2024 – 2025 Season

Delaware Annual Beach Change Report:

Bay Coast

Prepared by:

Delaware Department of Natural Resources and Environmental Control

Division of Watershed Stewardship
Shoreline and Waterway Management
285 Beiser Blvd, Suite 102
Dover, DE 19904
302-608-5500

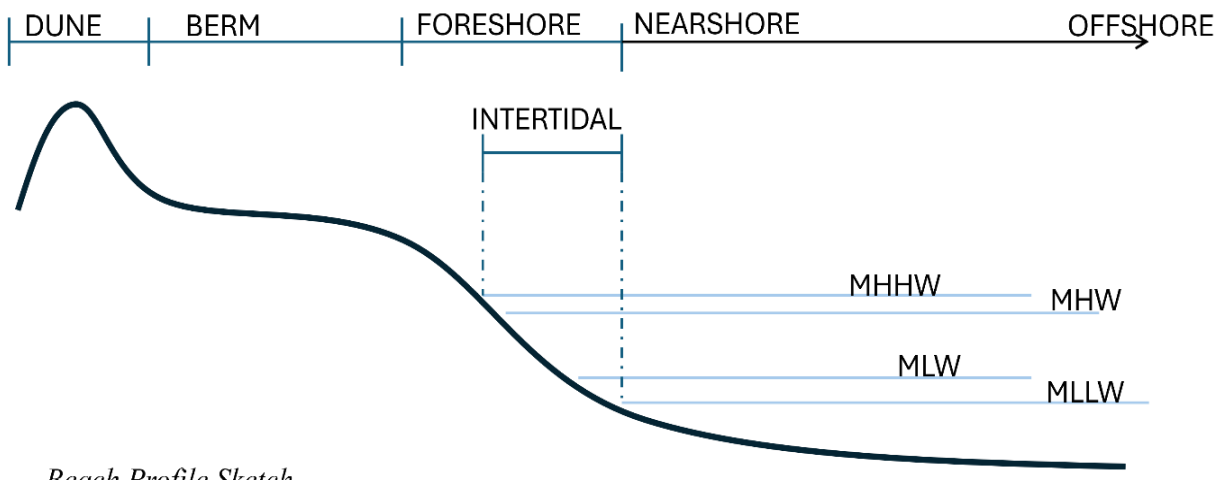
Table Of Contents

Abbreviations

CF/LF	Cubic Feet per Linear Foot (volume per unit length)
CY	Cubic Yard (volume)
DNREC	Department of Natural Resources & Environmental Control
FT	Foot (length)
GPS	Global Positioning System
LRP	Location Reference Point
MHHW	Mean Higher High Water
MHW	Mean High Water
MLLW	Mean Lower Low Water
MLW	Mean Low Water
NAVD	North American Vertical Datum
RTK	Real Time Kinematics
SWMS	Shoreline and Waterway Management Section
USACE	United States Army Corps of Engineers

Beach Profile Definitions

Berm	The relatively flat portion of the beach profile directly seaward of the dune that is typically above the MHHW elevation.
Dune	Natural or man-made geological feature that is shoreward of the berm and is characterized by a steep slope to the highest elevations along the beach profile.
Foreshore Slope	The natural slope directly seaward of the berm that is caused by tides and up rushing waves.
Intertidal Zone	The portion of the foreshore slope and nearshore that is between the MHHW and MLLW elevations.
MHHW	The average elevation reached by the higher of the two daily high tides over a 19-year tidal epoch. The value is computed by and available from NOAA.
MHW	The average elevation reached by all the high tides over a 19-year tidal epoch. These elevations exclude any storm surge or non-tidal residuals caused by onshore winds.
MLLW	The average elevation reached by the lower of the two daily low tides over a 19-year tidal epoch.
MLW	The average elevation reached by all the low tides over a 19-year tidal epoch.
Nearshore	For the purposes of this report, the nearshore is considered to extend from the lower portions of the intertidal zone to out beyond the surf zone where waves break, but onshore of most boating traffic.



Beach Profile Sketch

Executive Summary

Since 2022, DNREC's Shoreline and Waterway Management Section (SWMS) has published a yearly report titled, "Delaware Annual Beach Change Report: Bay Coast." The report shares the results of the Delaware Bay coast beach surveys and provides perspective on what causes the changes that are being observed. Data are compared to recent storm events, natural processes, and beach nourishment projects that are major drivers of shoreline change.

Twice per year, 43 beach profiles including the dune, berm, and nearshore bathymetry are surveyed along the Bay Coast. The report presents data from the two most recent summer and winter surveys and describes seasonal changes as well as long-term erosion and accretion trends. Data collected on 5/31/2023, 12/21/2023, 7/29/2024, and 3/20/2025 represent the Summer 2023, Winter 2024, Summer 2024, and Winter 2025 surveys, respectively. Bay beach communities are organized from north to south, and all survey lines were renamed as of the last published report for the 2023-2024 Season.

Introduction

The DNREC Shoreline and Waterway Management Section (SWMS) works to maintain and improve Delaware's beaches and waterways. The shoreline is managed through regulation of coastal construction activities and implementation of dune and beach management practices. By protecting and improving eroded beaches, SWMS works to enable continued recreational use of Delaware's coastal resources and enhance resiliency to protect property and infrastructure from the effects of coastal storms and erosion.

Monitoring beach change over time is a key component to shoreline management. During summer and winter seasons, beach profiles are measured along the Delaware Bay coast. Topographic and bathymetric data are collected from the dune out to a nearshore wading depth of about 4-feet using a RTK Trimble System paired with GPS. This system tracks the location and elevation of the ground where data points are collected. Figure 1 is a map showing the 43 profiles or Location Reference Point (LRP) lines from Pickering Beach, Kent County to Lewes Beach, Sussex County. In earlier reports, Cape Shores was considered a separate beach community and designated as LRP lines CS-1 through CS-3. As of this report, Cape Shores is included as part of Lewes Beach and defined as LB-7 through LB-9.

Figure 1: Bay Coast Survey Location Map

Delaware Bay Coastal Environments

Beaches are one part of the coastal environment of Delaware Bay. Sand dunes provide the first line of defense against the impacts of coastal storms and beach erosion. Landward of the dune system are wetlands and tidal creeks that offer important coastal habitat for wildlife and shield communities from storm surge. Preserving these environments is critical for protecting and enhancing the coastal communities of Delaware Bay that are vulnerable to storm damage and erosion.

While the report focuses on the Delaware Bay beaches, it is important to emphasize the entire coastal system is connected through geologic history, oceanographic processes, and human influence. Therefore, changes to the coastal environment may impact nearby wetlands, tidal flats, and/or communities. Similarly, coastal construction along with natural or human-induced changes to wetlands and tidal flats may impact beaches and dunes. For example, coastal structures and developed lands restrict the natural movement of sand along the shoreline. Due to these impacts, regulations in the Beach Preservation Act were developed to balance preservation and development pressures along the Delaware shoreline.

Geologic History and Formation of Delaware Bay

Delaware Bay formed thousands of years ago as glaciers in present-day New England and New York began melting and sea level rose. Waves eroded cliffs and other sandy geologic layers, forming small beaches. Eventually, the continued wave action and tides moved sand to form dunes and deposited mud in wetlands and tidal flats. As sea level rise persisted, the entire system shifted landward as large, storm-induced waves naturally pushed sand overtop of the dunes and deposited it landward. Through this process called overwash [1], the entire Delaware Bay coast eventually moved landward and overtopped the marshes and tidal flats. Similarly, tides flowing through coastal inlets allow sand to move landward and deposit in tidal flood shoals. These shoals provide a source of sand to be "recycled" within the Bay coast system over time.

Geologic deposits influence the amount of sand and gravel available to modern Bay beaches. A generalized geologic cross-section of the Delaware Bay coast from Port Mahon, Kent County to Broadkill Beach, Sussex County is shown in

Figure 2 [2]. The oldest geologic deposits were former hills and necks that originated during the Pleistocene where the shallowest deposits ranged from 80,000 to 120,000 years old [3]. Modern beaches and sand dunes sit on top of the older geologic sediments; however, erosion of the underlying hills and necks will naturally supply Pleistocene-aged gravel and sandy material to the overlying beaches. For example, at many locations in Delaware Bay, Pleistocene deposits are exposed on the shoreface where waves break in the surf zone. These sediments are transported towards the beach and/or along the coastline in the same manner it has for thousands of years.

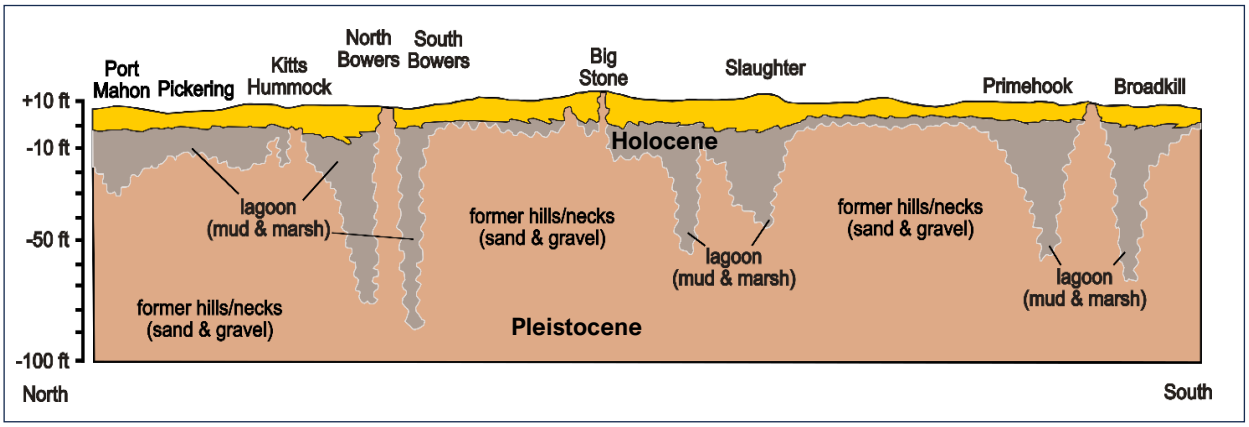


Figure 2: Geology of the Delaware Bay Coast from Port Mahon (north) to Broadkill Beach (south). Modified from French, 1990.

Additional sources of sand and gravel to Delaware Bay beaches include: 1) the transport of material around Cape Henlopen (prior to the 20th century), 2) minor contributions from the Atlantic Ocean continental shelf, and 3) the recycling of sand from tidal ebb shoals of former inlets. The latter is the largest additional source of sand and gravel to the Bay coast. Historical data shows that sediment erodes from the ebb shoals of old inlets and is subsequently driven towards and/or along the beach through wave action. In addition, sand is transported along the coast via the longshore current and can represent a new source of sand for individual beaches; however, this is not a new supply of material to the Delaware Bay coast [1].

The 2024-2025 Storm Season

NOAA Coastal Flood Events

Coastal storm events and flooding can have significant impacts on the Delaware Bay beaches. The NOAA National Centers for Environmental Information (NCEI) Storm Event Database lists several events within the "Delaware Beaches" and "Kent County" Zones that resulted in the Coastal Flood designation [4]. A Coastal Flood Event is defined as flooding of coastal areas due to the vertical rise above normal water level caused by strong, persistent onshore wind, high astronomical tide, and/or low atmospheric pressure, resulting in damage, erosion, flooding, fatalities, or injuries [5]. Listed below are the Coastal Flood Events recorded for the Delaware Beaches and Kent County Zones during the 2024-2025 storm season (Table 1).

Table 1: NOAA Coastal Flood Events

Date	Description Of Event
June 3, 2023	Steady onshore wind. Widespread moderate tidal flooding to the coast around the evening high tide.
Sept. 23, 2023	**Tropical Storm Ophelia.** Steady onshore flow along the Delaware coast, causing widespread tidal flooding.
Sept. 26, 2023	Steady onshore flow along the Delaware coast causing widespread tidal flooding.
Dec. 18, 2023	Strong onshore flow and a push of water onshore and up the Delaware Bay causing moderate coastal flooding.
Jan. 10, 2024	A strong system with steady southerly flow pushing water into coastal communities. Water levels in tidal areas were higher due to 2-4+ inches of rainfall.
Jan. 13, 2024	Strong S-SE winds. Widespread tidal flooding and a push of water up the Delaware Bay/River and back bays. Caused tidal inundation of roads & structures.

Feb. 13, 2024	A strong coastal system caused surge of 2-3 feet above the astronomical tides, resulting in widespread and impactful coastal flooding during high tides.
April 12, 2024	High astronomical tides and strong southerly flow resulted in higher water levels, mainly along the Delaware Bay.
Sept. 23, 2024	An offshore coastal storm and full moon resulted in higher tides and moderate coastal flooding.
Nov. 15, 2024	High astronomical tides associated with the full moon and a light onshore flow brought some moderate tidal flooding.

NOAA Water Level Stations

While significant storm events have impacted the Delaware Bay coastline, data from NOAA water level stations can be used to determine peak storm elevations. NOAA provides real-time water level information that is updated every six minutes from three locations in Delaware Bay [6]. Figure 3 shows these stations from north to south as Ship John Shoal, NJ; Brandywine Shoal Lighthouse, DE; and Lewes, DE.

Table 2 lists the highest water elevations (in feet above MHHW) recorded at each monitoring station during the 2024-2025 storm season. Peak water levels correlate with coastal flood events designated by NOAA. Particularly, the events on 6/3/2023 and 9/26/2023 (Tropical Storm Ophelia) resulted in the highest water levels reported across all Delaware Bay stations. Evaluation of the seasonal survey data will help determine the impacts the 2023 storms had on Bay coast communities.

Figure 3: NOAA Water Level Stations in Delaware Bay

Table 2: Maximum water level elevations recorded at NOAA Stations in Delaware Bay

Date	Ship John Shoal	Brandywine Shoal	Lewes, DE
	MHHW, feet	MHHW, feet	MHHW, feet
3-Jun-2023	2.75	2.44	2.59
26-Sep-2023	2.27	2.30	2.50
13-Jan-2024	2.57	2.36	2.23

Typical Seasonal to Annual Beach Change

Storm-driven erosion and wave overtopping (overwash) of the dunes control seasonal-to-annual-scale beach change along the Delaware Bay coast. While storm events are episodic, increases in frequency and intensity promote the likelihood of coastal erosion [2]. Nor'easters typically cause the most annual erosion along the Delaware Bay coast. Hurricanes are less frequent and more transient, but would induce major shoreline change and erosion. During fall and winter months, energetic waves and storm surge cause erosion and overwash, resulting in beach profiles with upper beach face erosion and dune scarping. During spring and summer months, calmer waves and less frequent/intense storms commonly result in beach accretion. Figure 4 demonstrates a schematic of a typical beach profile during summer versus winter months. It is possible that some beaches may not fully recover the volume lost between seasons [3]. Insufficient seasonal recovery is common on beaches along the Atlantic coast and in the world, leading to long-term erosion [7].

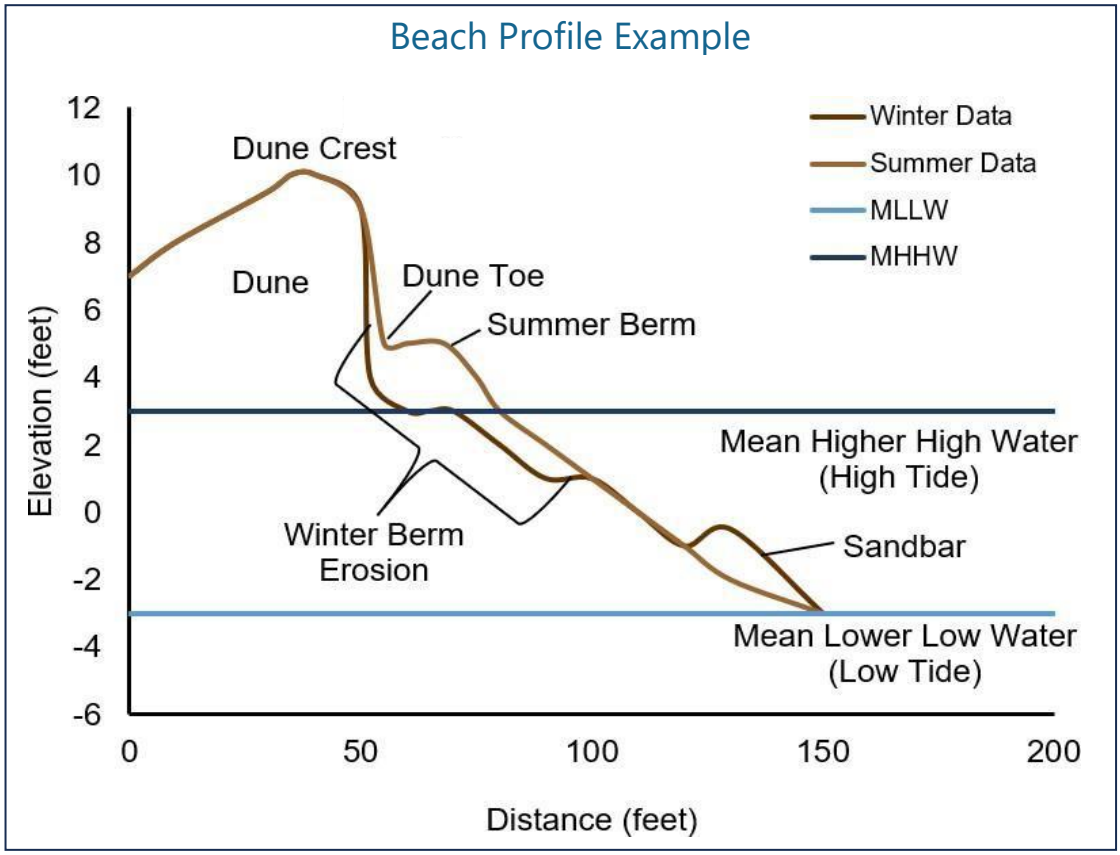


Figure 4: Schematic of typical summer versus winter beach profiles

Beach Nourishment

Beach nourishment is necessary for repairing eroded coastlines and protecting critical infrastructure, like homes and roads, due to storm surge. Throughout the 2024-2025 season, sand placement occurred at Lewes, Pickering, and North Bowers Beaches (Table 3). Please note, when reviewing beach profiles and profile volumes, beach nourishment influences the natural seasonal changes that occur along the shoreline.

In December 2023, Lewes Beach received almost 105,000 cubic yards (cy) of material dredged from Roosevelt Inlet that affected LRP lines LB-1, LB-2 and LB-3. In March 2024, 7,500 cy of truck-hauled sand was placed along the length of Pickering Beach as an emergency effort initiated by DNREC. In February 2025, a smaller (1,000 cy) nourishment project occurred at the southern end of North Bowers Beach, where the addition of truck-hauled sand impacted LRP lines NB-3 and NB-4. Beach nourishment is reflected in the survey data and described in more detail below.

Table 3: Beach nourishment completed during the 2024-2025 Season

Beach	Volume	Project Length	Affected LRPs
	CY	Linear feet	
Pickering	7,500	2,530	PB-1, PB-2, PB-3
North Bowers	1,000	860	NB-3*, NB-4
Lewes	105,000	1,400	LB-1, LB-2, LB-3
*LRP is located near the end of the project length			

Annual Beach Change by Community

Beach change is determined by calculating the measured volume difference between seasons for each transect or LRP line. Beach volume is measured along a 1-dimension transect and reported in cubic feet per linear foot of beach length (cf/lf). Two beach volumes are reported for each LRP line based on the mean high water (MHW) and mean low water (MLW) contours as demonstrated in Figure 5. The MHW volume represents the material between the crest of the dune and the intersection of the MHW contour. The MLW volume includes the

material between the MHW and MLW contours, in addition to the MHW volume.

The upper extent of the beach, above the MHW contour, is only reached during storm tides and/or when powerful wave action is occurring. Therefore, the MHW volume is an indicator of beach resiliency to flooding, overwash, and hazardous wave action. The MLW volume and the comparison of the MHW and MLW volumes are better indicators of seasonal beach change. During the stormy season when the upper beach erodes, sand washes down to the intertidal zone or just offshore. Some of the eroded material that ends up in the intertidal zone may be captured in the MLW data. By comparing the MHW and MLW volumes, seasonal erosion and accretion trends can be identified.

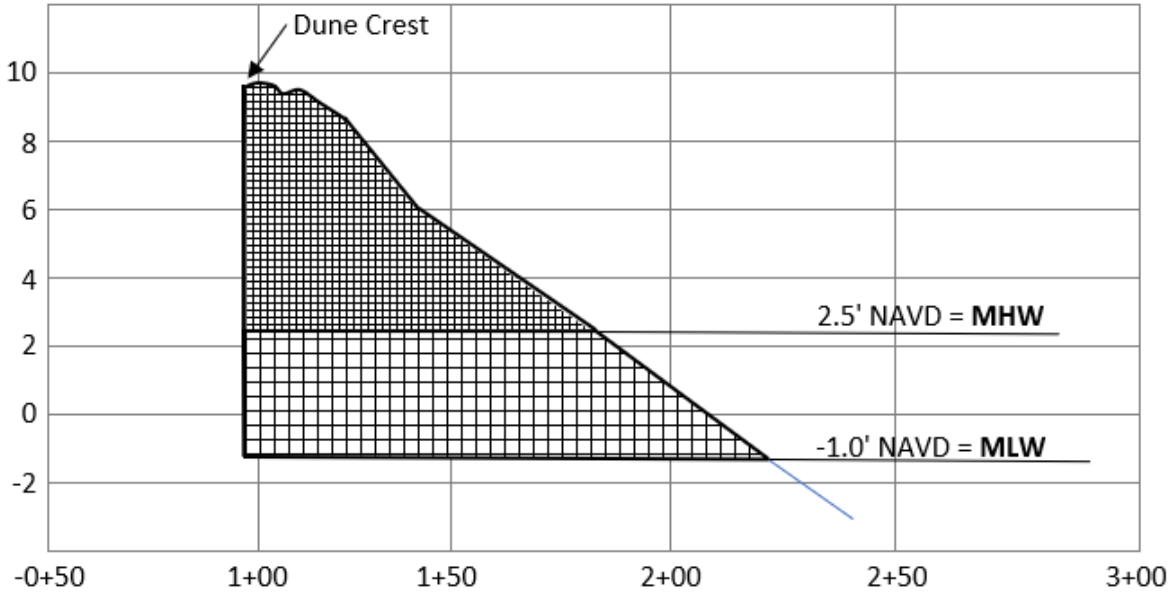


Figure 5: Sketch of beach profile and volume calculations

The following sections describe the average seasonal and annual beach change volumes determined for each of the Delaware Bay Coast communities. Volume data are paired with representative profiles and photographs per community. Beach profiles for all LRP lines are available in Appendix 1. Additional photographs are included in Appendix 2.

Pickering Beach

Pickering Beach (PB) is located southeast of Dover and is the northernmost region in SWMS's jurisdiction. This is a densely developed area that includes three LRP survey lines and about 2,300 feet of shoreline (Figure 6A).

