



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

The 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. Several sites have been moved slightly as new development on the profile line created problems. The Union Beach site was moved from the original site because the shoreline was completely armored with rock. The new location is in the middle of a State-owned public beach about a quarter-mile away. Site #172 was reestablished north of Lake Tackanassee in southern Long Branch to track sand movement to the south derived from the ACOE project.

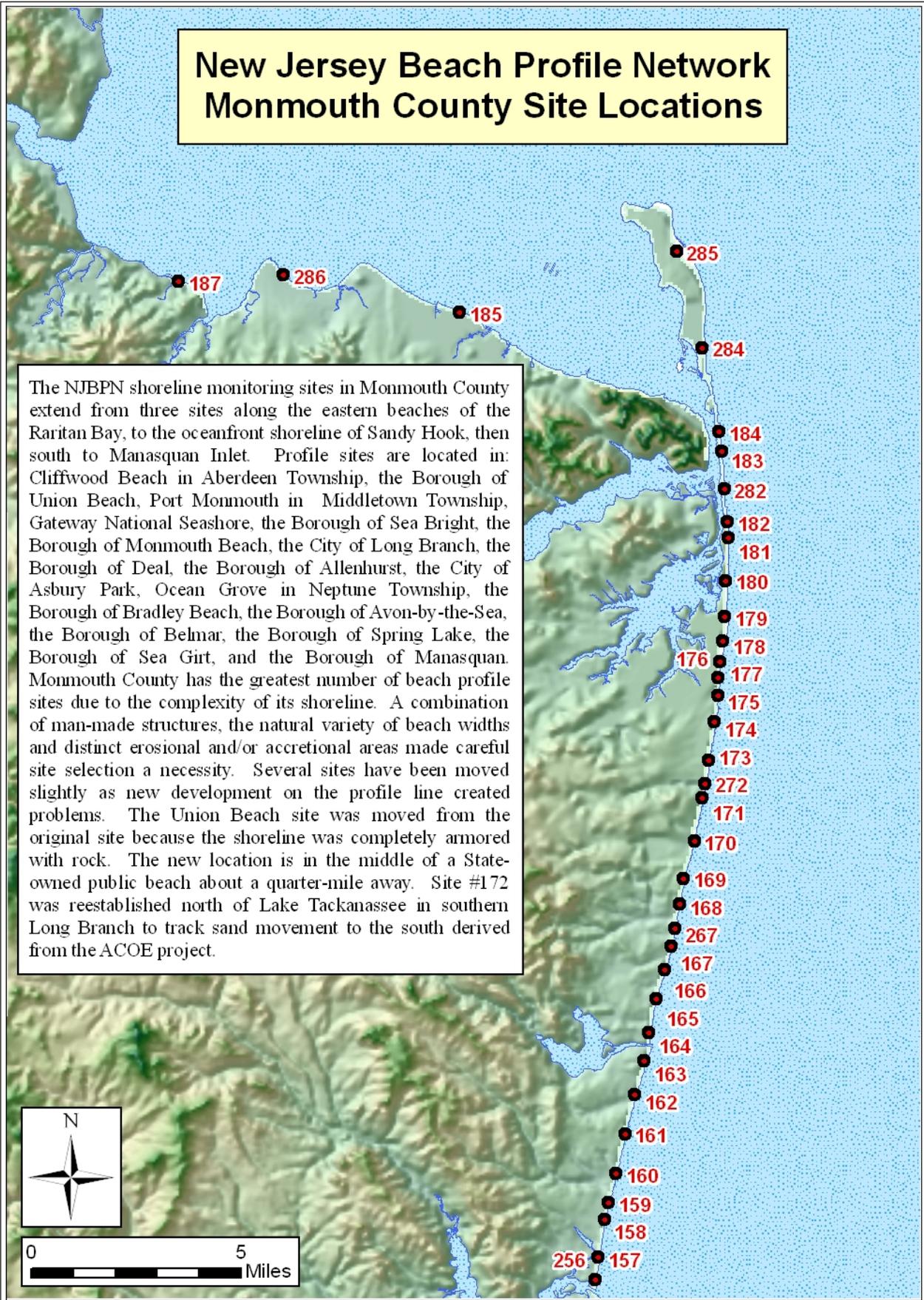
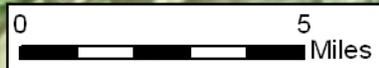


Figure 1. Survey site locations in Monmouth County.

Individual Site Descriptions:

The restoration of the Sea Bright shoreline was essentially complete by the fall 2013 survey. The NY Corps District returned to the original borrow zone offshore to extract sand for the work. The beaches along Raritan Bay were badly eroded, but some recovery has been documented. The New York District Corps of Engineers (ACOE) undertook multiple efforts in restoration. The Asbury Park Press reported that \$36.9 million was spent placing 900,000 cu. yds. of new sand along the Keansburg Raritan Bay shoreline, along with 2.1 million cu. yds. (\$25.6 million) 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). This effort was 100% federally funded under Public Law 113-2 passed by Congress in 2013. In addition, the impediments to continuing the ACOE project between Long Branch (Elberon to Loch Arbor) and Asbury Park have been resolved and later in 2014 work will commence placing an initial shore protection project between the two earlier efforts. This will not be 100% federally funded, but revert back to 65% federal and 35% State and local (NJ splits these costs 75-25% with the local municipalities on a prorated shoreline proportional cost of the entire project). This year, the focus was put on the degree, style and percentage in recovery from the damage to the beach and dune system brought on by Hurricane Sandy October 29-30, 2012.

TABLE 1 – Monmouth County Sand Volumes & Shoreline Changes Due to Sandy

LOCATION	Beach Loss	Gain Offshore	Shoreline	Beach Recovery	Offshore	Shoreline	Percent	Percent	Percent
	During Sandy	fm Sandy	Storm Retreat	by Fall 2013	Transfer to Bch	Advance	Bch Recovery	Offshore loss	Shoreline
	cu yds/ft.	cu yds/ft.	feet	cu yds/ft.	cu yds/ft.	feet	cu yds/ft.	cu yds/ft.	feet
Highlands Beach	-28.36	45.77	-46	74.03	ACOE Work	53	361%	no data	115%
Via Ripa	-38.32	39.65	-30	40.12	ACOE Work	21	205%	no data	70%
Shrewsbury Way	-52.52	43.42	-88	12.21	ACOE Work	20	123%	no data	23%
Sea Bright Public Beach	-30.21	28.22	-11	95.94	ACOE Work	73	318%	no data	664%
Municipal Beach	-26.83	9.28	15	110.88	ACOE Work	91	413%	no data	607%
Sunset Court	-22.84	15.84	9	101.64	ACOE Work	89	445%	no data	989%
Cottage Road	-55.34	10.38	-44	182.99	ACOE Work	199	331%	no data	452%
Monmouth Beach Club	-81.47	2.41	-86	140.98	ACOE Work	144	173%	no data	167%
177 Ocean Avenue	-52.00	11.62	-50	22.93	-45.98	-67	44%	396%	-134%
Seven Presidents Park	-47.39	42.49	-94	20.68	-29.24	27	44%	69%	29%
Broadway Avenue	-35.05	7.21	-59	22.72	-28.68	28	65%	398%	47%
Morris Avenue	-33.99	31.62	-55	12.49	-27.20	21	37%	86%	38%
West End Avenue	-27.48	29.42	-63	22.96	-28.14	49	84%	96%	78%
805 Ocean Avenue (site moved)	-24.40	23.39	-31	2.02	-11.96	-35	8%	51%	-113%
Pullman Avenue	-20.22	24.40	-9	38.85	-10.53	48	192%	43%	533%
Roosevelt Avenue	-33.22	20.23	-25	35.17	-24.30	61	106%	120%	244%
Darlington Avenue	-38.47	27.22	-43	21.60	-9.86	23	56%	36%	53%
Allenhurst	-70.29	5.67	-124	46.93	-33.48	106	67%	590%	85%
7th Ave Asbury Park	-39.61	27.56	-81	17.79	-36.78	27	45%	133%	33%
3rd Ave Asbury Park	-29.66	34.79	-84	26.98	-42.62	68	91%	123%	81%
Ocean Grove	-35.07	32.64	-94	22.65	-28.69	60	65%	88%	64%
Bradley Beach	-12.88	54.43	-48	9.77	-46.25	28	76%	85%	58%
Avon By the Sea	-15.68	9.73	-27	10.48	-11.30	25	67%	116%	93%
5th Ave Belmar	-47.65	10.51	-49	31.76	-14.94	44	67%	142%	90%
18th Ave Belmar	-13.41	22.33	-29	11.23	-36.16	31	84%	162%	107%
Brighton Spring Lake	-36.15	25.40	-62	31.40	-17.33	64	87%	68%	103%
Salem Ave Spring Lake	-8.52	10.87	-32	4.65	-36.99	15	55%	340%	47%
NY Ave Sea Girt	-69.52	16.36	-148	39.16	-18.30	86	56%	112%	58%
Trenton Ave Sea Girt	-67.07	44.78	-112	35.07	-16.69	34	52%	37%	30%
Riddle Way Manasquan	-13.75	59.07	-24	1.20	-33.69	-6	9%	57%	-25%
Pompano Ave Manasquan	-16.49	59.36	-31	12.80	-32.27	24	78%	54%	77%
Average Volume Changes	-36.25	26.65	-53.39	21.80	-27.02	33.09			
				60.1%	101.4%	62.0%			

Each cross section was examined from prior to Sandy to the survey after the storm and to October 2013 data. The objective is shown above in the average sand volume losses at the beach, deposition offshore and the percentage of the year later recovery represents of those initial losses. The NY District ACOE had started

restoration from Monmouth Beach north into Sea Bright, so beach recovery is shown in high percentage recovery numbers. However, it is interesting to note that even for Hurricane Sandy, with data from the hardest hit NJ shoreline, a year after the storm the Monmouth County beaches recovered an average of 60.1% of the beach sand lost, 62.0% of the shoreline retreat was regained as a result of 101.4% transfer of the sand deposited offshore during the storm back to the beach. The value greater than 100% of the deposit sand volume documented is largely due to the fact that swimmer surveys do not go far enough out to sea to cover all sediment transport seaward deposited in between 15 and 18 feet of depth. Sand will slowly return from deeper water and the 101.4% value proves that point. Over the next four years, absent another storm of equal intensity, one could expect to see about 150% return of sand the CRC documented as deposited offshore as material carried further seaward slowly migrates landward. The fact that the ACOE has completed restoration from Sandy Hook to Manasquan River Inlet does complicate this evaluation going forward. It is however, a point to make that even intense storms do see a prolonged period of sand recovery in both beach/dune volume and shoreline positions.

Cliffwood Park, Aberdeen; #187

This is a small County Park, 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. Between December 2012 and April 2013 this sand was relocated back to the beach and shoreline and by October 2013 a small dune had begun to form at the center of the original feature (March 2012 survey). By the fall of 2013 this site had lost 13.12 yds³/ft. with an 8.4 foot shoreline retreat largely the result of Sandy. The summer of 2013 produced little net recovery in either sand volume or shoreline position.

Union Beach; #286

The Union Beach site is now located in the middle of the municipal bathing beach on Raritan Bay. Formerly, positioned about 1,000 feet south along the bayshore, the old site was hardened with rock revetment over ten years ago and this effort virtually eliminated any change above low tide. 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. Between April and October 2013 just over 12 yds³/ft. of new sand was placed on the beach to approximately the elevation of high tide. The sand came from Amboy Aggregates funded by Union Beach in the amount of 14,000 cubic yards and the placement method was by truck.

Spy House Museum, 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. This new work had a positive impact in that little erosion took place during the storm, but no recovery or added sand has appeared since Hurricane Sandy.

Gunnison Beach, Sandy Hook National Seashore; #285

Three additional cross sections were established 18 years ago to collect data on sand volumes being added to the National Seashore. Gunnison Beach is the northernmost site, but still a substantial distance south of the tip of Sandy Hook spit. Access to the shoreline further north is restricted by limited roads. Sandy's storm waves sliced over 40 yds³/ft. from the active beach, did not transport much of that material onto the wide, normally dry

beach and appeared to deposit 50.88 yds³/ft. directly offshore within 350 feet of the low tide line. Since then onshore transport has moved 46.81 yds³/ft. back onto the dry beach such that the Fall 2013 beach portion of the profile almost exactly duplicates the pre-Sandy situation.

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. Sandy obliterated the dune at the site, washing the material landward. Sand was pushed back to generate a small, narrow dune more landward than the original. This was added to by the fall of 2013 with additional reclaimed sand. The beach and offshore segments gained material advancing the shoreline 56 feet and adding 68 yds³/ft. to the sand volume.

Highlands Beach, Sandy Hook National Seashore; #184

The southern site was initially established as the terminal location for the oceanfront beaches because it was felt that the Federal shoreline was not a State responsibility. After almost a decade of work it seemed obvious that the rest of Sandy Hook needed to be covered if only to understand what transpired along the Sea Bright beach section. The sand deposited at the seawall was stripped away during Sandy and the shoreline retreated 46 feet as well. A year later some recovery had occurred prior to the NY Corps District completing the Monmouth County shoreline restoration (October 2013 survey). This added 59.64 yds³/ft. with a 36-foot shoreline advance documented.

Via Ripa, Sea Bright; #183

This northern location lies just south of the bridge to Atlantic Highlands across the entrance into the Shrewsbury and Navesink Estuaries. Hurricane Sandy severely reduced the beach volume, but did deposit abundant sand offshore (-38.31 yds³/ft. from the beach, depositing 39.65 yds³/ft. offshore). Since Nov 26, 2012 natural recovery added 30.59 yds³/ft. to the beach as 40.14 yds³/ft. moved landward. The Army Corps project added 43.1 yds³/ft. to the beach producing a shoreline position almost equal to pre-Sandy conditions.

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%). Even so, the storm waves broke over the Sea Bright seawall as they ramped up the sand against the rocks allowing wave run-up to crest the 28-foot wall. The beach profile was cut by 52.52 yds³/ft. and the shoreline retreated 88 feet during Sandy. Natural recovery shifted some sand back to the beach from offshore, but the site continued to lose sand volume from the beach (-25.55 yds³/ft.). The Army Corps project restored sand to the beach, but the shoreline falls 156 feet short of the pre-Sandy conditions.

Sea Bright Public Beach, Sea Bright; #182

The next location north was obtained by NJ State purchase 25 years ago and converted into a public bathing area with some off-street parking. There was a modest dune at the toe of the rocks, but the waves ramped up and over the rocks using that sand as a deposit forming the ramp. In addition there was a timber bulkhead protecting a 20-foot wide gap in the rock seawall at this location. Sandy blew through the timber section and poured into Ocean Avenue with sand, debris and lots of salt water. This compounded the water coming in from Raritan Bay making flooding the worst ever recorded. This beach contained 98% 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. The federal project was complete at this side by March 2013 with some berm adjustment occurring over the summer. The current shoreline lies 62 feet seaward of the pre-Sandy conditions.

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. An ancient timber bulkhead was the back shot position for the survey and it had gaps cut in it to allow easy public access to the beach. The resulting storm wave damage and tidal flooding was intense and destruction was wide spread and devastating. Sand was hauled back to create a sizable dune ridge by March 2013 and some material was added to the post-Sandy beach as well. The federal project shows dramatically as a 76.32 yds³/ft. wedge of sand added to the beach by October 2013 advancing the shoreline 104 feet beyond that present prior to Sandy. No dune was constructed as of the October 2013 survey.

Sunset Court, Sea Bright; #180

The next location north of Cottage Road maintained 45% of the initial sand volume placed in 1999. The repeated deposition of maintenance material at Cottage Road moved north through this location. There was no dune, other than grass here and there among the rocks of the seawall. Storm waves over-topped the wall in quantity and caused flooding. Sand appeared offshore in quantity as material was pumped onto the beach by the Federal project (82.94 yds³/ft.). More material was added to the outer beach by October 2013 (39.92 yds³/ft.) pushing the shoreline 65 feet further seaward from the March 2013 position.

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. Here a massive stone groin was privately built decades ago to restrict sand movement north from the beach fronting a private beach club from the 19th Century. The groin obviously serves its intended purpose, but to the detriment of the Federal beach project’s durability just north of the groin. The Cottage Road site commenced losing sand as soon as it was completed. Losses were replaced in 1997, 1999, 2001, and modest sand volume was added in 2010 from Shrewsbury River dredging. 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. Sandy barreled over the seawall, dumping many thousands of tons of seawater into the highway making storm surge flooding worse. The post-storm survey in late March 2013 showed even more loss at the low tide line. By October 2013 a restoration had occurred where the berm was regenerated at elevation 10.0 feet and extending 500 feet from the seawall at that elevation. The spring to fall 2013 survey comparison found a shoreline advance of 293 feet due to the placement by the ACOE of 201.44 yds³/ft. in new sand.

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 the storm, 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 yds³/ft. with a 231-foot shoreline advance seaward.

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 was underway to the south in Long Branch, but had not impacted this location as of October 2013.

Seven Presidents Park, Long Branch; #176

This site was converted into open parkland space 25 years ago with the purchase of all commercial and private buildings near the waterfront. The area has 25 foot dunes with several prominent gaps to allow public easy access to the beach. The Federal project was completed here in 1999 and 74% of the initial sand placed was still present in October 2011. The cross section is located at the southern gap in the dunes, so storm damage in the form of abundant sand washed landward into the parking lot was evident. The storm damage is seen between the fall 2012 and spring 2013 surveys because the site was done prior to the hurricane. Some transfer of sand from offshore onto the beach occurred by October 2013.

Broadway Avenue, Long Branch; #175

Here the Corps project beach was at 79% of the as-built sand volume in the fall of 2011. Sandy's waves rolled across this beach as well and impacted the steel wall protecting the bluff. Water crashed down on the paved promenade without incident and cascaded into the new development causing minor flooding and damage. The storm transferred sand offshore between the early October 2012 and March 2013 surveys with 22.72 yds³/ft. deposited on the beach from a loss seen offshore of 28.68 yds³/ft. by the time of the October 2013 survey.

Morris Avenue, Long Branch; #174

This site is positioned along the old Long Branch beachfront along the former Ocean Avenue now reduced to a promenade. Sandy took the boardwalk away at the top of the bluff above the rock seawall. Since the storm sand moved landward from offshore regenerating the beach to that present just prior to the hurricane. Once again, the Corps program did not start until after the October 2013 survey date so all changes shown are natural. The pre-storm survey occurred in October 2012, so the comparison is between that and the spring 2013 survey. The post-storm transfer of sand back to the beach took about a year, but the ACOE plan calls for a complete restoration to the original design specifications.

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. Sandy rolled over the beach and struck the revetment with massive force tearing out the bluff under and the boardwalk over the grass strip. The erosion extended to the concrete curbing bordering the old roadway. Water damage existed on properties landward of the roadway as evidenced by debris and sand deposits. This site recovered in a similar pattern to the other Long Branch sites. Surveys prior to the storm were completed in October 2012, so the spring 2013 coverage shows the extensive beach erosion and the transport of sand offshore. The October 2013 survey shows a relatively complete reversal to the pre-Sandy cross section by a year later. Sand did not return to the

upper bluff however, the boardwalk position is gone and any replacement would have to be located on the old roadway, which was the original southbound roadway of a former four-lane Ocean Avenue along this segment.

Lake Tackanasee, Long Branch; #272

This new cross section designed to replace original site #172 abandoned years ago was positioned just south of a series of major condominium complexes between West End Avenue and the Lake. This is the northernmost “estuary lake” along the Monmouth County shoreline and, like the others has a fresh water drainage system constricted at the shoreline by a bay-mouth barrier. There is no bluff here, so the storm waves simply rolled over everything in their path into the lake where Ocean Avenue crosses it on a bridge. An historic life-saving station converted to a bathing complex was utterly destroyed. All traces of the beach survey established two years ago were gone, so the site was navigated to using the GPS coordinates for the reference monuments. The profile ran up-grade to a point where the slope reversed down-grade seaward into the water. It was necessary to relocate the profile to the south, further from the condominium’s parking lot retaining bulkhead, so the post-Sandy cross sections appear to be dramatically different in backshore orientation and elevation. This is real and unavoidable. All changes since the storm were variations in cross shore sediment transfers leading to some beach accumulation, but no net change to be concerned about. This phase of the NY District shore protection project is scheduled to start in late 2014 or early 2015.

Pullman Avenue, Elberon; #171

The single cross section located in Elberon at Pullman Avenue demonstrated the susceptibility of even the high bluff located here (28 feet NAVD88) to major erosion from the storm surge and waves generated by Hurricane Sandy. Homes built at the bluff edge were destroyed by waves with about a third of each lot’s width inland gone. The rock revetment and timber wall account for about 40% of the bluff height and were unaffected. Apparently waves broke on the revetment with crests at least 35 feet high because both homes were smashed in on the seaward side. This was not from wave spray on impact with the fortifications. The end of Pullman Avenue was eroded landward by about 50 feet. This is clearly illustrated in the cross sections where the bluff lost 12.63 yds³/ft. in Cretaceous-aged sediment due to the storm. Deposition occurred offshore where 24.40 yds³/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 yds³/ft. of new material and creating the best “beach” ever recorded at this location since 1986.

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. It is essentially a three-story building with just the top story presented at the end of Roosevelt Avenue. South of this street is a series of private homes built on the bluff with a decent sand beach seaward of the dune-mantled bluff edge. Phillips Avenue is the location of a public bathing complex that was totally destroyed by the loss of the Phillips Avenue fishing pier built decades ago over the rock groin at the end of Phillips Avenue. North of Roosevelt Avenue there is essentially no dry beach between closely-spaced groins. Site #170 has a 26-year history of a wet beach against the rocks. Occasional offshore bars have migrated to the shoreline yielding a temporary dry beach less than 25 feet in width. Sandy’s waves over-topped the rock wall and scoured deeply into the soil, fill debris (bricks etc.) and bluff sediments. 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.

Southern Deal;

Deal is divided from Allenhurst by a massive boxed pair of groins that retain all sand on the Allenhurst beach, letting none past to the north. The Darlington Avenue site is about a mile north into Deal 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. The wave forces over-matched the newer timber structures smashing them to rubble and exposing an erosional scarp in the bluff sediments. The spring 2013 survey shows the upper bluff sediment loss with a post-Sandy beach profile far below that seen in October 2012 just prior to the storm. By the fall 2013 survey approximately half the sand present prior to Sandy had returned from offshore.

