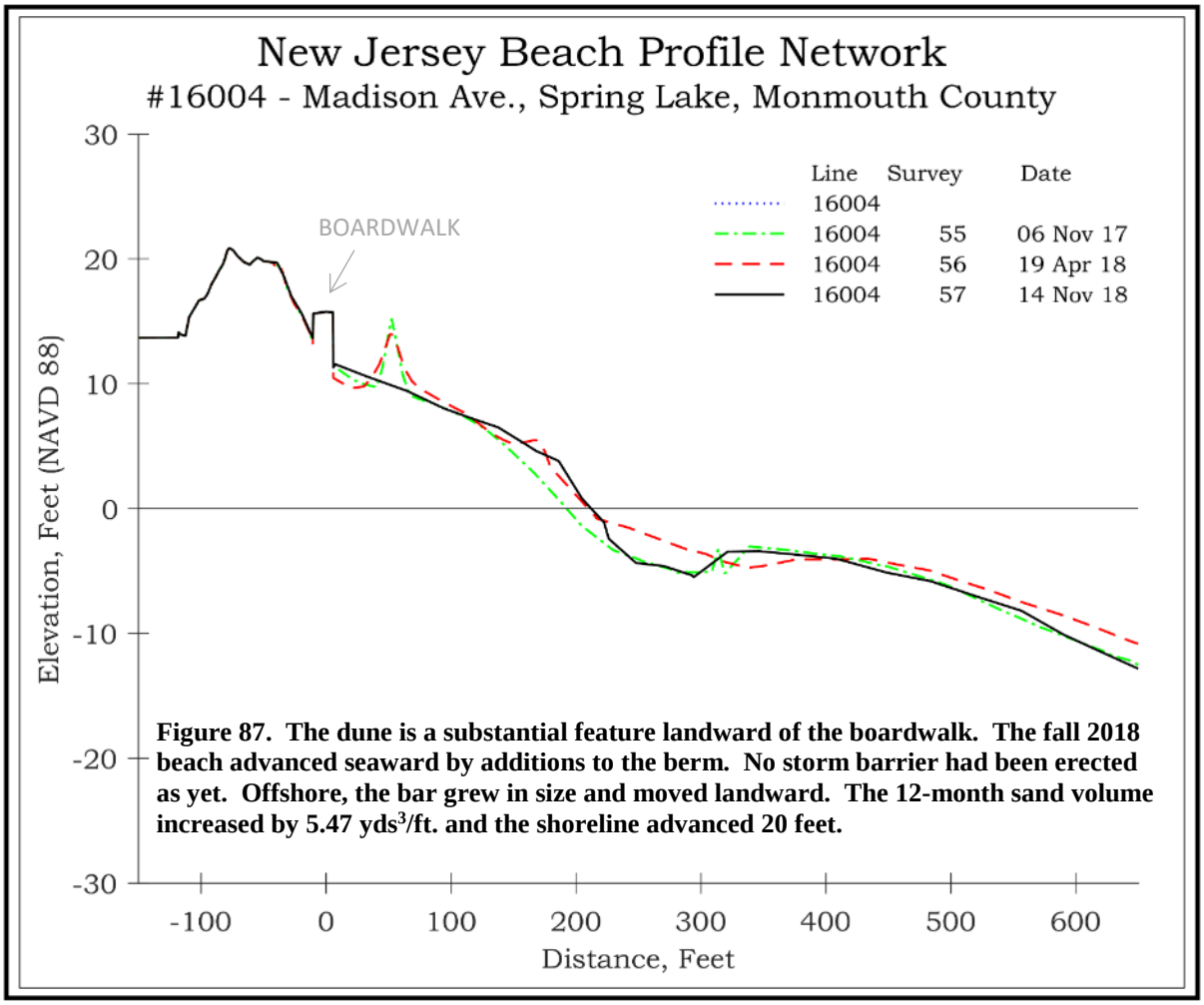


Figure 87. The dune is a substantial feature landward of the boardwalk. The fall 2018 beach advanced seaward by additions to the berm. No storm barrier had been erected as yet. Offshore, the bar grew in size and moved landward. The 12-month sand volume increased by 5.47 yds^3/ft. and the shoreline advanced 20 feet.

NJBPN 16003 – Morris Avenue, Spring Lake

The dune and boardwalk continue south without the storm barrier pushed as of the fall 2018 survey. There is a 300-foot wide terrace offshore without a bar present.

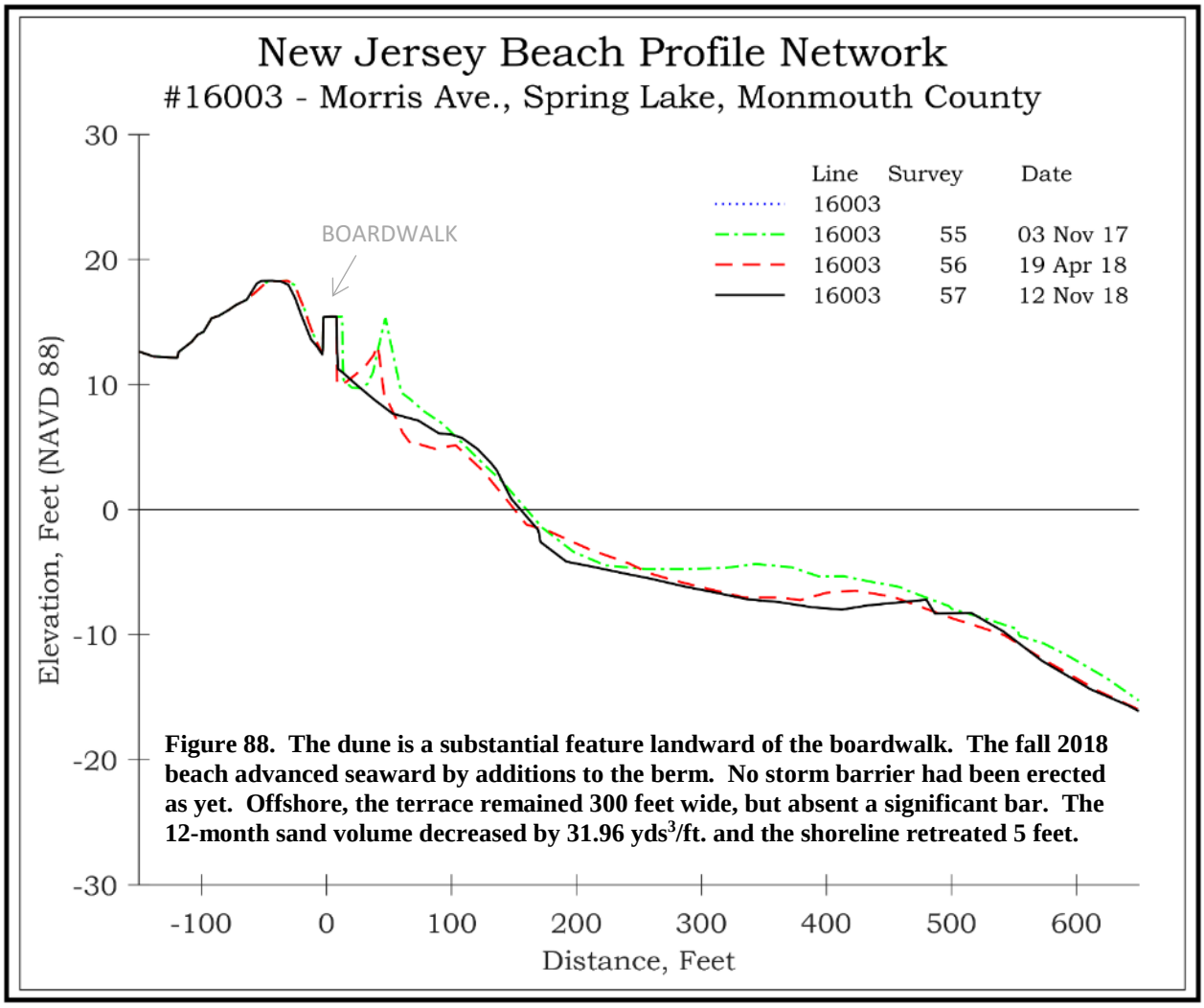


Figure 88. The dune is a substantial feature landward of the boardwalk. The fall 2018 beach advanced seaward by additions to the berm. No storm barrier had been erected as yet. Offshore, the terrace remained 300 feet wide, but absent a significant bar. The 12-month sand volume decreased by 31.96 yds^3/ft. and the shoreline retreated 5 feet.

NJBPN 16002 – Mercer Avenue, Spring Lake

The dune is slightly lower and narrower at Mercer Avenue with a distinct separation from the boardwalk. The storm barrier was not built at the time of the fall 2018 survey. the beachface slope ending in 4 feet of water begins at the seaward toe of the barrier. Offshore a substantial bar system exists.

