Bay Beach Nourishment

Prioritization Plan

2023

DNREC Division of Watershed Stewardship
Shoreline and Waterway Management Section

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Executive Summary

Since 2018, DNREC's Shoreline and Waterway Management Section (SWMS) has produced the annual Bay Beach Prioritization Plan, ranking the vulnerability of the 10 bay beach communities from Pickering Beach to Lewes Beach at the northern and southern ends, respectively. The plan explains the methodology and results of scoring five vulnerability factors: Beach and Dune Volume, Beach Profile Deficiency, Vulnerability of Houses, Vulnerability of Public Infrastructure, and Long-Term Shoreline Change Rate.

The plan produces a ranking for all communities for each of the vulnerability factors. The rankings are then used to develop a score for each factor based on statistical percentiles. To yield a final ranking, these scores are weighted, with the greatest weighting factor applied to the Beach and Dune Volume. Beach and Dune Volume is weighted the strongest because it is directly addressed by beach nourishment.

The final ranking of the bay beach communities determines the priority for beach nourishment projects, excluding Big Stone Beach and Prime Hook. These communities are private, and their beaches are not maintained by the state.

Pickering Beach project during construction

Since the 2022 report, SWMS divided the beach communities into reaches, with the understanding that there are different vulnerabilities and exposure to coastal flood hazards within each community. This allows SWMS to target specific vulnerability areas to avoid the skewing that can occur at the community scale.

The results indicate that the top six reaches for beach fill needs were the entirety of Pickering and Kitts Hummock beaches. The seventh-ranked section was the southern part of Slaughter Beach. Beach fill projects have been completed for the entirety of Kitts Hummock and Pickering Beach in the past two construction seasons. Yet, these communities still rank the highest for beach fill needs. This would suggest that management strategies in recent years have not substantially reduced risk in these communities. However, managing these shorelines has protected and/or rebuilt the dunes which is the last line of defense from Bay side flood hazards.

The report also describes future work to improve the data used to develop the vulnerability factors, including updating shoreline erosion rates and high tide shorelines on an annual basis.

Introduction

Since the 1970s, the Delaware Department of Natural Resources and Environmental Control (DNREC) has been placing sand on the beaches in communities along the Delaware Bay under the authority of the state's Beach Preservation Act. The placement of sand in these communities has historically been performed by dredging sand from offshore or by trucking sand from inland sources. The new sand is shaped into an appropriate berm and dune configuration for optimal performance.

The purpose of this report is to rank sections of the shoreline in bay beach communities by beach nourishment needs. The report includes all areas of population along the Delaware Bayshore within the authorized beach preservation area, including the private communities of Prime Hook Beach and Big Stone Beach.

While the lack of public access to the beaches in the Prime Hook Beach and Big Stone Beach communities makes them ineligible for DNREC nourishment projects, they have been included in this report for completeness. However, they are not included in the final ranking.

This report is produced following the completion of state-funded beach nourishment projects over the course of the year when nourishment projects were designed, funded and performed.

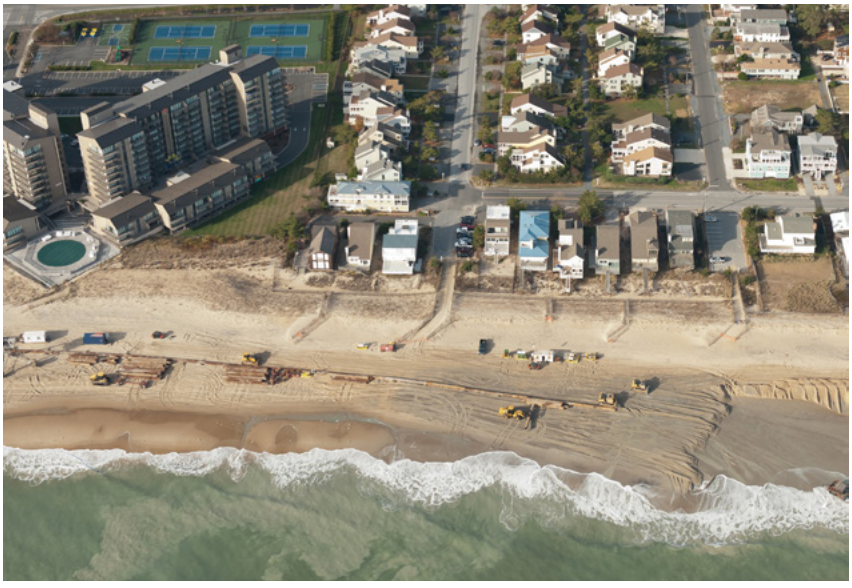
For the 2023 assessment, an additional factor was included: the Beach Profile Deficiency (Factor 2). This factor compliments Factor 1, Berm and Dune Volumes; Factor 1 indicates the size of the beach and dune that protects a particular shoreline reach whereas Factor 2 indicates whether or not the beach profile is deficient relative to a modest beach fill template designed to maintain the dune system. These factors are updated in each years assessment as the beach profile is continually changing.

For the other Factors, only one of the beaches was updated by utilizing a current shoreline based on recent survey: Broadkill Beach. This was identified in previous reports as the most pressing need for future work to improve the prioritization plan as these reports utilized a shoreline that preceded a large scale beach fill project.

Factors 4 and 5, Vulnerability of Houses and Publicly Maintained Assets at risk is dependent not only on shoreline position but based on the location and density of development. While the footprints associated with new construction is unavailable, DNREC is the permitting agency for coastal constructions. The number of permits issued indicates which communities are developing along the coast increasing the total vulnerability of the community.

