



5.4.2 Coastal Erosion

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the coastal erosion hazard in Cape May County.

2016 Plan Update Changes

- The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences (updated with events that occurred between 2009 and 2015), probability of future occurrence, and potential climate change impacts using best available data.
- A vulnerability assessment section was completed for the coastal erosion hazard that provides a more accurate estimated exposure and potential losses to Cape May County.

5.4.2.1 Profile

Hazard Description

Erosion is the process of the wearing away of beaches and bluffs along the coastline by large storms, flooding, strong wave action, sea level rise, and human activities. Erosion occurs when the waves and currents remove sand from the beach system. The loss of sand causes the beach to become narrower and lower in elevation. During storms, waves carry the sand offshore, depositing and storing the sediment in large sandbars. In weeks and months following the storm, the sand is returned to the beach by calmer waves (CRS Coordinator's Manual 2015).

Coastal erosion is a complex physical process shaped by both natural processes and human activity. Natural factors include the sand supply; changes in sea level or the water level in the Great Lakes; geologic characteristics of the shore; the effects of waves, currents, tides, and wind; and the bathymetry of the offshore sea bottom. Human activity may have direct or indirect effects on the coastal areas (U.S. Climate Resilience Toolkit 2014; USGS 2015).

Many natural factors affect erosion of the shoreline, including shore and nearshore morphology, shoreline orientation, and the response of these factors to storm frequency and sea level rise. Coastal shorelines change constantly in response to wind, waves, tides, sea-level fluctuation, seasonal and climatic variations, human alteration, and other factors that influence the movement of sand and material within a shoreline system.

Unsafe tidal conditions, as a result of high winds, heavy surf, erosion, and fog are ordinary coastal hazard phenomena. Some or all of these processes can occur during a coastal storm, resulting in an often detrimental impact on the surrounding coastline. Factors including: (1) storms such as Nor'Easters and hurricanes, (2) decreased sediment supplies, and (3) sea-level rise contribute to these coastal hazards.

Historically, some of the methods used by municipalities and property owners to stop or slow down coastal erosion or shoreline change have actually exacerbated the problem. Attempting to halt the natural process of erosion with shore parallel or perpendicular structures such as seawalls (groins and jetties) and other hard structures typically worsens the erosion in front of the structure (i.e. walls), prevents or starves any sediment behind the structure (groins) from supplying down-drift properties with sediment, and subjects down-drift beaches to increased erosion. Since most sediment transport associated with erosion and longshore drift has been reduced, some of the State's greatest assets and attractions – beaches, dunes, barrier beaches, salt marshes, and estuaries – are threatened and will slowly disappear as the sediment sources that feed and sustain them are eliminated.



Sandy barrier/bluff coastlines are constantly changing as the result of wind, currents, storms, and sea-level rise. Because of this, developed sandy shorelines are often stabilized with hardened structures (seawalls, bulkheads, revetments, rip-rap, gabions, and groins) to protect coastal properties from erosion. While hardened structures typically prove to be beneficial in reducing property damage, the rate of coastal erosion typically increases near stabilization structures. This increased erosion impacts natural habitats, spawning grounds, recreational activity areas, and public access (Frizzera 2011). According to the NJDEP, Cape May County has a number of shoreline structures that includes one breakwater structure, 94 groins, eight jetties, four revetments, and three seawalls (NJDEP 1993).