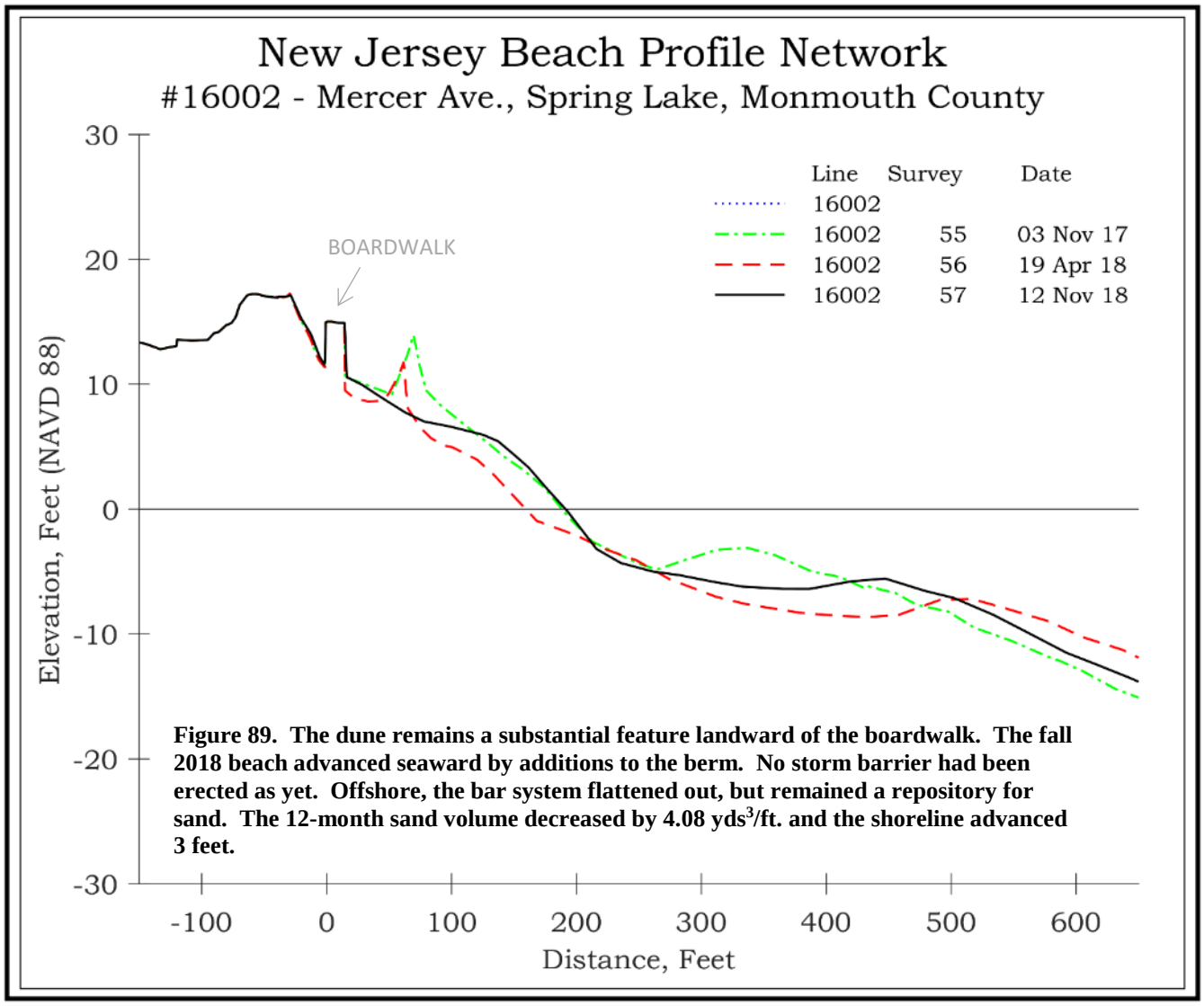


Figure 89. The dune remains a substantial feature landward of the boardwalk. The fall 2018 beach advanced seaward by additions to the berm. No storm barrier had been erected as yet. Offshore, the bar system flattened out, but remained a repository for sand. The 12-month sand volume decreased by 4.08 yds^3/ft. and the shoreline advanced 3 feet.

NJBPN 16001 – Essex Avenue, Spring Lake

The dune/boardwalk combination are quite large as a storm barrier. The fall 2018 survey did not include the emergency storm barrier.

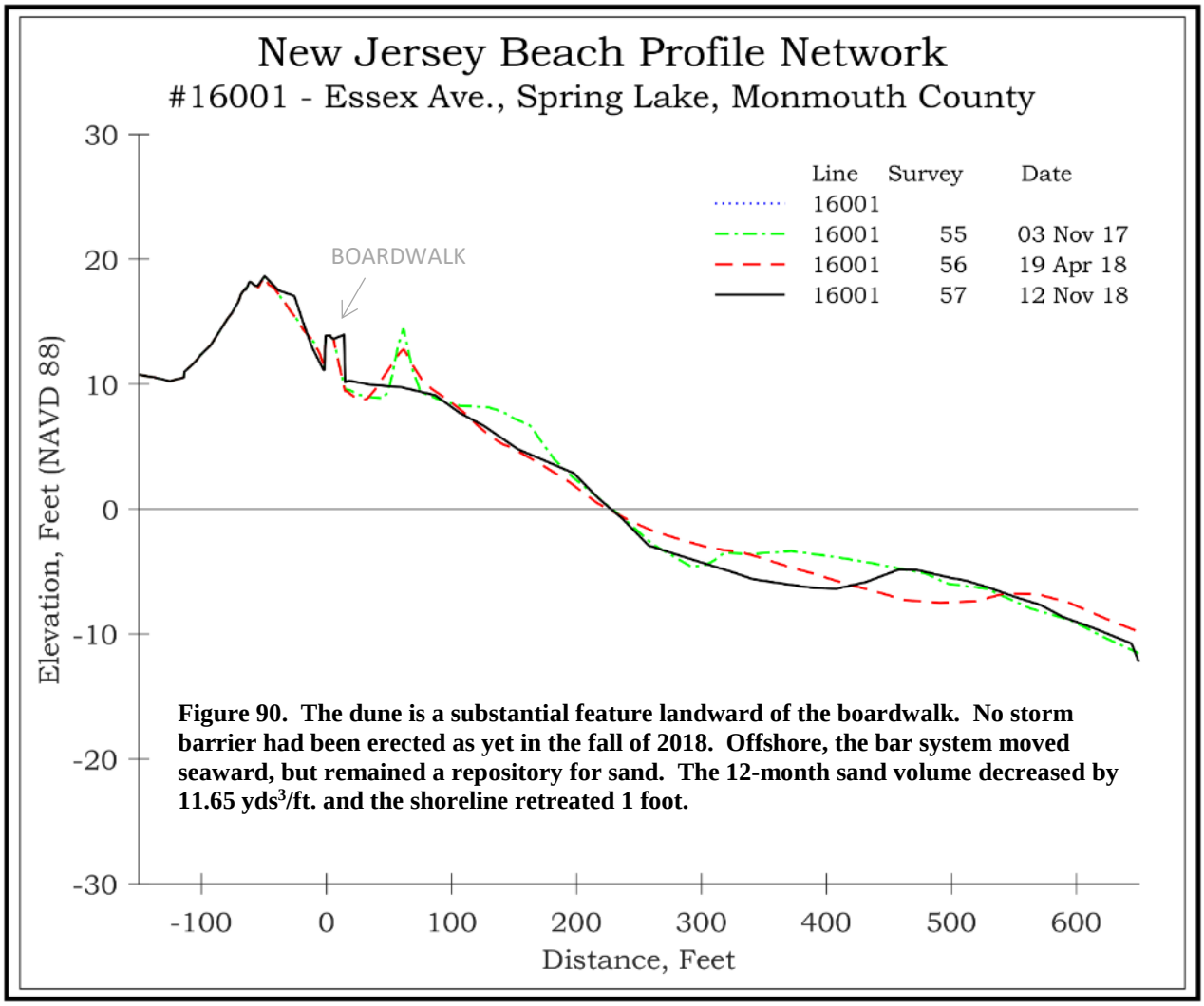


Figure 90. The dune is a substantial feature landward of the boardwalk. No storm barrier had been erected as yet in the fall of 2018. Offshore, the bar system moved seaward, but remained a repository for sand. The 12-month sand volume decreased by 11.65 yds^3/ft. and the shoreline retreated 1 foot.

NJBPN 160 – Salem Avenue, Spring Lake

The Salem Avenue beach site lies just south of one of the municipal beach facilities. The left photo was taken Sept. 29, 2017 showing a decent berm and wide, dry beach. On the right, the November 12, 2018 view shows a similar beach in place.

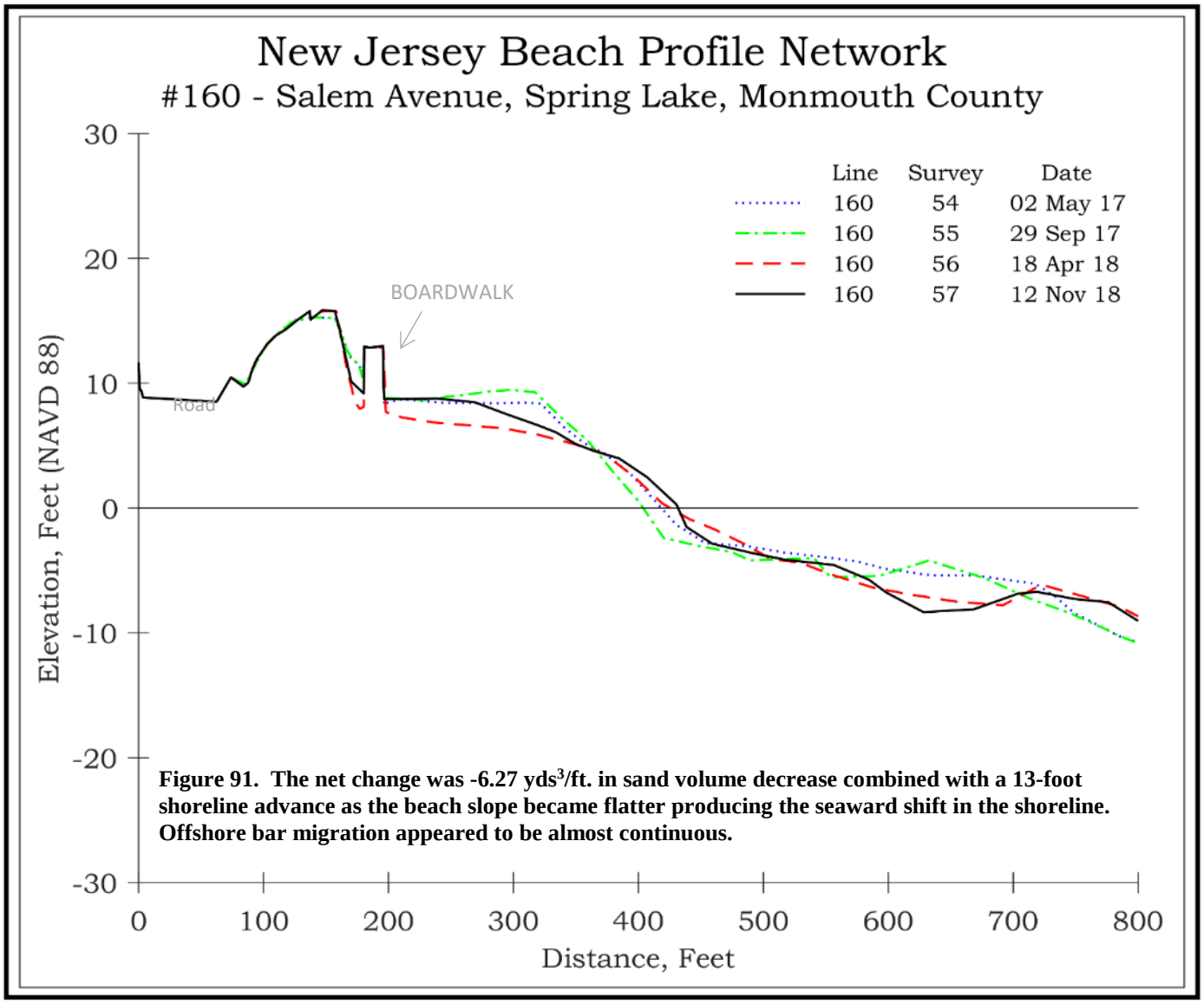


Figure 91. The net change was -6.27 yds^3/ft. in sand volume decrease combined with a 13-foot shoreline advance as the beach slope became flatter producing the seaward shift in the shoreline. Offshore bar migration appeared to be almost continuous.

NJBPN 15902 – Union Avenue, Spring Lake

This site has a narrow dune with the boardwalk seaward of it without the storm barrier sand ridge (as of Nov. 14th). There is a 100-foot wide, 10.0-foot elevation beach seaward of the boardwalk with a significant offshore bar system present.

