4.3.7 Flood

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 flood hazard in Gloucester County.

2022 HMP Update Changes

- New and updated figures from federal and state agencies are incorporated.
- Previous occurrences were updated with events that occurred between 2015 and 2021.

4.3.7.1Profile

Hazard Description

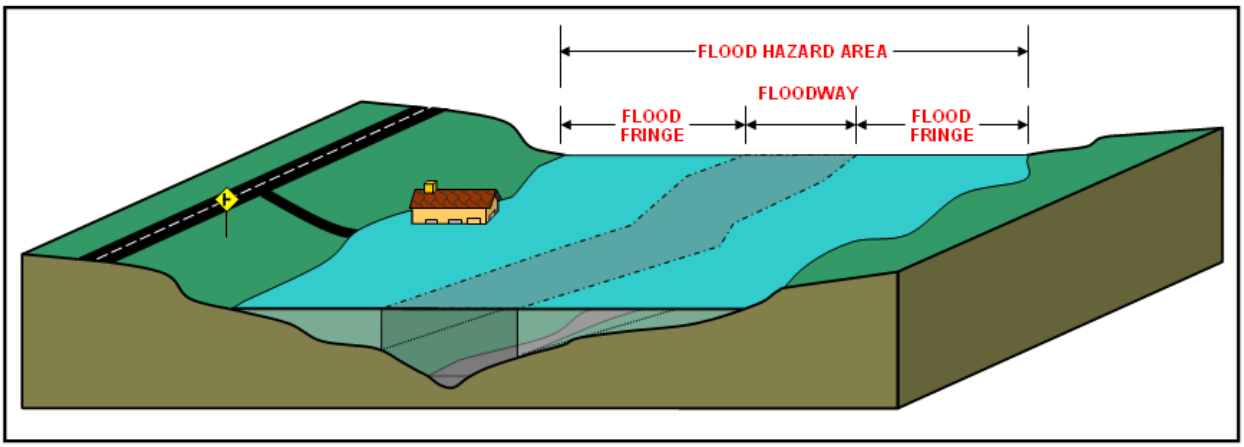
A flood is the inundation of normally dry land resulting from the rising and overflowing of a body of water. They can develop slowly over a period of days or develop quickly, with disastrous effects that can be local (impacting a neighborhood or community) or regional (affecting entire river basins, coastlines and multiple counties or states) (FEMA 2007). Floods are frequent and costly natural hazards in New Jersey in terms of human hardship and economic loss, particularly to communities that lie within flood-prone areas or floodplains of a major water source.

The flood-related hazards most likely to impact Gloucester County are coastal flooding, riverine (inland) flooding, ice jam flooding, and flooding as a result of a dam or levee failure. In addition, Gloucester County also experiences urban flooding which is the result of precipitation and insufficient drainage. Dam and levee failure is discussed in Section 4.3.2 (Dam and Levee Failure). Coastal flooding as a result of sea level rise is discussed in Section 4.3.1 (Coastal Erosion and Sea Level Rise). Coastal flooding as a result of storm surge is discussed in Section 4.3.10 (Hurricane).

Riverine (Inland) Flooding

A floodplain is defined as the land adjoining the channel of a river, stream, ocean, lake, or other watercourse or water body that becomes inundated with water during a flood. In Gloucester County, floodplains line the rivers, streams, and lakes of the County. The boundaries of the floodplains are altered as a result of changes in land use, the amount of impervious surface, placement of obstructing structures in floodways, changes in precipitation and runoff patterns, improvements in technology for measuring topographic features, and utilization of different hydrologic modeling techniques. Figure 4.3.7-1 depicts the flood hazard area, the flood fringe, and the floodway areas of a floodplain.

Figure 4.3.7-1. Floodplain



Source: New Jersey Department of Environmental Protection (NJDEP) Date Unknown

Ice Jam Flooding

As per the Northeast States Emergency Consortium and FEMA, an ice jam is an accumulation of ice that acts as a natural dam and restricts flow of a body of water. Ice jams occur when warm temperatures and heavy rains cause rapid snowmelt. The melting snow, combined with the heavy rain, causes frozen rivers to swell. The rising water breaks the ice layers into large chunks, which float downstream and often pile up near narrow passages and obstructions (bridges and dams). Ice jams may build up to a thickness great enough to raise the water level and cause flooding (FEMA 2015a). Ice jams may also be caused by frazil ice, which forms when mist freezes and then floats down a river, stream, or creek.

There are two different types of ice jams: freeze-up and breakup. Freeze-up jams occur in the early to mid-winter when floating ice may slow or stop due to a change in water slope as it reaches an obstruction to movement. Breakup jams occur during periods of thaw, generally in late winter and early spring. The ice cover breakup is usually associated with a rapid increase in runoff and corresponding river discharge due to a heavy rainfall, snowmelt, or warmer temperatures (White 2013).

Although potential exists, Gloucester County does not have a history of ice jam events (USACE CRREL 2021).

Urban Flooding

Heavy rainfall that overwhelms a developed area's stormwater infrastructure causing flooding is commonly referred to as urban flooding. Urban flooding can be worsened by aging and inadequate infrastructure and over development of land. The growing number of extreme rainfall events that produce intense precipitation are resulting in increased urban flooding (Center for Disaster Resilience 2016). While riverine and coastal flooding is mapped and studied by FEMA, urban flooding is not.

NOAA defines urban flooding as the flooding of streets, underpasses, low lying areas, or storm drains. (NOAA 2009). Urban drainage flooding is caused by increased water runoff due to urban development and inadequate drainage systems. Drainage systems are designed to remove surface water from developed areas

as quickly as possible to prevent localized flooding on streets and other urban areas. The systems make use of a closed conveyance system that channels water away from an urban area to surrounding streams. This bypasses the natural processes of water filtration through the ground, containment, and evaporation of excess water. Because drainage systems reduce the amount of time the surface water takes to reach surrounding streams, flooding in those streams can occur more quickly and reach greater depths than prior to development in that area (Harris 2008).

High groundwater levels can be a concern and cause problems even where there is no surface flooding. Basements are susceptible to high groundwater levels. Seasonally high groundwater is common in many areas, while elsewhere high groundwater occurs only after a long period of above-average precipitation (FEMA 1997).

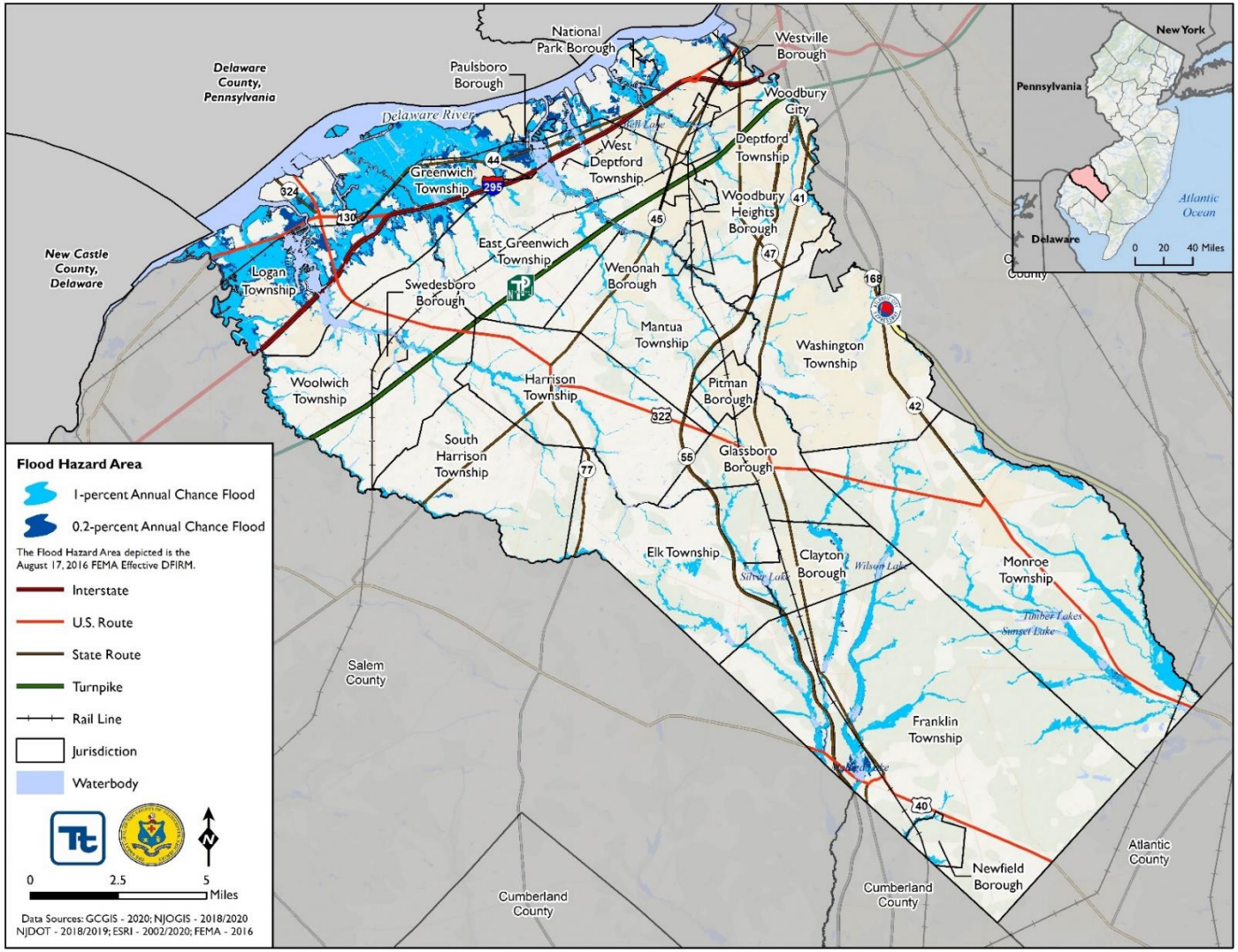
Location

Flooding potential is influenced by climatology, meteorology and topography. Extensive development can impact flooding potential as it leaves fewer natural surfaces available to absorb rainwater, forcing water directly into streams, rivers, and existing drainage systems swelling them more than when more natural surface buffered the runoff rate.

Flooding in Gloucester County is often the direct result of frequent weather events such as thunderstorms, heavy rains, tropical storms, and hurricanes. Floods can happen almost anywhere in County, although they do tend to occur in and around areas near existing bodies of water, such as rivers and streams.

The 1-percent annual chance of flood hazard zones are widely dispersed in Gloucester County, generally following riverine corridors as shown in Figure 4.3.7-2. In addition to the areas along riverine corridors, 1-percent annual chance flood hazard zones are concentrated in low lying areas near the Delaware River, including significant portions of the Township of Greenwich and the Township of Logan.

Figure 4.3.7-2. FEMA Flood Hazard Areas in Gloucester County



Watersheds in Gloucester County

Watersheds in New Jersey are referred to as the name of the water body to which the land area drains and the corresponding Hydrologic Unit Code (HUC). The HUC can range from 2 to 16 digits long- the longer the numeric code, the smaller the watershed area. NJDEP also has divided the state into 21 Watershed Management Areas (WMAs) based on large scale drainage pattern. Each WMA encompasses a particular group of major rivers. Gloucester County falls within parts of three regions: WMA 18: Lower Delaware; WMA 15: Great Egg Harbor; and WMA 17: Maurice, Salem, and Cohansey. These areas delineate the principal stream systems that drain the County's land area. WMA 17 and WMA 18 drain to the Delaware River and WMA 15 drains to the Atlantic Ocean (NJDEP 2007).

Flood Insurance Study (FIS)

According to the FEMA Flood Insurance Study for Gloucester County (FEMA 2016) a history of flooding throughout Gloucester County indicates that flooding may be experienced during any season of the year. Flooding during the winter months is less frequent. However, the Delaware River overflows most frequently during late winter and early spring because of snowmelt, with ice jams as an occasional factor increasing flooding conditions. Extensive flooding has occurred in the late summer and fall, usually being associated with thunderstorms, hurricanes and nor'easters along the Atlantic coast.

Principal Flood Problems

- Principal flood problems for Gloucester County are identified in the 2016 FIS. The Mantua Creek basin has suffered the greatest flood damages of any area of Gloucester County (FEMA 2016).
- Although the Township of Deptford is subject to both tidal and fluvial flooding from Big Timber Creek and South Branch Timber Creek, there has been only minor flood damage reported (FEMA 2016).
- In the Township of East Greenwich, historically, the community of Mount Royal has been subject to the worst flooding (FEMA 2016).
- In the Township of Franklin, aside from extremely large storms, the major flooding problem is located along Little Ease Run at the railroad crossing (FEMA 2016).
- Flooding in the Borough of Glassboro is caused by the overflow of Mantua Creek, Raccoon Creek, and Still Run #1. Historically, flooding has been confined to undeveloped lands and fruit orchards. Only a few isolated residences are within the floodplain (FEMA 2016).
- In the Township of Greenwich, with the exception of the Gibbstown residential area, the residential area adjacent to Paulsboro, and the oil storage facilities on Clonmell Road, much of the township is marshland which is subject to tidal flooding. Included in the flood-prone area are the DuPont explosives complex, and residential streets at the outskirts of Gibbstown. These include Willow Street, Allen Drive, Morse Street, Memorial Avenue, and those side streets which intersect these roads. In addition, the dead end streets between Ladner Avenue and Clonmell Creek in the Paulsboro area are subject to flooding. All major roads including state and interstate highways have sections which would be impassable during times of major flooding (FEMA 2016).

