

**FINAL REPORT FOR 2020
ON THE CONDITION OF THE MUNICIPAL OCEANFRONT BEACHES
BATHYMETRY OF TOWNSENDS INLET
THE BOROUGH OF AVALON, CAPE MAY COUNTY, NEW JERSEY**



View of the Avalon oceanfront December 27, 2020 overlooking the northern engineered beach subject to the greatest erosion. The Townsends Inlet shoals appear as the zone of breaking waves off Sea Isle and as yet no breakers appear surrounding the 8th Street jetty in Avalon. As of the end of 2020 with two northeast storms at the end of December, the beach was in decent condition going into 2021. PHOTO by Ted Kingston.

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February 17, 2021

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**ANNUAL REPORT FOR 2020 - TO THE BOROUGH OF AVALON
ON THE
CONDITION OF THE MUNICIPAL BEACHES & BATHYMETRY OF TOWNSENDS INLET**

Introduction:

The 2020 annual report provides the results and analyses from the fall 2019 to fall 2020 survey datasets from the 37 years of oceanfront surveys for Avalon. This report is focused on changes seen since the 2019 US Army Corps of Engineers-sponsored beach restoration. There were no additional efforts to add sand to the engineered beach zone during 2020, but it was the sixth year of evaluation of conditions in the ebb-tidal shoals of Townsends Inlet. The entire inlet area was surveyed this past November between 91st Street in Sea Isle City and 12th Street in Avalon following the US Army maintenance during the fall of 2019.

Recent Fill Projects:

2013: Post-Hurricane Sandy restoration;	USACE with 336,359 cubic yards.
2015: Avalon restored the engineered beach;	740,000 cubic yards.
2016: Avalon undertook a back-pass operation;	50,000 cubic yards.
2017: Maintenance of Avalon & Stone Harbor;	USACE with 944,000 cubic yards.
2018: Avalon undertook a back-pass operation;	53,000 cubic yards.
2019: Maintenance of Avalon;	USACE with 571,351 cubic yards.

TOTAL SAND VOLUME MOVED TO THE ENGINEERED BEACH SINCE 2013: 2,694,710 cu. yds.

Monitoring Program:

The CRC monitored the ten oceanfront cross sections four times in 2020 on a seasonal timeline. These surveying activities continue a monitoring program that started in 1981. The five northern sites are located within the engineered beach project area while the southern five sites cover the accretional region including the natural exclusion area and sand back-passing borrow zones. Monitoring provides details on natural sediment movement along the Borough's Atlantic shoreline and surveying has continued through multiple beach restoration projects that started in 1987 with a local/state sponsored project. These data focus on project performance evaluation. Each topographic beach profile starts at a fixed reference position landward of the dune. The repetitive surveys for each profile include changes to the dune, beach and nearshore.

The following is a list of quarterly studies included in this report and the dates of the surveys:

- Survey 152 December 3 & 9, 2019; 4th Quarter
- Survey 153 March 18 & 19, 2020; 1st Quarter
- Survey 154 June 3 & 4, 2020; 2nd Quarter
- Survey 155 September 17, 18, 2020; 3rd Quarter
- Survey 156 December 11, 2020; 4th Quarter

Winter Storm Impacts:

The 2019-2020 winter months started off quite mild with no northeast storms with durations over a day and winds above 35 MPH. The spring months were nearly as mellow with storms March 23, 2020, April 13th, and May 22nd and 23rd. Seasonal hurricanes along the Atlantic shoreline were limited to Tropical Storm Isaias which came on land in South Carolina and moved overland through New Jersey on August 4th with tropical force winds for one high tide. August 16th produced an all-day northeast storm with 30 MPH winds. There was one mild storm in October 2020, followed by a quiet period that ended December 16-17 with a moderate northeaster. Winds came in from the southeast at 60 MPH on December 24th into Christmas Day driving the surf in the opposite direction from the northeasters. The Dec. 16th storm did flatten the beach profiles based on

an official Avalon post-storm review of the beaches, plus several press photographs showing berm scarps in Ocean City.

Quarterly Beach Changes in 2020:

Oceanfront beaches were surveyed quarterly to depict both seasonal and annual changes, erosional and recovery rates and to assist in storm damage assessments and project performance assessments. Table 1 below shows the individual profile site trends for sand volume changes quarter by quarter during 2020.

**Table 1
2020 Oceanfront Beach Profile
Quarterly Sand Volume Changes at Each Survey Line Location**

Profile	Winter	Spring	Summer	Fall
Number	12/19 - 3/20	3/20 - 6/20	6/20 - 9/20	9/20 - 12/20
	(yds³/ft)	(yds³/ft)	(yds³/ft)	(yds³/ft)
8th Street Jetty				
AV-9	-8.65	-28.13	-22.23	0.24
AV-12	-53.54	-54.25	-18.20	-39.45
AV-17	-5.95	-31.81	-0.82	-37.00
AV-23	15.66	-2.55	9.94	-19.26
AV-28	0.78	6.92	-7.19	32.21
AV-35	16.36	-7.58	8.63	14.38
AV-44	11.68	-10.45	7.33	8.98
AV-58	2.19	-16.23	5.13	11.64
AV-70	27.62	-9.99	5.23	19.13
AV-78	0.92	-1.38	0.93	-4.36
Quarterly Volume Change (yds³) =	109,798	-267,876	38,883	74,889

The first quarter sand volume change was a sizable gain despite loss rates in the 50 yds³/ft. range at 12th Street. All sites south of 17th Street gained sand. The second quarter saw general erosion almost everywhere in Avalon, but not too extreme at 12th Street. The third quarter was less intense in terms of actual volume of sand moved around with losses continuing between 9th and 17th Streets. The final quarter produced bigger gains to the south of 28th Street with moderate sand loss between 12 and 23rd Streets. Summing across the bottom row in Table 1 generates an annual sand volume lost of 44,306 cubic yards along the entire Avalon oceanfront. This amounts to approximately one 10-yard truck load per yard of beachfront.

Table 2 below shows the fourth quarter changes at each profile location where sand eroded from the engineered beach shoreline but deposited in almost equal volumes south of 28th Street. Shoreline position changes (zero datum NAVD88) are measured in feet. Profile volume changes were averaged with adjacent sites to calculate an average volume change then multiplied by the distance between sites to determine a net cell volume change in cubic yards. Summation of each cell volume change provides the total change in sand volume for the Avalon oceanfront beaches during the fourth quarter.

Table 2
2020 Oceanfront Beach Profiles
Fourth Quarter Sand Volume Change Sept. to Dec. 2020

Profile Number	Shoreline Change (feet)	Volume Change (yds³/ft)	Avg. Volume Change (yds³/ft)	Cell Distance (yds³/ft)	Net Volume Change (yds³/ft)	Cumulative Volume (yds³/ft)
8th Street Jetty						
			0.243	500	122	122
AV-9	-31.9	0.24				
			-19.604	840	-16,467	-16,345
AV-12	-46.5	-39.45				
			-38.224	1400	-53,513	-69,858
AV-17	-35.0	-37.00				
			-28.128	1680	-47,255	-117,113
AV-23	-83.1	-19.26				
			6.476	1400	9,066	-108,047
AV-28	2.4	32.21				
			23.298	2025	47,177	-60,870
AV-35	54.1	14.38				
			11.681	2510	29,318	-31,551
AV-44	6.2	8.98				
			10.308	3925	40,459	8,907
AV-58	26.3	11.64				
			15.387	3360	51,699	60,606
AV-70	2.7	19.13				
			7.388	2240	16,549	77,155
AV-78	8.0	-4.36				
			-4.358	520	-2,266	74,889
Volume Change for Beaches Between the Jetty & 78th St. =					74,889	(yds³)

The fourth quarter beach changes were distributed between minimal losses at 9th Street increasing to high thirty cubic yards per foot of oceanfront at 12th and 17th Streets, then declining at 23rd Street and substantially reversing by 28th Street and continuing south as sand volume increases ending with a minor loss at the 78th Street site.

The third table below contains the direct annual comparison of survey 152 done December 2019 with survey 156 completed in December 2020. This provides the annual assessment for 2020 beach changes.

**Table 3
Annual Beach Changes
December 2019 to December 2020**

Profile Number	Shoreline Change (feet)	Volume Change (yds³/ft)	Avg. Volume Change (yds³/ft)	Cell Distance (yds³/ft)	Net Volume Change (yds³/ft)	Cumulative Volume (yds³/ft)
8th Street Jetty						
			-60.400	500	-30,200	-30,200
AV-9	-151.3	-60.40				
			-112.343	840	-94,368	-124,568
AV-12	-220.5	-164.29				
			-118.749	1400	-166,248	-290,816
AV-17	-88.7	-73.21				
			-34.984	1680	-58,772	-349,588
AV-23	2.9	3.25				
			18.345	1400	25,682	-323,906
AV-28	50.7	33.44				
			30.813	2025	62,396	-261,509
AV-35	23.9	28.18				
			22.438	2510	56,318	-205,191
AV-44	-77.4	16.69				
			11.690	3925	45,881	-159,310
AV-58	68.0	6.69				
			24.682	3360	82,932	-76,378
AV-70	73.4	42.68				
			19.791	2240	44,332	-32,046
AV-78	19.8	-3.10				
			-3.096	520	-1,610	-33,656
Annual Volume Change for Oceanfront Beaches =					-33,656	cu. yds.

The annual sand volume change amounted to -33,656 cubic yards dominated by the large losses to the 2019 US Army Corps maintenance work between the jetty to 9th and south to 17th Streets amounting to 349,588 cubic yards with over 200 feet of shoreline retreat at 12th Street. However, at 23rd Street site the situation reversed to net sand deposition which increased to 50.7 yds³/ft. at 28th Street. The annual picture was one of sand accumulation south of 23rd Street except a small loss at 78th Street which did not include shoreline retreat.

The difference in summarizing the four quarterly survey results (-44,306 cubic yards) with the direct comparison of the Dec. 2019 survey with the Dec. 2020 survey (-33,656 cubic yards) is a direct result of individual surveys ending at different distances offshore and that the three quarterly surveys include changes that would be missed with just the annual comparison. The USACE pay volume was reported to be 571,351 cubic yards of sand within the project envelope. Therefore, over half the sand volume placed between the jetty and 17th Street has eroded away, but most of it has deposited from 23rd Street south to the Stone Harbor boundary (315,932 cubic yards). The net loss to the Avalon oceanfront beach is relatively small.

Individual Site Review:

Each of the ten survey stations is illustrated with photographs and the individual cross sections to document 2020 changes to the beach. The storm frequency was relatively low with no serious events.