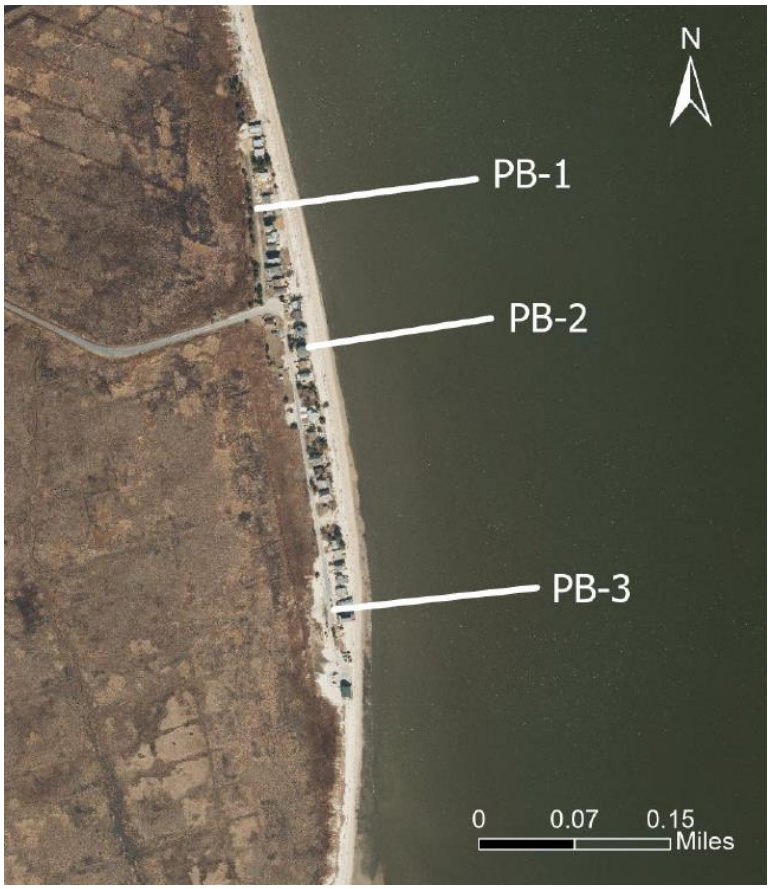


Figure 6A. LRP lines at Picking Beach

The average beach volumes determined for Pickering Beach are shown in Table 4. Comparison of the Summer 2023 and Winter 2024 profiles demonstrates the impacts the 2023 storms, including Tropical Storm (TS) Ophelia, had on the coastline. At LRP line PB-3, the Winter 2024 profile shows a total loss of dune that is attributable to coastal storm erosion (Figure 6B).

To restore some of the lost volume, DNREC completed an emergency beachfill project in March 2024 that delivered 7,500 cy of sand to Pickering Beach (Table 3). Nourishment impacted all LRP lines and volume gains above the MHW line were measured in Summer 2024. However, despite nourishment, dune erosion continued through Winter 2025. In addition, erosion of the nearshore profile

was observed at PB-3 (Figure 6B) as incremental volume loss was measured from Summer 2023 through Winter 2025.

Table 4: Beach volume calculations for Pickering Beach

LRP		PB-1		PB-2		PB-3	
Volume Limit		MHW	MLW	MHW	MLW	MHW	MLW
Season	Date	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf
Summer 2023	5/31/2023	N/A	N/A	N/A	N/A	117	407
Winter 2024	12/21/2023	148	518	130	494	74	359
Summer 2024	7/29/2024	199	554	175	490	90	342
Winter 2025	3/20/2025	178	531	153	463	83	338

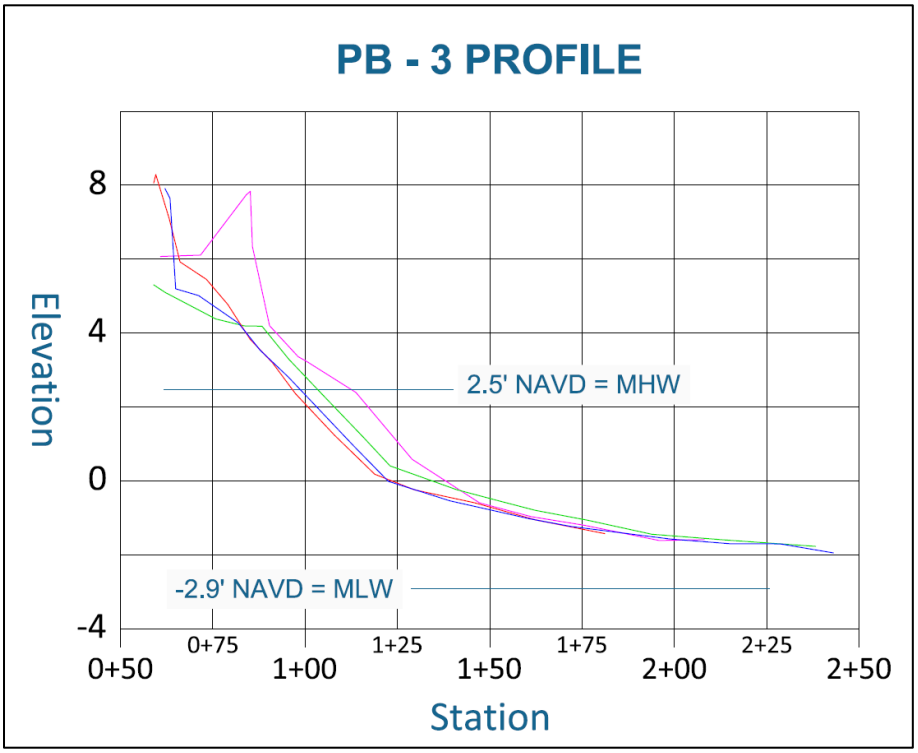


Figure 6B. Beach Profiles at Pickering Beach, Station PB-3
Pink: Summer '23, Green: Winter '24, Red: Summer '24, Blue: Winter '25

An aerial view of the Pickering Beach shoreline is shown in Figure 6C. This photo was taken following completion of the emergency beachfill project described above.

Figure 6C. Aerial view of Pickering Beach (03/19/2024, 12:24) at low tide, looking north.

Kitts Hummock

Kitts Hummock (KH) is located south of Pickering Beach and is a densely developed coastline. This area includes four LRP lines and 4,500 feet of shoreline (Figure 7A).

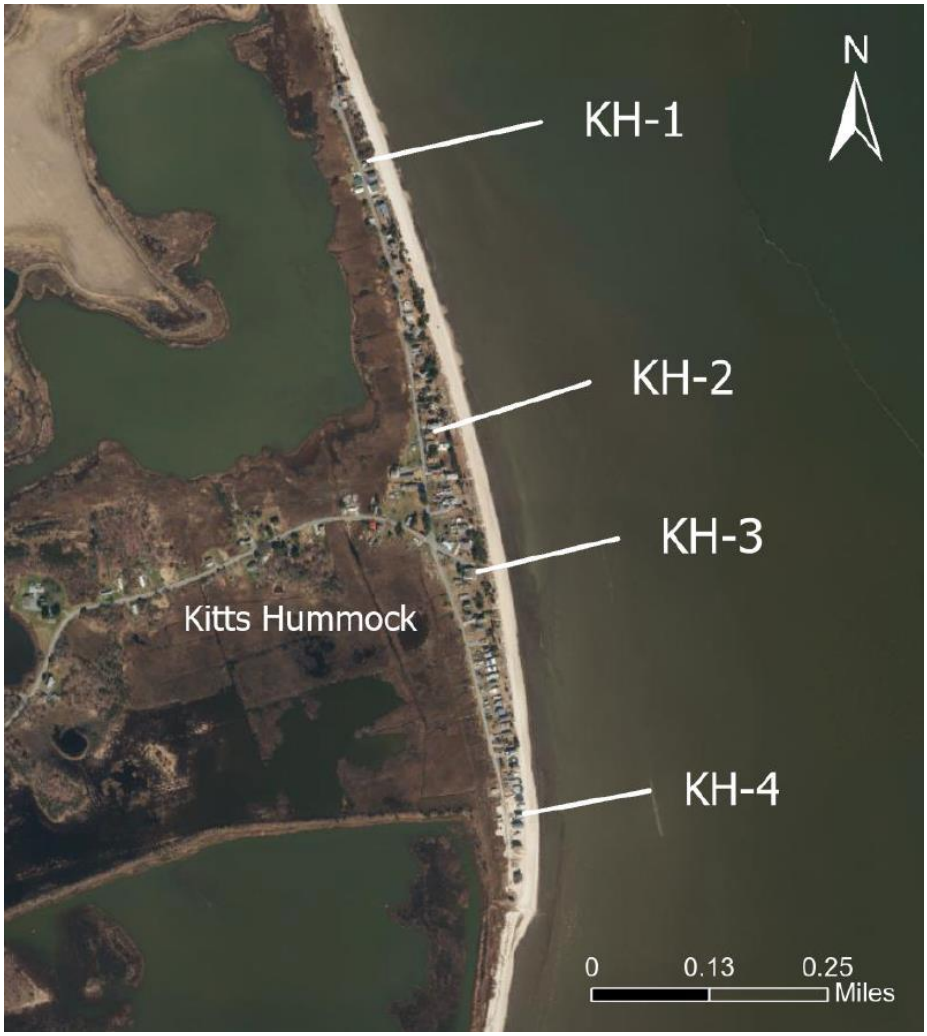


Figure 7A. LRP lines at Kitts Hummock

The average beach volumes determined for Kitts Hummock are shown in Table 5. Overall, Kitts Hummock beach is eroding as annual volume losses were measured from Summer 2023 to Summer 2024 and Winter 2024 to Winter 2025. Impacts from the 2023 storms, including TS Ophelia, resulted in significant volume losses along the shoreline. Figure 7B demonstrates erosion of the dune and nearshore profile in the central Kitts Hummock community (KH-2) following the Summer 2023 survey, while minor changes were observed in subsequent seasons.

Table 5: Beach volume calculations for Kitts Hummock									
LRP		**KH-1**		**KH-2**		**KH-3**		**KH-4**	
Volume Limit		MHW	MLW	MHW	MLW	MHW	MLW	MHW	MLW
Season	Date	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf
Summer 2023	5/31/2023	232	594	142	365	173	401	126	309
Winter 2024	12/21/2023	221	611	123	328	165	397	106	283
Summer 2024	7/29/2024	202	569	119	326	155	367	89	244
Winter 2025	3/20/2025	206	560	110	313	148	363	78	229

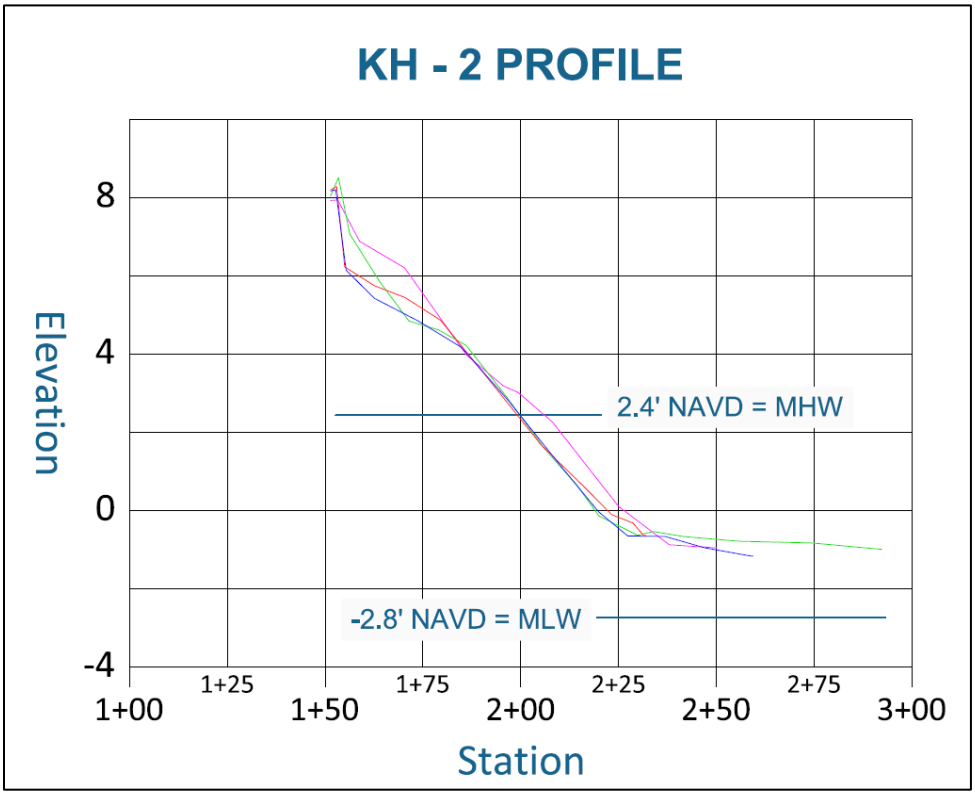


Figure 7B. Beach Profiles at Kitts Hummock, Station KH-2
Pink: Summer '23, Green: Winter '24, Red: Summer '24, Blue: Winter '25

Figure 7C shows an aerial view of Kitts Hummock beach during low tide. The Kitts Hummock Beach Road crossover can be seen in the foreground, which is nearest to LRP line KH-3.

Figure 7C. Aerial view of Central Kitts Hummock Beach (4/17/2024, 12:52) at low tide, looking north

North Bowers Beach

North Bowers (NB) Beach includes 2,300 feet of shoreline and is bound by the Saint Jones River to the north and the Murderkill River and jetty to the south. There is one LRP survey line (NB-1) located north of the northern groin where there is no coastal development (Figure 8A). The remaining three LRP lines are located within the densely developed portion of the community.

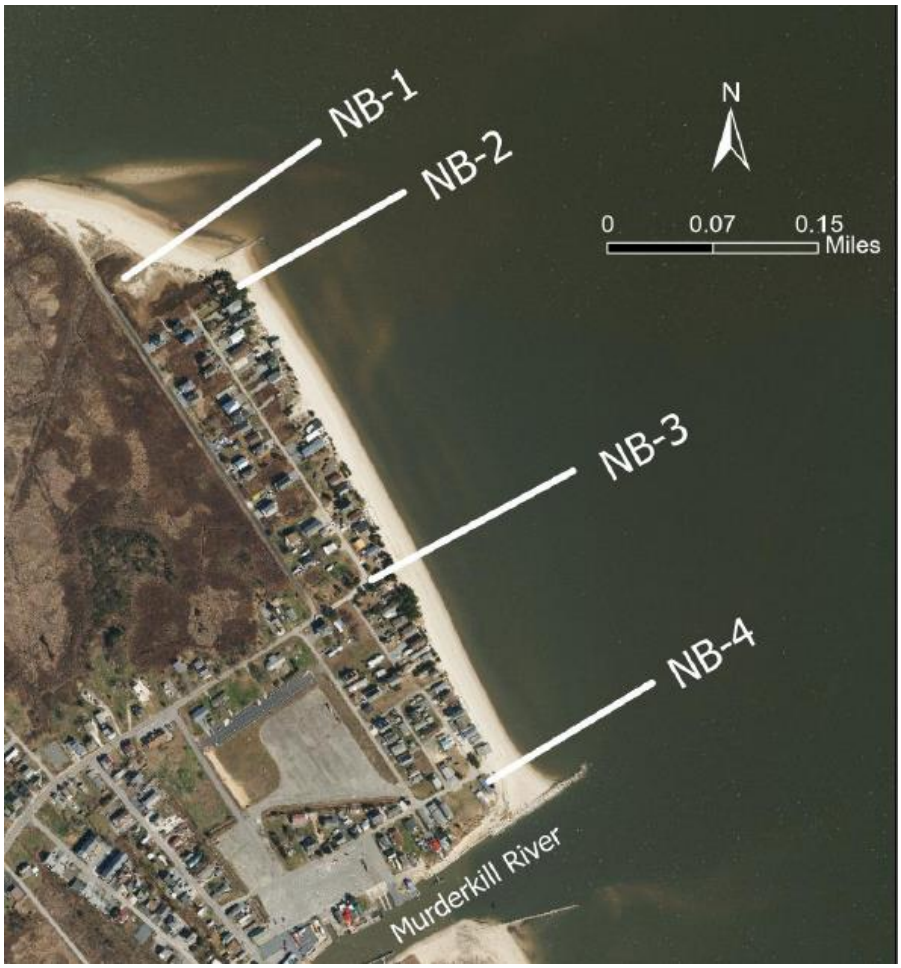


Figure 8A. LRP lines at North Bowers Beach

The average beach volumes determined for North Bowers Beach are shown in Table 6. The northernmost profile (NB-1) is accreting material overtime as annual gains in volume are measured from Summer 2023 to Summer 2024 and Winter 2024 to Winter 2025. This area is influenced by the St. Jones River ebb flow and the adjacent jetty that helps trap material in the nearshore. Conversely, LRP line NB-2 experienced significant nearshore erosion due to

impacts from the 2023 storms, including TS Ophelia (Figure 8B). While erosion continued through Summer 2024, recovery of nearshore material and reformation of a berm is observed from the Winter 2025 profile.

The southern half of North Bowers Beach received 1,000 cy of sand in February 2025 (Table 3), which facilitated accretion measured in the upper beach profile at LRP line NB-3 during Winter 2025. Nourishment in this area is necessary as annual volume losses are measured between summer and winter seasons. At NB-4, beach nourishment helped to mitigate annual winter erosion as similar volumes were measured for Winter 2024 and Winter 2025.

Figure 8C shows an aerial view of North Bowers Beach. The northern jetty and St. Jones River are visible in the background.

Table 6: Beach volume calculations for North Bowers Beach

LRP		NB-1		NB-2		NB-3		NB-4	
Volume Limit		MHW	MLW	MHW	MLW	MHW	MLW	MHW	MLW
Season	Date	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf
Summer 2023	5/31/2023	186	429	564	1090	440	883	187	492
Winter 2024	12/21/2023	213	485	465	922	417	849	198	488
Summer 2024	7/29/2024	270	601	465	886	384	795	234	567
Winter 2025	3/20/2025	253	541	459	905	390	784	199	486

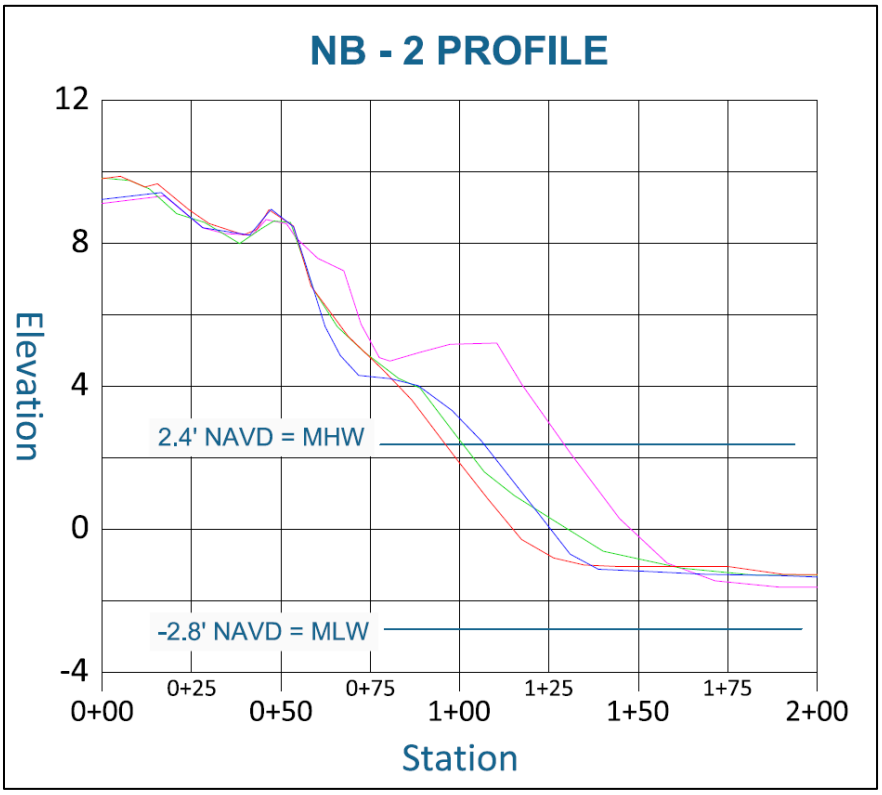


Figure 8B. Beach Profiles at North Bowers Beach, Station NB-2
Pink: Summer '23, Green: Winter '24, Red: Summer '24, Blue: Winter '25

Figure 8C. North Bowers (4/17/2024, 12:06) nearing low tide, looking north.

South Bowers Beach

Located south of the Murderkill River, South Bowers (SB) Beach is approximately 3,000 ft long and contains four LRP survey lines (Figure 9A). In the more densely developed area adjacent to the Murderkill River jetty, two LRP lines are spaced close together (SB-1, SB-2). In the less developed region, LRP lines SB-3 and SB-4 are spaced farther apart.

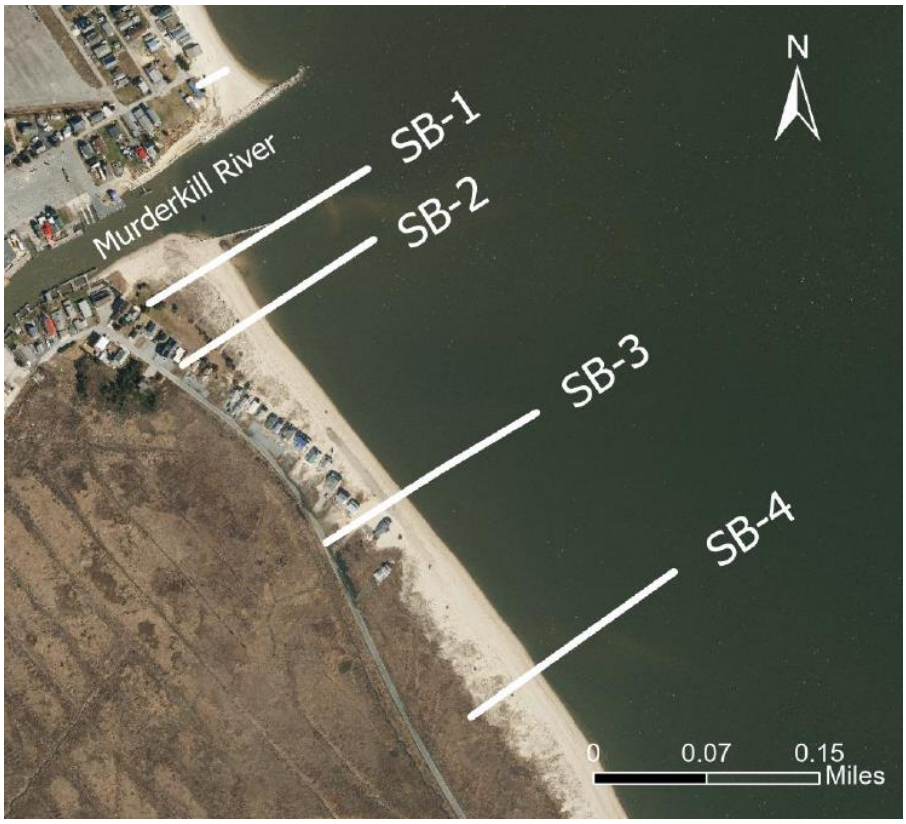


Figure 9A. LRP lines at South Bowers Beach

The average beach volumes determined for South Bowers Beach are shown in Table 7. The northernmost LRP line (SB-1) accreted volume throughout the 2024-2025 season due to the adjacent (south) Murderkill River jetty, which traps the northward flow of sand by the longshore current. In Winter 2025, significant accretion at SB-1 is directly attributable to the Murderkill Jetty Rehabilitation Project that was completed in early February 2025. Sand excavation was necessary for achieving the proper elevation to replace the jetty; therefore, subsequent growth is due to the new jetty trapping the longshore sediment transport, which has greatly increased beach volume and width in this area (Figure 9B). Given the proximity to SB-1, modest accretion is also measured at LRP line SB-2.