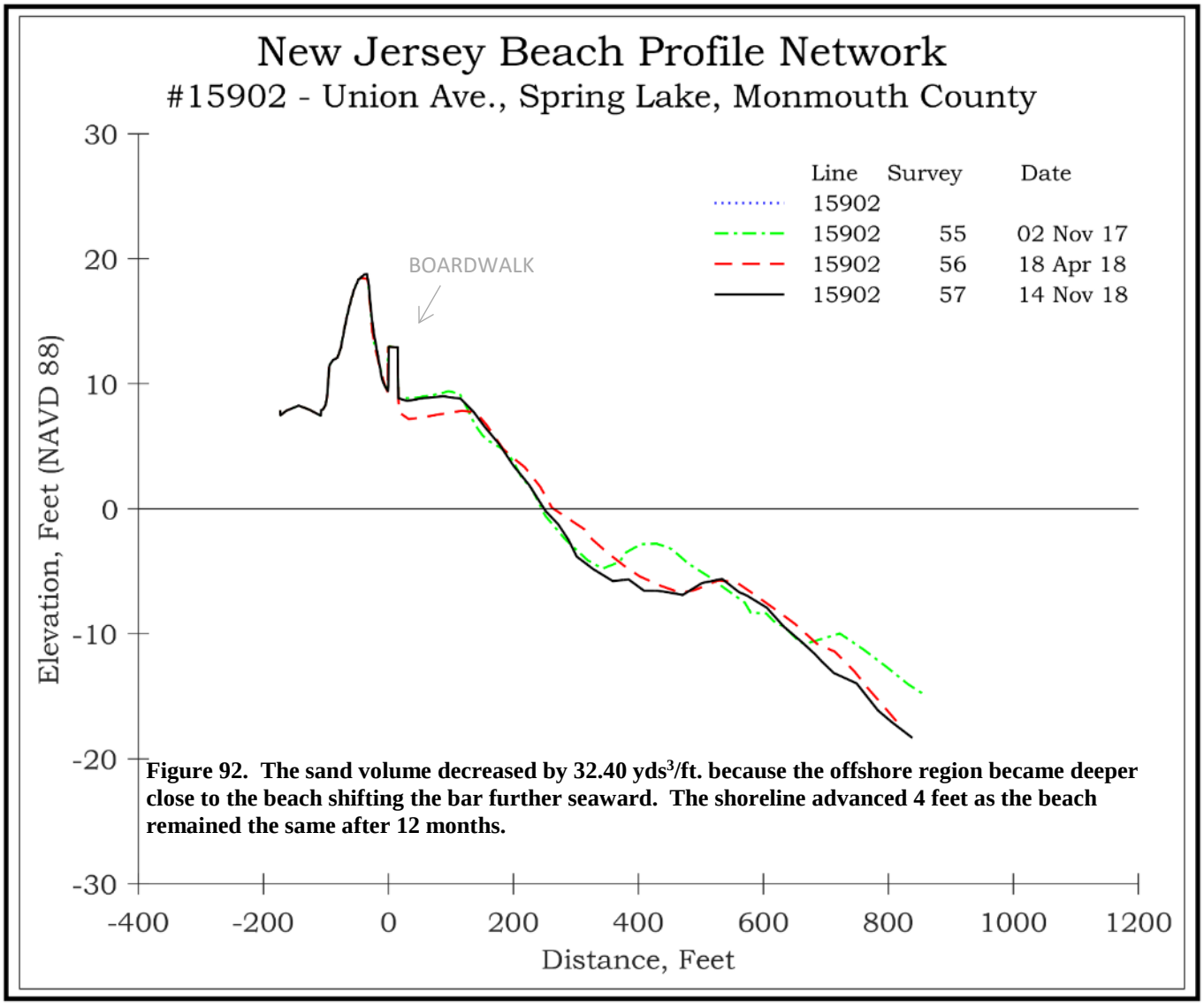


Figure 92. The sand volume decreased by 32.40 yds^3/ft. because the offshore region became deeper close to the beach shifting the bar further seaward. The shoreline advanced 4 feet as the beach remained the same after 12 months.

NJBPN 15901 – Brown Avenue, Spring Lake

At the south end of Spring Lake, the dune is not significantly higher than the surface of the boardwalk. The storm barrier is not present as of Nov 12th at this location with a 70-foot wide beach seaward of it. There is a small offshore bar present well seaward. The recently rebuilt Wreck Pond flume for fresh water to reach the ocean lies just to the south.

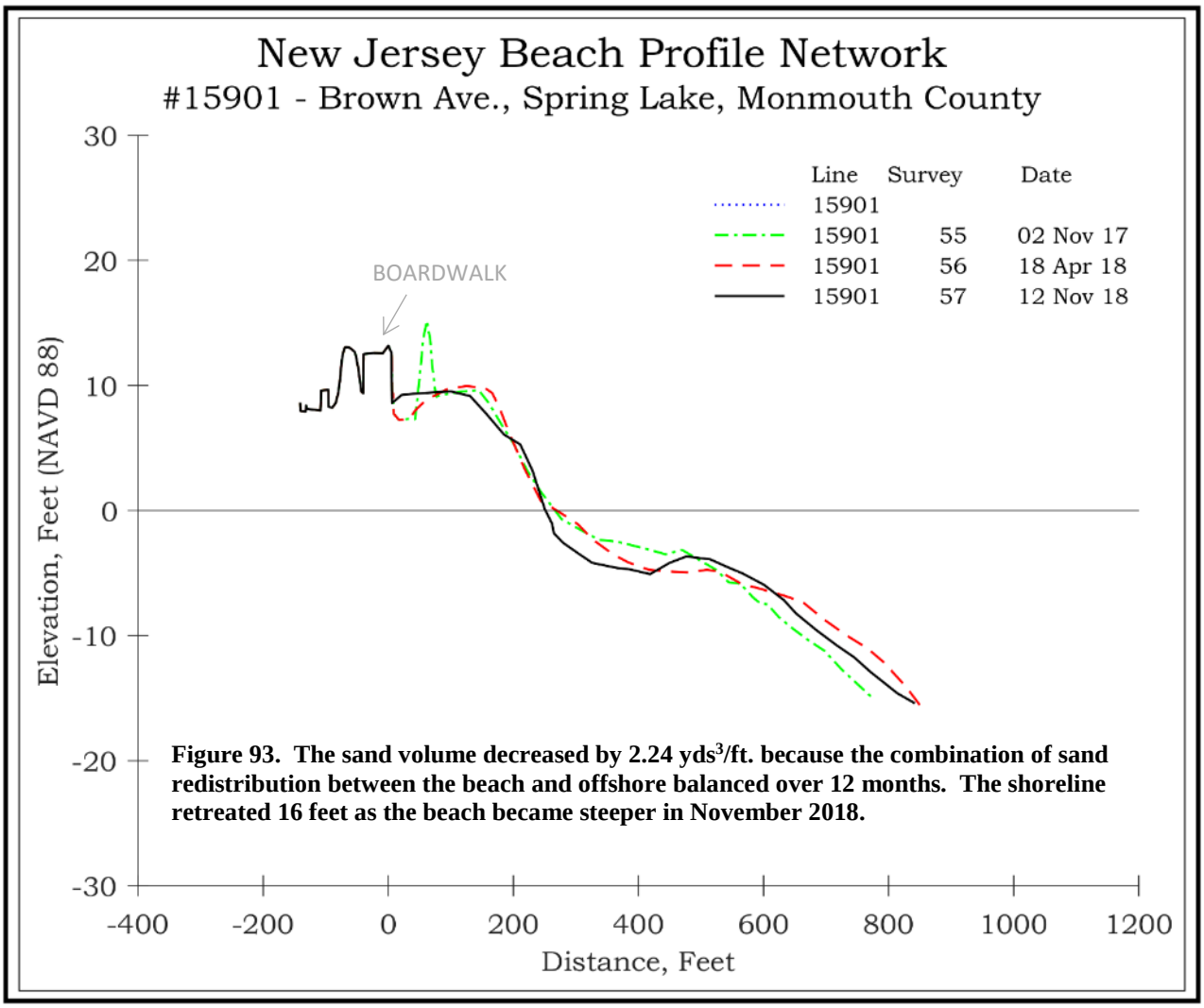


Figure 93. The sand volume decreased by 2.24 yds^3/ft. because the combination of sand redistribution between the beach and offshore balanced over 12 months. The shoreline retreated 16 feet as the beach became steeper in November 2018.

NJBPN 159 – New York Avenue, Sea Girt

The northern site in Sea Girt had the dune restored after Sandy. The Sept. 29, 2017 northerly view was taken from the dune crest (left photo). The Nov. 12, 2018 view (right photo) shows grass growth, and some added sand but the pedestrian gaps at the beach elevation will direct major storm waves through with dire consequences for the boardwalk.

