5.4.1 Climate Change and Sea Level Rise

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

2021 Plan Update Changes

- New and updated figures from federal and state agencies are incorporated.
- A vulnerability assessment was conducted using best available data from NOAA Office for Coastal Management 2017 sea level rise 1 through 4-foot scenarios, 2020 tax assessor data from Cape May County's jurisdictions, and Cape May County GIS 2020 building and critical facility data, supplemented with 2013 MOD-IV tax assessor data[1] where parcel information was missing.

5.4.1.1 Profile

Hazard Description

Climate Change

Climate change refers to any significant change in the measures of climate lasting for an extended period of time. Climate change includes major changes in temperature, precipitation, or wind patterns, which occur over several decades or longer. New Jersey has experienced a 3.5° F (1.9° C) increase in the State's average temperature since the end of the 1890s (Office of the New Jersey State Climatologist 2020), which is faster than the rest of the Northeast region (2° F [1.1° C]) (Melillo et al. 2014) and the world (1.5° F [0.8° C]) (IPCC 2014). Due to continuing increases in greenhouse gas concentrations, this warming trend is expected to continue. By 2050, temperatures in New Jersey are expected to increase by 4.1 to 5.7° F (2.3° C to 3.2° C) (Horton et al. 2015). Thus, New Jersey can expect to experience an average annual temperature that is warmer than any to date (low emissions scenario) and future temperatures could be as much as 10° F (5.6° C) warmer (high emissions scenario) (Runkle et al. 2017). New Jersey can also expect that by the middle of the 21st century, 70% of summers will be hotter than the warmest summer experienced to date (Runkle et al. 2017). The increase in temperatures is expected to be felt more during the winter months (December, January, and February), resulting in less intense cold waves, fewer sub-freezing days, and less snow accumulation.

As temperatures increase, Earth's atmosphere can hold more water vapor which leads to a greater potential for precipitation. Currently, New Jersey receives an average of 46 inches of precipitation each year (Office of the New Jersey State Climatologist 2020). Since the end of the twentieth century, New Jersey has experienced slight increases in the amount of precipitation it receives each year, and over the last 10 years there has been a 7.9% increase. By 2050, annual precipitation in New Jersey could increase by 4% to 11% (Horton et al. 2015). By the end of this century, heavy precipitation events are projected to occur two to five times more often (Walsh et al. 2014) and with more intensity (Huang et al. 2017) than in the last century. New Jersey will experience more intense rain events, less snow, and more rainfalls (Fan et al. 2014, Demaria et al. 2016, Runkle et al. 2017). Also, small decreases in the amount of precipitation may occur in the summer months, resulting in greater potential for more frequent and prolonged droughts (Trenberth 2011). New Jersey could also experience an increase in the number of flood events (Broccoli et al. 2020).

[1] Please note that the 2013 MOD-IV tax assessor data is the most recent data published for Cape May County.

A warmer atmosphere means storms have the potential to be more intense (Guilbert et al. 2015) and occur more often (Coumou and Rahmstorf 2012, Marquardt Collow et al. 2016, Broccoli et al. 2020). In New Jersey, extreme storms typically include coastal nor'easters, snowstorms, spring and summer thunderstorms, tropical storms, and on rare occasions hurricanes. Most of these events occur in the warmer months between April and October, with nor'easters occurring between September and April. Over the last 50 years, in New Jersey, storms that resulted in extreme rain increased by 71% (Walsh et al. 2014) which is a faster rate than anywhere else in the United States (Huang et al. 2017). As temperatures increase so will the energy in a storm system, increasing the potential for more intense tropical storms (Huang et al. 2017), especially those of Category 4 and 5 (Melillo et al. 2014).

As carbon dioxide concentrations in the atmosphere increase, the chemistry of the ocean will change. Carbon dioxide dissolves in seawater, beginning a chain reaction leading to more acidic conditions. Since the Industrial Revolution, the ocean has become 30% more acidic and ocean pH levels will continue to decline along the coast of New Jersey, causing shellfish and coral species to build weaker shells. Ocean acidification also affects the success of hatching, larval development, organ development, immune response, metabolic processes, and olfaction (smell) in marine species. New Jersey is at increased risk to the effects of ocean acidification due to its economic dependence on shellfish harvests, with southern New Jersey counties ranking second in the United States in economic dependence on shelled mollusks (NRDC 2015). While New Jersey is not predicted to see unfavorable acidification conditions for shellfish until 2100, given the State's dependence on shellfish resources, there could be high social and economic impacts (NRDC 2015, Ekstrom et al. 2015).

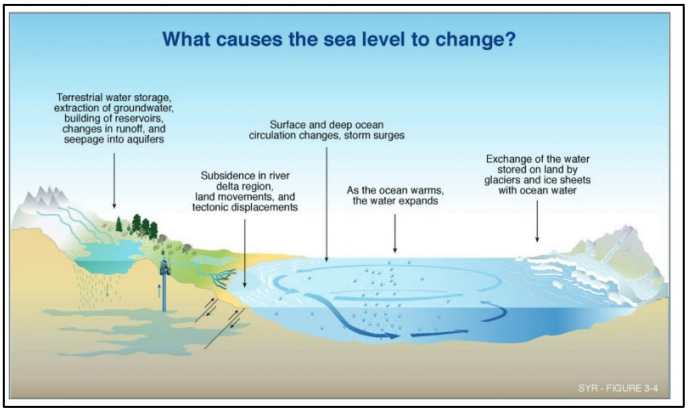
The changing climate impacts populations and ecosystems in numerous ways. For the purpose of this HMP update, this profile will include climate change and sea level rise in Cape May County. Each of the hazard profiles (Section 5.4.2 through Section 5.4.11) discuss the impacts of climate change on each of the hazards of concern for the County.

Sea Level Rise

Sea level rise associated with climate change will have significant effects on coastal areas, including Cape May County. Long-term sea level records show changes in global temperatures, hydrologic cycles, coverage of glaciers and ice sheets, and storm frequency and intensity. Sea levels provide a key to understanding the impact of climate change.

There are two types of sea level: global and relative. Global sea level rise refers to the increase currently observed in the average global sea level trend (primarily attributed to changes in ocean volume due to ice melt and thermal expansion). The melting of glaciers and continental ice masses can contribute significant amounts of freshwater input to the earth's oceans. In addition, a steady increase in global atmospheric temperature creates an expansion of salt water molecules, increasing ocean volume. Figure 5.4.1-1 illustrates the causes of sea level change.

Figure 5.4.1-1. Causes of Sea Level Change



Source: U.S. Climate Resilience Toolkit 2019

Local sea level refers to the height of the water as measured along the coast relative to a specific point on land. Water level measurements at tide stations are referenced to stable vertical points on the land and a known relationship is established. Measurements at any given tide station include both global sea level rise and vertical land motion (subsidence, glacial rebound, or large-scale tectonic motion). The heights of both the land and water

are changing; therefore, the land-water interface can vary spatially and temporally and must be defined over time. Relative sea level trends reflect changes in local sea level over time and are typically the most critical sea level trend for many coastal applications (coastal mapping, marine boundary delineation, coastal zone management, coastal engineering, and sustainable habitat restoration) (U.S. Climate Resilience Toolkit 2019).

Short-term variations in sea level typically occur on a daily basis and include waves, tides, or specific flood events. Long-term variations in sea level occur over various time scales, from monthly to several years and may be repeatable cycles, gradual trends, or intermittent differences. Seasonal weather patterns (changes in the earth's declination), changes in coastal and ocean circulation, anthropogenic influences, vertical land motion, etc. may influence changes in sea level over time. When estimating sea level trends, a minimum of 30 years of data are used in order to account for long-term sea level variations and reduce errors in computing sea level trends based on monthly mean sea level (U.S. Climate Resilience Toolkit 2019).

In New Jersey, sea levels are rising faster than they are globally due to changes in the Gulf Stream, localized land subsidence, and continued geologic influences as land slowly adjusts to the loss of the North American ice sheet at the end of the last ice age. In Atlantic City, Cape May, and Sandy Hook, sea-level has risen at a rate of approximately 0.2 to 0.5 inches per year since the beginning of the 20th century, and this rate will continue to increase (Kopp et al. 2019). The amount of greenhouse gases that are emitted is tied to rates of sea level rise. By 2050, New Jersey will likely experience at least a 0.9 to 2.1-foot increase (above the levels in 2000; all emissions scenarios), 1.4 to 3.1-foot increase by 2070 (moderate emissions scenario), and potentially a 2.0 to 5.1-foot increase by 2100 (moderate emissions scenario) (Kopp et al. 2019). Understanding how precipitation and sea level rise will change in the future is vital to New Jersey's coastal zone because low-lying coastal areas are already experiencing tidal flooding, even on sunny days in the absence of precipitation events.