The methodology is still evolving as data needs are met and lessons are learned from previous reports. Geophysical characteristics and the proximity of private and public infrastructure to the shoreline varies throughout most communities. Considering this, DNREC may choose to nourish just one section of a bay beach community. Breaking each beach into small "reaches," allows more precise planning of nourishment projects and may highlight small sections of the coast that require more fill than larger areas. This is the second assessment report in which bay beach communities have been broken down into reaches. The beach communities and their general physical characteristics are summarized in Table 2 on page 5.

Table 1: Factors and Subfactors that Determine Final Beach Ranking	
Factor	**Sub-Factor**
1. Beach and dune volume	• History of nourishment • Planning • Level of protection from storms and tides • Habitat • Public perception of the problem
2. Beach profile deficiency	• Construction costs • Planning • Level of protection from storms and tides • Vulnerability of the dune dystem
3. Long-term erosion rates	• Physical environment • History of nourishment • Habitat • Nourishment project longevity • Vulnerability of structures
4. Vulnerability of houses	• Damages avoided • Relative hazard exposure of communities
5. Publicly maintained infrastructure at risk	• Damages avoided • State/county investment • Public accessibility • Recreational opportunities



Beach construction in 2011.

Table 2: Beach Communities - Reach Segmentation and Description

Community	Reach	Length feet	Orientation	Ranked
Pickering Beach	1. Northern limit of the community to 300 ft North of Pickering Beach Road	450	Facing slightly north of due east	Yes
	2. Center of the community between 1 and 3	1300	Facing slightly north of due east	Yes
	3. Southernmost 350 ft	350	Facing due east	Yes
Kitts Hummock	1. Northernmost 1200 ft of the community	1200	North northeast	Yes
	2. Center of the community between 1 and 3	2450	North northeast to slightly north of due east	Yes
	3. Southernmost 900 ft of the community	900	Slightly north of due east to slightly south of due east	Yes
Bowers Beach	1. From the northern jetty to 250 ft south of beach access at the end of Main Street	1550	Northeast	Yes
	2. From south end of section 1 to the jetty	750	Northeast	Yes
South Bowers	1. From the jetty to 600 ft south	600	Northeast	Yes
	2. From 600 ft south of the jetty to 4152 South Bowers Road, Slaughter Beach.	750	Northeast	Yes
Slaughter Beach	1. From Driftwood Circle to 495 Bay Ave.	6650	From south south east to east northeast	Yes
	2. From 495 Bay Ave. to the Slaughter Beach Fire Hall	3700	From east north east to Northeast	Yes
	3. From the fire hall to the south end of Bay Ave.	4400	Northeast	Yes
Prime Hook Beach	N/A	8500	Northeast	No
Broadkill Beach	1. From Beach Plum Ave. to Mississippi Ave.	3550	North northeast	Yes
	2. From Mississippi Ave. to the Route 16 crossover	2300	Northeast	Yes
	3. From the Route 16 crossover to the 1100 South Bayshore Drive	2550	Northeast	Yes
	4. From 1100 S Bayshore Drive 2722 South Bayshore Drive	5100	East northeast	Yes
	5. From 2722 South Bayshore Drive to south end of South Bayshore Drive	3500	East northeast	Yes
Big Stone Beach	N/A	5400	North of east	No
Lewes Beach	1. From Roosevelt Inlet south jetty to 1400 ft south	1400	Slightly east of north	Yes
	2. From 1400 ft south of the jetty to New Jersey Ave.	3450	Slightly east of north	Yes
	3. From New Jersey Ave. to the inner breakwater	6600	Slightly east of north to slightly west of north	Yes
Cape Shores	1. Port Lewes revetment to Cape Shore fishing pier	2000	West of north	Yes
	2. From Cape Shore fishing pier to Cape Henlopen State Park	1350	West of north	Yes

Factor 1: Beach and Dune Volume

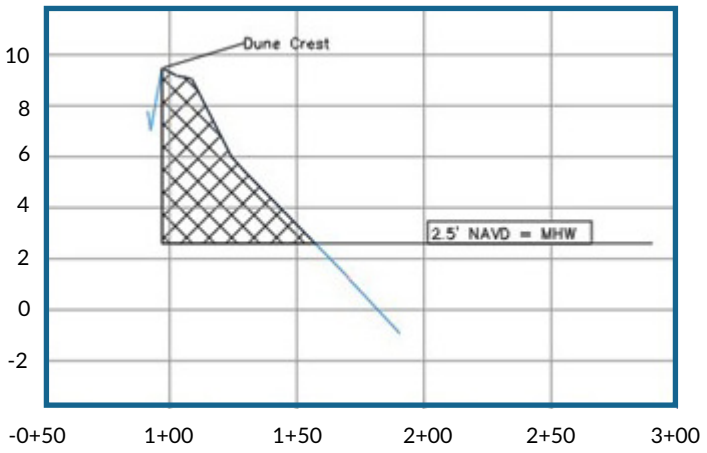
The first factor examined as a part of this prioritization project was the volume of each beach. This factor also encompasses several sub-factors of concern, including construction costs, planning concerns, history of nourishment projects, level of erosion protection from storms and tides, and habitat. In addition, it serves as a verification of the public perception of the problem, as many comments from the public center around a perception of lost dune or berm volumes.

