4.7 FLOOD

SECTION 4.7 FLOOD

4.7-1 HAZARD OVERVIEW

This section provides a profile and vulnerability assessment for flood hazards including the following types of flooding:

- riverine (inland) flooding
- coastal flooding
- ice jams
- stormwater flooding
- urban flooding
- nuisance flooding
- tsunami
- storm surge
- sea-level rise

Flooding caused by dam and levee failure is discussed in Section 4.3: Dam and Levee Failure. Storm surge, coastal flooding, and sea-level rise have been relocated into this profile for this update.

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. 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, 2008).

The flood-related hazards most likely to affect New Jersey are riverine (inland) flooding and coastal flooding. Other flood-related hazards that have historically occurred and will continue to affect the State include flooding associated with ice jams, flooding associated with tsunamis, stormwater flooding due to local drainage and high groundwater levels, and storm surge/coastal flooding. Each is described below, along with the sub-categories associated with each hazard type.

Hazard Definitions

Riverine (Inland) Flooding

Riverine floods are the most common flood type. They occur along a channel and include overbank and flash flooding. Channels are defined, ground features that carry water through and out of a watershed. They may be called rivers, creeks, streams, or ditches. When a channel receives too much water, the excess water flows over its banks and inundates low-lying areas (FEMA, 2008; The Illinois Association for Floodplain and Stormwater Management, 2006).

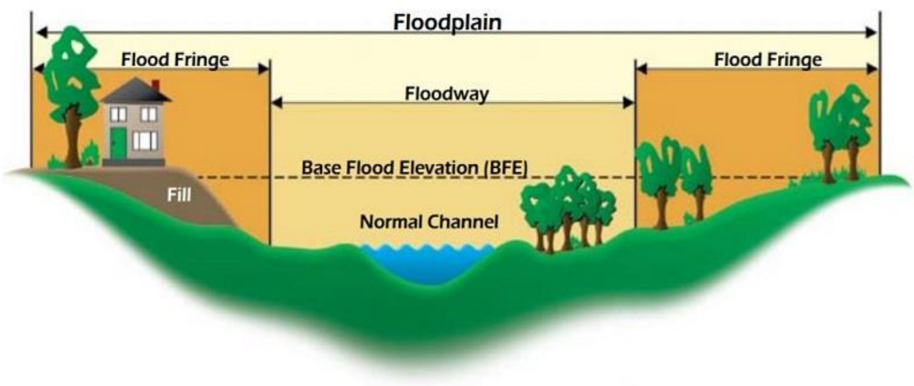
Flash floods are "a rapid and extreme flow of high water into a normally dry area, or a rapid water level rise in a stream or creek above a predetermined flood level, beginning within six hours of the causative event (e.g., intense rainfall, dam failure, ice jam). However, the actual time threshold may vary in different parts of the country. Ongoing flooding can intensify to flash flooding in cases where intense rainfall results in a rapid surge of rising flood waters" (National Weather Service [NWS], 2009).

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. Most often floodplains are referred to as 100- year floodplains or 1-percent annual chance floodplains, which represent the extent of a flood that has a 1% probability to occur each year. Similarly, the 0.2% annual chance flood for coastal flooding represents the elevation of the coastal flood having a 0.2% chance (1 in 500) of being equaled or exceeded in any given year. This constitutes moderate flood risk.

While the term 100-year floodplain was used in the past, the 1% annual chance flood is now the standard used by most federal and state agencies and by the NFIP (FEMA, 2002). It is important to note that this indicates this storm has a 1% chance of occurring at least once each year; over the course of a 30-year mortgage, the likelihood of flooding grows to 25 percent.

The Special Hazard Flood Area (SFHA) is the area where the NFIP's floodplain management regulations must be enforced and the area where the mandatory purchase of flood insurance applies. SFHA are defined as the area that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year. The 1-percent annual chance flood is also referred to as the base flood. Base Flood Elevation (BFE) is the elevation of surface water resulting from a flood that has a 1% chance of equaling or exceeding that level in any given year.

Figure 4.7-1 Characteristics of a Floodplain



Source: FEMA, 2009

In New Jersey, new development within the floodway is restricted in compliance with DEP and FEMA regulations. Generally, only development that must occur within the floodway is permitted, such as bridges, culverts, or bank stabilization measures. New buildings are prohibited in the floodway to protect people that could be present during a flood, first responders, and other members of the public downstream that may be impacted by debris.

Coastal Flooding

Coastal flooding occurs along the coasts of oceans, bays, estuaries, coastal rivers, and large lakes. It is the result of a storm surge where local sea levels rise, often resulting in weakened or destroyed coastal structures. Hurricanes and tropical storms, and Nor'easters cause most of the coastal flooding in New Jersey. Coastal flooding has many of the same problems identified for riverine flooding but also has additional problems such as beach erosion; loss or submergence of wetlands and other coastal ecosystems; saltwater intrusion; high water tables; loss of coastal recreation areas, beaches, protective sand dunes, parks, and open space; and loss of coastal structures. Coastal structures can include sea walls, piers, bulkheads, bridges, or buildings (FEMA, 2011).