According to NOAA, sea level rise can amplify factors that currently contribute to coastal flooding: high tides, storm surge, high waves, and high runoff from rivers and creeks. All of these factors change during extreme weather and climate events (NOAA 2012). Other secondary hazards that could occur along the mid-Atlantic coast in response to sea level rise:

- Bluff and upland erosion – shorelines composed of older geologic units that form headland regions of the coast will retreat landward with rising sea level. As sea level rises, the uplands are eroded and sandy materials are incorporated into the beach and dune systems along the shore and adjacent compartments (Gutierrez et al. 2007).
- Overwash, inlet processes, shoreline retreat, and barrier island narrowing – as sea level rise occurs, storm overwash will become more likely. Tidal inlet formation and migration will become important components of future shoreline changes. Barrier islands are subject to inlet formation by storms. If the storm surge produces channels that extend below sea level, an inlet may persist after the storm. The combination of rising sea level and stronger storms can create the potential to accelerate shoreline retreat in many locations. Assessments of shoreline change on barrier islands have shown that barrier island narrowing has been observed on some islands over the last 100 years (Gutierrez et al. 2007).
- Threshold behavior – changes in sea level can lead to conditions where a barrier system becomes less stable and crosses a geomorphic threshold; making the potential for rapid barrier-island migration or segmentation/disintegration high. Unstable barriers may be defined by rapid landward recession of the ocean shoreline, decrease in barrier width and height, increased overwashing during storms, increased barrier breaching and inlet formation, or chronic loss of beach and dune sand volume. With the rates of sea level rise and climate change, it is very likely that these conditions will worsen (Gutierrez et al. 2007).
- Loss of critical habitat – natural ecosystems may be impacted by warmer temperatures and associated changes in the water cycle. The changes could lead to loss of critical habitat and further stresses on some threatened and endangered species (Rutgers 2013).

An increase in sea level will cause further issues as stormwater recharge is challenged as sea-levels submerge discharge points, resulting in increases in flooding (Kopp et al. 2019).

Location

Climate change is a concern for the entire United States and it will impact all areas of the country. Sea level rise is associated with climate change and has been experienced by coastal communities for the past 100 years. In New Jersey, coastal communities include any land adjacent to a tidally influenced waterway and includes the Atlantic Coast and the Delaware Bayshore (Kopp et al. 2019). Cape May County is located in the coastal areas of New Jersey and is vulnerable to both climate change and sea level rise. According to Table 5.4.1-1 and Figure 5.4.1-2, sea level rise of just one foot will impact nearly half of Cape May County.

Table 5.4.1-1. Total Land Area Affected by Sea Level Rise Hazard Areas

Total Acres in County	Hazard Area Type	Number of Acres Exposed to the Sea Level Rise Hazard Areas	Percent of Total
183,127	Sea Level Rise +1 foot	65,049	35.5%
	Sea Level Rise +2 foot	71,860	39.2%
	Sea Level Rise +3 foot	77,002	42.0%
	Sea Level Rise +4 foot	83,098	45.4%

Source: Cape May County GIS 2020; NOAA 2017

Notes: Acres of County does include waterways within county boundary; % = Percent

Extent

The extent (or severity) of climate change and sea level rise may pose a significant threat to the people, homes, businesses, and infrastructure of Cape May County. The following provides a description of the extent for climate change and sea level rise.

Climate Change

Each day, thousands of land and ocean temperatures are recorded around the world. This includes measurements from climate reference stations, weather stations, ships, buoys and autonomous gliders in the oceans. The surface measurements are also supplemented with satellite measurements. The global surface temperature is based on air temperature data over land and sea surface temperatures observed from ships, buoys, and satellites. Based on these measurements, there is a clear long-term global warming trend. In the United States, surface temperatures averaged across the country have also risen (NOAA NCDC 2020).

The U.S. Climate Extremes Index (CEI) was developed to quantify observed changes in climate within the contiguous United States. The CEI is the average of five indicators of the percentage of the specific area in the United States. These five indicators include:

1) The sum of (a) percentage of the United States with maximum temperatures much below normal and (b) percentage of the United States with maximum temperatures much above normal;

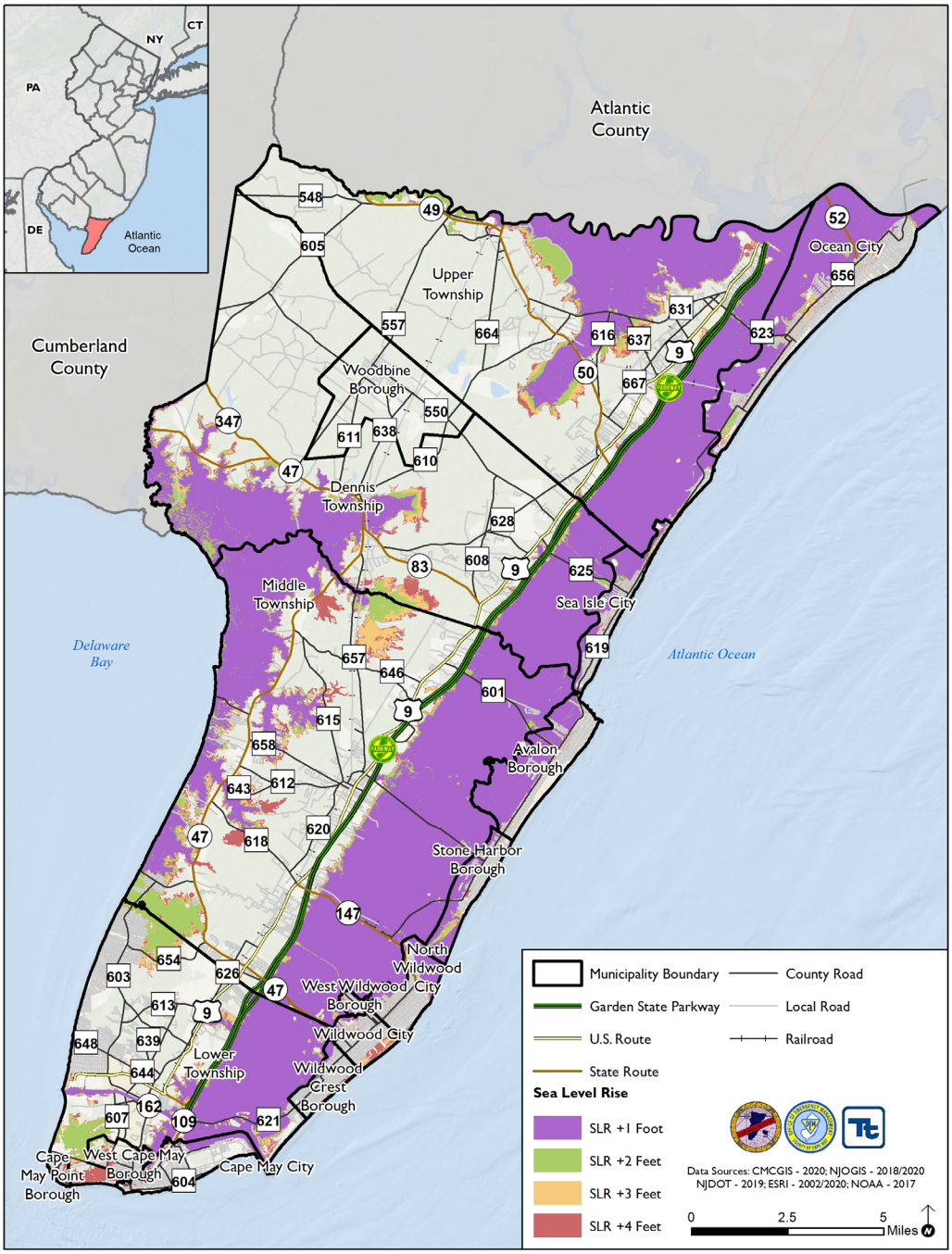
2) The sum of (a) percentage of the United States with minimum temperatures much below normal and (b) percentage of the United States with minimum temperatures much above normal;

3) The sum of (a) percentage of the United States in severe drought (equivalent to the lowest tenth percentile) based on the PDSI and (b) percentage of the United States with severe moisture surplus (equivalent to the highest tenth percentile) based on the PDSI;

4) Twice the value of the percentage of the United States with a much greater than normal proportion of precipitation derived from extreme (equivalent to the highest tenth percentile) 1-day precipitation events; and

5) The sum of (a) percentage of the United States with a much greater than normal number of days with precipitation and (b) percentage of the United States with a much greater than normal number of days without precipitation