AV-9 - Ninth Street

The US Army Corps returned to Townsend's Inlet in the fall of 2019 and placed 144.46 yds³/ft. of inlet sand on the 9th Street beach producing a 263-foot shoreline advance. Since the December 2019 survey 9th Street saw 151 feet of shoreline retreat, but just 60.4 yds³/ft. in sand volume loss. This was largely due to sand deposition offshore (-12.4 yds³/ft. above the zero-elevation position versus +12.6 yds³/ft. deposited offshore during the final quarter of 2020. Sediment appears to be beginning to appear around the inlet jetty tip and immediately seaward of 9th and 10th Street beaches.



1a. December 3, 2019



1b. June 3, 2020



1c. December 11, 2020

Photographs 1a to 1c. 9th Street view to the south.

View 1a shows the foredune where sand has buried the newest row of fencing by Dec. 2019. The beach was at its widest extent after the USACE maintenance work.

View 1b was taken in June following addition of new fencing. Some beach retreat had occurred, but the site remains in good condition.

View 1c This view from December 2020 and shows the remaining expanse added to the beach width by the USACE maintenance effort. Wind transport was actively burying the new fence line.

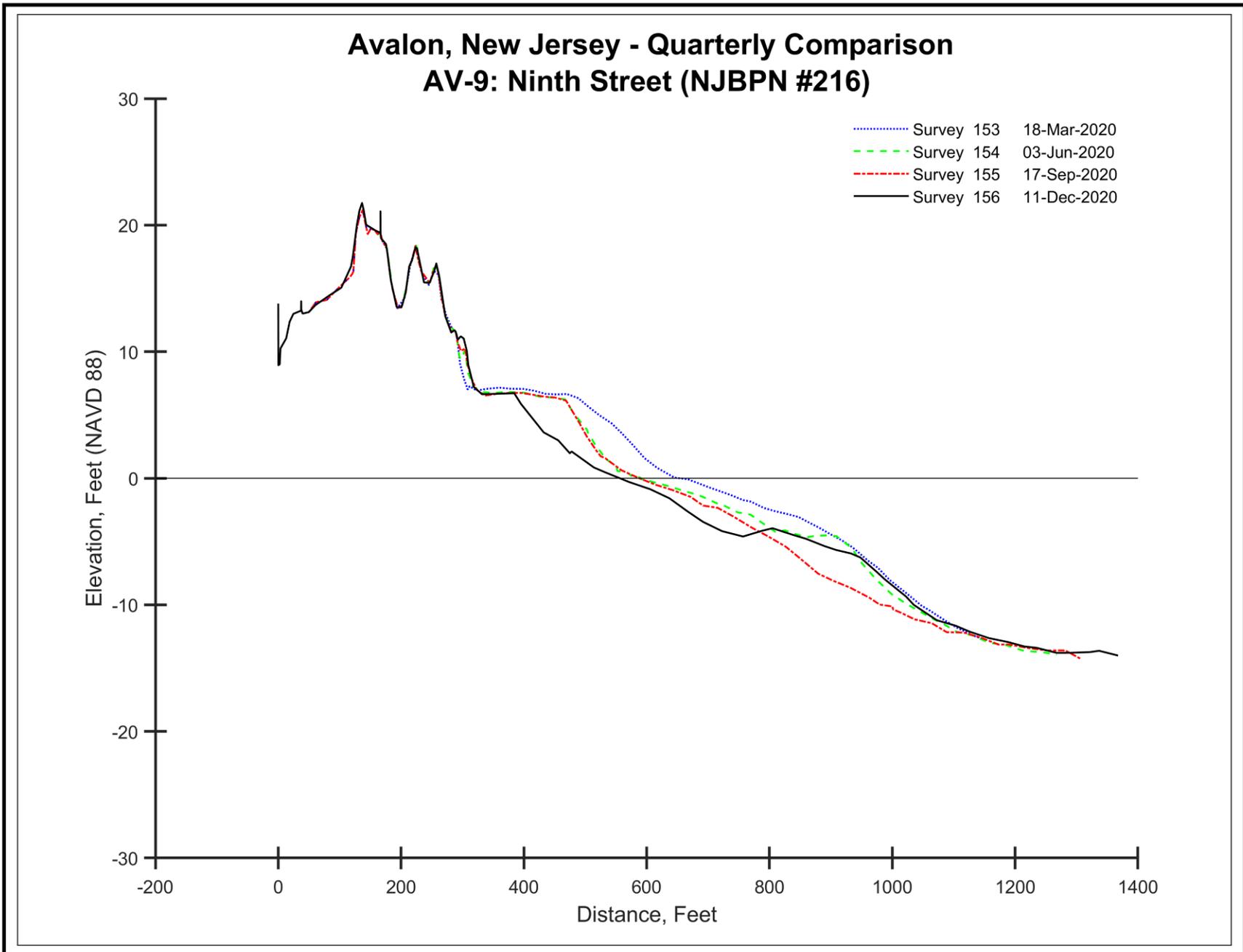


Figure 2. At 9th Street the beach retreated to the June position, remained stable through September, then retreated a lesser amount at the shoreline compared to that seen March to June (54 versus 32 feet). The sand volume lost by June was 8.65 yds³/ft. versus a gain of 0.24 yds³/ft. by December 2020 all due to deposition of a bar offshore as of the December 2020 profile.

AV-12 - Twelfth Street

Unlike the 9th Street site, the beach from 11th to 17th absorbs the most direct assault by storm energy combined with a general lack of sand sources to resupply the beachfront after loss events occur. Hope continues that the sand supply derived from Sea Isle City accumulates in a configuration that permits natural by-passing of the Townsend's Inlet ebb-tidal delta at some point. As of December 2020, there does appear to be deposition surrounding the inlet margin of the 8th Street jetty and shallower water extends seaward of the jetty tip. This might be a prelude to sediment arriving on the Avalon oceanfront from the inlet for the first time in two decades.

The 2019 project placed 218.46 yds³/ft. in new sand adding 347 feet to the beach width. The largest sand volume was placed here among the three sites in our study that received material in 2019. Unfortunately, the largest losses were seen at this site as well (-220.5 feet of shoreline retreat combined with sand volume losses of 164.3 yds³/ft. during 2020). This represents 63.5% of the beach width added in 2019 and 75.2% of the added sand volume. This sand was transported south with redeposition starting at 23rd Street.



3a. December 3, 2019



3b. June 3, 2020



3c. December 11, 2020

Photographs 3a to 3c. 12th Street Views to the south.

View 3a was taken after the latest federal maintenance was complete, but the damage to the dune scarp had not been addressed by grading. The April 2017 work was augmented by the fall 2019 effort greatly expanding the beach width.

View 3b was taken after Memorial Day following fencing and grading work. Some berm retreat had occurred

View 3c. The December 2020 photograph shows the beach at the end of the year with some continued narrowing, but still in decent condition.

AV-17 - Seventeenth Street

The profile is located at the southern terminus of a rock revetment which extends to here from 8th Street. The annual sand volume loss declined from 164.3 yds³/ft. at 12th Street to 73.2 yds³/ft. at 17th Street. Shoreline retreat was cut from 220 feet to 89 feet at this location. The 2019 federal work added 118.1 yds³/ft. to this site so the loss rate was 62% of the sand quantity placed.



5a. December 3, 2019



5b. May 30, 2020



5c. December 11, 2020

Photographs 5a to 5c. 17th Street, view to the south.

View 5a By December 2019, the new beach width produced greater protection for this site following the US Army maintenance effort.

View 5b By May 30th the grass had advanced into the ridge between the fences. The beach remained in decent condition as the new dune ridge continued to grow.

View 5c shows the beach width reduced somewhat, but still an effective barrier to dune erosion as of the end of 2020.

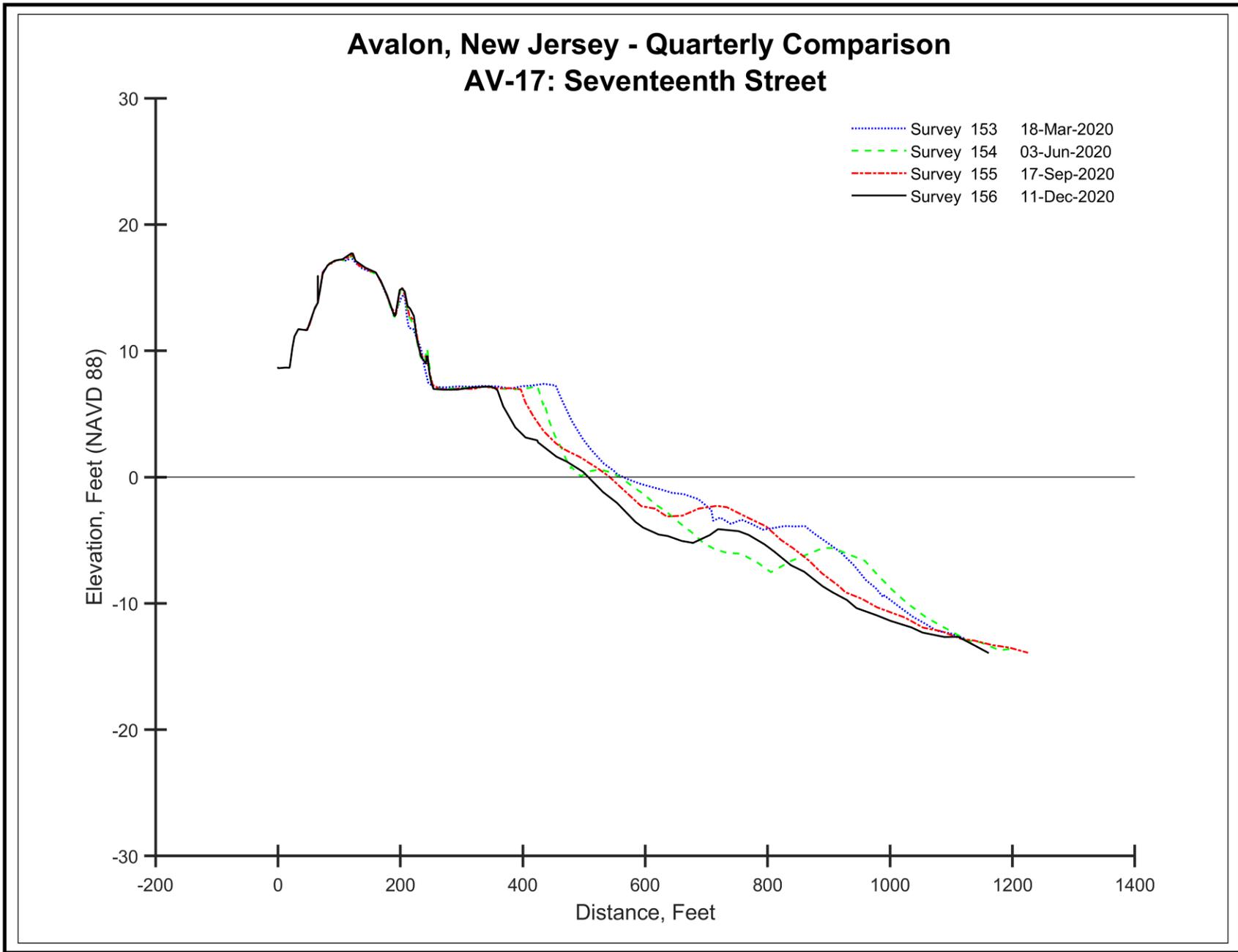


Figure 6. The first three quarters of 2019 saw minor beach retreat by September, but there was a sizable offshore bar about to attach to the beachface. The federal work added 118.12 yds³/ft. of sand moving the shoreline 185 ft. seaward. Berm retreat has definitely occurred.