Methodology

Since 1998, beach profiles have been measured and recorded digitally at 32 permanent stations along Delaware's bay coast. These profiles are referred to as Longitudinal Range Planning (LRP) profiles. The LRP profiles are measured twice per year, in the summer and winter, to account for seasonal variability. Most profiles are located within developed areas of the bay shore communities of interest to this report. The most recent LRP is the best representation of the current beach conditions except where recent fill projects have been completed. Since the purpose of this report is to prioritize the next set of bay beach projects, the post-fill project surveys are used to represent the condition of reaches in Cape Shores. This is because the LRP data pre-dates the fill project, whereas the LRP data are more recent than the post-fill survey for Pickering Beach and Kitts Hummock (both fully nourished in the fall/winter of 2022/2023). LRP data was used for all reaches other than those in the Cape Shores community as it is the best available data.

Post-fill surveys are collected at a spacing of 100 feet, whereas LRP lines are spaced by thousands of feet. As such, software such as AutoCAD Civil 3D, Foresight, or ArcMap can create beach three-dimensional surfaces based on post-fill surveys, while LRP lines are too sparse to create accurate surfaces. Since 3-D surfaces cannot be created from LRP data, profiles are analyzed along the line along which data is collected. Beach volumes were computed along one-dimensional lines as cubic foot per linear foot (cf/lf) from mean high water (MHW), or high tide, to the crest of the dune was calculated as depicted in Figure 1. Where there is more than one survey line in a reach the average unit volume is reported.

Figure 1: Pickering Beach North



The example profile above is from the northern reach of Pickering Beach. The hatched area is the unit volume computed for this reach. As shown, the volume is bounded by the MHW line and the dune crest location.

Results

The average beach volumes for each community reach, reported as cubic feet per unit length (cf/lf) per unit length of the beach in the alongshore direction in reported in Table 3.

Table 3: Dune and Berm Unit Volume	
Location	**Volume of the beach profile (cf/lf)**
Pickering Beach	1. 140 2. 147 3. 245
Kitts Hummock Beach	1. 153 2. 360 3. 129
Broadkill Beach	1. 2202 2. 1013 3. 705 4. 1473 5. 861
Big Stone Beach	1. 179
South Bowers Beach	1. 254 2. 465
Lewes Beach	1. 761 2. 548 3. 781
Bowers Beach	1. 225 2. 435
Slaughter Beach	1. 290 2. 565 3. 194
Prime Hook Beach	1. 443
Cape Shores/Breakwater Harbor	1. 328 2. 580

These values represent the unit volume of the beach from the MHW shoreline to the crest of the dune at a representative section for each reach. The numbers in blue refer to the reaches described in Table 1. Broadkill Beach has the most volume, indicating the beach and dunes are taller and/or wider at this location than others. Reach 3, Kitts Hummock, by comparison, has much less volume, indicating a narrow beach with little to no dune protection. Reach 3, Slaughter Beach, also has a relatively low volume. This reach has been identified as an area where regular beach fill projects have been needed over the past few years. It is to be expected that Broadkill Beach reaches have the largest volumes owing to the fact that this beach received 1.7 million cubic yards (cys) of sand during a 2015 beach nourishment project.

Factor 2: Beach Profile Deficiency

This factor was in the first prioritization plan in 2018 but was replaced by the Beach and Dune Volume (formerly referred to as Berm and Dune Deficiency). At that time, the design template used to assess the volume deficiency was from a 2010 10 year management plan for the Delaware Bay coast. These templates proved to misrepresent the capacity of SWMS for maintaining beach as recent fill projects employed more moderate design template. Over the past couple of years, ~~however~~, SWMS has nourished several bay beaches. The templates associated with these projects provide a better representation of fill projects that SWMS has the capacity to execute. This factor compliments Factor 1, which indicates the existing beach conditions, but is not necessarily redundant. This is because the design template volumes are not the same for all reaches.

Beach nourishment has been happening in Delaware since the 1950s.

Methodology

The methodology for computing volumetric deficiencies is like the methods described for Factor 1. The key difference is that the unit volume is computed based on the area of fill required to elevate the existing beach conditions to match the design template. The difference is represented in Figure 2 where the red indicates deficient volume (Factor 2) whereas the green represents the existing volume of the beach and dune (Factor 1). It is noted that where the existing grade is fuller than the template, 0 volume is reported. Negative volumes representing cutting from the existing grade is not reported. Figure 3 demonstrates a beach that has an existing profile that exceeds the template. SWMS does not remove sand from beach profiles to match a designed template geometry.