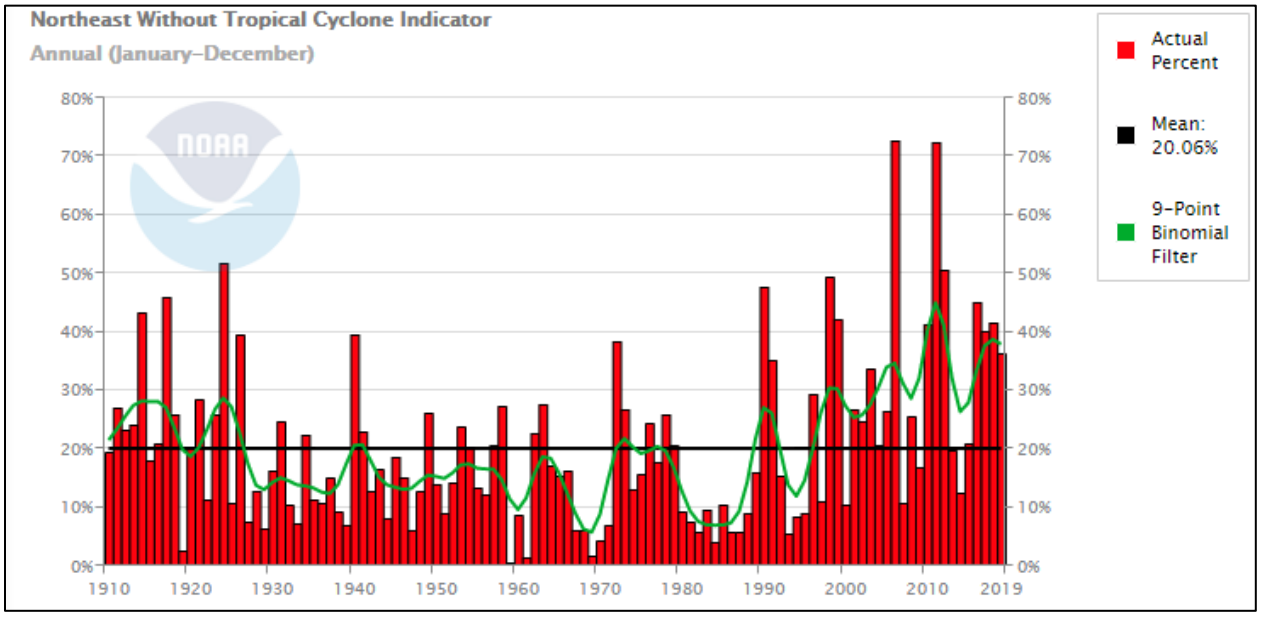
Figure 5.4.1-2. Sea Level Rise Scenarios for Cape May County



There is a sixth indicator (the sum of squares of U.S. landfalling tropical storm and hurricane wind velocities scaled to the mean of the first five indicators); however, it is only used when the period of interest includes months with significant tropical activity. The figure below shows the CEI graph for the northeast United States, which includes New Jersey and Cape May County. A value of 0% for the CEI indicates that no portion of the period of record was subject to any extremes of temperature or precipitation considered in the index. A value of 100% means that the entire country had extreme conditions throughout the year for each of the indicators. Therefore, observed CEI values of more than 20 percent indicate "more extreme" conditions than average, and CEI values less than 20 percent indicate "less extreme" conditions than average.

The figure below (Figure 5.4.1-3) shows the CEI for the northeast United States, from 1910 to 2019. According to this figure, in the last 30 years, the northeast has experienced extreme conditions for the indicators of the CEI (NOAA NCDC 2020).

Figure 5.4.1-3. Northeast CEI, 1910-2019



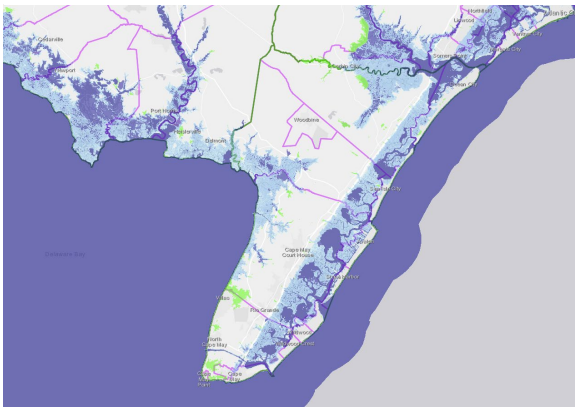
Source: NOAA NCDC 2020

Sea Level Rise

For New Jersey, Rutgers University, in partnership with other academic, local, federal and state agencies and programs, has developed online tools that help provide an understanding of how climate change is affecting and will continue to affect the State. With the interactive, user-centered NJFloodmapper web tool, New Jersey decision-makers can visualize flood risk due to sea level rise and extreme storms to aid resilience and hazard mitigation planning efforts. NJFloodmapper streamlines the latest spatial data and decision-support tools into a single resource that provides current, accessible, science-based and state-specific data and visualizations.

NJFloodmapper offers a unique Total Water Level approach to flood risk visualization that reflects user-defined combinations of sea level rise and flood conditions, providing flexibility to evaluate a range of flood conditions and time horizons for planning. NJFloodmapper also includes enhanced data layers that show physical infrastructure, evacuation routes, land uses, and socio-demographics to give a fuller picture of community vulnerability. Users can choose hazard overlays including Total Water Level, SLOSH for Categories 1-4, Sea Level Rise for 1-10 feet, FEMA Flood Zones, and Sandy Surge Extent. After creating a map, users can share a link or create a pdf for further use (Figure 5.4.1-4).

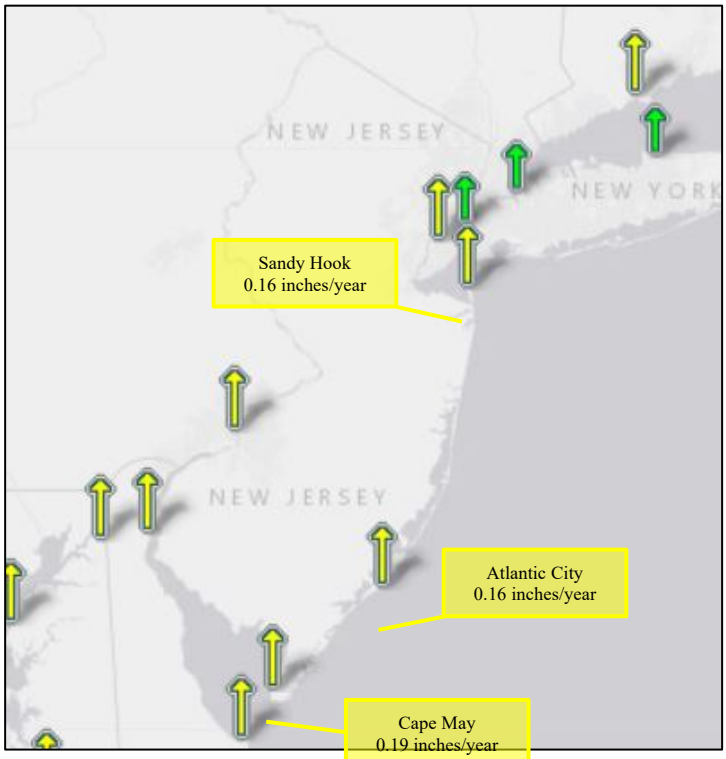
Figure 5.4.1-4. Screenshot of NJFloodMapper



NJFloodmapper also includes Municipal Snapshots that provide easy access to information about the people, places, and assets that are at risk from coastal flood hazards in each of New Jersey's municipalities. The mapping portal is found here: https://www.njfloodmapper.org/. In addition, Cape May County has its own flood tool located at https://cmcgis.maps.arcgis.com/apps/MapSeries/index.html?appid=dfc9972f2f8f4c92bce2187194d81ff5.

The global sea level trend has been recorded by satellite altimeters since 1992 and the latest calculation can be obtained from NOAA's Laboratory for Satellite Altimetry. The University of Colorado's Sea Level Research Group compares global sea level rates calculated by different research organizations and provides detailed explanations about the issues involved (NOAA 2020). A map of regional MSL in the United States can be found here: http://tidesandcurrents.noaa.gov/sltrends/slrmap.htm. The map provides an overview of variations in the rates of relative local MSL at long-term tide stations. The variations in sea level trends primarily reflect differences in rates and sources of vertical land motion. Areas that experienced little-to-no change in MSL are shown in green, including stations consistent with average global sea level rise rate of 1.7 to 1.8 mm/year. These stations do not experience significant vertical land motion. Stations that experienced positive sea level trends (yellow to red) experience both global sea level rise and lowering or sinking of the local land, causing an apparent exaggerated rate of relative sea level rise. Stations that are blue to brown have experienced global sea level rise and a greater vertical rise in local land, causing an apparent decrease in relative sea level. The rates of relative sea level rise reflect actual observations and must be accounted for in any coastal planning or engineering applications (NOAA 2020).

Figure 5.4.1-5. Mean Sea Level Trends in New Jersey



Source: NOAA 2020

There are three NOAA tide gauge stations located in New Jersey. This is where tide gauge measurements are made with respect to

a local fixed reference level on land. Figure 5.4.1-4 shows these changes for Atlantic City, Sandy Hook, and Cape May. Table 5.4.1-2 presents the history and MSL trends at the three New Jersey stations, which show the result of a combination of the global sea level rate and the local vertical land motion.

Table 5.4.1-2. Linear MSL Trends and 95% Confidence Intervals

Station Name	First Year	Year Range	For all data to 2019 MSL Trend (inches/year)
Atlantic City	1911	108	0.16
Cape May	1965	54	0.19
Sandy Hook	1932	87	0.16

Source: NOAA 2020
MSL Mean Sea Level

Additionally, in an article titled "A geological perspective on sea level rise and its impacts along the U.S. mid-Atlantic coast" written by Kenneth Miller, Robert Kopp, Benjamin Horton, James Browning, and Andrew Kemp, an analysis of geological and historical sea level records was done. This showed a significant rate of increase in sea level rise since the 19th century. It was stated that in New Jersey, it is extremely likely that sea level rise in the 20th century was faster than during any century in the last 4,300 years. Based on the findings of this article and the 2019 update of the initial study, it is anticipated that the arrival of one foot of sea level rise will be experienced before 2050. As sea level rise is expected to accelerate in this century, three feet of sea level rise is very likely before 2100. The table below (Table 5.4.1-3) shows the "low", "high", and "best" estimates for sea level rise projects in New Jersey for the years 2050 and 2100. "Best" refers to a 50% likelihood of that level of sea level rise occurring.