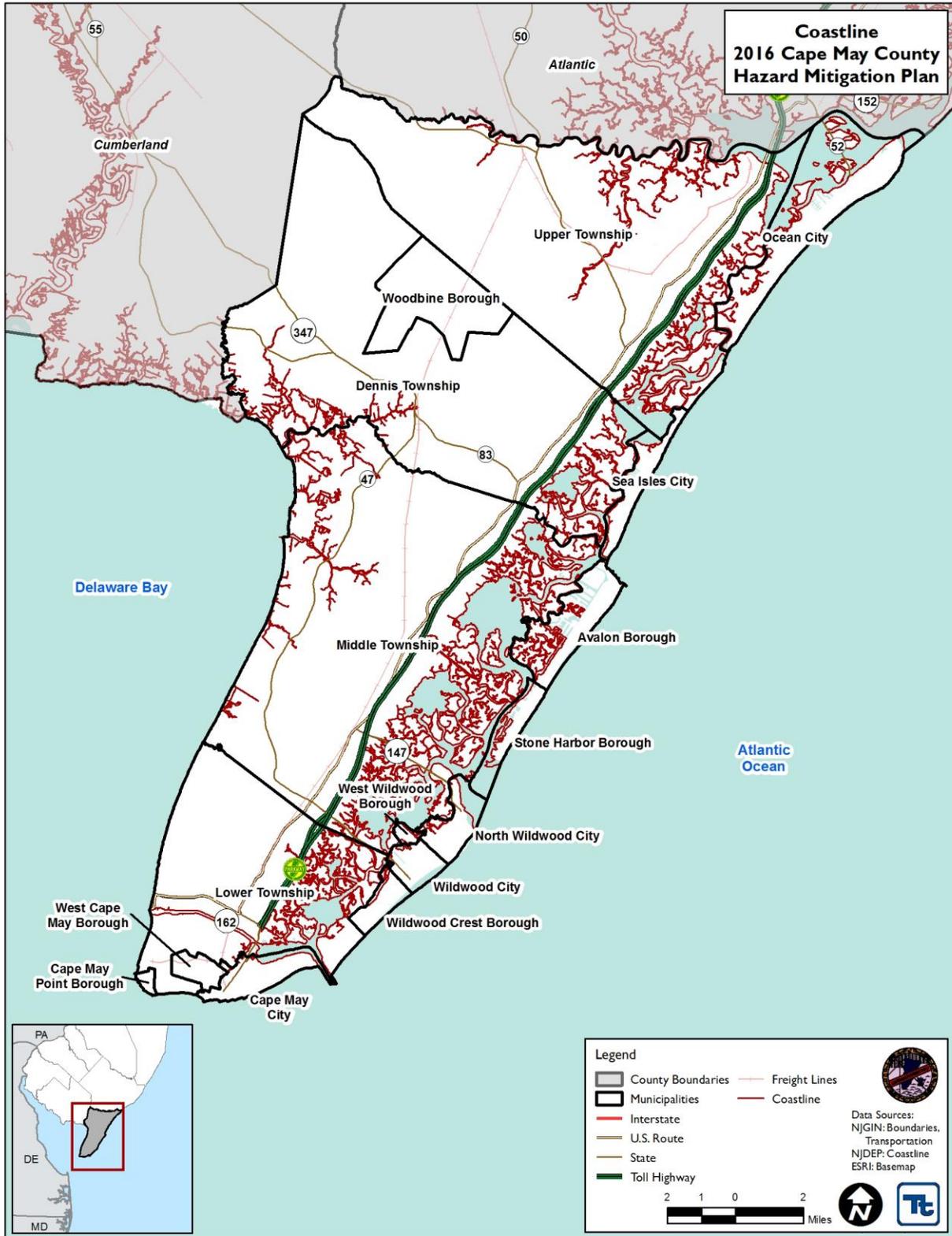
Coastal erosion is classified as short-term and long-term. The long-term changes of shoreline may not be evident on a day-to-day or even year-to-year basis. They occur over a period of decades, over which short-term changes tend to average out to the underlying erosion or accretion trend. However, short-term changes due to storm events are immediately noticed. Short-term changes occur over periods ranging from a few days to a few years. They can be highly variable in direction and magnitude.

Location

NJDEP defines ‘coastal’ as any land adjacent to a tidally influenced waterway. New Jersey has three primary coastal regions: the Atlantic Coast which includes communities along the Atlantic Ocean and communities that lie inland of the Atlantic coast barrier islands; the Delaware Bayshore; and the urban coast which includes communities such as Jersey City and Hoboken that lie along the tidal portion of the Hudson River (Rutgers 2014). The coastal area includes coastal waters to the limit of tidal influence including: the Atlantic Ocean (to the limit of New Jersey's seaward jurisdiction); Upper New York Bay, Newark Bay, Raritan Bay and the Arthur Kill; the Hudson, Raritan, Passaic, and Hackensack Rivers, and the tidal portions of the tributaries to these bays and rivers. The Delaware River and Bay and other tidal streams of the Coastal Plain are also in the coastal area, as is a narrow band of adjacent uplands in the Waterfront Development area beyond the CAFRA area (NJDEP 2014). As previously stated, a coastal area is any land adjacent to a tidally influenced waterway; therefore, Cape May County is considered a coastal county because nearly all its municipalities lie along the tidal portion of the Delaware Bay or the Atlantic Ocean. Figure 5.4.2-1 illustrates the coastal areas of Cape May County.



Figure 5.4.2-1. Coastline of Cape May County



Source: NJDEP





Catastrophic events can alter the natural features of the shoreline, such as beaches, dunes, and wetlands, and threaten people and property. The prediction of a rising sea level and an increase in storm frequency and intensity, vulnerability to the risks of coastal hazards will be exacerbated (NJDEP 2015).

New Jersey Beach Profile Network

In 1986, The Richard Stockton College Coastal Research Center (CRC) established the New Jersey Beach Profile Network (NJBPN) for the purpose of monitoring shoreline conditions along New Jersey's coast. NJBPN consists of over 100 beach profile sites along the entire shoreline of New Jersey, including the Raritan and Delaware Bays. The profile sites are spaced approximately one mile apart, with at least one site located in each oceanfront municipality. The dune, beach, and nearshore are surveyed at each profile site twice a year (fall and spring), and analyzed for seasonal and multiyear changes in shoreline position and sand volume. Reports on all beach profiles are published annually (Stockton University 2015).

In Cape May County, there are 31 NJBPN survey sites along the beaches of Cape May County, consisting of a combination of barrier islands, coastal headlands, and the Delaware Bay shore. There are 27 sites along the Atlantic Ocean and four set along the Delaware Bay of western Cape May County. The profile sites are located in the following municipalities of the County: Ocean City, Strathmere (Upper Township), Sea Isle City, Avalon Borough, Stone Harbor Borough, City of North Wildwood, City of Wildwood, Lower Township, City of Cape May and the Borough of Cape May Point. The four Delaware Bay profiles are located in Reeds Beach (Middle Township), Villas (Lower Township), North Cape May (Lower Township), and Higbee Beach State Park.