AV-23 - Twenty Third Street

The 23rd Street cross section is located seaward of the Avalon boardwalk near the southern end of the engineered beach and federal project.

The 2019 USACE project did not place sand at this site. The losses experienced north of 23rd Street have been transferred to the site providing a net positive sand volume for 2020 (3.25 yds³/ft.) The quarterly changes were positive during the spring, negative between March and May, then positive during the summer, and finally, negative as of the December quarter. This site often continues the pattern of sand volume losses seen to the north, but this year, appears to be where deposition of those sand volume losses starts and continues with increasing intensity to the south.



7a. December 3, 2019



7b. September 18, 2020



7c. December 11, 2020

Photographs 7a to 7c. 23rd Street, views to the north.

View 7a In December, just the tips of the 4-foot sand fence was showing, while the beach had narrowed considerably. The federal project did not directly place sand at this site, but material will migrate quickly into the region.

View 7b By September the beach was somewhat wider as sand was transferred to the site from further north. Little additional fence burial occurred.

View 7c By December 2020 the beach showed added wind deposition on the dune slope with added material at the stormwater pipeline in the distance.

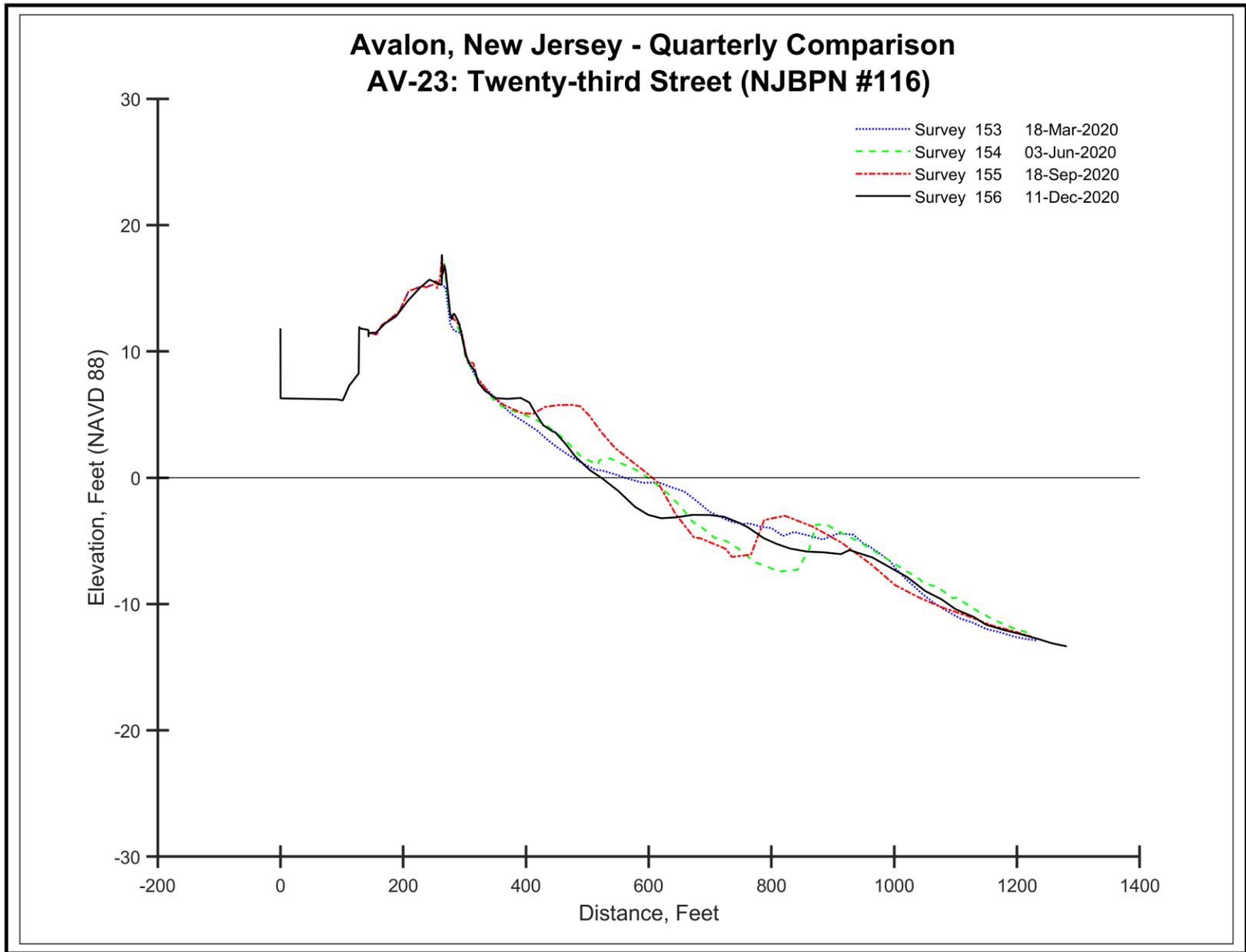


Figure 8. The widest beach was present in September as offshore bar material was moved onto the dry beach. This berm eroded significantly by December 2020, but sand appeared offshore as a broad bar feature.

AV-28 - Twenty Eighth Street

The 28th Street location has usually been the nodal point between chronic erosion and regular sand deposition in Avalon. No sand was added in 2019.

The beach site gained sand during three of the four survey quarterly intervals. The largest gain was documented between September and December 2020 (+37.00 yds³/ft. and a 2.4-foot shoreline advance. This new sand was deposited both on the beach (15.06 yds³/ft. and offshore 17.15 yds³/ft.) The proximity of the site to the zone of sand loss indicates southerly transport during the final quarter of 2020.



9a. December 4, 2019



9b. September 18, 2020



9c. December 11, 2020

Photographs 9a to 9c. 28th Street, views to the north.

View 9a. The sand fencing has been buried as the seaward dune slope accumulated wind transported material. The high tide line is only 50 feet from the dune toe despite the completion of the federal beach restoration project to the north.

View 9b shows the 28th Street beach following the summer season as the beach width improved in width due to sand deposition derived from northern beach sites.

View 9c shows the beach with wind deposition along the seaward dune slope and a generally higher beach elevation.

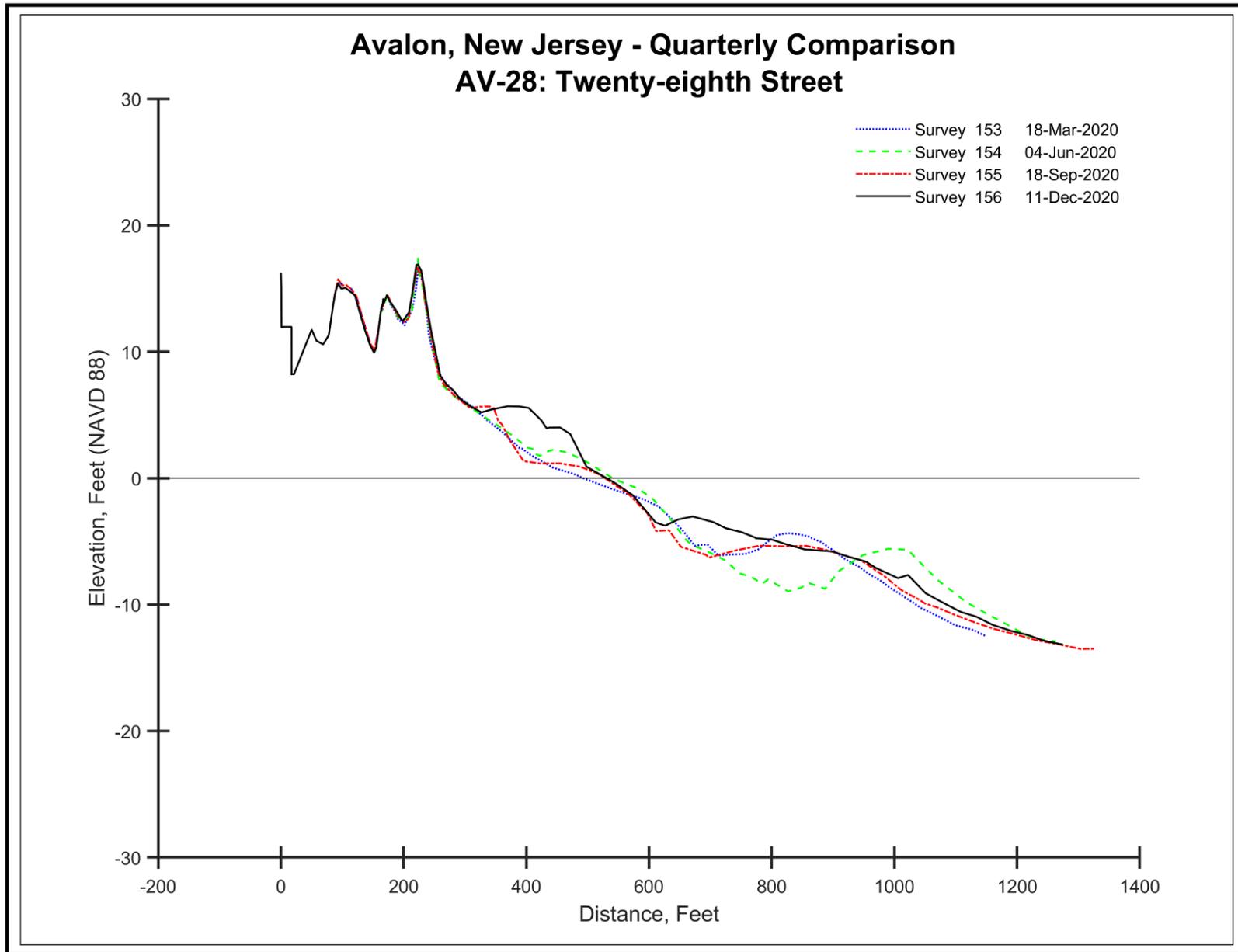


Figure 10. The 28th Street site was south of the USACE sand template for 2019. The first three quarters of 2020 produced limited changes while the December 2020 survey shows a very large berm deposit on the beach plus a wide, low amplitude bar system offshore.