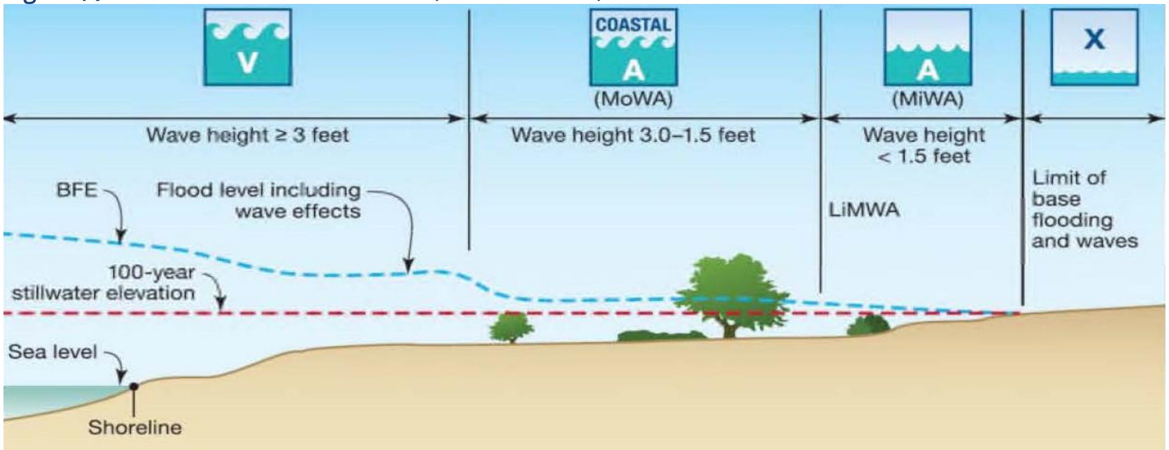
According to the Coastal Construction Manual, FEMA P-55, Zone V (including Zones VE, V1-30, and V) identifies the Coastal High Hazard Area. Zone V includes coastal areas with a 1% or greater chance of flooding and an additional hazard associated with storm waves. Zone V is the portion of the Special Flood Hazard Area (SFHA) that extends from offshore to the inland limit of a primary frontal dune along an open coast and any other portion of the SFHA that is subject to high-velocity wave action from storms or seismic sources. The boundary of Zone V is generally based on wave heights (3 feet or greater) or wave run-up depths (3 feet or greater). Zone V can also be mapped based on the wave overtopping rate (when waves run up and over a dune or barrier).

Zones A or AE identify portions of the SFHA that are not within the Coastal High Hazard Area. They may be coastal or riverine. Zones A and AE are areas with a 1% annual chance of flooding that do not face an additional hazard associated with wave action, although Coastal A or AE zones may experience waves under 3 feet of height during an event. Regulatory requirements of the NFIP for buildings located in Zone A are the same for both coastal and riverine flooding hazards.

Zone X is the area beyond the base flood elevation. This zone includes the 0.2% annual chance flood and represents low to moderate flood risk

Figure 4.7-2 shows a typical transect illustrating coastal zones and the effects of energy dissipation and regeneration of a wave as it moves inland . Zones include Zone V, the Coastal A-Zone (characterized by Moderate Wave Action (MoWA) where waves can be between 1.5 to 3 feet during a BFE) and Zone A (characterized by Minimal Wave Action (MiWA) where waves are less than 1.5 feet during a BFE) which are separated by the Limit of Wave Action (LiMWA).Wave elevations are decreased by obstructions such as vegetation and rising ground elevation (FEMA, 2011).

Figure 4.7-2 Transect Schematic of Zone V, Coastal A-zone, and Zone A



Source: FEMA, 2011

Ice Jam

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, 2008). Ice jams may also be caused by frazil ice, which forms when mist, perhaps from a waterfall, 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 and are usually associated with a rapid increase in runoff and corresponding river discharge due to a heavy rainfall, snowmelt, or warmer temperatures (United States Army Corps of Engineers [USACE], 2002).

Stormwater Flooding

Stormwater flooding is due to local drainage issues and high groundwater levels. Locally, heavy precipitation may produce flooding in areas other than delineated floodplains or along recognizable channels. If local conditions cannot accommodate intense precipitation through a combination of infiltration and surface runoff, water may accumulate and cause flooding problems. During winter and spring, frozen ground and snow accumulations may contribute to inadequate drainage and localized ponding. Flooding issues of this nature generally occur in areas with flat gradients and generally increase with urbanization, which speeds the accumulation of floodwaters because of impervious areas. Shallow street flooding can occur unless channels have been widened or deepened to account for increased flows (FEMA, 1997).

Urban Flooding

NOAA defines urban flooding as the flooding of streets, underpasses, low lying areas, or storm drains. This type of flooding is mainly an inconvenience but can be life threatening, especially to those that inhabit low lying areas or basement units. Urban flooding is caused by increased water runoff due to urban development and drainage systems that are unable to accommodate high amounts of runoff. 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. They 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. Since 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 (FEMA, 2008).

Nuisance Flooding

Nuisance flooding is a flood event influenced by minor impacts, such as high tide or minor rainstorm occurrences. Nuisance flooding occurs fairly frequently because it is caused by events that happen on a regular basis. Nuisance flooding causes public inconvenience by influencing frequent road closures, overwhelmed storm drains and deterioration of infrastructure. Recently, nuisance flooding has been increasing around the coastal United States due to sea level rise and land subsidence (NOAA, 2018).