- Low-lying areas of the Township of Logan are subject to inundation by high tides from the Delaware River. Extreme high tides flood these lowlands to the same elevation as reached in the Delaware River. Flooding in Logan is most likely to occur in the late summer and fall when hurricanes are prevalent (FEMA 2016).
- According to Township of Monroe officials, the township has experienced no riverine-associated flooding problems. Damage from storms comes mainly from high water table seepage. Residents along the lakeside area have reported that they have never seen the lake water surface rise significantly (FEMA 2016).
- Because the floodplains of Fourmile Branch are uninhabited, little information on past flooding is available. However, the poor drainage characteristics as evidenced by the marshlands adjacent to the stream indicate that wide inundation will occur with moderate increases in water-surface elevation (FEMA 2016).
- In the Borough of National Park, several blocks are in an area with the potential to flood from tidal, riverine, or a combination of both flows. Areas susceptible to flooding from the 1-percent annual chance flood are: Riverview Avenue, Grove Street (south of Woodlawn Avenue), Temple Avenue, Jefferson Avenue, and Belmont Avenue. Most flooding in these areas would be tidal and therefore would have a low velocity (FEMA 2016).
- Low-lying areas of the Borough of Swedesboro in the vicinity of Raccoon Creek Reach 1 are subject to being inundated by high tidal flooding from the Delaware River. Extreme high tides would flood these lowlands to the same elevation as reached in the Delaware River (FEMA 2016).
- Washington Township is subject to fluvial flooding from Mantua Creek and South Branch Big Timber Creek, and their tributaries. Despite the numerous streams which traverse the township, flooding has been relatively minor. This is due to the fact that, until recently, development within Washington has been minimal (FEMA 2016).
- Several other areas along Mantua Creek are also in the floodplain. They include the River Drive Road and Heppard Road area. In addition, a trailer park at the intersection of Paradise Road and Crown Point Road is partially inundated by tidal flow along Little Mantua Creek (FEMA 2016).
- Several areas in the eastern portion of the township are susceptible to flooding from Woodbury Creek and its tributaries, Matthews Branch and Hessian Run. A trailer park between Hessian Run and Woodbury Creek is vulnerable to flooding from tides as low as the 1- percent annual chance recurrence interval. Parts of Watson Street, Edwin Street, Ellwood Avenue, Atkins Avenue, and Miller Avenue are all subject to flooding from Hessian Run. Homes on Lancing Road and Lynn Avenue are just out of the 1- percent annual chance recurrence interval floodplain of Woodbury Creek, however, three industrial structures at the end of Frances Avenue would be vulnerable to flooding. There is minor flooding along Matthews Branch at Myrtle Avenue and Queen Street, and an unnamed tributary to the Delaware River causes flooding along the streets between the river and Belmont Avenue (Red Bank Avenue) (FEMA 2016).
- Low-lying areas of the Township of Woolwich in the vicinity of Raccoon Creek are subject to being inundated by high tidal flooding from the Delaware River. Extreme high tides would flood these

lowlands to the same elevation as reached in the Delaware River. Flooding in this area would most likely occur in the late summer and early fall during the hurricane season (FEMA 2016).

- Please refer to Section 9 for information regarding specific areas of flooding within each municipality.

Flood Protection Measures

There are several dams in the Maurice River Basin. These include Willow Grove Lake dam on the Maurice River, Malaga Lake dam on Scotland Run and Iona Lake dam on Still Run #1. Scotland Run and Still Run #1 are both tributaries of the Maurice River. While the purpose of these dams is not for flood control, they do have the effect of reducing flooding downstream of them. This is especially true if the dams are not full when a storm hits (FEMA 2016).

In the Township of Greenwich, for protection against storm surge, flood gates have been installed on Repaupo Creek, White Sluice Race, Clonmell Creek, and Sand Ditch. The tops of these gates are at a high enough elevation to protect against a 2-percent annual chance storm surge, however, low spots in the berm between the gates will allow a 10-percent annual chance storm surge (6.6 feet) to inundate the area (FEMA 2016).

In December 2009 a project was completed to rebuild the floodgate and levee along Repaupo Creek by the Gloucester County Improvement Authority. However, the repaired system does not provide protection against the 1-percent annual chance flood (FEMA 2016).

In the Township of Logan, near the coastline of the Delaware River levees have been built to protect areas inland from some degree of coastal flooding from the Delaware River. However, these levees do not provide protection against the 1-percent annual chance flood (FEMA 2016).

In the Township of Monroe, the dams which impound water to form Diamond Lake and Timber Lake will act to dampen the peak flood discharges downstream. This effect was considered in the hydrologic analysis (FEMA 2016).

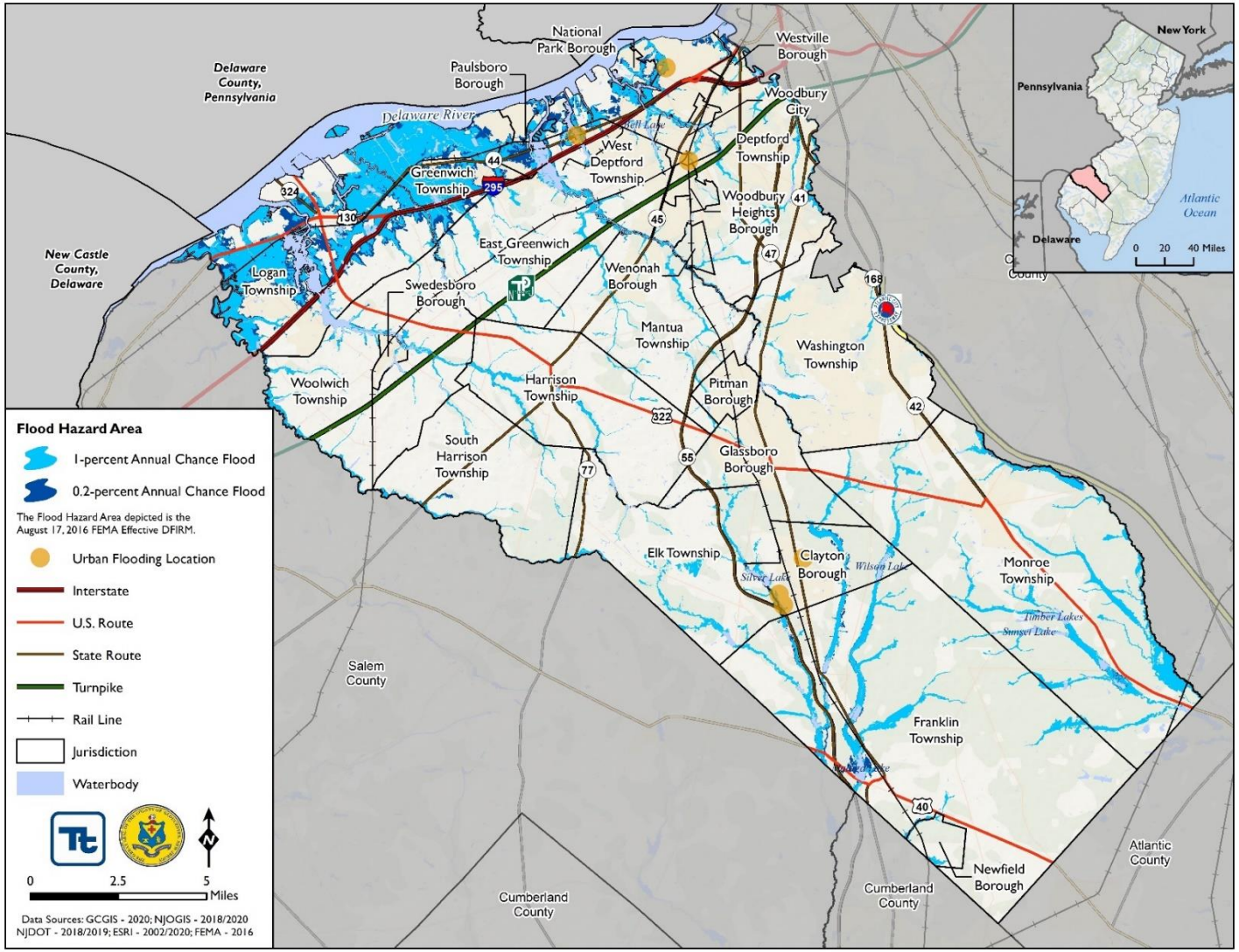
Within the Townships of Greenwich, Logan, and Pennsauken, existing levees along the Delaware River do not protect against the 1-percent annual chance flood (FEMA 2016).

A number of man-made structures commonly called agricultural or salt-hay levees have been identified in this County. These structures do not meet the definition of a levee for the purpose of the NFIP (FEMA 2016).

Urban Flooding

Throughout Gloucester County, low-lying surface flooding and interior shallow ponding occurs as a result of heavy rainfall and inadequate capacity of stormwater systems. While riverine flooding is mapped by FEMA, urban flooding is not. Each municipality was asked to identify areas that flood outside the FEMA-mapped floodplain in an attempt to identify problem areas and assist with identifying mitigation solutions. Figure 4.3.4-3 illustrates the urban flood areas identified by the municipalities participating in the 2021 HMP update

Figure 4.3.7-3. Urban Flood Areas Identified in Gloucester County



Natural and Beneficial Floodplain Areas

Although typically associated as a hazard area, floodplains also serve beneficial and natural functions (on ecological/environmental, social, and economic levels). Some of the more well-known water-related functions for floodplains include:

- Natural flood and erosion control
  - Provide flood storage and conveyance
  - Reduce flood velocities
  - Reduce flood peaks
  - Reduce sedimentation
- Surface water quality maintenance
  - Filter nutrients and impurities from runoff
  - Process organic wastes
  - Moderate temperatures of water
- Groundwater recharge
- Promote infiltration and aquifer recharge
- Reduce frequency and duration of low surface flows (FEMA)

Areas in the floodplain that typically provide these natural functions are wetlands, riparian areas, sensitive areas, and habitats for rare and endangered species. According to NJ DEP 2019 the County has several floodplain areas that could serve natural and beneficial functions. This information is summarized in Tables 4.3.7-1 and 4.3.7-2.

Table 4.3.7-1. Acreage of Wetlands by Municipality

Municipality	Total Area (acres)	Wetland Area (acres)	Percent of Total
Clayton (B)	4,646	1,093	23.5%
Deptford (Twp)	11,246	1,197	10.6%
East Greenwich (Twp)	9,550	1,548	16.2%
Elk (Twp)	12,366	2,656	21.5%
Franklin (Twp)	36,082	6,283	17.4%
Glassboro (B)	5,994	1,141	19.0%
Greenwich (Twp)	7,485	2,600	34.7%
Harrison (Twp)	12,171	1,048	8.6%
Logan (Twp)	16,840	5,542	32.9%
Mantua (Twp)	10,296	772	7.5%
Monroe (Twp)	30,029	5,465	18.2%
National Park (B)	928	86	9.2%
Newfield (B)	1,115	80	7.2%

Municipality	Total Area (acres)	Wetland Area (acres)	Percent of Total
Paulsboro (B)	1,703	117	6.9%
Pitman (B)	1,444	31	2.2%
South Harrison (Twp)	10,210	1,365	13.4%
Swedesboro (B)	495	26	5.3%
Washington (Twp)	13,789	1,123	8.1%
Wenonah (B)	646	38	5.9%
West Deptford (Twp)	11,421	1,542	13.5%
Westville (B)	871	42	4.8%
Woodbury (C)	1,346	33	2.5%
Woodbury Heights (B)	804	30	3.8%
Woolwich (Twp)	13,689	1,245	9.1%
Gloucester County Total	**215,166**	**35,103**	**16.3%**