AV-35 - Thirty Fifth Street

35th Street has been a depositional zone for decades and recently has been used as a sand source to augment the erosional beaches in the 12th to 15th Street area. The “borrowing” area is the lower beachface and any nearby bar exposed at low tide where harvesting of sand can occur.

Similar conditions occurred this year where deposition occurred in the spring summer and later fall of 2020. The March to May interval saw 7.58 yds³/ft. in sand volume loss. This produced an annual sand volume gain of 28.18 yds³/ft. and a 24-foot shoreline advance seaward. The final quarter saw more sand added to the offshore region (11.96 yds³/ft.) than on the beach (2.42 yds³/ft.) implying that the littoral transport was still in the offshore bar phase at 35th Street.



11a. December 4, 2019



11b. June 4, 2020



11c. September 23, 2020

Photographs 11a to 11c. 35th Street, views to the north.

View 11a. Sand continued to add to the foredune with a beach wide enough to provide a continuous supply.

View 11b. By June 2020 all traces of the raking had vanished and grass was moving downslope onto the beach.

View 11c. The September view along the toe of the dune slope shows continued grass growth, but little new wind transported sand added.

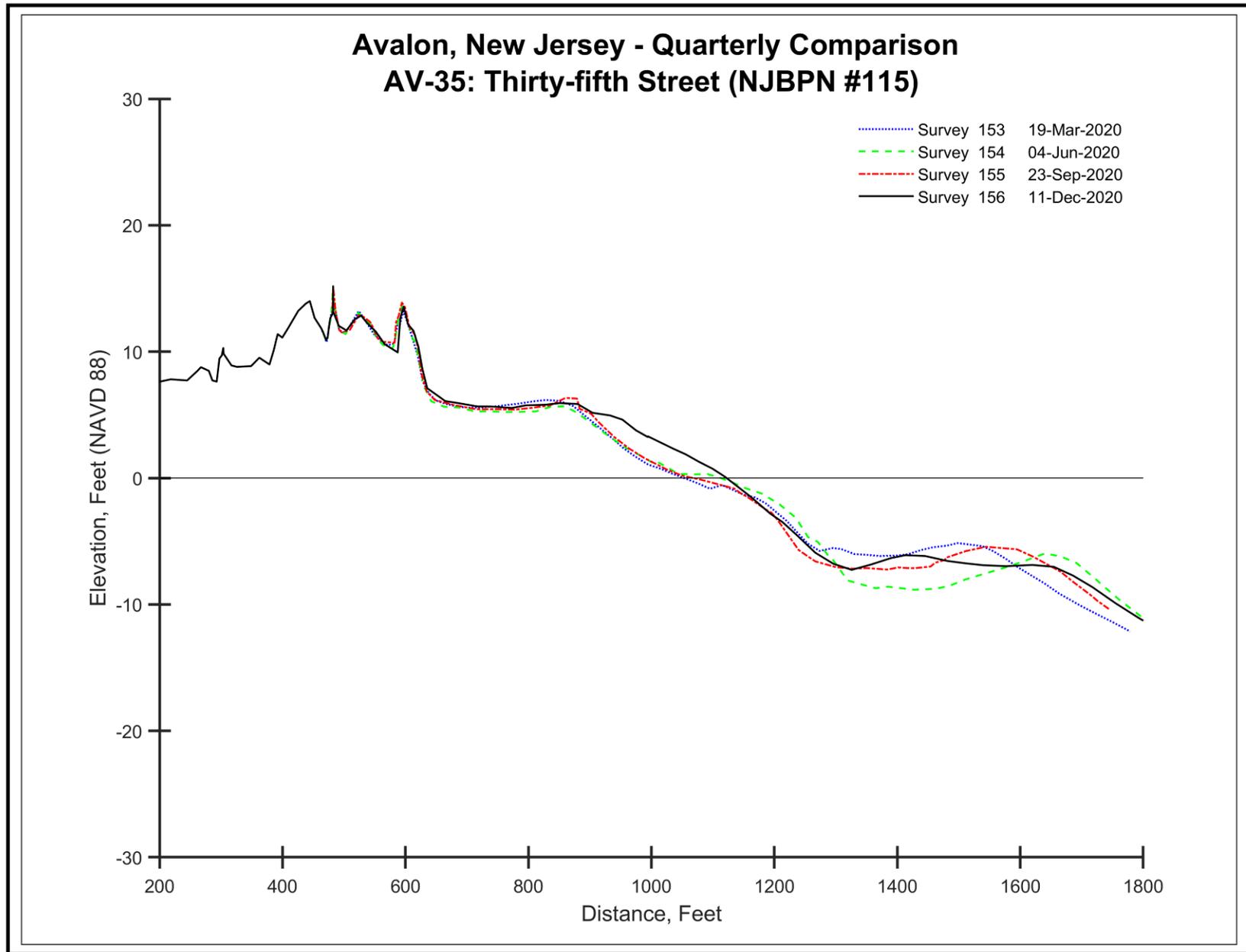


Figure 12. 35th Street location also saw an offshore bar shift positions allowing sand to migrate onto the beachface adding substantially in the final quarter survey adding half the annual 28 cubic yards per foot seen in that comparison.

AV-44 - Forty Fourth Street

This site is located within an exclusion zone in the Avalon “High Dune Area” established by the NJ Endangered Species Program to govern how and where Avalon could harvest beach sand for back pass operations. Their goal was to create a habitat not under repetitive excavation that could impact food sources for piping plover chicks hatching in the spring of the year. Therefore, as a result, no sand has been harvested from this survey site during the Borough’s multiple sand back-passing programs.

This site also had three of the four quarter surveys show positive sand accumulation, just losing 10.45 yds³/ft. between March and May 2020. The annual accumulation was 16.7 yds³/ft., but with a 77-foot shoreline retreat that was related to the arrival of offshore bar sand at the zero-elevation position as the Dec. 2019 survey was completed.



13a. March 18, 2019



13b. June 4, 2020



13c. September 23, 2020

Photographs 13a to 13c. 44th Street, views to the south.

View 13a shows the seaward dune toe slope with grass plants migrating down the slope. Beach widths have remained constant over time.

View 13b is the same view in June showing grass growth and wind deposition in the dunes.

View 13c is the September view to the south showing the dunes and beach where debris has been deposited near the dune toe recently.

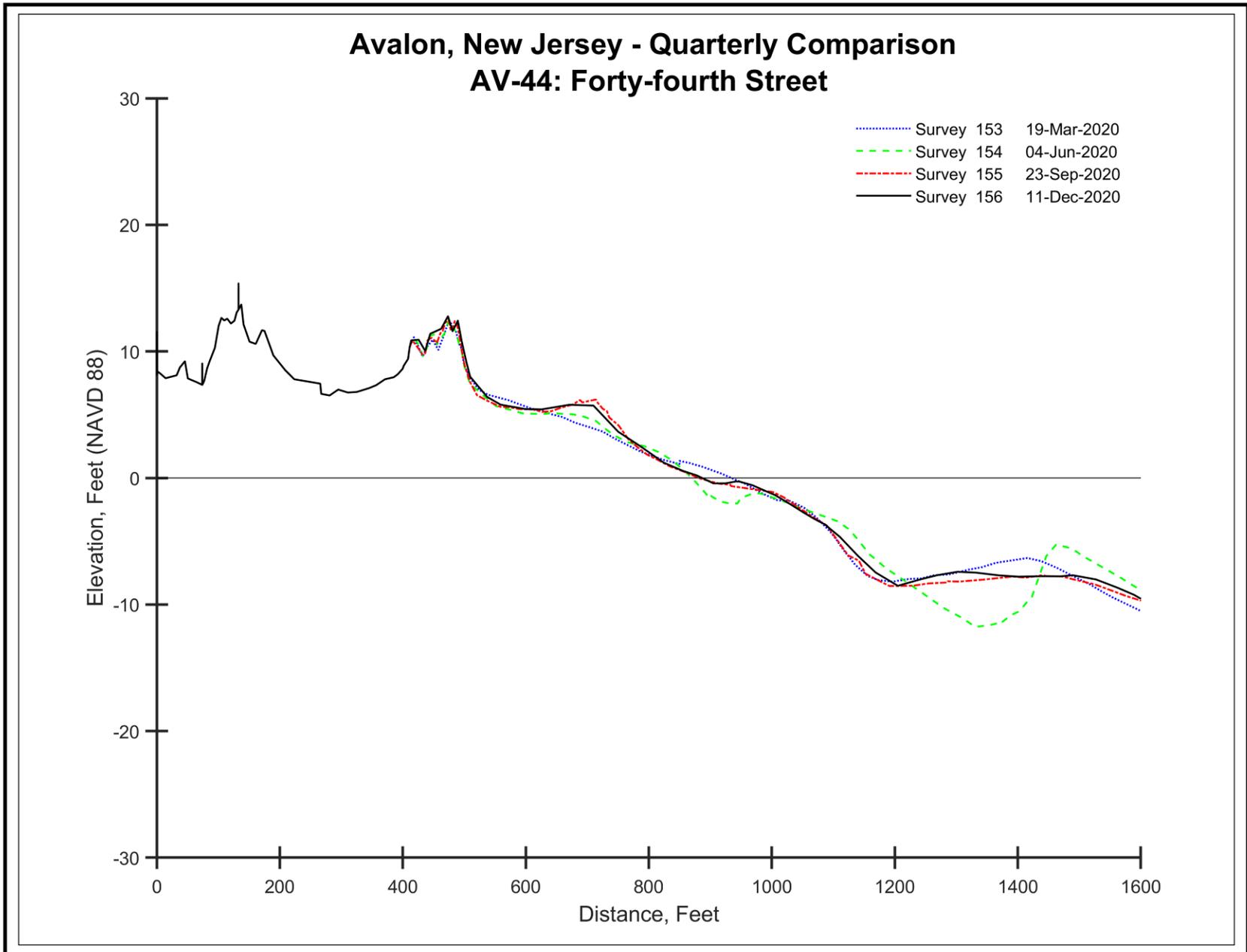


Figure 14. The beach accumulated a berm as of September 2020 while the June 2020 offshore bar system flattened out considerably with few subsequent changes seen.

AV-58 - Fifty Eighth Street

The 58th Street site continues to add sand accumulation on the dune and adds to the general beach width over the years. No sand has been harvested from the southern back-pass borrow zone in the past four cycles because sufficient material was available within the northern zone centered at 35th Street.

During 2020 this site gained sand in three of four quarterly surveys, only seeing erosion during the March to May interval (-16.23 yds³/ft.). The annual net change was a gain of 6.69 yds³/ft. and a 68-foot shoreline advance.