Tsunami

FEMA and NOAA state that tsunamis are a series of traveling ocean waves created by sudden displacements of the ocean floor (earthquakes), landslides, or volcanic activity. A tsunami can move hundreds of miles per hour in the open ocean and crash into land with waves exceeding 100 feet in height (FEMA, 2009).

A tsunami consists of a series of high-energy waves that travel outward, like pond ripples, from the area where the tsunami originated. The sequence of tsunami waves arrives at the shoreline over an extended period of time and builds height as it gets closer (FEMA, 2007; Humboldt County Hazard Mitigation Plan, 2008). A tsunami approaching the shoreline may take three forms:

- Non-breaking waves that act as a rapidly rising tide
- A large, turbulent wall-like wave (bore)
- A series of partially developed waves.

There are two types of tsunamis: local and distant. A locally generated tsunami is caused by an undersea disturbance near the coast. They have minimal warning times and may be accompanied by earthquake damage due to ground shaking, surface faulting, liquefaction, or landslides. A local tsunami, due to its close proximity to the coast, leaves few options for escaping, except to run to high ground. Distant tsunamis may travel for hours before striking a coastline, leaving enough time for warning (Humboldt County Hazard Mitigation Plan, 2008; Grays Harbor County Hazard Mitigation Plan, 2005).

Storm Surge

Storm surges inundate coastal floodplains by dune over wash, tidal elevation rise in inland bays and harbors, and backwater flooding through coastal river mouths. Strong winds can increase tide levels and water- surface elevations. Storm systems generate large waves that run up and flood coastal beaches. The combined effects create storm surges that affect the beach, dunes, and adjacent low-lying floodplains. Shallow, offshore depths can cause storm-driven waves and tides to pile up against the shoreline and inside bays. Based on an area’s topography, a storm surge may inundate only a small area or storm surge may inundate coastal lands for a mile or more inland from the shoreline.

Sea-Level Rise

Global sea level is rising, due to rising temperatures and other processes such as ocean circulation, and is putting coastal residents, economies, and natural resources at risk. One of the most noticeable consequences of sea-level rise is an increase in coastal and nuisance flooding. Sea-level rise contributes in this way by making flooding more likely as it inundates low-lying areas and wetlands, erodes shorelines, and increases the flow of salt water into estuaries and groundwater aquifers (EPA, 2021). The impacts of sea-level rise are intensified during storm events. Studies have suggested that higher sea levels contributed to greater impacts from Superstorm Sandy, attributing around $3.7 billion of the nearly $30 billion in damage directly to sea-level rise and the resulting storm surge (NJDEP, 2021). The state is considering further revisions to its Flood Hazard Area Control Act Rules, which will increase the regulatory flood elevations in tidally controlled flood hazard areas.

Community Rating System (CRS) Program

The CRS is a voluntary incentive program within NFIP that is administered by the Insurance Services Office (ISO) and that provides discounts to flood insurance rate premiums for participating communities based on the community's floodplain management efforts.

As of October 2023, there were 92 communities within the State of New Jersey participating in the CRS program. The participating communities are shown in Table 4.7-1; FEMA maintains an active list of participating communities on its website for the Community Rating System. The CRS classifications in New Jersey range from a low of Class 10 (no discount) to a high of Class 3 (35% discount). New Jersey has state standards that provide all municipalities in New Jersey with points for the program, but communities are responsible for applying and maintaining their status for the CRS program directly. More information on the CRS program in New Jersey is available is Section 5.0: Capability Assessment.

As of 2023, New Jersey has:

- 17 communities with a Class 10 (0%) premium reduction
- 3 communities with a Class 9 rating (5% premium reduction)
- 17 communities with a Class 8 rating (10% premium reduction)
- 33 communities with a Class 7 rating (15% premium reduction)
- 20 communities with a Class 6 rating (20% premium reduction)
- 18 communities with a Class 5 rating (25% premium reduction)
- 2 communities with a Class 4 rating (30% premium reduction)
- 1 community with a Class 3 rating (35% premium reduction)

The changes since 2018 are one less Class 10 communities, four less Class 8 communities, ten more Class 7 communities, eight less Class 6 communities, and two more Class 4 communities. Of the participating CRS communities, 17 of them had their CRS classifications rescinded due to failure to meet annual participation requirements and their participation is considered retrograde (status marked R in the table below). These communities are receiving no CRS Discount.

Table 4.7-1 Participating CRS Communities in New Jersey July 2023

Community Number	Community Name	CRS Entry Date	Current Eff. Date	Class	% Discount For SFHA	% Discount For Non- SFHA	Status*
345279	Avalon, Borough of	35339	43952	3	35	10	C
345310	Ocean City, City of	33878	43952	4	30	10	C
345318	Sea Isle City, City of	41183	45017	4	30	10	C
345283	Belmar, Borough of	42125	43952	5	25	10	C
345286	Brigantine, City of	33878	42278	5	25	10	C
345288	Cape May, City of	34608	44105	5	25	10	C
345300	Lincoln Park, Borough of	42491	42491	5	25	10	C
340011	Linwood, City of	41913	43952	5	25	10	C
340401	Little Falls, Township of	40299	44105	5	25	10	C
345303	Manasquan, Borough of	33878	43221	5	25	10	C
340437	Manville, Borough of	41913	43952	5	25	10	C
345304	Margate City, City of	33878	41548	5	25	10	C
345311	Pequannock, Township of	40817	42644	5	25	10	C
345528	Pompton Lakes, Borough of	40817	41395	5	25	10	C
340393	Stafford Township	33512	41548	5	25	10	C
340159	Upper, Township of	40817	42856	5	25	10	C
345326	Ventnor City, City of	33878	43221	5	25	10	C