Figure 2: Pickering Beach Middle

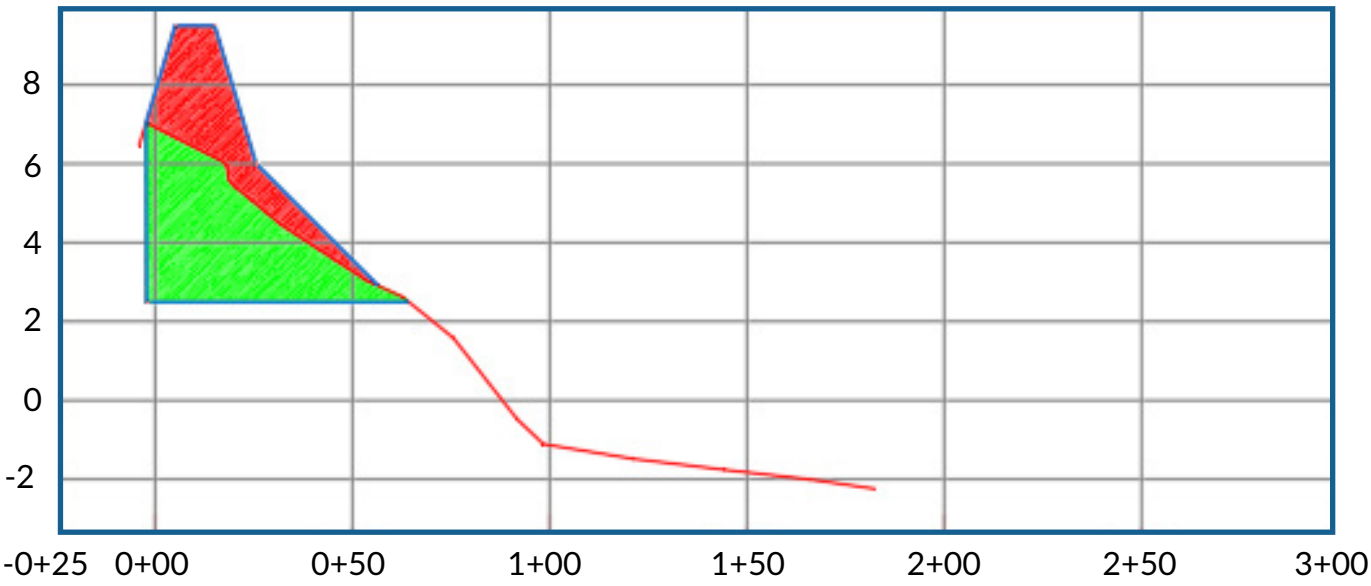


Figure 2A: Example profile showing unit volumes of deficiency (red) and existing conditions above MHW (green).

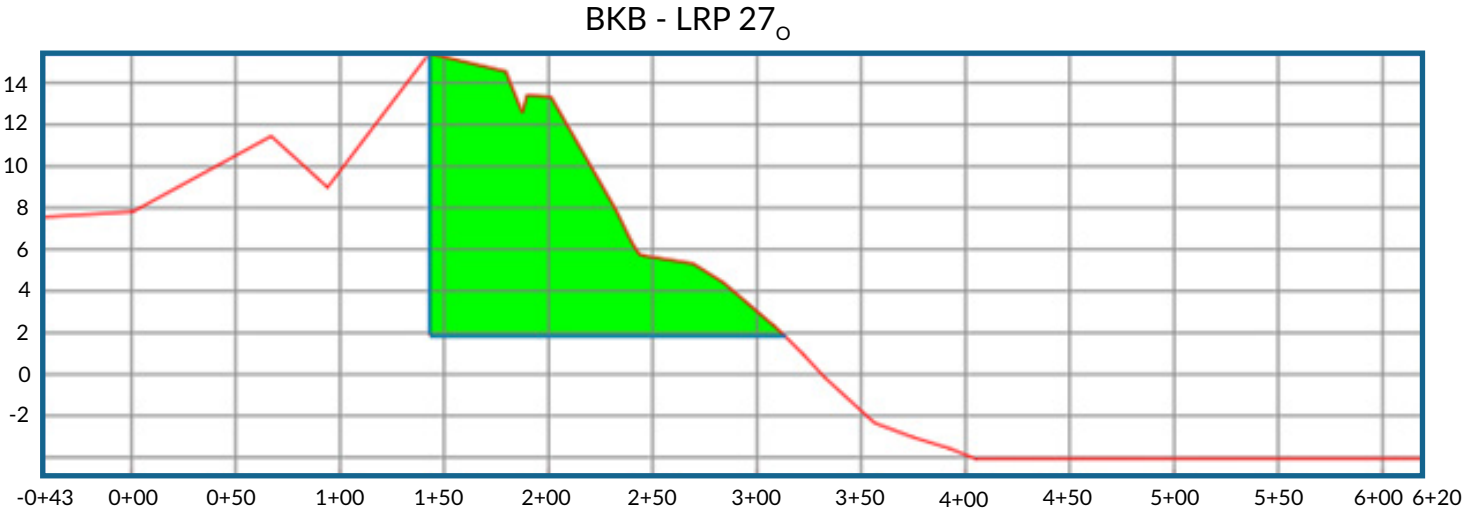


Figure 2B: The existing beach profile in Broadkill Beach is greater than a modest design template throughout the community.

The result of this analysis is reported below. Just like for Factor 1, if 2 LRP lines are within a reach that require fill, the average volume deficiency is reported.

Table 4: Beach Profile Deficiency	
Location	**Volume of the beach profile below design template (cf/lf)**
Pickering Beach	1. 65 2. 83 3. 245
Kitts Hummock Beach	1. 25 2. 17 3. 96
Broadkill Beach	1. 0 2. 0 3. 0 4. 0 5. 0
Big Stone Beach	1. 0
South Bowers Beach	1. 31 2. 0
Lewes Beach	1. 275 2. 258 3. 0
Bowers Beach	1. 77 2. 0
Slaughter Beach	1. 41 2. 0 3. 107
Prime Hook Beach	1. 0
Cape Shores/Breakwater Harbor	1. 0 2. 0

It should be noted that Prime Hook and Big Stone Beach do not have a design fill template, since these beaches are not managed by the State. Also, the fact that Cape Shores has 0 volume deficiency is most likely since the beach was filled within weeks of drafting this plan and post beach fill data were used in the analysis. It is also unsurprising that Broadkill Beach has 0 deficiency because the federal design template is vastly greater than a typical fill template that the State constructs. Management concerns at Broadkill is beach accessibility owing to the large scarps incised into the tall dunes. Volume deficiency, on the other hand, is not a concern.

Factor 3: Long-Term Shoreline Change Rates*

Long-term erosion (shoreline change) rates from previous studies were examined for each beach. The shoreline change rate is expected to be a response to the physical forces present at each community, such as waves, currents, beach slope, beach orientation, beach grain size and underlying geology, as well as sand budget and sand supply. This factor also addresses several other sub-factors of concern, specifically history of nourishment, which artificially alters the long-term change rates, habitat loss and vulnerability of structures on the shore.