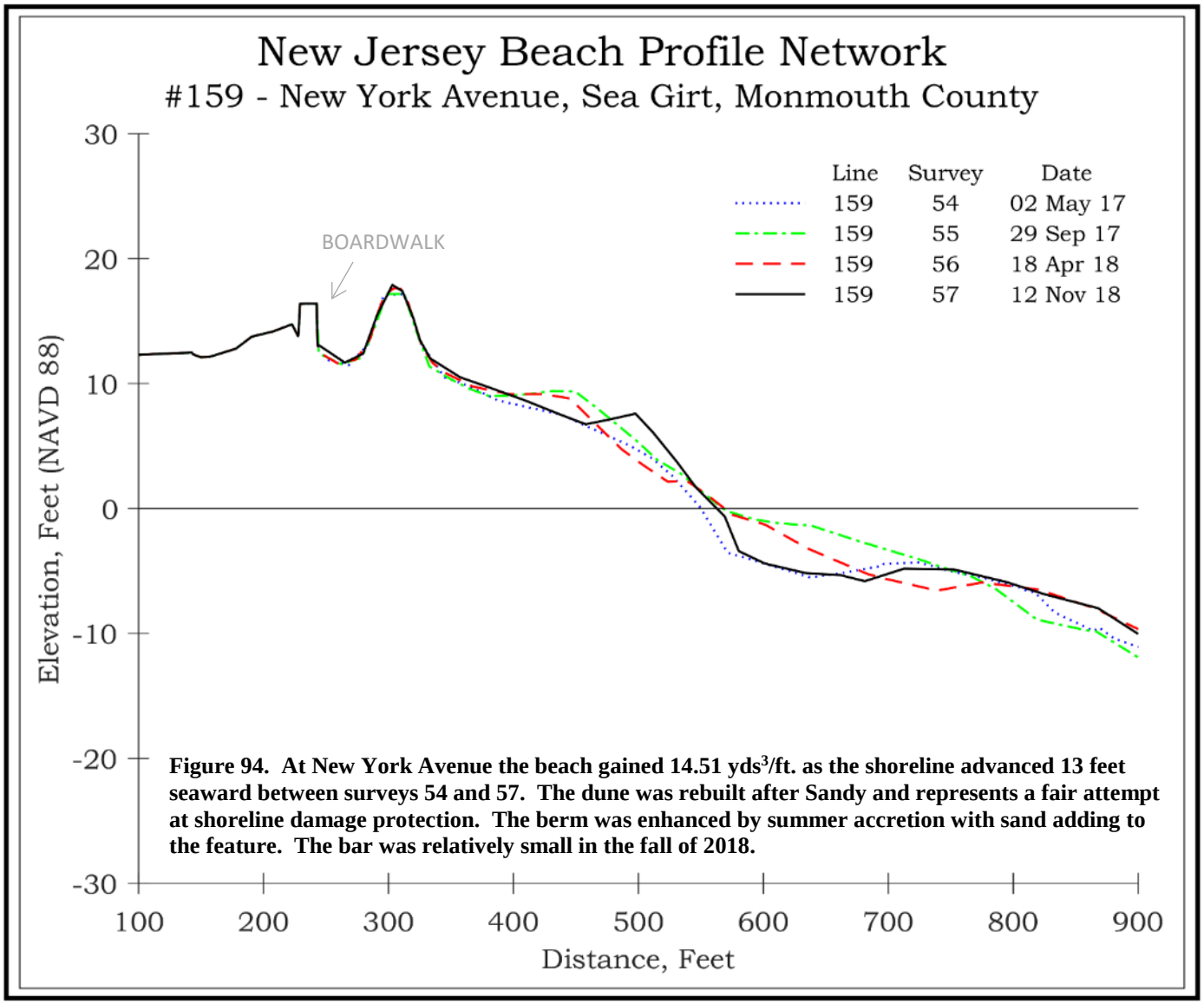


Figure 94. At New York Avenue the beach gained 14.51 yds^3/ft. as the shoreline advanced 13 feet seaward between surveys 54 and 57. The dune was rebuilt after Sandy and represents a fair attempt at shoreline damage protection. The berm was enhanced by summer accretion with sand adding to the feature. The bar was relatively small in the fall of 2018.

NJBPN 15801 – Crescent Park, Sea Girt

The landward limit of this site corresponds to the last segment of the Monmouth County coastal bluff exposed at the shoreline. The boardwalk is the starting point for the survey. The dune and beach occupy the first 200 feet of the cross section with a beachface that ends in 4 feet of water. There is a minor bar offshore.

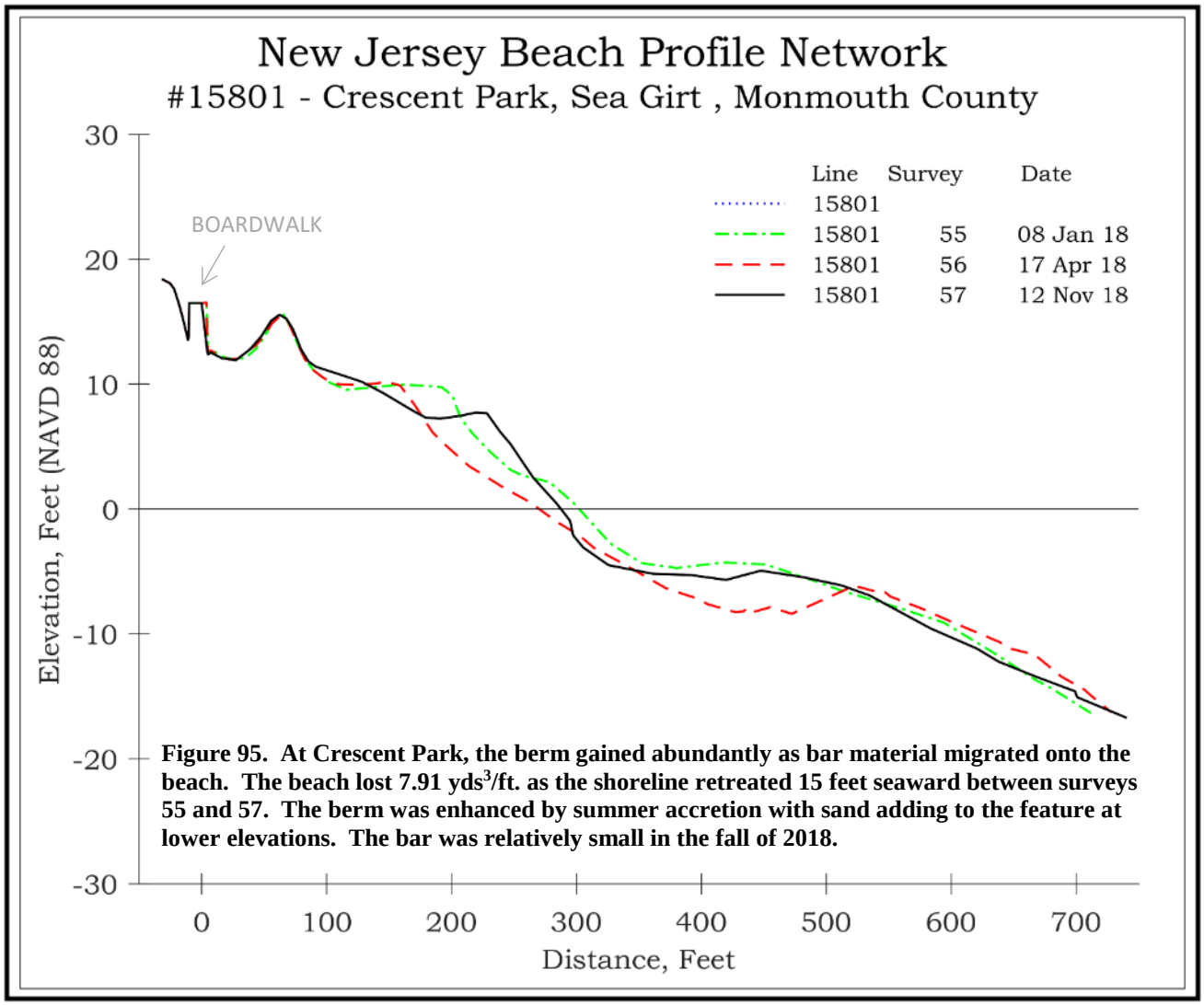


Figure 95. At Crescent Park, the berm gained abundantly as bar material migrated onto the beach. The beach lost 7.91 yds^3/ft. as the shoreline retreated 15 feet seaward between surveys 55 and 57. The berm was enhanced by summer accretion with sand adding to the feature at lower elevations. The bar was relatively small in the fall of 2018.

NJBPN 158 – Trenton Avenue, Sea Girt

The Sept. 28, 2017 view on the left shows the dune toe view to the north seaward of both the dune and the boardwalk. The Nov. 12, 2018 view (right photo) is from the berm and dry beach extending seaward of the dunes looking north.

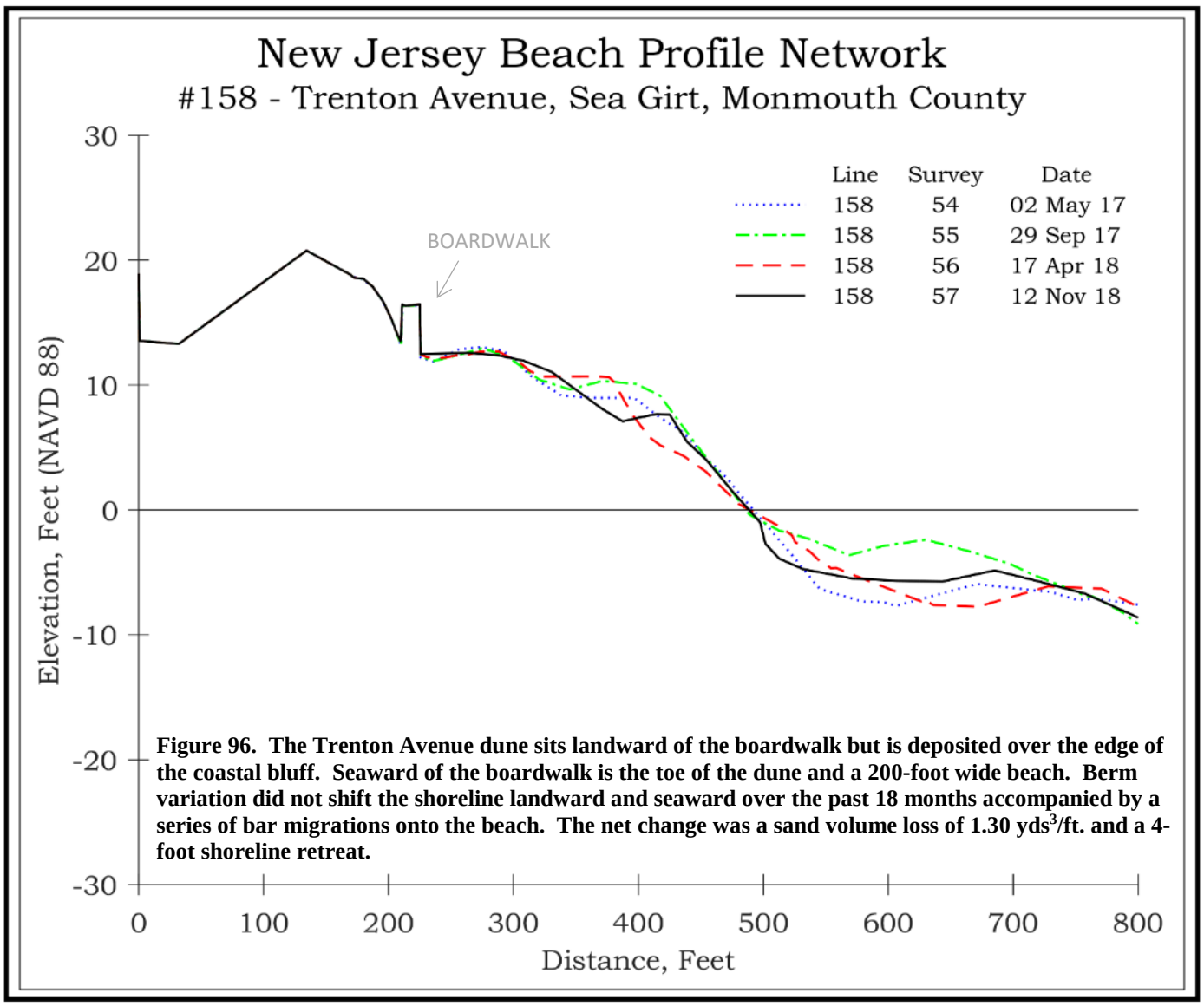


Figure 96. The Trenton Avenue dune sits landward of the boardwalk but is deposited over the edge of the coastal bluff. Seaward of the boardwalk is the toe of the dune and a 200-foot wide beach. Berm variation did not shift the shoreline landward and seaward over the past 18 months accompanied by a series of bar migrations onto the beach. The net change was a sand volume loss of 1.30 yds^3/ft. and a 4-foot shoreline retreat.