Source: NJDEP 2019

Table 4.3.7-2. Natural and Beneficial Land in Gloucester County

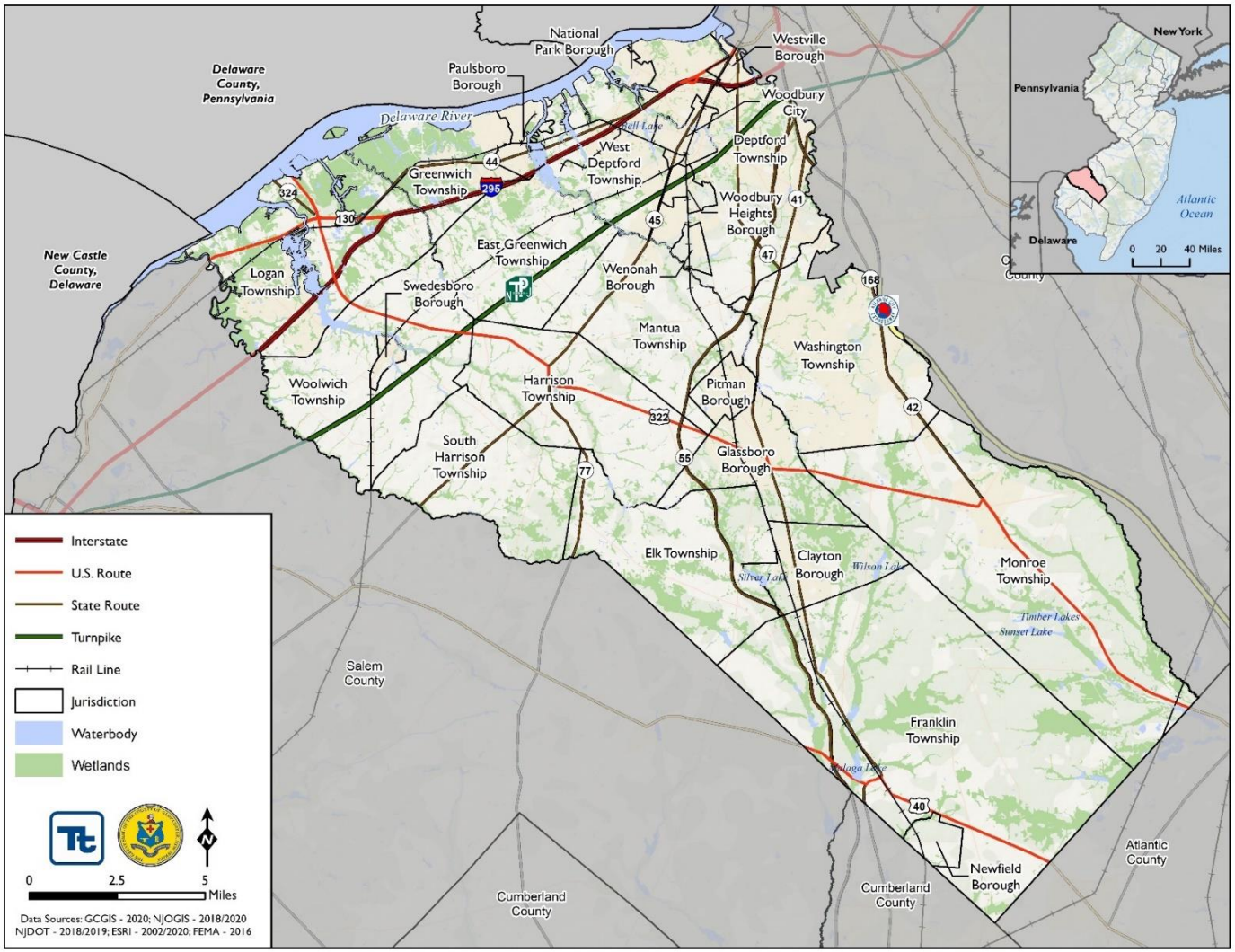
Wetlands	Area (acres)	Forest	Area (acres)	Endangered Species	Area (acres)
Agricultural Wetlands (Modified)	1,420	Coniferous Brush/Shrubland	682	Special Concern	23,508
Altered Lands	18	Coniferous Forest (>50% Crown Closure)	3,001	State Endangered	9,511
Atlantic White Cedar Wetlands	910	Coniferous Forest (10-50% Crown Closure)	442	State Threatened	3,362
Cemetery On Wetland	1	Deciduous Brush/Shrubland	1,882		
Commercial/Services	5	Deciduous Forest (>50% Crown Closure)	23,503		
Coniferous Scrub/Shrub Wetlands	111	Deciduous Forest (10-50% Crown Closure)	2,681		
Coniferous Wooded Wetlands	1,636	Mixed Deciduous/Coniferous Brush/Shrubland	2,636		
Cropland And Pastureland	0	Mixed Forest (>50% Coniferous With >50% Crown Closure)	3,333		
Deciduous Scrub/Shrub Wetlands	2,380	Mixed Forest (>50% Coniferous With 10-50% Crown Closure)	492		
Deciduous Wooded Wetlands	18,345	Mixed Forest (>50% Deciduous With >50% Crown Closure)	6,190		
Disturbed Tidal Wetlands	8	Mixed Forest (>50% Deciduous With 10-50% Crown Closure)	648		

Wetlands	Area (acres)	Forest	Area (acres)	Endangered Species	Area (acres)
Disturbed Wetlands (Modified)	517	Old Field (< 25% Brush Covered)	2,249		
Extractive Mining	1	Phragmites Dominate Old Field	386		
Former Agricultural Wetland (Becoming Shrubby, Not Built-Up)	93	Plantation	24		
Freshwater Tidal Marshes	1,636				
Herbaceous Wetlands	862				
Industrial	8				
Managed Wetland In Built-Up Maintained Rec Area	76				
Managed Wetland In Maintained Lawn Greenspace	192				
Mixed Scrub/Shrub Wetlands (Coniferous Dom.)	81				
Mixed Scrub/Shrub Wetlands (Deciduous Dom.)	258				
Mixed Wooded Wetlands (Coniferous Dom.)	1,547				
Mixed Wooded Wetlands (Deciduous Dom.)	2,495				
Old Field (< 25% Brush Covered)	0				
Orchards/Vineyards/Nurseries/Horticultural Areas	0				
Other Agriculture	2				
Other Urban Or Built-Up Land	0				
Phragmites Dominate Coastal Wetlands	364				
Phragmites Dominate Interior Wetlands	1,693				
Phragmites Dominate Urban Area	25				
Residential, Rural, Single Unit	7				
Residential, Single Unit, Low Density	3				
Residential, Single Unit, Medium Density	0				

Wetlands	Area (acres)	Forest	Area (acres)	Endangered Species	Area (acres)
Stormwater Basin	6				
Transitional Areas	19				
Transportation/Communication/Utilities	1				
Upland Rights-Of-Way Undeveloped	0				
Wetland Rights-Of-Way	448				

Source: NJDEP 2019

Figure 4.3.7-4. Wetlands in Gloucester County



According to the Landscape Project data, Gloucester County contains potential habitats for over 30 endangered species from multiple taxonomic classes, including Aves, Bivalvia, Insecta, Mammalia, and Reptilia. Habitats for about 22 of these species are located within the 1-percent annual chance floodplain. These species include, the Indiana bat, the bald eagle, the blue-spotted salamander, and the bog turtle.

Extent

The frequency and severity of riverine flooding are measured using a discharge probability, which is the probability that a certain river discharge (flow) level will be equaled or exceeded in a given year. Flood studies use historical records to determine the probability of occurrence for the different discharge levels.

Floodplains are often referred to as 100-year floodplains. A 100-year floodplain is not a flood that will occur once every 100 years; the designation indicates a flood that has a 1-percent chance of being equaled or exceeded each year. Thus, the 100-year flood could occur more than once in a relatively short period of time. Due to this misleading term, FEMA has properly defined it as the 1-percent annual chance flood, or the SFHA. Similarly, the 500-year floodplain will not occur every 500 years but is an event with a 0.2-percent chance of being equaled or exceeded each year. The "1-percent annual chance flood" is now the standard term used by most federal and state agencies and by the National Flood Insurance Program (NFIP) (FEMA 2003). The 1-percent annual chance floodplain establishes the area that has flood insurance and floodplain management requirements and is also referenced as the regulatory floodplain.

The NJDEP is mandated to delineate and regulate flood hazard areas pursuant to N.J.S.A. 58:16A-50 et seq., the Flood Hazard Area Control Act. This Act authorizes the DEP to adopt land use regulations for development within the flood hazard areas, to control stream encroachments and to integrate the flood control activities of the municipal, County, state and federal governments. The State's Flood Hazard Area delineations are defined by the New Jersey Flood Hazard Area Design Flood which is equal to a design flood discharge 25 percent greater in flow than the 1-percent annual chance flood. In addition, the floodway shall be based on encroachments that produce no more than a 0.2-foot water surface rise above the 1-percent annual chance flood.

The USGS National Water Information System (NWIS) collects surface water data from more than 850,000 stations across the country. The time-series data describes stream levels, streamflow (discharge), reservoir and lake levels, surface water quality, and rainfall. The data is collected by automatic recorders and manual field measurements at the gage locations. Gloucester County has roughly 20 active USGS stream gages; in addition, stream gauges are located upstream in neighboring counties.

In the case of riverine flood hazard, once a river reaches flood stage, the flood extent or severity categories used by the NWS include minor flooding, moderate flooding, and major flooding. Each category has a definition based on property damage and public threat:

- Minor Flooding - minimal or no property damage, but possibly some public threat or inconvenience.

- Moderate Flooding - some inundation of structures and roads near streams. Some evacuations of people and/or transfer of property to higher elevations are necessary.
- Major Flooding - extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations (NWS 2011).

The severity of a flood depends not only on the amount of water that accumulates in a period of time, but also on the land's ability to manage this water. The size of rivers and streams in an area and infiltration rates are significant factors. When it rains, soil acts as a sponge. When the land is saturated or frozen, infiltration rates decrease and any more water that accumulates must flow as runoff (Harris 2008).

Currently, there is no measurement used to further define the frequency and severity of urban flooding.

Previous Occurrences and Losses

Many sources provided historical information regarding previous occurrences and losses associated with flooding throughout Gloucester County. With so many sources reviewed for the purpose of this HMP, loss and impact information for many events may vary. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP.

FEMA Major Disasters and Emergency Declarations

Between 1954 and 2021, Gloucester County was included in two declarations for flood-related events. Table 4.3.7-3 lists these events.

Table 4.3.7-3. Flood-Related Disaster (DR) and Emergency (EM) Declarations 1954-2021

Declaration	Event Date	Declaration Date	Event Description
DR-310	September 4, 1971	September 4, 1971	Flood: Heavy Rains & Flooding
DR-477	July 23, 1975	July 23, 1975	Flood: Heavy Rains, High Winds, Hail & Tornadoes

Source: FEMA 2021

U.S. Department of Agriculture Disaster Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated County. Between 2015 and 2021, Gloucester County was not included in any flood related agricultural disaster declarations (USDA 2021a, USDA 2021b).

Flood Events

The National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI) Storm Events database records and defines flood events as follows:

- Coastal Flood is reported in the NOAA-NCEI database for flooding of coastal areas due to the vertical rise above normal water level caused by strong, persistent onshore wind, high astronomical tide,

and/or low atmospheric pressure, resulting in damage, erosion, flooding, fatalities, or injuries. Coastal areas are defined as those portions of coastal land zones (coastal County/parish) adjacent to the waters, bays, and estuaries of the oceans.

- Flash Flood is reported in the NOAA-NCEI database for a life-threatening, rapid rise of water into a normally dry area beginning within minutes to multiple hours of the causative event (e.g., intense rainfall, dam failure, ice jam).
- Flood is reported in the NOAA-NCEI database for any high flow, overflow, or inundation by water which causes damage. In general, this would mean the inundation of a normally dry area caused by an increased water level in an established watercourse, or ponding of water, that poses a threat to life or property.

Flood events that have impacted Gloucester County between 2015 and 2021 are identified in Table 4.3.7-4. With flood documentation for New Jersey and Gloucester County being so extensive, not all sources have been identified or researched. Therefore, Table 4.3.7-4 may not include all events that have occurred in the County. Please see Section 9 (Jurisdictional Annexes) for detailed information regarding impacts and losses to each municipality.