Table 7: Beach volume calculations for South Bowers Beach									
LRP		**SB-1**		**SB-2**		**SB-3**		**SB-4**	
Volume Limit		MHW	MLW	MHW	MLW	MHW	MLW	MHW	MLW
Season	Date	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf
Summer 2023	5/31/2023	316	897	210	543	882	1539	162	604
Winter 2024	12/21/2023	360	927	264	628	785	1390	218	682
Summer 2024	7/29/2024	433	1195	266	633	690	1253	203	676
Winter 2025	3/20/2025	1052	2056	290	678	663	1185	208	674

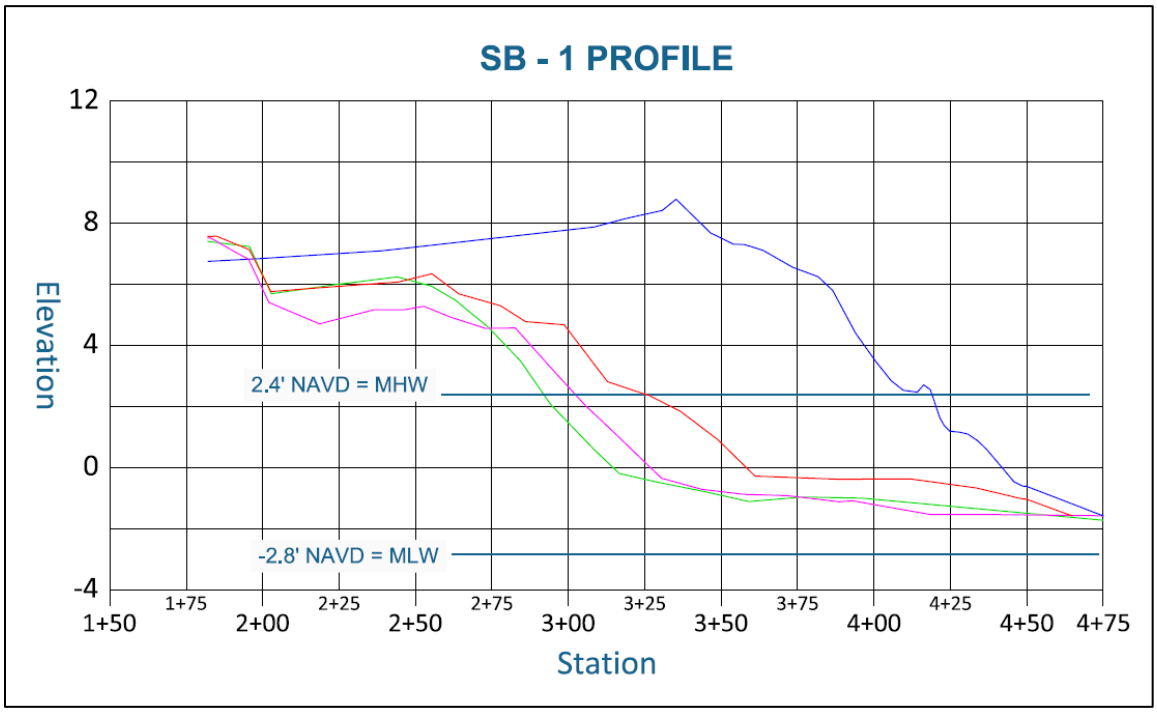


Figure 9B. Beach Profiles at South Bowers Beach, Station SB-1.
Pink: Summer '23, Green: Winter '24, Red: Summer '24, Blue: Winter '25

Conversely, LRP line SB-3 lost volume throughout the 2024-2025 season as demonstrated in Figure 9C. The Summer 2023 profile was influenced by two main events. In August 2022, this area received about 35,000 cy of dredged material from the Murderkill River, and then one year later, impacts from the 2023 storms, including TS Ophelia, eroded some of the nourished profile. Given continuous volume losses were measured in subsequent seasons, SB-3 appears to be an area prone to erosion. The southernmost LRP line (SB-4) shows variable volume distributions within the dune and nearshore profiles. In addition, this area gained volume in Winter 2024 despite the 2023 storms.

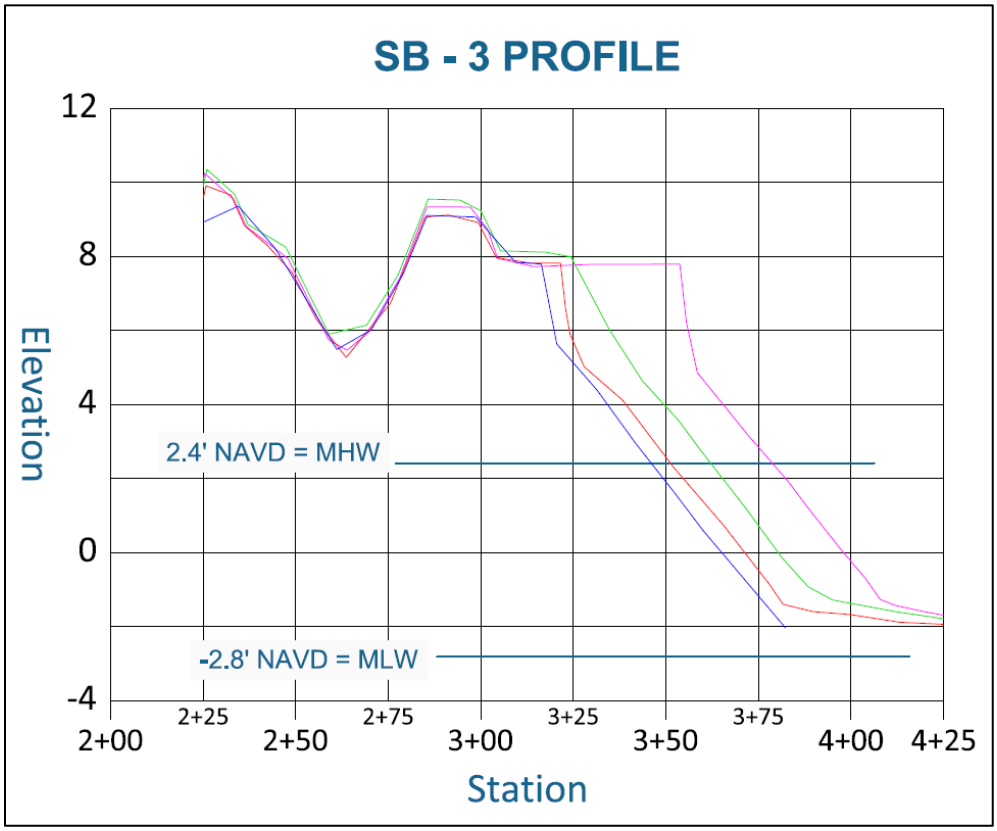


Figure 9C. Beach Profiles at South Bowers Beach, Station SB-3.
Pink: Summer '23, Green: Winter '24, Red: Summer '24, Blue: Winter '25

Figure 9D shows the newly rehabilitated Murderkill River (south) jetty and South Bowers Beach. The volume accumulation at LRP line SB-1, due to the jetty repair, is observed in the photo.

Figure 9D. Aerial view of South Bowers Beach (6/16/2025, 12:58) and the newly rehabilitated jetty, looking south from the Murderkill River inlet.

Bennett's Pier

Bennett's Pier (BP) is located south of South Bowers Beach and contains one LRP line (Figure 10A). This beach is entirely privately owned, undeveloped, and adjacent to wetlands. DNREC collects data at Bennett's Pier through an agreement with the landowner, Delaware Wild Lands, Inc.

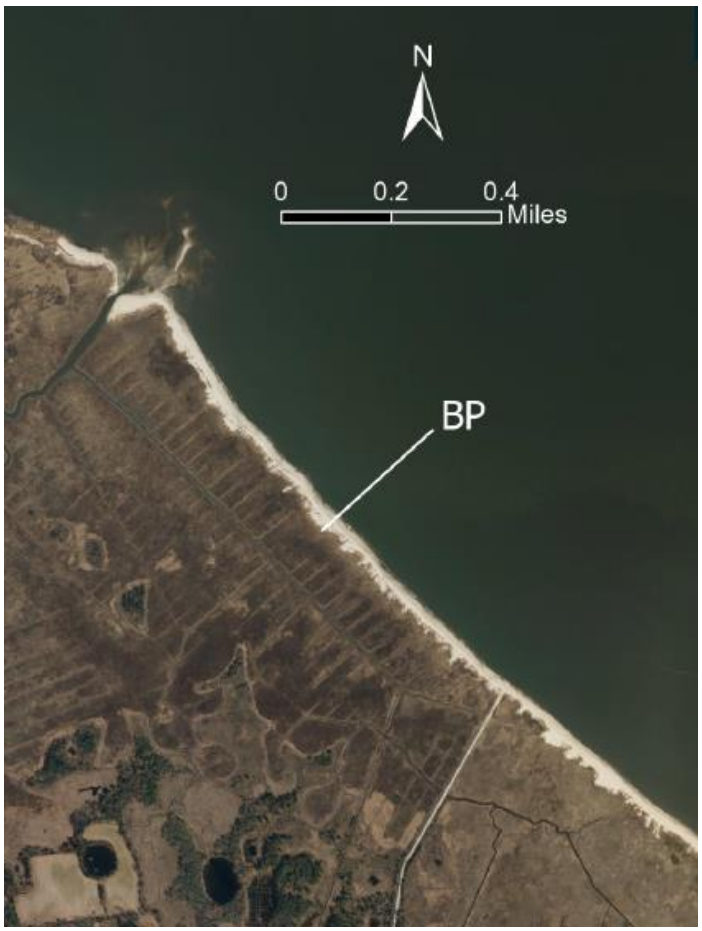


Figure 10A. LRP line at Bennett's Pier

The average beach volumes determined for Bennett's Pier are shown in Table 8. Volume loss measured in Winter 2024 suggests this shoreline was impacted by the 2023 storms, including TS Ophelia. Figure 10B demonstrates the seasonal nearshore profile changes as well as a shift in the upper beach profile during Summer 2024 at Bennett's Pier Beach.

Table 8: Beach volume calculations for Bennett's Pier			
LRP		BP	
Volume Limit		MHW	MLW
Season	Date	cf/lf	cf/lf
Summer 2023	5/31/2023	127	749
Winter 2024	12/21/2023	127	727
Summer 2024	7/29/2024	165	746
Winter 2025	3/20/2025	N/A	N/A

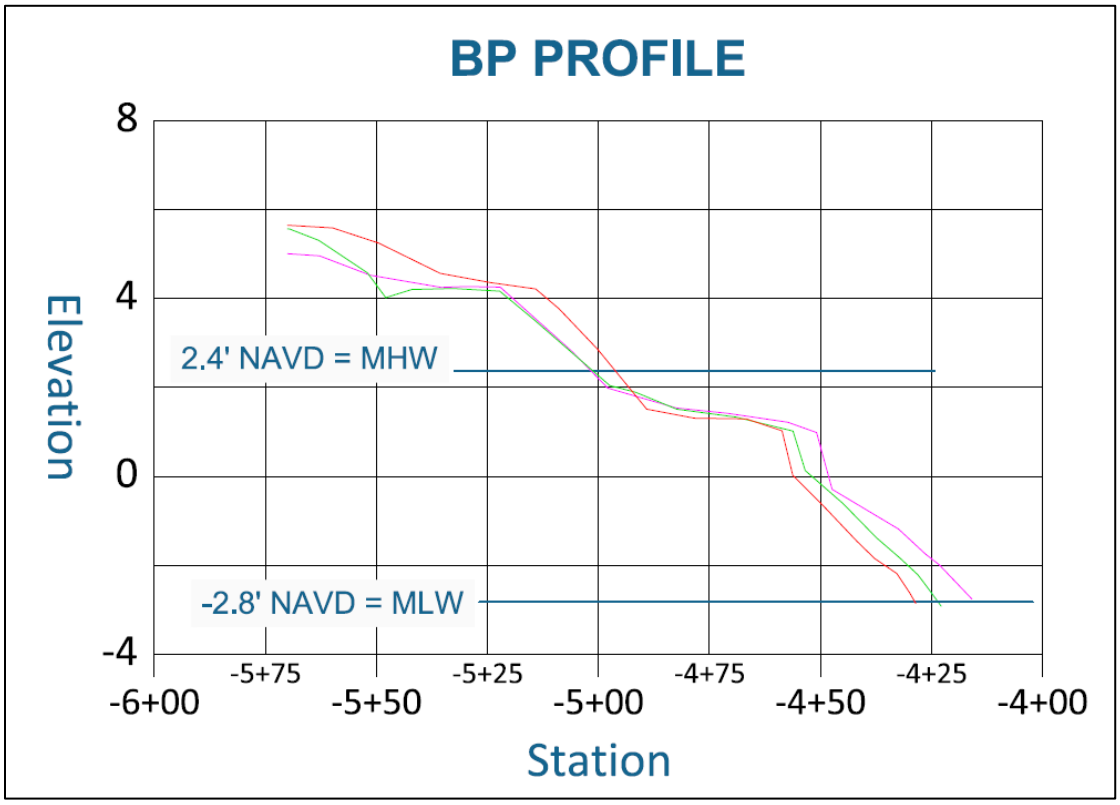


Figure 10B. Beach Profiles at Bennett's Pier Beach.
Pink: Summer '23, Green: Winter '24, Red: Summer '24, Blue: Winter '25

Big Stone Beach

Big Stone Beach (BSB) is bound by Bennett's Pier to the north and the Mispillion River to the south. One LRP survey line exists north of Big Stone Beach Road (Figure 11A). This area is undeveloped and privately owned by Delaware Wild Lands, Inc. Similar to Bennett's Pier, DNREC collects data through an agreement with the landowner.

Figure 11A. LRP line at Big Stone Beach

The average beach volumes determined for Big Stone Beach are shown in Table 9. Survey data demonstrate modest accretion from Summer 2023 through Summer 2024, followed by erosion during Winter 2025. In Figure 11B, the Summer 2023 survey shows an eroded dune profile that recovered volume in subsequent seasons.

Table 9: Beach volume calculations for Big Stone Beach			
LRP		**BSB**	
Volume Limit		MHW	MLW
Season	Date	cf/lf	cf/lf
Summer 2023	5/31/2023	228	600
Winter 2024	12/21/2023	248	607
Summer 2024	7/29/2024	254	622
Winter 2025	3/20/2025	244	601

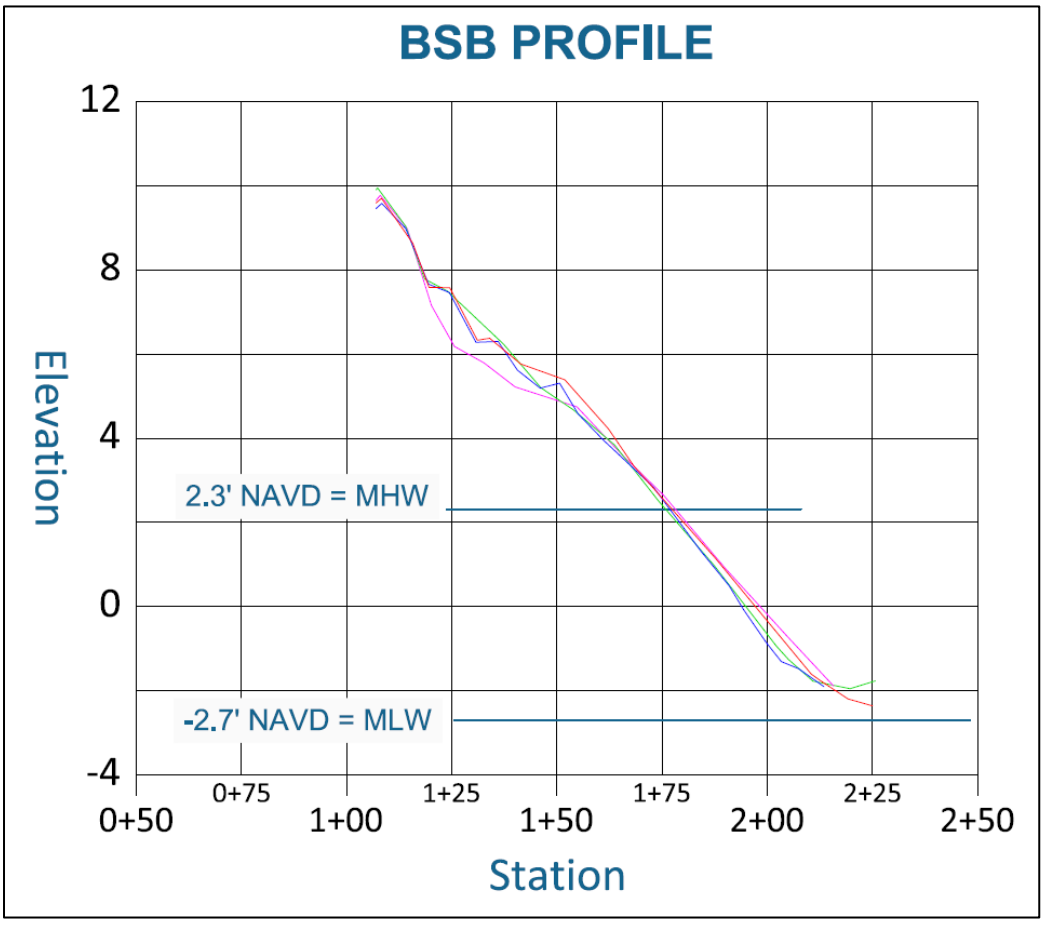


Figure 11B. Beach Profiles at Big Stone Beach
Pink: Summer '23, Green: Winter '24, Red: Summer '24, Blue: Winter '25

Slaughter Beach

Slaughter Beach (SLB) is a densely developed coastal town located east of Milford. This area is situated between the Mispillion River and Cedar Creek to the north and Prime Hook National Wildlife Refuge to the south. Slaughter Beach includes five LRP survey lines and approximately 16,000 feet, or about three miles, of coastline (Figure 12A).

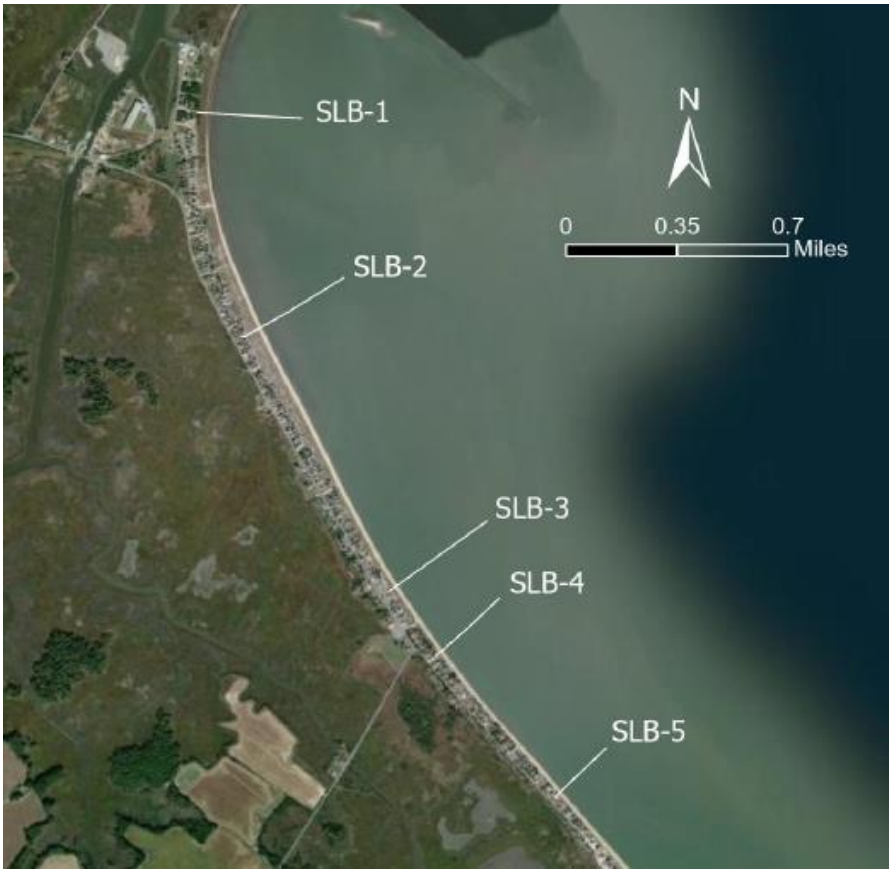


Figure 12A. LRP lines at Slaughter Beach

The average beach volumes determined for Slaughter Beach are shown in Table 10. The northern end of the community (SLB-1, SLB-2) gained volume throughout the 2024-2025 season. This area is influenced by the Mispillion River jetty to the north, which partially shelters the coastline and traps sand as it moves northward with the longshore current.

Conversely, the southern end of Slaughter Beach (SLB-5) is prone to erosion as volume losses are measured continuously from Summer 2023 through Winter

2025. Since the upland terrain is greater in elevation, the dune scarp is steeper and more vulnerable to collapse (Figure 12B). The central part of the community (SLB-3, SLB-4), however, experiences both erosion and accretion and serves as a transition area where the upper terrain begins to gain elevation and steepness.

Table 10: Beach volume calculations for Slaughter Beach

LRP		SLB-1		SLB-2		SLB-3	
Volume Limit		MHW	MLW	MHW	MLW	MHW	MLW
Season	Date	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf
Summer 2023	5/31/2023	120	277	313	625	275	719
Winter 2024	12/21/2023	130	295	341	670	282	734
Summer 2024	7/29/2024	138	312	350	684	282	724
Winter 2025	3/20/2025	154	328	354	694	271	703

Table 10 continued: Beach volume calculations

LRP		SLB-4		SLB-5	
Volume Limit		MHW	MLW	MHW	MLW
Season	Date	cf/lf	cf/lf	cf/lf	cf/lf
Summer 2023	5/31/2023	290	734	260	641
Winter 2024	12/21/2023	291	736	251	635
Summer 2024	7/29/2024	293	720	223	585
Winter 2025	3/20/2025	281	701	234	586

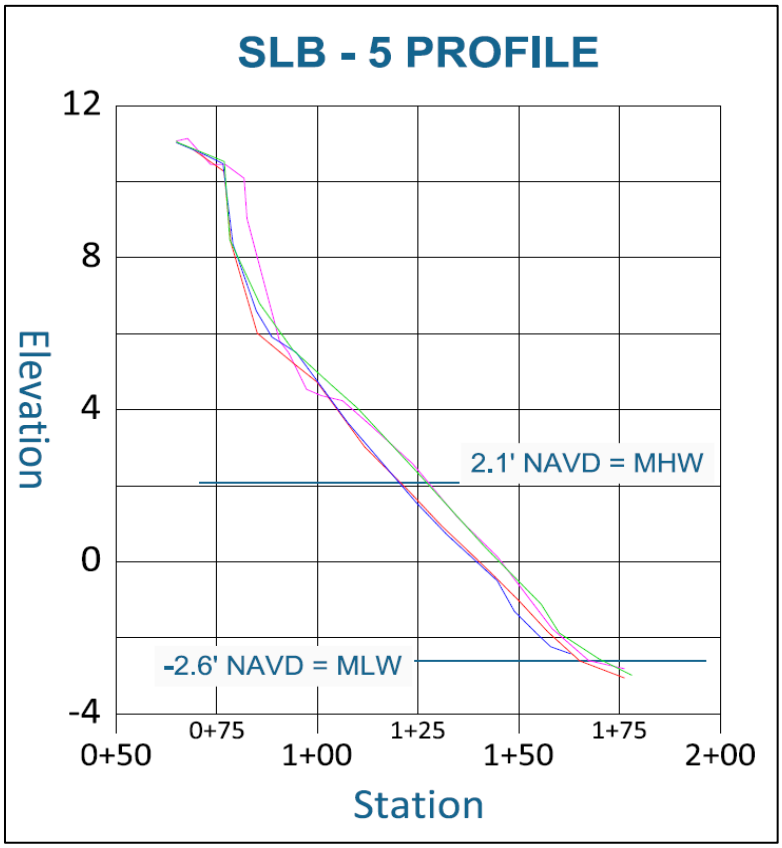


Figure 12B. Beach Profiles at Slaughter Beach, Station SLB-5
Pink: Summer '23, Green: Winter '24, Red: Summer '24, Blue: Winter '25

Figure 12C. Slaughter Beach (4/17/2024, 12:10) at low tide, looking north

Prime Hook Beach

Prime Hook (PH) Beach is a developed community bordered by the Prime Hook National Wildlife Refuge to the north and west. Prime Hook Beach contains three LRP survey lines and approximately 10,000 feet of shoreline (Figure 13A).