Allenhurst – Loch Arbor;

The site #168 at Allenhurst sits on top of an ancient 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 located about 100 feet from the low tide line on the beach. About 50 feet of the boardwalk was stripped from the supports and shifted toward the roadway with ample evidence that waves had moved across the lawns of the major houses further landward. There was a recovery berm and offshore bar along the entire segment between the Deal boundary groin and the Deal Lake flume. Loch Arbor is 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. Deal Lake is the largest of the now-closed stream estuaries along the Monmouth County shoreline. It has been mapped as open to the tide flow as late as 1880, but closed by 1889. There was no paved road across the bay mouth sand bar until after 1920 according to the earliest aerial photography. There is a sizable weir and boxed flume carrying freshwater seaward to drain the lake. This was still functioning though sand had spilled into the lake at the seaward end. No Federal Project sand was deposited along this short segment, but over the past 13 years material has escaped by the large terminal groin in Asbury Park enhancing this small reach. The April 2013 survey represents a post-Sandy situation with a very narrow beach and deep scour offshore with sand extending beyond the range of these surveys to water 20 feet in depth. The spring 2013 to fall 2013 comparison shows that 46.93 yds³/ft. was deposited on the beach to the concrete wall transferring much of that sand back to the beach without any human intervention. The zero elevation shoreline position advanced 106 feet seaward and the October 2013 cross section very closely resembles that present October 5, 2012 (except to the offshore portion where the pre-Sandy conditions favored shallower water 400 feet seaward of the reference location; -38.64 yds³/ft.).

Asbury Park; Sites 267 & 167

The Federal project beach in Asbury Park had no dune, but the sand was ramped up to the elevation of the boardwalk. As a consequence, at both survey sites there was minor ‘walk deck damage, some railings destroyed and the majority of the wave energy passed over the boardwalk into Ocean Avenue. Sand was in front of business establishments on the landward side of the boardwalk with flow at each street end. The impact of Hurricane Sandy can be seen with a comparison of the fall 2012 survey taken prior to Sandy with the spring

2013 cross section taken in April 2013. The beach at site 267 lost 39.61 yds³/ft. while 27.56 yds³/ft. were deposited offshore out to 915 feet from the reference into 17 feet of water. The shoreline retreated 81 feet in the process. By the fall of 2013, the shoreline had advanced 27 feet with 17.79 yds³/ft. returned to the beach.

At site #167 on Third Avenue, the same process repeated with a storm loss of 29.66 yds³/ft. from the beach, an 84-foot shoreline retreat and sand moved well offshore beyond 17.6-foot depths (NAVD88). By October 2013 26.98 yds³/ft. had returned to the beach as 42.62 yds³/ft. migrated onshore or to the south from the storm deposits seaward. The shoreline advanced 68 feet.

Ocean Grove;

Ocean Grove had severe damage to the beach and boardwalk focused to the south of Main Street. At Ocean Pathway the dune remained as did the large, open, but roofed seating area seaward of the boardwalk. The dune remained with the instrument monument about 1.5 feet from the scarp. The pre-Sandy survey shows the beach/dune system just prior to the storm. The April 2013 profile shows a narrow beach, cut dune and a deposit over 2 feet thick for 300 feet offshore (the profile extends to 950 feet to an elevation of -18.98 feet NAVD88). The April survey defined a storm loss of 35.07 yds³/ft. on the beach, dune and near shore with 32.64 yds³/ft. deposited offshore (94 feet of shoreline retreat). By the fall of 2013 22.65 yds³/ft. had recovered on the beach as 28.69 yds³/ft. migrated landward (the shoreline advanced 60 feet in the process).

Bradley Beach;

The McCabe Avenue site had some damage, but fared better than most locations. The dunes did survive in places and kept the worst of wave impacts out of the Borough. Storm surge flooding did occur with damage to some structures and boardwalk sections. The storm-generated changes at the site saw the elimination of the dune, but less retreat on the beach, perhaps due to the extraction of the dune volume (25.33 yds³/ft. in sand volume taken above the elevation of 7.24 feet on the berm). The shoreline retreat was just 48 feet without a serious trough at the foot of the beach slope. 54.43 yds³/ft. was deposited offshore between -1.68 and -17.90 feet elevation offshore (816 feet from the reference). The recovery deposit seen in the April 2013 cross section amounted to 7.09 yds³/ft. extracted from overwash deposits on the uplands.

Avon-by-the-Sea;

Avon has one site located at Sylvania Avenue where damage to the boardwalk was extensive extending to the structures adjacent to the boardwalk. Sand occupied Ocean Avenue with evidence of wave damage to businesses on the far side of the roadway. Avon had a "landscaped" dune that did little to protect the infrastructure, so once the waves crossed the beach, there was little to prevent them from dissipating their energy on the infrastructure. Sand lost from the beach was carried inland, not deposited in a 2-foot thick wedge offshore. The recovered overwash material was pushed back onto the beach by the June survey date in 2013 producing most of the recovery evidenced. Little further recovery occurred between June and September 2013.

Belmar; Sites 163 & 162

Belmar has two survey sites, one at 18th Avenue and the second at 5th Avenue near Shark River Inlet. The Belmar beach has a boardwalk between it and Ocean Avenue that suffered damage but was still largely present. Sand was in Ocean Avenue. The erosion is defined by the April 2013 survey data with some deep scour and offshore deposition in evidence at site #163, but there was less scour at site #162 and deposition offshore. Sand

recovery was vigorously pursued in moving the overwash deposition back to the beach and appears to have contributed to the overall recovery prior to the ACOE work in 2014.

Spring Lake; Sites 161 & 160

Two cross sections located in Spring Lake showed that the dune, developed decades ago landward of the boardwalk, was also insufficient to protect the town landward of it. Storm wave up-rush went under the boardwalk, hit the dunes, was forced upward lifting the entire Spring Lake boardwalk off excellent concrete supports and eventually deposited most of it in Ocean Avenue. Hurricane Irene had previously damaged some of the structure the August previously in 2011, so the walk had recently been re-surfaced with composite decking. Large quantities of sand had been transported onto Ocean Avenue and down many side streets. Large scale damage to homes was not evident; however flooding by the water level was evident. The “estuary” lake (Lake Como) between Spring Lake and Belmar was likewise being both pumped out and excavated to locate and clear the drainage weir to the ocean. The October 2012 survey preceded the storm, so the comparison between that and the April 2013 survey defines the Sandy impacts. Nearshore and beach scour with deposition offshore beyond the limits of surveying occurred both places. -36.15 yds³/ft. lost from the beach and 25.40 yds³/ft. gained offshore to a point 857 feet from the reference at an elevation of -16.63 feet (NAVD88).

Sea Girt Borough; Sites 159 & 158

Sea Girt is divided into two parts, each with a profile site. The southern site at Trenton Avenue typifies the coastal bluff with major homes and a wide, reasonably high dune landward of the boardwalk that protected the bluff face from erosion and kept the overwash out of the street ends. Some overwash had occurred at Trenton Avenue, but was well on its way to clean-up. The boardwalk had been damaged at Trenton Avenue, but otherwise survived. A dune had grown seaward of the boardwalk since the ACOE project, but it had been eroded away.

The northern half is represented by the New York Avenue site #159 where a shore-parallel Ocean Avenue allows vehicle to park at the boardwalk and beach for public access. Homes exist across Ocean Avenue. Here there were incipient dunes built since Hurricane Irene in 2011, Sandy’s waves washed over the beach, across the boardwalk and down the streets a block inland. Tidal flooding also entered by way of Wreck Pond, the second “estuary” lake north of Manasquan Inlet. New York Avenue lost 69.52 yds³/ft. from the beach and nearshore. 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. Deposition offshore amounted to 16.36 yds³/ft. that was documented 936 feet seaward from the reference monument. Clearly the majority of the sand was further seaward because by September 2013 39.16 yds³/ft. had returned to the beach producing an 86-foot advance in the zero elevation position.

The Trenton Avenue site saw similar erosion and deposition offshore (-67.07 yds³ lost from the beach and 44.78 yds³/ft. gained offshore) with recovered sand positioned seaward of the boardwalk as a substantial restoration dune. Recovery saw 35.07 yds³/ft. added to the beach as sand from offshore moved landward. The shoreline advanced 34 feet seaward in the process.

Manasquan Borough; Sites 157 & 256

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. Developed at the turn of the 20th Century, many small homes populate the former primary dune between the ocean and First Avenue. Prior to the ACOE project, the

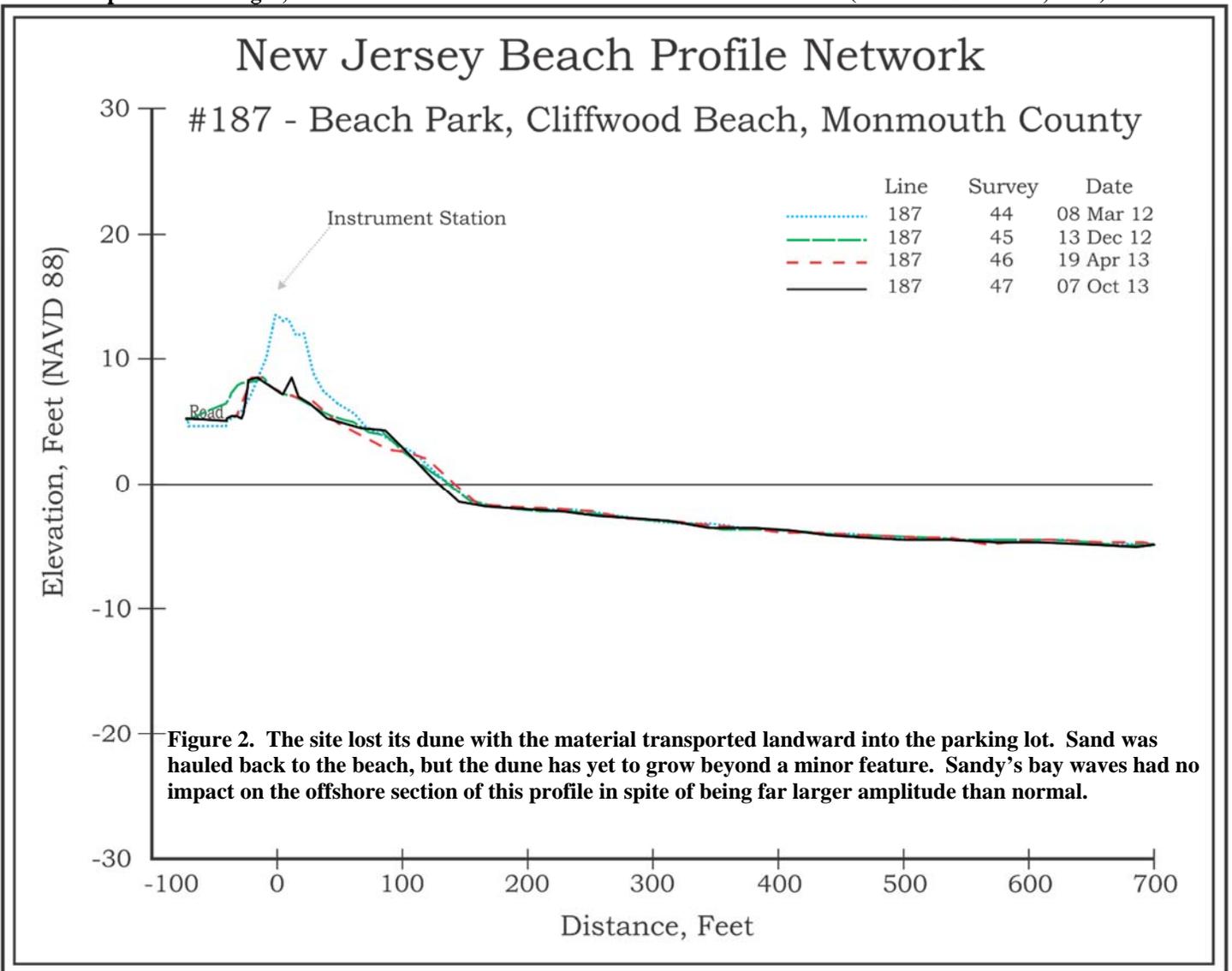
Borough had established a small dune system seaward of the paved promenade that is in front of the oceanfront homes. This was primarily in response to the December 1992 northeast storm that last damaged the community. Litigation over the dune height, width and access pathways limited the enthusiasm for enlarging the dune's footprint in spite of the Borough's winning the litigation. Sandy broke through the dune line and passed over the promenade into the initial row of homes. Since there are frequently more than one dwelling between the promenade and First Avenue, a great deal of moderate damage was done as water, sand and debris were forced between the narrow passages between buildings. Vast amounts of sand and debris clogged First Avenue such that the oceanfront area was still closed to the public and barely passable on November 12, 2012.

There are two cross sections in Manasquan. No promenade remained at Pompano Avenue (site #256) with tiny remnant dunes present at Riddle Way (site #157). A ridge of excavated sand had been built along the alignment of the promenade at the south end of the Borough Beach. At Riddle Way the dune was all but removed, but the promenade surface remained intact. The dune provided 11.24 yds³/ft. of sand to the beach during the storm, but the beach lost and additional 13.75 yds³/ft. as the offshore added 59.07 yds³/ft. The shoreline retreated 24 feet.

At the Pompano Avenue site (#256) the dune was removed as well as the entire promenade with most of the sand transported inland. A huge bar appeared offshore (59.36 yds³/ft. deposited). Since April 2013 only 12.80 yds³/ft. has returned to the beach, but 32.27 yds³/ft. of that deposit has moved elsewhere either landward or toward the Manasquan Inlet.

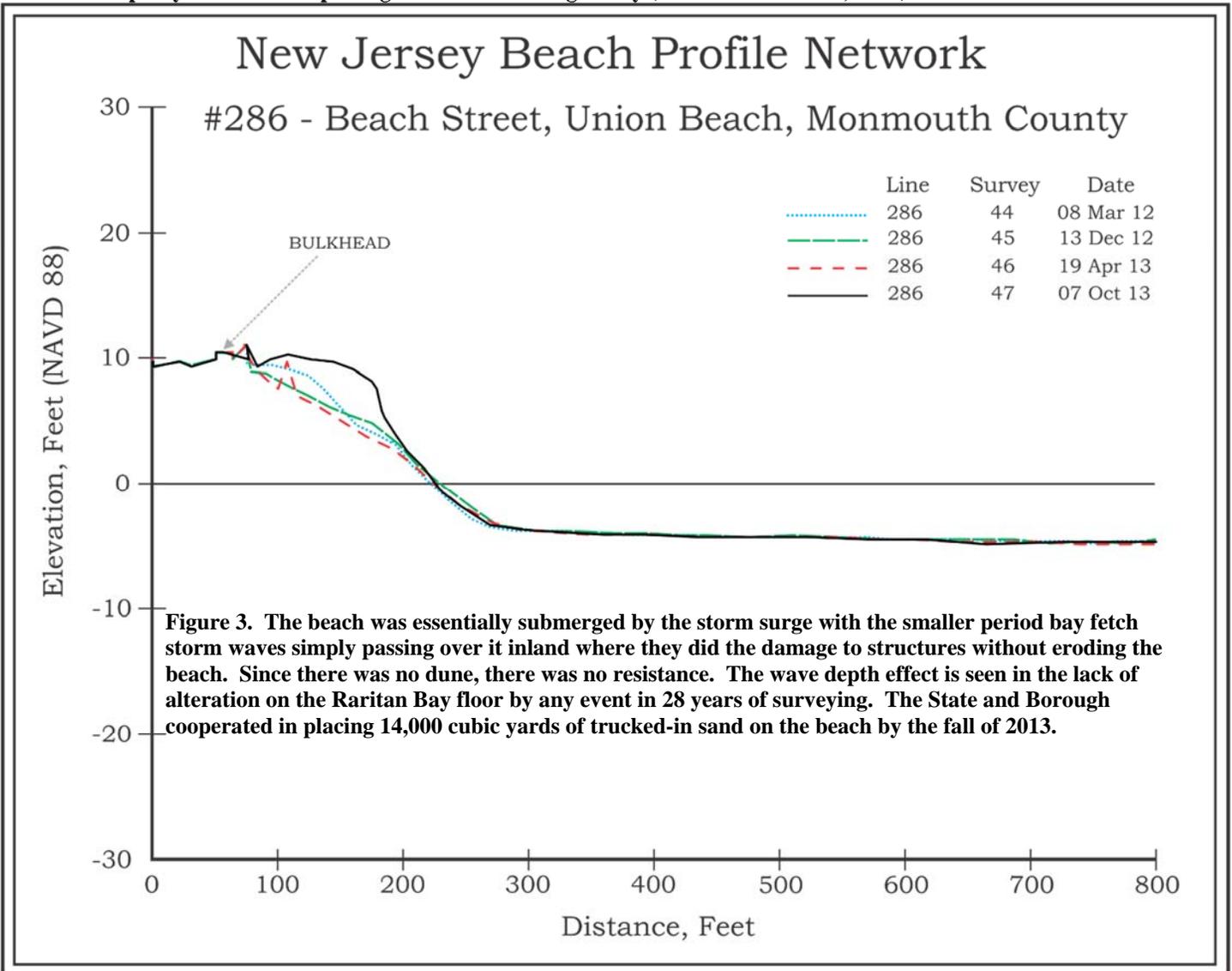


This is the westernmost NJBPN site located on Raritan Bay. The photograph on the left shows the shoreline on December 13, 2012. The photo on the right, at low tide shows the new dune fence with a modest dune (taken on October 7, 2013).



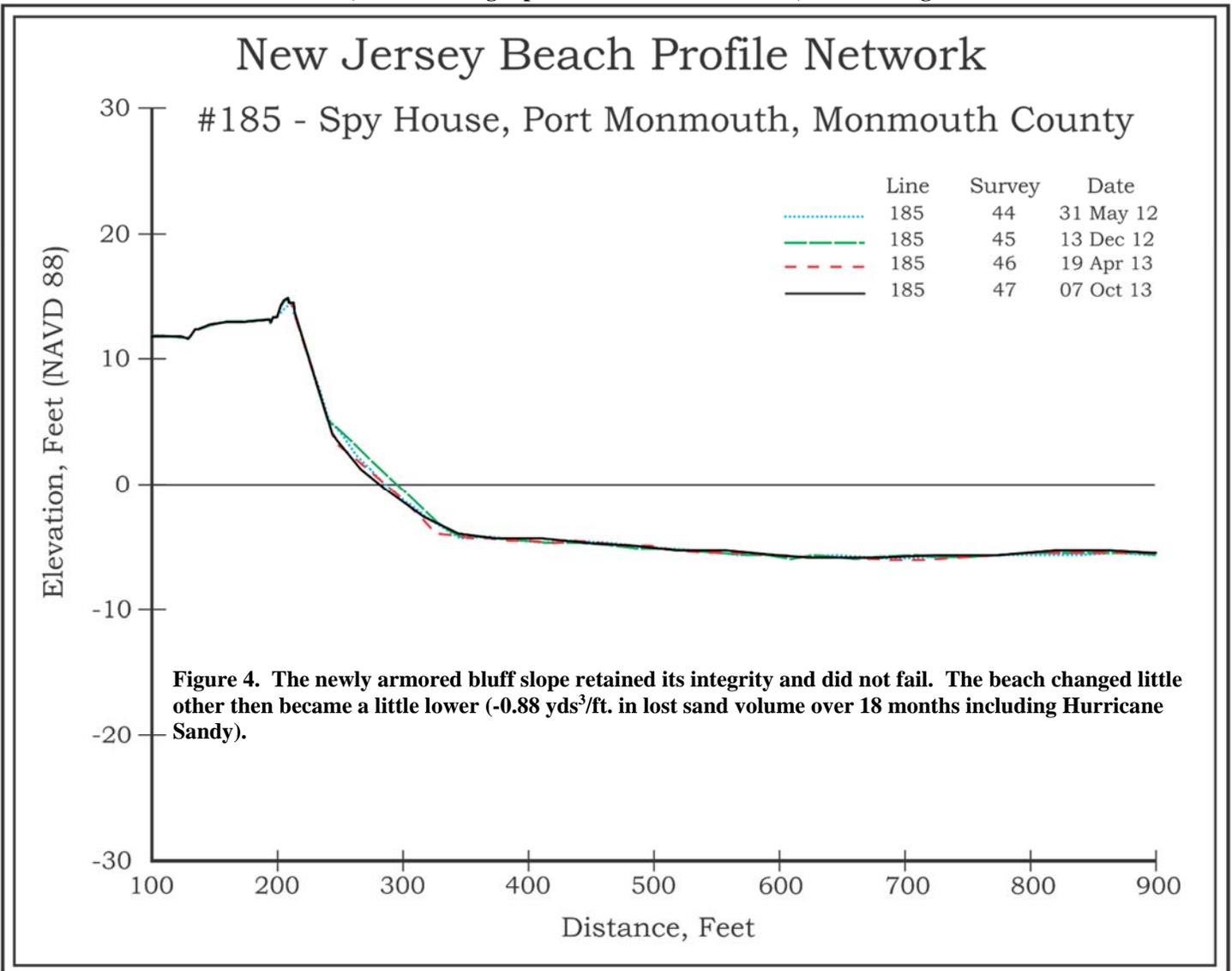


This site is located at the public bathing beach and was established in 2009. The photograph on the left shows the shoreline on November 13, 2012. The photo on the right shows the beach following addition of 14,000 cu. yds. of trucked in sand as a result of the municipality’s efforts in replacing lost sand following Sandy (taken on October 7, 2013).