Table 5.4.1-3. Sea Level Rise Projections for New Jersey (ft. above year 2000 average sea level) for New Jersey From 2030 to 2150 Under Low, Moderate and High Emissions Scenarios.

Low End	Chance SLR Exceeds >95% chance	2030 0.3	2050 0.7	2070 Emissions Low 0.9	2070 Emissions Mod. 1.0	2070 Emissions High 1.1	2100 Emissions Low 1.0	2100 Emissions Mod. 1.3	2100 Emissions High 1.5	2150 Emissions Low 1.3	2150 Emissions Mod. 2.1	2150 Emissions High 2.9
Likely Range	>83% chance	0.5	0.9	1.3	1.4	1.5	1.7	2.0	2.3	2.4	3.1	3.8
	~50% chance	0.8	1.4	1.9	2.2	2.4	2.8	3.3	3.9	4.2	5.2	6.2
	<17% chance	1.1	2.1	2.7	3.1	3.5	3.9	5.1	6.3	6.3	8.3	10.3
High End	<5% chance	1.3	2.6	3.2	3.8	4.4	5.0	6.9	8.8	8.0	13.8	19.6

Source: Kopp et al. 2019
Note: The likely range represents the range of levels between which there is 66% chance that SLR will occur

Looking at Figure 5.4.1-2, just one foot of sea level rise will inundate the eastern coast of Cape May County, which is dominated by salt marsh, including northern sections of Upper Township, portions of Dennis Township, and the western border of Middle Township along the Delaware Bay.

Previous Occurrences and Losses

Climate change and sea level rise have been documented since the 19th century. New Jersey has experienced a 3.5° F (1.9° C) increase in the State's average temperature (Office of the New Jersey State Climatologist 2020). This warming trend is expected to continue. Since the end of the twentieth century, New Jersey has experienced slight increases in the amount of precipitation it receives each year, and over the last 10 years there has been a

7.9% increase. Data has shown that mean sea level rise in Cape May County is 0.19 inches/year. Since the turn of the twentieth century, sea level has risen approximately 16 inches along the Jersey Shore.

One method assessing impacts from climate change and sea level rise is through measuring the persistence of high tide flooding. NOAA defines high tide flooding as the inundation that occurs when ocean waters reach 0.5 m to 0.65 m (1.64 ft to 2.13 ft) above daily average high tide (mean higher high water) and begin to bubble up from storm drains and spill onto streets. According to a 2019 report by the National Weather Service, 2009 was the year of record for high tide flooding (14 days). The number of days with high tide flooding per year has increased from three in 2000 to seven in 2019 and is projected to increase to 15-30 by 2030 and 55-135 by 2050 (NOAA 2019).

Specific financial losses due to climate change and sea level rise are not easily quantifiable. However, sea level rise has likely contributed to flood damages experienced in the last century by increasing the overall elevation of flood waters and contributing to the climatic conditions that cause storms to develop.

Probability of Future Occurrences

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. Impacts of climate change on coastal communities in New Jersey, like Cape May County, will primarily result from sea level rise and extreme storm events.

Sea level has been gradually rising for the past 100 years and the rate of sea level rise is predicted to accelerate as a result of climate change (refer to the Extent section of this profile). Rising sea levels will continue to increase occurrences of inundation and erosion along the coastal areas of Cape May County. Coastal communities in the County may also see an increase risk of flood-related damages to homes, businesses and infrastructure. An increase in sea level also implies that storm surges will operate from an elevated base, so severe coastal flooding may be more frequent in the future (NJ Climate Adaptation Alliance 2016).

Based on information provided earlier in this profile, Cape May County will experience the effects of a changing climate in the future. These effects may include an increase in a number of severe weather events, erosion along the coastline, and an increase in the degree of damage as a result of storms and flooding. Refer to the other hazard profiles (Section 5.4.2-10) for the probability of future occurrence for coastal erosion, disease outbreak, flood, hurricanes/tropical storms, Nor'Easters, severe weather, severe winter weather, tsunami, and wildfire.

In Section 5.3, the identified hazards of concern for Cape May 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 climate change and sea level rise in the County is considered 'frequent' (100% chance of occurring, occurs multiple times a year).

5.4.1.2 Vulnerability Assessment

To assess Cape May County's risk to climate change and sea level rise, a qualitative review of climate impacts in the County was assessed in addition to a spatial analysis that was conducted using the best available spatially-delineated sea level rise data from NOAA. Sea level rise 2017 data was used to conduct an exposure analysis for the 1- through 4-foot inundation areas. These results are summarized below. Refer to Section 5.1 (Methodology and Tools) for additional details on the methodology used to assess the County's risk to climate change and sea level rise.

Impact on Life, Health and Safety

The entire population of Cape May County is exposed to potential impacts from warmer temperatures and severe weather events associated with climate change. For more detailed discussion on the impacts of extreme temperature and severe weather events, refer to the Severe Weather profile (Section 5.4.8).

People living and working in the sea level rise hazard area may be displaced as homes and businesses become flooded and permanently lost. To estimate population exposed and vulnerable to the sea level rise hazards, a spatial analysis was conducted using the NOAA sea level rise inundation areas; refer to Table 5.4.1-4. This table summarizes the impacts of sea level rise for the 1-foot through 4-foot scenarios by Cape May County's municipalities. Please note the limitations of this analysis are recognized and the results should only be used as an estimate.

The analysis estimates that 508 persons living in the sea level rise +1 foot hazard area and up to 15,738 persons living in the sea level rise +4 foot hazard area. Overall, West Wildwood Borough has the greatest proportion of its population in the sea level rise hazard areas that may be displaced (i.e., 26.8-percent in the +1 foot hazard area and up to 99.2-percent in the +4 foot hazard area). Additionally, Middle Township has the greatest number of persons residing in the +1 foot and +2 foot sea level rise hazard areas that may be displaced (i.e., 191 and 457 persons, respectively), and Ocean City has the greatest number of persons residing in the +3 foot and +4 foot sea level rise hazard areas that may be displaced (i.e., 2,086 and 4,579 persons, respectively).

Table 5.4.1-4. Estimated Population Exposed to the Sea Level Rise Hazard Areas

Jurisdiction	American Community Survey (2014-2018) Total Population	Estimated Population Exposed							
		Number of Persons Exposed to Sea Level Rise +1 foot	Percent of Total	Number of Persons Exposed to Sea Level Rise +2 foot	Percent of Total	Number of Persons Exposed to Sea Level Rise +3 foot	Percent of Total	Number of Persons Exposed to Sea Level Rise +4 foot	Percent of Total
Avalon Borough	1,409	1	0.1%	3	0.2%	64	4.6%	322	22.9%
Cape May City	3,491	14	0.4%	22	0.6%	64	1.8%	409	11.7%
Cape May Point Borough	188	0	0.0%	0	0.0%	0	0.0%	59	31.5%
Dennis Township	6,244	2	0.0%	7	0.1%	16	0.3%	34	0.5%
Lower Township	21,838	80	0.4%	127	0.6%	524	2.4%	1,160	5.3%
Middle Township	18,492	191	1.0%	457	2.5%	985	5.3%	1,738	9.4%
North Wildwood City	3,849	14	0.4%	165	4.3%	1,215	31.6%	2,236	58.1%
Ocean City	11,202	53	0.5%	343	3.1%	2,086	18.6%	4,579	40.9%
Sea Isle City	1,955	4	0.2%	10	0.5%	147	7.5%	772	39.5%
Stone Harbor Borough	955	0	0.0%	4	0.4%	90	9.4%	273	28.6%
Upper Township	11,909	6	0.1%	59	0.5%	277	2.3%	623	5.2%
West Cape May Borough	1,103	0	0.0%	4	0.4%	19	1.8%	243	22.0%
West Wildwood Borough	376	101	26.8%	294	78.2%	363	96.4%	373	99.2%
Wildwood City	5,073	41	0.8%	236	4.6%	1,441	28.4%	2,536	50.0%
Wildwood Crest Borough	3,131	1	0.0%	13	0.4%	74	2.3%	381	12.2%
Woodbine Borough	2,490	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Cape May County (Total)	**93,705**	**508**	**0.5%**	**1,742**	**1.9%**	**7,366**	**7.9%**	**15,738**	**16.8%**

Source: American Community Survey 2018; NOAA 2017
Notes: % = Percent

Research has shown that some populations, while they may not have more hazard exposure, may experience exacerbated impacts and prolonged recovery if/when impacted. This is due to many factors including their physical and financial ability to react or respond during a hazard. Of the population exposed, the most vulnerable include the economically disadvantaged and the population over age 65. Economically disadvantaged populations may be more vulnerable because they are likely to evaluate their risk and make decisions to evacuate based on net economic impacts on their families. The population over age 65 is also more vulnerable because they are more likely to seek or need medical attention that may not be available due to isolation during a flood event, and they may have more difficulty evacuating. Within Cape May County, there are approximately 23,572 people over the age of 65 and 10,140 people below the poverty level (American Community Survey 2018). In the three jurisdictions where the most persons or highest proportion of persons are within the sea level rise hazard areas (i.e., West Wildwood Borough, Middle Township, and Ocean City), persons over 65 years old make up 39.9-percent, 21.3-percent, and 31.6-percent of the municipality's total population (American Community Survey 2018).