Note: This factor has not been updated since the first prioritization plan report in 2018.

Methodology

In the Dredge Material Utilization Feasibility Report (DMU), shoreline change rates from previous studies by the United States Army Corps of Engineers (USACE) and other scientific studies were examined, and the project team determined which rates were most appropriate. Where available, these rates were used to determine rankings based on long-term erosion in a community. For sites not included in the DMU, other sources were used as indicated in Table 4.

It is noteworthy that long-term erosion rates reported in the DMU did not consider subsections of each beach community, except for Lewes Beach. To account for the alongshore variability in change rates and for "hot-spots" of erosion, DNREC's semiannual LRP survey data were analyzed.

Bowers Beach jetty along the Murderkill River Inlet

Because beach nourishment projects artificially affect the shoreline position and change rate, analyzing shoreline change rates not only assesses natural shoreline change but also the performance of management strategies in maintaining shorelines. Winter LRP data collection may capture a beach shortly after a fill project or in an eroded condition following a stormy fall. Therefore, winter LRP data has not been considered in this analysis as the summer LRP theoretically represents the beach conditions in a state of recovery from impacts such as fall and winter nourishments and storms.

Results

In general, shoreline position change rates decreased from north to south. Pickering Beach and Kitts Hummock Beach had the highest shoreline change rates, according to those used by the DMU feasibility study.

Table 5: Shoreline Position Change from Dredge Material Utilization	
Community	**Shoreline position change (feet/year)***
Pickering Beach	-4.9[1,2]
Kitts Hummock Beach	-4.3[1,3]
Broadkill Beach	-3.8[2,3]
Big Stone Beach	-3.6[1,2,3]
South Bowers Beach	-3[1,2,3,4]
Lewes Beach (west)	-3[1,2,3]
Bowers Beach	-2.5[1,2,3,4]
Slaughter Beach	-1.9[1,3,4]
Prime Hook Beach	-0.7[4]
Lewes Beach (east)	0[1,2,3]
Cape Shores/Breakwater Harbor	0[5]

Footnotes:
[1] USACE DMU Feasibility Study, 2018
[2] USACE Delaware Bay Coastline, DE & NJ Feasibility Study, 1991
[3] French 1990 – graduate thesis
[4] 2015 Bay Beach Verification Project Designs and Report, 2015
[5] Cape Shores Report by CB&I commissioned by DNREC, 2016
*The shoreline position value is applied to each reach within each respective community. A negative value indicated shoreline retreat or loss.

Long Range Planning

The total change for each beach from the summer of 2000 to 2021 is summarized in Table 4. The total change includes beach nourishment. This total change enables insight to be garnered on how well beach nourishment activities are performing in the context of holding shoreline positions over the past 20 years. It is noted that the advancement of the shoreline in Broadkill Beach is a result of a large nourishment project, which placed 1.7 million cubic yards of sand dredged from the Delaware River on Broadkill Beach. There are two sections that do not have survey data dating back to 2000 (Pickering and Bowers).

Table 6: Shoreline Position Change Since 2001	
Community	**Shoreline change 2000 to 2021 (feet)**
Pickering Beach	1. -33 2. -50 3. -75
Kitts Hummock Beach	1. -40 2. -40 3. -45
Broadkill Beach	1. 168 2. 136 3. 206 4. 180 5. 103
Big Stone Beach	1. -151
South Bowers Beach	1. -48 2. -6
Lewes Beach	1. -30 2. -6 3. -35
Bowers Beach	1. -93 2. -93
Slaughter Beach	1. 104 2. -3 3. -18
Prime Hook Beach	1. -80
Cape Shores/Breakwater Harbor	1. 0

The shoreline change 2000 to 2021 (feet) column indicates the distance, in feet, that the high tide shoreline retreated, resulting in a negative value, or advanced, a positive value. The Broadkill Beach shoreline advanced, owing to the large nourishment project completed in 2015. Advancement in the northern reach 1 of Slaughter Beach is likely due to the fact that the jetty at the Mispillion River inlet traps sand and protects this reach from erosive wave action. The fact that Big Stone Beach has retreated far greater than other reaches indicates that beach nourishment activity has been effective in slowing the rate of shoreline loss.