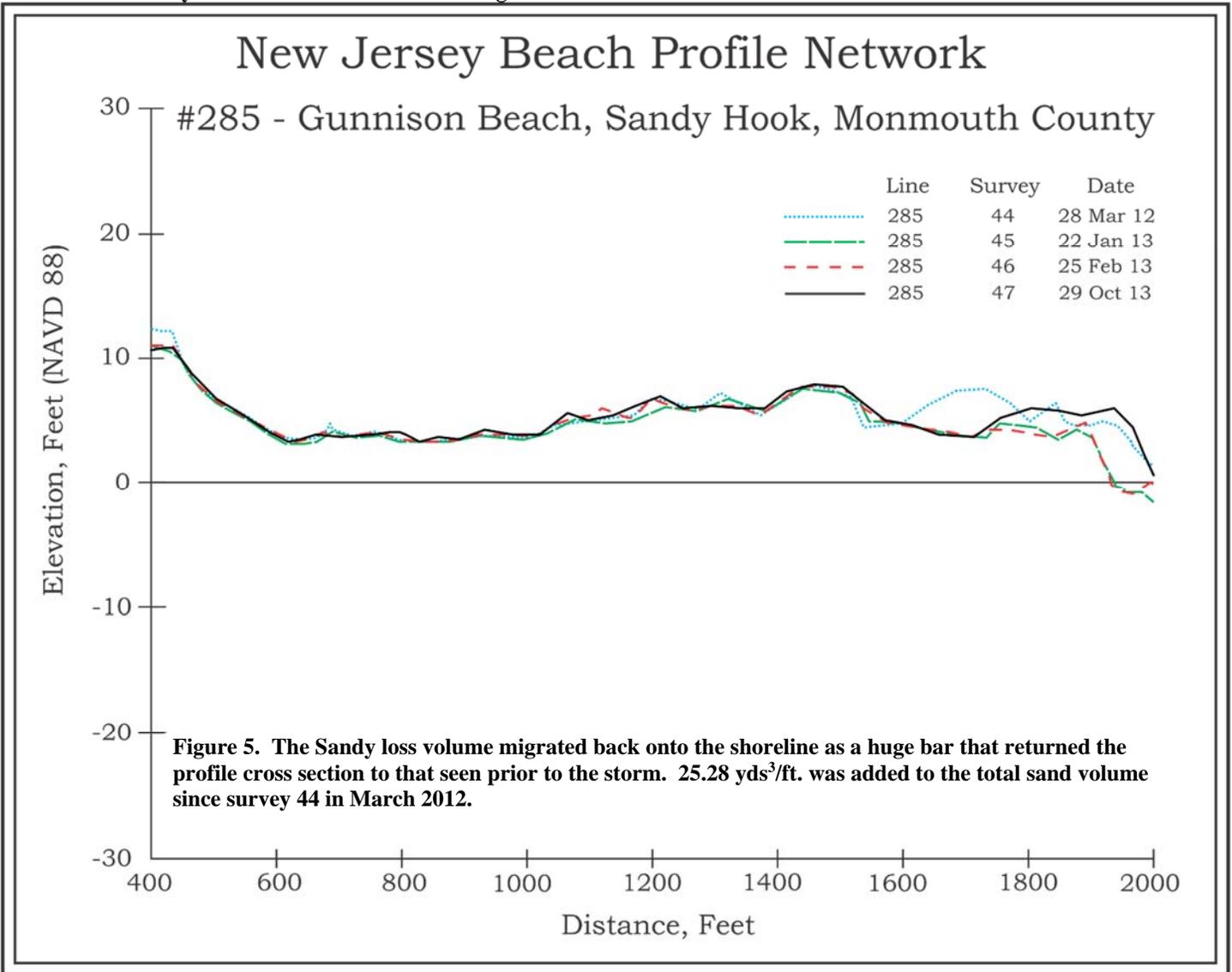


This site was enhanced by adding slope protection to the eroding uplands bluff prior to Sandy. The photograph on the left shows the shoreline on December 13, 2012. The right picture was taken October 7, 2013 at a higher level of the tide.



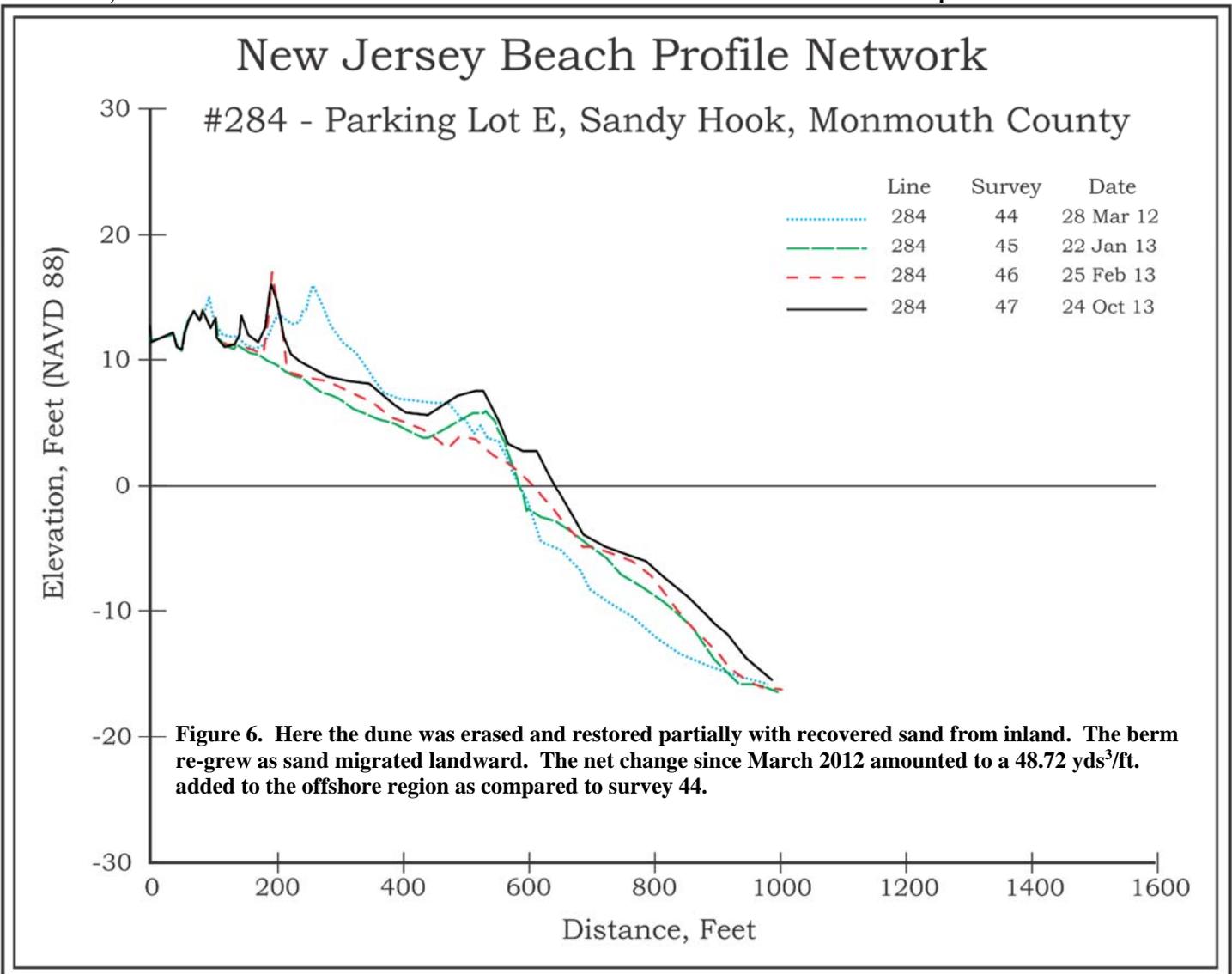


This is the northernmost ocean NJBPN survey site that has shown advances in the berm position since 1999. The photograph on the left shows a sand ridge in the process of attaching to the beach following Sandy (Jan. 22, 2013). By October 29, 2013 the sand was effectively added to the shoreline widening the beach another 100 feet.



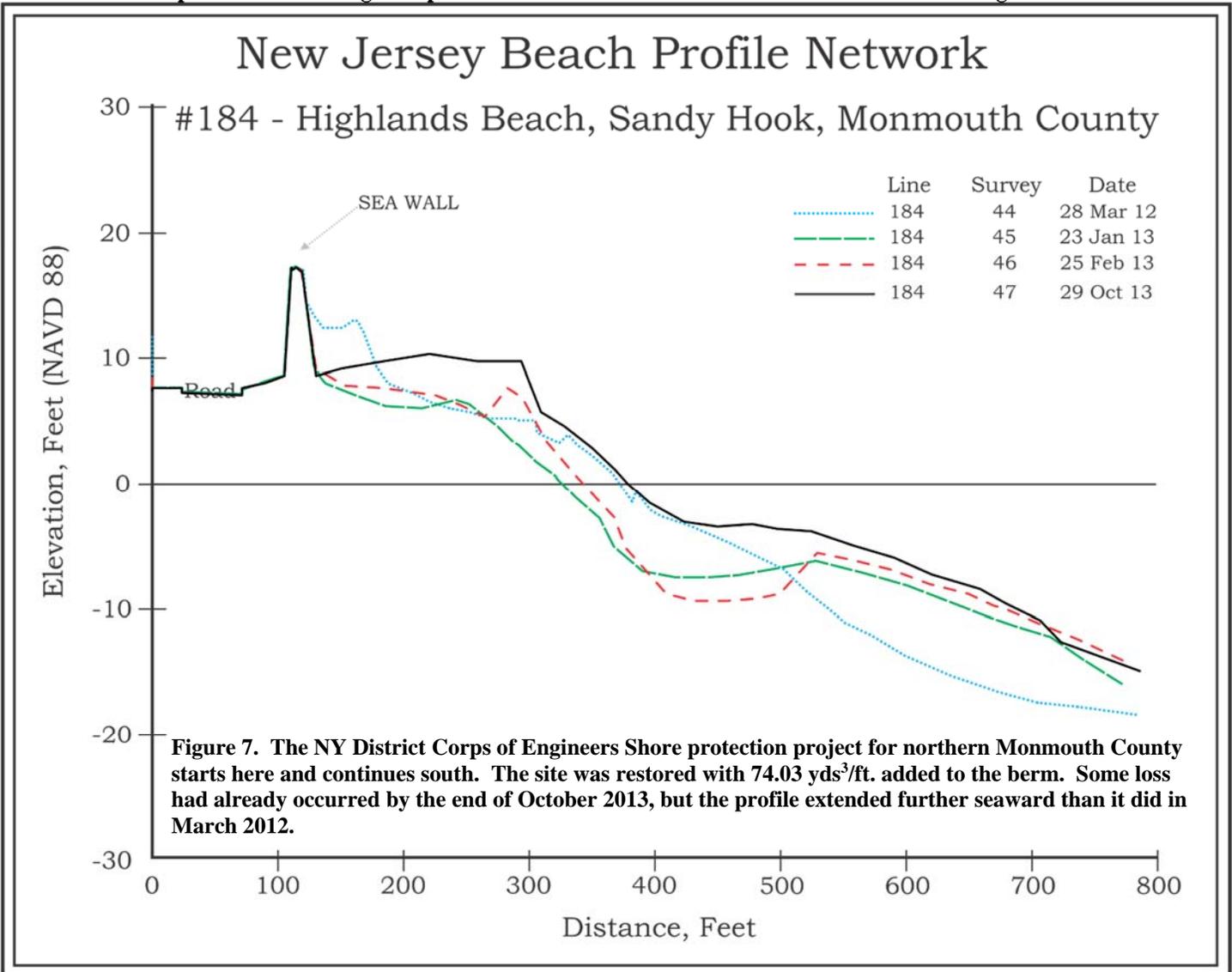


Hurricane Sandy’s damage was significant because it broke through the dunes, but the beach remained (Jan. 22, 2013). By October 29, 2013 a modest berm had welded back to the shoreline and a new dune had been completed.



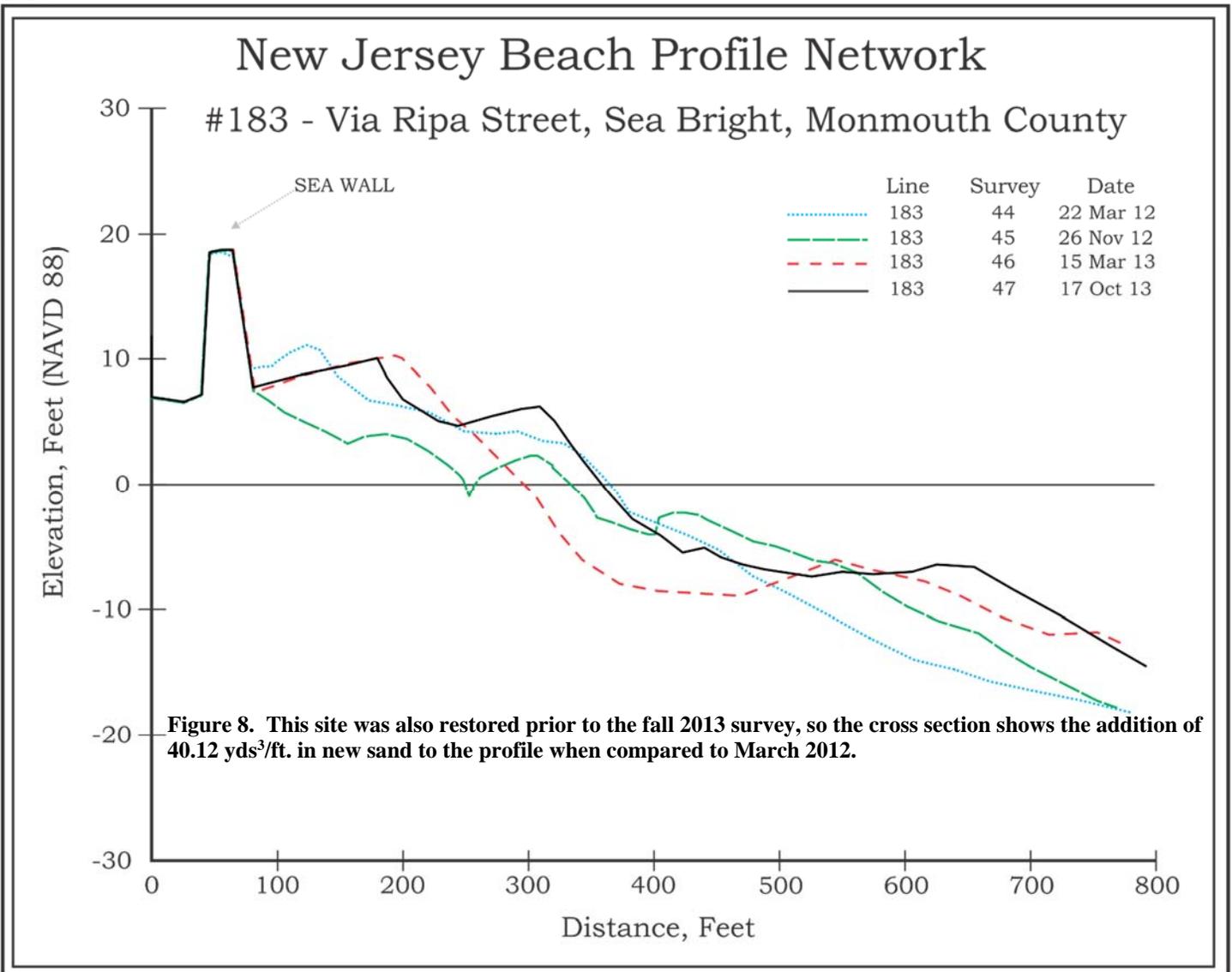


This southern Sandy Hook site is located near the entrance to the park and has gained in volume since the 1995 start of the federal shore protection project. The left view was taken following Sandy on Jan 22, 2013. By October 29, 2013 the ACOE had returned and placed sand to design template cross section. Erosion of the berm is evident following a minor NE storm.



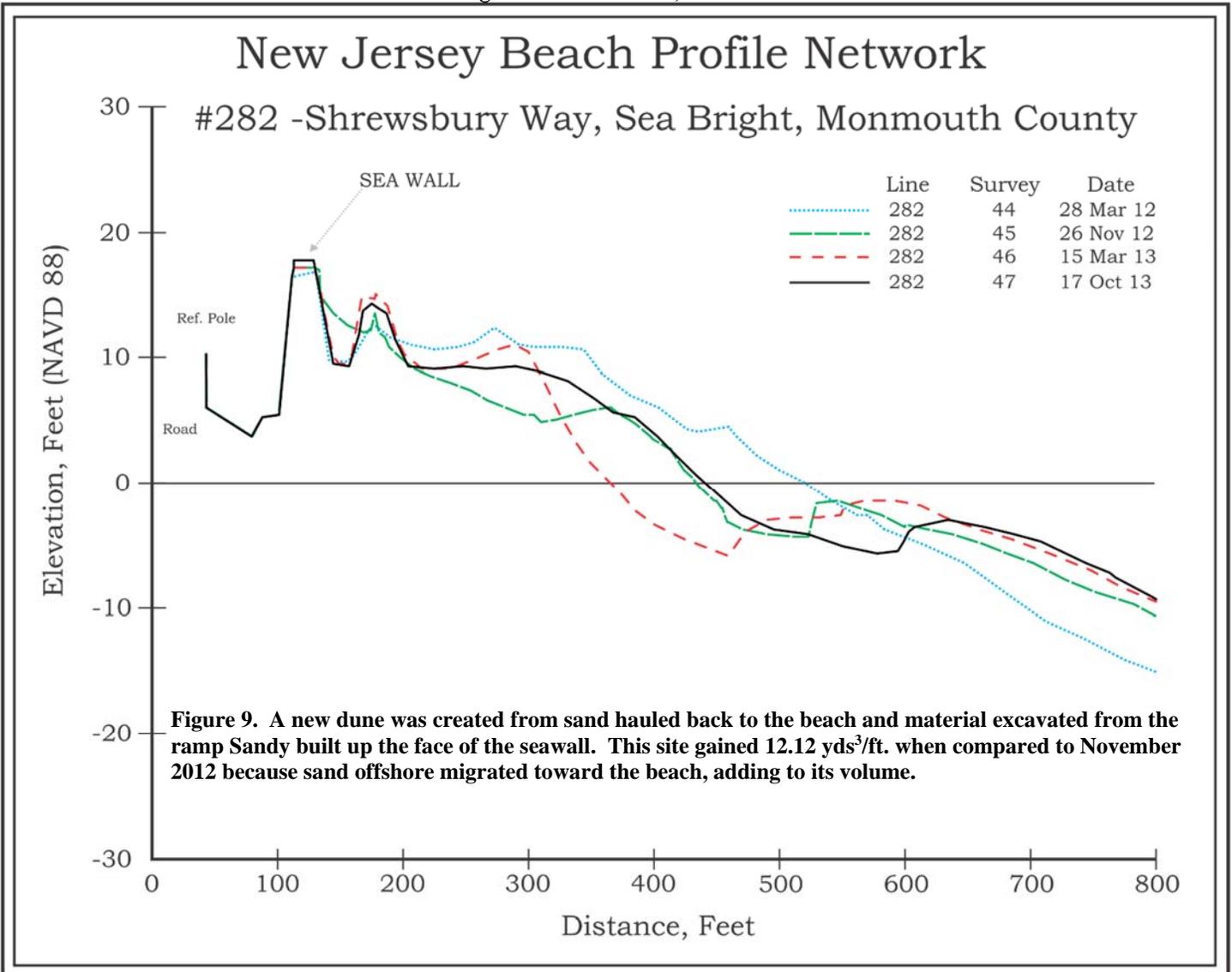


This site was near the northern limit of the initial Federal shore protection project and shows the narrower beach following Sandy on Nov. 26, 2012. The right side shows the results of the placement of 40.12 yds³/ft. of new sand on the beach by Oct 17, 2013.



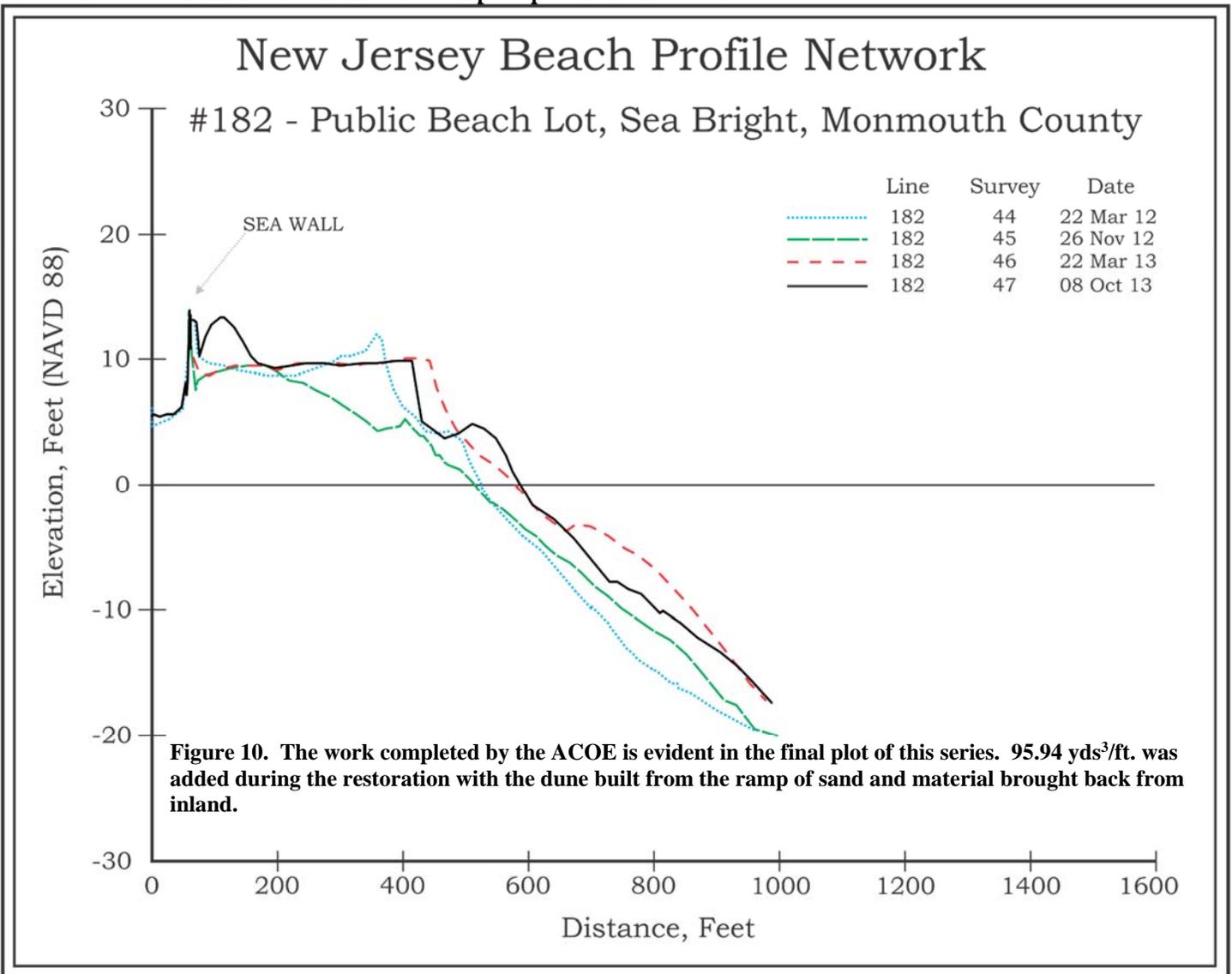


The left view shows the remnants of the “dunes” with sand ramped up to the seawall taken November 26, 2012. The ACOE pumped sand back to the original design cross section and the sand the storm pushed up the seaward face of the seawall was extracted and formed into the dune seen on the right view October 17, 2013.