Table 4.3.7-4. Flooding Events in Gloucester County, 2015 to 2021

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Gloucester County Designated?	Location	Description
June 1, 2015	Flash Flood	N/A	N/A	Franklin Township, Monroe Township	A nearly stationary frontal boundary and a low pressure system moving along it combined to develop thunderstorms that produced isolated damaging wind gusts as well as more widespread flash flooding across the southern half of New Jersey during the afternoon and evening of June 1st. The second wave of thunderstorms with very heavy rain caused flash flooding of smaller creeks and roadways in Franklin and Monroe Townships near the border with Atlantic County. Event precipitation totals included 4.91 inches in Piney Hollow (Franklin Township) and 3.12 inches in South Harrison Township.
July 15, 2015	Flash Flood	N/A	N/A	Franklin Township, Washington Township	Double barrel cold fronts helped trigger a series of showers and thunderstorms across southern New Jersey during the morning of the 15th. Thunderstorms that were accompanied by very heavy rain caused flash flooding in parts of Salem, Gloucester, Atlantic and Ocean Counties. The flash flooding in Gloucester and Salem Counties was exacerbated because of the heavy rain and flooding that occurred just the previous morning. Thunderstorms with very heavy caused small creek and roadway flash flooding in Franklin Township. Sections of Marshall Mill Road and New Jersey State Route 47 were flooded and closed near the Malaga Branch. Two day event precipitation totals included 4.33 inches in Franklin Township. Thunderstorms with very heavy caused small creek and roadway flash flooding in Washington Township in the Bells Lake drainage basin. Sections of Greentree Road and the Black Horse Pike (New Jersey State Route 42) were flooded and closed. Doppler Radar storm total estimates reached 2.5 inches in the Township.
September 10-11, 2015	Flash Flood	N/A	N/A	Greenwich Township, Logan Township, Woodbury Township, Mantua	A series of thunderstorms which rode along a wavy cold frontal boundary brought heavy rain into New Jersey on the 10th. The heaviest rain fell along the Interstate 95/295 corridor (especially in Gloucester County) and along coastal sections of New Jersey. This caused poor drainage as well as some creek flash flooding, mainly in Gloucester County where some event precipitation totals exceeded 5 inches.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Gloucester County Designated?	Location	Description
				Township, Wenonah Borough, Pitman Borough	A nearly stationary thunderstorm caused flash flooding from Gibbstown (Greenwich Township) through northern East Greenwich Township and Paulsboro. Many roadways were flooded in the area and closed. Vehicles were stuck in flood waters, but no serious injuries were reported. Two event precipitation totals from East Greenwich Township were 4.28 inches and 4.05 inches respectively. A nearly stationary thunderstorm caused flash flooding in Logan Township. The flash flooding affected Interstate 295 as the left and center southbound lanes between exits 11 and 14 were flooded and closed. A nearly stationary thunderstorm caused flash flooding in Woodbury. Vehicles were stuck in flood waters at the intersection of Glassboro Road and Evergreen Avenue near the Hesters Branch. No serious injuries were reported. Slow moving thunderstorms caused flash flooding in Mantua Township and Wenonah Borough in the Mantua Creek Basin. In Mantua Township, New Jersey State Route 45 was closed and a few vehicles were trapped in the flood waters. No serious injuries were reported. Event precipitation totals included 5.79 inches in Wenonah and 2.88 inches in Pitman.
July 28, 2016	Flood	N/A	N/A	Pitman Borough	A cold frontal boundary moved southward into the region. This led to the development of afternoon showers and thunderstorms. Some of thunderstorms became severe with locally heavy rainfall as well. Many locations saw between 2 and 3 inches of heavy rainfall total for this event in Southern NJ. Minor street flooding occurred in Pitman due to heavy rainfall with thunderstorms.
September 19, 2016	Flood	N/A	N/A	Monroe Township	The remnants of tropical storm Julia and a frontal boundary interacted leading to several rounds of rainfall over the region. Water in Williamstown in Monroe Township was a foot or two deep on some roads.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Gloucester County Designated?	Location	Description
March 31, 2017	Flood	N/A	N/A	Washington Township	Low pressure with an occluding frontal boundary moved through the region. With this system periods of heavy rain fell on the 31st. The heavy rain led to localized flooding issues. Flooding took place on the Black Horse Pike in Washington Township.
July 24, 2017	Flash Flood	N/A	N/A	Rowan University	A stalled frontal boundary was the focus for several rounds of thunderstorms that produced damaging winds and flooding in spots. Several thousand people lost power throughout the state. Dorms at Rowan University were evacuated due to flash flooding.
August 23, 2017	Flood	N/A	N/A	West Deptford	Severe thunderstorms formed in a hot and humid airmass ahead of a cold front. NJ 45 closed at the intersection with 130 due to flooding.
February 11, 2018	Flood	N/A	N/A	Clayton Borough	Several waves of heavy rainfall moved along a slow moving frontal boundary which led to flooding in a few spots. Rainfall of one to four inches occurred across the state. The highest totals over three inches were in southwestern New Jersey. NJ 47 southbound was reported to be flooded in Clayton.
April 16, 2018	Coastal Flood	N/A	N/A	Gloucester County	An extended period of onshore flow occurred, beginning with east-northeast winds Saturday Night, which then shifted to the southeast on Sunday Night into Monday Morning April 16th. Widespread winds gusts of 40 to 50 mph occurred in the east-northeast flow Saturday Night and Sunday, with a lull Sunday Night, then occasionally again in the south-southeast flow along and just in advance of a heavy line of showers and thunderstorms on Monday Morning. The onshore flow, and to a lesser extent the heavy rainfall, lead to multiple rounds of coastal flooding along the oceanfront and back bays with the high tide cycles on Sunday evening and again on Monday Morning. Moderate coastal flooding along the tidal Delaware River and its tidal tributaries. There were a number of road closures including New Jersey Route 47 in Westville and US Route 130 in Logan Township. Peak tide was 9.47 feet MLLW at Philadelphia.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Gloucester County Designated?	Location	Description
June 11, 2018	Flood	N/A	N/A	Deptford Township, Westville Borough	Torrential rain occurred on the night of June 10 across parts of southeastern Pennsylvania, and central and southern New Jersey. Rainfall totals up to 3 to 6 inches were reported. Flooding on State Highway 45 southbound at U.S. Highway 130. Lane restrictions in place.
July 3, 2018	Flash Flood	N/A	N/A	Westville Borough	Severe thunderstorms caused wind damage across portions of southwestern New Jersey on the evening of July 3. Rainfall amounts of 1 to 3 inches fell along the Interstate 95/New Jersey Turnpike Corridor in a short amount of time. A few locations received 3 to 4 inches of rain. Several streets in Westville were reported under water.
September 7, 2018	Flash Flood	N/A	N/A	Westville Borough, West Deptford Township, Deptford Township	Locally heavy rain fell in the northwestern parts of Gloucester County and Camden County during the late afternoon and evening of September 7. Rainfall totals ranged from 3 to 5 inches. A supercell developed along a boundary and produced isolated wind damage. The southbound lanes of both US Route 130 and NJ Route 45 in Westville were closed due to flash flooding. There were lane closures on Interstate 295 near Interchange 23 in West Deptford Township. Widespread flash flooding took place on the New Jersey Turnpike in Deptford Township resulting in lane closures. A vehicle was trapped in flood waters on NJ Route 55 at Interchange 56 in Deptford Township.
September 10, 2018	Coastal Flood	N/A	N/A	Gloucester County	A persistent onshore flow and unusually high astronomical tides associated with the new moon resulted in widespread moderate coastal flooding along the bays and other tidal waterways in central and southern New Jersey. The flooding occurred across three consecutive high tide cycles, from the evening of September 9 through the early hours of September 11. Moderate flooding occurred along the Delaware River and its tidal tributaries in Gloucester County. The tide gauge at Philadelphia reached 9.65 feet MLLW.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Gloucester County Designated?	Location	Description
October 11, 2018	Flash Flood	N/A	N/A	Pitman Borough	Rainfall totals of 3 to 5 inches fell in parts of northeastern Maryland, Delaware, and southern and central New Jersey on the night of October 11. There were a few reports of rainfall amounts in excess of 5 inches. Minor flooding occurred along the Mantua Creek at Pitman.
November 26, 2018	Coastal Flood	N/A	N/A	Gloucester County	A coastal storm resulted in tidal flooding along the northern part of the New Jersey coast and along the tidal Delaware River. Moderate tidal flooding occurred along the tidal Delaware River and its tidal tributaries. Some roads were flooded. The tide gauge at Marcus Hook, Pennsylvania reached 8.77 feet MLLW.
June 19-20, 2019	Flash Flood	N/A	N/A	Mantua Township, Greenwich Township, Logan Township, West Deptford Township, Westville Borough	Showers and thunderstorms produced heavy rainfall and flash flooding from the afternoon of June 19 into the nighttime hours. Rainfall amounts of 3 to near 6 inches were reported in the counties of Gloucester, Camden and Burlington. Significant flash flooding occurred in those counties. A state of emergency was declared by Governor Phil Murphy. NJ Route 45 in Mantua Township was closed in both directions due to flash flooding. NJ Route 44 was closed in both directions in Gibbstown (Greenwich Township) due to flash flooding. Flash flooding resulted in lane closures on Interstate 295 in Logan Township between Interchanges 13 and 14. Flood waters blocked all northbound lanes of the New Jersey Turnpike in West Deptford Township. NJ Route 47 was closed in Westville due to flash flooding. A total of 50 residents were evacuated from an apartment complex on Broadway in Westville.
July 6, 2019	Flash Flood	N/A	N/A	Paulsboro Borough	Thunderstorms brought locally heavy rain to parts of New Jersey on the afternoon of July 6. Rainfall amounts of 2 to near 3 inches occurred in sections of

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Gloucester County Designated?	Location	Description
					Warren County and Gloucester County. Rainfall totals of 3 to over 5 inches fell in parts of Ocean County. NJ Route 44 was closed due to flash flooding around Delaware Street in Paulsboro.
June 20, 2020	Flash Flood	N/A	N/A	Pitman Township, Washington Township	Thunderstorms brought heavy rain to parts of Gloucester County on the afternoon of June 20. There were localized rainfall amounts of 2.5 to 3.5 inches. Minor flooding occurred along Mantua Creek in Pitman and Washington Township.
July 10, 2020	Tropical Storm Fay, Flash Flood	N/A	N/A	Swedesboro Borough, South Harrison Township, Deptford Township, Mantua Township, Glassboro Borough, Pitman Township	Tropical Storm Fay moved northward along the coasts of Delaware and New Jersey on the afternoon and evening of July 10. The storm produced rainfall totals up to 3 to 6 inches in New Jersey, with the highest totals occurring in the southern part of the state. Some areas also experienced a period of tropical storm force winds, especially near the coast. Overall impacts from wind were limited. Widespread roadway flooding occurred in Swedesboro, with some streets becoming impassable. NJ Route 45 was closed between Oldmans Creek and Harrisonville Road in South Harrison Township due to flooding. Mantua Creek overflowed onto Glassboro Road in the vicinity of the border between Deptford Township and Mantua Township. NJ Route 47 was closed to the south of US Route 322 in Glassboro due to flooding. Minor flooding occurred along the Mantua Creek near Pitman.
August 4, 2020	Tropical Storm	N/A	N/A	Mantua Township	Tropical Storm Isaias brought high winds, heavy rain, several tornadoes, and coastal flooding to the mid-Atlantic region, becoming the most impactful tropical cyclone to impact most of the region since Sandy in 2012.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Gloucester County Designated?	Location	Description
	Isaias, Flash Flood				NJ Route 45 was closed near Berkley Road in Mantua Township due to flooding.
August 7, 2020	Flash Flood	N/A	N/A	Logan Township, Swedesboro Borough, Woolwich Township, South Harrison Township, Franklin Township	An impulse riding along a west to east boundary stalled near the Mason-Dixon line produced severe thunderstorms and heavy rain across sections of South Jersey from late afternoon through the evening hours on August 7th. Strong winds knocked down trees, and torrential downpours on ground already saturated from the remnants of Hurricane Isaias produced flash flooding on many roadways and small streams in the area. Several vehicles were trapped in flood waters in Logan Township. Widespread roadway flooding occurred in Swedesboro. A section of Oliphant's Mill Road in Woolwich Township was washed away by flood waters. The New Jersey Turnpike was closed in Woolwich Township, south of Interchange 2, due to flooding. NJ Route 45 was closed near Harrisonville Road in South Harrison Township due to flooding. NJ Route 47 was closed north of US Route 40 in Franklin Township due to flooding.
August 12, 2020	Flash Flood	N/A	N/A	Deptford Township, Mantua Township, Woodbury Heights Borough	Thunderstorms brought locally heavy rain to southern New Jersey on the afternoon of August 12. Rainfall amounts were as high as 2 to 4 inches. Sections of Princeton Boulevard in Deptford Township were inundated. Parts of Glassboro Road and Livingstone Road in Mantua Township were closed due to flooding. Bridgeton Road was closed at Barry Drive in Mantua Township due to flooding. About 3 feet of water covered parts of the northbound side of the New Jersey Turnpike in Woodbury Heights. Three cars and a tractor trailer were stranded in the flood waters.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Gloucester County Designated?	Location	Description
August 29, 2020	Flash Flood	N/A	N/A	Pitman Township	Showers and thunderstorms associated with the remnants of Hurricane Laura brought locally heavy rain to southwestern New Jersey during the morning and early afternoon of August 29. Rainfall totals as high as 3 to 5 inches were reported. Minor flooding occurred along Mantua Creek in Pitman.

Source: *FEMA 2021; NOAA-NCEI 2021; NWS 2021; SPC 2021; NJOEM 2019*
Note: *Not all events that have occurred in Gloucester County are included due to the extent of documentation and the fact that not all sources have been identified or researched.*
K: Thousand
DR *Disaster Declaration (FEMA)*
FEMA *Federal Emergency Management Agency*
Mph *miles per hour*
N/A *Not Applicable*

Probability of Future Occurrences

Based on the historic and more recent flood events in Gloucester County, it is clear that the County has a high probability of flooding for the future. The fact that the elements required for flooding exist and that major flooding has occurred throughout the County in the past suggests that many people and properties are at risk from the flood hazard in the future. It is estimated that Gloucester County will continue to experience direct and indirect impacts of flooding events annually that may induce secondary hazards such as infrastructure deterioration or failure, utility failures, power outages, water quality and supply concerns, and transportation delays, accidents and inconveniences.

According to the NOAA National Climate Data Center (NCDC) and the CRREL database, Gloucester County experienced 52 flood events between 1950 and 2021, including 28 coastal floods, 28 floods, 48 flash floods, and no ice jams. The table below shows these statistics, as well as the annual average number of events and the percent chance of these individual flood hazards occurring in Gloucester County in future years (NOAA NCEI 2021).