The New Jersey 2019 Hazard Mitigation Plan suggests that changes in sea level rise will be a key indicator to understanding the impacts climate change is having on the State (State of New Jersey 2019). Based on the projections provided in the state hazard mitigation plan, climate change may exacerbate the effects of sea level rise in the State. Persons that are living in the projected inundation areas caused by future sea level rise may experience greater risk due to the fluctuations in climate and areas bordering inundation areas may be at higher risk to flooding events.

Impact on General Building Stock

The County's entire building stock is exposed to potential impacts from warmer temperatures and severe weather events associated with climate change. For more detailed discussion on the impacts of extreme temperature and severe weather events, refer to the Severe Weather profile (Section 5.4.8).

Structures and land may become permanently inundated due to sea level rise over time. Exposure to the sea level rise hazard areas was determined using NOAA's 2017 1-foot increment spatial data and updated building stock data for Cape May County. Up to 19.8-percent of the County's total replacement cost value and up to 20.4-percent of the County's total building stock is estimated to be located in the +4 foot sea level rise hazard area and at risk to permanent inundation. This is a value of approximately $17.9 billion in building and content costs for the County. Overall, West Wildwood Borough and Ocean City have the greatest number of buildings and replacement cost value located in the +1 through +4 foot sea level rise hazard areas (i.e., 215 and 626 buildings in West Wildwood Borough for the +1 and +2 foot sea level rise hazard areas; 3,443 and 7,496 buildings in Ocean City for the +3 and +4 foot sea level rise hazard areas). Refer to Table 5.4.1-5 and Table 5.4.1-6 for a breakdown of general building stock exposure summarized by municipality. It is important to keep in mind that there are impacts not reported in these results due to the unpredictable changes in climate that could exacerbate the impacts sea level rise on the building stock in the County.

Table 5.4.1-5. Estimated General Building Stock and Replacement Cost Value Exposed to the +1 foot and +2 foot Sea Level Rise Hazard Areas

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposed to the Sea Level Rise Hazard Areas							
			Number of Buildings Exposed - Sea Level Rise + 1 foot	Percent of Total	Total Replacement Cost Value Exposed - Sea Level Rise + 1 foot	Percent of Total	Number of Buildings Exposed - Sea Level Rise + 2 foot	Percent of Total	Total Replacement Cost Value Exposed - Sea Level Rise + 2 foot	Percent of Total
Avalon Borough	5,867	$8,232,959,879	7	0.1%	$6,461,488	0.1%	13	0.2%	$8,777,953	0.1%
Cape May City	4,234	$5,153,049,612	18	0.4%	$22,892,723	0.4%	28	0.7%	$31,609,249	0.6%
Cape May Point Borough	785	$663,183,164	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Dennis Township	7,301	$3,813,425,173	3	0.0%	$1,992,275	0.1%	7	0.1%	$3,272,619	0.1%
Lower Township	19,597	$9,950,232,225	71	0.4%	$25,189,189	0.3%	118	0.6%	$50,011,925	0.5%
Middle Township	18,197	$11,557,342,752	167	0.9%	$49,746,146	0.4%	480	2.6%	$139,022,281	1.2%
North Wildwood City	4,729	$4,423,365,953	18	0.4%	$11,571,932	0.3%	193	4.1%	$116,604,672	2.6%
Ocean City	18,172	$17,100,920,036	90	0.5%	$60,287,388	0.4%	574	3.2%	$417,034,339	2.4%
Sea Isle City	6,712	$7,663,928,227	14	0.2%	$8,751,675	0.1%	36	0.5%	$27,611,556	0.4%
Stone Harbor Borough	3,836	$3,291,756,871	0	0.0%	$0	0.0%	14	0.4%	$14,833,423	0.5%
Upper Township	9,627	$6,506,171,365	8	0.1%	$6,706,164	0.1%	45	0.5%	$32,596,816	0.5%
West Cape May Borough	1,623	$1,178,516,373	0	0.0%	$0	0.0%	7	0.4%	$2,075,913	0.2%
West Wildwood Borough	805	$459,103,094	215	26.7%	$87,268,313	19.0%	626	77.8%	$312,631,574	68.1%
Wildwood City	3,679	$4,379,038,844	30	0.8%	$27,100,287	0.6%	157	4.3%	$102,222,691	2.3%
Wildwood Crest Borough	5,410	$4,552,156,876	1	0.0%	$286,221	0.0%	22	0.4%	$19,015,605	0.4%
Woodbine Borough	1,416	$1,335,589,432	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Cape May County (Total)	**111,990**	**$90,260,739,877**	**642**	**0.6%**	**$308,253,801**	**0.3%**	**2,320**	**2.1%**	**$1,277,320,617**	**1.4%**

Source: Cape May County GIS 2020; MOV-ID 2013; RS Means 2019; NOAA 2017
Notes: % = Percent

Table 5.4.1-6. Estimated General Building Stock and Replacement Cost Value Exposed to the +3 foot and +4 foot Sea Level Rise Hazard Areas

Jurisdiction	Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposed to the Sea Level Rise Hazard Areas							
			Number of Buildings Exposed - Sea Level Rise + 3 foot	Percent of Total	Total Replacement Cost Value Exposed - Sea Level Rise + 3 foot	Percent of Total	Number of Buildings Exposed - Sea Level Rise + 4 foot	Percent of Total	Total Replacement Cost Value Exposed - Sea Level Rise + 4 foot	Percent of Total
Avalon Borough	5,867	$8,232,959,879	275	4.7%	$317,084,954	3.9%	1,349	23.0%	$1,628,907,915	19.8%
Cape May City	4,234	$5,153,049,612	82	1.9%	$83,895,405	1.6%	500	11.8%	$478,848,397	9.3%
Cape May Point Borough	785	$663,183,164	0	0.0%	$0	0.0%	245	31.2%	$227,712,035	34.3%
Dennis Township	7,301	$3,813,425,173	17	0.2%	$8,545,966	0.2%	39	0.5%	$24,021,383	0.6%
Lower Township	19,597	$9,950,232,225	481	2.5%	$221,234,057	2.2%	1,102	5.6%	$510,881,744	5.1%
Middle Township	18,197	$11,557,342,752	1,010	5.6%	$320,887,172	2.8%	1,723	9.5%	$652,416,848	5.6%
North Wildwood City	4,729	$4,423,365,953	1,431	30.3%	$916,458,803	20.7%	2,699	57.1%	$1,891,479,570	42.8%
Ocean City	18,172	$17,100,920,036	3,443	18.9%	$2,467,888,642	14.4%	7,496	41.3%	$5,905,104,782	34.5%
Sea Isle City	6,712	$7,663,928,227	506	7.5%	$475,890,037	6.2%	2,657	39.6%	$2,822,880,368	36.8%
Stone Harbor Borough	3,836	$3,291,756,871	364	9.5%	$295,168,367	9.0%	1,104	28.8%	$894,135,788	27.2%
Upper Township	9,627	$6,506,171,365	192	2.0%	$104,930,344	1.6%	431	4.5%	$262,359,973	4.0%
West Cape May Borough	1,623	$1,178,516,373	31	1.9%	$15,698,589	1.3%	328	20.2%	$228,347,465	19.4%
West Wildwood Borough	805	$459,103,094	772	95.9%	$428,876,311	93.4%	794	98.6%	$447,868,047	97.6%
Wildwood City	3,679	$4,379,038,844	940	25.6%	$610,413,671	13.9%	1,690	45.9%	$1,339,903,138	30.6%
Wildwood Crest Borough	5,410	$4,552,156,876	125	2.3%	$99,942,236	2.2%	653	12.1%	$537,611,026	11.8%
Woodbine Borough	1,416	$1,335,589,432	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Cape May County (Total)	**111,990**	**$90,260,739,877**	**9,669**	**8.6%**	**$6,366,914,554**	**7.1%**	**22,810**	**20.4%**	**$17,852,478,479**	**19.8%**

Source: Cape May County GIS 2020; MOV-ID 2013; RS Means 2019; NOAA 2017
Notes: % = Percent

Impact on Critical Facilities

All of the County's critical facilities are exposed to potential impacts from warmer temperatures and severe weather events associated with climate change. For more detailed discussion on the impacts of extreme temperature and severe weather events, refer to the Severe Weather profile (Section 5.4.8).

Sea level rise may potentially impact critical facilities identified within the County. Critical services may not be available if critical facilities are directly damaged or transportation routes to access these critical facilities are permanently inundated by sea level rise. Residual impacts from sea level rise include increased frequency of coastal flooding events and coastal erosion. Flooding could disrupt utilities that are not protected with berms or other flood-proof measures. Coastal erosion may destabilize the roadways leading to facilities or destroy the foundation that supports the critical facilities along the shoreline.