Due to the geomorphic conditions of the barrier islands, the northeast corner of each island is vulnerable to northeast wave conditions especially when the main tidal channel lies close to the southern shoreline of the Great Egg Inlet. Additionally, there are four "hot spots" in the County because of this: Ocean City (the Gardens area), Strathmere in Upper Township, Avalon between 10th and 15th Streets, and North Wildwood between 2nd and 5th Avenues. These four locations have high rates of beach erosion due to inlet tidal current processes combined with incident waves impacting the adjacent shoreline. The four spots have consumed 50% of all sand placed in the County since 1983 and are currently in the process of receiving maintenance sand placement with work to start in Strathmere, Avalon and North Wildwood.

For details regarding the restoration and/or beach nourishments efforts within the County, please refer to the NJBPN Annual Reports found here: <http://intraweb.stockton.edu/eyos/page.cfm?siteID=149&pageID=9>

Extent

All beaches are affected by storms and other natural events that cause erosion; however, the extent and severity of erosion differs across the United States. It may be intensified by activities such as boat wakes, shoreline hardening, or dredging. Natural recovery after erosive episodes can take months or years. If a dune or beach does not recover quickly enough via natural processes, coastal and upland property may be exposed to further damage in subsequent events. Coastal erosion can cause the destruction of buildings and infrastructure (FEMA 1996).

Erosion is typically expressed as a rate: rate of linear retreat (feet of shoreline recession per year) or volumetric loss (cubic yards of eroded sediment per linear foot of shoreline frontage per year). Erosion rates are cited as positive numbers, with corresponding shoreline change rates as negative numbers. For example, an erosion rate of two feet per year is equivalent to a shoreline change rate of -2 feet per year. Accretion rates are stated as positive numbers, with corresponding shoreline change rates as positive numbers. For example, an accretion rate of two feet per year is equivalent to a shoreline change rate of two feet per year (FEMA 2015).



Erosion rates are usually computed and cited as long-term, average annual rates. However, erosion rates are not uniform in time or space and can vary substantially. This includes: from one location along the shoreline to another, even when the two locations are only a short distance apart; over time at a single location; or seasonally (FEMA 2015).

Previous Occurrences and Losses

As mentioned previously, coastal erosion can occur gradually as a result of natural processes or from episodic events such as hurricanes, Nor’Easters, and tropical storms. Coastal erosion also results from sea-level rise, which occurs for a variety of reasons. Many sources provided historical information regarding previous occurrences and losses associated with coastal erosion events throughout the State of New Jersey and Hudson County. With so many sources reviewed for the purpose of this HMP, loss and impact information for many events could vary depending on the source. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP.

Between 1954 and 2015, the State of New Jersey was included in eight FEMA coastal erosion-related disasters (DR) or emergencies (EM), classified as one or a combination of the following event types: severe storm, flood, coastal storm, high tides, heavy rain, Nor’Easter, tropical storm, and hurricane. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. Of those eight declarations, Cape May County was included in six of the declarations (FEMA 2016).

Table 5.4.2-1. Coastal Erosion-Related FEMA DR and EM Declarations for Cape May County

FEMA Declaration Number	Date(s) of Event	Event Type	Location
DR-973	December 10-17, 1992	Coastal Storm, High Tides, Heavy Rain, Flooding	Atlantic, Bergen, Cape May, Cumberland, Essex, Hudson, Middlesex, Monmouth, Ocean, Salem, Somerset, Union
DR-1206	February 4-8, 1998	Coastal Storm	Atlantic, Cape May and Ocean
DR-1867	November 11-19, 2009	Severe Storms and Flooding Associated with Tropical Depression Ida and a Nor’Easter	Atlantic, Cape May and Ocean
DR-4021	August 26 – September 5, 2011	Hurricane Irene	Twenty-one Counties in New Jersey including Cape May County
DR-4048	October 29, 2011	Severe Storm	Bergen, Cape May, Essex, Hunterdon, Middlesex, Morris, Passaic, Somerset, Sussex, Union, Warren
DR-4086	October 26 – November 8, 2012	Hurricane Sandy	Twenty-one Counties in New Jersey including Cape May County

Source: FEMA 2016

For this 2016 Plan Update, known coastal erosion events that have impacted Cape May County between 2009 and 2016 are identified in Appendix G. For events prior to 2009, see the 2010 Cape May County HMP. For information regarding coastal erosion events prior to 2009, refer to the 2010 Cape May County HMP. For detailed information on damages and impacts to each municipality, refer to Section 9 (jurisdictional annexes).

Probability of Future Occurrences

Long-term coastal erosion is a continuous and dynamic process, impacting the coastal counties along the Atlantic Ocean and those with shorelines along the Great Lakes. It is anticipated that coastal erosion will continue due to the predicted increase in sea level rise and storm frequency and intensity. In New Jersey, coastal erosion will continue to be an on-going problem along many areas of coastline. It is difficult to assign a probability to the near constant small on-going erosion that may occur over a continuous period of time. However, a probability



can be assigned to larger storm events such as Nor'easters and hurricanes, which can result in significant, rapid coastal erosion. The period of time suggest the probability of coastal erosion will be about the same in the future, with year-to-year variations.

For Cape May County, impacts will vary from place to place along the surge-impacted areas of the County. As temperatures increase (see climate change impacts), the probability for future events will likely increase as well. It is estimated that Cape May County will continue to experience direct and indirect impacts of coastal erosion on occasion.

In Section 5.3, the identified hazards of concern for the County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for coastal erosion in the County is considered 'frequent' (likely to occur within 25 years, as presented in Table 5.3-3).

Climate Change Impacts

Providing projections of future climate change for a specific region is challenging. Shorter term projections are more closely tied to existing trends making longer term projections even more challenging. The further out a prediction reaches the more subject to changing dynamics it becomes. Coastal areas may be impacted by climate change in different ways.