Table 4.3.7-5. Probability of Future Flood Events

Hazard Type	Number of Occurrences Between 1950 and 2021	Percent chance of occurrence in any given year
Coastal Flood	28	38.89
Flood	28	38.89
Flash Flood	48	66.67
Ice Jams	0	0
Total	104	100

Source: NOAA-NCEI 2021; CRREL 2021

In Section 4.4, the identified hazards of concern for Gloucester 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 flood in the County is considered 'frequent' (100 percent annual probability; a hazard event may occur multiple times per year, as presented in Table 4.4-1). The ranking of the flood hazard for individual municipalities is presented in the jurisdictional annexes.

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.

Climate change includes major changes in temperature, precipitation, or wind patterns, which occur over several decades or longer. Due to the increase in greenhouse gas concentrations since the end of the 1890s,

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), 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). 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 percent 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. Changes in winter temperatures could result in a change in the frequency of ice jam events.

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 percent increase. By 2050, annual precipitation in New Jersey could increase by 4 percent to 11 percent (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).

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 percent (Walsh et al. 2014) which is a faster rate than anywhere else in the United States (Huang et al. 2017).

4.3.7.2 Vulnerability Assessment

To assess Gloucester County's risk to the flood hazard, a spatial analysis was conducted using the FEMA Risk Map products dated 2016. The 1- and 0.2-percent annual chance flood events were examined to determine the assets located in the hazard areas and to estimate potential loss using the FEMA Hazus model. These results are summarized below. Refer to Section 4.2 (Methodology and Tools) for additional details on the methodology used to assess flood risk.

Impact on Life, Health and Safety

The impact of flooding on life, health, and safety is dependent upon several factors including the severity of the event and whether or not adequate warning time is provided to residents. Exposure represents the population living in or near floodplain areas that could be impacted should a flood event occur. Additionally, exposure should not be limited to only those who reside in a defined hazard zone, but everyone who may be affected by the effects of a hazard event (e.g., people are at risk while traveling in flooded areas, or their access to emergency services is compromised during an event). The degree of that impact will vary and is not strictly measurable.

To estimate population exposure to the 1-percent- and 0.2-percent annual chance flood events, the DFIRM flood boundaries were used. Based on the spatial analysis, there are an estimated 4,305 residents living in the SFHA (or 1-percent annual chance floodplain), or 1.5-percent of the County's total population. There are an estimated 8,715 residents living in the 0.2-percent annual chance floodplain, or 3.0-percent of the County's total population. The Township of Greenwich has the greatest number of residents living in the floodplain with approximately 1,330 residents living in the 1-percent annual chance floodplain and 2,377 residents in the 0.2-percent annual chance floodplain. Table 4.3.7-6 summarizes the population exposed to the flood hazard by jurisdiction.

Table 4.3.7-6. Estimated Gloucester County Population Exposed to the 1-percent and 0.2-percent Flood Hazard Area

Jurisdiction	Total Population	Estimated Population Exposed to the Flood Hazard Areas			
		1-percent Annual Chance Flood	Percent of Total	0.2-percent Annual Chance Flood	Percent of Total
Clayton (B)	8,626	28	0.3%	42	0.5%
Deptford (Twp)	30,448	207	0.7%	210	0.7%
East Greenwich (Twp)	10,488	18	0.2%	31	0.3%
Elk (Twp)	4,135	9	0.2%	9	0.2%
Franklin (Twp)	16,440	48	0.3%	172	1.0%
Glassboro (B)	19,826	4	0.0%	4	0.0%
Greenwich (Twp)	4,831	1,330	27.5%	2,377	49.2%
Harrison (Twp)	12,995	3	0.0%	9	0.1%
Logan (Twp)	5,924	286	4.8%	397	6.7%
Mantua (Twp)	14,941	22	0.1%	29	0.2%
Monroe (Twp)	36,789	181	0.5%	231	0.6%
National Park (B)	2,959	338	11.4%	712	24.0%
Newfield (B)	1,521	2	0.1%	2	0.1%
Paulsboro (B)	5,904	526	8.9%	2,232	37.8%
Pitman (B)	8,805	0	0.0%	0	0.0%
South Harrison (Twp)	3,148	16	0.5%	18	0.6%
Swedesboro (B)	2,579	3	0.1%	3	0.1%
Washington (Twp)	47,833	12	0.0%	18	0.0%
Wenonah (B)	2,259	0	0.0%	0	0.0%

Jurisdiction	Total Population	Estimated Population Exposed to the Flood Hazard Areas			
		1-percent Annual Chance Flood	Percent of Total	0.2-percent Annual Chance Flood	Percent of Total
West Deptford (Twp)	21,149	813	3.8%	1,410	6.7%
Westville (B)	4,169	306	7.4%	642	15.4%
Woodbury (C)	9,861	116	1.2%	116	1.2%
Woodbury Heights (B)	2,986	0	0.0%	0	0.0%
Woolwich (Twp)	12,549	37	0.3%	50	0.4%
Gloucester County (Total)	**291,165**	**4,305**	**1.5%**	**8,715**	**3.0%**

Sources: American Community Survey 2019 5-year estimates; FEMA 2016
Note: B – Borough; C - City; Twp – Township; % = 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 the age of 65. There are 21,340 persons below the poverty level and 44,794 persons that are over 65 years old in the County. Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions to evacuate based on the net economic impact to their family. The population over the age of 65 is more vulnerable because they are more likely to seek or need medical attention which may not be available to due isolation during a flood event and they may have more difficulty evacuating. Special consideration should be taken when planning for disaster preparation, response, and recovery for these vulnerable groups.

In addition, displaced populations were estimated for the 1-percent annual chance flood event. Using 2010 U.S. Census data, Hazus estimates 208 people may seek short-term sheltering. These statistics, by jurisdiction, are presented in Table 4.3.7-7.

Table 4.3.7-7 Estimated Population Displaced or Seeking Short-Term Shelter from the 1-percent Annual Chance Flood Event

Jurisdiction	Total Population	Persons Seeking Short-Term Sheltering
Clayton (B)	8,626	0
Deptford (Twp)	30,448	5
East Greenwich (Twp)	10,488	0
Elk (Twp)	4,135	0
Franklin (Twp)	16,440	1
Glassboro (B)	19,826	4
Greenwich (Twp)	4,831	48
Harrison (Twp)	12,995	0
Logan (Twp)	5,924	1
Mantua (Twp)	14,941	0
Monroe (Twp)	36,789	1
National Park (B)	2,959	7
Newfield (B)	1,521	0
Paulsboro (B)	5,904	51
Pitman (B)	8,805	0
South Harrison (Twp)	3,148	0

Jurisdiction	Total Population	Persons Seeking Short-Term Sheltering
Swedesboro (B)	2,579	0
Washington (Twp)	47,833	20
Wenonah (B)	2,259	0
West Deptford (Twp)	21,149	21
Westville (B)	4,169	17
Woodbury (C)	9,861	32
Woodbury Heights (B)	2,986	0
Woolwich (Twp)	12,549	0
Gloucester County (Total)	291,165	208

Sources: ACS 2019; Hazus 4.2; FEMA 2016
Note: B – Borough; C - City; Twp – Township

The total number of injuries and casualties resulting from flooding is generally limited based on advance weather forecasting, blockades, and warnings. Therefore, injuries and deaths generally are not anticipated if proper warning and precautions are in place. Ongoing mitigation efforts should help to avoid the most likely cause of injury, which results from persons trying to cross flooded roadways or channels during a flood.

Cascading impacts may also include exposure to pathogens such as mold. After flood events, excess moisture and standing water contribute to the growth of mold in buildings. Mold may present a health risk to building occupants, especially those with already compromised immune systems such as infants, children, the elderly and pregnant women. The degree of impact will vary and is not strictly measurable. Mold spores can grow in as short a period as 24-48 hours in wet and damaged areas of buildings that have not been properly cleaned. Very small mold spores can easily be inhaled, creating the potential for allergic reactions, asthma episodes, and other respiratory problems. Buildings should be properly cleaned and dried out to safely prevent mold growth (CDC 2020).

Molds and mildews are not the only public health risk associated with flooding. Floodwaters can be contaminated by pollutants such as sewage, human and animal feces, pesticides, fertilizers, oil, asbestos, and rusting building materials. Common public health risks associated with flood events also include:

- Unsafe food
- Contaminated drinking and washing water and poor sanitation
- Mosquitos and animals
- Carbon monoxide poisoning
- Secondary hazards associated with re-entering/cleaning flooded structures
- Mental stress and fatigue

Current loss estimation models such as Hazus are not equipped to measure public health impacts. The best level of mitigation for these impacts is to be aware that they can occur, educate the public on prevention, and be prepared to deal with these vulnerabilities in responding to flood events.

Impact on General Building Stock

After considering the population exposed and potentially vulnerable to the flood hazard, the built environment was evaluated. Exposure includes those buildings located in the flood zone. Potential damage is the modeled loss that could occur to the exposed inventory, including structural and content replacement cost values. Table 4.3.7-8 summarizes these results County-wide.

In summary, there are 2,106 buildings located in the 1-percent annual chance flood boundary with an estimated $2.7 billion of replacement cost value (i.e., building and content replacement costs). In total, this represents approximately 2.8-percent of the County's total general building stock inventory. In addition, there are 4,248 buildings located in the 0.2-percent annual chance flood boundary with an estimated $5.7 billion of building stock and contents exposed. This represents approximately 5.8-percent of the County's total general building stock inventory.

The Hazus flood model estimated potential damages to the buildings in Gloucester County at the structure level using the custom structure inventory developed for this HMP and the depth grid generated using the effective DFIRM data. The estimated potential damage estimated by Hazus to the general building stock inventory associated with the 1-percent annual chance flood is greater than $284 million or less than 1-percent of the total building stock replacement cost value. The Township of Greenwich has the greatest amount of estimated building loss—approximately $148 million (i.e. 5.4-percent of the total replacement cost value). Refer to Table 4.3.7-9 for the estimated losses by jurisdiction, which also shows the estimated losses for residential, commercial, and other occupancy structures, respectively.

Table 4.3.7-8. Estimated General Building Stock Located in the FEMA Flood Zones - All Occupancies

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value	Estimated Building Stock Exposed to the Flood Hazard Areas							
			Number of Buildings - 1-percent Annual Chance Flood	Percent of Total	Replacement Cost Value Exposed - 1-percent Annual Chance Flood	Percent of Total	Number of Buildings - 0.2-percent Annual Chance Flood	Percent of Total	Replacement Cost Value Exposed - 0.2-percent Annual Chance Flood	Percent of Total
Clayton (B)	3,295	$1,933,299,905	11	0.3%	$3,681,479	0.2%	16	0.5%	$5,508,279	0.3%
Deptford (Twp)	11,284	$10,081,159,584	76	0.7%	$82,167,813	0.8%	78	0.7%	$82,780,216	0.8%
East Greenwich (Twp)	4,346	$2,927,045,409	12	0.3%	$15,145,184	0.5%	21	0.5%	$29,158,395	1.0%
Elk (Twp)	2,339	$1,784,179,937	12	0.5%	$5,815,138	0.3%	12	0.5%	$5,815,138	0.3%
Franklin (Twp)	8,432	$5,637,186,975	27	0.3%	$30,891,619	0.5%	85	1.0%	$50,791,052	0.9%
Glassboro (B)	5,959	$5,816,332,907	4	0.1%	$43,604,375	0.7%	4	0.1%	$43,604,375	0.7%
Greenwich (Twp)	2,807	$2,734,741,222	721	25.7%	$605,150,365	22.1%	1,273	45.4%	$1,234,816,681	45.2%
Harrison (Twp)	4,817	$4,828,239,008	3	0.1%	$2,252,723	0.0%	5	0.1%	$3,126,532	0.1%
Logan (Twp)	2,805	$6,591,573,691	192	6.8%	$886,244,791	13.4%	343	12.2%	$1,967,386,876	29.8%
Mantua (Twp)	6,569	$4,738,271,524	12	0.2%	$8,906,343	0.2%	15	0.2%	$12,158,031	0.3%
Monroe (Twp)	12,553	$8,458,118,166	59	0.5%	$36,593,935	0.4%	74	0.6%	$42,646,713	0.5%
National Park (B)	1,483	$781,021,288	174	11.7%	$66,628,650	8.5%	357	24.1%	$136,815,759	17.5%
Newfield (B)	891	$622,948,021	7	0.8%	$23,209,639	3.7%	7	0.8%	$23,209,639	3.7%
Paulsboro (B)	2,615	$2,076,864,026	296	11.3%	$368,373,748	17.7%	1,036	39.6%	$918,921,038	44.2%
Pitman (B)	3,521	$2,916,470,733	2	0.1%	$7,434,815	0.3%	2	0.1%	$7,434,815	0.3%
South Harrison (Twp)	1,726	$1,494,748,661	9	0.5%	$6,222,624	0.4%	10	0.6%	$7,403,314	0.5%
Swedesboro (B)	1,040	$936,236,069	3	0.3%	$3,603,255	0.4%	3	0.3%	$3,603,255	0.4%
Washington (Twp)	17,413	$13,732,374,547	13	0.1%	$25,988,210	0.2%	20	0.1%	$30,172,382	0.2%
Wenonah (B)	930	$778,702,966	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
West Deptford (Twp)	7,561	$9,201,121,261	278	3.7%	$204,551,082	2.2%	550	7.3%	$621,895,802	6.8%
Westville (B)	1,733	$1,529,846,612	131	7.6%	$200,755,745	13.1%	263	15.2%	$320,628,760	21.0%
Woodbury (C)	3,605	$4,139,381,075	52	1.4%	$140,772,569	3.4%	55	1.5%	$231,994,353	5.6%
Woodbury Heights (B)	1,295	$1,265,332,236	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value	Estimated Building Stock Exposed to the Flood Hazard Areas							
			Number of Buildings - 1-percent Annual Chance Flood	Percent of Total	Replacement Cost Value Exposed - 1-percent Annual Chance Flood	Percent of Total	Number of Buildings - 0.2-percent Annual Chance Flood	Percent of Total	Replacement Cost Value Exposed - 0.2-percent Annual Chance Flood	Percent of Total
Woolwich (Twp)	4,074	$4,551,585,778	12	0.3%	$4,483,019	0.1%	19	0.5%	$11,312,422	0.2%
Gloucester County (Total)	**113,093**	**$99,556,781,602**	**2,106**	**1.9%**	**$2,772,477,118**	**2.8%**	**4,248**	**3.8%**	**$5,791,183,828**	**5.8%**