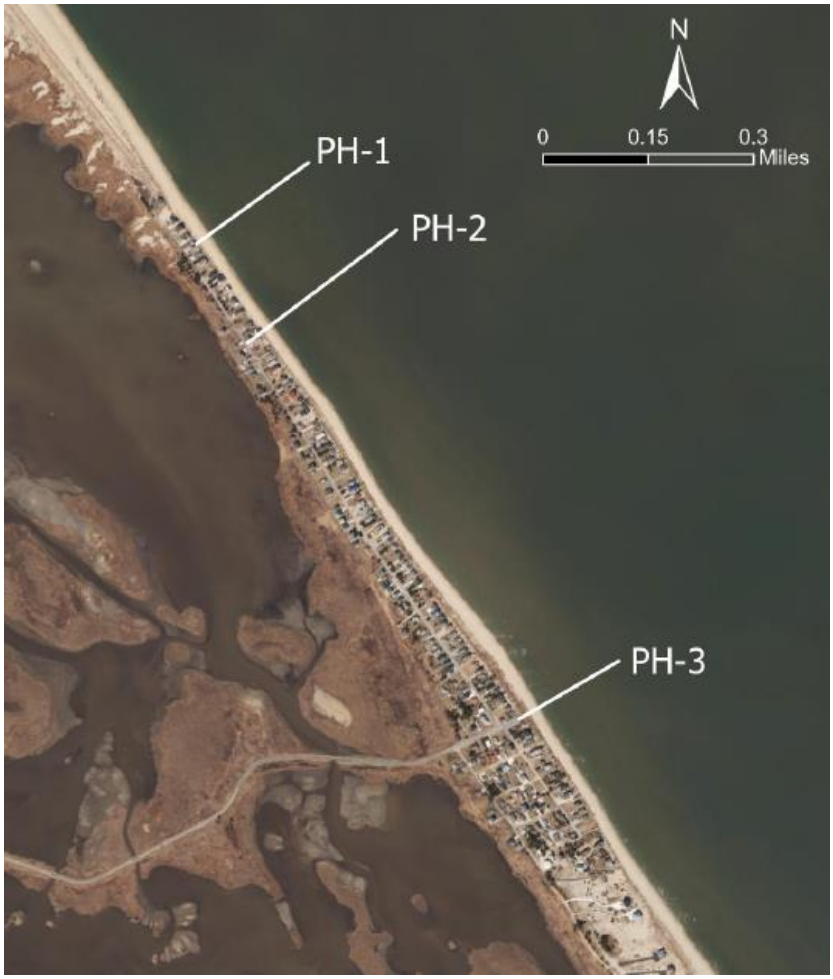


Figure 13A. LRP lines at Prime Hook Beach

The average beach volumes determined for Prime Hook Beach are shown in Table 11. Overall, this stretch of shoreline gained volume throughout the 2024-2025 season. Accretion is most abundant at LRP line PH-3, near Prime Hook Beach Road, where the nearshore profile accumulated approximately 16 feet between Summer 2023 and Winter 2024, despite impacts from the 2023 storms, including TS Ophelia (Figure 13B). While the reason for accretion is unknown, it is possible that previously eroded material was transported northward with the longshore current and deposited on Prime Hook Beach.

Table 11: Beach volume calculations for Prime Hook Beach							
LRP		**PH-1**		**PH-2**		**PH-3**	
Volume Limit		MHW	MLW	MHW	MLW	MHW	MLW
Season	Date	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf
Summer 2023	5/31/2023	308	744	245	597	137	367
Winter 2024	12/21/2023	343	802	244	600	159	443
Summer 2024	7/29/2024	352	812	247	602	212	488
Winter 2025	3/20/2025	357	831	266	635	211	490

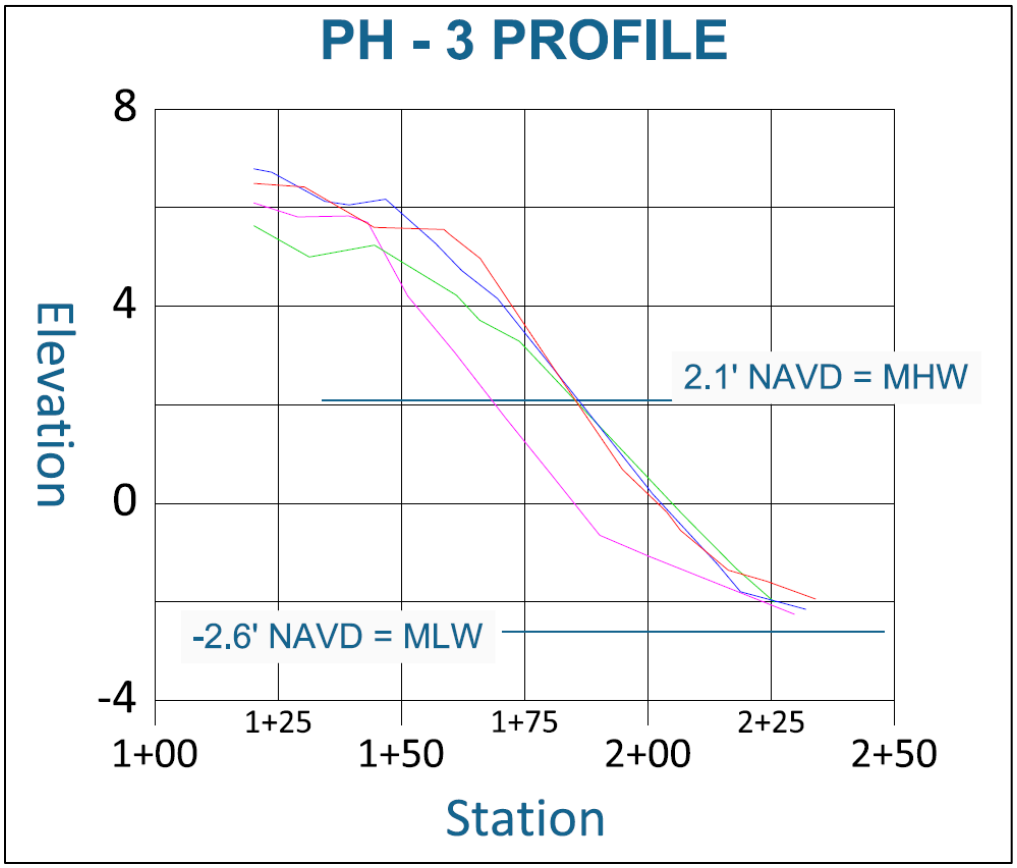


Figure 13B. Beach Profiles at Prime Hook Beach, Station PH-3
Pink: Summer '23, Green: Winter '24, Red: Summer '24, Blue: Winter '25

Broadkill Beach

Broadkill Beach (BKB) is bound by Prime Hook Beach to the north and Lewes Beach to the south. This area includes nine LRP lines within 18,000 feet or 3.4 miles of shoreline (Figure 14A). Changes to the northern end of the community were captured by LRP line BKB-1. The more densely developed section includes LRP lines BKB-2 to BKB-6, which are spaced approximately 1,500 feet apart, and the remaining three LRP lines (BKB-7 to BKB-9) at the southern end of the community are spaced about 2,000 feet apart. Broadkill Beach was previously nourished in 2016 by the USACE when 1.7 million cy of dredged material from the Delaware River Main Channel was placed to create a 150-foot berm and dune with a crest of 15-16 feet. Subsequent storm events, however, have greatly impacted the morphology of the shoreline.

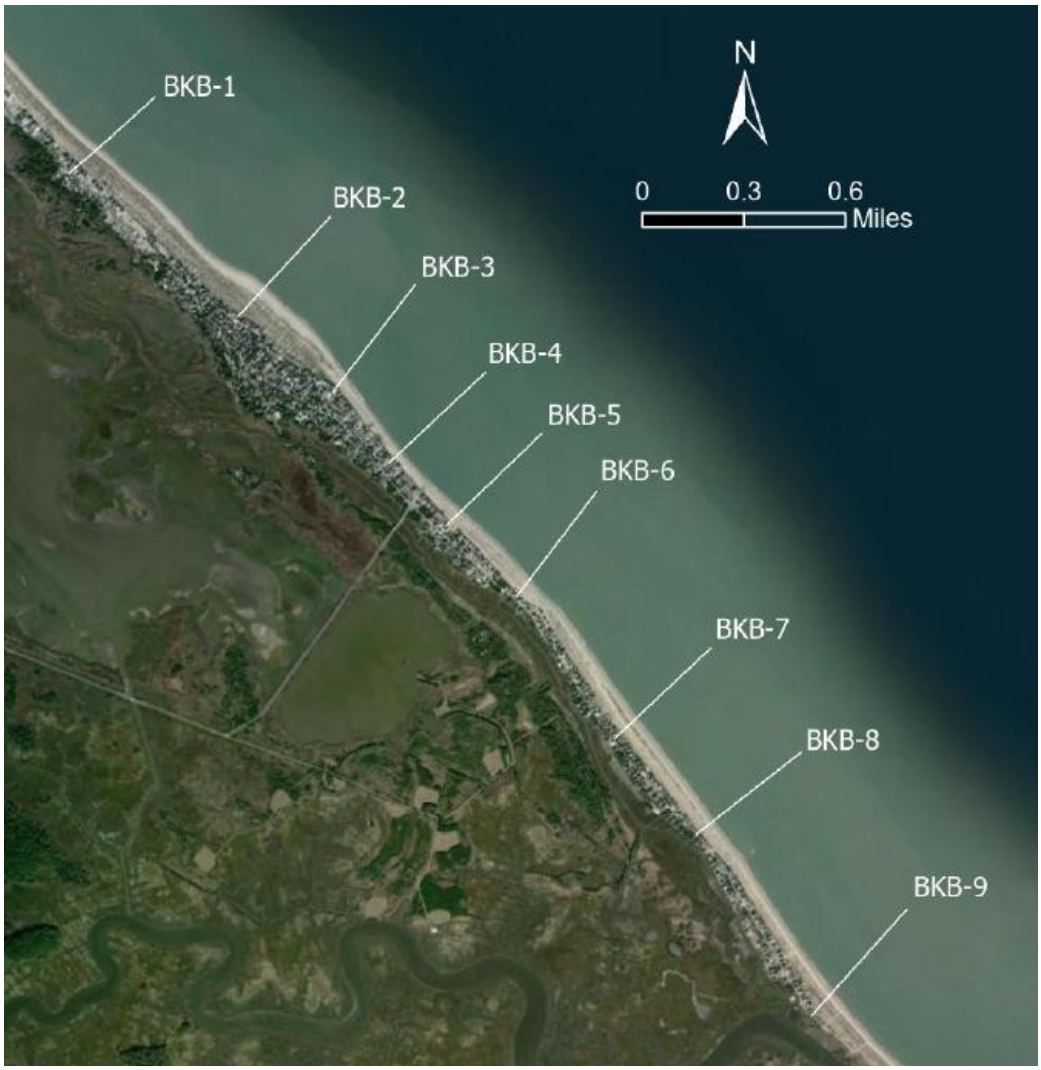


Figure 14A. LRP lines at Broadkill Beach

The average beach volumes determined for Broadkill Beach are shown in Table 12. Survey data show the central Broadkill Beach community is eroding while the northern and southern ends are accreting. This is due to the orientation of the constructed dune relative to the natural shoreline. In the center of Broadkill Beach, LRP lines BKB-3 through BKB-7 continuously lost volume throughout the 2024-2025 season. Erosion is most severe near the Route 16 beach access, between LRP lines BKB-4 and BKB-5. Figure 14B demonstrates erosion of the dune and nearshore profiles at BKB-4, where the upper beach is severely scarped in Winter 2024 following the impacts of the 2023 storms. In addition, the nearshore profile eroded approximately 30 feet from Summer 2023 through Winter 2025. Comparatively, BKB-5 is greater in elevation and thus the dune scarp is steeper and more susceptible to collapse, hence the near total loss of dune in this area (Figure 14C).

Conversely, surveys of the northern section of Broadkill Beach (BKB-1, BKB-2) measure accretion each season. At the southern end, LRP lines BKB-8 and BKB-9 demonstrate the expected seasonal pattern of erosion during winter followed by summer accretion. LRP line BKB-8, however, did not fully recover the volume lost during winter like BKB-9. Comparison of the annual summer and winter beach change volumes at BKB-9 suggest this area is naturally accreting overtime.

Table 12: Beach volume calculations for Broadkill Beach

LRP		BKB-1		BKB-2		BKB-3		BKB-4		BKB-5	
Volume Limit		MHW	MLW	MHW	MLW	MHW	MLW	MHW	MLW	MHW	MLW
Season	Date	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf
Summer 2023	5/31/23	216	528	1305	2490	467	814	652	1069	896	1404
Winter 2024	12/21/23	193	538	1369	2636	437	814	508	901	797	1301
Summer 2024	7/29/24	292	652	1303	2658	442	778	478	825	768	1220
Winter 2025	3/20/25	N/A	N/A	1576	2942	420	733	427	748	722	1135

Table 12 continued: Beach volume calculations for Broadkill Beach									
LRP		**BKB-6**		**BKB-7**		**BKB-8**		**BKB-9**	
Volume Limit		MHW	MLW	MHW	MLW	MHW	MLW	MHW	MLW
Season	Date	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf
Summer 2023	5/31/2023	709	1122	702	1443	923	1410	592	1133
Winter 2024	12/21/2023	601	1018	666	1404	893	1383	576	1126
Summer 2024	7/29/2024	602	971	676	1392	928	1392	647	1189
Winter 2025	3/20/2025	513	845	681	1366	914	1359	640	1168

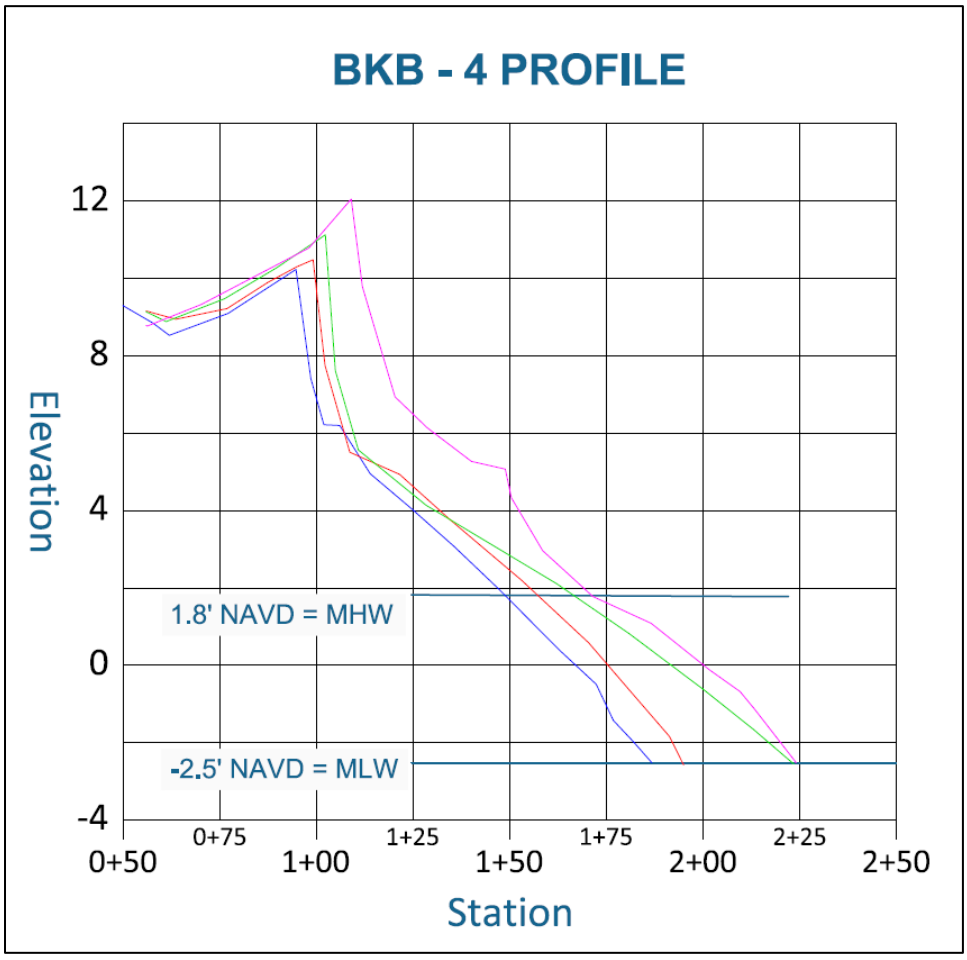


Figure 14B. Beach Profiles at Broadkill Beach, Station BKB-4
Pink: Summer '23, Green: Winter '24, Red: Summer '24, Blue: Winter '25

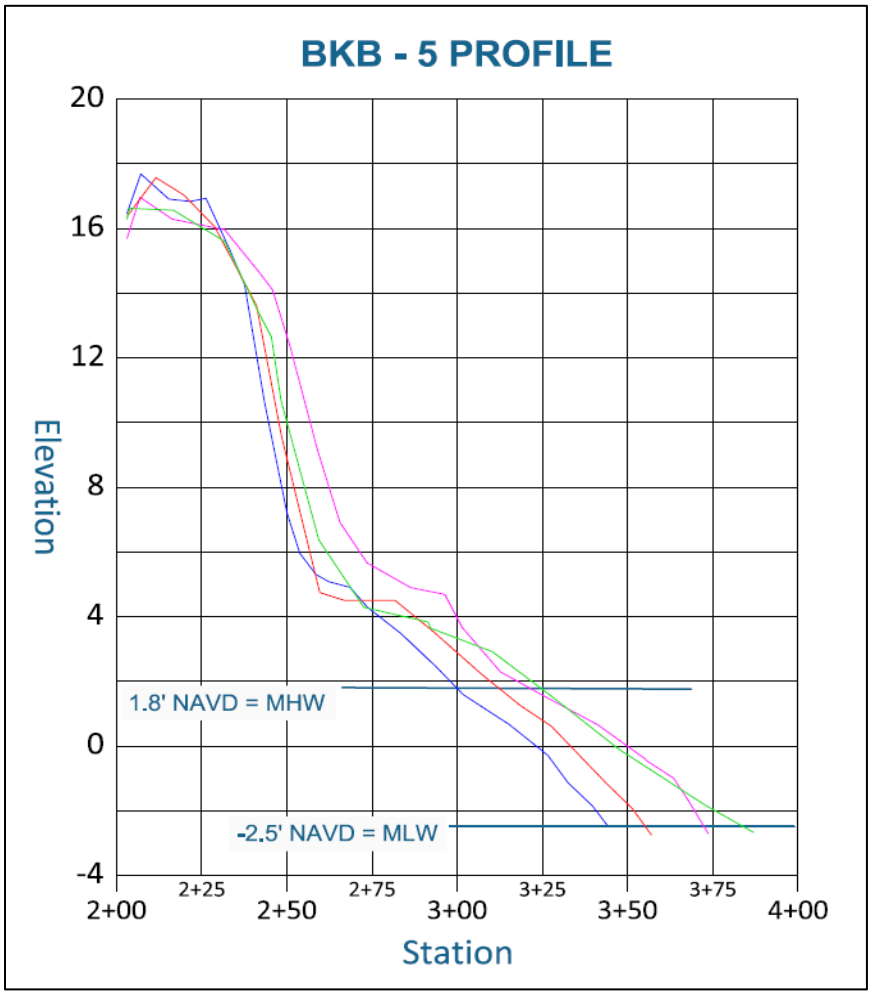


Figure 14C. Beach Profiles at Broadkill Beach, Station BKB-5
Pink: Summer '23, Green: Winter '24, Red: Summer '24, Blue: Winter '25

In January 2026, construction of the 'Broadkill Beach Dune Realignment Project' began to temporarily realign a one-mile section of dune that would correspond with the current shoreline orientation. The project entails shifting the existing dune landward, redistributing sand to reconstruct the severely eroded central section, and removing existing scarping at beach access points.

Figure 14D shows an aerial view of Broadkill Beach. Severe scarping near the Route 16 crossover is visible in the foreground.

Figure 14D. Broadkill Beach (10/9/2024, 8:56) approaching high tide, looking south

Lewes Beach

Lewes Beach (LB) extends from Roosevelt Inlet to Cape Henlopen State Park and accounts for approximately 15,500 ft or 3.4 miles of coastline. As of this report, Lewes Beach includes a densely developed public coastline, the Cape Shores Community and nine LRP lines (Figure 15A). Survey lines are spaced relatively evenly, except for LB-1 and LB-2. For planning purposes, DNREC has divided Lewes Beach into four segments: proximal to the Roosevelt Inlet (LB-1 and LB-2); center of the developed shoreline (LB-3 and LB-4); center of the shoreline to the Cape May-Lewes Ferry Terminal (LB-5 and LB-6); and Cape Shores (LB-7 to LB-9). The Cape Shores segment was previously considered a separate beach community and formerly designated as LRP lines CS-1 to C-3.

Figure 15A. LRP lines at Lewes Beach

The average beach volumes determined for Lewes Beach are shown in Table 13. In December 2023, the USACE completed a beach nourishment project that delivered nearly 105,000 cy of dredged material to the shoreline near Iowa and Missouri Avenues, which is proximal to Roosevelt Inlet (LB-1 and LB-2). While data is not available for Winter 2024, large volume gains are measured in Summer 2024. Figure 15B demonstrates the nourished profile at LB-1, which

subsequently eroded approximately 58 feet during Winter 2025. The western end of Lewes Beach generally suffers the most damage from storms and tends to be erosional.

Following the USACE project, SWMS continued nourishment of Lewes Beach eastward to New York Avenue through February 2024, adding 1,400 cy of material. This volume gain is captured in the Summer 2024 survey of LRP line LB-3, which continued to accrete through Winter 2025. However, beach nourishment did not go beyond LRP line LB-3 as LB-4 continuously lost volume throughout the 2024-2025 season. The nearshore profile eroded about 27 feet from Summer 2024 to Winter 2025 at LB-4.

Areas of accretion and erosion are variable along the eastern half of Lewes Beach. From the center of the community to the Cape May-Lewes Ferry Terminal (LB-5 and LB-6) accretion is measured throughout the 2024-2025 season. This area is influenced by the eastern jetty that traps sand as it moves northward with the longshore current. In the Cape Shores segment of Lewes Beach, LRP lines LB-7 and LB-8 are eroding over time as volume loss was measured by comparing annual summer and winter surveys. Conversely, LRP line LB-9 is accreting. Figure 16C demonstrates the volume increase measured at LB-9 during summer and winter, and particularly in the upper beach profiles.