15a. December 3, 2019



15b. June 4, 2020



15c. December 11, 2020

Photographs 15a to 15c. 58th Street, views to the north along the seaward dune toe.

View 15a The December view is looking north along the seaward dune toe at the expanse of dry beach at this site.

View 15b This June view shows the impact of beach raking at the dune toe with the debris removed from the beach.

View 15c The December 2020 view shows sand accumulation in the dunes at the site.

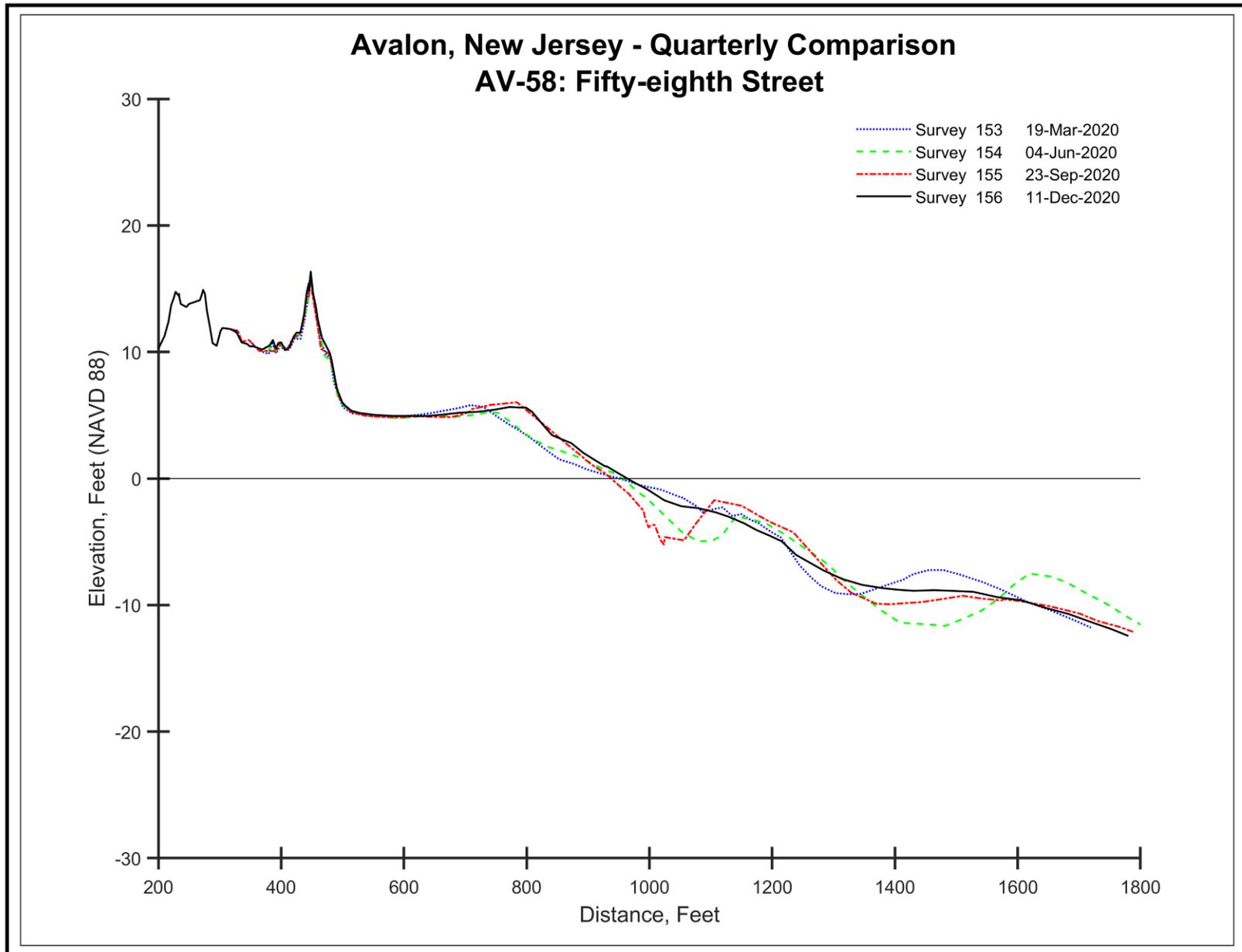


Figure 16. The upper beach and dune system changed relatively little over 2020. The offshore zone was active especially with the September cross section showing a large bar about to move onto the beach. If it did, the effect was short lived because the berm was essentially unchanged as of the December 2020 survey, but the nearshore trough was filled in.

AV-70 - Seventieth Street

The 70th Street dune has increased its mass over time as sand deposited in the seaward ridge raising its elevation and extending it inland up the main dune's seaward slope. The resulting dune array is a consolidation of multiple small foredune ridges developed at fencing that have amalgamated into one large feature at this site.

The annual changes amounted to substantial sand volume increases (+42.68 yds³/ft.) appearing almost entirely below the zero-elevation position (+18.90 yds³/ft. versus 0.23 yds³/ft. added to the beach above the zero elevation). This site also lost sand volume during the March to May quarter in 2020.



17a. December 3, 2019



17b. September 23, 2019



17c. December 11, 2020

Photographs 17a to 17c. 70th Street, views to the south along the dune toe.

View 17a illustrates the new foredune, blending into the primary dune to become part of the original feature.

View 17b is a view along the dune toe showing the expanse of dry beach and the foredune seaward slope.

View 17c This view from north of the access pathway shows the dunes and dry beach with some sand pushed up along the pathway.

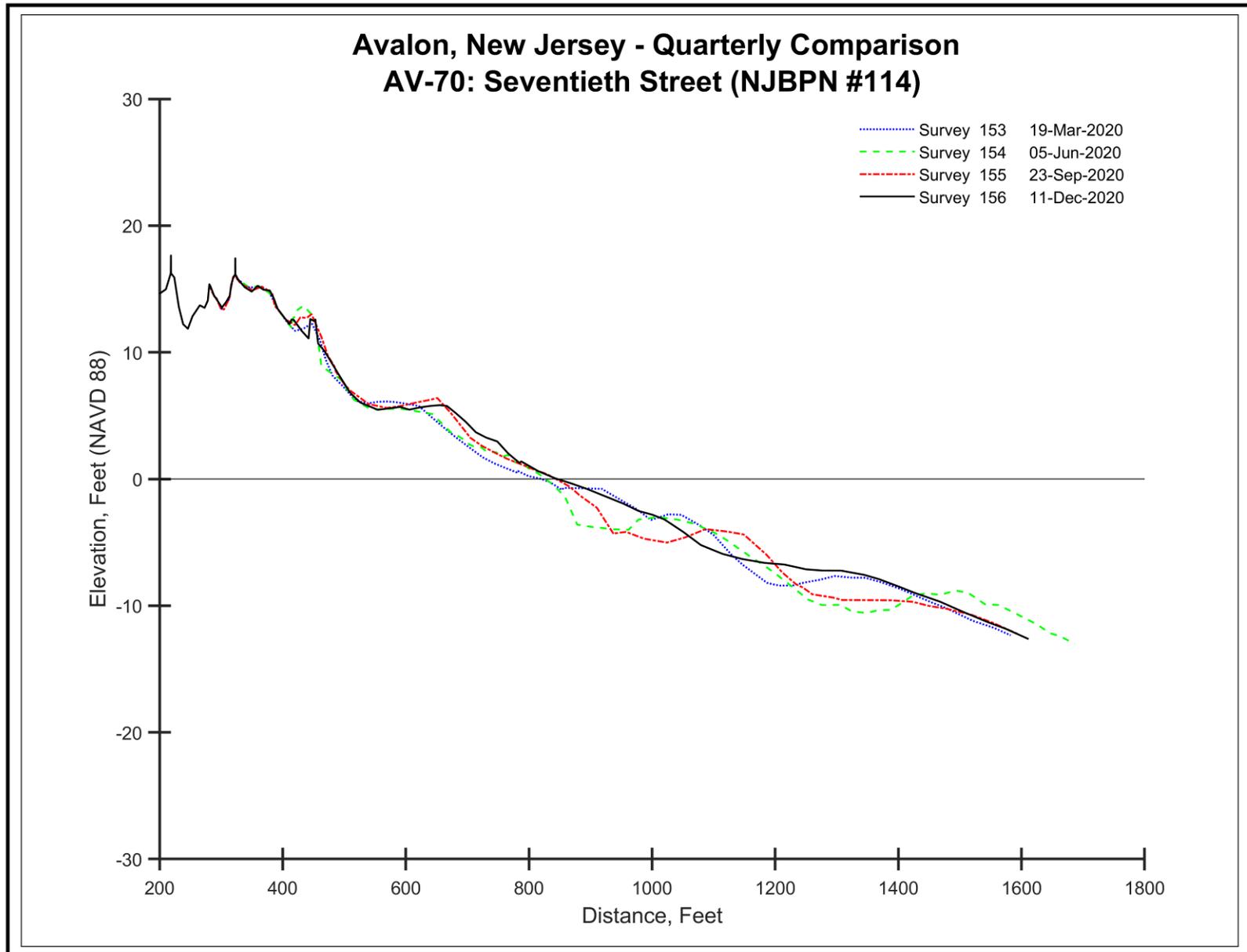


Figure 18. The growth in another in a series of foredunes is becoming a feature on the seaward slope. The beach and berm remain within normal limits. Offshore sand appears to have raised the seaward elevation considerably generating the large offshore volume addition seen.

AV-78 - Seventy Eighth Street

This site is located 520 feet from the boundary with Stone Harbor and is within the placement taper established for the Stone Harbor federal nourishment project. Since Stone Harbor declined to participate in the 2019 maintenance effort because of the issues surrounding the use of Hereford Inlet ebb-tidal delta deposits using federal funds (CBRS controversy not yet settled among those involved), no major additions were seen at this site during 2020. The annual change for 2020 was a modest sand volume loss of 3.1 yds³/ft. but a 20-foot shoreline advance. The quarterly sand volume shifts were also rather modest (+0.92 yds³/ft. Dec. 2019 to March 2020; -1.38 yds³/ft. March to June; +0.93 yds³/ft. June to Sept.; and -4.36 yds³/ft. from Sept. to Dec. 2020.

Perhaps the sizable gains seen at the three northern Stone Harbor sites reflects sand transfer from Avalon's southern beaches to Stone Harbor.



19a. December 3, 2019



19b. June 5, 2020



19c. December 11, 2020

Photographs 19a to 19c. 78th Street, views to the north.

View 19a This December view of the dunes, beach and oceanfront expanse shows the protection these extensive features provide Avalon residents.

View 19b The spring view shows grass growth in full swing as the season gets going.

View 19c This view along the foredune area shows continued stability at the site with added sand across the seaward dune slope.