NJBPN 15703 – Seaside Place, Sea Girt

Located at the southern limit of Sea Girt, this site has a dune with a narrow beach which drops steeply into the ocean. There is a modest offshore bar positioned very close to the base of the beachface.

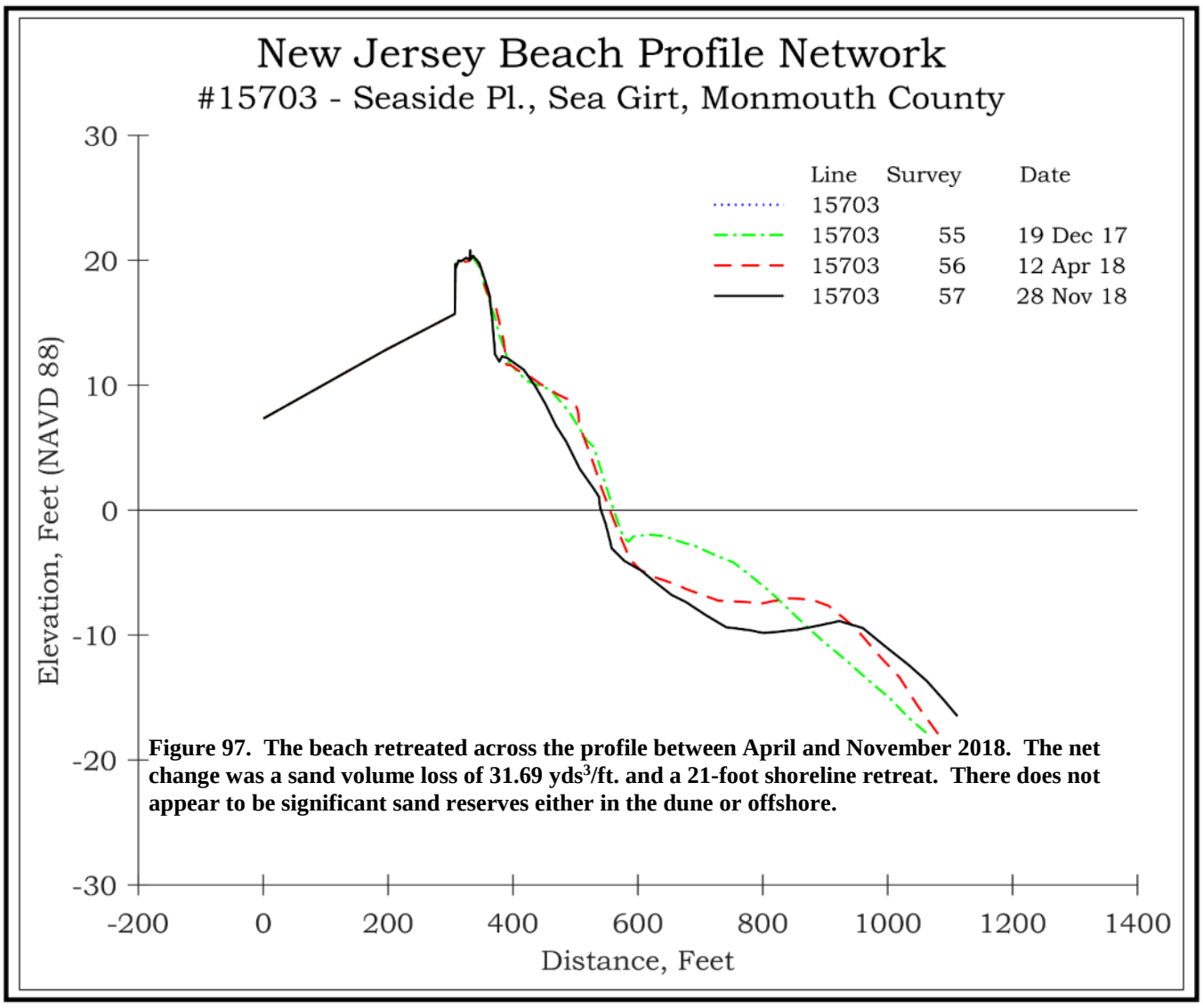


Figure 97. The beach retreated across the profile between April and November 2018. The net change was a sand volume loss of 31.69 yds^3/ft. and a 21-foot shoreline retreat. There does not appear to be significant sand reserves either in the dune or offshore.

NJBPN 15702 – NGTC - North, Sea Girt

The extraordinary dune elevation is because the National Guard shooting range ends at its landward side, so the extra height was added to stop bullets. This beach is off limits to the public, about 150 feet wide with an offshore bar.

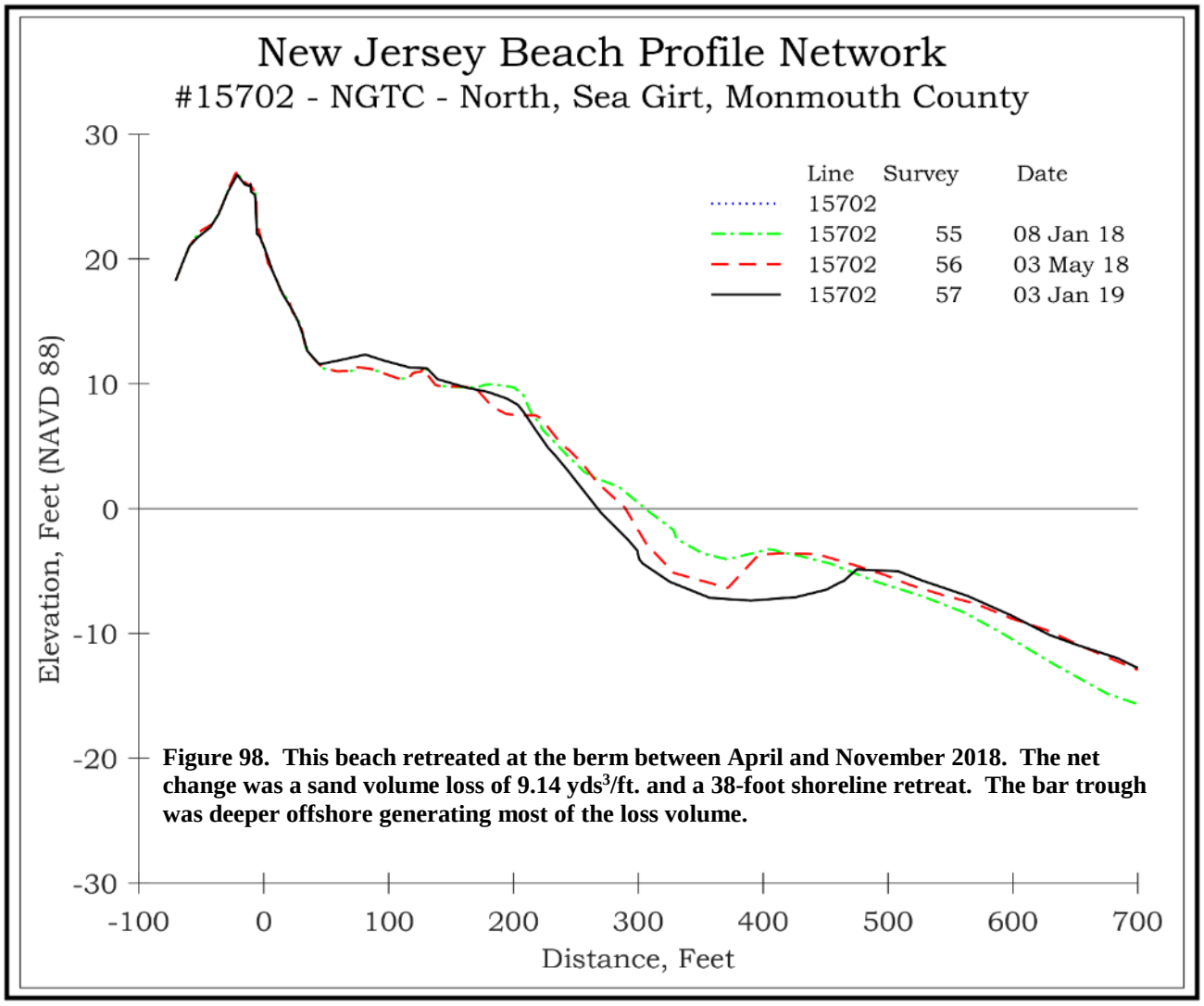


Figure 98. This beach retreated at the berm between April and November 2018. The net change was a sand volume loss of 9.14 yds^3/ft. and a 38-foot shoreline retreat. The bar trough was deeper offshore generating most of the loss volume.

NJBPN 15701 – NGTC - South, Sea Girt

This site is located at the south end of the National Guard training facility beachfront. The dune is lower because it is outside the rifle range aiming area. The beach is 300 feet wide with minimal bar development offshore.