Overall, most of the critical facilities within the sea level rise hazard areas are marinas. Bridges and wastewater pump stations are the second most exposed categories of critical facilities for the County. Middle Township and Lower Township have the greatest number of critical facilities located in the +1 and +2 foot sea level rise hazard areas, whereas Ocean City has the greatest number of critical facilities located in the +3 and +4 foot sea level rise hazard areas. Nearly 30-percent of the County's critical facilities are built in the projected +4 foot sea level rise hazard area, (i.e., 218 total). Of the total critical facilities exposed to the +4 foot sea level rise hazard area, 217 are considered lifelines for the County. Refer to Table 5.4.1-7 and Table 5.4.1-8 for a summary of critical facilities and lifelines exposed to the sea level rise hazard areas for each municipality. Table 5.4.1-9 through Table 5.4.1-12 show the distribution of exposed critical facilities by type in each municipality.

Table 5.4.1-7. Critical Facilities and Lifelines Exposed to the +1 foot and +2 foot Sea Level Rise Hazard Areas

Jurisdiction	Total Critical Facilities	Total FEMA Lifelines	+ 1 foot Sea Level Rise				+ 2 foot Sea Level Rise			
			Number of Critical Facilities Exposed	Percent of Total	Number of Lifelines Exposed	Percent of Total	Number of Critical Facilities Exposed	Percent of Total	Number of Lifelines Exposed	Percent of Total
Avalon Borough	30	30	6	20.0%	6	20.0%	6	20.0%	6	20.0%
Cape May City	32	32	9	28.1%	9	28.1%	9	28.1%	9	28.1%
Cape May Point Borough	10	10	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Dennis Township	60	60	1	1.7%	1	1.7%	2	3.3%	2	3.3%
Lower Township	111	111	13	11.7%	13	11.7%	16	14.4%	16	14.4%
Middle Township	181	181	17	9.4%	17	9.4%	18	9.9%	18	9.9%
North Wildwood City	30	29	0	0.0%	0	0.0%	2	6.7%	2	6.9%
Ocean City	59	58	10	16.9%	10	17.2%	17	28.8%	17	29.3%
Sea Isle City	26	26	3	11.5%	3	11.5%	4	15.4%	4	15.4%
Stone Harbor Borough	26	26	1	3.8%	1	3.8%	1	3.8%	1	3.8%
Upper Township	73	68	7	9.6%	7	10.3%	9	12.3%	9	13.2%
West Cape May Borough	10	10	1	10.0%	1	10.0%	1	10.0%	1	10.0%
West Wildwood Borough	8	8	4	50.0%	4	50.0%	6	75.0%	6	75.0%
Wildwood City	39	37	2	5.1%	2	5.4%	5	12.8%	5	13.5%
Wildwood Crest Borough	23	23	1	4.3%	1	4.3%	1	4.3%	1	4.3%
Woodbine Borough	21	21	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Cape May County (Total)	**739**	**730**	**75**	**10.1%**	**75**	**10.3%**	**97**	**13.1%**	**97**	**13.3%**

Source: Cape May County GIS 2020; NOAA 2017
Notes: % = Percent

Table 5.4.1-8. Critical Facilities and Lifelines Exposed to the +3 foot and +4 foot Sea Level Rise Hazard Areas

Jurisdiction	Total Critical Facilities	Total FEMA Lifelines	+ 3 foot Sea Level Rise				+ 4 foot Sea Level Rise			
			Number of Critical Facilities Exposed	Percent of Total	Number of Lifelines Exposed	Percent of Total	Number of Critical Facilities Exposed	Percent of Total	Number of Lifelines Exposed	Percent of Total
Avalon Borough	30	30	13	43.3%	13	43.3%	23	76.7%	23	76.7%
Cape May City	32	32	9	28.1%	9	28.1%	12	37.5%	12	37.5%
Cape May Point Borough	10	10	0	0.0%	0	0.0%	1	10.0%	1	10.0%
Dennis Township	60	60	4	6.7%	4	6.7%	4	6.7%	4	6.7%
Lower Township	111	111	25	22.5%	25	22.5%	28	25.2%	28	25.2%
Middle Township	181	181	20	11.0%	20	11.0%	23	12.7%	23	12.7%
North Wildwood City	30	29	4	13.3%	4	13.8%	17	56.7%	16	55.2%
Ocean City	59	58	31	52.5%	31	53.4%	43	72.9%	43	74.1%
Sea Isle City	26	26	8	30.8%	8	30.8%	16	61.5%	16	61.5%
Stone Harbor Borough	26	26	4	15.4%	4	15.4%	8	30.8%	8	30.8%
Upper Township	73	68	10	13.7%	10	14.7%	13	17.8%	13	19.1%
West Cape May Borough	10	10	2	20.0%	2	20.0%	3	30.0%	3	30.0%
West Wildwood Borough	8	8	6	75.0%	6	75.0%	6	75.0%	6	75.0%
Wildwood City	39	37	9	23.1%	9	24.3%	17	43.6%	17	45.9%
Wildwood Crest Borough	23	23	1	4.3%	1	4.3%	4	17.4%	4	17.4%
Woodbine Borough	21	21	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Cape May County (Total)	**739**	**730**	**146**	**19.8%**	**146**	**20.0%**	**218**	**29.5%**	**217**	**29.7%**

Source: Cape May County GIS 2020; NOAA 2017
Notes: % = Percent

Table 5.4.1-9. Distribution of Critical Facilities Exposed to the +1 foot Sea Level Rise Hazard Area

Jurisdiction	Critical Facilities Exposed to +1 foot Sea Level Rise									
	Bridge	Dams	DPW	Marinas	Municipal Facilities	Potable Water Facilities	Superfund Sites	Wastewater Facilities	Wastewater Pump Station	Well
Avalon Borough	3	0	0	3	0	0	0	0	0	0
Cape May City	1	0	2	1	0	1	1	0	0	3
Dennis Township	0	1	0	0	0	0	0	0	0	0
Lower Township	3	0	0	9	0	0	0	0	1	0
Middle Township	9	0	0	7	0	0	0	0	1	0
Ocean City	4	0	0	4	0	0	0	1	1	0
Sea Isle City	2	0	0	1	0	0	0	0	0	0
Stone Harbor Borough	1	0	0	0	0	0	0	0	0	0
Upper Township	4	0	0	3	0	0	0	0	0	0
West Cape May Borough	1	0	0	0	0	0	0	0	0	0
West Wildwood Borough	0	0	0	3	1	0	0	0	0	0
Wildwood City	0	0	0	2	0	0	0	0	0	0
Wildwood Crest Borough	0	0	0	1	0	0	0	0	0	0
Cape May County (Total)	**28**	**1**	**2**	**34**	**1**	**1**	**1**	**1**	**3**	**3**

Source: Cape May County GIS 2020; NOAA 2017
Notes: % = Percent

Table 5.4.1-10. Distribution of Critical Facilities Exposed to the +2 foot Sea Level Rise Hazard Area

Jurisdiction	Critical Facilities Exposed to +2 foot Sea Level Rise														
	Bridge	Communications Tower	Dams	DPW	Marinas	Medical Clinics	Municipal Facilities	Police Stations	Polling Places	Potable Water Facilities	Senior Facility	Superfund Sites	Wastewater Facilities	Wastewater Pump Station	Well
Avalon Borough	3	0	0	0	3	0	0	0	0	0	0	0	0	0	0
Cape May City	1	0	0	2	1	0	0	0	0	1	0	1	0	0	3
Dennis Township	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Lower Township	3	0	0	0	12	0	0	0	0	0	0	0	0	1	0
Middle Township	9	0	0	0	8	0	0	0	0	0	0	0	0	1	0
North Wildwood City	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0
Ocean City	4	0	0	0	4	0	0	0	0	0	1	2	1	5	0
Sea Isle City	2	0	0	0	1	0	0	0	0	0	0	0	0	1	0
Stone Harbor Borough	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upper Township	5	0	0	0	3	0	0	0	0	0	0	0	0	0	1
West Cape May Borough	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
West Wildwood Borough	0	0	0	0	3	0	1	1	1	0	0	0	0	0	0
Wildwood City	0	0	0	0	3	1	0	0	0	0	0	0	0	1	0
Wildwood Crest Borough	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Cape May County (Total)	**29**	**2**	**1**	**2**	**39**	**1**	**1**	**1**	**1**	**1**	**1**	**3**	**1**	**10**	**4**

Source: Cape May County GIS 2020; NOAA 2017
Notes: % = Percent

Table 5.4.1-11. Distribution of Critical Facilities Exposed to the +3 foot Sea Level Rise Hazard Area

Jurisdiction	Critical Facilities Exposed to +3 foot Sea Level Rise																		
	Airport	Bridge	Communications Facility	Communications Tower	Dams	DPW	Fire Stations	Marinas	Medical Clinics	Municipal Facilities	Police Stations	Polling Places	Potable Water Facilities	Primary Education	Senior Facility	Superfund Sites	Wastewater Facilities	Wastewater Pump Station	Well
Avalon Borough	0	3	0	0	0	0	0	3	0	0	0	0	0	1	0	0	0	6	0
Cape May City	0	1	0	0	0	2	0	1	0	0	0	0	1	0	0	1	0	0	3
Dennis Township	0	0	0	1	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Lower Township	0	3	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	6	2
Middle Township	0	9	0	1	0	0	0	8	0	0	0	0	0	0	0	0	1	1	0
North Wildwood City	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0
Ocean City	1	6	0	0	0	0	0	4	0	1	0	1	0	2	1	3	1	11	0
Sea Isle City	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	4	0
Stone Harbor Borough	0	1	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Upper Township	0	5	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	1
West Cape May Borough	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
West Wildwood Borough	0	0	0	0	0	0	0	3	0	1	1	1	0	0	0	0	0	0	0
Wildwood City	0	1	0	0	0	0	0	3	2	0	0	0	1	0	0	0	0	2	0
Wildwood Crest Borough	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Cape May County (Total)	**1**	**32**	**1**	**4**	**2**	**2**	**1**	**46**	**3**	**2**	**1**	**2**	**2**	**3**	**1**	**4**	**2**	**31**	**6**