Table 13: Beach volume calculations for Lewes Beach

LRP		LB-1		LB-2		LB-3		LB-4		LB-5	
Volume Limit		MHW	MLW	MHW	MLW	MHW	MLW	MHW	MLW	MHW	MLW
Season	Date	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf
Summer 2023	5/31/23	316	748	352	696	574	944	584	996	984	1596
Winter 2024	12/21/23	N/A	N/A	N/A	N/A	553	934	565	965	1029	1610
Summer 2024	7/29/24	1551	2791	1653	2757	645	1130	558	958	1077	1654
Winter 2025	3/20/25	1332	2322	1568	2577	706	1229	484	812	1062	1680

Table 13 continued: Beach volume calculations for Lewes Beach									
LRP		**LB-6**		**LB-7**		**LB-8**		**LB-9**	
Volume Limit		MHW	MLW	MHW	MLW	MHW	MLW	MHW	MLW
Season	Date	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf	cf/lf
Summer 2023	5/31/2023	674	1290	382	695	350	674	199	594
Winter 2024	12/21/2023	675	1295	350	694	306	651	197	602
Summer 2024	7/29/2024	685	1307	339	646	310	620	252	633
Winter 2025	3/20/2025	728	1406	394	672	320	619	259	652

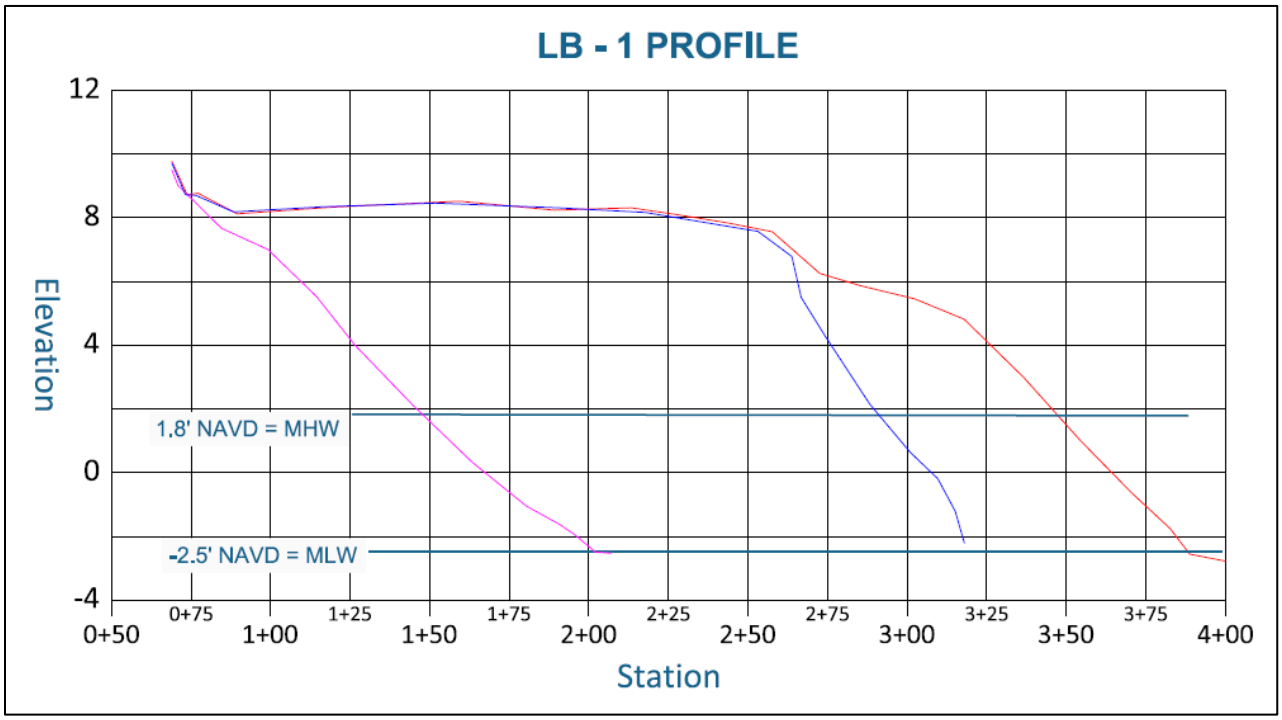


Figure 15B. Beach Profiles at Lewes Beach, Station LB-1
Pink: Summer '23, Red: Summer '24, Blue: Winter '25

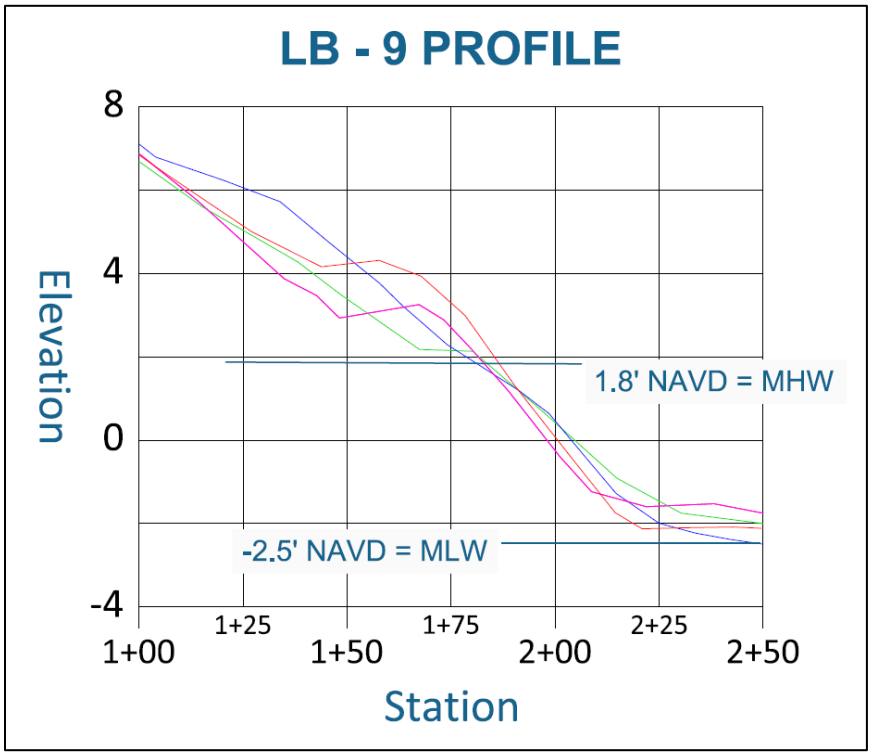


Figure 15C. Beach Profiles at Lewes Beach, Station LB-9
Pink: Summer '23, Green: Winter '24, Red: Summer '24, Blue: Winter '25

Figure 15D. Aerial view of Lewes Beach (1/8/24, 11:51) approaching low tide with 1.4-ft storm surge, looking west from center of the developed shoreline.

References

[1] Maurmeyer, E.M., 1978, Geomorphology and evolution of transgressive estuarine washover barriers along the western shore of Delaware Bay, University of Delaware, Unpublished Doctoral Dissertation.

[2] French, G.T., 1990, Historical shoreline changes in response to environmental conditions in West Delaware Bay, University of Maryland, Doctoral Dissertation, http://hdl.handle.net/1903/16876

[3] Ramsey, K.W., 2003, Geologic Map of the Lewes and Cape Henlopen Quadrangles, Delaware, Delaware Geological Survey, Geologic Map Series No. 12, https://www.dgs.udel.edu/sites/default/files/publications/geomap12.pdf

[4] NOAA National Centers for Environmental Information Storm Events Database. https://ncei.noaa.gov

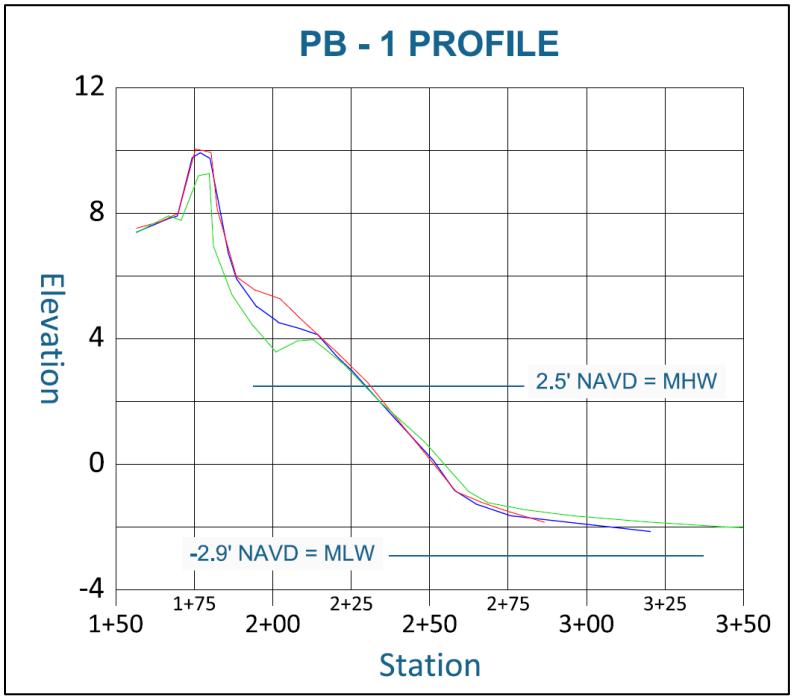
[5] NOAA National Weather Service Instruction 10-1605, Storm Data Preparation, 3/2016.

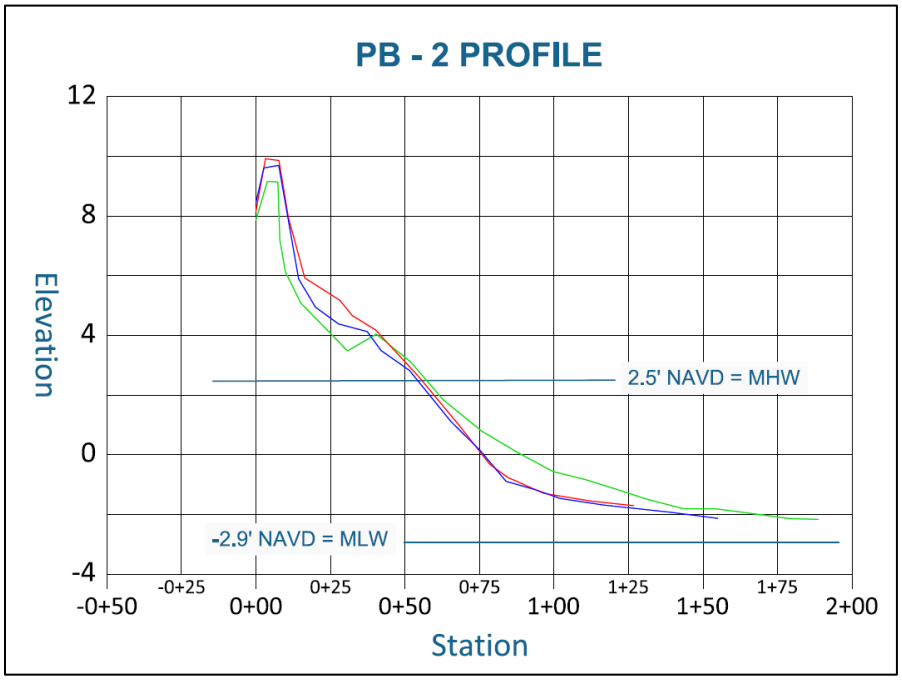
[6] NOAA National Ocean Service, Tides and Currents. https://tidesandcurrents.noaa.gov

[7] Harris, D.L., Vila-Concejo, A., Austin, T. and Benavente, J., 2020, Multi-scale morphodynamics of an estuarine beach adjacent to a flood-tide delta: Assessing decadal scale erosion, Estuar. Coast. Shelf Sci., 241, https://doi.org/10.1016/j.ecss.2020.106759.

Appendix 1: Bay Coast Beach Profiles

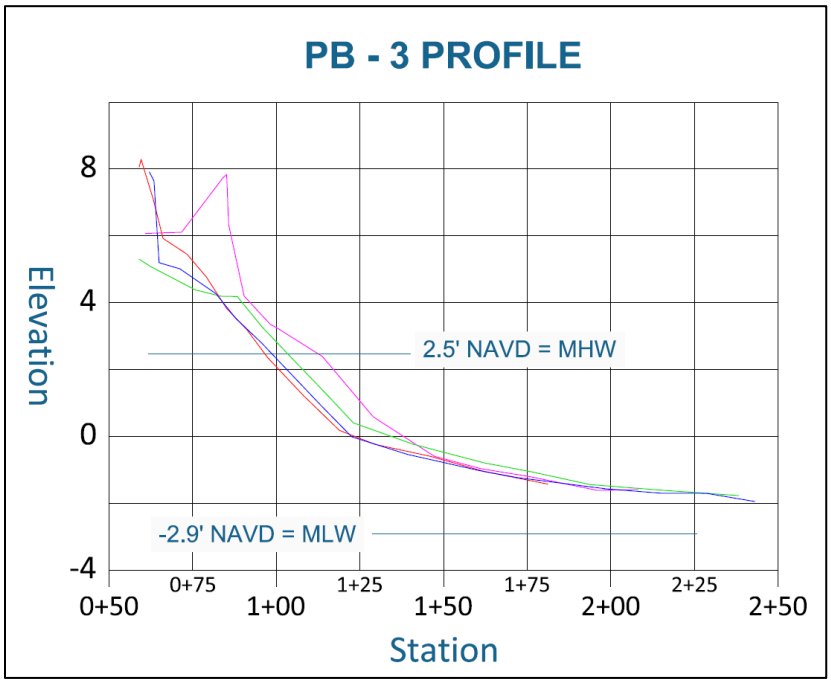
Pickering Beach



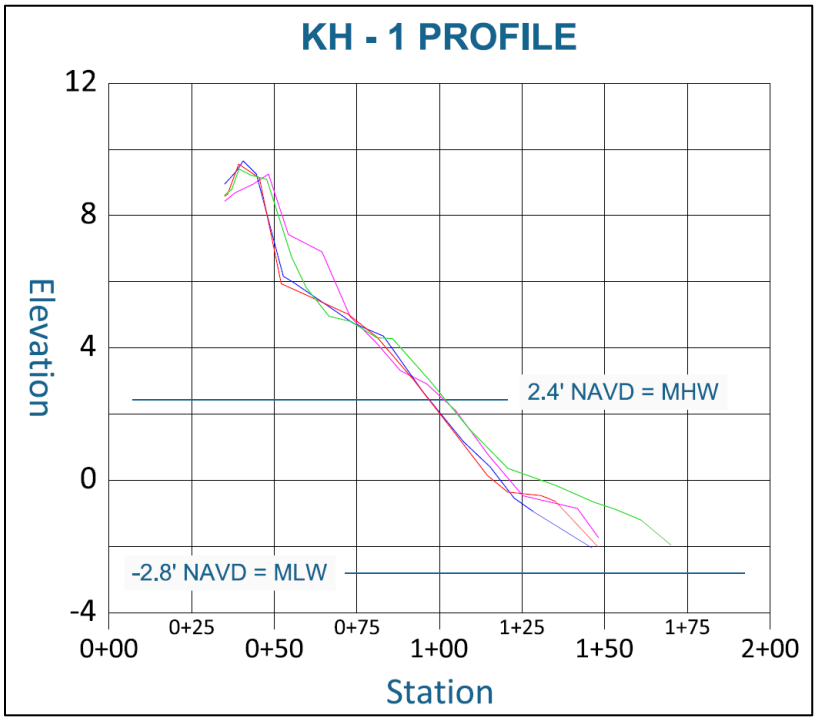


Pink: Summer 2023, Green: Winter 2024, Red: Summer 2024, Blue: Winter 2025

Pickering Beach (continued).

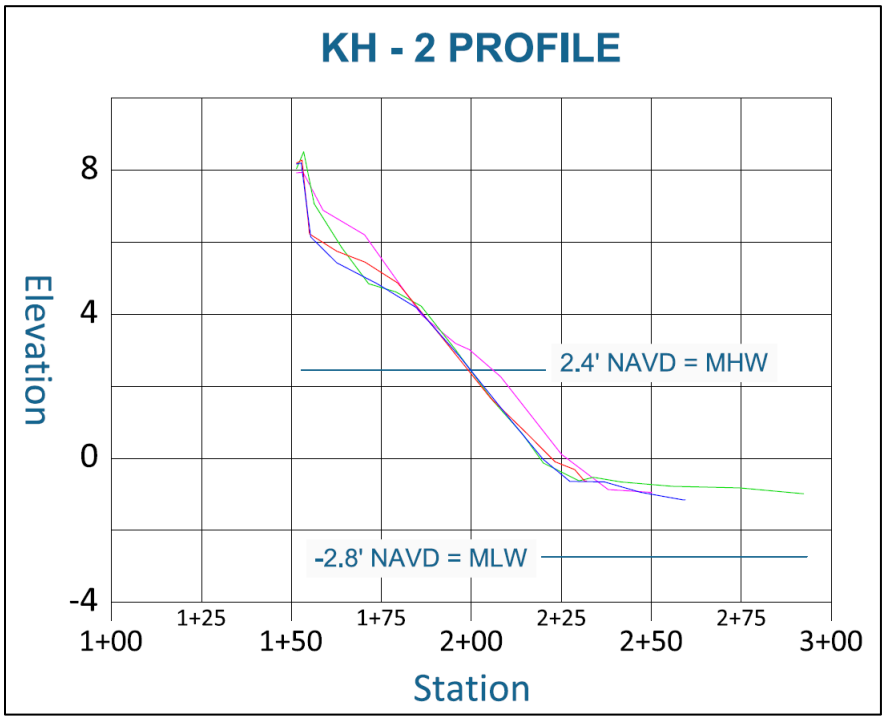


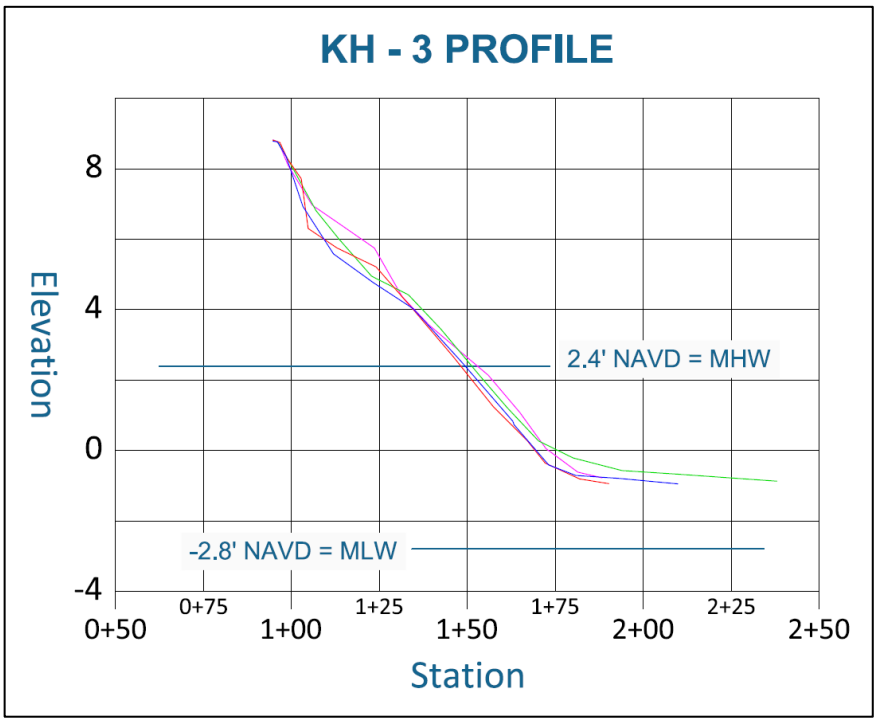
Kitts Hummock



Pink: Summer 2023, Green: Winter 2024, Red: Summer 2024, Blue: Winter 2025

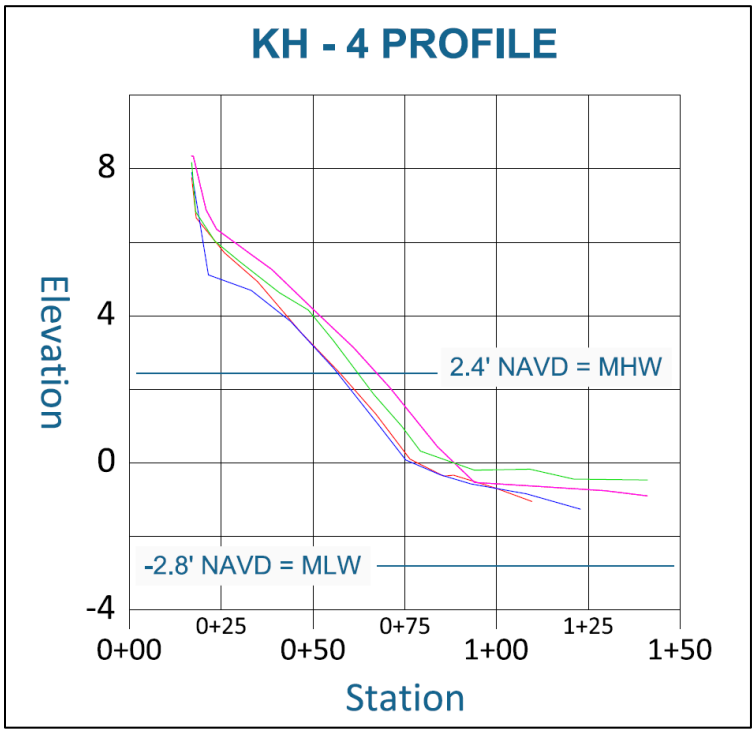
Kitts Hummock (continued).



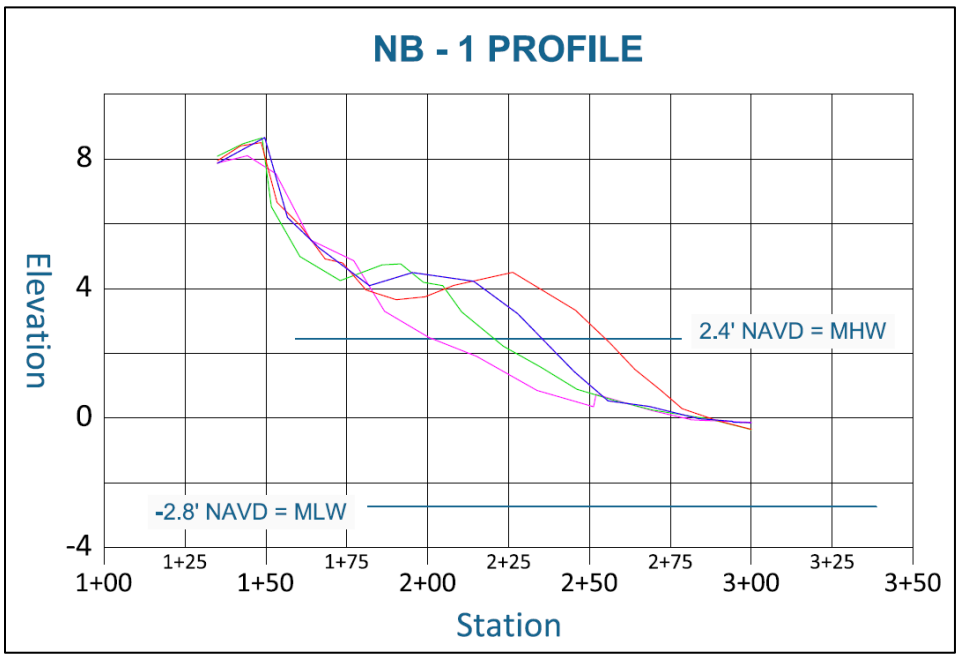


Pink: Summer 2023, Green: Winter 2024, Red: Summer 2024, Blue: Winter 2025

Kitts Hummock (continued).