Temperatures in the Northeast United States have increased 1.5 degrees Fahrenheit (°F) on average since 1900. Most of this warming has occurred since 1970. The State of New Jersey, for example, has observed an increase in average annual temperatures of 1.2°F between the period of 1971-2000 and the most recent decade of 2001-2010 (ONJSC, 2011). Winter temperatures across the Northeast have seen an increase in average temperature of 4°F since 1970 (Northeast Climate Impacts Assessment [NECIA] 2007). By the 2020s, the average annual temperature in New Jersey is projected to increase by 1.5°F to 3°F above the statewide baseline (1971 to 2000), which was 52.7°F. By 2050, the temperature is projected to increase 3°F to 5°F (Sustainable Jersey Climate Change Adaptation Task Force 2013).

Changes in global temperatures, hydrologic cycles, coverage of glaciers and ice sheets, and storm frequency and intensity are captured in long-term sea level records. Sea levels provide a key to understanding the impact of climate change (NOAA 2013). Sea level rise increases the risks coastal communities face from coastal hazards (floods, storm surges, and chronic erosion). It may also lead to the loss of important coastal habitats. The historical rate of sea level rise along the New Jersey coast over the past 50 years was 0.12 to 0.16 inches per year. Future rates are predicted to increase to 0.5 inches/year (Miller and Kopp 2013).

Coastal areas are sensitive to sea-level rise, changes in the frequency and intensity of storms, increase in precipitation, and warmer ocean temperatures. According to NASA, warmer temperatures may lead to an increase in frequency of storms, thus leading to more weather events that cause coastal erosion.

5.4.2.2 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable to the identified hazard. Coastal erosion may impact public safety, property, infrastructure, environmental resources and local economies. The following text evaluates and estimates the potential impact of coastal erosion on Cape May County including:

- Overview of vulnerability
- Data and methodology used for the evaluation



- Impact on: (1) life, health and safety of residents, (2) general building stock, (3) critical facilities, (4) economy, and (5) future growth and development
- Effect of climate change on vulnerability
- Change in vulnerability compared to that presented in the 2010 Cape May County Hazard Mitigation Plan
- Further data collections that will assist understanding this hazard over time

Overview of Vulnerability

Coastal erosion is a significant concern because of the large number of communities and cultural resources located along the coast in Cape May County. Beach dunes and other protective measures like sea walls serve as a buffer and protect the built environment and other natural resources on the mainland from coastal storm events such as hurricanes, tropical storms, and nor'easters, which can cause shoreline erosion or accretion. A changing climate and rising sea levels will have devastating impacts on New Jersey's economy, the health of its residents, the State's natural resources, and the extensive infrastructure system that provides transportation services, energy and clear water to millions of people in New Jersey (Rutgers University 2014). Please refer to Section 5.4.1 (Climate Change and Sea Level Rise) and Section 5.4.3 (Flood) for more information on the County's vulnerability to sea level rise and coastal flood hazards.

As summarized earlier, the northeast corner of each barrier island is vulnerable to northeast wave conditions especially when the main tidal channel lies close to the southern shoreline of the Great Egg Inlet. Additionally, there are four "hot spots" in the County with high rates of beach erosion: Ocean City (the Gardens area), Strathmere in Upper Township, Avalon between 10th and 15th Streets, and North Wildwood between 2nd and 5th Avenues.

Data and Methodology

The New Jersey Administrative Code (N.J.A.C.) Coastal Zone Management Rules, amended July 15, 2013, defines erosion hazard areas as, "shoreline areas that are eroding and/or have a history of erosion causing them to be highly susceptible to further erosion, and damage from storms. Erosion hazard areas may be identified by any one of the following characteristics:

- Lack of beaches
- Lack of beaches at high tide
- Narrow beaches
- High beach mobility
- Foreshore extended under boardwalk
- Low dunes or no dunes
- Escarped foredune
- Steep beach slopes
- Cluffed bluffs as adjacent to beach
- Exposed, damaged, or breached jetties, groins, bulkheads, or seawalls
- High long-term erosion rates
- Pronounced downdrift effects of groins (jetties)" (N.J.A.C. 2013)

Further, erosion hazard areas are defined as extending inland from the edge of a stabilized upland area to the limit of the area likely to be eroded in 30 years for one- to four-unit dwelling structures, and 60 years for all other structures, including developed and undeveloped areas (N.J.A.C. 2013). The extent of an erosion hazard area may be calculated by multiplying the projected annual erosion rate at a site by 30 for the development of one- to four-unit dwelling structures, and by 60 for all other developments.