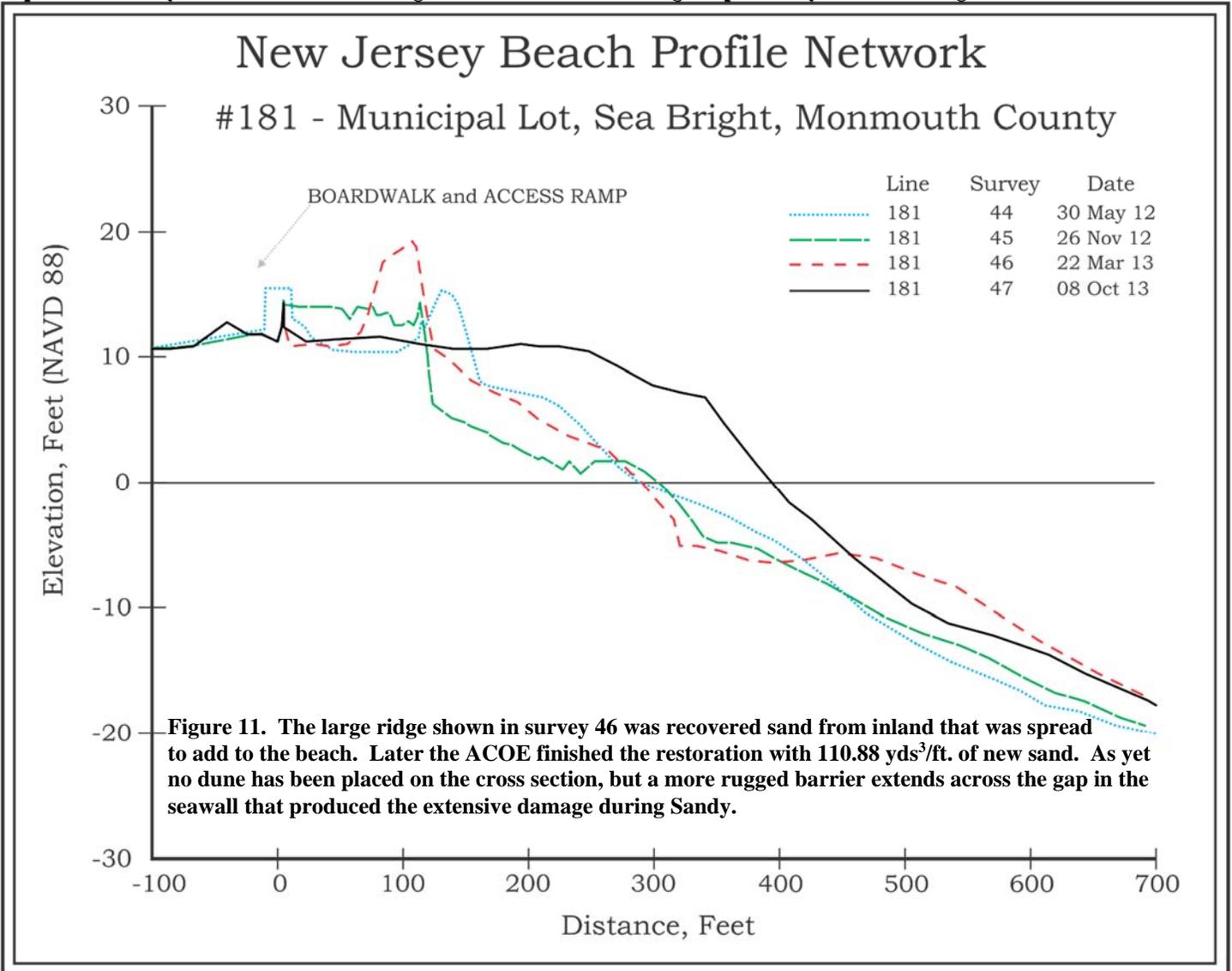


Low, wide dunes established naturally following the initial Federal beach nourishment project did not stop the Sandy storm waves (left view November 26, 2012. By October 8, 2013 the ACOE had restored the beach width and a dune was added from sand extracted from inland and the material ramped up to the rock seawall.



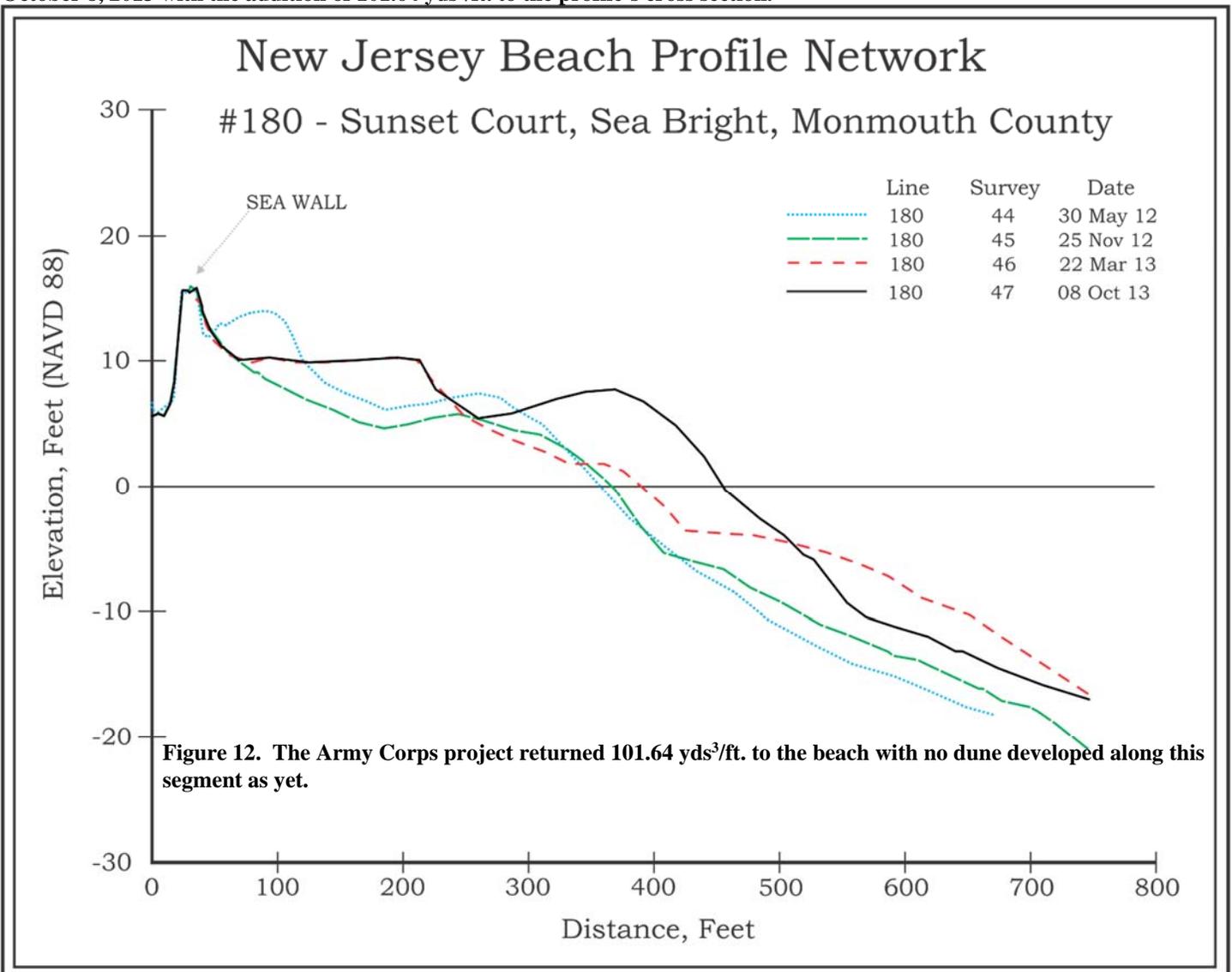


This site was the most heavily damaged along the northern Monmouth County shoreline from Hurricane Sandy, with the left view showing sand pushed back to the beach from inland deposits in November 26, 2012. By October 8, 2013 the ACOE had deposited 110.88 yds³/ft. to restore the design cross section. The change in proximity of the buildings to the water is evident.



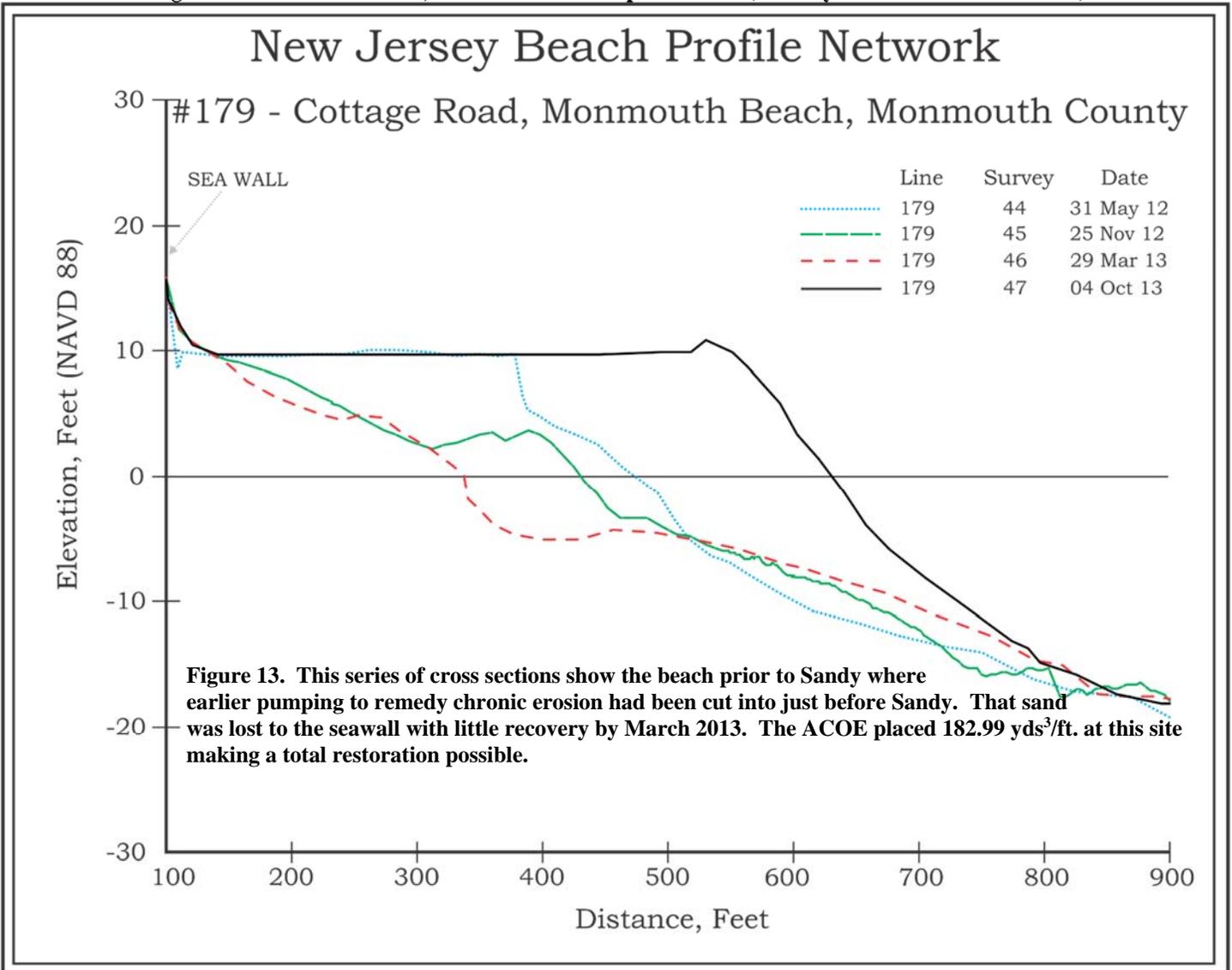


This site received sand from the initial Federal beach nourishment project. The left photograph (Nov. 21, 2012) shows where Sandy’s waves pushed sand into a gentle ramp up the seaward rock slope and allowed the wave bores to pour over the wall into Ocean Avenue and associated properties. The restoration by the ACOE had just been completed in the right photo taken October 8, 2013 with the addition of 101.64 yds³/ft. to the profile’s cross section.



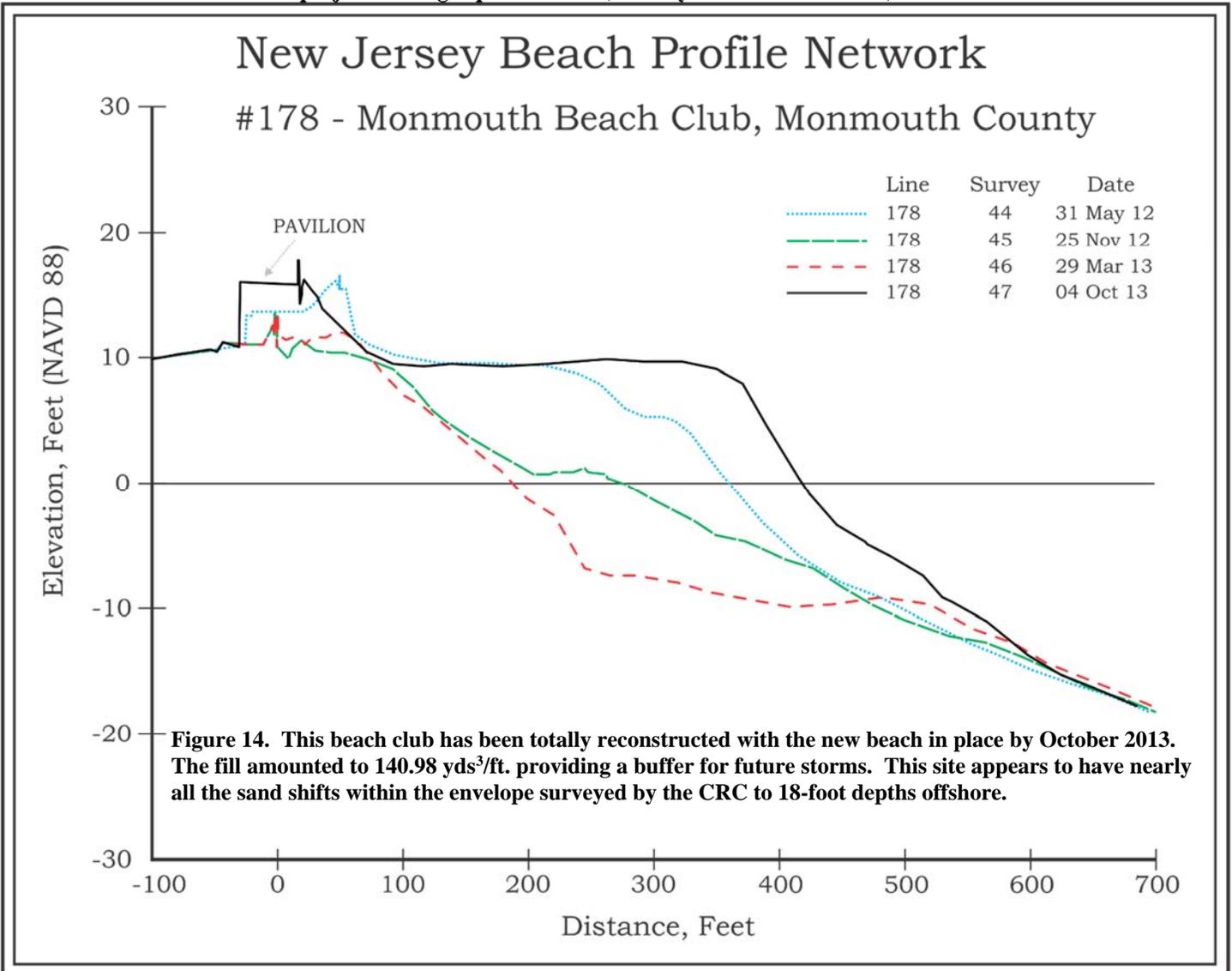


This site has the worst erosion history of any site in Monmouth County. Chronic volume losses have been recorded over the years because the rock groin just south of the site blocks sand transport from the south. Most of the sand placed by Jan. 2012 was moved to the nearshore or over the seawall during Sandy. The left photograph (Nov 21, 2012) shows the renourishment activities following the storm and the Oct. 4, 2013 shows the completed work (182.99 yds³/ft. added to the beach).



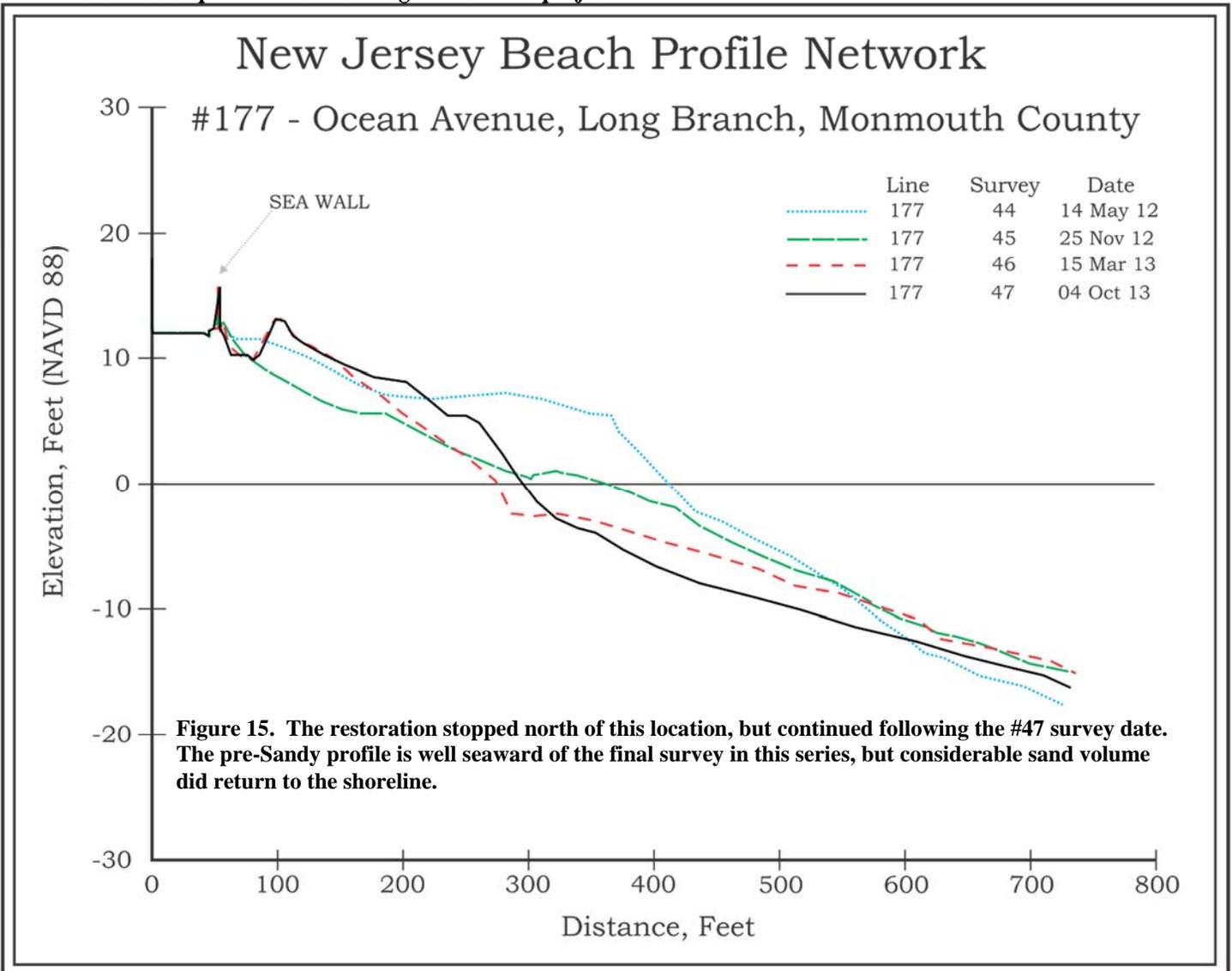


This profile received the initial Federal beach nourishment project and the winter 2011 to 2012 renourishment (left photo taken Nov. 25, 2012 after Sandy). Hurricane Sandy removed significant amounts of sand from the berm, destroyed a moderate-sized dune and badly damaged the beach club buildings. The right photo taken October 4, 2013 shows the results of the ACOE work to restore the project to design specifications (140.98 yds³/ft. of added sand).



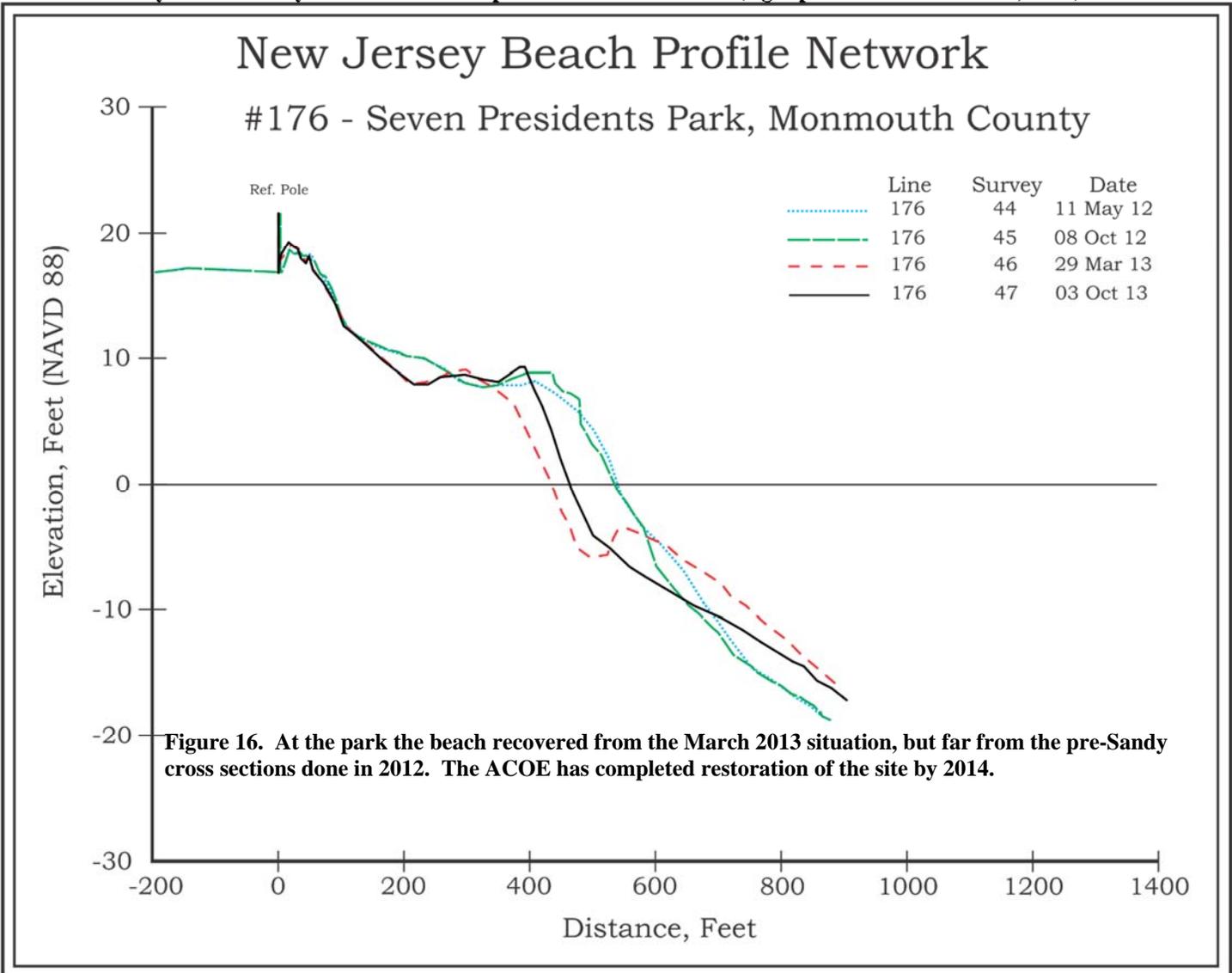


Sand was placed during the initial Federal beach nourishment project. This site was the southernmost one NOT surveyed prior to Sandy. After Sandy, the berm was reduced in elevation and pushed landward (left photo taken November 25, 2012). The right photo was taken October 4, 2013 following the recovery of 22.93 yds³/ft. on the beach naturally, prior to the arrival of the ACOE to complete the northern segment of their project.