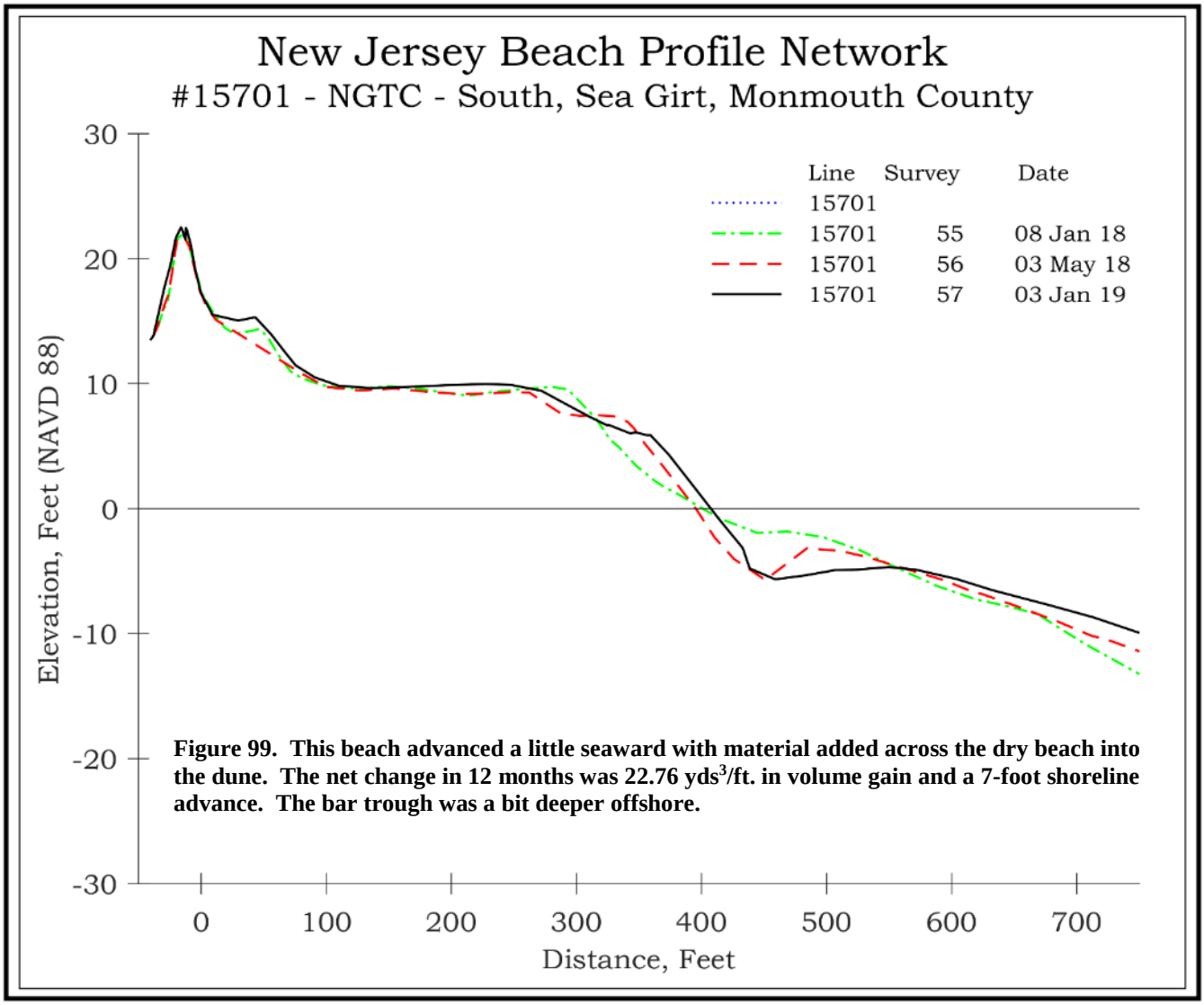
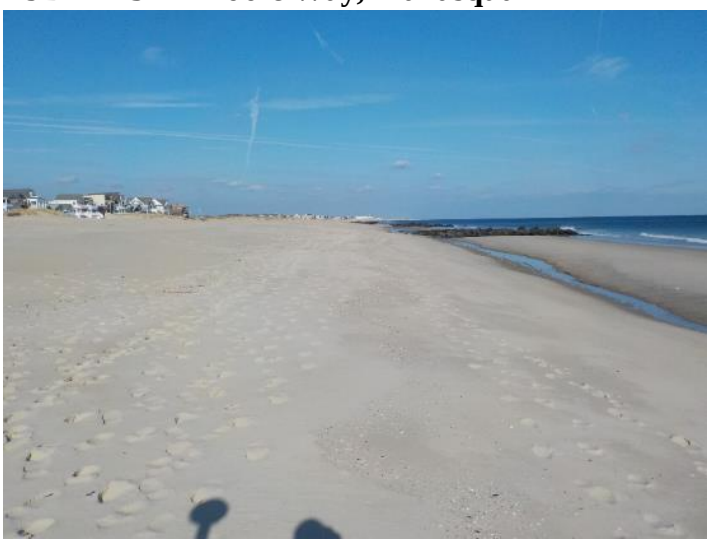


Figure 99. This beach advanced a little seaward with material added across the dry beach into the dune. The net change in 12 months was 22.76 yds^3/ft. in volume gain and a 7-foot shoreline advance. The bar trough was a bit deeper offshore.

NJBPN 157 – Riddle Way, Manasquan



The Dec. 19, 2017 view to the north in Manasquan (left photo) shows a sizable bar moving onto the beach The Nov. 27, 2018 view (right photo) was taken at the row of fencing placed in an attempt to keep the sand off the promenade.

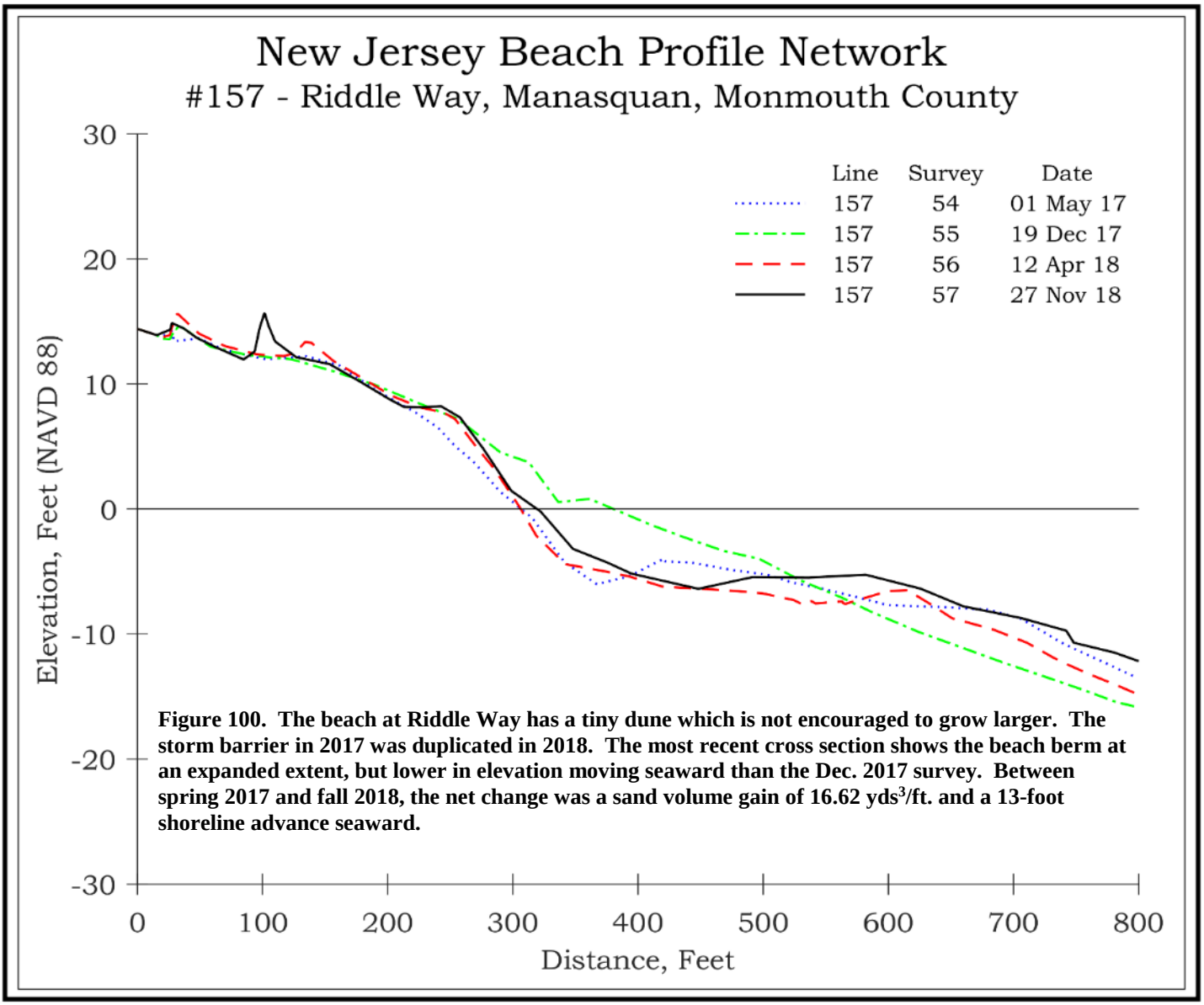
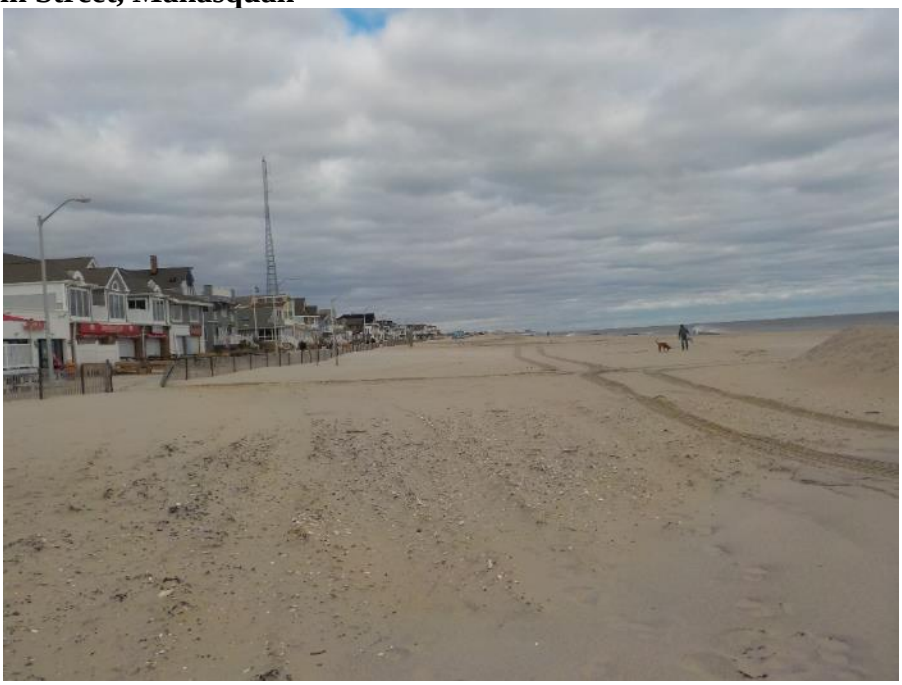


Figure 100. The beach at Riddle Way has a tiny dune which is not encouraged to grow larger. The storm barrier in 2017 was duplicated in 2018. The most recent cross section shows the beach berm at an expanded extent, but lower in elevation moving seaward than the Dec. 2017 survey. Between spring 2017 and fall 2018, the net change was a sand volume gain of 16.62 yds^3/ft. and a 13-foot shoreline advance seaward.

NJBPN 25602 – Main Street, Manasquan



Nearly the identical beach configuration was surveyed at this location as was seen at Riddle Way on the initial survey. The tiny dune lies immediately seaward of an asphalt promenade in front of the private homes. Sand is pushed into a ridge, but not everywhere in Manasquan.