Factor 4: Vulnerability of Houses*

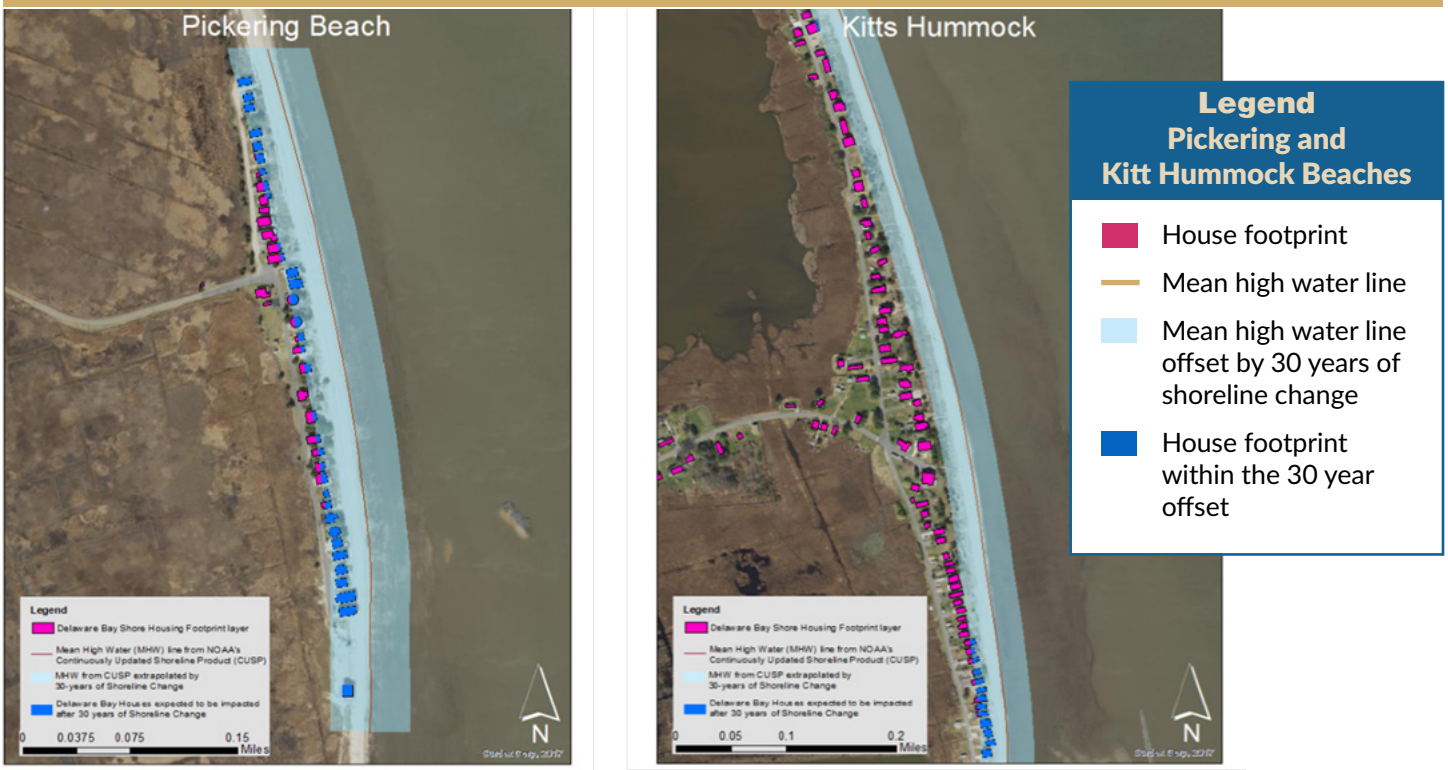
One of the driving factors for any beach replenishment project is the reduction of coastal storm risk for properties in a coastal community. In Delaware Bayshore communities, most of the properties along the beaches include private residential properties. For this reason, one of the five factors assessed in the prioritization of beach projects along the bay shore is the vulnerability of houses to beach erosion in each community.

***Note: This factor has not been updated since the first prioritization plan report in 2018.**

Methodology

A quantitative measure of the vulnerability of property in this study was, for each community, the number of houses expected to be seaward of the MHW line within 30 years based on the shoreline change rates used in Factor 2. The current MHW line (from the National Oceanic and Atmospheric Administration's Continuously Updated Shoreline Product) was extrapolated landward by the community's shoreline change rate multiplied by 30 years. This time frame (30 years) was chosen because most mortgages are 30-year term. This shoreline is particularly out of date for Broadkill Beach, as it predates the 2015 federal beach fill project. This year, SWMS surveyed the MHW shoreline at Broadkill Beach and used this shoreline for the Broadkill Beach reaches. House footprints for most communities were derived from an update to the housing GIS database produced as a part of the Delaware Bayshore Communities Economic Analysis for Options for Shoreline Management (2014); this update was performed using 2017 aerial imagery, and the beach permit application database. For Lewes and Cape Shores, neither of which were analyzed in the Delaware Bayshore Communities Economic Analysis for Options for Shoreline Management, house footprints were taken from a Sussex County dataset from 2002 and updated based on 2017 aerial imagery as well as the beach permit database. Future work includes drone surveys to identify the location of the MHW shoreline, annually, rather than relying on NOAA's CUSP and historic reports. Also, new construction in each community would alter the percentage of vulnerable homes. Future reports should consider that when calculating percentages.

Figure 3: Houses Seaward of Mean High Water in 30 years for Pickering Beach and Kitts Hummock Beach



While new construction is not accounted for when considering the vulnerability of housing stock, information from coastal construction permits can be used to infer the increase of houses in hazardous areas in terms of coastal flooding. To date, this assessment has not been included in prioritization plans.

DNREC regulates coastal construction within the most seaward three rows in each coastal community or lots that are within 1,000 feet rows. Therefore, if the fourth row is within 1,000 feet from the shoreline, the lot is unregulated. Permits are classified by zones based on the proximity to DNREC's building line. The current building line is still the line defined when it was originally established. This building line is defined as:

- Along beaches extending from the tip of Cape Henlopen to Rosemary Street in Prime Hook Beach, 100 feet landward of the adjusted seaward-most 6-foot elevation contour above the North America Vertical Datum. NAVD is a common reference for elevations across the continent. Other datums such as Mean Sea Level vary from location to location. For uniformity, surveyors and engineers typically collect and use data whose elevation is in NAVD.
- Along beaches extending from Rosemary Street in Prime Hook Beach to the Old Marina Canal north of Pickering Beach: 75 feet landward of the adjusted seaward-most 6-feet elevation contour above NAVD.
- Or, at the landward limits of the beach, as defined in these regulations, whichever is most seaward. The beach is defined as the area within 1,000 feet of the high-water line.