Community Number	Community Name	CRS Entry Date	Current Eff. Date	Class	% Discount For SFHA	% Discount For Non- SFHA	Status*
345329	Wildwood, City of	42491	43221	5	25	10	C
345331	Woodbridge, Township of	43586	44105	5	25	10	C
345278	Atlantic City, City of	33878	43221	6	20	10	C
340396	Barnegat, Township of	41760	45017	6	20	10	C
345282	Beach Haven, Borough of	33512	45017	6	20	10	C
340427	Bedminster, Township of	35339	39203	6	20	10	C
340369	Berkeley, Township of	39722	45017	6	20	10	C
345285	Brick, Township of	42856	42856	6	20	10	C
345295	Fairfield, Township of	41395	41395	6	20	10	C
340434	Franklin, Township of	40299	42125	6	20	10	C
340380	Little Egg Harbor, Township of	43221	43221	6	20	10	C
345301	Long Beach, Township of	33878	45017	6	20	10	C
345302	Longport, Borough of	34973	45017	6	20	10	C
340317	Neptune, Township of	42125	45017	6	20	10	C
345308	North Wildwood, City of	36800	42856	6	20	10	C
340518	Ocean, Township of	45017	45200	6	20	10	C
340015	Pleasantville, City of	41913	45017	6	20	10	C
340388	Point Pleasant Beach, Borough of	39934	42278	6	20	10	C
340067	Ridgewood, Village of	33878	43374	6	20	10	C
345317	Sea Bright, Borough of	43374	43374	6	20	10	C
340017	Somers Point, City of	43221	45200	6	20	10	C
345330	Wildwood Crest, Borough of	34243	41760	6	20	10	C
340001	Absecon, City of	41913	43739	7	15	5	C
340287	Avon-By-The-Sea, Borough of	42644	45017	7	15	5	C
345280	Barnegat Light, Borough of	33878	43586	7	15	5	C
345281	Bay Head, Borough of	34243	45017	7	15	5	C
340428	Bernards Township	40452	42856	7	15	5	C
340289	Bradley Beach, Borough of	34973	36800	7	15	5	C
345287	Burlington, City of	35886	43374	7	15	5	C
345289	Cape May Point, Borough of	34243	45017	7	15	5	C
345291	Cranford, Township of	42644	42644	7	15	5	C
345292	Denville, Township of	40817	44470	7	15	5	C
340246	Hamilton, Township of	33878	43374	7	15	5	C
340298	Hazlet, Township of	40664	45017	7	15	5	C
340303	Keansburg, Borough of	42125	42125	7	15	5	C
340237	Lambertville, City of	41030	42856	7	15	5	C
340379	Lavallette, Borough of	38108	45200	7	15	5	C
340046	Little Ferry, Borough of	42278	42278	7	15	5	C
340307	Long Branch, City of	43221	43221	7	15	5	C
340356	Long Hill, Township of	43009	43009	7	15	5	C
340153	Lower, Township of	43374	43374	7	15	5	C
340383	Mantoloking, Borough of	33878	45017	7	15	5	C
340313	Middletown, Township of	41030	45017	7	15	5	C
340570	New Jersey Sports & Exposition Authority	33878	39934	7	15	5	C

Community Number	Community Name	CRS Entry Date	Current Eff. Date	Class	% Discount For SFHA	% Discount For Non- SFHA	Status*
345309	Oakland, Borough of	42856	42856	7	15	5	C
340110	Palmyra, Borough of	40087	42125	7	15	5	C
345314	Rahway, City of	33878	43374	7	15	5	C
340070	Rochelle Park, Township of	38991	43739	7	15	5	C
340472	Roselle, Borough of	33878	41395	7	15	5	C
345319	Seaside Park, Borough of	38991	42856	7	15	5	C
345320	Ship Bottom, Borough of	33878	39934	7	15	5	C
340329	Spring Lake, Borough of	34608	45017	7	15	5	C
345323	Stone Harbor, Borough of	34608	45017	7	15	5	C
345293	Toms River, Township of	33878	43374	7	15	5	C
340331	Union Beach, Borough of	37895	45017	7	15	5	C
345327	Wayne, Township of	33512	42125	7	15	5	C
340312	Aberdeen, Township of	40299	42278	8	10	5	C
345284	Bloomingdale, Borough of	42644	42644	8	10	5	C
345296	Harvey Cedars, Borough of	33512	36434	8	10	5	C
340467	Linden, City of	33512	37530	8	10	5	C
340315	Monmouth Beach, Borough of	43009	43009	8	10	5	C
340209	National Park, Borough of	41183	43009	8	10	5	C
345307	North Plainfield, Borough of	33878	40087	8	10	5	C
340319	Ocean, Township of	43009	43009	8	10	5	C
340320	Oceanport, Borough of	40299	45017	8	10	5	C
340512	Pennsville, Township of	42644	42644	8	10	5	R
345313	Point Pleasant, Borough of	34243	45017	8	10	5	C
340359	Riverdale, Borough of	34608	41760	8	10	5	C
345324	Surf City, Borough of	33878	45017	8	10	5	C
340446	Warren, Township of	40299	42125	8	10	5	C
340081	Westwood, Borough of	42644	42644	8	10	5	C
340412	Woodland Park, Borough of	42644	42644	8	10	5	C
340026	Dumont, Borough of	43009	43009	9	5	5	C
340204	Greenwich, Township of	39203	39203	9	5	5	C
340272	Perth Amboy, City of	43009	43009	9	5	5	C
340459	Berkeley Heights, Township of	34608	36281	10	-	-	R
340178	Bloomfield, Township of	33878	35704	10	-	-	R
340007	Egg Harbor, Township of	43009	45200	10	-	-	R
340031	Englewood, City of	33512	37165	10	-	-	R
340037	Garfield, City of	41030	41913	10	-	-	R
340376	Lacey, Township of	33878	34243	10	-	-	R
340047	Lodi, Borough of	33878	34243	10	-	-	R
340188	Montclair, Township of	34608	34973	10	-	-	R
340517	Mullica, Township of	34608	39569	10	-	-	R
340355	Parsippany-Troy Hills, Township of	33512	39934	10	-	-	R
345312	Plainfield, City of	33512	36069	10	-	-	R
340473	Roselle Park, Borough of	42278	44835	10	-	-	R
340474	Scotch Plains, Township of	34608	34973	10	-	-	R
340389	Seaside Heights, Borough of	42856	44835	10	-	-	R