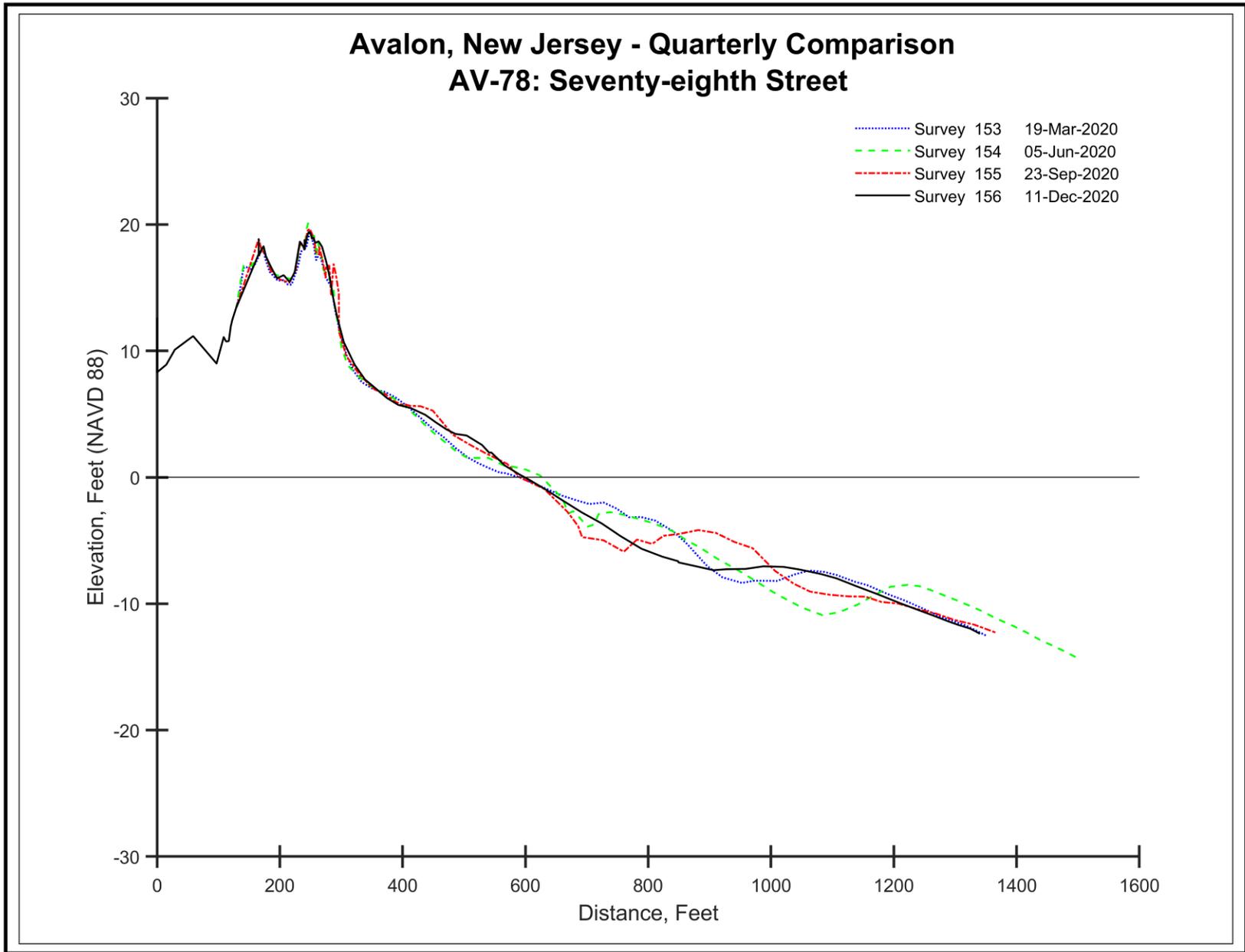


Figure 20. The primary dune is the dominant feature on the beach. The width of dry sand is smaller than other locations but appears sufficient to prevent dune damage. The beach changed very little in 2020, while the offshore region had bar locations vary between very close to the beach (Sept. survey) and quite distant (June survey). By Dec. 2020, the entire beach and bar profile had become quite uniform in slope.

Summary of Avalon's Oceanfront Beaches:

In the fall of 2019, the USACE added 564,264 cubic yards of sand between the jetty and a point south of 17th Street to restore early erosion to augment the 940,000 cubic yards added during their 2017 effort.

The seasonal surveys provided evidence for the most serious beach volume losses between March and June 2020 (-267,876 cubic yards) following a relatively mild winter (Dec. 2019 to March 2020 where 109,798 cubic yards of sand were added to the oceanfront). The next two quarters saw an additional 113,772 cubic yards added to the oceanfront shoreline leaving a modest annual deficit along the Borough oceanfront (-33,656 cubic yards). There were few isolated storms with one tropical system (Isaias) and no moderate or severe northeast events. December produced two northeast events not included within the survey time series. Neither generated serious damage however (reference the cover photograph from 12-27-2020).

Townsend's Inlet Bathymetric Survey:

In 2019 the USACE was implementing the most recent beach restoration for Avalon and the dredge was centered in Townsend's Inlet making the bathymetric survey difficult to conduct. The contractor agreed to provide the after dredging surveys conducted for sand volume delivered payment and those data were used for the 2019 inlet review. In December 2020 the CRC was able to return to the ebb-tidal area and adjacent beaches to conduct a complete inlet survey. This information has been compared to both the conditions after dredging in 2019 and between the full survey done in 2018 and the Dec. 2020 survey data collected for this review.

November 2018 to December 2019 Done During USACE Beach Maintenance Work;

A digital elevation map (DEM) was prepared showing the ocean beach shorelines adjacent to Townsends Inlet on both the Sea Isle City and Avalon sides of the inlet. The land crew stopped their survey at approximately 1,000 feet from the high tide line on the beach. Normally the CRC survey vessel takes over from there and continues seaward for about 2,500 feet. The Great Lakes survey contractor surveyed the area in and surrounding the authorized sediment borrow zone in Townsends Inlet and that information was compared to the 2018 inlet survey done by the CRC. A comparison map was also generated to show the changes in the inlet since that survey was completed in the fall of 2018.

Figure 21 displays the inlet-adjacent beaches and the borrow zone and the immediate vicinity in Townsends Inlet. The excavation made into the sand deposited in the borrow area is easily visible in the figure. Dredging depths of -24 feet were recorded which removed as much as 22 feet of sand at the western end of the dredging cut. 569,210 cubic yards of sand were removed from the borrow zone for beach restoration, the actual project pay volume was given as 571,351 cubic yards. This was based on sand placed on the Avalon oceanfront beaches but compares quite well with the excavation volume indicated in the borrow zone comparison.

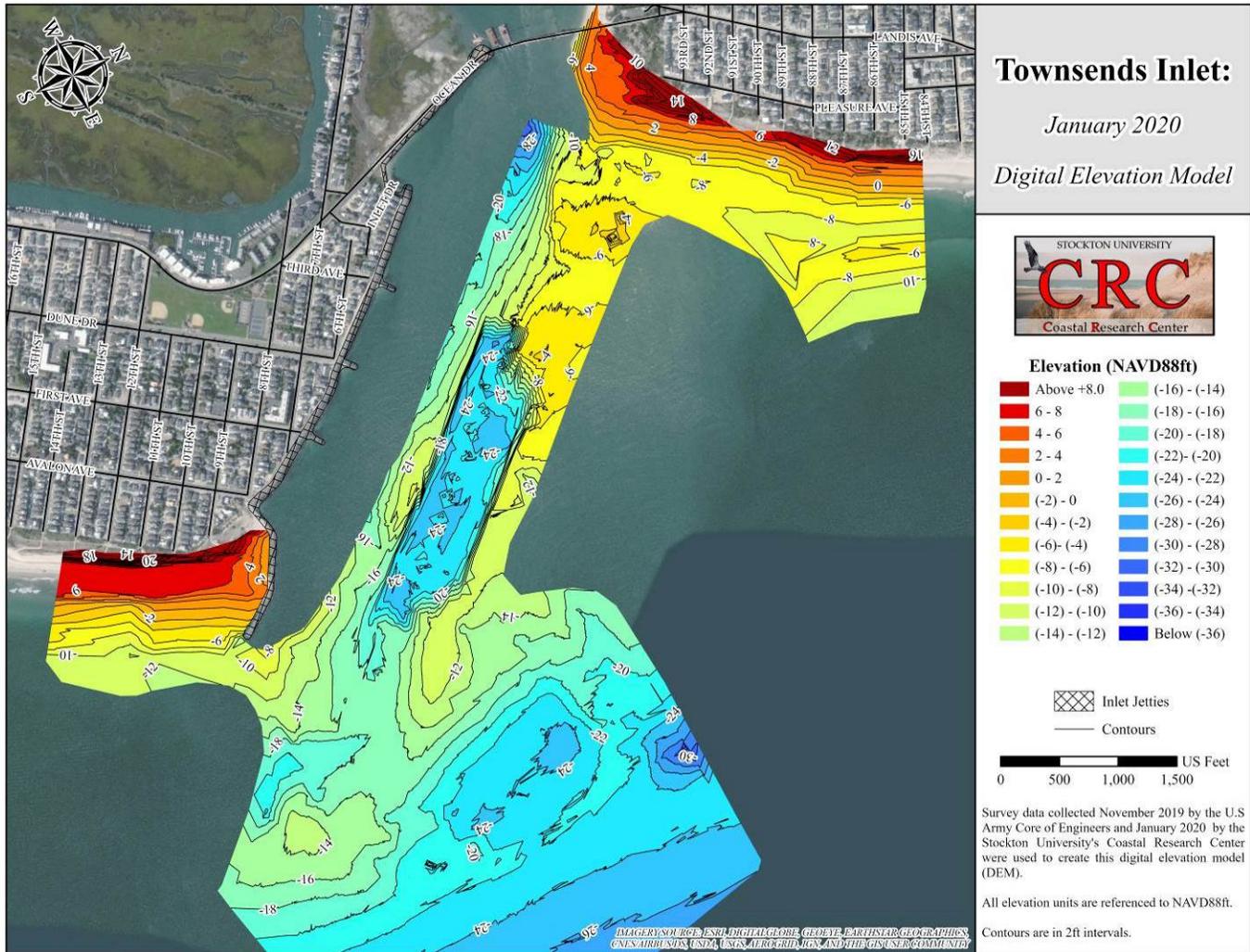


Figure 21. This Digital Elevation Model (DEM) combines post-dredging surveys by the contractor working on the USACE beach maintenance effort for the Avalon oceanfront completed by early December 2019, augmented by CRC shoreline surveys on both the Sea Isle City and northernmost Avalon beaches in January 2020. The dredging footprint is immediately evident in the center of the inlet channel. It is interesting that most of the ebb-shoals immediately seaward of Sea Isle City's beaches was not disturbed and the outer shoals of the ebb-delta were left intact.