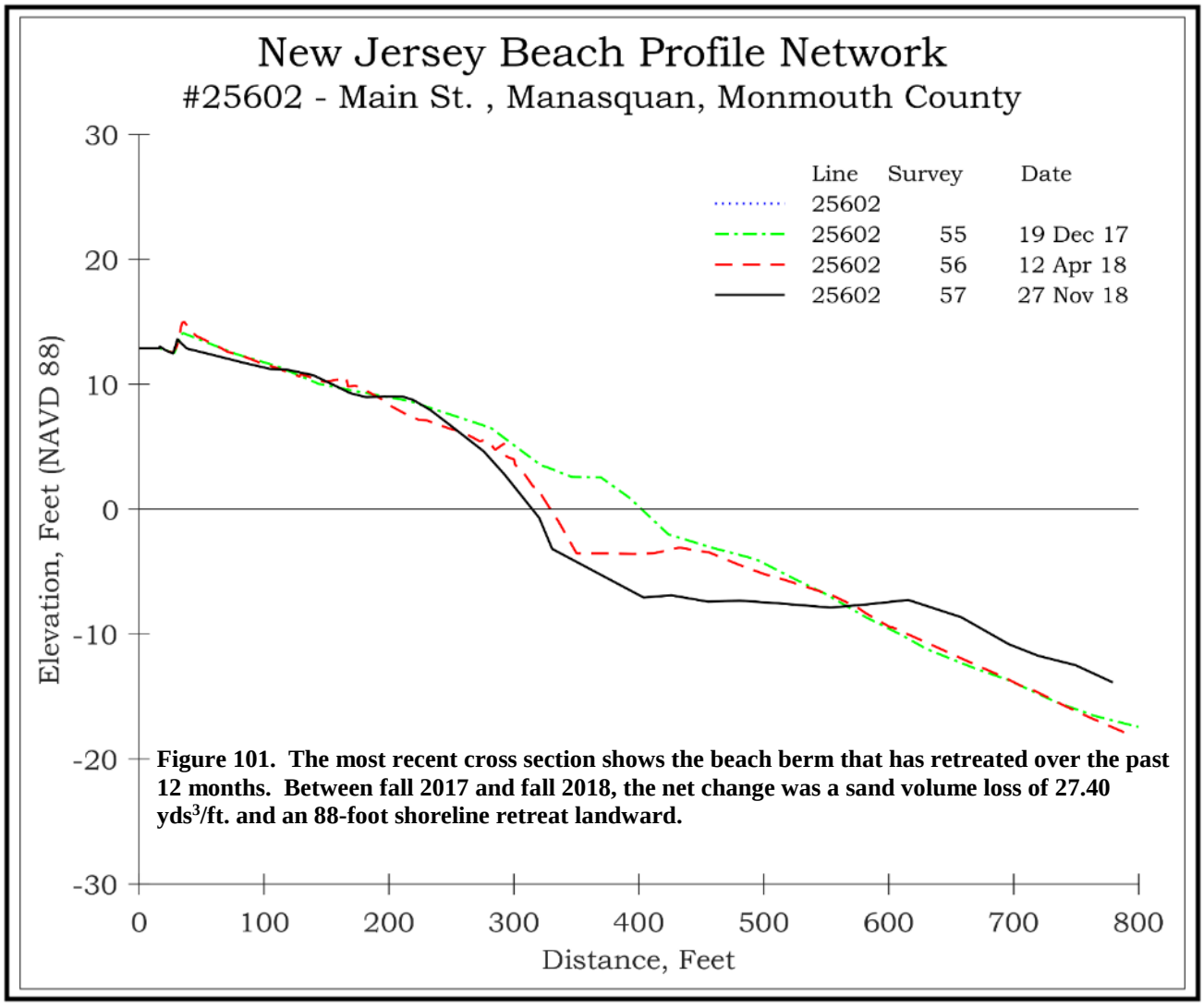


Figure 101. The most recent cross section shows the beach berm that has retreated over the past 12 months. Between fall 2017 and fall 2018, the net change was a sand volume loss of 27.40 yds^3/ft. and an 88-foot shoreline retreat landward.

NJBPN 25601 – Brielle Road, Manasquan

The December 2017 surveys of the Manasquan beach seemed to follow a pattern of relatively generalized slopes into the ocean without any offshore features (bar or terrace development). This changed at all sites by April 2018 where berm erosion provided sand to the offshore region creating the bar system.

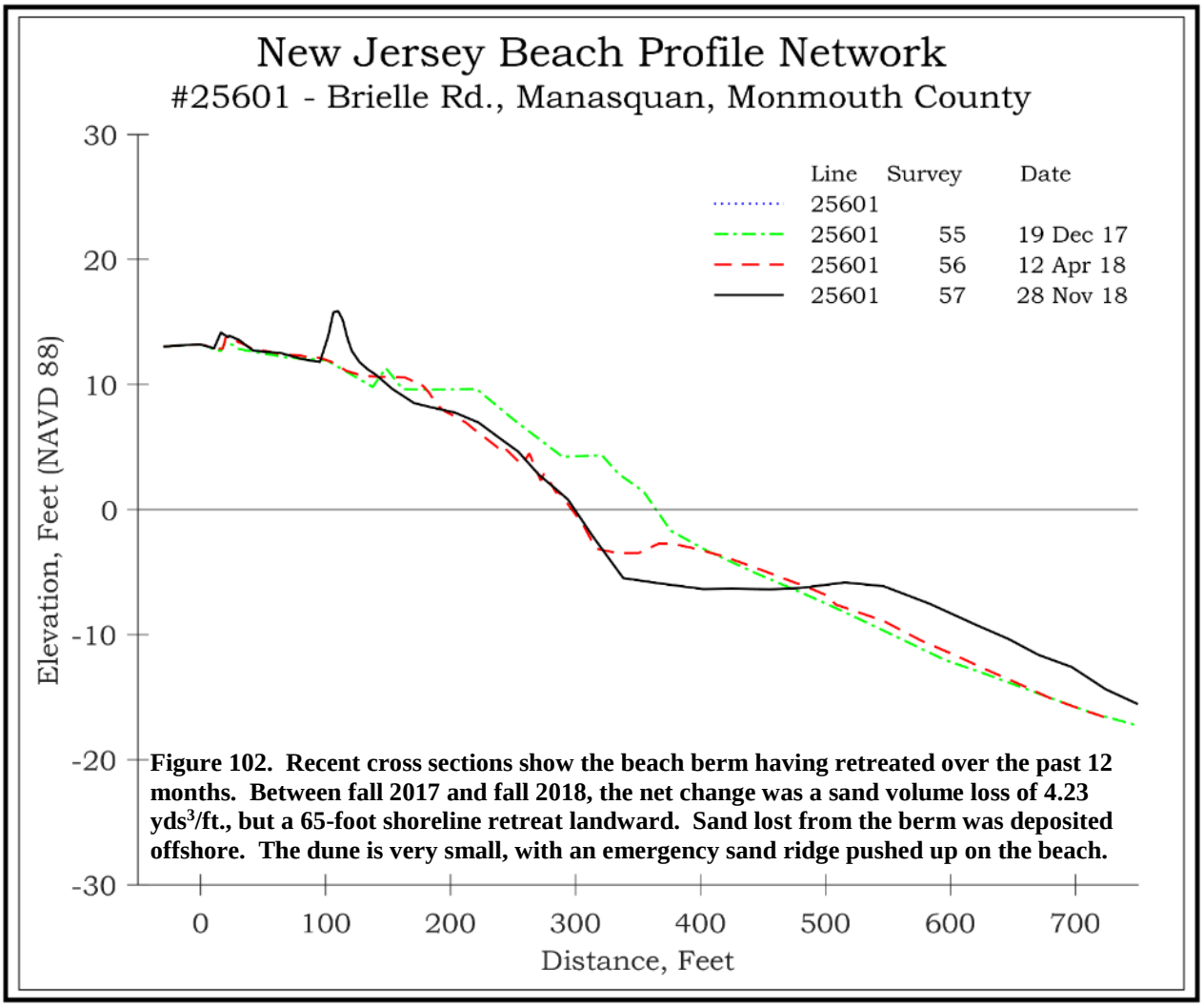
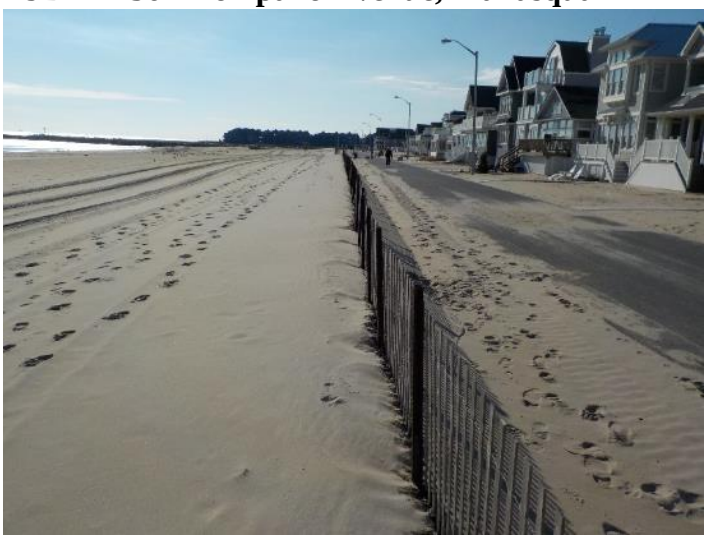


Figure 102. Recent cross sections show the beach berm having retreated over the past 12 months. Between fall 2017 and fall 2018, the net change was a sand volume loss of 4.23 $yds^3/ft.$, but a 65-foot shoreline retreat landward. Sand lost from the berm was deposited offshore. The dune is very small, with an emergency sand ridge pushed up on the beach.

NJBPN 256 – Pompano Avenue, Manasquan



The Dec. 19, 2017 view to the south (left photo) shows the asphalt promenade with the row of fence. The Nov. 27, 2018 view (right photo) includes the promenade, houses, and the wind-transported sand causing problems because there is no dune system in the Borough.