Sources: FEMA 2016; Gloucester County Planning Partners - 2021; HIFLD - 2020; EPA - 2021
Note: B – Borough; C - City; Twp – Township;

Table 4.3.7-9. Estimated General Building Stock Potential Loss to the 1-Percent Annual Chance Flood Event

Jurisdiction	Total Replacement Cost Value	All Occupancies		Residential		Commercial		Agricultural, Industrial, Religious, Education and Government	
		Estimated Loss	Percent of Total Replacement Cost Value	Estimated Loss	Percent of Total Replacement Cost Value	Estimated Loss	Percent of Total Replacement Cost Value	Estimated Loss	Percent of Total Replacement Cost Value
Clayton (B)	$1,933,299,905	$135,401	0.0%	$135,401	0.0%	$0	0.0%	$0	0.0%
Deptford (Twp)	$10,081,159,584	$9,732,287	0.1%	$7,900,914	0.1%	$1,831,373	0.0%	$0	0.0%
East Greenwich (Twp)	$2,927,045,409	$832,453	0.0%	$644,171	0.0%	$184,610	0.0%	$3,672	0.0%
Elk (Twp)	$1,784,179,937	$87,675	0.0%	$29,867	0.0%	$57,807	0.0%	$0	0.0%
Franklin (Twp)	$5,637,186,975	$2,490,708	0.0%	$440,913	0.0%	$2,049,795	0.0%	$0	0.0%
Glassboro (B)	$5,816,332,907	$28,866	0.0%	$0	0.0%	$28,866	0.0%	$0	0.0%
Greenwich (Twp)	$2,734,741,222	$148,142,785	5.4%	$51,057,549	1.9%	$11,636,914	0.4%	$85,448,322	3.1%
Harrison (Twp)	$4,828,239,008	$22,650	0.0%	$0	0.0%	$22,650	0.0%	$0	0.0%
Logan (Twp)	$6,591,573,691	$35,697,807	0.5%	$6,988,845	0.1%	$20,419,548	0.3%	$8,289,414	0.1%
Mantua (Twp)	$4,738,271,524	$533,260	0.0%	$396,260	0.0%	$137,000	0.0%	$0	0.0%
Monroe (Twp)	$8,458,118,166	$1,092,794	0.0%	$1,031,352	0.0%	$0	0.0%	$61,441	0.0%
National Park (B)	$781,021,288	$19,459,725	2.5%	$10,634,205	1.4%	$3,092,608	0.4%	$5,732,912	0.7%
Newfield (B)	$622,948,021	$925,815	0.1%	$354,740	0.1%	$0	0.0%	$571,074	0.1%
Paulsboro (B)	$2,076,864,026	$19,189,342	0.9%	$6,968,043	0.3%	$10,191,511	0.5%	$2,029,788	0.1%
Pitman (B)	$2,916,470,733	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
South Harrison (Twp)	$1,494,748,661	$834,857	0.1%	$472,584	0.0%	$0	0.0%	$362,273	0.0%
Swedesboro (B)	$936,236,069	$13,732	0.0%	$0	0.0%	$13,732	0.0%	$0	0.0%
Washington (Twp)	$13,732,374,547	$596,313	0.0%	$150,311	0.0%	$398,181	0.0%	$47,821	0.0%
Wenonah (B)	$778,702,966	$312,037	0.0%	$0	0.0%	$312,037	0.0%	$0	0.0%
West Deptford (Twp)	$9,201,121,261	$21,949,656	0.2%	$12,464,109	0.1%	$5,199,674	0.1%	$4,285,874	0.0%
Westville (B)	$1,529,846,612	$12,782,139	0.8%	$6,207,242	0.4%	$6,284,833	0.4%	$290,065	0.0%
Woodbury (C)	$4,139,381,075	$8,779,768	0.2%	$4,682,991	0.1%	$3,476,397	0.1%	$620,381	0.0%
Woodbury Heights (B)	$1,265,332,236	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Woolwich (Twp)	$4,551,585,778	$724,887	0.0%	$706,495	0.0%	$0	0.0%	$18,392	0.0%
Gloucester County (Total)	**$99,556,781,602**	**$284,364,956**	**0.3%**	**$111,265,993**	**0.1%**	**$65,337,534**	**0.1%**	**$107,761,429**	**0.1%**

Sources: FEMA 2016; Gloucester County Planning Partners - 2021; HIFLD - 2020; EPA - 2021
Note: B – Borough; C - City; Twp – Township

NFIP Statistics

FEMA provided a list of properties with NFIP policies, past claims, and multiple claims. According to FEMA, a repetitive loss (RL) property is a NFIP-insured structure that has had at least two paid flood losses of more than $1,000 in any 10-year period since 1978. A severe repetitive loss (SRL) property is a NFIP-insured structure that has had four or more separate claim payments made under a standard flood insurance policy, with the amount of each claim exceeding $5,000 and with the cumulative amount of such claims payments exceeding $20,000; or at least two separate claims payments made under a standard flood insurance policy with the cumulative amount of such claim payments exceed the fair market value of the insured building on the day before each loss (FEMA 2018).

Table 4.3.7-10, Table 4.3.7-11, and Table 4.3.7-12 summarize the NFIP policies, claims, and repetitive loss statistics for Gloucester County. The majority of the RL and SRL properties are single-family residences (77.7-percent and 81.8-percent, respectively). This information is current as of September 30, 2019. The locations of repetitive flooding were geocoded and mapped.

Table 4.3.7-10 illustrates these properties with the understanding that there are varying tolerances between how closely the longitude and latitude coordinates correspond to the location of the property address.

Table 4.3.7-10. Occupancy Class of Repetitive Loss Structures in Gloucester County

Occupancy Class	Total Number of NFIP Repetitive Loss (RL) Properties (excludes SRL)	Total Number of NFIP Severe Repetitive Loss (SRL) Properties (excludes RL)	Total NFIP RL and SRL Properties
Business Non-Residential	3	0	3
Non-Residential	1	0	1
Single Family	60	1	61
Gloucester County (Total)	**64**	**1**	**65**

Source: FEMA 2019
Note: Policies, claims, repetitive loss and severe repetitive loss statistics provided by FEMA Region 2, and are current as of September 30, 2019.
**Valid means the Severe Repetitive Loss Indicator is equal to V, VN, VU, VNU, MV, and MVU. Repetitive Loss Properties include properties that have a Severe Repetitive Loss Indicator of P, PU, PNU, and are left blank. V = Valid Insured Residential SRL property; VN = Valid Insured Non-Residential SRL property; VU = Valid Uninsured Residential SRL property; VNU = Valid Uninsured Non-Residential SRL property; MV = Mitigated Valid Insured Residential SRL property; MVU = Mitigated Valid Uninsured Residential SRL property; P = Pending Insured Residential SRL property; PN = Pending Insured Non-Residential SRL property; PU = Pending Uninsured Residential SRL property; PNU = Pending Uninsured Non-Residential SRL property*

Table 4.3.7-11 Occupancy Class of Repetitive Loss Structures in Gloucester County, by Municipality

Jurisdiction	NFIP Repetitive Loss (RL) Properties (excludes SRL)			NFIP Severe Repetitive Loss (SRL) Properties		
	Business Non-Residential	Non-Residential	Single Family	Business Non-Residential	Non-Residential	Single Family
Clayton (B)	0	0	0	0	0	0
Deptford (Twp)	0	0	1	0	0	0
East Greenwich (Twp)	0	0	2	0	0	0
Elk (Twp)	0	0	1	0	0	0
Franklin (Twp)	0	0	1	0	0	0
Glassboro (B)	0	0	0	0	0	0
Greenwich (Twp)	0	0	4	0	0	0
Harrison (Twp)	0	0	0	0	0	0
Logan (Twp)	1	0	6	0	0	0
Mantua (Twp)	0	0	6	0	0	0
Monroe (Twp)	0	0	5	0	0	0
National Park (B)	1	0	6	0	0	0
Newfield (B)	0	0	0	0	0	0
Paulsboro (B)	0	1	0	0	0	0
Pitman (B)	0	0	0	0	0	0
South Harrison (Twp)	0	0	0	0	0	0
Swedesboro (B)	0	0	0	0	0	0
Washington (Twp)	0	0	1	0	0	0
Wenonah (B)	0	0	0	0	0	0
West Deptford (Twp)	1	0	18	0	0	1
Westville (B)	0	0	7	0	0	0
Woodbury (C)	0	0	1	0	0	0
Woodbury Heights (B)	0	0	0	0	0	0
Woolwich (Twp)	0	0	1	0	0	0
Gloucester County (Total)	**3**	**1**	**60**	**0**	**0**	**1**

Source: FEMA Region 2, 2019

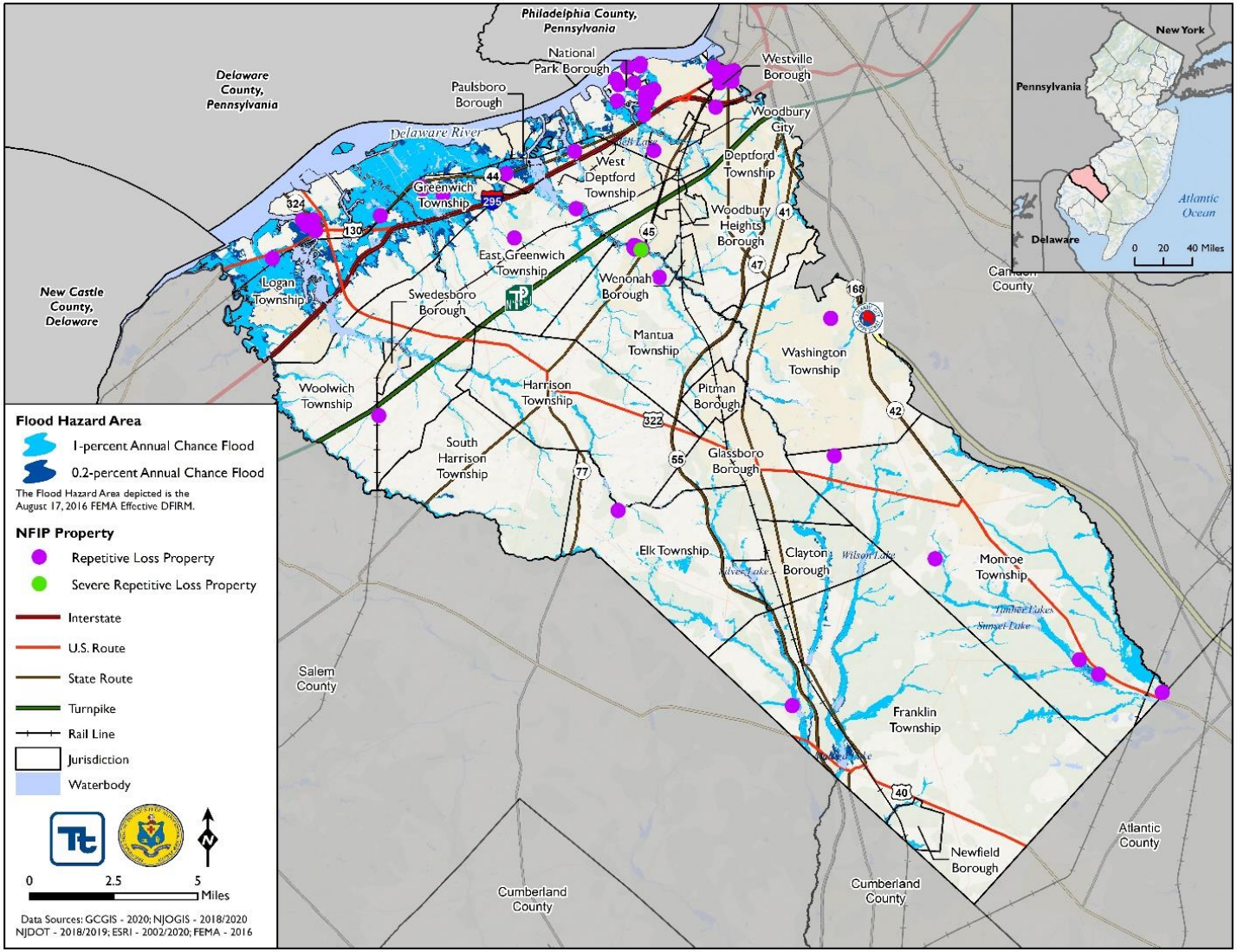
Notes: Multi-family designation is defined as two to four families. Repetitive loss and severe repetitive loss statistics provided by FEMA Region 2 and are current as of September 2019. The statistics were summarized using the Community Name provided by FEMA Region 2.