Community Number	Community Name	CRS Entry Date	Current Eff. Date	Class	% Discount For SFHA	% Discount For Non- SFHA	Status*
340280	South River, Borough of	41913	44105	10	-	-	R
340395	Tuckerton, Borough of	34243	36069	10	-	-	R
345328	West Wildwood, Borough of	34243	38626	10	-	-	R

*Status: C-Cycle, R-Retrograde

Source: FEMA, 2023

Secondary Hazards

The most problematic secondary hazard for flooding is bank erosion and landslides, which in some cases can be more harmful than actual flooding. This is especially true in the upper courses of rivers with steep gradients, where floodwaters may pass quickly and without much damage, but scour the banks, edging properties closer to the floodplain or causing them to fall in. Flooding is also responsible for hazards such as landslides when high flows on steep slopes with saturated soils cause them to fail. Hazardous materials spills are also a secondary hazard of flooding if storage tanks rupture and spill into streams, rivers, or storm sewers. Other impacts from ice jams can include structural damage from intake blockages, ice forces, or scouring under ice. Ice jams can cause bank failure, erosion and scour, and channel shifting. Natural habitats for fish, microbial communities, and riverine margins and estuaries may also be impacted by ice jams (USACE, 2013).

Aside from the tremendous hydraulic force of the tsunami waves themselves, floating debris carried by a tsunami can endanger human lives and batter inland structures. Ships moored at piers and in harbors often are swamped and sunk or are left battered and stranded high on the shore. Breakwaters and piers collapse, sometimes from scouring actions that sweep away their foundation and sometimes because of the direct wave impact. Railroad yards and oil tanks situated near the waterfront are particularly vulnerable. Oil fires frequently result and can be spread by the waves.

Port facilities, naval facilities, fishing fleets, and public utilities are often the backbone of the economy of the affected areas. These resources generally receive the most severe damage. Until debris can be cleared, wharves and piers rebuilt, utilities restored, and fishing fleets reconstituted, communities may find themselves without fuel, food, and employment. Wherever water transport is a vital means of supply, disruption of coastal systems caused by tsunamis can have far-reaching economic effects.