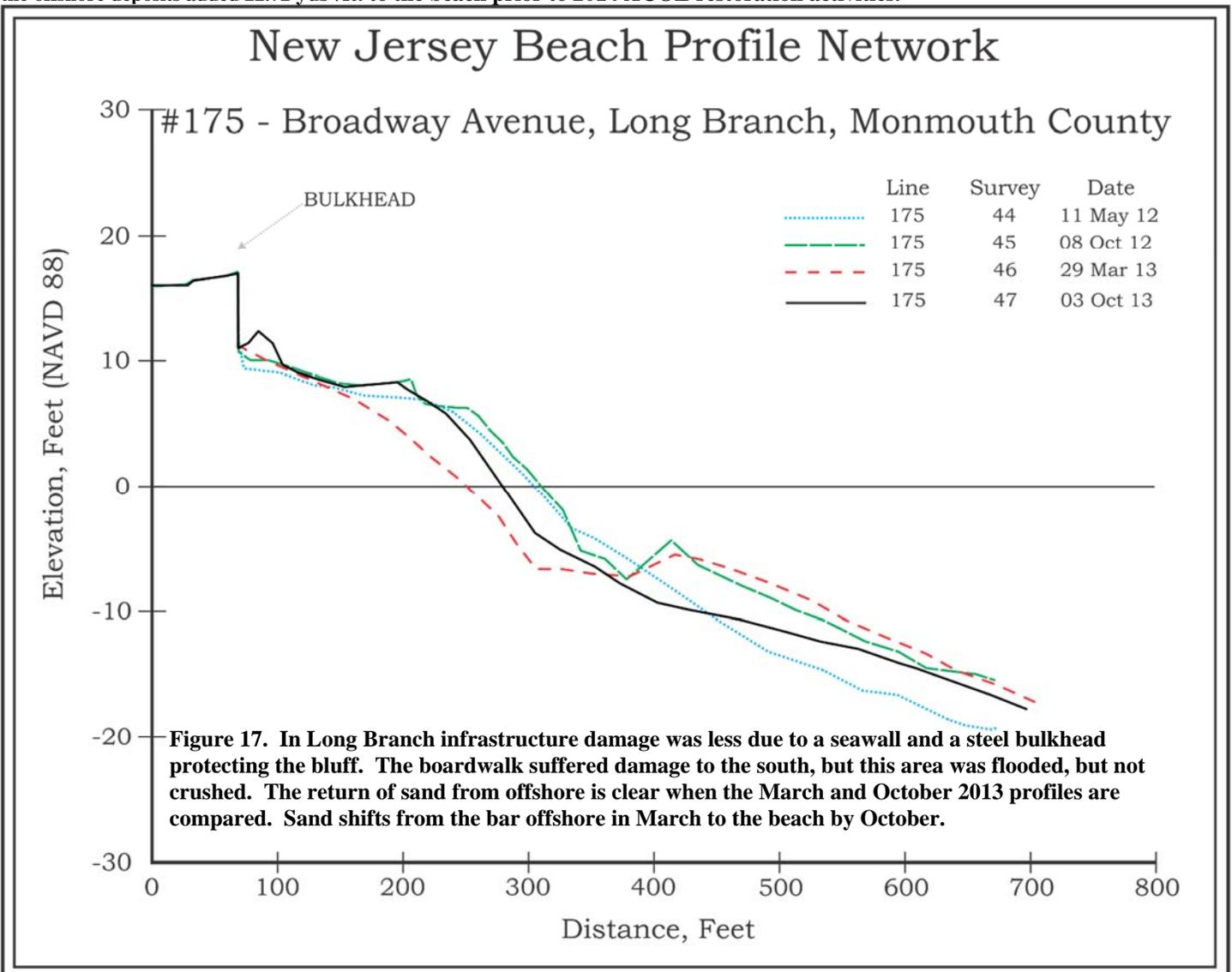


This site is a popular recreational park with a partial ridge of 25-foot elevation dunes and an expansive berm that has undergone variable volume changes through the years (left photo taken Nov. 13, 2012). During Hurricane Sandy, the grade-level public access points created channeled flow from the storm waves and washed sand landward into the parking lots. Natural recovery added 20.68 yds³/ft. to the beach prior to the ACOE work (right photo taken October 3, 2013).



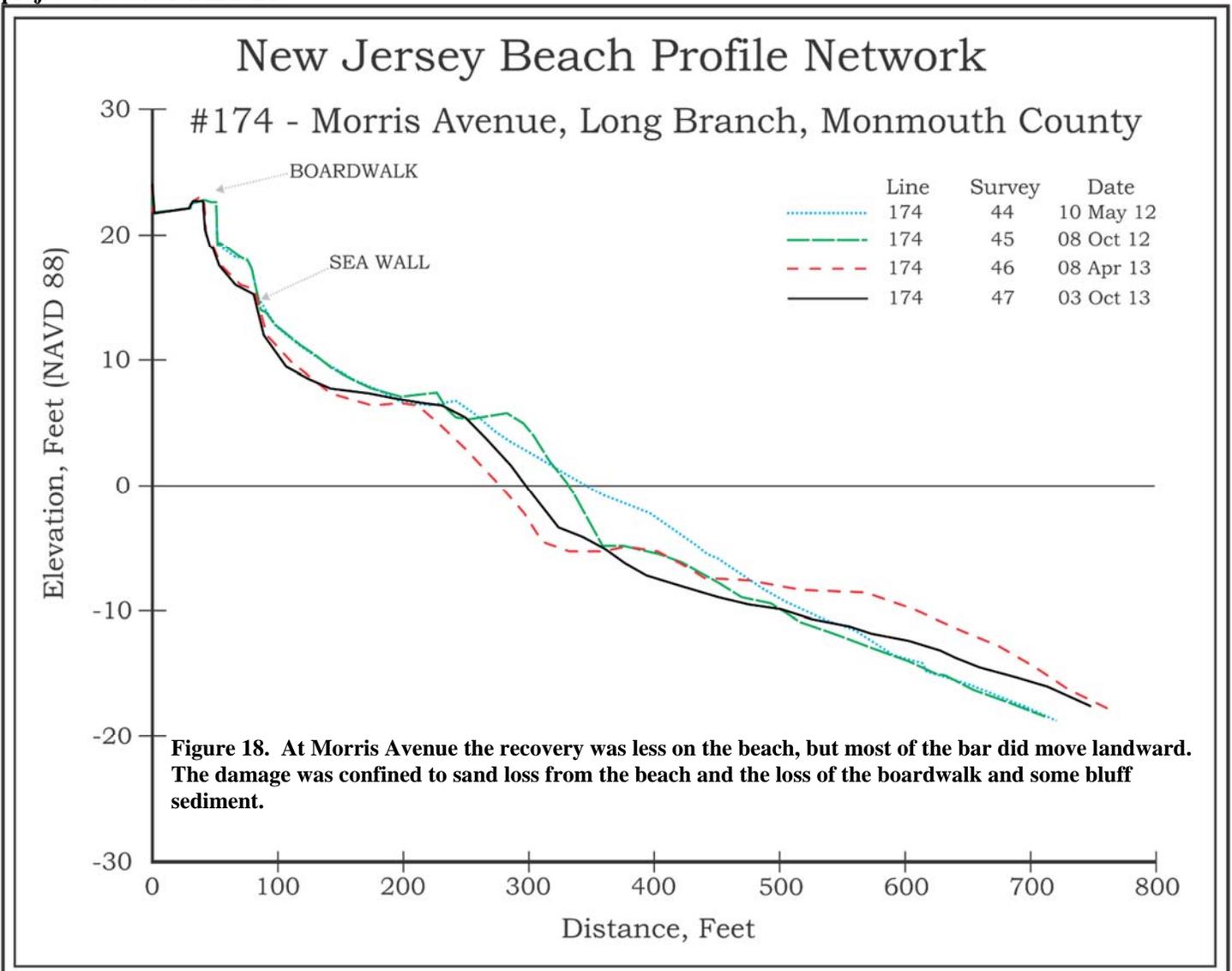


This site was part of the Federal shore protection project and renourishment activities (left photo taken November 13, 2012). H. Sandy relocated the berm sand over the vertical steel wall, but the vast majority of sand was deposited offshore. The railing on the left photograph was bent landward by wave action 17 feet above the zero datum elevation. Natural recovery from the offshore deposits added 22.72 yds³/ft. to the beach prior to 2014 ACOE restoration activities.



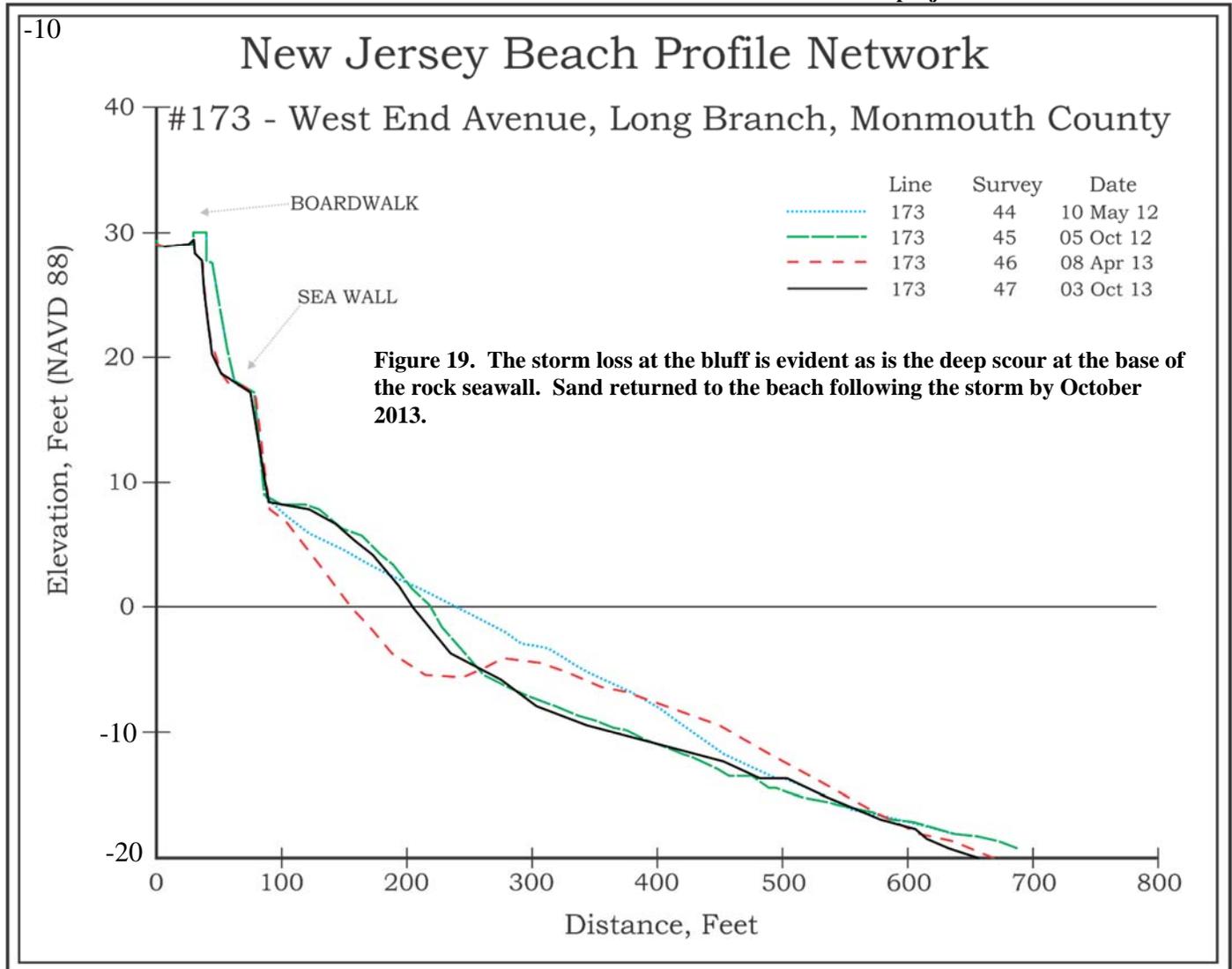


This site participated in the Federal beach nourishment project and was a direct beneficiary from the 2010 maintenance fill completed to the south (left photo taken November 13, 2012). No attempt has been made to replace the boardwalk since Sandy, but natural recovery from offshore deposits returned 12.49 yds³/ft. to the beach prior to the ACOE completing the project's restoration in 2014.



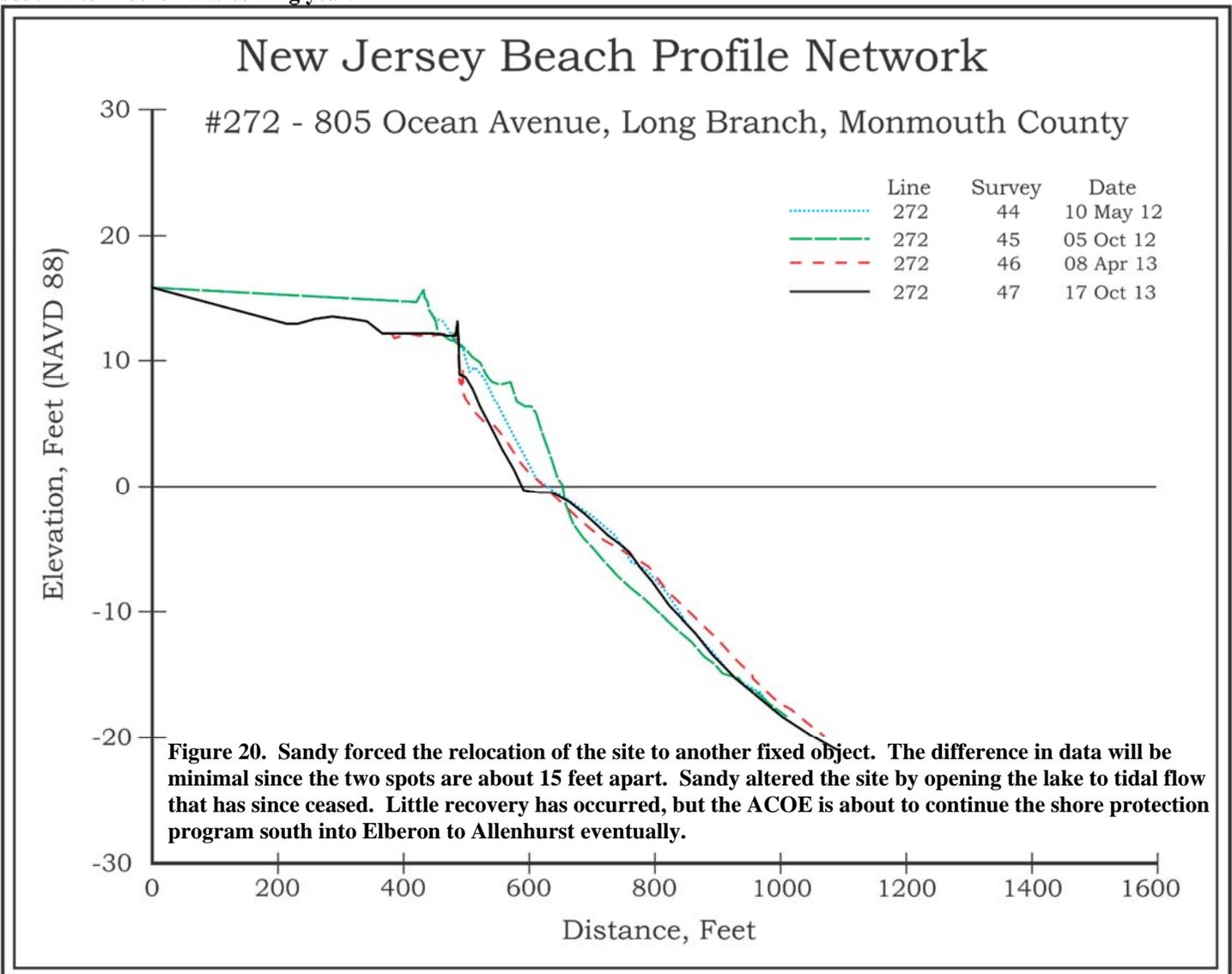


This site is located near the southern limit of the Federal beach nourishment project. Long Branch did not include the construction of a protective dune. It was decided at the time of project planning that the bluff elevation and the presence of the rock revetment was enough protection for landward properties. While the revetment held in place during H. Sandy, the boardwalk built on the upper bluff sediments was destroyed when the bluff retreated to the edge of the old southbound Ocean Ave. roadway (left photo taken November 13, 2012). By October 3, 2013 natural recovery restored 22.96 yds³/ft. to the beach, but no local restoration to the boardwalk had occurred. In 2014 the ACOE announced the project's restoration.



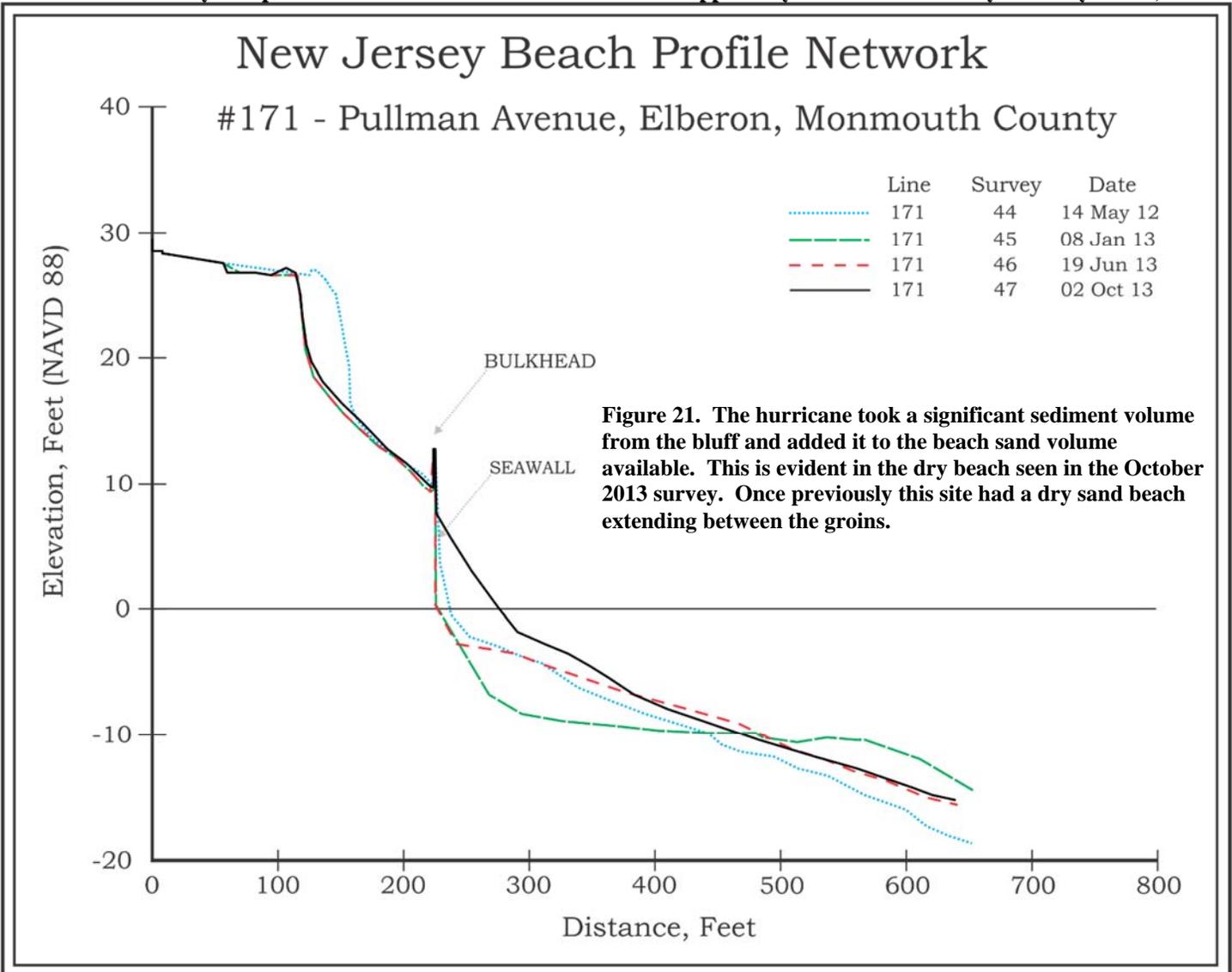


This site, established in 2010, is located on the northeastern edge of Lake Takanassee and within a groin compartment. The left photo (taken November 13, 2012) shows the lowered berm and debris from structures that were destroyed in the storm. On the right (Oct. 17, 2013) the swash zone and beach extends to the north. The ACOE restoration effort will extend to the south into Elberon this coming year.