Table 4.3.7-12. NFIP Policies, Claims, and Repetitive Loss Statistics

Jurisdiction	Total Number of Policies	Total Claims	Total Payments	Number of NFIP Repetitive Loss (RL) Properties (Excludes SRL)	Number of NFIP Severe Repetitive Loss (SRL) Properties (Excludes RL)	Number of Mitigated RL/SRL Properties
Clayton (B)	13	8	$95,164	0	0	0
Deptford (Twp)	68	15	$81,400	1	0	0
East Greenwich (Twp)	17	10	$25,157	2	0	0
Elk (Twp)	11	8	$53,921	1	0	0
Franklin (Twp)	21	10	$106,635	1	0	0
Glassboro (B)	21	4	$3,033	0	0	0
Greenwich (Twp)	238	102	$189,353	4	0	0
Harrison (Twp)	16	2	$18,338	0	0	0
Logan (Twp)	59	31	$239,991	7	0	0
Mantua (Twp)	21	25	$342,122	6	0	0
Monroe (Twp)	63	43	$180,898	5	0	0
National Park (B)	69	67	$339,901	7	0	0
Newfield (B)	0	0	$0	0	0	0
Paulsboro (B)	48	37	$74,611	1	0	0
Pitman (B)	5	0	$0	0	0	0
South Harrison (Twp)	4	0	$0	0	0	0
Swedesboro (B)	2	3	$2,699	0	0	0
Washington (Twp)	43	9	$24,745	1	0	0
Wenonah (B)	3	0	$0	0	0	0
West Deptford (Twp)	88	143	$1,433,875	19	1	2
Westville (B)	66	82	$523,000	7	0	2
Woodbury (C)	21	9	$61,269	1	0	0
Woodbury Heights (B)	4	3	$118,015	0	0	0
Woolwich (Twp)	23	6	$129,747	1	0	0
Gloucester County (Total)	**924**	**617**	**$4,043,874**	**64**	**1**	**4**

Source: FEMA Region 2 2019; NFIP Bureau of Statistical Agency 2020
Notes: NFIP - National Flood Insurance Program
**Policies, claims, repetitive loss, and severe repetitive loss statistics provided by FEMA Region 2, and are current as of October 13, 2020 and September 30, 2019, respectively. The number of claims represents claims closed by October 13, 2020. FEMA noted that where there is more than one entry for a property, there may be more than one policy in force or more than one GIS possibility. A zero percentage denotes less than 1/100th percentage, and not zero damages or vulnerability, as may be the case.*

Figure 4.3.7-5. NFIP Repetitive and Severe Repetitive Loss Areas in Gloucester County



Impact on Critical Facilities and Lifelines

It is important to determine the critical facilities and infrastructure that may be at risk to flooding, and who may be impacted should damage occur. Critical services during and after a flood event may not be available if critical facilities are directly damaged or transportation routes to access these critical facilities are impacted. Roads that are blocked or damaged can isolate residents and can prevent access throughout the planning area to many service providers needing to reach vulnerable populations or to make repairs.

Critical facility exposure to the flood hazard was examined. Table 4.3.5-12 lists the critical facilities located in the 1-percent and 0.2-percent annual chance flood boundaries. There are 81 critical facilities located in the 1-percent annual chance flood event boundary. Additionally, there are 115 critical facilities located in the 0.2-percent annual chance flood event boundary. A majority of the critical facilities located in the 1-percent and 0.2-percent annual chance flood event boundaries are in the Township of West Deptford.

In cases where short-term functionality is impacted by flooding, other facilities of neighboring municipalities may need to increase support response functions during a disaster event. Mitigation planning should consider means to reduce flood impacts to critical facilities and ensure sufficient emergency and school services remain when a significant event occurs.

Table 4.3.7-13. Critical Facilities Located in the 1-Percent and 0.2-Percent Annual Chance Event Floodplain

Jurisdiction	Total Number of Critical Facilities	Number of Critical Facilities Located in the 1-Percent Annual Chance Flood Zone	Number of Critical Facilities Located in the 0.2-Percent Annual Chance Flood Zone
Clayton (B)	25	0	0
Deptford (Twp)	77	5	5
East Greenwich (Twp)	46	0	0
Elk (Twp)	6	0	0
Franklin (Twp)	35	0	0
Glassboro (B)	137	4	4
Greenwich (Twp)	31	15	20
Harrison (Twp)	26	0	0
Logan (Twp)	50	7	13
Mantua (Twp)	30	1	2
Monroe (Twp)	26	0	0
National Park (B)	41	4	5
Newfield (B)	9	0	0
Paulsboro (B)	29	15	22
Pitman (B)	19	0	0
South Harrison (Twp)	12	0	0

Jurisdiction	Total Number of Critical Facilities	Number of Critical Facilities Located in the 1-Percent Annual Chance Flood Zone	Number of Critical Facilities Located in the 0.2-Percent Annual Chance Flood Zone
Swedesboro (B)	9	0	0
Washington (Twp)	75	0	0
Wenonah (B)	4	0	0
West Deptford (Twp)	149	18	29
Westville (B)	21	3	6
Woodbury (C)	59	8	8
Woodbury Heights (B)	9	0	0
Woolwich (Twp)	16	1	1
Gloucester County (Total)	**941**	**81**	**115**

Sources: FEMA 2016; Gloucester County Planning Partners - 2021; HIFLD - 2020; EPA – 2021
Note: B – Borough; C - City; Twp – Township

Table 4.3.7-14. Critical Facilities within the 1-percent Annual Chance Flood Boundary

Jurisdiction	Number of Critical Facilities Located in the 1-percent Annual Chance Flood Event Hazard Area													
	Dam	DPW	EMS	Fire Station	Hazardous Material Facility	Medical Center	Police Station	Port Facility	Post-Secondary Education	Potable Water Facility	Primary Education	Secondary Education	Wastewater Metering Station	Wastewater Pump Station
Clayton (B)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deptford (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	5	0
East Greenwich (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Elk (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Franklin (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glassboro (B)	0	0	0	0	0	0	0	0	4	0	0	0	0	0
Greenwich (Twp)	0	0	0	2	6	0	0	2	0	0	4	1	0	0
Harrison (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Logan (Twp)	0	0	0	0	3	0	0	1	0	3	0	0	0	0
Mantua (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Monroe (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
National Park (B)	0	0	0	0	1	0	0	1	0	1	0	0	0	1
Newfield (B)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paulsboro (B)	0	0	1	0	3	1	1	8	0	0	0	0	0	1
Pitman (B)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
South Harrison (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Swedesboro (B)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Washington (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wenonah (B)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
West Deptford (Twp)	0	0	0	0	1	0	0	2	0	0	1	2	2	10
Westville (B)	0	2	0	0	0	0	0	0	0	0	0	0	0	1
Woodbury (C)	1	0	0	0	0	1	0	1	0	0	0	1	4	0
Woodbury Heights (B)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Woolwich (Twp)	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Gloucester County (Total)	**1**	**2**	**1**	**2**	**14**	**2**	**1**	**16**	**4**	**4**	**5**	**4**	**12**	**13**

Sources: FEMA 2016; Gloucester County Planning Partners - 2021; HIFLD - 2020; EPA - 2021
Note: B – Borough; C - City; Twp – Township
**Please note that only critical facilities exposed to the flood hazard area are represented in this table. Critical facility types that are found within each municipality but are not exposed to the flood hazard area may not be listed in the table.*

Table 4.3.7-15. Critical Facilities within the 0.2-percent Annual Chance Flood Boundary

Jurisdiction	Number of Critical Facilities Located in the 0.2-percent Annual Chance Flood Event Hazard Area																	
	Board of Education	County Building	Cultural Site	Dam	DPW	EMS	Fire Station	Food Pantry	Hazardous Material Facility	Medical Center	Police Station	Port Facility	Post-Secondary Education	Potable Water Facility	Primary Education	Secondary Education	Wastewater Metering Station	Wastewater Pump Station
Clayton (B)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deptford (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0
East Greenwich (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Elk (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Franklin (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glassboro (B)	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
Greenwich (Twp)	2	0	0	0	0	0	2	0	7	0	0	3	0	0	4	2	0	0
Harrison (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Logan (Twp)	0	0	0	0	0	0	0	0	3	0	0	1	0	9	0	0	0	0
Mantua (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Monroe (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
National Park (B)	0	1	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	1
Newfield (B)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paulsboro (B)	0	0	0	0	0	2	2	0	4	1	2	9	0	0	1	0	0	1
Pitman (B)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
South Harrison (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Swedesboro (B)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Washington (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wenonah (B)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
West Deptford (Twp)	0	0	0	0	0	0	0	2	2	0	0	3	0	0	1	2	3	16

Jurisdiction	Number of Critical Facilities Located in the 0.2-percent Annual Chance Flood Event Hazard Area																	
	Board of Education	County Building	Cultural Site	Dam	DPW	EMS	Fire Station	Food Pantry	Hazardous Material Facility	Medical Center	Police Station	Port Facility	Post-Secondary Education	Potable Water Facility	Primary Education	Secondary Education	Wastewater Metering Station	Wastewater Pump Station
Westville (B)	0	0	1	0	4	0	0	0	0	0	0	0	0	0	0	0	0	1
Woodbury (C)	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	1	4	0
Woodbury Heights (B)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Woolwich (Twp)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Gloucester County (Total)	**2**	**1**	**1**	**1**	**4**	**2**	**4**	**2**	**17**	**2**	**2**	**19**	**4**	**10**	**6**	**5**	**14**	**19**

Sources: FEMA 2016; Gloucester County Planning Partners - 2021; HIFLD - 2020; EPA - 2021

Note: B – Borough; C - City; Twp – Township

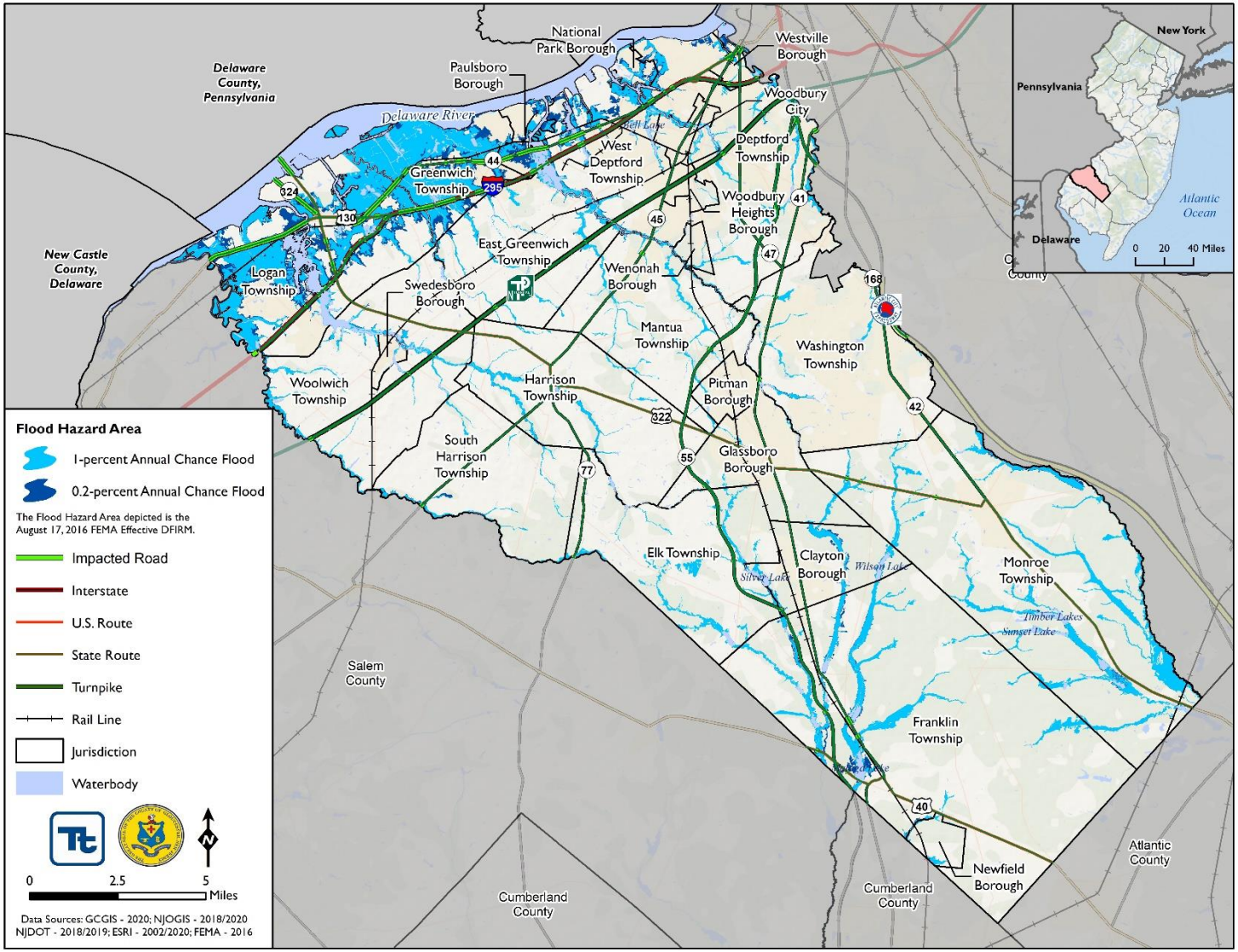
**Please note that only critical facilities exposed to the flood hazard area are represented in this table. Critical facility types that are found within each municipality but are not exposed to the flood hazard area may not be listed in the table.*