4.7-2 LOCATION, EXTENT, AND MAGNITUDE

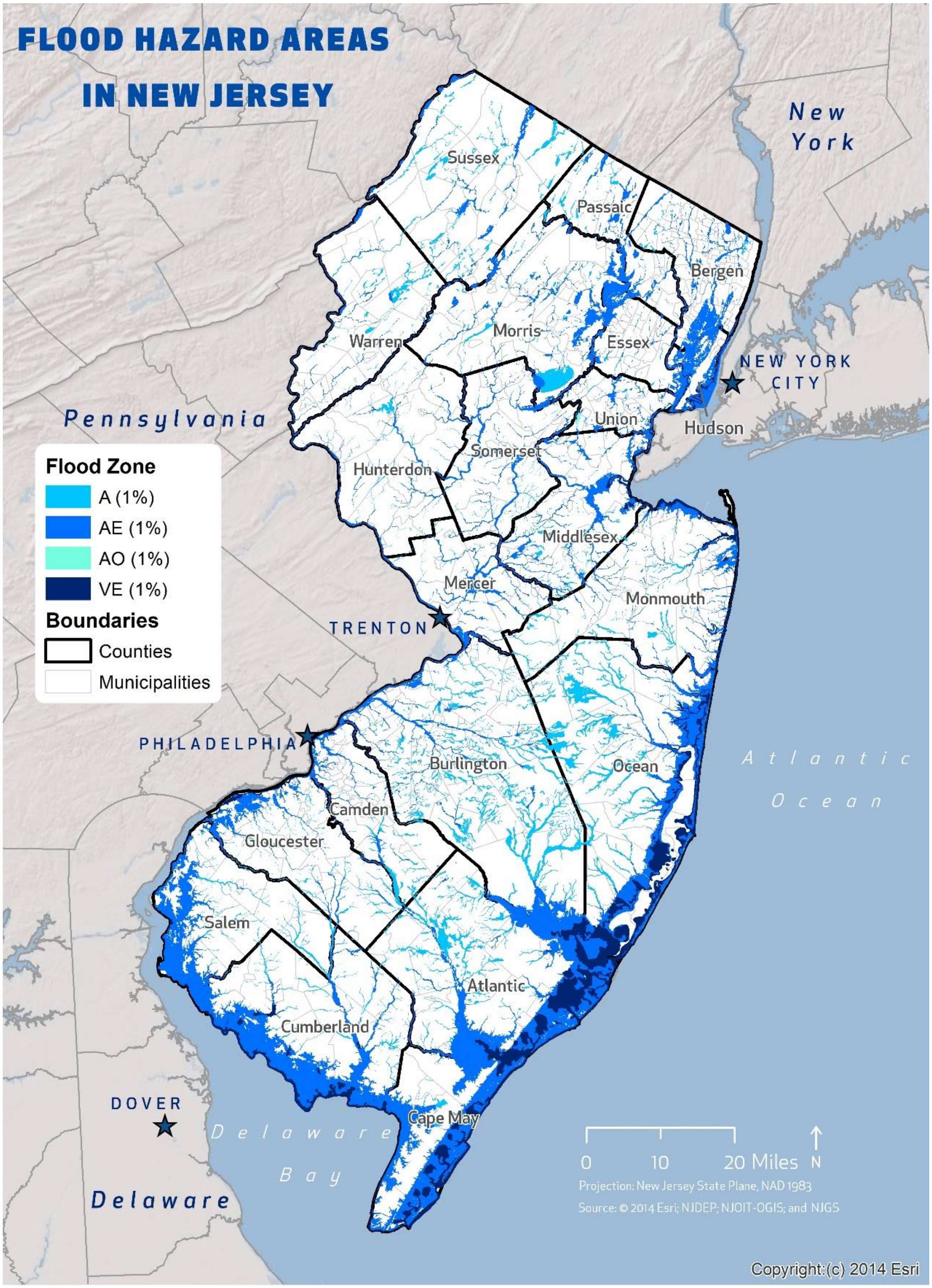
Location

Riverine and Coastal Flooding

Flooding in New Jersey is often the direct result of frequent weather events such as nor'easters, heavy rains, tropical storms, hurricanes, and nor'easters. Floods are the most frequent natural hazards in New Jersey and occur any time of the year. Areas of greatest risk occur in known floodplains where there is intense rainfall over a short period of time; prolonged rain over several days; and/or ice or debris jams causing rivers or streams to overflow (NJOEM, 2006). The areas within the one-percent annual chance flood areas have a higher chance of becoming inundated during storm events.