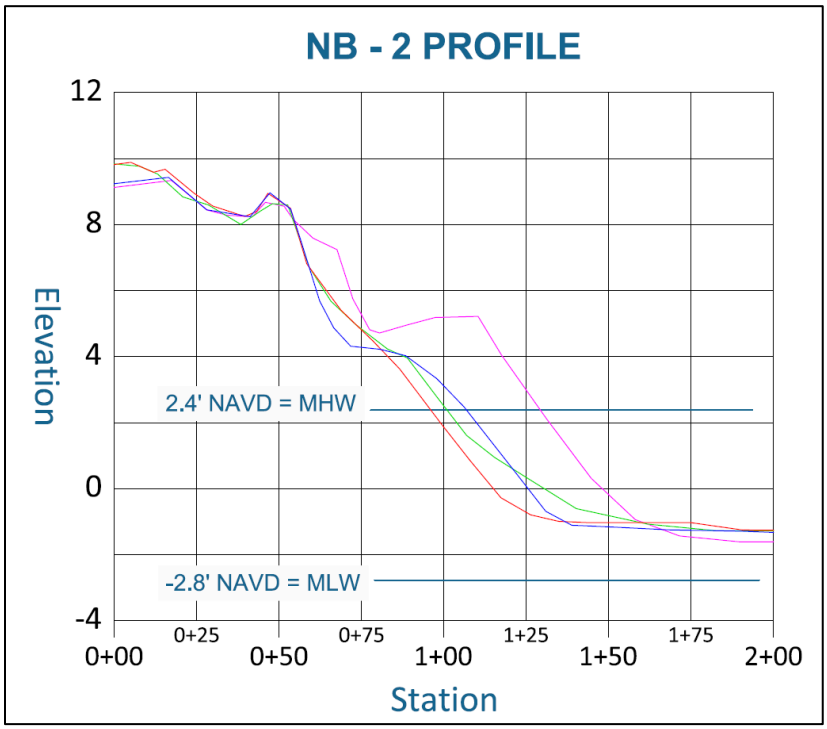


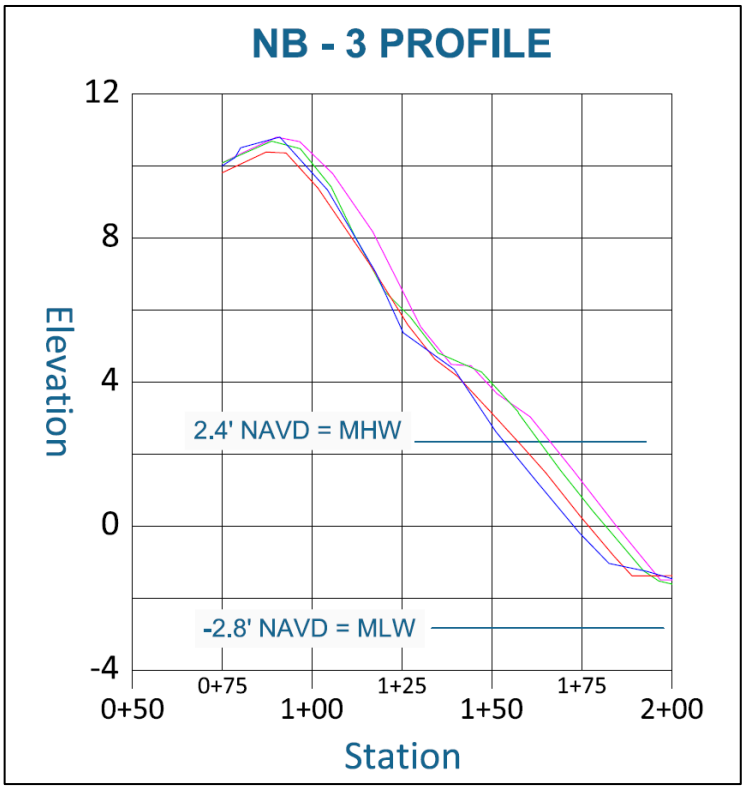
North Bowers Beach



Pink: Summer 2023, Green: Winter 2024, Red: Summer 2024, Blue: Winter 2025

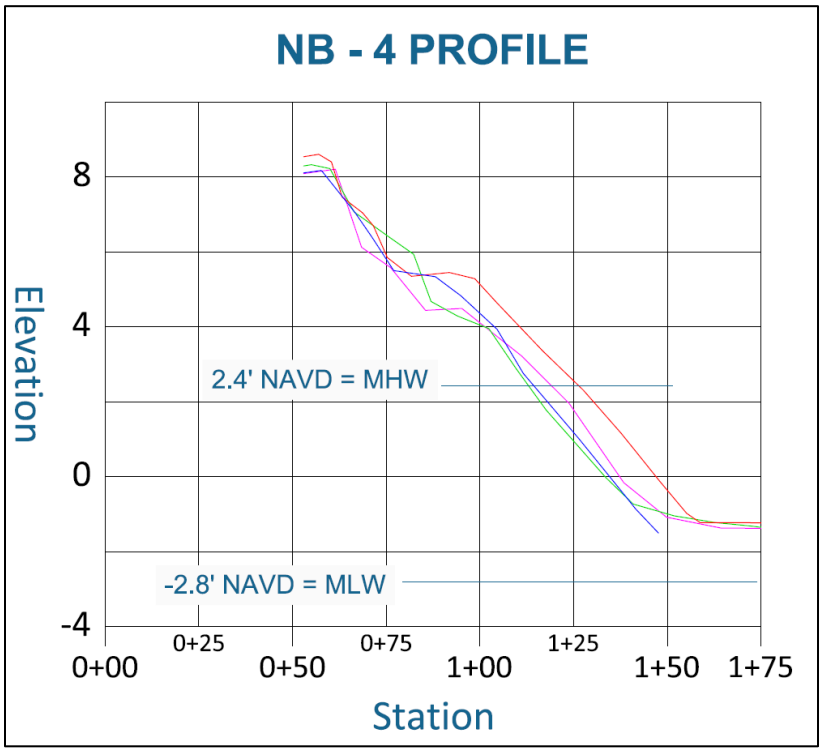
North Bowers Beach (continued).



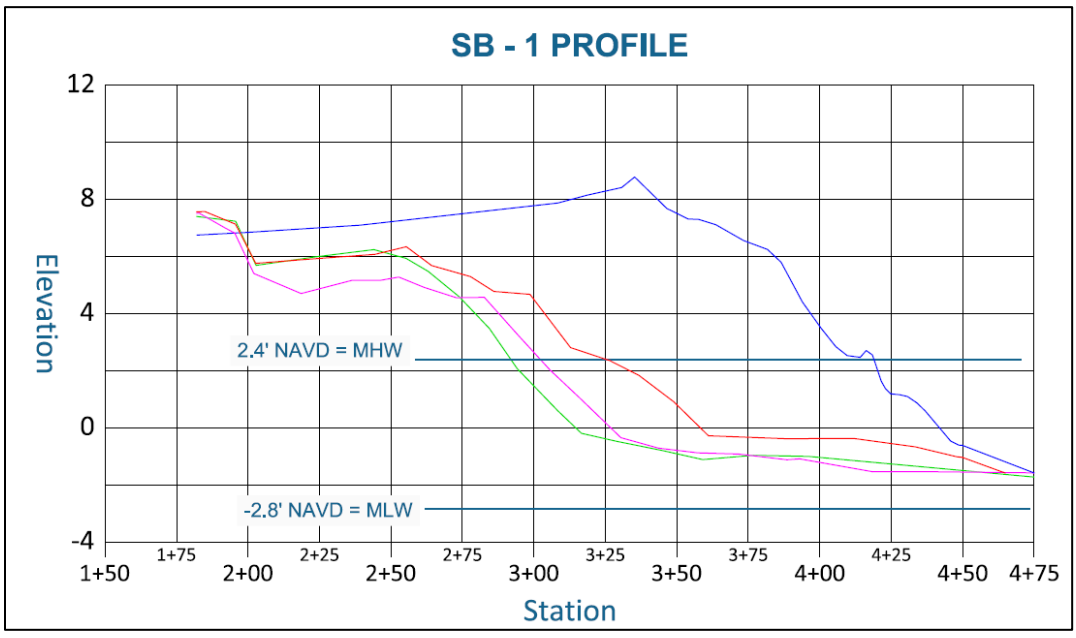


Pink: Summer 2023, Green: Winter 2024, Red: Summer 2024, Blue: Winter 2025

North Bowers Beach (continued).

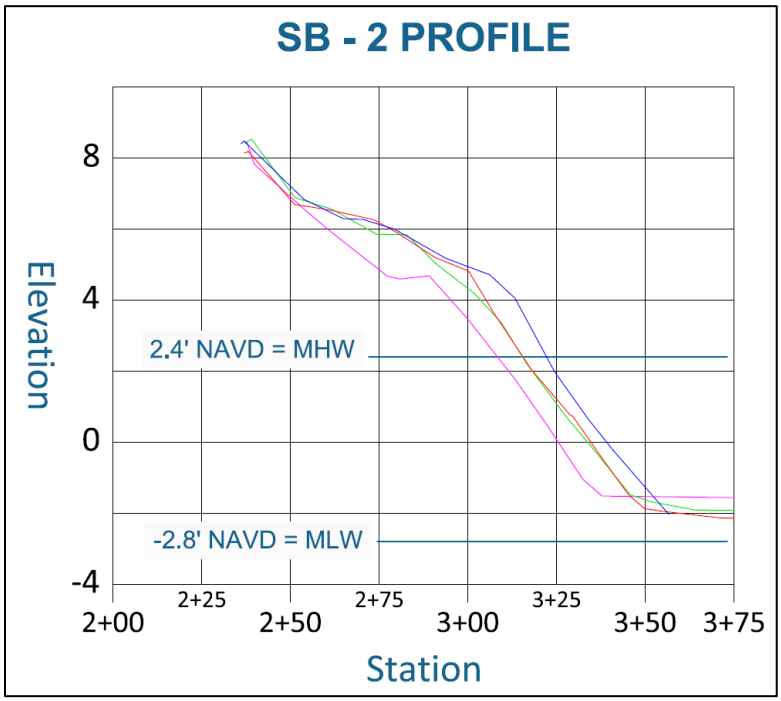


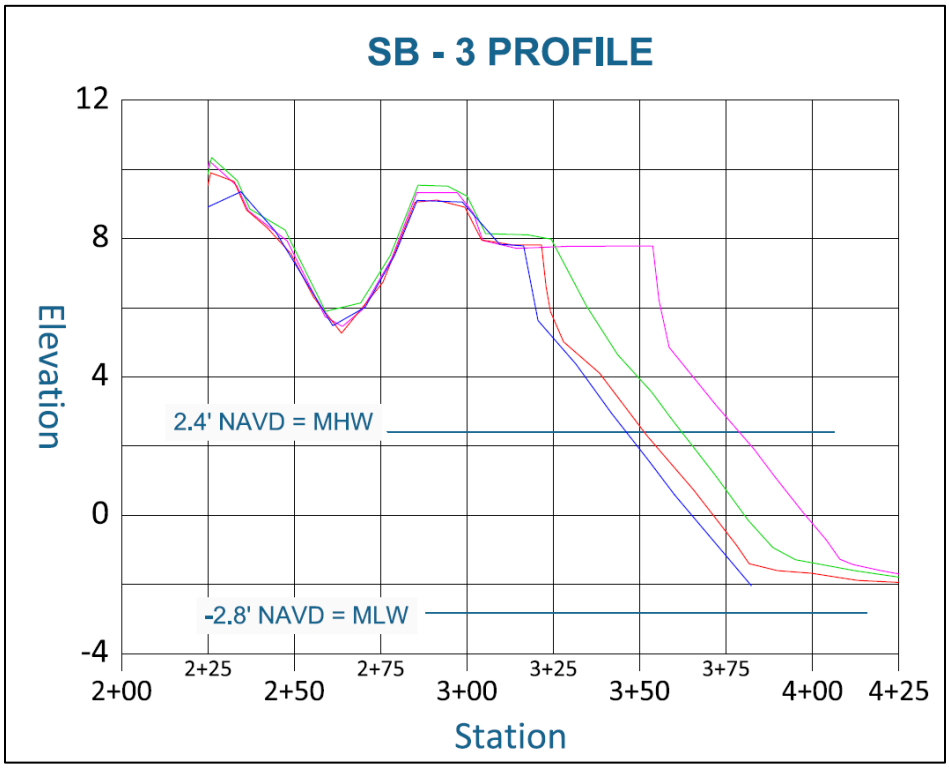
South Bowers Beach



Pink: Summer 2023, Green: Winter 2024, Red: Summer 2024, Blue: Winter 2025

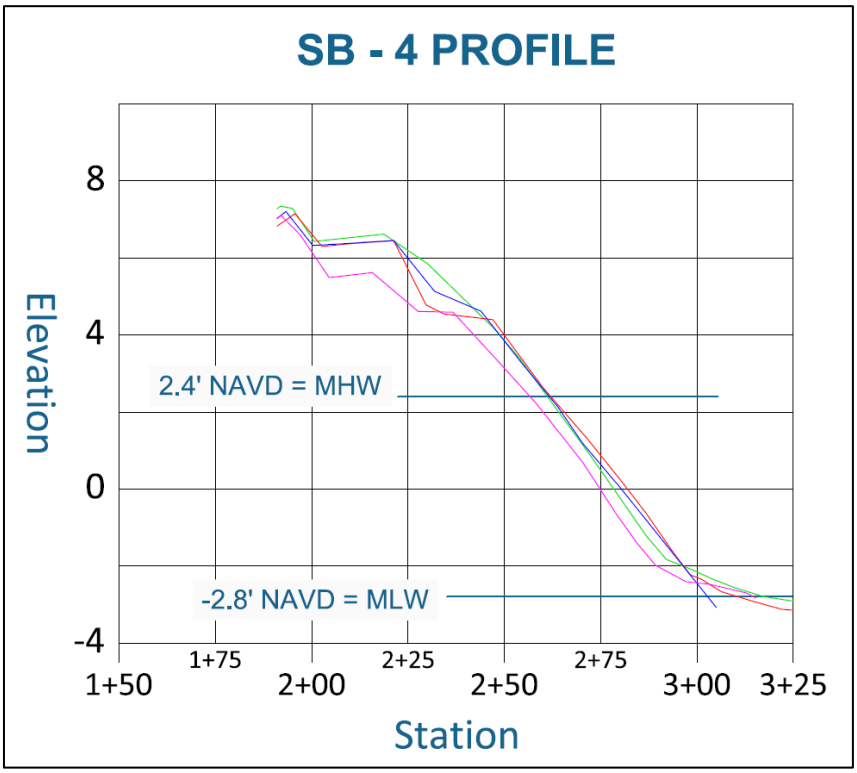
South Bowers Beach (continued).



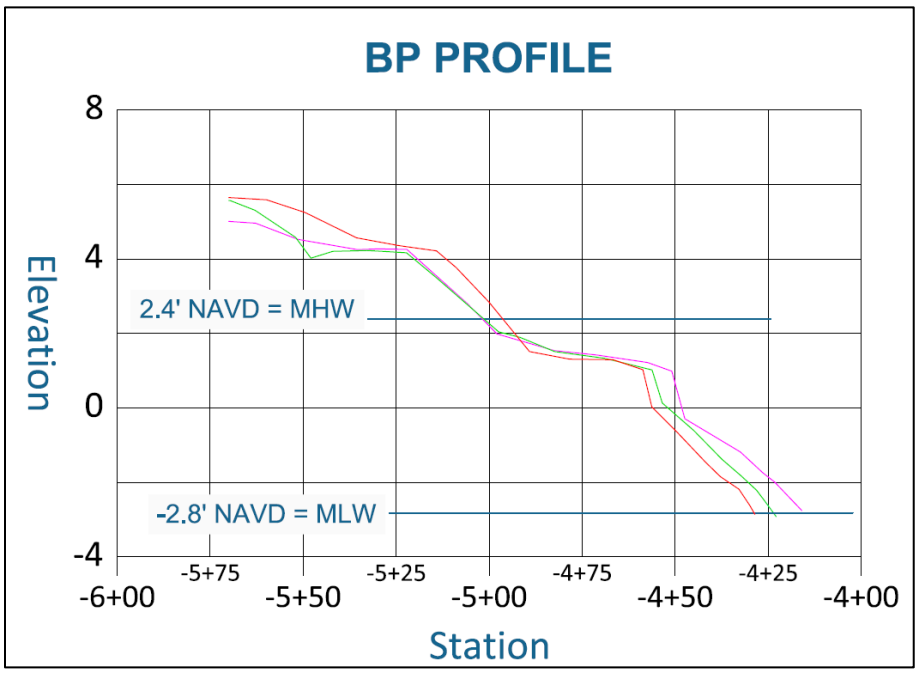


Pink: Summer 2023, Green: Winter 2024, Red: Summer 2024, Blue: Winter 2025

South Bowers Beach (continued).

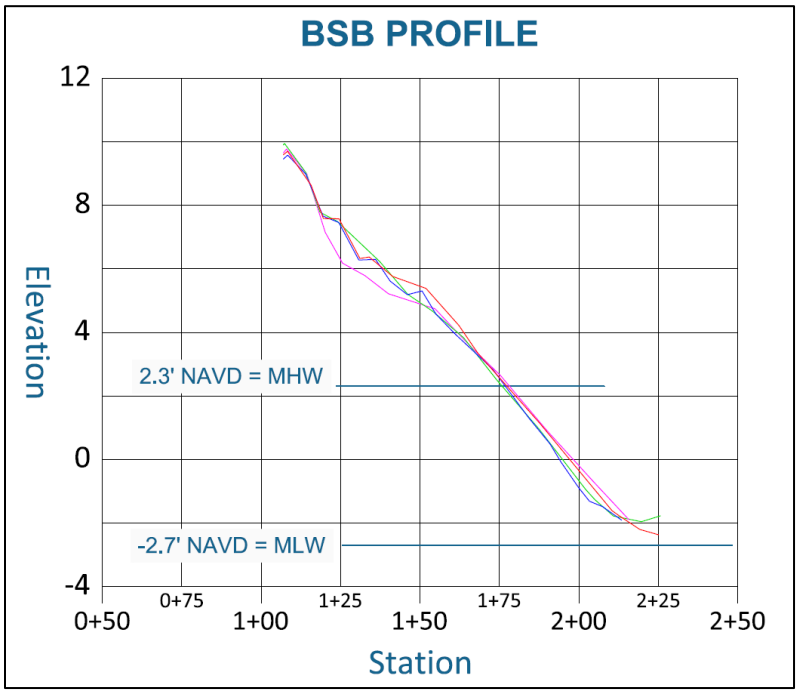


Bennett's Pier

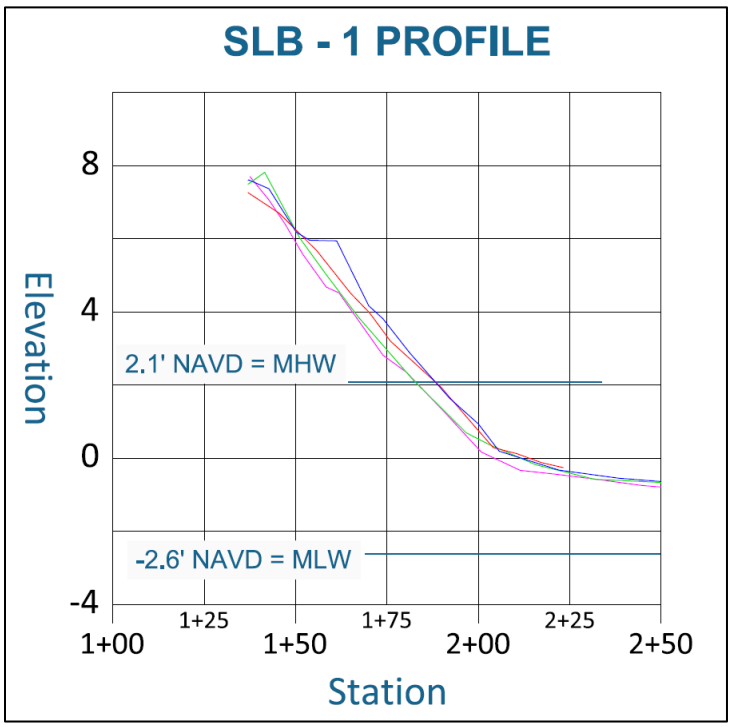


Pink: Summer 2023, Green: Winter 2024, Red: Summer 2024, Blue: Winter 2025

Big Stone Beach

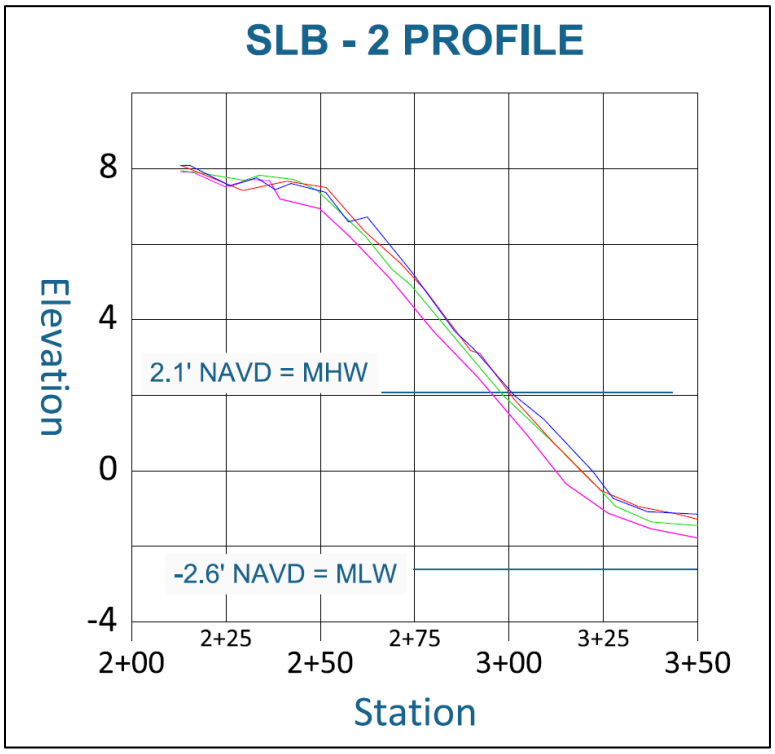


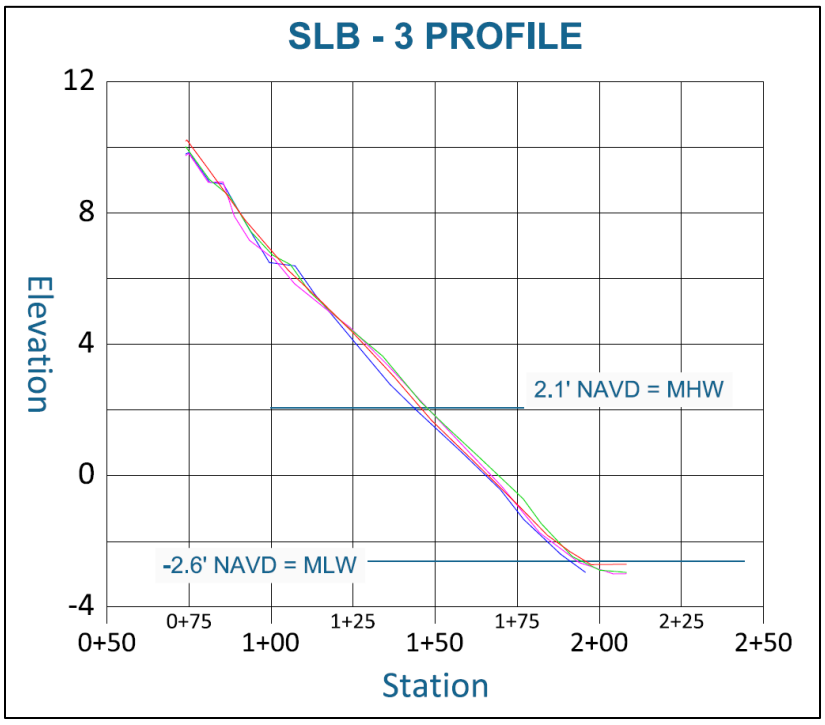
Slaughter Beach



Pink: Summer 2023, Green: Winter 2024, Red: Summer 2024, Blue: Winter 2025

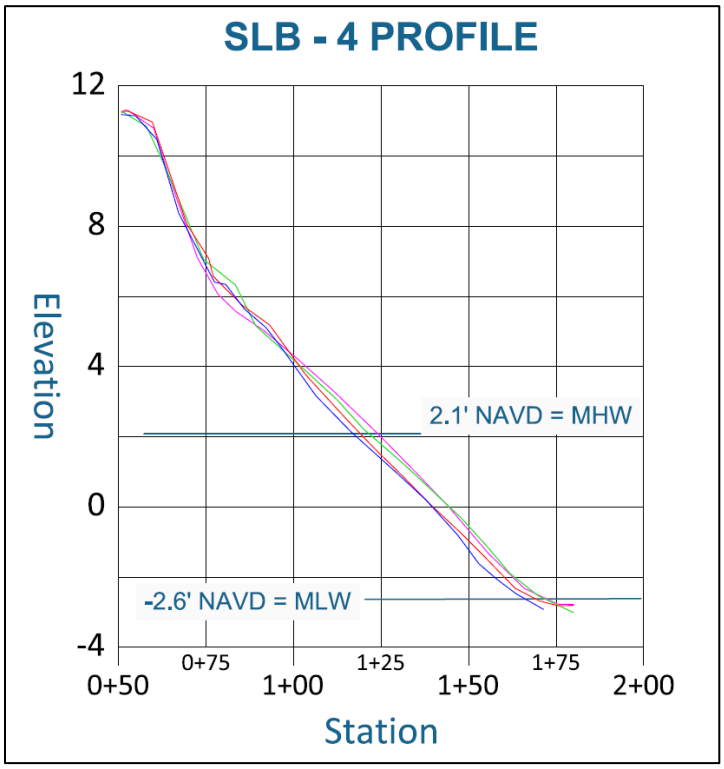
Slaughter Beach (continued).