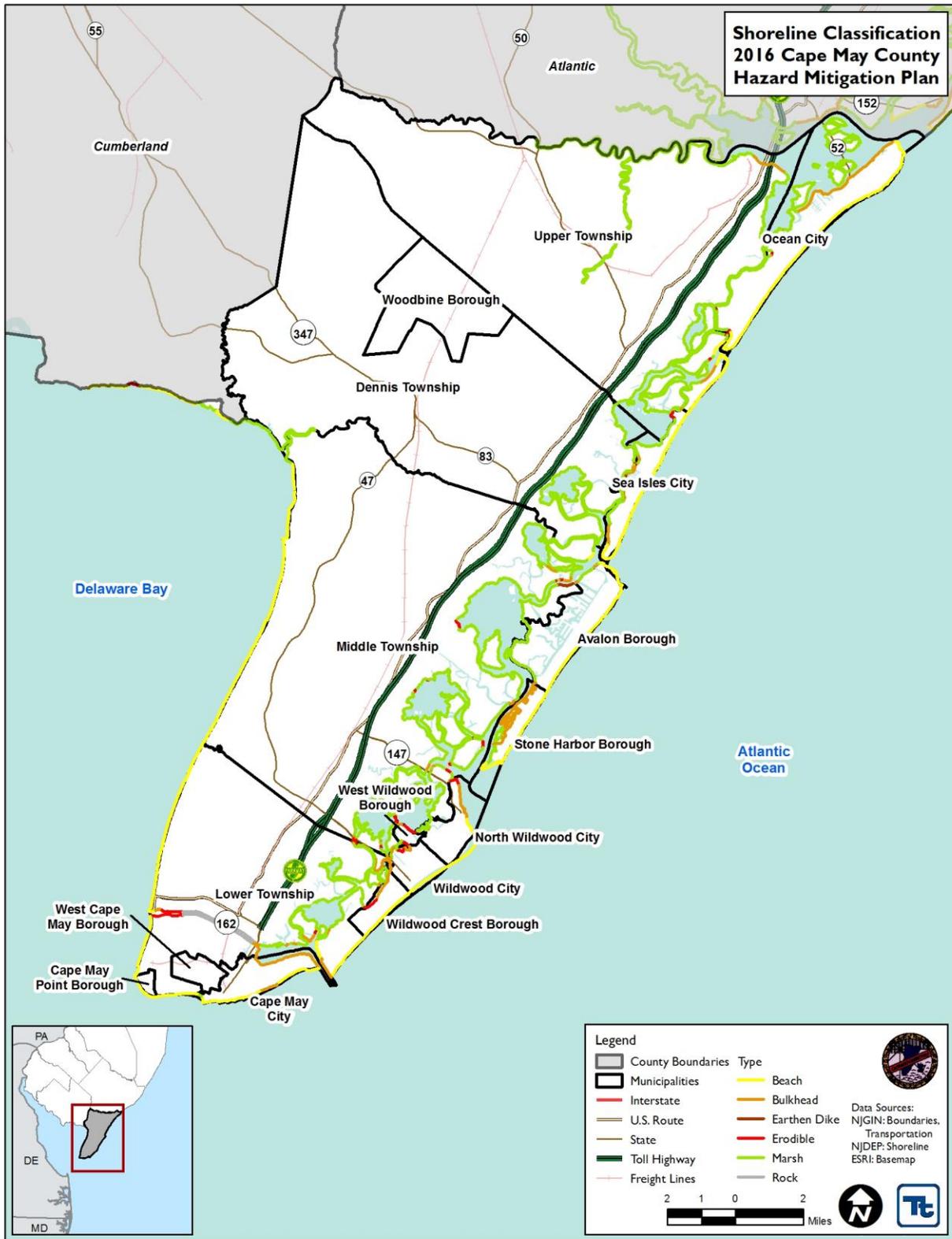
A USGS report for the National Assessment of Shoreline Change entitled *Historical Shoreline Change along the New England and Mid-Atlantic Coasts* was released in 2011. The New England and Mid-Atlantic shores were subdivided into a total of 10 analysis regions for the purpose of reporting regional trends in shoreline change rates. The average rate of long-term shoreline change for the New England and Mid-Atlantic coasts was -0.5 meters per year. The average net long-term rate of shoreline change for the New Jersey ‘North’ region (located from Sandy Hook to south to Little Egg Inlet) was -0.6 meters per year. Meanwhile, the long-term net shoreline change rate in the New Jersey ‘South’ region (located from Little Egg Inlet south to Cape May Point) is strongly accretional (0.8 meters per year) (USGS 2011).

To estimate risk to long-term coastal erosion for purposes of this assessment, the following shoreline types as defined by NJDEP were used: (1) “beach,” which includes waterfront areas composed of 100 percent sand; and (2) “erodible,” which includes any soft shoreline other than beach, such as rock, marsh, sea wall or earthen dike. Figure 5.4.1-2 illustrates the NJDEP shoreline classifications along the coast in Cape May County. To generate the extent of the estimated coastal erosion hazard area, an erosion rate of 0.6 meters per year was multiplied by 60 to include all structure types and developed/undeveloped areas (annual erosion rate of 0.6 meters x 60 years = 36 meters or approximately 120 feet). Although the ‘South’ region indicated an average accretion rate, the average rate of erosion of the ‘North’ region was used as a conservative estimate. Therefore, population, buildings, and infrastructure within 120 feet of the identified beach or erodible shoreline types are identified as potentially vulnerable to coastal erosion. Please note this methodology assumes that once lost to erosion, an area of land is not subsequently restored. This methodology is consistent with that used to evaluate coastal erosion in the 2014 New Jersey State Hazard Mitigation Plan.

Figure 5.4.2-2 illustrates the estimated coastal erosion hazard area in Cape May County as calculated for this planning effort. The analysis presented below is based upon this defined hazard area.