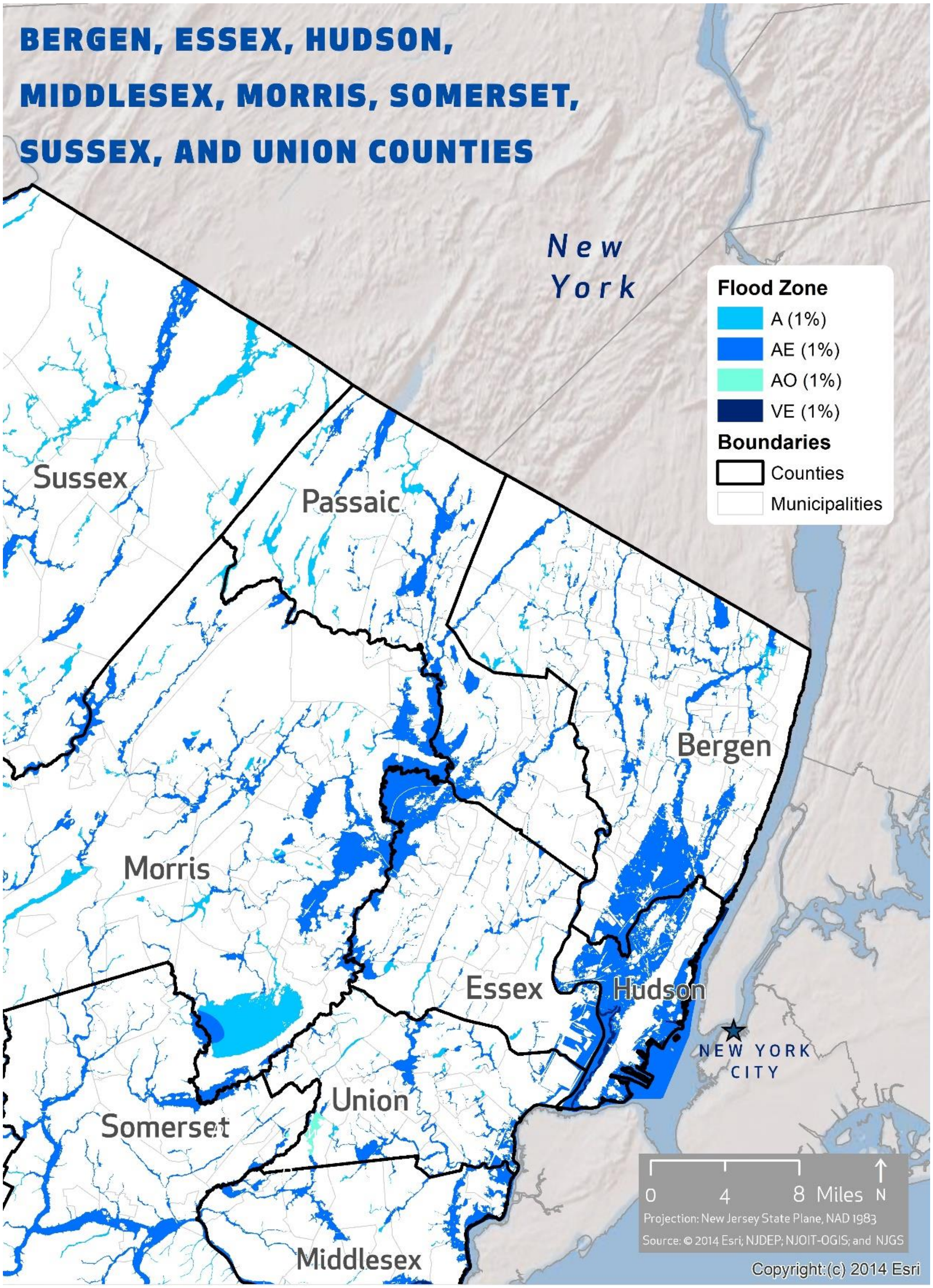
Most damaging riverine floods in New Jersey appear to occur in the northern half of the State. This is a function of several physiographic and physical features of the landscape, as well as the densely developed floodplain. Greater geographic relief in the northern half results in flowing water moving down steeper gradients and being naturally or artificially channelized. Since the Delaware, Raritan and Passaic Rivers drain more than 90% of the northern New Jersey counties, these rivers and their tributaries are common locations for flooding. The one-percent annual chance of flood hazard zones (both A and V-zones) and 0.2- percent annual chance flood zone throughout New Jersey are identified in Figure 4.7-3 through Figure 4.7-9. In order to present the best available data, the flood zones presented in these maps are a composite of the most recent preliminary and effective FIRMs.