The sand mining started inside the ebb-delta lobe which allowed sand accumulation to continue where it could assist Avalon's beach sediment supply naturally. The Sea Isle City side sand deposition was also not eliminated leaving material available to fill the excavation now at -24-foot elevations.

The 2019 combined bathymetric and topographic data was compared to similar November 2018 information obtained by the CRC as part of this inlet monitoring effort. The comparison only shows where the 2019 dataset overlapped with the 2018 information because that is the limit for direct comparison models. Areas of deposition greater than 0.2 feet vertically are in green, areas of plus or minus 0.2-foot vertical change are in yellow, while areas of greater than 0.2 feet of vertical erosion are in red shades (Figure 22).

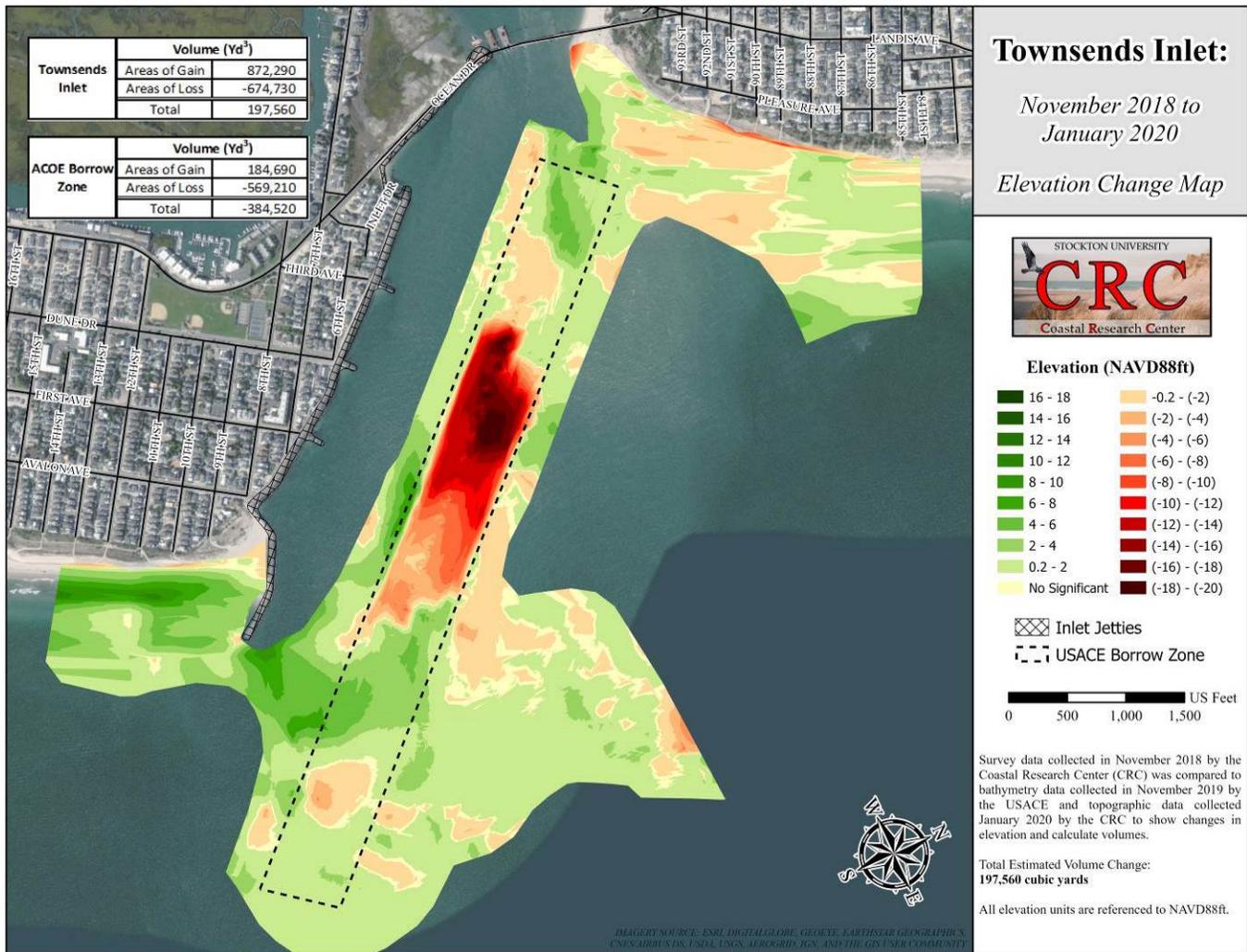


Figure 22. Digital comparison between surveys completed in November 2018 with the 2019 data where overlap exists. Again, the excavation footprint is extremely clear with areas of deposition evident as well. The beachfront in Avalon displays the deposition of the inlet material with 10 to 12 feet of new material added at the maximum value for fill. However, sand accumulated naturally at the northeast of the tip of the Avalon jetty as well (+6 to 8 feet vertically in spots).

The USACE excavation for sand deposited on the Avalon oceanfront shows as deep red areas mirroring the DEM footprint above in Figure 21. Between Nov. 2018 and Dec. 2019 deposition of sand was extensive around the ebb-tidal delta seaward of the Avalon jetty tip. Up to 10 feet of vertical accretion took place directly to the northeast of the jetty itself. The 10 to 12 feet of deposition on the surveyed part of the Avalon beachfront is the result of sand placement by the federal maintenance project. The pattern of erosion and accretion on the Sea Isle City side of the inlet was the result of a year of sand bar accumulation and migration to the south toward the inlet. Some beach erosion occurred between 87th and 92nd Streets in Sea Isle.

November 2018 to December 2020 as a Comparison of the Entire Inlet and Adjacent Beaches;

On December 7, 2020 ideal sea conditions allowed a complete boat survey of the adjacent Sea Isle and Avalon beach conditions offshore along with the entire Townsend's Inlet seaward of the bridge between Sea Isle and Avalon to points ending in over 30 feet of water beyond the ebb-tidal shoals. The beaches adjacent to the inlet were surveyed November 2 and 5, 2020 from the dunes to depths of -10 feet offshore. These sets of data were combined to generate both the elevation map and a change in elevation map between November 2018 and December 2020. These two products are designed to show the filling of the 2019 excavation effort

in the approved borrow zone and changes since the recent beach restoration in the sand accumulation area for these processes.

Figure 23 is the digital elevation map for December 2020 and shows that the maintenance dredging cut in figure 21 above has completely filled in. The deepest part of the borrow zone is located opposite the 8th Street jetty at -20 feet. The large northeast shoal attached to the Sea Isle City beach has a 1,500 by 2,500-foot scale of area above the -6-foot contour which is separated from the beach by a narrow exit channel along the base of the beachface with -10-foot depths.

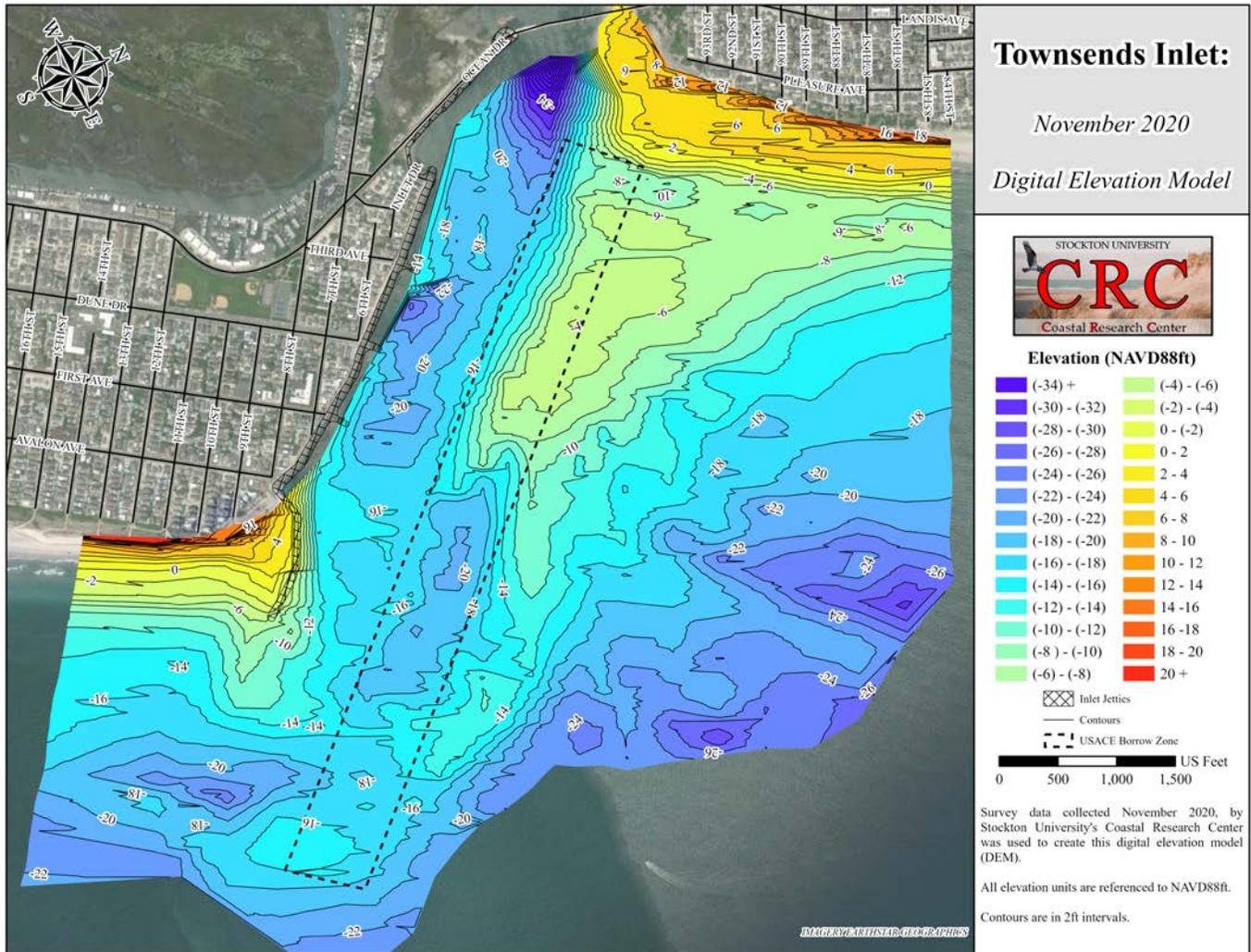


Figure 23. November 2020 Townsends Inlet bathymetry showing the oceanfront beaches on both sides of the inlet and the ebb-tidal delta deposited seaward of the inlet opening. The main tidal channel axis has shifted further toward Avalon making the deepest passage under the inlet bridge at the second fixed span, not at the drawbridge span. The majority of the main channel extent has moved adjacent to the Avalon inlet revetment from the inlet bridge seaward to where the 8th Street jetty begins. This deeper area contrasts with that seen in the 2018 map (Figure 24). At the jetty sand has accumulated in considerable quantity around the jetty.