Source: Cape May County GIS 2020; NOAA 2017
Notes: % = Percent

Table 5.4.1-12. Distribution of Critical Facilities Exposed to the +4 foot Sea Level Rise Hazard Area

Jurisdiction	Critical Facilities Exposed to +4 foot Sea Level Rise																													
	Airport	Bridge	Communications Facility	Communications Tower	County Facilities	Dams	DPW	Education	Electric Substation	EMS	EOC	Ferry Facilities	Fire Stations	Library	Marinas	Medical Clinics	Municipal Facilities	Natural Gas Facility	Police Stations	Polling Places	Potable Water Facilities	Primary Education	Recreation	Secondary Education	Senior Facility	Superfund Sites	Wastewater Facilities	Wastewater Pump Station	Well
Avalon Borough	0	3	0	1	0	0	0	0	0	0	0	0	0	2	4	0	2	0	1	0	0	1	0	0	0	0	0	9	0
Cape May City	0	1	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	1	0	2	3
Cape May Point Borough	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Dennis Township	0	0	0	1	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lower Township	0	3	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	1	0	7	3
Middle Township	0	9	0	1	0	1	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	1	0	0	1	1	1
North Wildwood City	0	0	0	2	1	0	0	0	0	1	1	0	3	0	1	0	0	1	0	1	0	2	1	0	1	0	0	2	0
Ocean City	1	6	0	0	0	0	0	0	0	0	0	1	2	0	6	1	1	0	1	3	0	2	0	0	1	3	1	14	0
Sea Isle City	0	2	0	0	0	0	0	0	0	0	1	0	0	1	2	0	0	0	0	1	0	0	0	0	0	1	0	7	1
Stone Harbor Borough	0	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	2	1
Upper Township	0	5	0	0	0	0	0	0	0	0	0	0	1	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	1
West Cape May Borough	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
West Wildwood Borough	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	1	1	0	0	0	0	0	0	0	0	0
Wildwood City	0	1	0	0	0	0	1	1	1	0	0	0	0	0	3	2	0	2	0	1	1	2	0	0	0	0	0	2	0
Wildwood Crest Borough	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Cape May County (Total)	**1**	**32**	**1**	**8**	**1**	**3**	**3**	**1**	**1**	**1**	**2**	**1**	**6**	**4**	**51**	**4**	**4**	**4**	**3**	**7**	**2**	**8**	**1**	**1**	**2**	**6**	**2**	**48**	**10**

Source: Cape May County GIS 2020; NOAA 2017
Notes: % = Percent

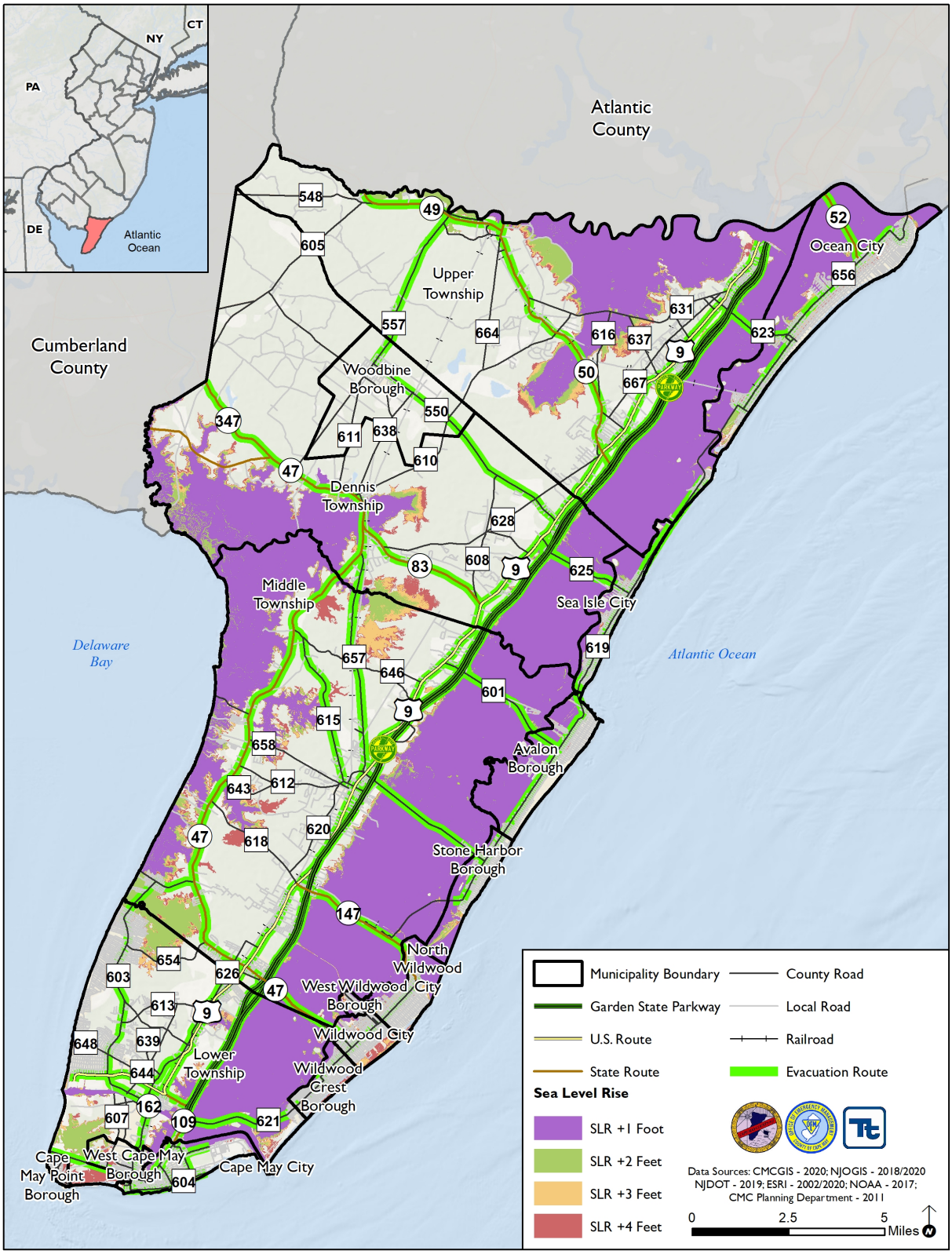
Additionally, sea level rise can have a major impact on transportation routes in the County, particularly roadways that serve as evacuation routes for the community. Evacuation routes in the County are at risk of becoming breached with rising tide or erosion along the shoreline caused by sea level rise. If these routes become inoperable from flooding or the infrastructure becomes unstable from erosion and/or permanent inundation, these communities can become isolated during an evacuation event. Overall, out of the 224 miles of evacuation routes in the County, approximately 15-percent will become inundated by the projected +4 foot sea level rise hazard area (refer to Table 5.4.1-13). Roadways at risk of sea level rise inundation include: State Road 109, State Road 49, State Road 50, State Road 52, North Wildwood Blvd, Delsea Dr, Avalon Blvd, Bayshore & Jonathan Hoffman Rd, Sunset Blvd, Goshen Rd & Mechanic St, Ocean Dr, Pittsburgh & Texas Ave, Roosevelt Blvd, Sea Isle & JFK Blvd, Sea Shore Rd & Railroad Ave, Lafayette Ave, Delaware Ave, Bay Ave, Stone Harbor Blvd, and Garden Statement Parkway. Refer to Figure 5.4.1-5 for the estimated number of miles evacuation routes in Cape May County will be exposed to the projected sea level rise hazard areas.

Table 5.4.1-13. Miles of Evacuation Routes Exposed to the Sea Level Rise Hazard Areas

Total Miles of Evacuation Routes in County	Sea Level Rise Hazard Area	Total Miles of Evacuation Routes Exposed to the Sea Level Rise Hazard Areas	Percent of Total
224	Sea Level Rise +1 foot	3	1.5%
	Sea Level Rise +2 foot	6	2.5%
	Sea Level Rise +3 foot	20	8.7%
	Sea Level Rise +4 foot	33	14.9%

Source: Cape May County GIS 2020; NOAA 2017; Cape May County Planning Department 2011
Notes: % = Percent

Figure 5.4.1-6. Evacuation Routes Exposed to Sea Level Rise in Cape May County



Impact on the Economy

Vulnerability to sea level rise is assessed as the potential permanent loss of land and assets. This permanent loss will severely impact the economy given the presence of major infrastructure and residential and commercial properties associated with the tourism industry along the coast in Cape May County. In addition, the densely developed coast has high property values and contributes to the tax base, as well as local and regional economies. The total replacement cost value of structures located in the +1 foot through +4 foot sea level rise inundation areas are $308.3 million, $1.3 billion, $6.4 billion, and $17.9 billion, respectively.