Where:

- **Zone 1** – Construction that is 100% seaward of the building line
- **Zone 2** – Construction on a lot that is intersected by the building line
- **Zone 3** – Construction inland of the building line

It is likely that the building line would be different if it were mapped today, due to changing shoreline positions and improved surveying techniques. Updating the building line, is under consideration. Though there are accuracy issues with the building line, and proximity to the shoreline is not as precise as the sea level rise projections, it can be presumed that new residential structures in Zones 1 and 2 are prone to damage by coastal hazards. Future work includes using the permit drawings to update the house footprints shapefile. Doing so, along with updating the MHW shoreline, will account for annual changes in the number of vulnerable homes.

It is also noted that previous plans exclude this information since it is not as accurate or precise, spatially, as the building footprint layer. In addition, the number of new houses is relatively small compared to the existing housing stock in each community, and this assessment does not quantify all new homes since DNREC only permits three rows of lots. Therefore, new houses are not considered in the final ranking.

Results

If shoreline change continues at the current estimated rate from Factor 3, Pickering Beach will lose up to 100% of its existing houses (Table 6). This high percentage is both a product of the fast rate of erosion and the small number of houses in this community. Big Stone Beach is estimated to lose 50% of its housing stock in 30 years. However, there are a very small number of houses in this private community. Kitts Hummock Beach is expected to lose roughly 40% of its housing stock in 30 years, mostly at the southern end of the community (Table 7). The number of new homes based on DNREC's permit database has not been included in calculating the percentages.

The percentage reported for Bowers Beach is controlled by the number of houses bayward of Flack Avenue. This acknowledges that beach nourishment only mitigates against bay front flooding. Also, other communities consist of a single or just a few rows of homes along the bayfront, whereas Bowers housing stock includes many homes that are not directly adjacent to the bay. Including the entire community would skew the prioritization score against Bowers Beach.

Table 7: Houses Seaward of Mean High Water (MHW) in 30 years

Community	Number of houses Seaward of MHW in 30 years	Percent of houses Seaward of MHW in 30 years
Pickering Beach	1. 8 2. 17 3. 8	1. 100 2. 85 3. 100
Big Stone Beach	1. 6	1. 50
Kitts Hummock Beach	1. 1.7 2. 2.3 3. 9	1. 53.8 2. .06 3. 18
Broadkill Beach	1. 0 2. 0 3. 0 4. 0 5. 0	1. 0 2. 0 3. 0 4. 0 5. 0
Bowers Beach*	1. 2 2. 7	1. 0.4 2. 20.0
South Bowers Beach	1. 0	1. 0
Slaughter Beach	1. 0	1. 0
Prime Hook Beach	1. 0	1. 0
Lewes Beach	1. 0	1. 0
Cape Shores/Breakwater Harbor	1. 0	1. 0

For this year's report, the shoreline for Broadkill Beach was updated with recent survey data. As suggested in the previous years' reports, updating the shoreline had a significant impact on results. This is because the data that had been used was from a dataset that predated the large scale Federal beachfill project.

*Percent based on the total housing stock seaward of Flack Avenue.

Table 8: Permitted Coastal Construction			
Community	**Number of new houses in Zone 1**	**Number of new houses in Zone 2**	**Number of new houses in Zone 3**
Slaughter Beach	0 (0)	22 (3)	7
Broadkill Beach	0 (0)	28 (2)	23 (3)
Prime Hook Beach	0 (0)	4 (2)	9 (1)
Kitts Hummock Beach	0 (0)	4 (1)	0
Bowers Beach	0 (0)	1	4
Pickering Beach	0 (0)	0 (0)	0 (0)
Big Stone Beach	0 (0)	0 (0)	0 (0)
South Bowers Beach	0 (0)	0 (1)	0
Lewes Beach	0 (0)	0 (2)	18
Cape Shores/Breakwater Harbor	0 (0)	1 (1)	5 (2)

*The number outside the parenthesis is the number of homes approved for construction since 2017, when the building footprints were updated. The numbers in parenthesis is the number of additions added to homes in each zone ~~since 2017.~~ this year

- Zone 1 – Construction that is 100% seaward of the building line
- Zone 2 – Construction on a lot that is intersected by the building line
- Zone 3 – Construction inland of the building line

Beach nourishment project in progress.

Factor 5: Publicly Maintained Infrastructure at Risk*

This final factor captures the vulnerability of the publicly-maintained infrastructure as well as the state, county, or municipal investments at risk from storm damage, overwash and overtopping of the dunes. For roads, the possible types of damage include sand across the road or damage to the roadbed. For sanitary and storm sewers, when seawater enters the system, it brings sand with it that can cause lasting damage to the infrastructure.

***Note: This factor has not been updated since the first prioritization plan report in 2018.**

Methodology

A simple GIS overlay methodology was used to assess which state-maintained roads in the bay shore communities were at risk. The current MHW line was extrapolated landward by 30 years based on the shoreline change rates used in Factor 2, and then an additional 150-foot or 300-foot buffer was used to estimate the extent of overwash expected from a storm event. The shoreline data are the same as those used for Factor 3. The distances used for these buffers were determined by measuring the lengths of overwash features on adjacent unpopulated stretches of shoreline. State-maintained roads were obtained from the Roads Inventory Maintenance Responsibility layer on First Map; an inventory of the parties responsible for the maintenance of roads statewide aggregated by the Delaware Department of Transportation (DelDOT). For this factor, the beach communities were treated as a whole rather than the identified sections. Future work includes drone surveys to identify the location of the MHW shoreline rather than relying on long term trends available from the CUSP and historic reports. For this report, the Broadkill Beach MHW shoreline was updated.