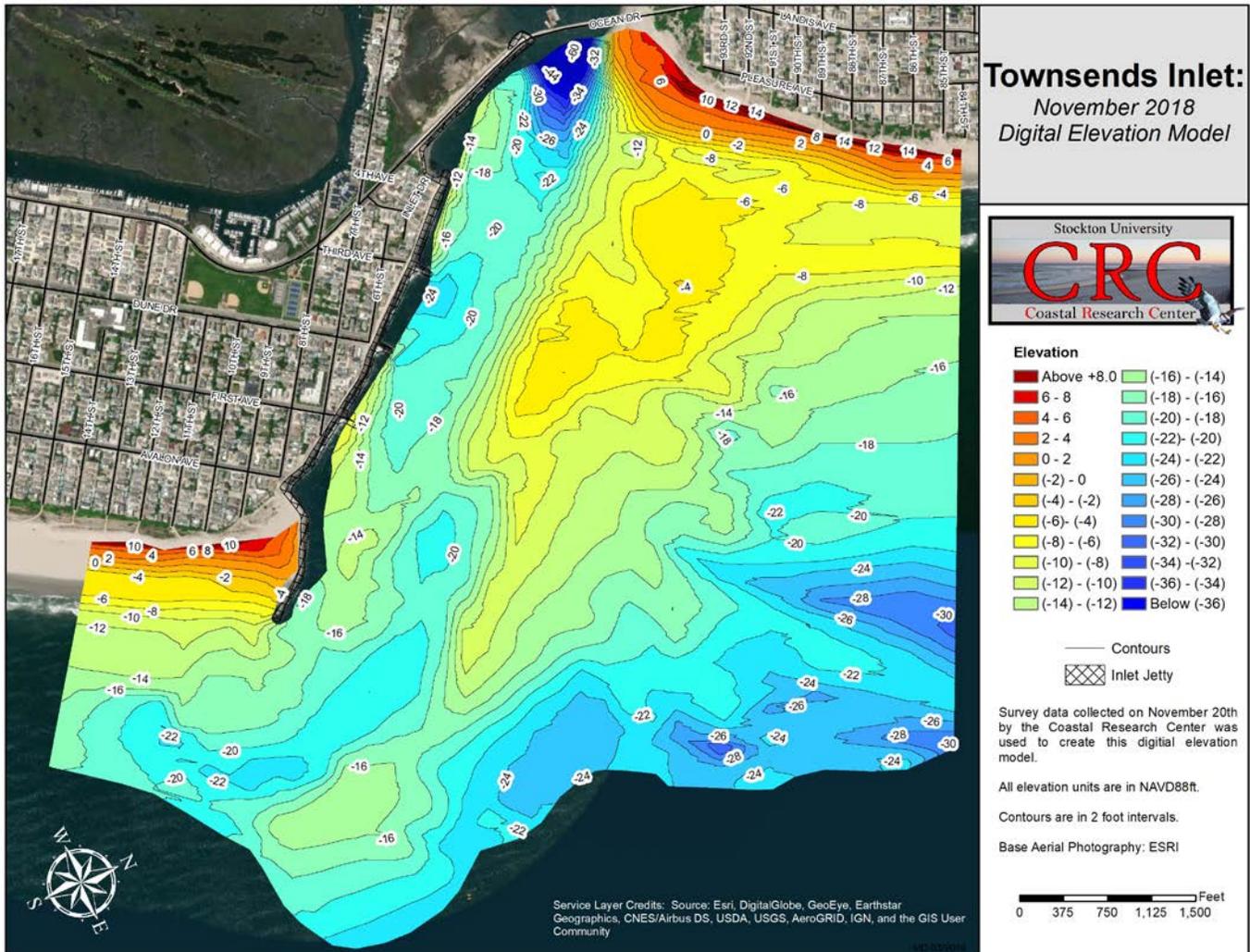


Figure 24. The 2018 Townsend's Inlet bathymetry shows the deepest area at the inlet bridge more centered under the bridge spans and with a zone of shallower channel margins along the Avalon inlet revetment. The water is over 18 feet deep at the inlet jetty as well, reduced to 6 feet by 2020. The Sea Isle shoals seaward of the City beaches were about the same in depth and extent but the exit into the Atlantic Ocean was reduced from -22 feet to -14 feet between 2018 and 2020.

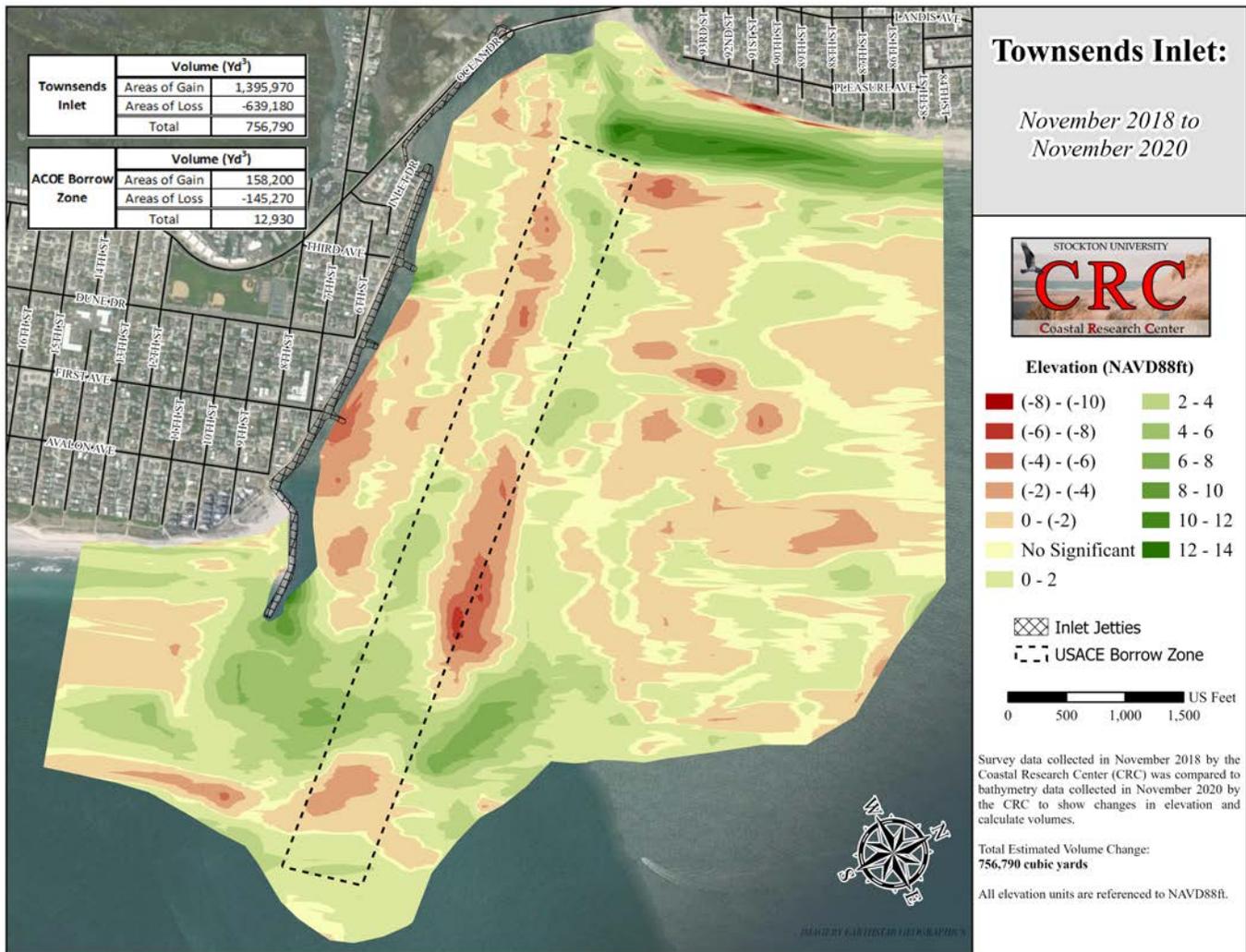


Figure 25. This comparison of the 2020 data with that taken in November 2018 allows the use of a complete area data set to show the regional changes around the inlet. There is one excavation at a maximum of 8 feet deeper in 2020 within the outline of the authorized borrow zone for the Avalon beach maintenance. The 2019 excavation sand volume was 569,210 cubic yards from the borrow zone. The contractor got paid for 571,351 cubic yards of sand. This comparison shows that since 2018 the borrow zone gained 12,930 cubic yards of sand meaning that the entire amount excavated in 2019 has been replaced as of November/December 2020.

The digital elevation comparison between 2018 before the 2019 maintenance dredging and the November/December 2020 data shows that the entire sand volume extracted for the Avalon beaches has been replaced within the borrow area leaving only one deep zone on the northeast edge about midway along the zone axis. The extensive multiple shades of green at the seaward end of the ebb-tidal delta that reach from the tip of the 8th Street inlet jetty around the borrow zone and toward the Sea Isle side of the inlet show a decrease in water depth of 6 to 8 feet creating a net sand volume gain of 756,790 cubic yards in two years. Little of this new sand lies within the borrow zone, but a total recovery from a 569,210 cubic yard removal from the borrow area in 2019 is significant nonetheless.

Townsend's Inlet Conclusions:

The Townsend's Inlet sand supply remains dependent on losses from Sea Isle City. The USACE derived the Sea Isle beach sand from offshore which is a net benefit to the current NJ beach environment, but the supply transferred to the inlet is a function of northeast storm frequency and intensity, both of which shifted toward more frequent and intense as of mid-December 2020.

The 2019 maintenance effort, focused solely on Avalon's needs, did not severely impact either the sand volume available or the geomorphic arrangement of the shallow shoal areas vital to inlet stability in the zone where sand accumulates as the "ebb-tidal delta" deposit. Frequent observations along the 8th Street Avalon inlet jetty also may indicate continued movement of sand from Sea Isle City into the inlet ebb-tidal shoals and adding to that present over the past two years. If water depths southeast of the jetty tip become less than -8 feet at low tide, the waves will begin to break and act to quickly move sand toward the oceanfront beaches between the jetty and 12th Street. This could represent a renewal of sediment by-passing of Townsends Inlet in Avalon's favor. Keep an eye on the offshore just south of the jetty for breaking waves between 500 and 800 feet off the oceanfront beaches.