Figure 5.4.2-2. NJDEP Shoreline Classification for Cape May County

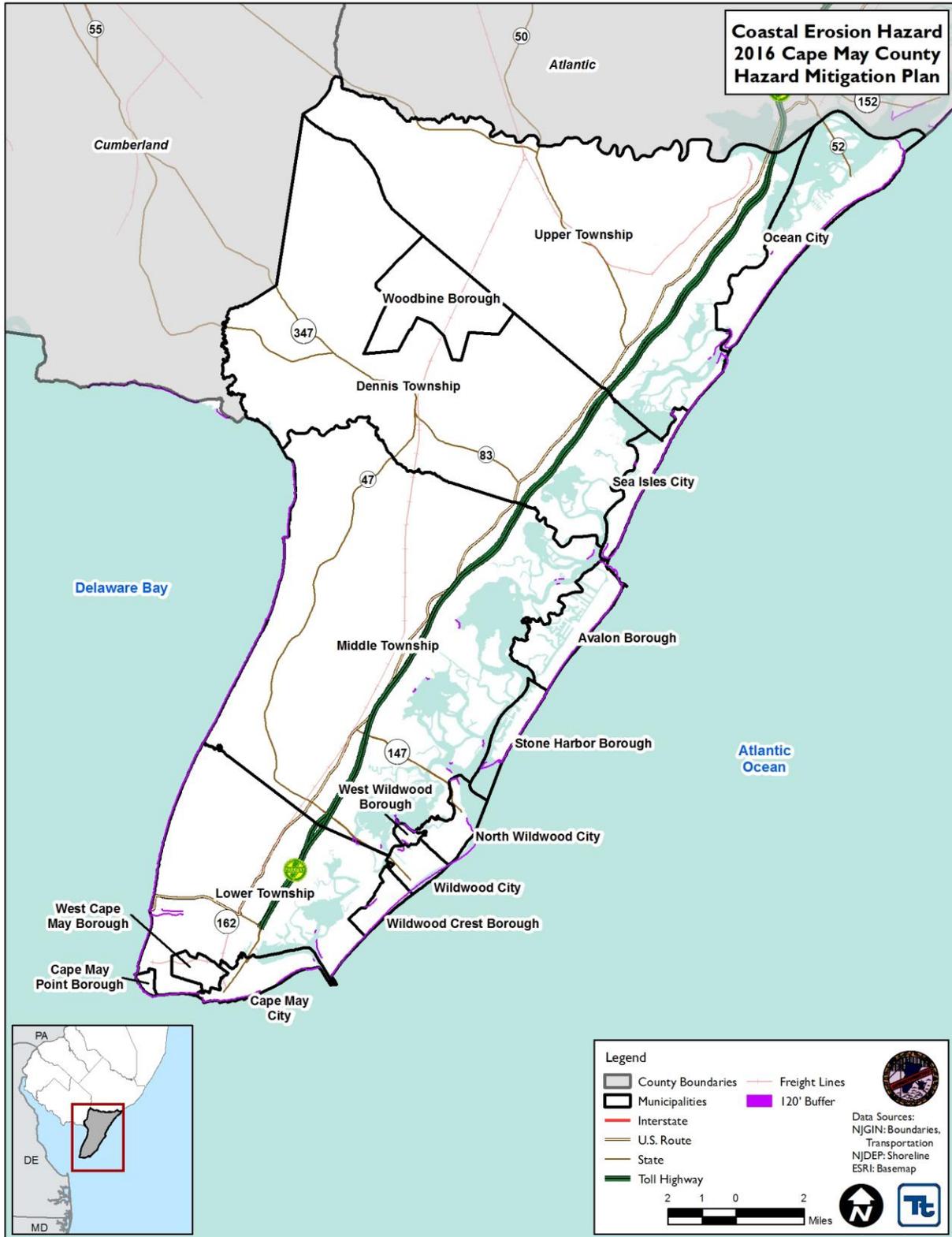


Source: NJDEP





Figure 5.4.2-3. Estimated Coastal Erosion Hazard Area for Cape May County



Source: NJDEP





Impact on Life, Health and Safety

Coastal erosion is not generally considered an imminent threat to public safety when the changes are gradual over many years. However, drastic changes to the shoreline may occur as a result of a single storm event which can threaten homes and public safety. The population exposed, or located in the estimated hazard area, is also considered vulnerable to this hazard.

To estimate population located in the coastal erosion hazard, a spatial analysis was conducted using the centroid of the 2010 Census blocks located within 120 feet of the shoreline. Table 5.4.2-2 summarizes these results by municipality. Please note the limitations of this analysis are recognized and the results should only be used as an estimate. The analysis indicates that 104 people are located in the estimated coastal erosion hazard area. Please note this table does not account for an increase in seasonal population along the County’s coastal shores.

Table 5.4.2-2. Estimated Population Exposed to the Coastal Erosion Hazard

Municipality	U.S. Census 2010 Population	Estimated Population Exposed	
		Number in the Estimated Coastal Erosion Hazard Area	% of Total Exposed
Avalon Borough	1,334	0	0.0%
Cape May City	3,607	0	0.0%
Cape May Point Borough	291	0	0.0%
Dennis Township	6,467	0	0.0%
Lower Township	22,866	13	<1%
Middle Township	18,911	0	0.0%
North Wildwood City	4,041	8	<1%
Ocean City	11,701	35	<1%
Sea Isle City	2,114	27	1.3%
Stone Harbor Borough	866	0	0.0%
Upper Township	12,373	10	<1%
West Cape May Borough	1,024	0	0.0%
West Wildwood Borough	603	11	1.8%
Wildwood City	5,325	0	0.0%
Wildwood Crest Borough	3,270	0	<1%
Woodbine Borough	2,472	0	0.0%
Cape May County (Total)	97,265	104	<1%

Source: U.S. Census 2010, NJDEP

Impact on General Building Stock

To estimate the general building stock exposed to coastal erosion, the updated building inventory was used. The buildings with their centroid in the estimated hazard area were determined in GIS for each municipality. It is estimated that 310 buildings accounting for approximately \$223 million (replacement cost value) are located in the estimated coastal erosion hazard area.