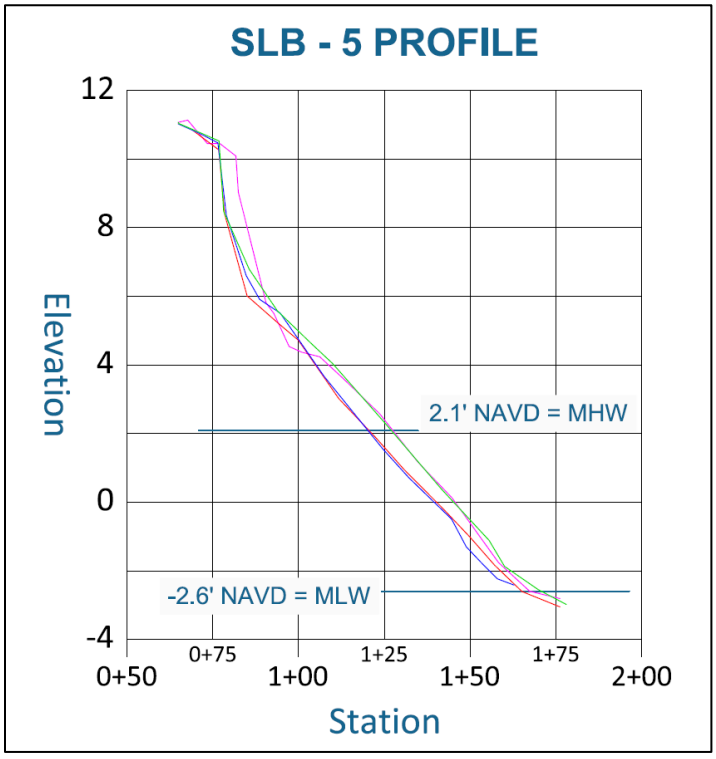




Pink: Summer 2023, Green: Winter 2024, Red: Summer 2024, Blue: Winter 2025

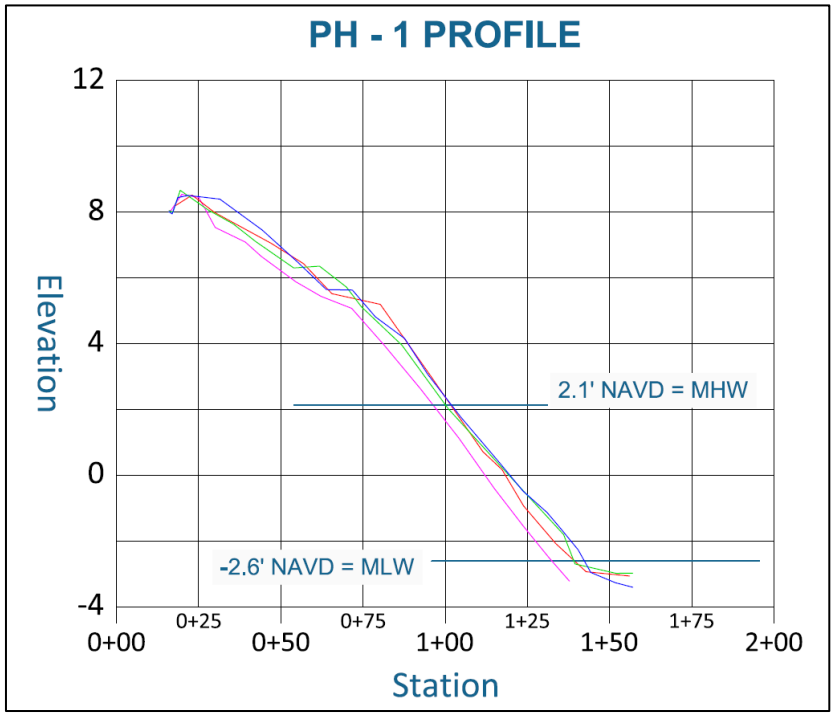
Slaughter Beach (continued).

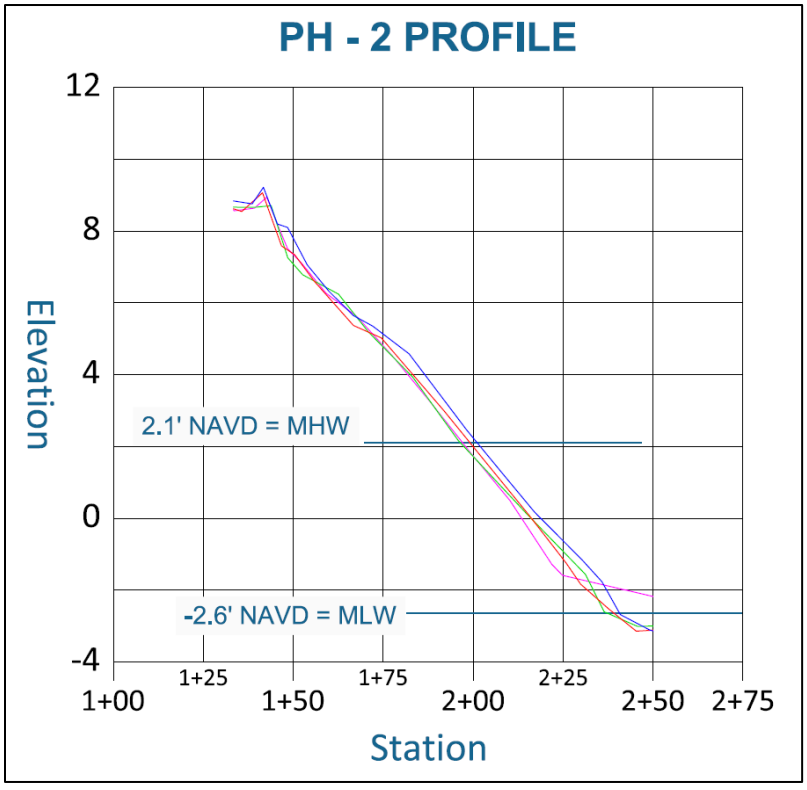




Pink: Summer 2023, Green: Winter 2024, Red: Summer 2024, Blue: Winter 2025

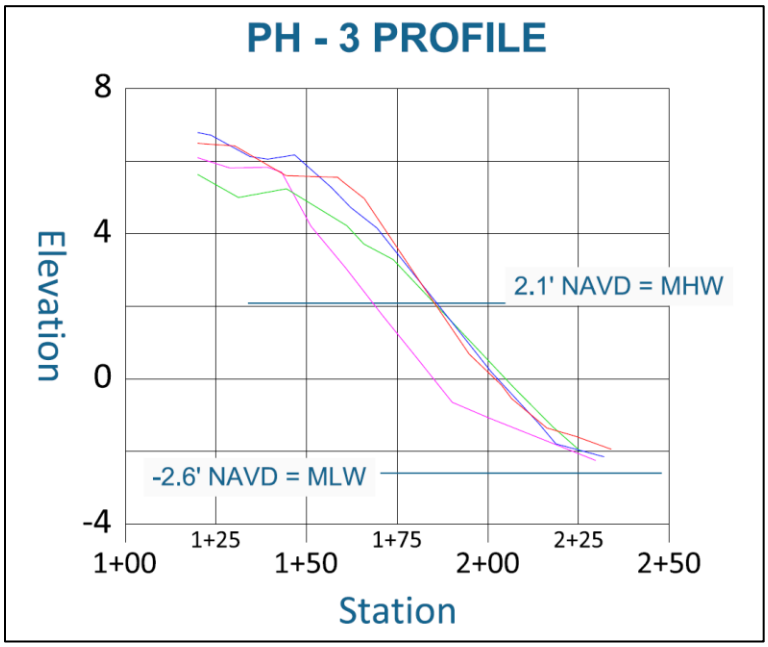
Prime Hook Beach



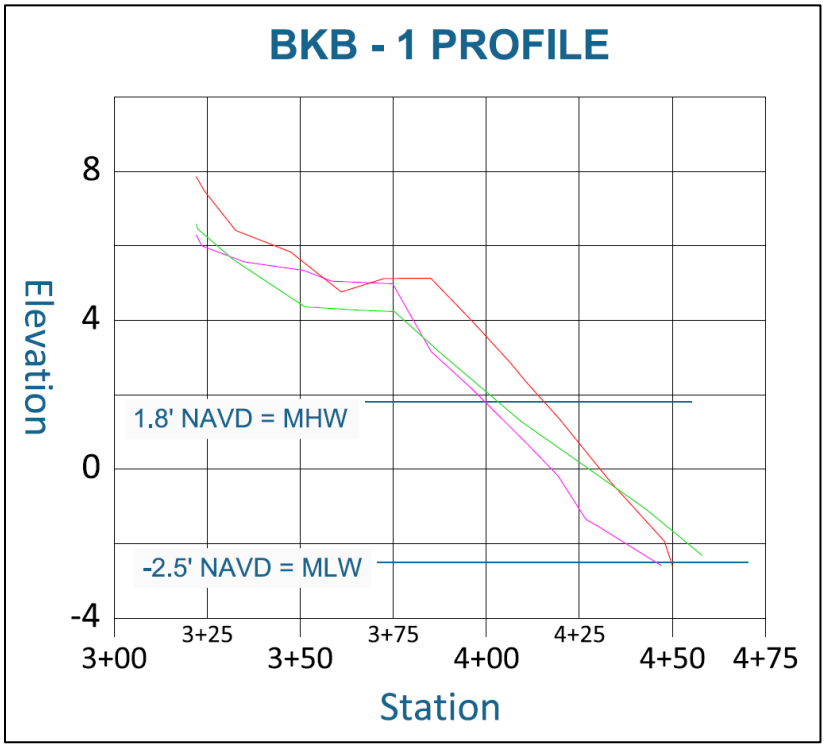


Pink: Summer 2023, Green: Winter 2024, Red: Summer 2024, Blue: Winter 2025

Prime Hook Beach (continued).

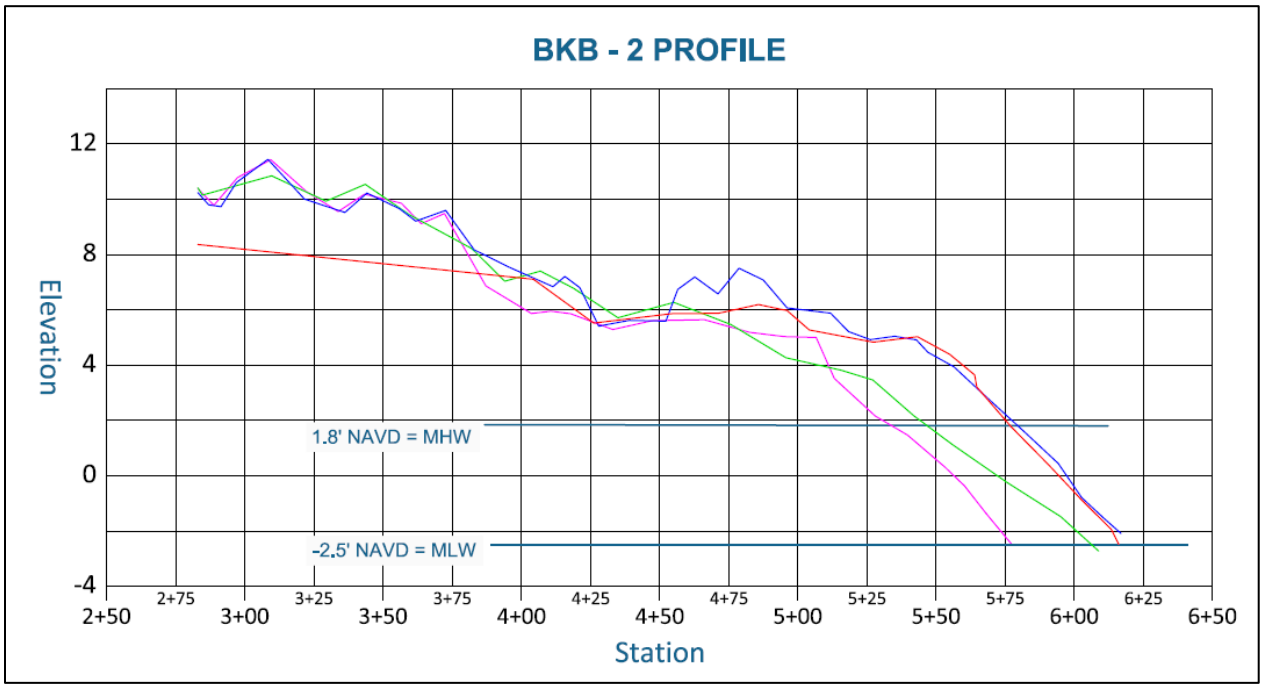


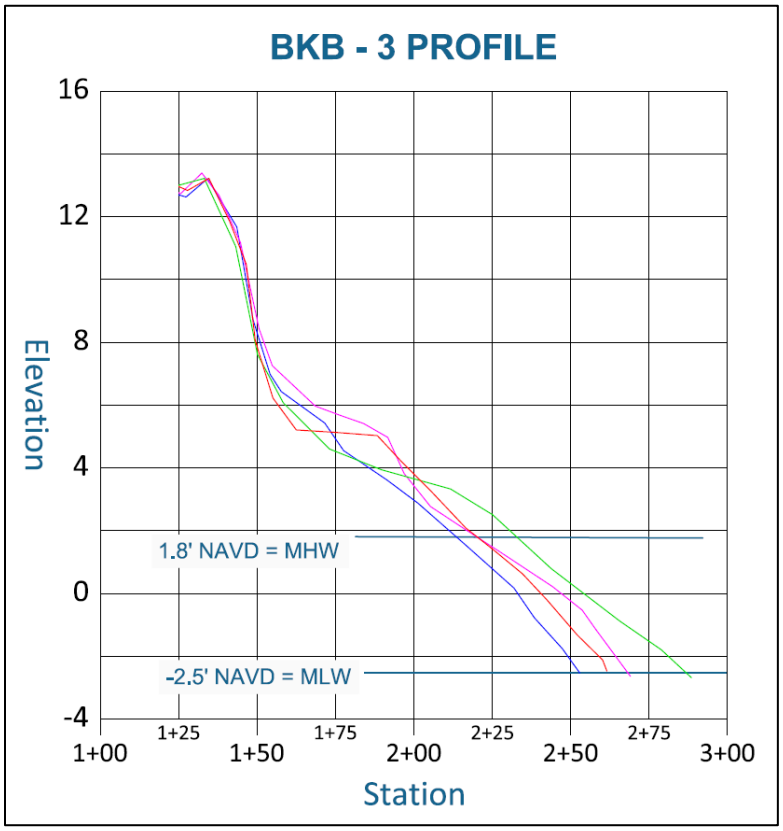
Broadkill Beach



Pink: Summer 2023, Green: Winter 2024, Red: Summer 2024, Blue: Winter 2025

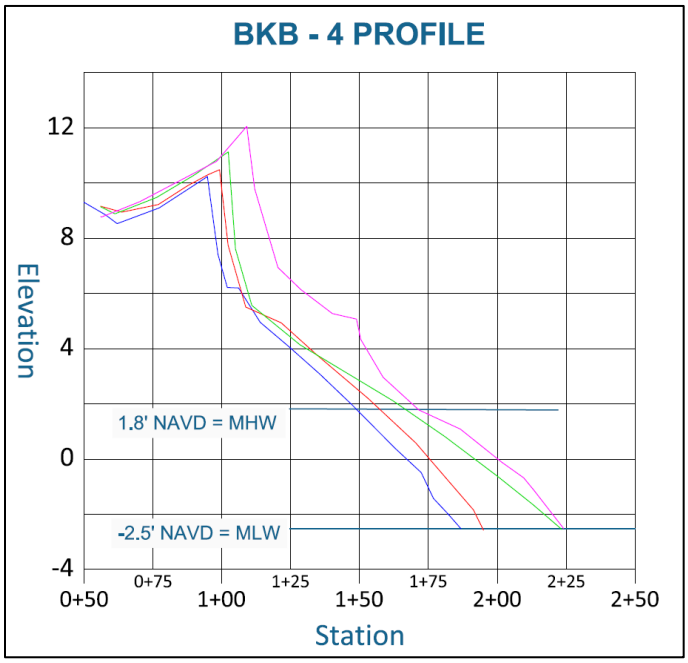
Broadkill Beach (continued).

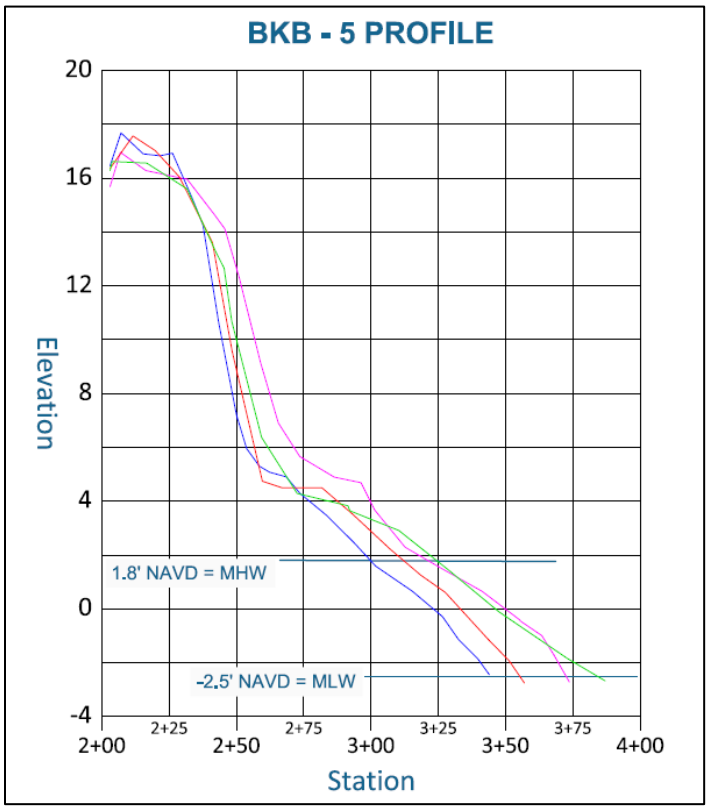




Pink: Summer 2023, Green: Winter 2024, Red: Summer 2024, Blue: Winter 2025

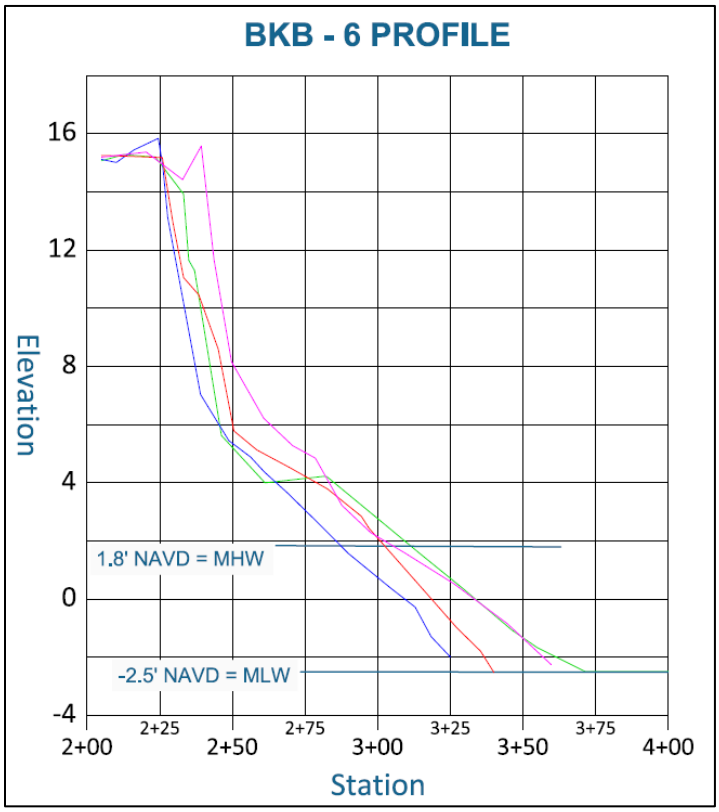
Broadkill Beach (continued).

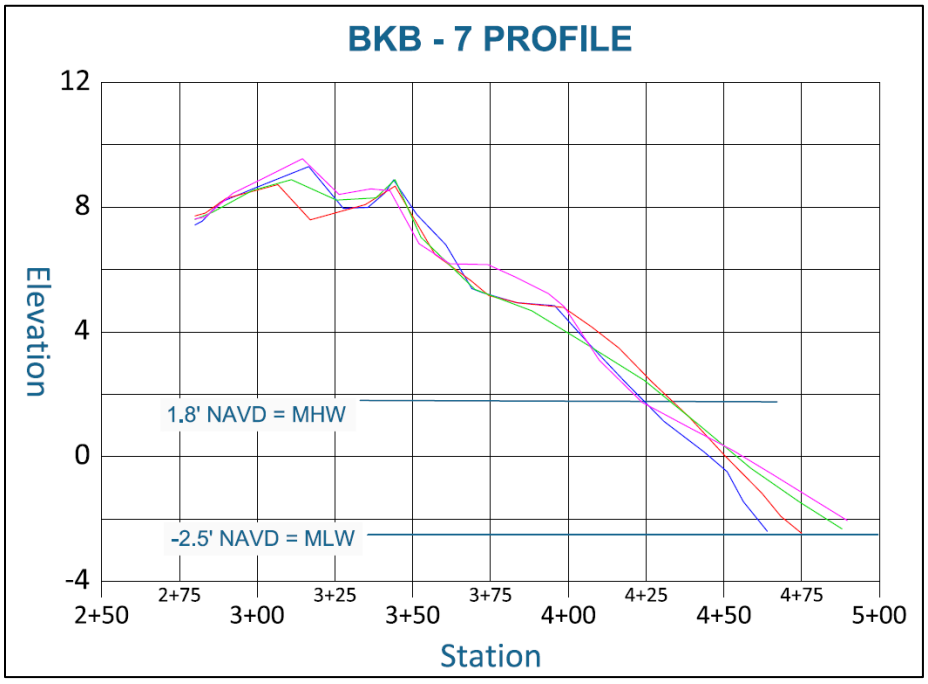




Pink: Summer 2023, Green: Winter 2024, Red: Summer 2024, Blue: Winter 2025

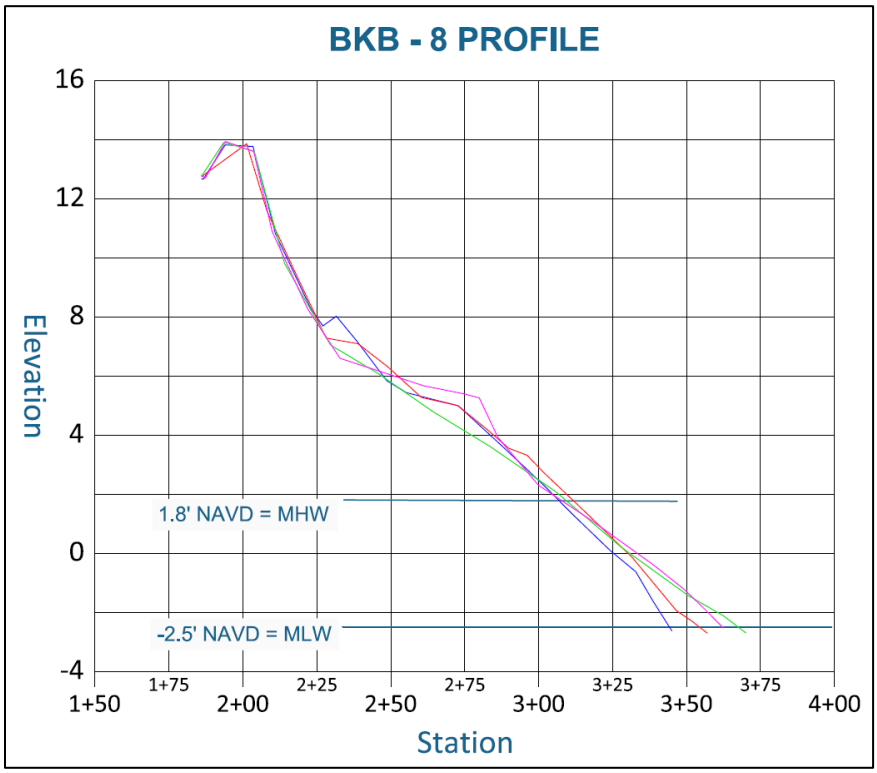
Broadkill Beach (continued).