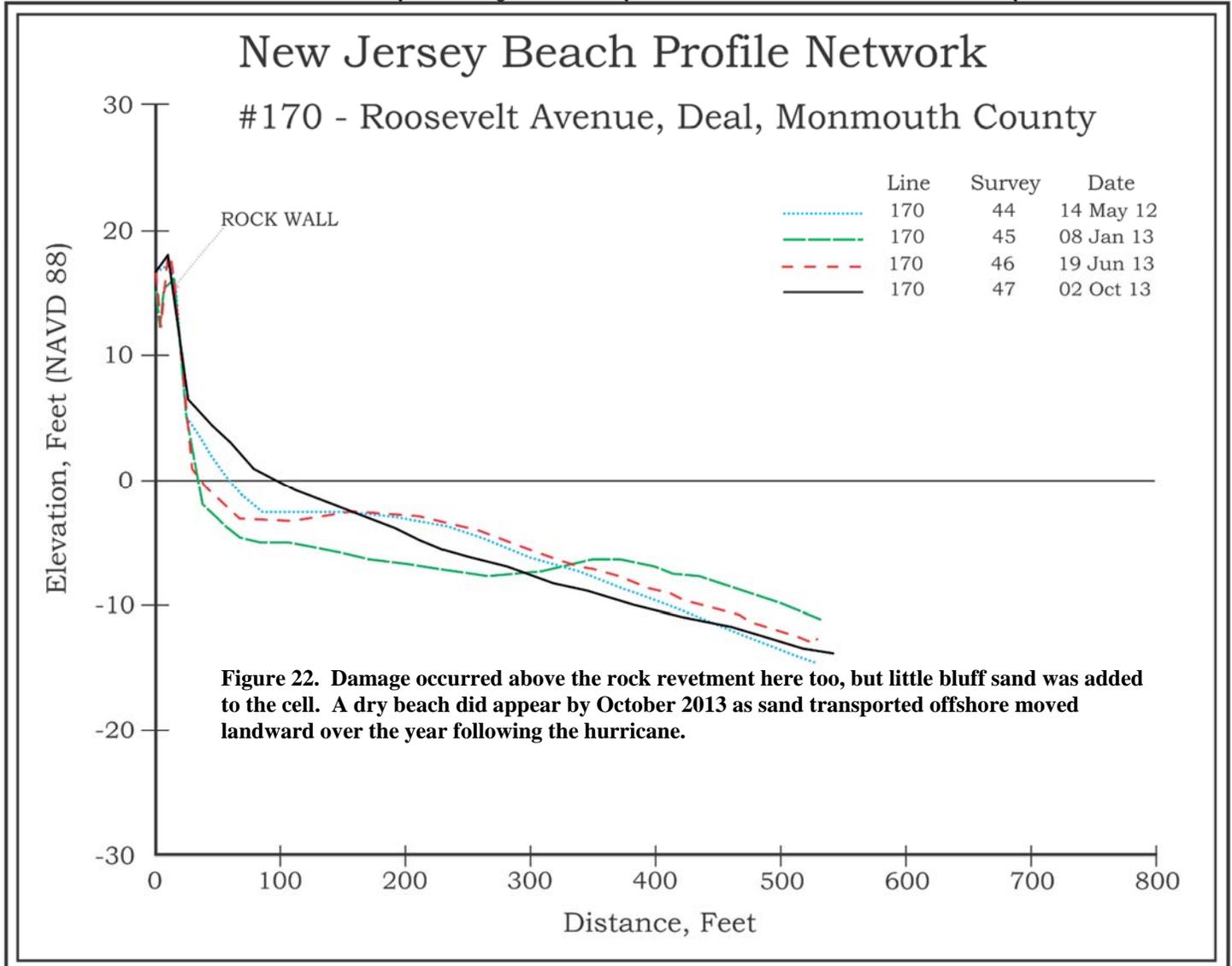


This site is located on the highest point along the bluff shoreline and in the past, has had very little sub-aerial beach as this community was not included in the Federal beach nourishment projects (left photo taken November 13, 2012). Waves apparently broke over the rock revetment, attacked upper un-armored bluff sediments and pushed the edge back 40 feet. The loss of over 12 cubic yards per foot of bluff sediment to the beach zone apparently has resulted in a dry beach by Oct. 2, 2013.



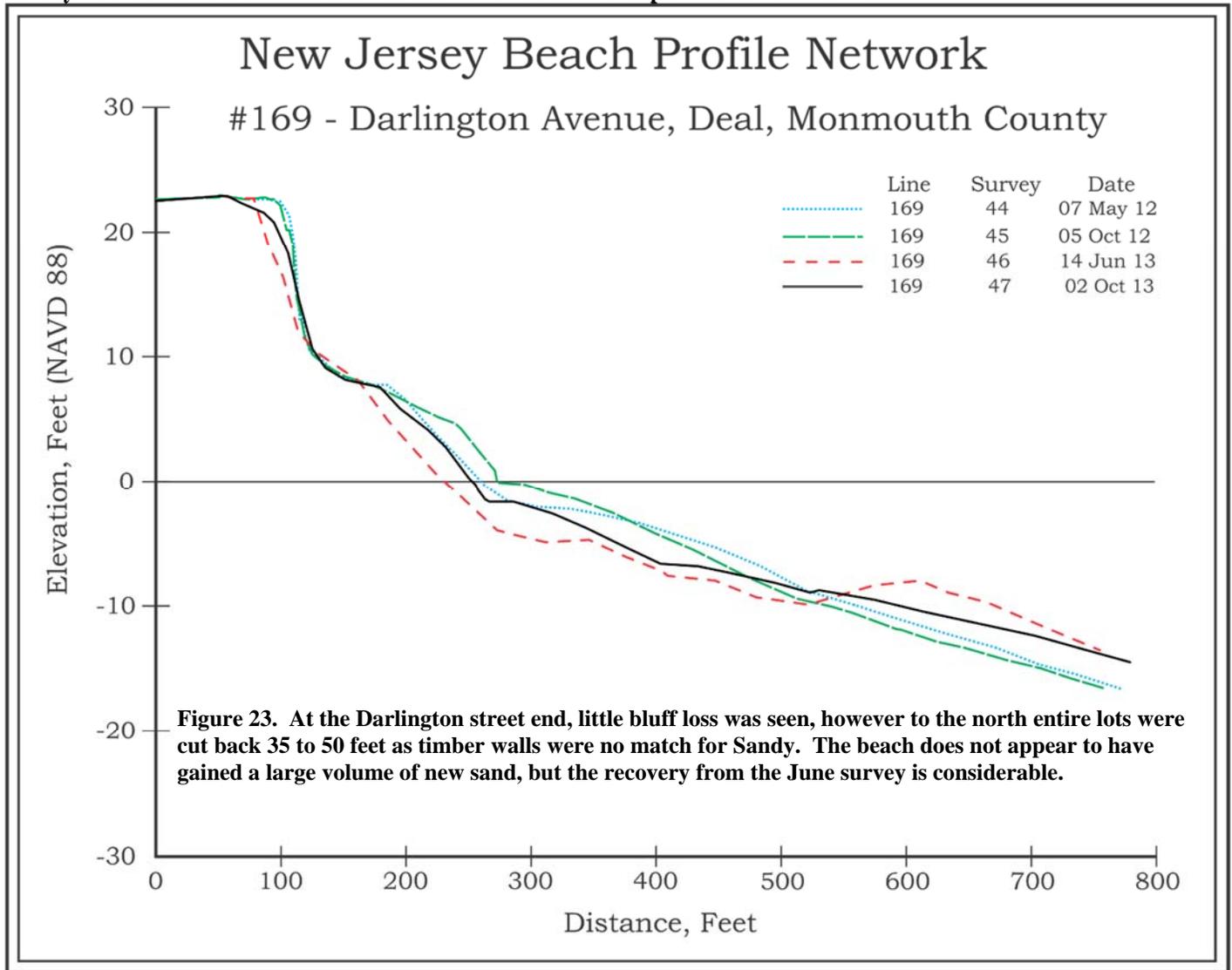


This profile is located between two rock groins that limit sediment movement. This area has never received sand from direct beach nourishment and has never benefited from the addition of sand from the littoral system derived from the Federal beach fills. The photo on the left (taken November 13, 2012) shows the impacts of Sandy where waves crashed over the rocks and dug deeply into the area just landward of the rock revetment. By October 2, 2013 sand moved offshore and eroded from the bluff contributed to an addition of 35.17 yds³/ft. to generate a dry beach at this site for the 2nd time in 28 years.



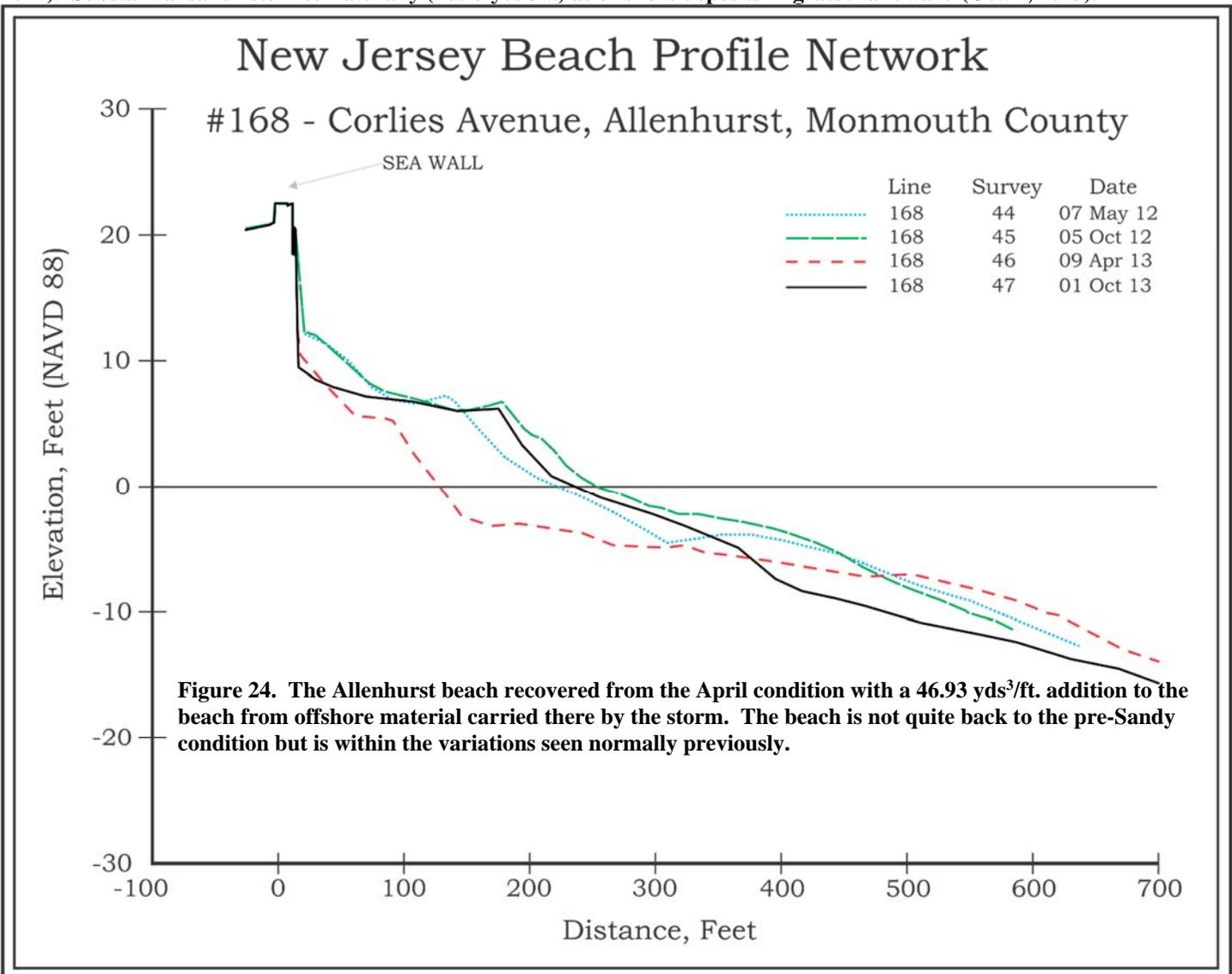


The Darlington site has a small sub-aerial beach contained between two larger groins. The upland bluff was eroded significantly during Sandy and added to the beach sand volume (Nov. 13, 2012). By October 2, 2013 natural recovery added 21.60 yds³/ft. back to the beach with some reconstruction of bluff protection structures.



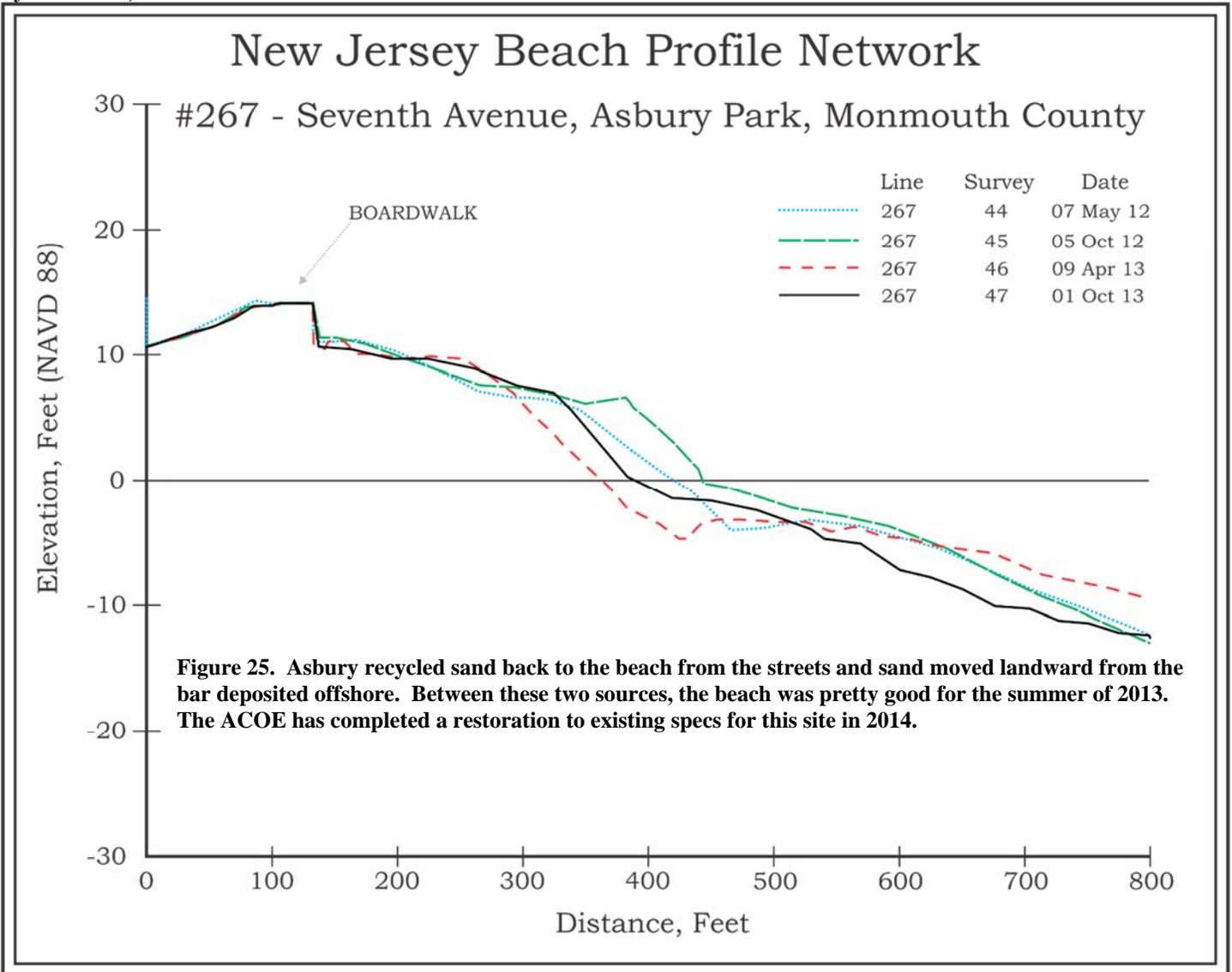


This site in Allenhurst also represents the shoreline conditions for Loch Arbor’s 2-block shoreline. Here an old concrete wall protects the sedimentary bluff. Age and decay has had an effect, but Sandy’s waves clearly broke over the top of the wall with sufficient force to dislodge about 50 feet of the boardwalk (left photograph in front of the white truck, taken November 13, 2012). Substantial sand returned naturally (46.93 yds³/ft.) as offshore deposits migrated landward (Oct. 1, 2013).



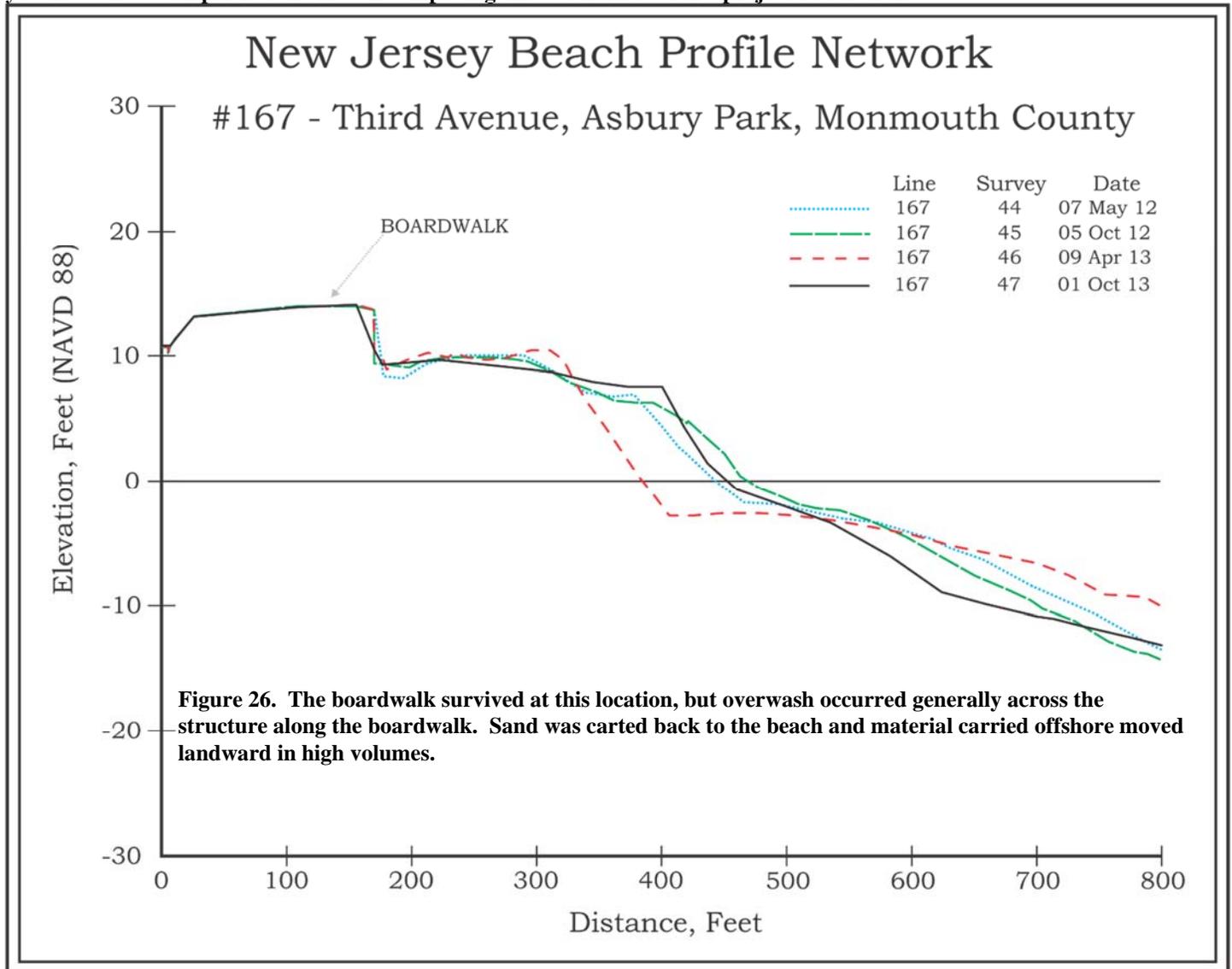


This site is the northernmost site included in the Federal shore protection southern project. The left photo (taken on November 13, 2012) sand stripped from the beach, pushed landward and washed up to the boardwalk as a ramp allowing the waves to pass over the structure inland. Natural recovery permitted 17.79 yds³/ft. in offshore deposition to return to the beach by October 1, 2013.