An exposure analysis was conducted to determine how many miles of major highways may be impacted by flood events. Several major roadways are located in the 1-percent annual chance flood hazard area including I295, NJ-42, NJ-44, NJ-45, NJ-47, NJ-55, NJ 168, NJ-322, NJ-324, US-40, and US-130. Approximately 23.3-percent and 46-percent of the total roadway miles within the County are located in the 1-percent and 0.2-percent annual chance flood hazard areas (Table 4.3.7-16). Refer to Figure 4.3.7-6 which illustrates the roadways located in the FEMA flood hazard areas.

Table 4.3.7-16. Number of Miles of Roadway Located in the FEMA Floodplain

Road Type	Total Miles for County	Roadway Miles Located in the Flood Hazard Areas			
		Miles Located in the 1-Percent Annual Chance Flood Area	Percent of Total	Miles Located in the 0.2-Percent Annual Chance Flood Area	Percent of Total
Interstate	34	2	5.8%	7	20.5%
US Route	60	6	10%	9	15%
State Route	125	6	4.8%	10	8.0%
Turnpike	36	1	2.7%	1	2.7%
Gloucester County (Total)	**255**	**15**	**23.3%**	**27**	**46%**

Figure 4.3.7-6. Roads that Intersect the FEMA Floodplain



Impact on the Economy

Flood events can significantly impact the local and regional economy. This includes but is not limited to general building stock damages and associated tax loss, impacts to utilities and infrastructure, business interruption, impacts on tourism, and impacts on the tax base to Gloucester County. In areas that are directly flooded, renovations of commercial and industrial buildings may be necessary, disrupting associated services. Refer to the 'Impact on Buildings' subsection earlier which discusses direct impacts to buildings in Gloucester County. Other economic components such as loss of facility use, functional downtime and socio-economic factors are less measurable with a high degree of certainty.

Flooding can cause extensive damage to public utilities and disruptions to delivery of services. Loss of power and communications may occur and drinking water and wastewater treatment facilities may be temporarily out of operation.

Debris management may also be a large expense after a flood event. Hazus estimates the amount of debris generated from the 1-percent annual chance event. The model breaks down debris into three categories: (1) finishes (dry wall, insulation, etc.); (2) structural (wood, brick, etc.) and (3) foundations (concrete slab and block, rebar, etc.). The distinction is made because of the different types of equipment needed to handle the debris. Table 4.3.7-17 summarizes the debris Hazus estimates for these events. As a result of the 1-percent annual chance event, Hazus estimates approximately 13,134 tons of debris will be generated in total.

Table 4.3.7-17. Estimated Debris Generated from the 1-percent Annual Chance Flood Event

Jurisdiction	1-Percent Annual Chance Flood Event			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Clayton (B)	6	6	0	0
Deptford (Twp)	856	496	210	150
East Greenwich (Twp)	139	138	0	0
Elk (Twp)	11	11	0	0
Franklin (Twp)	113	113	0	0
Glassboro (B)	74	74	0	0
Greenwich (Twp)	3,841	3,817	13	12
Harrison (Twp)	36	36	0	0
Logan (Twp)	1,122	966	95	60
Mantua (Twp)	121	115	3	2
Monroe (Twp)	57	57	0	0
National Park (B)	852	723	77	52
Newfield (B)	24	24	0	0
Paulsboro (B)	554	526	17	11
Pitman (B)	29	29	0	0
South Harrison (Twp)	161	59	60	42
Swedesboro (B)	72	72	0	0
Washington (Twp)	206	204	2	1
Wenonah (B)	29	29	0	0
West Deptford (Twp)	1,804	825	456	523
Westville (B)	553	553	0	0

Jurisdiction	1-Percent Annual Chance Flood Event			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Woodbury (C)	2,427	1,106	771	550
Woodbury Heights (B)	7	7	0	0
Woolwich (Twp)	40	40	0	0
Gloucester County (Total)	**13,134**	**10,028**	**1,703**	**1,403**

Sources: FEMA 2016; Gloucester County Planning Partners - 2021; HIFLD - 2020; EPA - 2021
Note: B – Borough; C - City; Twp – Township;

Impact on the Environment

Flood extents for the 1- and 0.2-percent annual flood events will continue to evolve alongside natural occurrences such as sea level rise, climate change, and/or severity of storms. Further, residents living in and around areas of wildfire may be at increased risk of flooding in the future due to changes in the natural landscape.

Flood events will inevitably impact Gloucester County's natural and local environment. Severe flooding not only influences the habitat of these natural land areas, it can be disruptive to species that reside in these natural habitats. Further, Table 4.3.4-20 lists the number of acres natural land use types within Gloucester County that are at risk to flooding.

Table 4.3.5-20. Acreage of Natural and Beneficial Land Located in the Floodplain

Wetlands	Area in the 1-Percent Annual Chance Floodplain (acres)	Area in the 0.2-Percent Annual Chance Floodplain (acres)
Wetlands	15,475	16,097
Forest	2,068	2,470

Source: NJDEP data used - 2015 LULC data was published in 2019, 2012 LULC data includes 2007 and 2012 LULC published in 2015

Cascading Impacts on Other Hazards

Flood events can exacerbate the impacts of disease outbreak and landslides. After a flooding event, runoff can pick up and transport pollutants from wildlife and soils. Such organisms can then appear in water drinking facilities and transmit illnesses water-borne and vector diseases to the population (WHO, 2020). Flooding can also put additional strain on dams, which may lead to dam failure. More information about these hazards of concern can be found in Section 4.3.1 (Dam and Levee Failure) and Section 4.3.2 (Disease Outbreak).

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:

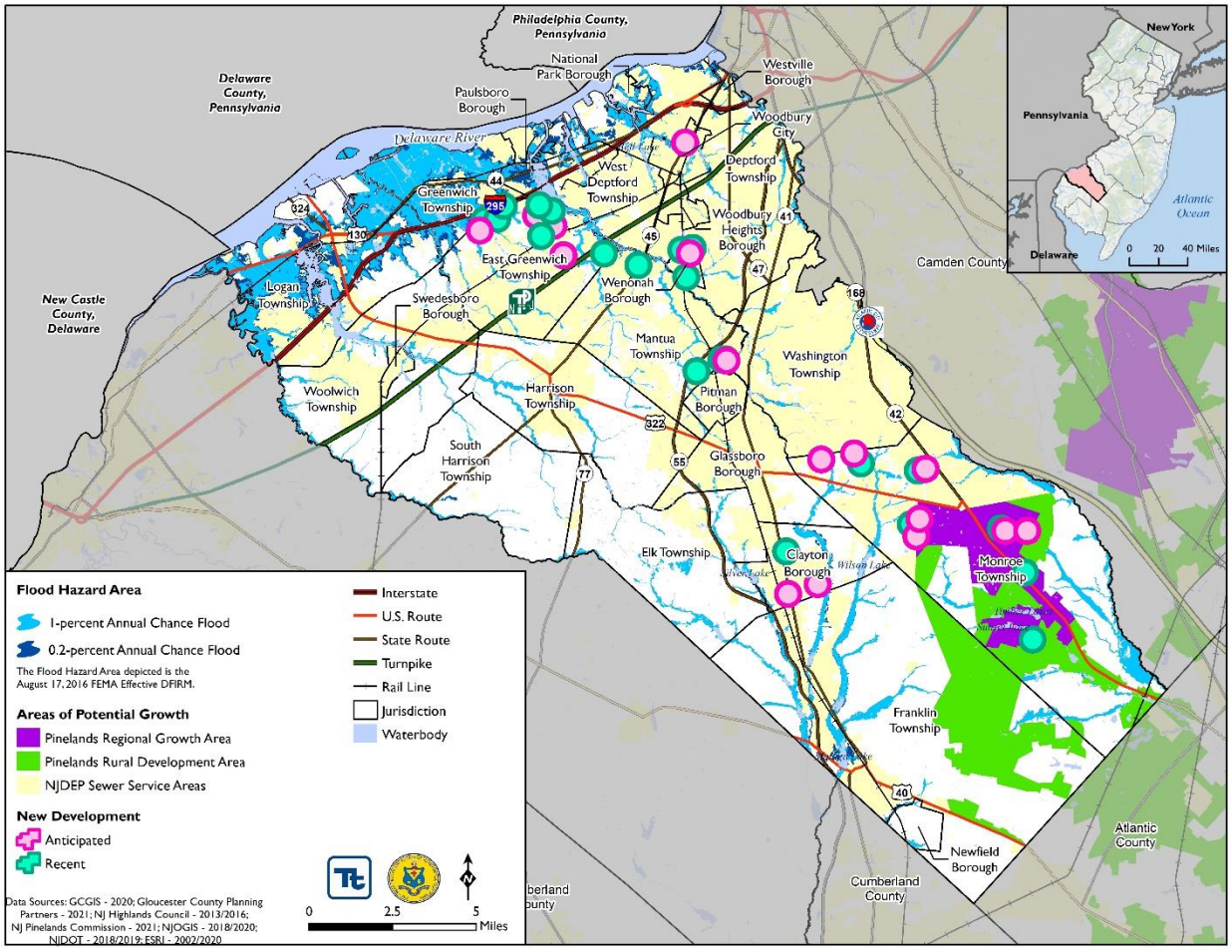
- Potential or projected development

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

Projected Development

As discussed and illustrated in Section 3 (County Profile), areas targeted for future growth and development have been identified across the County. The New Jersey Pinelands Commission has identified areas of potential growth (Regional Growth Areas and Rural Development Areas) in Gloucester County, and NJDEP has delineated Sewer Service Areas that may provide insight as to where potential new development may occur. In addition, each community was requested to provide potential major new development and infrastructure over the next five years; summarized in Section 9 (Jurisdictional Annexes). According to the Gloucester County Planning Partners, there are 38 new development projects that have occurred in the last five years or are anticipated to occur in the next five years. Out of the total new development projects, no sites are located in the 1-percent annual chance flood area or the 0.2-percent annual chance flood area (Figure 4.3.7-7). This new development will be constructed in accordance with current building codes and standards.

Figure 4.3.7-7. Recent and Anticipated New Development and Flood Boundaries in Gloucester County



Projected Changes in Population

Gloucester County has experienced an increase in population of approximately 1.0-percent between 2010 and 2019. According to the ACS 5-year population estimates, in 2019 Gloucester County had a population of 291,165. The Township of Woolwich and the Borough of Glassboro have experienced the greatest increases with an increase of 23.0-percent and 6.7-percent, respectively. As the population increases, so may the number of people impacted by this hazard if an increased number of residents are moving into, or development is occurring the floodplain.

Climate Change

As discussed above, most studies project that the State of New Jersey will see an increase in average annual temperatures and precipitation. Annual precipitation amounts in the region are projected to increase, primarily in the form of heavy rainfalls, which have the potential to increase the risk to flash flooding and riverine flooding, and flood critical transportation corridors and infrastructure. Increases in precipitation may alter and expand the floodplain boundaries and runoff patterns, resulting in the exposure of populations, buildings, and critical facilities and infrastructure that were previously outside the floodplain. This increase in exposure would result in an increased risk to life and health, an increase in structural losses, a diversion of additional resources to response and recovery efforts, and an increase in business closures affected by future flooding events due to loss of service or access.

Change of Vulnerability Since 2016 HMP

The FEMA flood maps have not changed since the 2016 HMP; however, the 2022 planning process has resulted in the collection of additional flood problem areas (urban flooding) not reflected on the flood maps. As a result of changes in storm frequency and intensity, it seems as though the County's flood risk continues to increase. This updated HMP utilized more current population statistics, buildings, and infrastructure to provide more accurate results for the exposure and loss estimation analysis. Gloucester County will continue to be vulnerable to the flood hazard.