Results

Broadkill Beach, Slaughter Beach and Prime Hook Beach are the only beaches with more than one mile of state-maintained road at risk, However, none of these communities are on public sewer. Pickering Beach, South Bowers Beach and Kitts Hummock Beach are on Kent County public sewer and have several state-maintained roads at risk as well. Bowers Beach is on public sewer but has no state-maintained roads at risk as many of the roads are maintained by the municipality.

Table 9: Publicly Maintained Infrastructure (Roads and Sewers)

Community	Miles of state-maintained road per community	Public sewer
Kitts Hummock Beach	0.82	Yes
South Bowers Beach	0.37	Yes
Pickering Beach	0.35	Yes
Broadkill Beach	0	No
Slaughter Beach	2.60	No
Prime Hook Beach	1.23	No
Big Stone Beach	.025	No
Lewes Beach	0	Yes
Cape Shores/Breakwater Harbor	0	Yes
Bowers Beach	0	Yes

Note: Just as with Factor 4, the update of Broadkill's shoreline reflects that roads in the community are at low risk from flooding from the Delaware Bay. However, the Bay coast is not the only flood source for these communities. This plan strictly addresses hazards along the Bay coast.

Discussion

For individual prioritization factors, Pickering Beach and Kitts Hummock repeatedly ranked in the top two or three communities. Private beaches of Primehook Beach and Big Stone Beach were not included in the composite ranking because the state currently will not perform beach nourishment projects in these communities, however, they often ranked highly for individual factors. It should be noted that Cape Shores is ranked low for each of the Factors. This indicates that the regular beach fill projects at Cape Shores is more effective at reducing vulnerability as compared to other fill sites like Pickering Beach. This is likely because the project are larger in term of volume. These large projects are feasible due to a cost-sharing agreement with between the state and the community. This suggests that cost sharing agreements between the state and local counties or communities for periodic nourishment projects are more effective than ad-hoc beach fill projects.

It has been mentioned throughout the report that methodologies can be improved. A summary of the proposed work includes:

- Utilizing survey (drone) data to update the MHW shoreline
- Digitizing the new construction footprints
- Including more public infrastructure such as water supply and stormwater networks
- Replacing long-term erosion rates with more recent observations

Final Ranking

Each of the five factors was given a percentile score from 1 to 25, based on most to least vulnerable section. For the Long-Term Erosion and Publicly Maintained Infrastructure factors, the whole community was considered for ranking. The new construction ranking was not used in final scoring due to uncertainty and the low number of new construction relative to existing development.

Each score was weighted as follows: Long Term Erosion (1); Beach and Dune Volume (3); Beach Profile Deficiency (2); Vulnerability of Houses (1.5); Publicly Maintained Infrastructure at Risk (2). Long-term erosion was ranked the lowest since it is reliant on data from times when different sea level change rates were experienced, different impacts of erosion control structures and different regional sand management outcomes.

Future work reports may use the shoreline change rates based on LRP data once this analysis has been fully vetted. Vulnerability of Houses and Infrastructure were also ranked low for the same reason but slightly higher because they have implications for private/public infrastructure. The Beach and Dune Volume was ranked the highest because the beach and dune are the most important shoreline feature that protects homes and infrastructure inland of the coast, and the features can be repaired by performing beach nourishment projects. The weighted scores were summed up and ranked from 1 to 23. It is noted that Prime Hook and Big Stone were omitted from the ranking because the State of Delaware does not nourish private beaches.

Table 10: 2022 Total Ranking		
Community	**Final score**	**Final rank**
Pickering Beach	1. 6.99 2. 6.675 3. 6.07	2 3 4
Kitts Hummock Beach	1. 7.11 2. 5.975 3. 6.805	5 6 1
Bowers Beach	1. 4.13 2. 4.93	10 17
South Bowers Beach	1. 4.61 2. 5.13	9 14
Slaughter Beach	1. 4.57 2. 4.99 3. 4.77	8 16 7
Prime Hook Beach	1. 5.32	-
Broadkill Beach	1. 5.78 2. 2.78 3. 3.08 4. 3.47 5. 2.93	25 22 19 24 20
Big Stone Beach	1. 6.16	-
Lewes Beach	1. 1.12 2. 1.7 3. 2.97	15 12 21
Cape Shores/Breakwater Harbor	1. 3.85 2. 2.91	18 23

The results indicate that the entirety of Pickering Beach and Kitts Hummock make up the highest priority reaches. Following Kitts Hummock is the southernmost section of Slaughter Beach, which is the section that needs regular nourishment. These seven reaches have been among those that have been nourished in the recent couple of years. The next highest reach is the northern part of Slaughter Beach. This section of coast is not thought to be highly vulnerable to flooding. This is because the homes are setback from the shore, sand is trapped by the jetty, which also shelters the shoreline from wave attack. This highlights the need to use judgement when ultimately deciding where to do projects. Though exposure to wave action and longshore transport patterns are implicit in most factors, it is not direct considered in the prioritization plan.

It is also important to consider the fact that this is a static report describing the conditions of a dynamic coastline. There may be storm events that cause erosion that would have alter these results following the publication of the report. Further, the beach conditions for Factors 1 and 2 are based on the time of survey and may not reflect the actual current condition along the respective reaches.

The entirety of Broadkill Beach is the lowest priority. In previous reports this was not the case. This highlights the importance of updating the shoreline data. In future years, we expect to utilize more recent data in the analysis though the significance is expected to be far less for other communities.

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