As mentioned above, please note the limitations of this analysis are recognized and the results should only be used as an estimate.

Table 5.4.2-3. Estimated Buildings Exposed to the Coastal Erosion Hazard

Municipality	Total # Buildings	Total RCV (Structure and Contents)	Estimated Building Stock Exposed			
			Number in the Estimated Coastal Erosion Hazard Area	% of Total Exposed	Number in the Estimated Coastal Erosion Hazard Area	% of Total Exposed
Avalon Borough	5,638	\$4,356,689,569	19	<1%	\$17,299,066	<1%
Cape May City	3,841	\$3,632,761,948	6	<1%	\$14,491,249	<1%
Cape May Point Borough	771	\$430,491,384	0	0.0%	\$0	0.0%
Dennis Township	5,399	\$8,441,112,842	0	0.0%	\$0	0.0%
Lower Township	16,092	\$8,900,817,333	11	<1%	\$8,085,436	<1%
Middle Township	18,277	\$9,811,565,458	115	<1%	\$41,689,229	<1%
North Wildwood City	4,933	\$3,628,478,725	8	<1%	\$4,417,409	<1%
Ocean City	13,420	\$10,266,944,384	100	<1%	\$92,951,394	<1%
Sea Isle City	4,092	\$3,541,474,565	26	<1%	\$27,861,236	<1%
Stone Harbor Borough	3,385	\$2,018,537,786	4	<1%	\$3,301,687	<1%
Upper Township	8,064	\$5,687,095,330	0	0.0%	\$0	0.0%
West Cape May Borough	1,624	\$802,060,161	0	0.0%	\$0	0.0%
West Wildwood Borough	879	\$393,019,604	17	1.9%	\$11,861,963	3.0%
Wildwood City	4,202	\$3,814,321,614	0	0.0%	\$0	0.0%
Wildwood Crest Borough	4,209	\$3,148,190,196	4	<1%	\$790,982	<1%
Woodbine Borough	1,884	\$1,176,480,160	0	0.0%	\$0	0.0%
Cape May County (Total)	96,710	\$70,050,041,059	310	<1%	\$222,749,650	<1%

Source: U.S. Census 2010, NJDEP

Impact on Critical Facilities

Coastal erosion can also impact critical facilities. There are nine critical facilities located in the coastal erosion hazard area. Refer to Table 5.4.2-4 for these results by municipality and critical facility type.

Table 5.4.2-4. Critical Facilities Located in the Estimated Coastal Erosion Hazard Area

Municipality	Facility Type		
	Marina	Place of Interest	Wastewater Treatment
Avalon Borough	-	-	2
Cape May City	-	-	-
Cape May Point Borough	-	-	-



Municipality	Facility Type		
	Marina	Place of Interest	Wastewater Treatment
Dennis Township	-	-	-
Lower Township	-	1	-
Middle Township	3	-	-
North Wildwood City	-	-	-
Ocean City	-	-	-
Sea Isle City	2	-	-
Stone Harbor Borough	-	-	-
Upper Township	-	-	-
West Cape May Borough	-	-	-
West Wildwood Borough	-	-	-
Wildwood City	-	-	-
Wildwood Crest Borough	1	-	-
Woodbine Borough	-	-	-
Cape May County (Total)	6	1	2

Source: Cape May County, NJDEP

Impact on Economy

Coastal erosion can also impact roads and infrastructure. As coastline evolution continues, evacuation and emergency routes need to be considered. Cape May County includes many significant roadways used for daily travel and hurricane evacuation routes. Using the hurricane evacuation routes for New Jersey spatial dataset, the exposure of these roadways to coastal erosion is evident. Major roadways that may be impacted by coastal erosion include Delsea Drive, Avalon Blvd, Beach Ave, Ocean Drive, Sea Isle & JFK Blvd, and Madison Ave.

Table 5.4.2-5. Location of Coastal Erosion Vulnerability for Hurricane Evacuation Routes

Evacuation Route	Location of Potential Erosion
Delsea Drive	Southern portion of the roadway near the border of Middle and Lower Townships
Avalon Blvd	Bridge crossing the Ingram Thorofare in Middle Township
Beach Ave	Along the coastline in Cape May City
Ocean Drive	Near the northern border of Sea Isle City and Upper Township; The Townsends Inlet Bridge between Sea Isle City and Avalon Borough; Along the coast of Sunset Lake in Wildwood Crest Borough; The Middle Thorofare Bridge in Lower Township
Sea Isle & JFK Blvd	Bridge crossing the Ludlam Thorofare between Sea Isle City and Dennis Township
Madison Ave	Near the intersection of Beach Ave and Madison Ave in Cape May City

Source: Cape May County, NJDEP



Effect of Climate Change on Vulnerability

Climate is defined not simply as average temperature and precipitation but also by the type, frequency and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of events that exacerbate coastal erosion. While predicting changes of coastal erosion under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society, and the environment (U.S. Environmental Protection Agency [EPA], 2006).