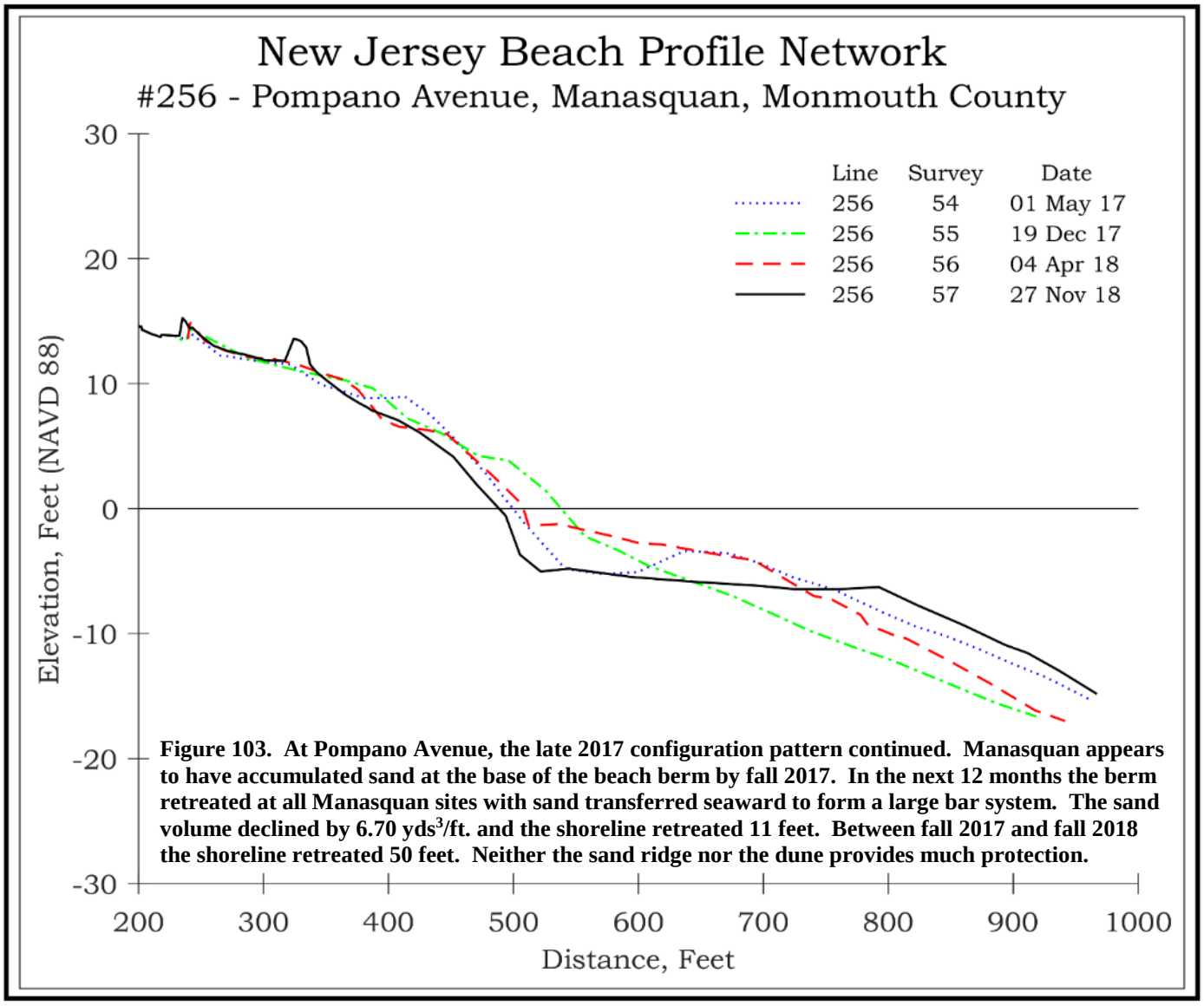


Figure 103. At Pompano Avenue, the late 2017 configuration pattern continued. Manasquan appears to have accumulated sand at the base of the beach berm by fall 2017. In the next 12 months the berm retreated at all Manasquan sites with sand transferred seaward to form a large bar system. The sand volume declined by 6.70 yds^3/ft. and the shoreline retreated 11 feet. Between fall 2017 and fall 2018 the shoreline retreated 50 feet. Neither the sand ridge nor the dune provides much protection.

NJBPN 15601 – Riverside Drive, Manasquan

The southernmost survey site in Monmouth County lies a few hundred feet from the north Manasquan Inlet jetty. This site has the largest "tiny" dune seen in Manasquan and shows a mounded berm deposit that eventually slopes seaward to the zero elevation position. The offshore region is a uniform slope seaward minus any bar features.

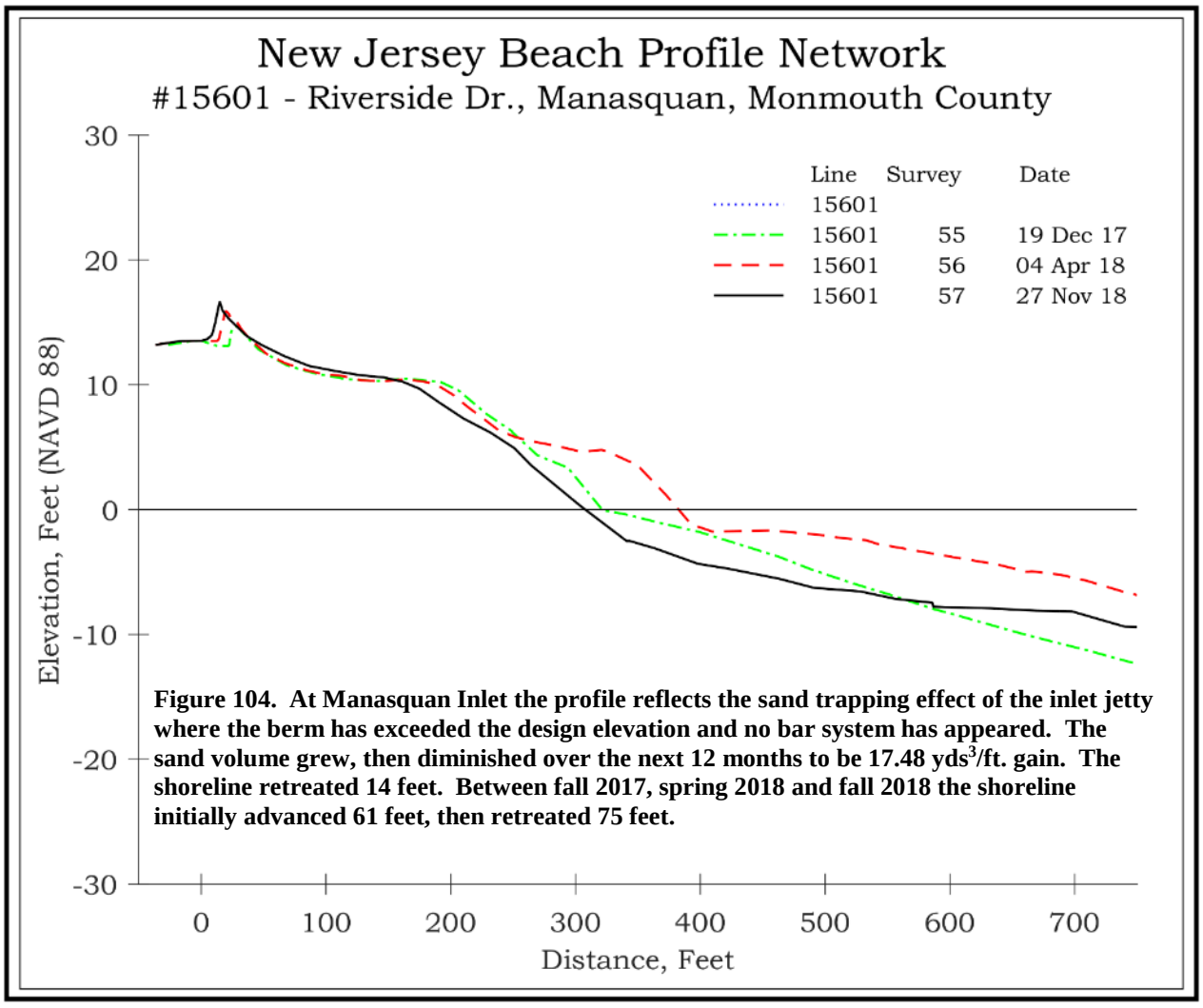


Figure 104. At Manasquan Inlet the profile reflects the sand trapping effect of the inlet jetty where the berm has exceeded the design elevation and no bar system has appeared. The sand volume grew, then diminished over the next 12 months to be 17.48 yds^3/ft. gain. The shoreline retreated 14 feet. Between fall 2017, spring 2018 and fall 2018 the shoreline initially advanced 61 feet, then retreated 75 feet.

Summary & Conclusions

The NY District of the US Army Corps of Engineers completed Phase III of the Monmouth County shore protection project in late 2016. It covered Loch Arbor, Allenhurst, Deal, Elberon into Long Branch. This effort followed the post-Sandy restoration of both Phase I and Phase II at an expense of $109.3 million dollars to pump 7.7 million cubic yards from offshore in order to restore the entire federal Coastal Storm Risk Management and Erosion Control Project to the original design specifications.

Sandy Hook is of increased interest in the NJBPN research, since most project losses are moving onto the hook along its 6-mile reach. The Gunnison Profile site (#285) boasts a 2,500-foot wide dry beach half of which has accumulated since 1998 shortly following the initial USACOE work in Sea Bright. The recent addition of a new cross section 3,500 feet north of the Gunnison site will provide added data on sand quantities depositing along the National Seashore coastline.

The Raritan Bay restoration took place at Port Monmouth adding a half-million cubic yards of sand at a site covered by NJBPN site #185. More sand was added at Keansburg and has been surveyed for results since placement under a separate NJDEP contract. Army Corps (NY District) planning is continuing toward restoration and flood control efforts around Union Beach on Raritan Bay as well.

In 2017, the NY District Corps and the Division of Coastal Engineering collaborated with the CRC to establish an additional 65 profile locations between Gunnison Beach and Manasquan Inlet, positioned among the existing 34 NJBPN oceanfront sites, to gather a more dense set of sand volume change and shoreline migration data for the District. The first cross section data was collected during the fall 2017 survey season. Comparison plots were completed in 2018 to gain insight on beach performance over the past 12 months.

Appendix Tables 2 and 3 provide the seasonal and annual profile volume and shoreline changes for Monmouth County. The average sand volume that migrated back to the shoreline as of fall 2015 since Sandy was 33.56 yds^3/ft. and represents 92.3% of the sand lost due to Sandy (-36.27 yds^3/ft.). This does include the work completed by the USACE in 2014 minus losses up to fall 2015. Work in in Deal and Long Branch contributed 17.88 yds^3/ft. to the Monmouth County total by the fall of 2016. Therefore, after the completion of Phase III, the Monmouth County oceanfront shoreline has had a post-Sandy sand volume increase of 51.44 yds^3/ft. or 141.8% of the Hurricane Sandy sand volume loss. Using a Google Earth distance measurement between the Sandy Hook National Seashore and Manasquan Inlet, the net sand volume increase above that present prior to Hurricane Sandy is 1.65 million cubic yards {51.44 yds^3/ft. minus 36.27 yds^3/ft. equals 15.17 yds^3/ft. multiplied by the distance along the county shoreline (108,940 feet) generates the 1,652,620 cubic yards of new sand}

Monmouth County averaged a sand volume loss across all 99 oceanfront survey sites of -2.56 yds^3/ft., which if multiplied by the shoreline distance yields 278,886 cubic yards of sand removed outside the survey envelope. There were few moderate northeast storms and no hurricane effects. The minor northeast events were numerous, but did little damage. The oceanfront shoreline retreated an average of 6.67 feet largely due to sand transfer offshore into bar systems (particularly on the Manasquan beachfront).

The Sea Bright sites lost an average of 8.02 yds^3/ft., Long Branch sites lost 24.46 yds^3/ft., the new Deal sites lost 12.64 yds^3/ft., but the Asbury to Manasquan Phase II sites gained 6.04 yds^3/ft.

Shoreline shifts followed a similar pattern with Sea Bright retreating an average of 18 feet, Long Branch 41 feet (dominated by Pullman Avenue retreating 151 feet), Deal retreated 22 feet, while the Asbury to Manasquan sites advanced an average of 9 feet seaward.

Perhaps the multiple mild northeast storms derived material from Sea Bright to Deal and shifted some of it to the Phase II beaches ending at the Manasquan Inlet, because neither the losses nor the gains were extensive.