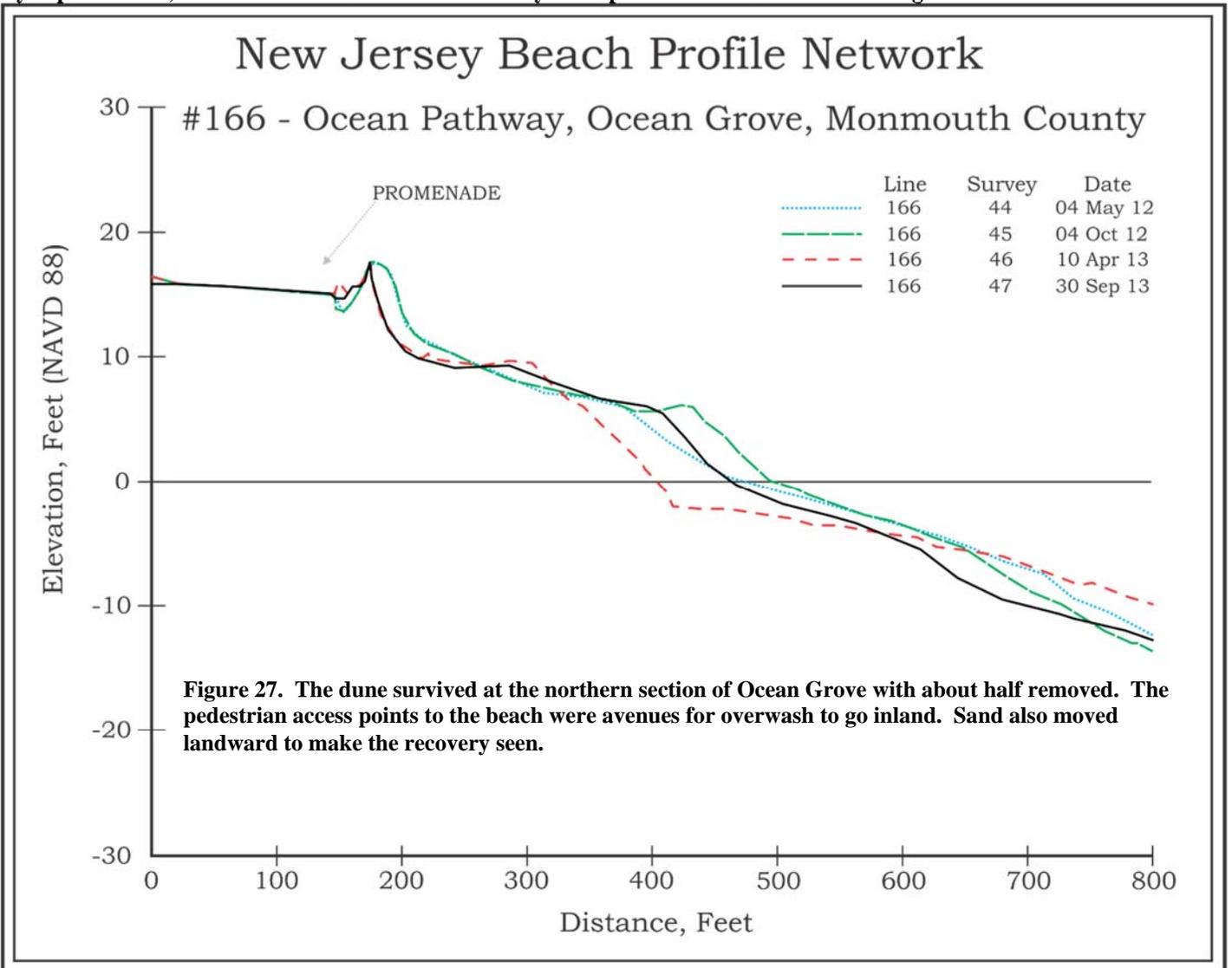


Asbury Park experienced sand stripped from the beach and ramped up to the boardwalk allowing the waves to pass over the structure without destroying it (left photo taken November 13, 2012). By October 1, 2013 natural recovery had restored 26.98 yds³/ft. to the beach prior to the ACOE completing this southern section’s project restoration.



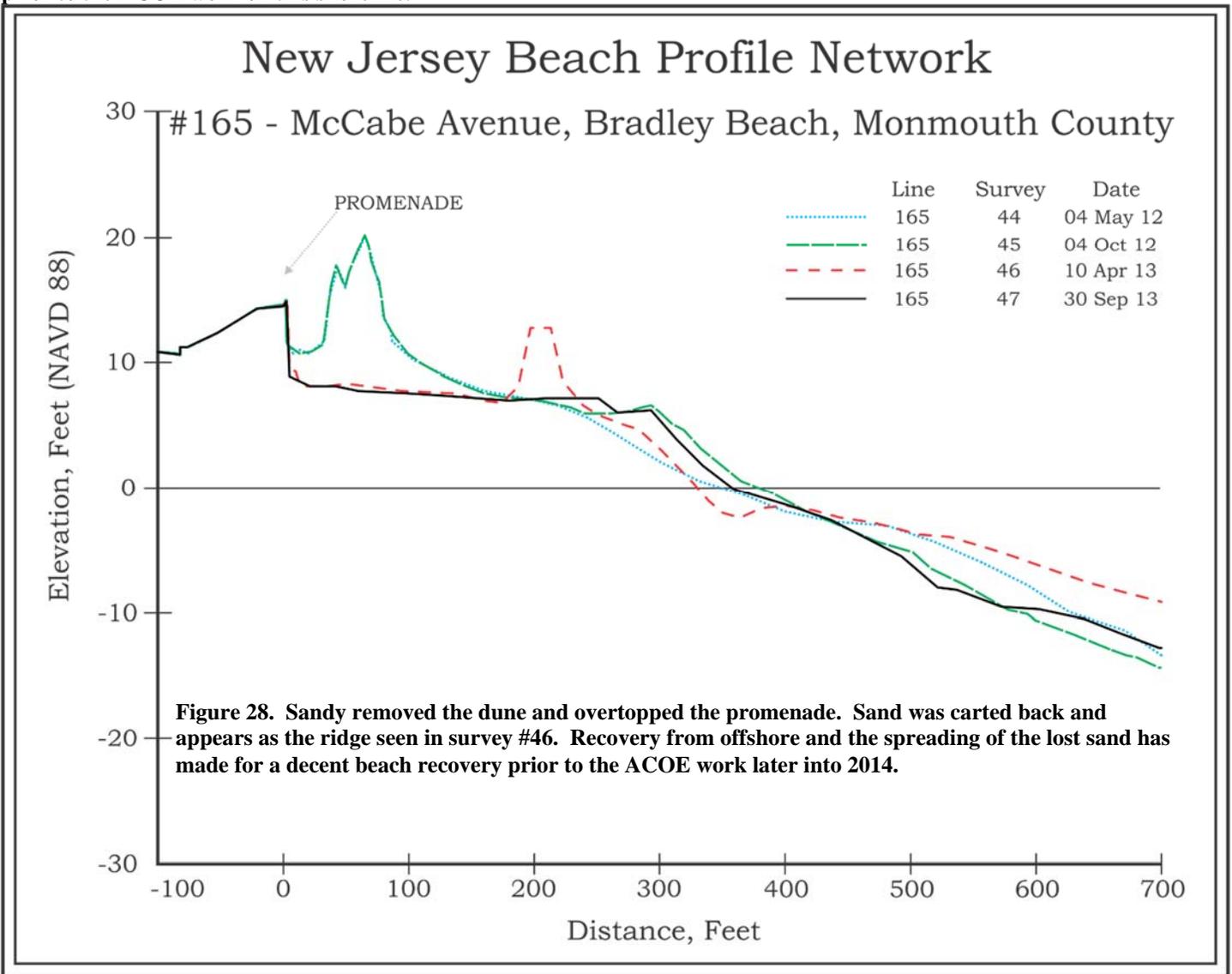


Following Sandy, the dunes along the northern Ocean Grove shoreline survived in partial sections, but were removed south of Main Street. Sand was excavated from Ocean Avenue and carted back to the beach (vehicle in left photo November 13, 2012). By September 29, 2013 the beach had recovered 22.65 yds³/ft. prior to the ACOE commencing restoration work.



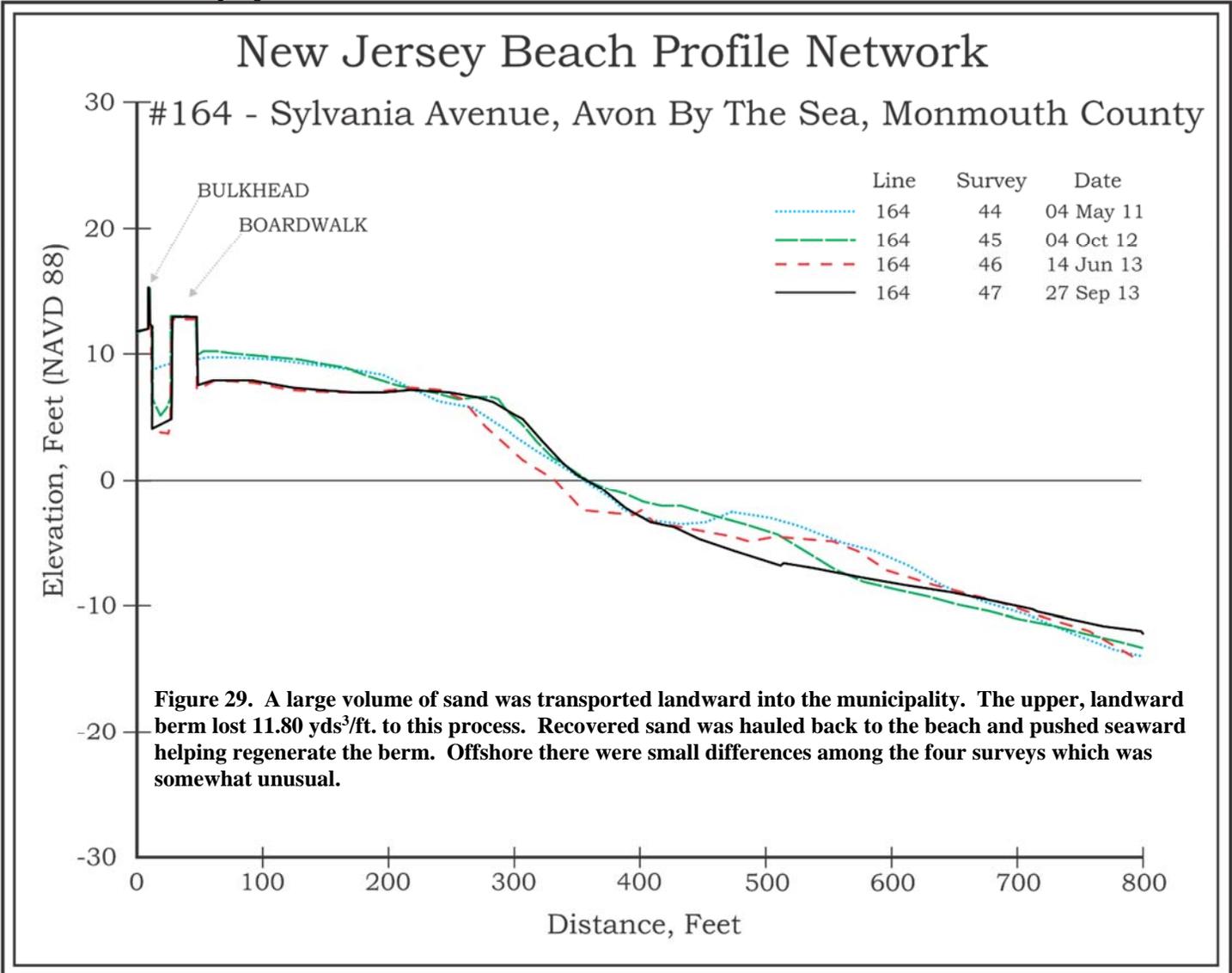


The promenade was impacted, but not destroyed but abundant sand was still present in Ocean Avenue (left photo taken Nov 12, 2012). No dune was restored by September 30, 2013, but 9.77 yds³/ft. in offshore sand deposits had returned to the beach prior to the ACOE work on this shoreline.



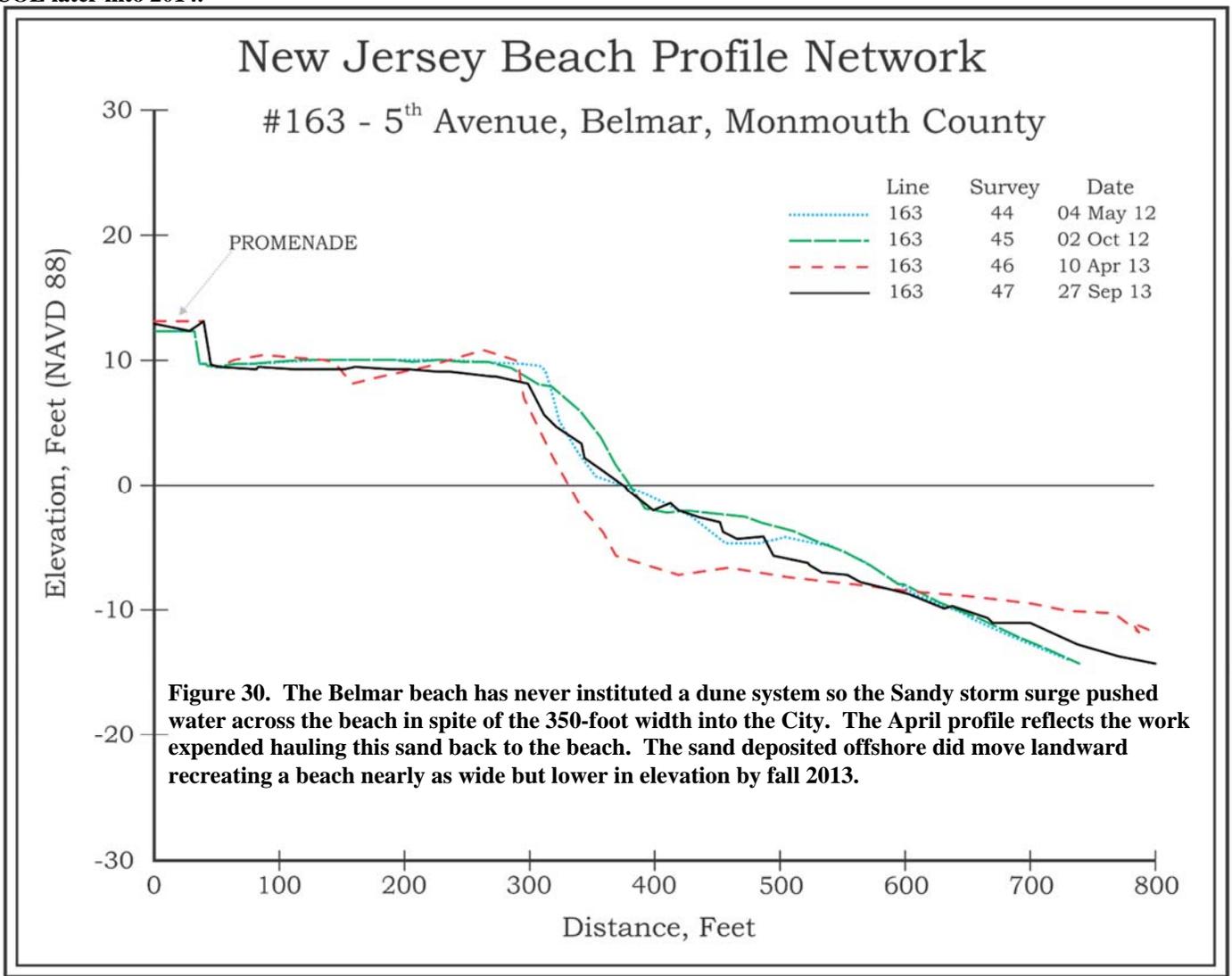


This site is located north of the Shark River inlet and was nourished in the 1999 Federal shore protection project. During Sandy, the beach had been totally submerged and sand was washed inland well beyond Ocean Avenue (left photo taken November 12, 2012). 10.48 yds³/ft. in natural recovery was added to the beach by Sept 27, 2013 prior to the ACOE restoring the beach to their design specifications.



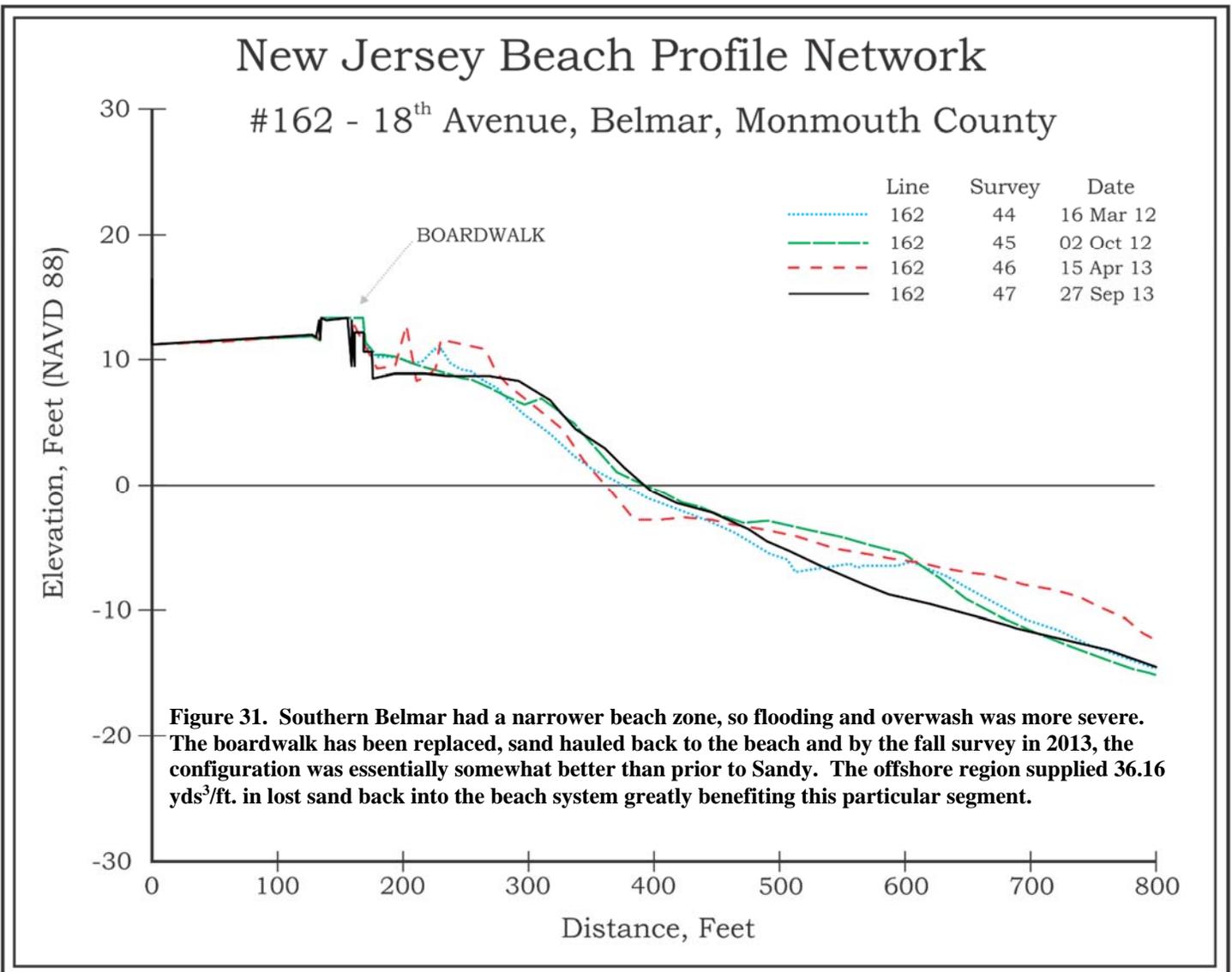


This site did not have a dune prior to Sandy but had a wide, dry beach. During Sandy, the dry beach was submerged by the storm surge. Sand was carried landward onto Ocean Avenue accompanied by extensive flooding (left photo taken November 12, 2012). Natural recovery brought 31.76 yds³/ft. of sand back to the beach leaving little additional sand placement by the ACOE later into 2014.



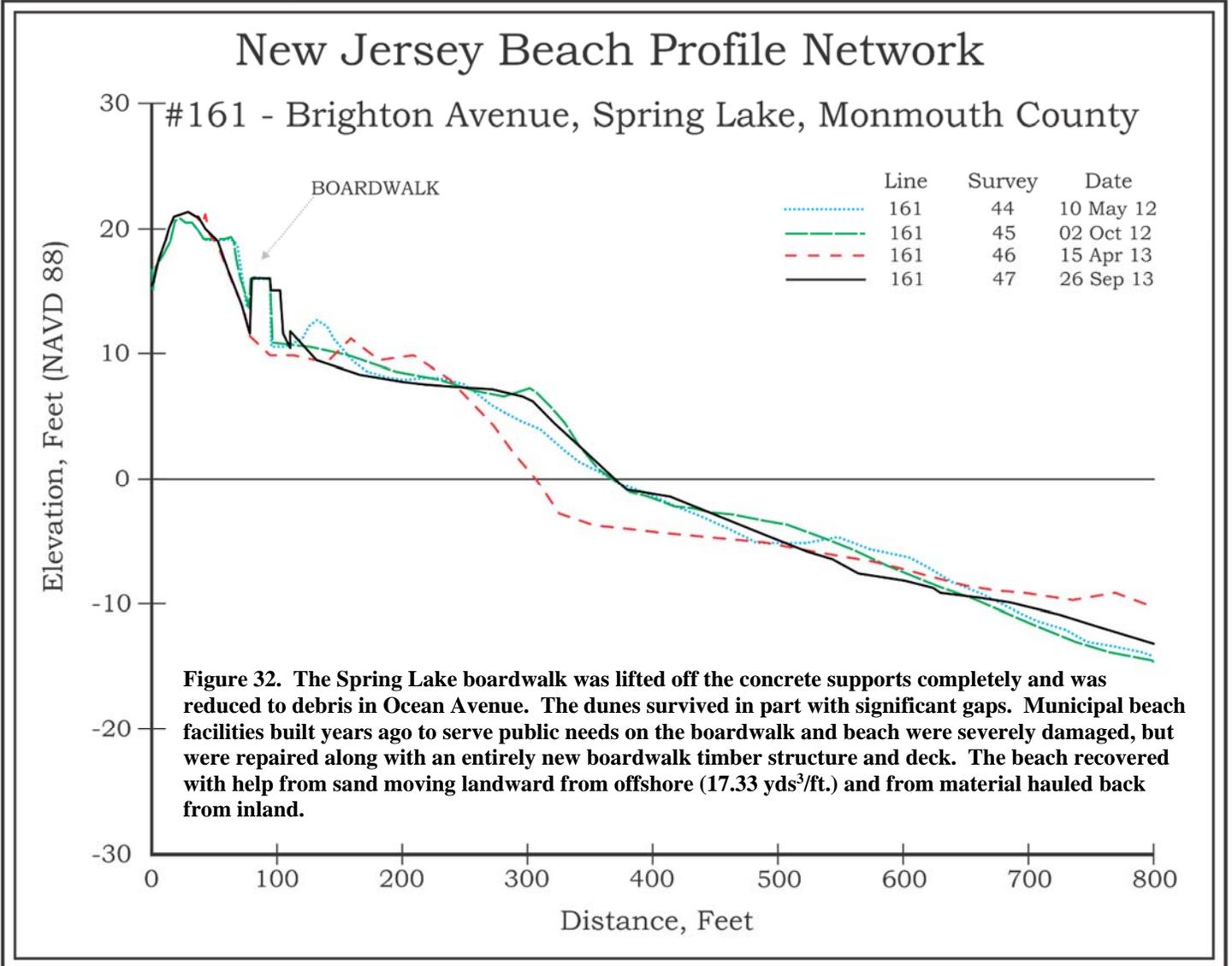


The southern Belmar shoreline was completely overrun by the force of Hurricane Sandy. The Lake Como segment was closed to traffic because multiple pumping pipelines were in place moving lake water back to the sea. Nothing but the supports remained from the boardwalk (left photo, November 12, 2012). 11.23 yds³/ft. recovered on the beach naturally by 9/27/2013.