Impacts of climate change can lead to shoreline erosion, coastal flooding, and water pollution, affecting man-made coastal infrastructure and coastal ecosystems. Coastal areas may be impacted by climate change in different ways. Coastal areas are sensitive to sea-level rise, changes in the frequency and intensity of storms, increase in precipitation, and warmer ocean temperatures. Additionally, oceans are absorbing more carbon dioxide from the rising atmospheric concentrations of the gas, resulting in oceans becoming more acidic. This could have significant impacts on coastal and marine ecosystems (EPA 2013). As previously stated, warmer temperatures may lead to an increase in frequency of storms, thus leading to more weather events with potentially increased severity, that cause coastal erosion.

Future Growth and Development

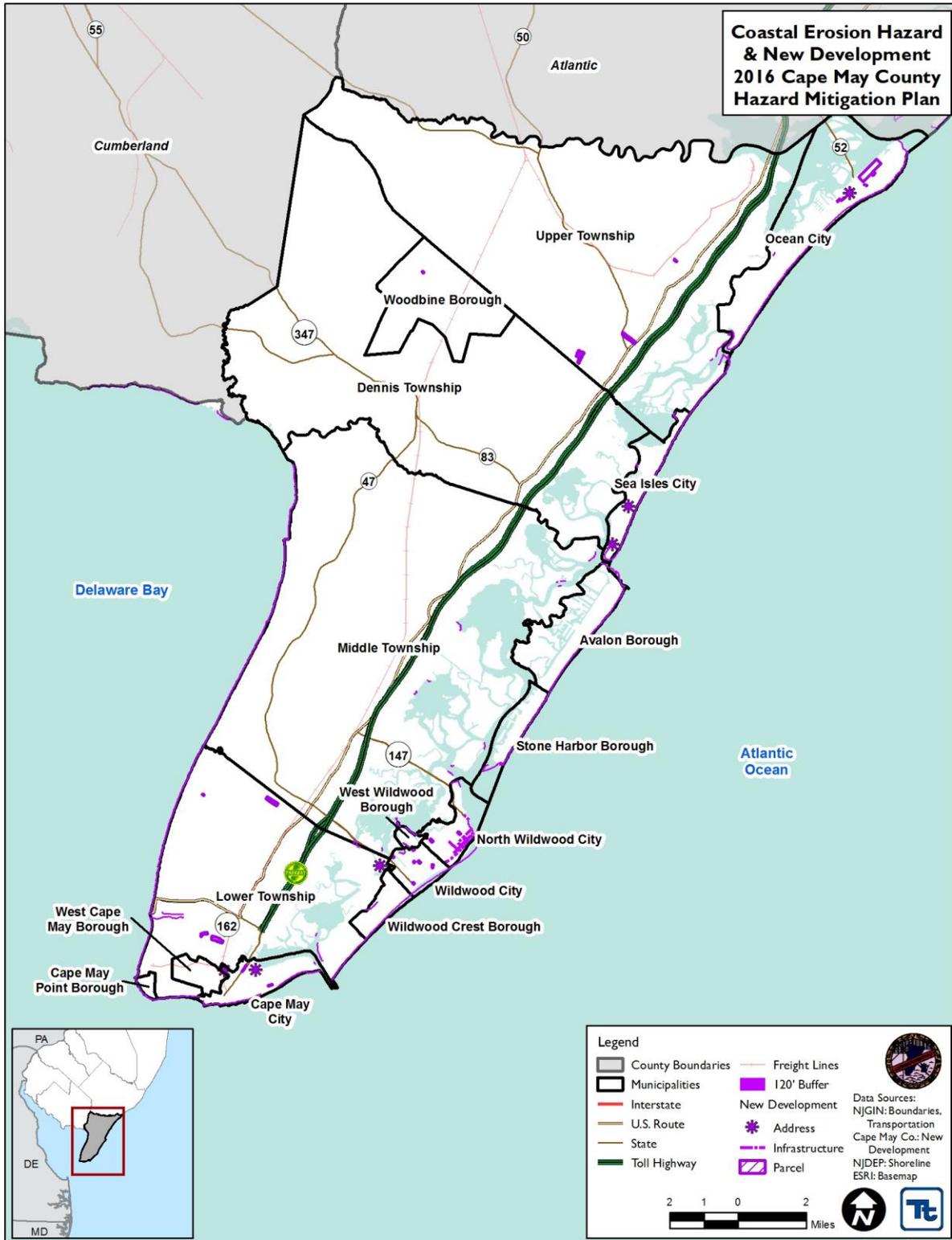
As discussed in Section 4, areas targeted for future growth and development have been identified across the County. Any areas of growth located in the defined coastal erosion hazard areas could be potentially impacted by coastal erosion similar to those that currently exist within the County. Please refer to Figure 5.4.2-4 for the potential new development in the County and the coastal erosion hazard area.

Additional Data and Next Steps

When more comprehensive coastal erosion hazard area maps are created, this section of the plan will be updated to reflect areas and/or assets located in the coastal erosion hazard area. Additional data on historic costs incurred to reconstruct buildings, cultural resources and/or infrastructure due to coastal erosion impacts would assist in estimating future losses.



Figure 5.4.2-4. Potential New Development in Cape May County, FEMA Flood Hazard Area, NFIP Repetitive Loss Areas



Source: FEMA 2015, Cape May County