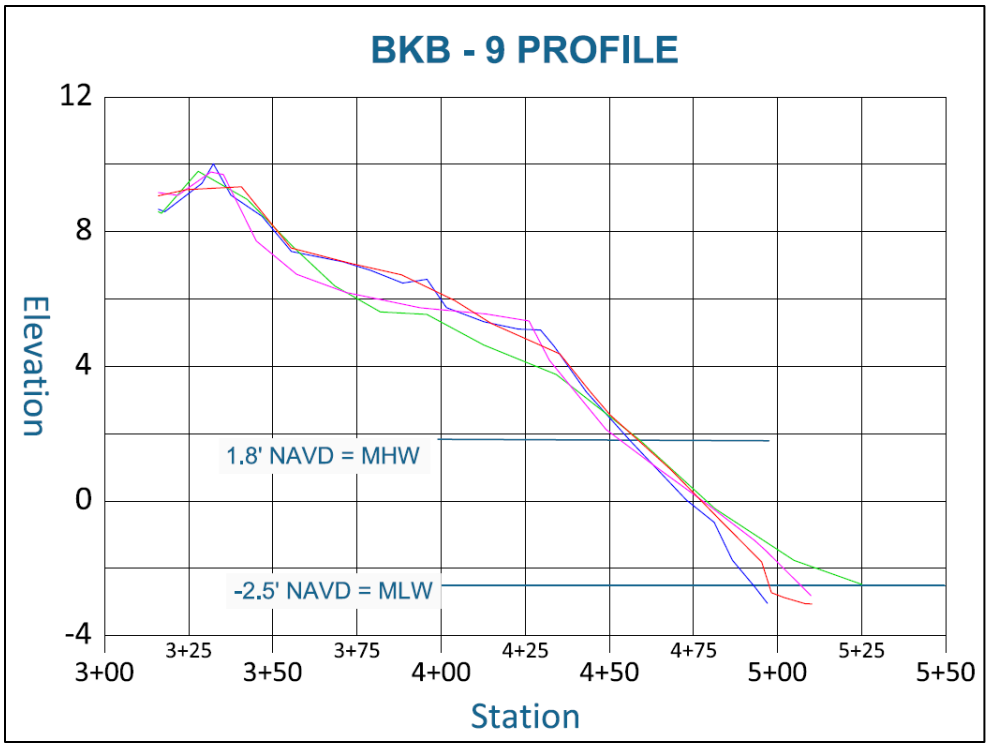




Pink: Summer 2023, Green: Winter 2024, Red: Summer 2024, Blue: Winter 2025

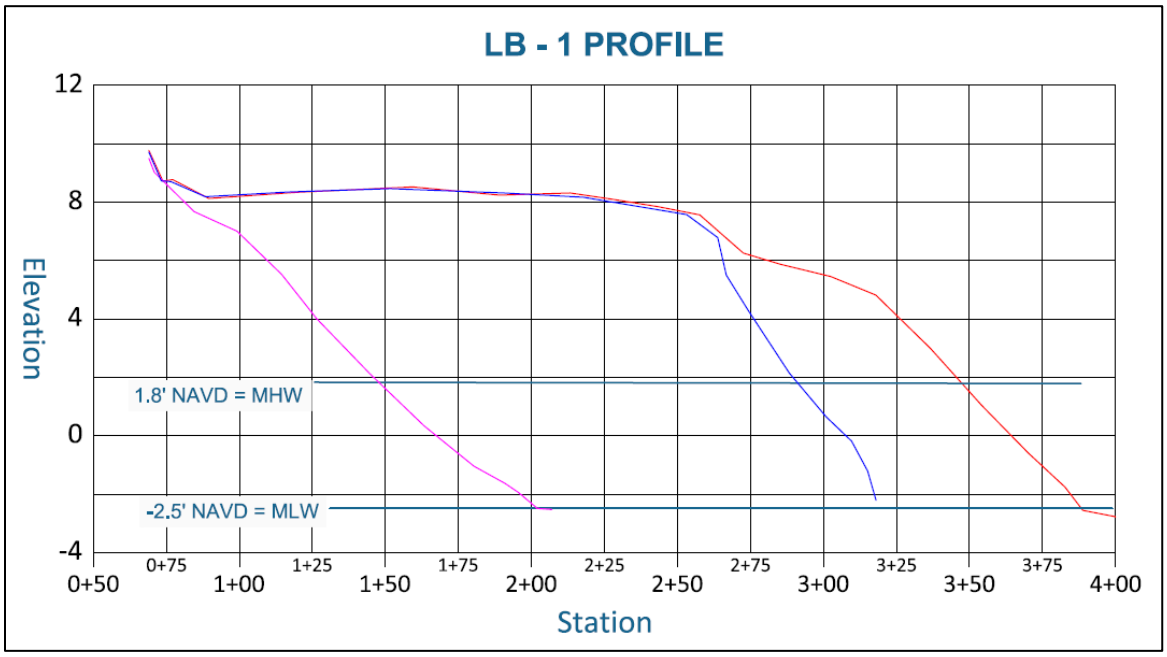
Broadkill Beach (continued).

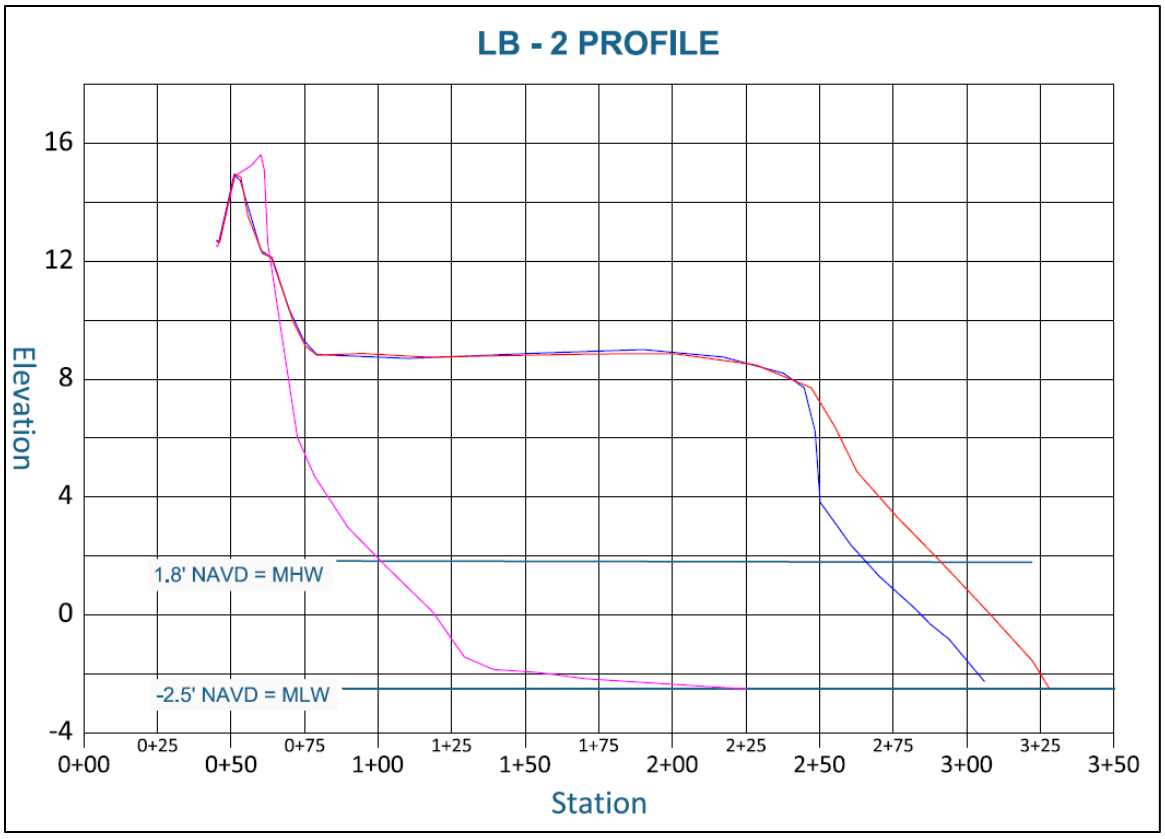




Pink: Summer 2023, Green: Winter 2024, Red: Summer 2024, Blue: Winter 2025

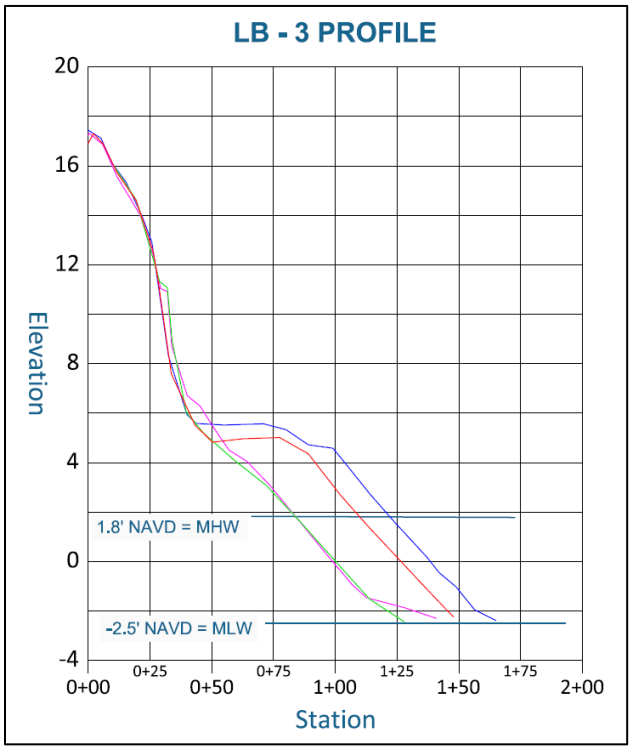
Lewes Beach

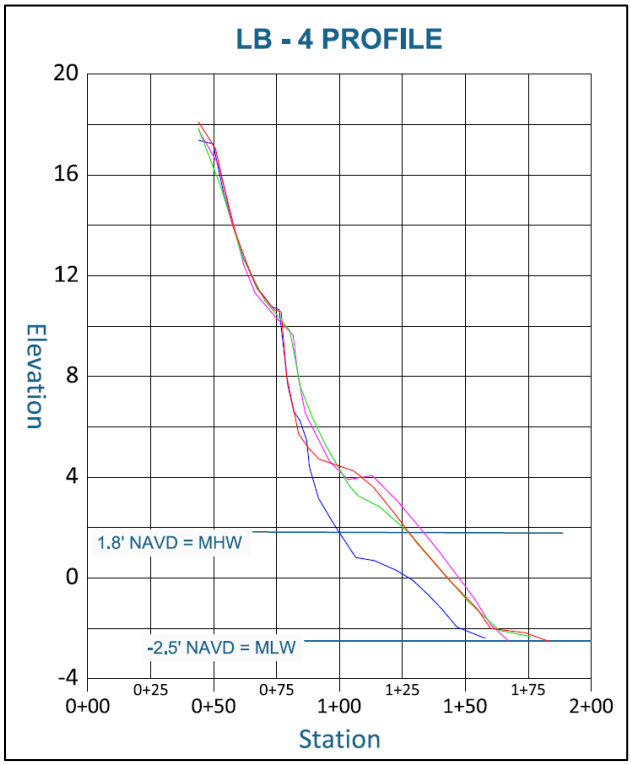




Pink: Summer 2023, Green: Winter 2024, Red: Summer 2024, Blue: Winter 2025

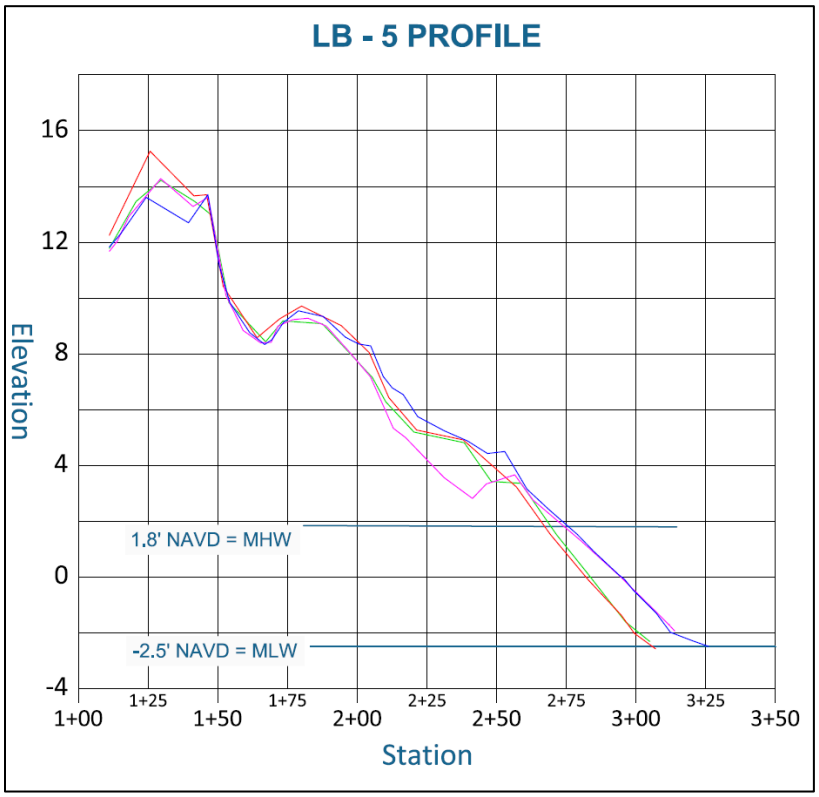
Lewes Beach (continued).

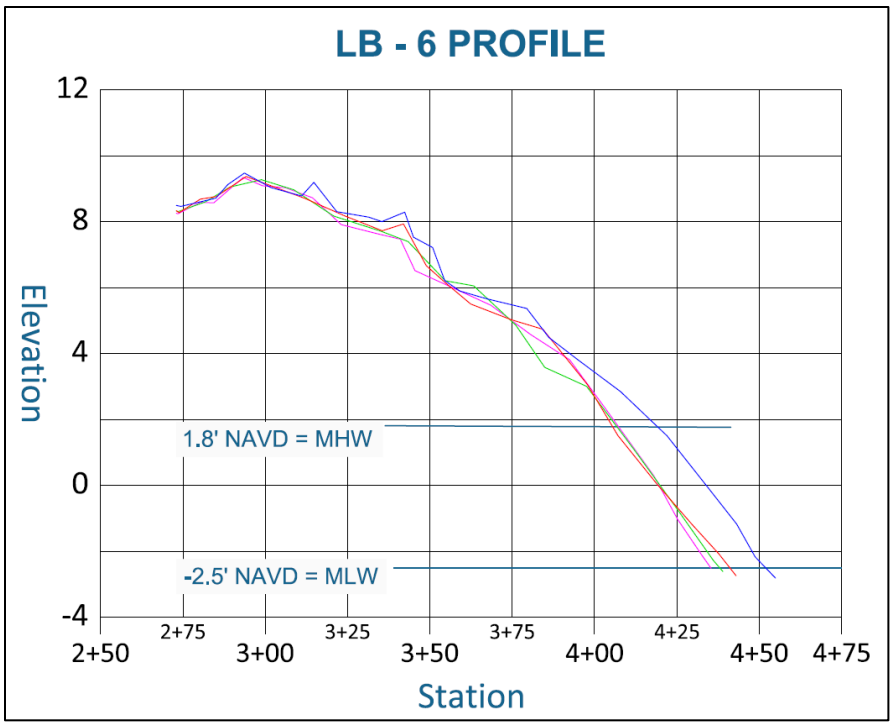




Pink: Summer 2023, Green: Winter 2024, Red: Summer 2024, Blue: Winter 2025

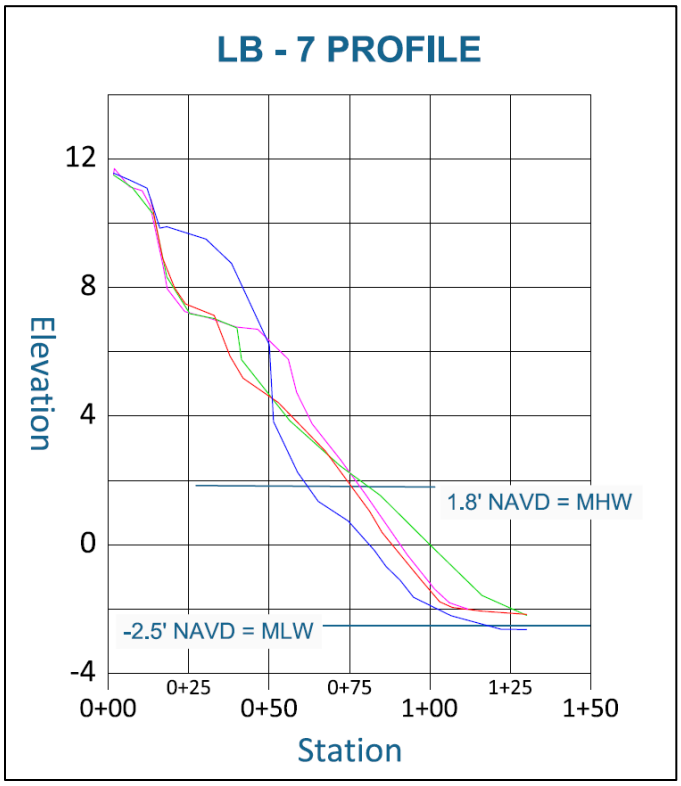
Lewes Beach (continued).

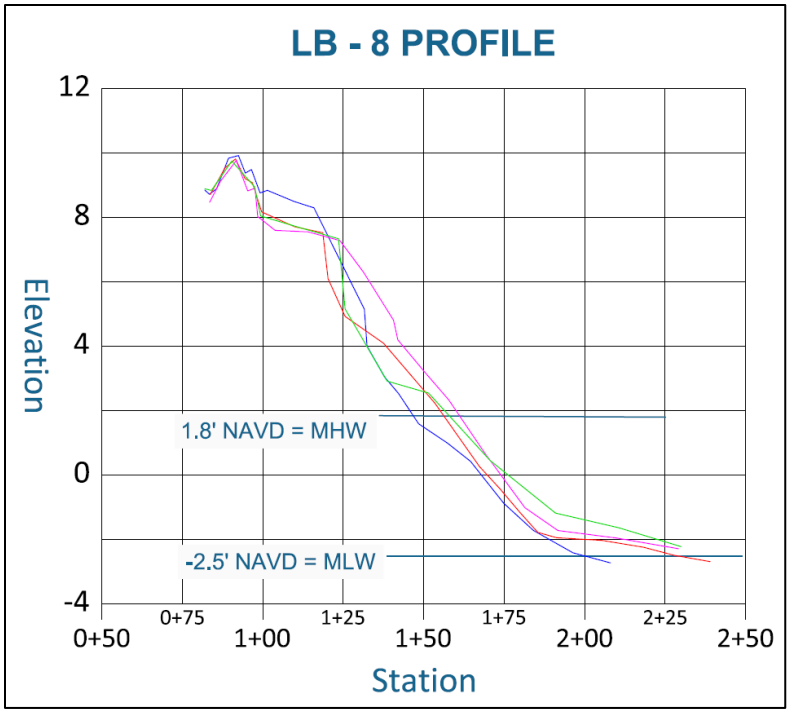




Pink: Summer 2023, Green: Winter 2024, Red: Summer 2024, Blue: Winter 2025

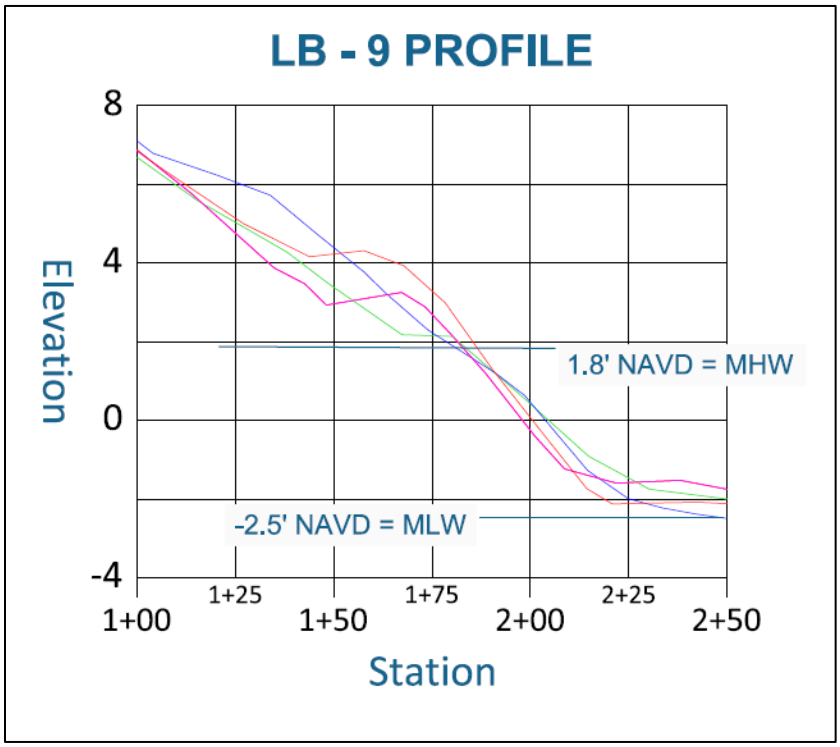
Lewes Beach (continued).





Pink: Summer 2023, Green: Winter 2024, Red: Summer 2024, Blue: Winter 2025

Lewes Beach (continued).



Pink: Summer 2023, Green: Winter 2024, Red: Summer 2024, Blue: Winter 2025

Appendix 2: Bay Coast Photographs

Pickering Beach (4/4/2024 at 11:23)

Approaching low tide looking north. Photo taken a couple weeks after an emergency beach fill project.

Kitts Hummock (04/17/2024 at 12:52)

North Section: Photo taken at low tide looking north

Kitts Hummock (04/17/2024 at 12:52) continued.

North Section: Photo taken at low tide looking south

Middle Section: Photo taken at low tide looking north

Middle Section: Photo taken at low tide looking south

Kitts Hummock (04/17/2024 at 12:52) continued

South Section: Photo taken at low tide looking north

South Section: Photo taken at low tide looking south

North Bowers Beach (4/17/2024 at 12:06)

Photo taken approaching low tide looking north

Photo taken approaching low tide looking south

South Bowers Beach (4/17/2024 at 12:15)

Photo taken approaching low tide looking south

Slaughter Beach (4/17/2024 at 12:10)

North Section: Photo taken approaching low tide looking north

Slaughter Beach (4/17/2024 at 12:10) continued.

North Section: Photo taken approaching low tide looking south

Middle Section: Photo taken approaching low tide looking north

Middle Section: Photo taken approaching low tide looking south

Slaughter Beach (4/17/2024 at 12:10) continued.

South Section: Photo taken approaching low tide looking north

South Section: Photo taken approaching low tide looking south

Broadkill Beach (4/17/2024 at 11:30)

North Section: Photo taken approaching low tide looking north

North Section: Photo taken approaching low tide looking south

Middle Section: Photo taken approaching low tide looking north

Broadkill Beach (4/17/2024 at 11:30) continued.

Middle Section: Photo taken approaching low tide looking south

South Section: Photo taken approaching low tide looking north

South Section: Photo taken approaching low tide looking south

Broadkill Beach (10/9/2024 at 8:56)

Middle Section: Photo taken approaching high tide looking south

Lewes Beach (1/8/2024 at 11:51)

Photo taken looking west towards the developed shoreline, approaching low tide with 1.4-feet of storm surge.

Lewes Beach (1/8/2024 at 11:51) continued.

Photo taken looking west from Cape Shores, approaching low tide

Cape Shores Section: Photo taken approaching low tide, looking east towards Cape Henlopen