Additionally, disruption to business operations can occur in cases where infrastructure is breached by erosion caused by sea level rise. Loss of income may occur as a secondary impact if businesses are closed under repairs due to this breaching. To prevent these potential business losses, public expenditures may need to be spent to implement shoreline stabilizers and to protect key infrastructure like highways and interstates that follow along the coastline.

For discussion on the impacts of climate change influenced extreme temperature and severe weather events on the economy, refer to the Severe Weather profile (Section 5.4.8).

Impact on Land Use Types and the Environment

According to the State of New Jersey 2019 Hazard Mitigation Plan, sea level rise exacerbates coastal erosion and shoreline destabilization. Erosion would inhibit these natural landscapes to perform important ecosystem services such as buffering against future land loss, filtering pollutants, and maintaining a livable habitat that enhances the aesthetics of these coastal environments. Consequentially, natural habitats that would mitigate and protect the coastline become unstable and require replenishment actions (State of New Jersey 2019). The 2019 State Hazard Mitigation Plan references a 2016 report by Rutgers University Science and Technical Advisory Panel (STAP), which projects a 50-percent probability that:

- By 2030, sea level rise will meet or exceed 0.8 feet;
- By 2050, sea level rise will meet or exceed 1.4 feet;
- By 2100, sea level rise will meet or exceed 2.3 feet.

It should be noted that while the current State Hazard Mitigation Plan references the Rutgers STAP projections, at this time, there is no agreed upon model across agencies in the State to project sea level rise. The STAP report was updated in 2019 to slightly increase the expected sea level rise likely to occur in 2100 (3.3 feet in a moderate emissions scenario).

In addition, an exposure analysis utilizing the NOAA 2017 sea level rise projections and the acreage of land use types were assessed for Cape May County's updated hazard mitigation plan. Residential, non-residential, and natural land use types were assessed using the 2015 NJDEP land use land cover data for Cape May County. Overall, natural land use types are the most exposed to the sea level rise hazard areas (up to 55.9-percent). Refer to Table 5.4.1-14.

Table 5.4.1-14. Land Use Types Exposed to the Sea Level Rise Hazard Areas

Land Use Type	Total Acres of Land Use Type Category in Cape May County	Land Use Types Exposed to Sea Level Rise + 1 foot Hazard Area	Percent of Total Acres of Land Use Type	Land Use Types Exposed to Sea Level Rise + 2 foot Hazard Area	Percent of Total Acres of Land Use Type	Land Use Types Exposed to Sea Level Rise + 3 foot Hazard Area	Percent of Total Acres of Land Use Type	Land Use Types Exposed to Sea Level Rise + 4 foot Hazard Area	Percent of Total Acres of Land Use Type
Residential Land Use Type	22,296	142	0.6%	566	2.5%	1,744	7.8%	3,311	14.9%
Non-Residential Land Use Type	160,338	64,865	40.5%	71,214	44.4%	75,060	46.8%	79,469	49.6%
Natural Land Use Type	139,026	64,731	46.6%	70,815	50.9%	74,068	53.3%	77,683	55.9%
Cape May County (Total)	**182,633****	**65,008**	**35.6%**	**71,780**	**39.3%**	**76,804**	**42.1%**	**82,781**	**45.3%**

Sources: NJDEP 2015; NOAA 2017

Notes:

Residential land use types from the 2015 land use land cover data include mixed residential, residential high density or multiple dwelling, residential rural single unit, residential single unit low density, and residential single unit medium density.

Non-residential land use types include: agricultural wetlands (modified), airport facilities, altered lands, artificial lakes, athletic fields (schools), Atlantic Ocean*, bare exposed rock, rock slides, etc*, beaches*, bridge over water, commercial/services, coniferous brush/shrubland*, coniferous forest (>50% crown closure)*, coniferous forest (10-50% crown closure)*, coniferous scrub/shrub wetlands*, coniferous wooded wetlands*, cropland and pastureland, deciduous brush/shrubland*, deciduous forest (>50% crown closure)*, deciduous forest (10-50% crown closure)*, deciduous scrub/shrub wetlands*, deciduous wooded wetlands*, disturbed tidal wetlands*, disturbed wetlands (modified)*, dredged lagoon, former agricultural wetland (becoming shrubby, not built-up), herbaceous wetlands*, industrial, major roadway, managed wetland in built-up maintained rec area*, managed wetland in maintained lawn greenspace*, military installations, mixed deciduous/coniferous brush/shrubland*, mixed forest (>50% coniferous with >50% crown closure)*, mixed forest (>50% coniferous with 10-50% crown closure)*, mixed forest (>50% deciduous with >50% crown closure)*, mixed forest (>50% deciduous with 10-50% crown closure)*, mixed scrub/shrub wetlands (coniferous dom.)*, mixed scrub/shrub wetlands (deciduous dom.)*, mixed urban or built-up land, mixed wooded wetlands (coniferous dom.)*, mixed wooded wetlands (deciduous dom.)*, natural lakes*, old field (< 25% brush covered)*, open tidal bays*, orchards/vineyards/nurseries/horticultural areas, other urban or built-up land, phragmites dominate coastal wetlands*, phragmites dominate interior wetlands*, phragmites dominate old field*, railroads, recreational land, saline marsh (high marsh)*, saline marsh (low marsh)*, stadium, theaters, cultural centers and zoos, stormwater basin, streams and canals*, tidal mud flat*, tidal rivers, inland bays, and other tidal waters*, transitional areas, transportation/communication/utilities, upland rights-of-way undeveloped*, vegetated dune communities, and wetland rights-of-way*.*

Please note, natural land areas are a sub-section of non-residential land use types and are referenced with an asterisk (*).

***Acres is based upon the NJDEP 2015 boundary, which could over or underestimate the number of acres of land area compared to the County boundary provided by the County*

For more detailed discussion on the impacts of climate change influenced extreme temperature and severe weather events on land use and the environment, refer to the Severe Weather (Section 5.4.8).

Cascading Impacts on Other Hazards

Sea level rise and climate change can exacerbate the impacts of coastal erosion, drought, flooding, hurricanes, tropical storms, Nor'Easters, severe weather, severe winter weather, tsunamis, and wildfires. However, truly understanding the future impacts sea level rise and climate change will have on other hazards is challenging. As discussed in earlier sections, sea level rise projections show that coastal areas will become inundated. This inundation may cause a loss in protective shoreline dunes and stabilizing plant material. Further, the level of inundation will vary along the shoreline, which will change the flood dynamics of the coastal communities. Climate change will have an effect on all natural hazards of concern for the County and are discussed in Section 5.4.2 (Coastal Erosion), Section 5.4.4 (Drought), Section 5.4.5 (Flood), Section 5.4.6 (Hurricane and Tropical Storms), Section 5.4.7 (Nor'Easter), Section 5.4.8 (Severe Weather), Section 5.4.9 (Severe Winter Weather), Section 5.4.10 (Tsunami), and Section 5.4.11 (Wildfire).

Future Changes That May Impact Vulnerability

Understanding future changes that affect vulnerability can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The County considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Projected Development

As discussed in Section 4 (County Profile), areas targeted for future growth and development have been identified across Cape May County. Any areas of growth located in the projected sea level rise hazard areas may become permanently inundated. It is recommended that the County and municipal partners implement design strategies that mitigate against the risk of sea level rise and climate change or avoid development in potential sea level rise inundation areas.

Cape May County has already begun mitigation projects to help reduce the future impacts sea level rise will have on future development. The New Jersey State Hazard Mitigation Plan lists several projects that have been proposed, are ongoing, or have been complete in Cape May County such as a beach nourishment projects, inlet flood reduction projects, and coastal habitat restoration and protection projects (State of New Jersey 2019).

Projected Changes in Population

Cape May County has experienced population declines since 2010. However, the County has a highly variable seasonal population that is estimated to be an eight-fold increase from its year-round population. These population increases are most noticeable in barrier island communities such as Ocean City, where the Census population of 11,701 people in 2010 explodes to an estimated 147,612 people when factoring day-trippers, marina slips, and hotel/motel units. Increases in seasonal population will increase the overall number of persons at risk to the impacts of future climate change and sea level rise.

Climate Change

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 (NOAA 2020). As the coastline recedes inland as a result of climate change and sea level rise, the County's vulnerability to other hazards, including hurricanes and coastal erosion, may increase.

Change of Vulnerability Since the 2016 HMP

This hazard mitigation plan includes population spatial data referencing the 5-Year 2014-2018 American Community Survey population estimates; an updated general building stock using tax assessor data provided by the County and its municipalities supplemented with 2013 MOD-IV parcel data, building footprints data from the County, and 2019 RS Means replacement cost values for buildings and content in the County; and an updated critical facility dataset provided by the County. Furthermore, NOAA's 2017 modeled 1-foot increment sea level rise data was also used to assess potential change in future flood inundation risk. This data is an update compared to the 2010 U.S. Census population and 2012 NOAA sea level rise inundation polygon data used in the 2016 hazard mitigation plan.

Overall, this vulnerability assessment provides the County an estimated exposure assessment for the sea level rise hazard.