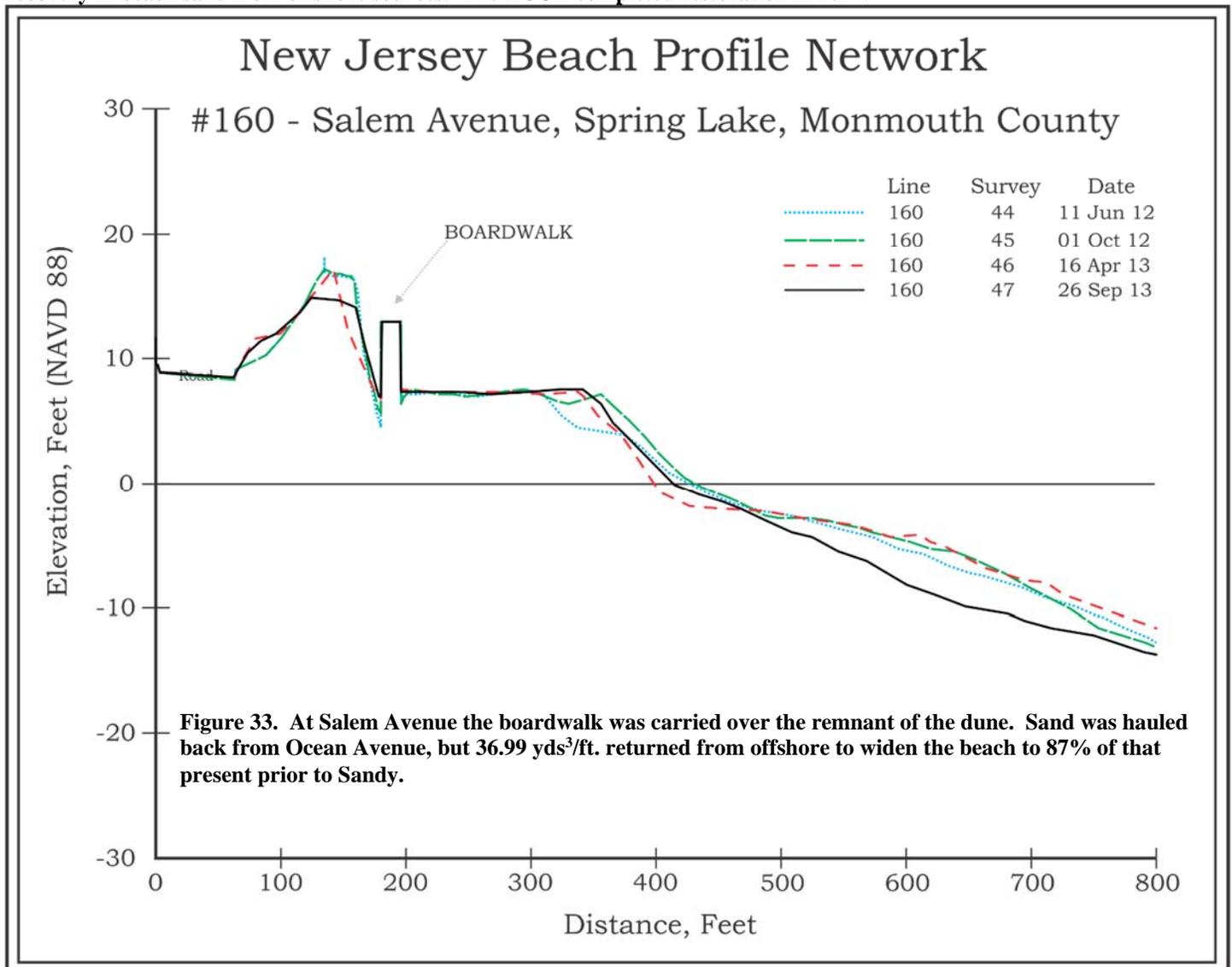


During Sandy, Spring Lake lost the entire boardwalk deck. Extensive damage occurred at the ocean-side bathing buildings with most of the dunes breached and some segments removed entirely (left photo taken November 12, 2012). A massive effort restored the boardwalk by Sept 26, 2013 and 31.40 yds³/ft. in eroded beach/dune sand returned to the beach naturally.



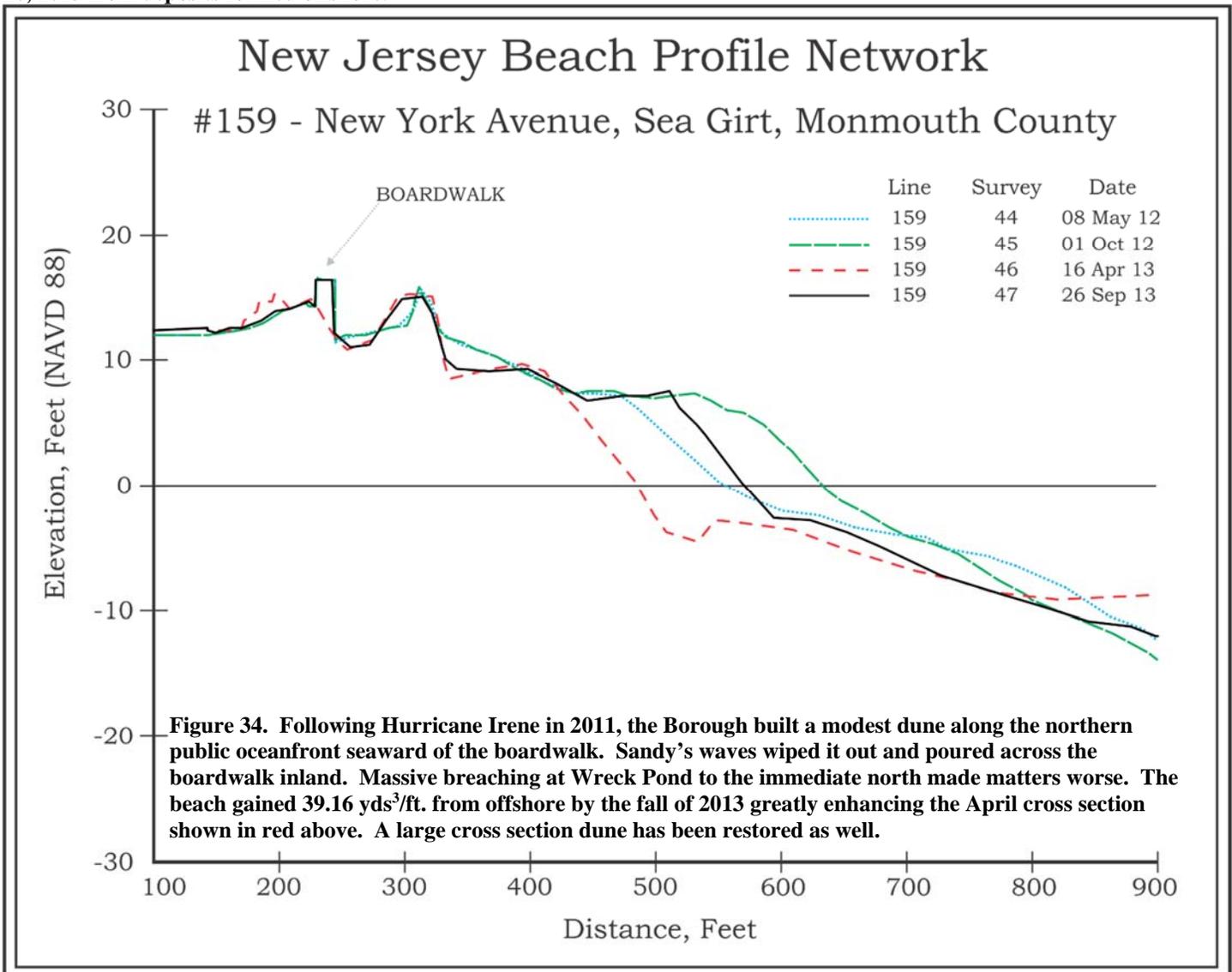


Sandy caused serious dune erosion that allowed waves to move sand into Ocean Avenue and strip the boardwalk deck from the supports. A ridge of sand had been carted back to the beach as the feature showing on the beach on the November 12th survey line (left photo taken November 12, 2012). By the end of September 2013 the boardwalk was replaced with a modest recovery in beach sand from offshore sources. The ACOE completed restoration in 2014.



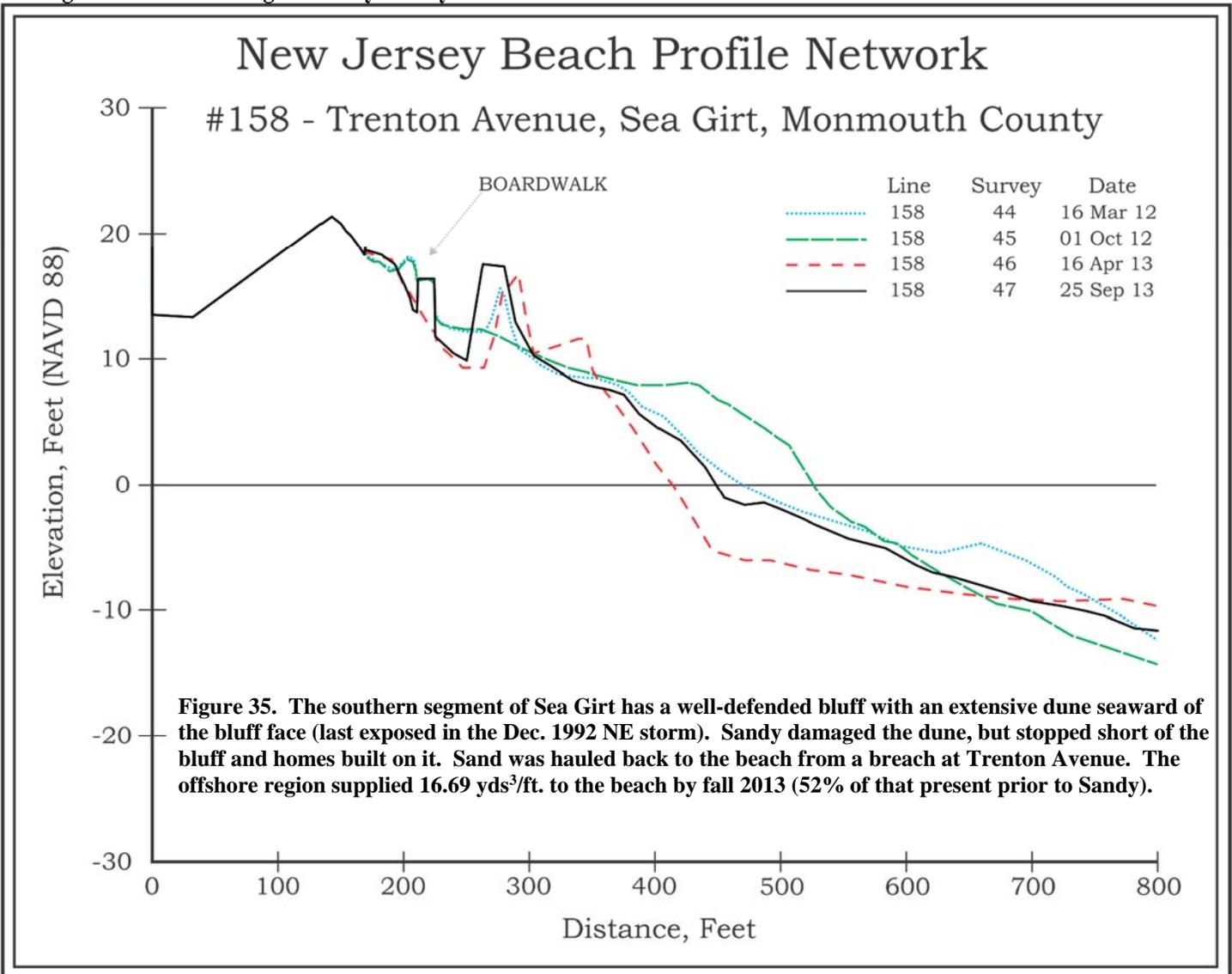


Sandy caused damages along the northern Sea Girt shoreline and impacted the infrastructure more intensely than at locations further south. The boardwalk was damaged and washed over completely. Sand was being carted back the beach as a sizable ridge (left photo taken November 12, 2012). Boardwalk damage restored and 39.16 yds³/ft. in lost sand was returned by Sept 26, 2013 from deposits formed offshore.





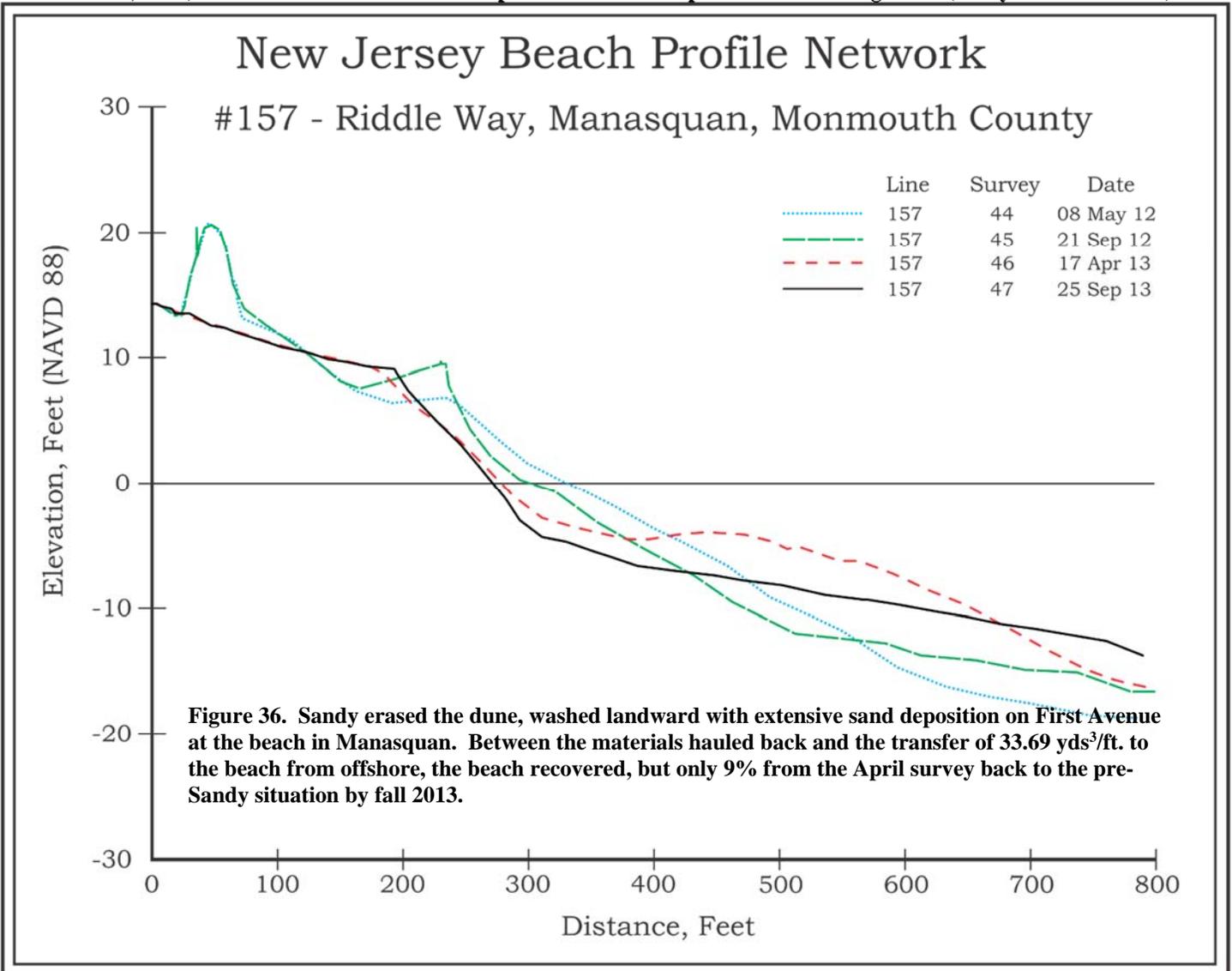
H. Sandy reduced the elevation and width of the berm and the sand from the street end was carted back to the beach (see the ridge shown in the left photo taken November 12, 2012). The ridge of recovered sand remains along this segment of the Borough beach and was augmented by 35.07 yds³/ft. in sand returned to the beach from offshore.



NJBPN 157 – Riddle Way, Manasquan

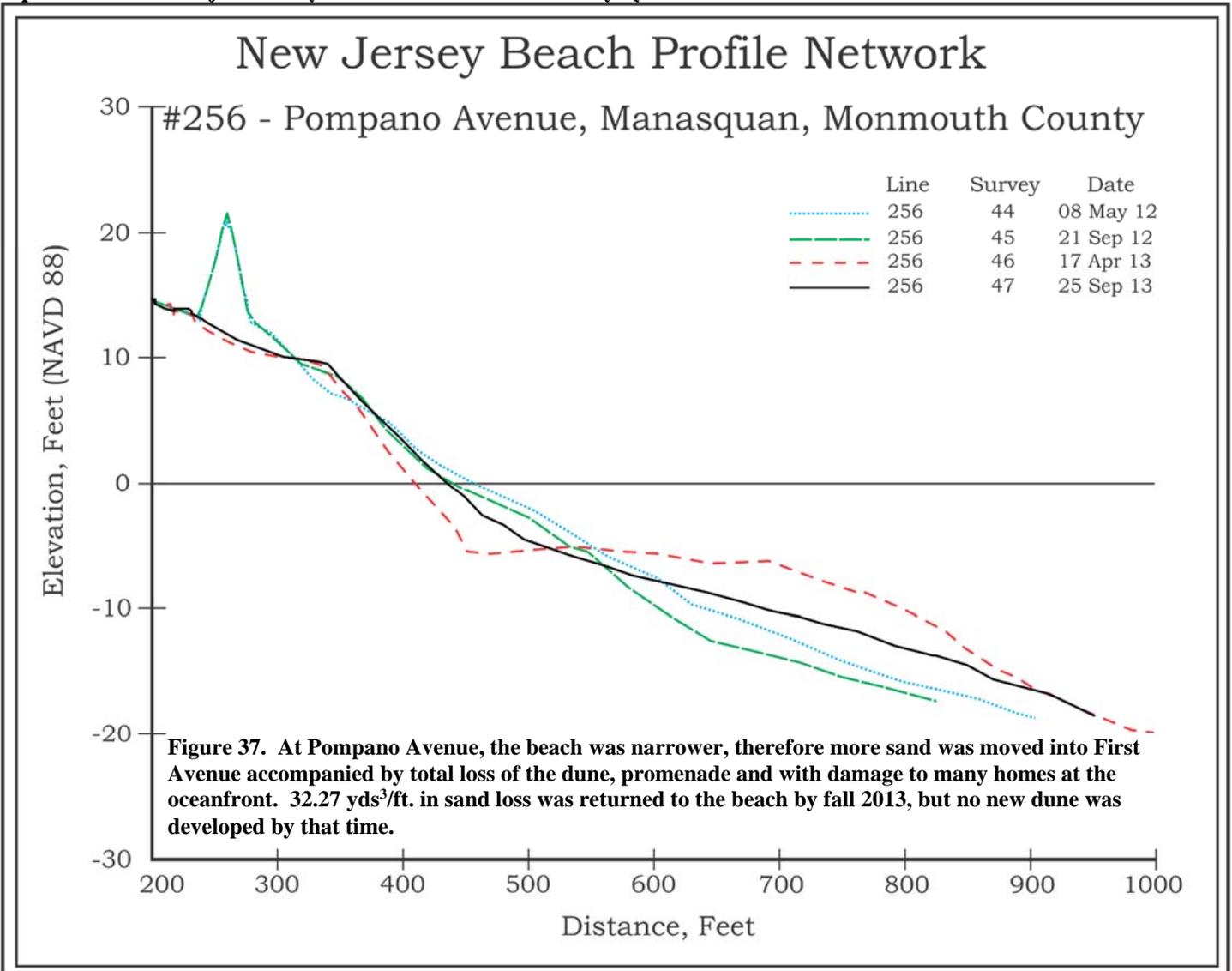


Both Manasquan sites were heavily damaged with massive waves and flooding that transported sand among the homes and into First Avenue. The promenade survived at Riddle Way, but the dune was removed and washed landward (photo taken November 12, 2012). Material was recovered and spread with little help from offshore migration (1.20 yds³/ft. 9/25/2013).





This site is located just north of the Manasquan Inlet. Following Sandy, damages were worse at this location than to the north. The promenade was removed, as were the dunes and all the berm sand had been transported through the homes into First Avenue in the Borough (left photo taken November 12, 2012). By 9/25/2013 the structural damage was restored, no dune replaced the loss and just 12.80 yds³/ft. was recovered naturally by the beach from offshore.



Summary & Conclusions

As this is written the NY District has announced that the restoration of the Monmouth County shore protection project is now complete under their direction. The press release said that the Sea Bright to Monmouth Beach segment took 2.1 million cubic yards of sand pumped for \$25.6 million. The Long Branch section took 3.3 million cy and cost \$40.1 million. The Asbury Park to Manasquan section was completed for \$43.6 million with 2.3 million cubic yards placed. Therefore, the entire completed work was restored to the design specifications of the original project. Over the next year work continues to contract for the center segment between Elberon and Loch Arbor including Deal and Allenhurst. If that work goes to construction, then the entire Monmouth County oceanfront will be under federal management for beach nourishment. Since the sand from Long Branch north goes to Sandy Hook, that natural shoreline benefits greatly as well. It benefits so well, that, should the concept gain traction with the park service, a dredge could be stationed at the northern tip of Sandy Hook and work every winter season pumping sand from the tip back to Long Branch/Monmouth Beach or Sea Bright reversing the long term sand transport loss in beach sediments. The mechanism would likely be that of filling barges with surplus sand and hauling them back to dump it in as shallow water offshore as possible anywhere between Elberon and Sea Bright.

Reviewing the data collected for this report on Monmouth County the surprise was in the relatively high sand volumes that returned to the beach naturally prior to the ACOE work south of Monmouth Beach. 21.80 yds³/ft. was the average sand volume that migrated back to the shoreline since Sandy and represents 60.1% of the sand lost due to Sandy. 101.4% of the offshore deposits documented by the CRC survey crews was taken between the fall of 2012 and the fall of 2013 meaning that the process was pretty efficient, but the probability is that some material also made its way back from further seaward than the CRC crew normally survey offshore.

If the ACOE completes the Elberon to Loch Arbor section, then the entire Monmouth County shoreline will be under federal management with a high likelihood that future storm damage to the beach would be covered by federal disaster relief funding. The storm protection and economic benefit to the region from this project cannot be over stressed. Had nothing been done since 1995, the impact of Hurricane Sandy would have been so much worse, the damages could have been doubled easily, so in spite of complaints on costs, the benefits have been realized in ways not always covered by the public media.