Figure 4.7-3 FEMA Flood Hazard Areas in New Jersey



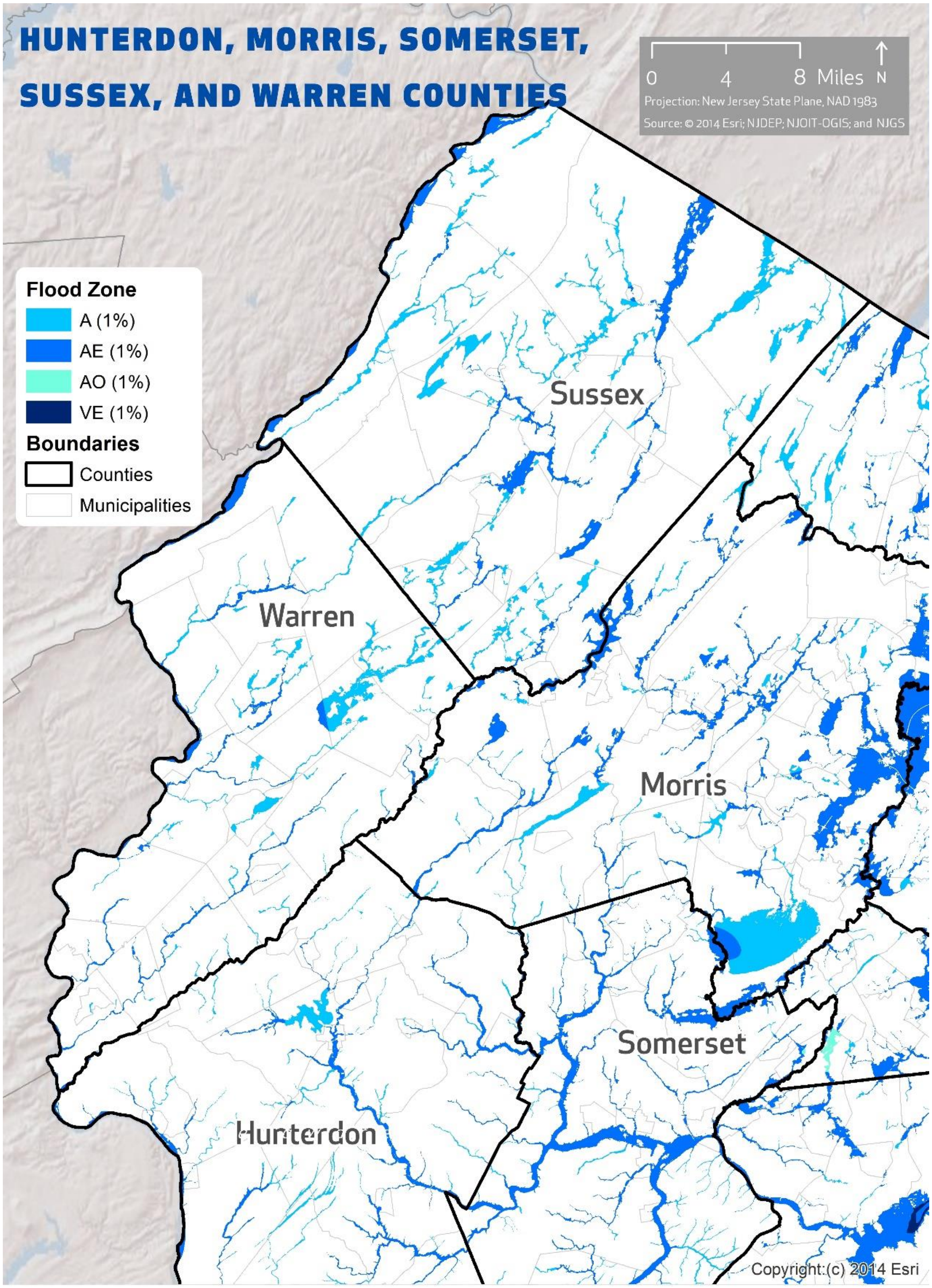
Source: NJGIN, 2023; FEMA, 2023

Figure 4.7-4 FEMA Flood Hazard Areas in Northeastern New Jersey



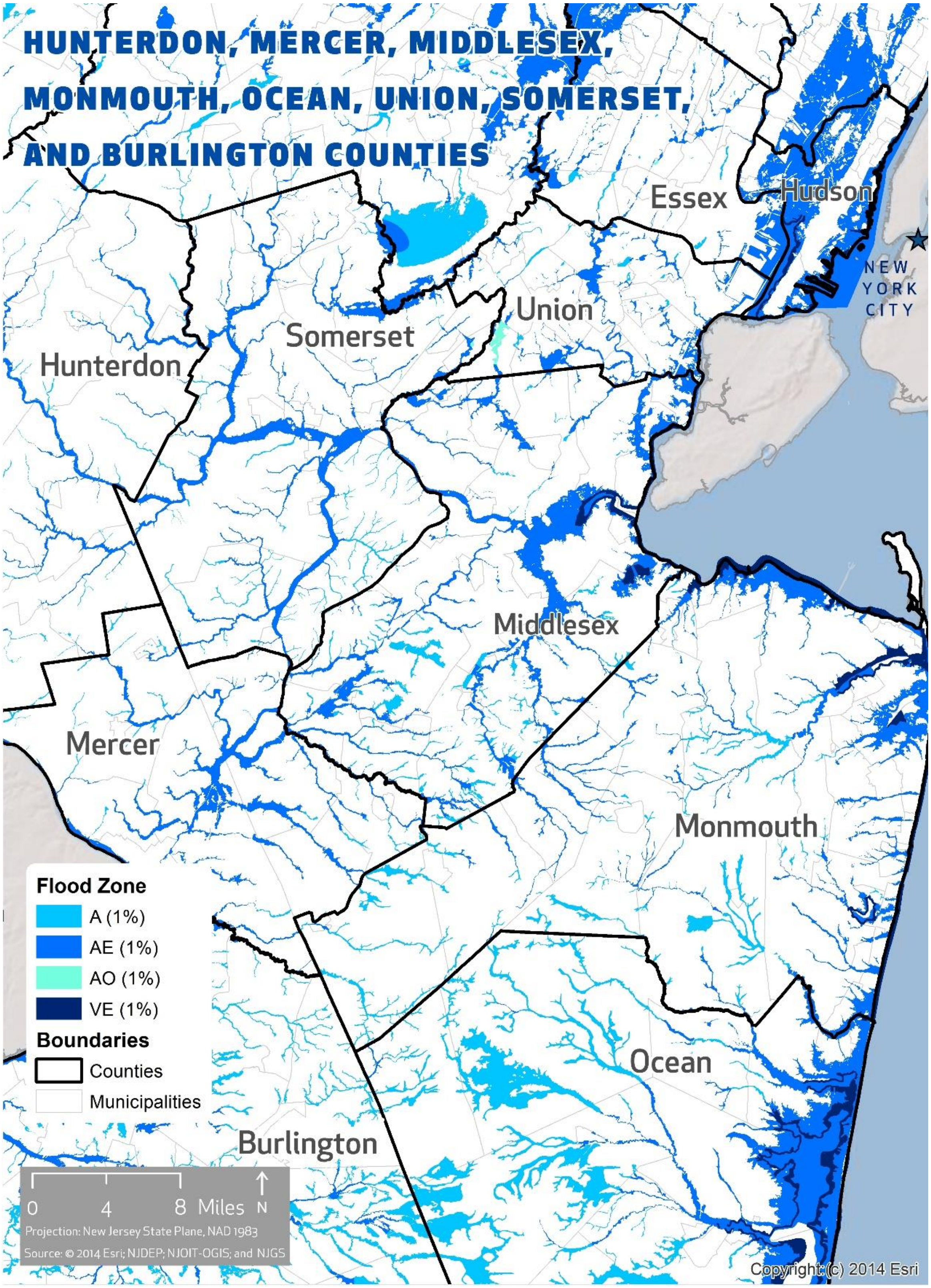
Source: NJGIN, 2023; FEMA, 2023

Figure 4.7-5 FEMA Flood Hazard Areas in Northwestern New Jersey



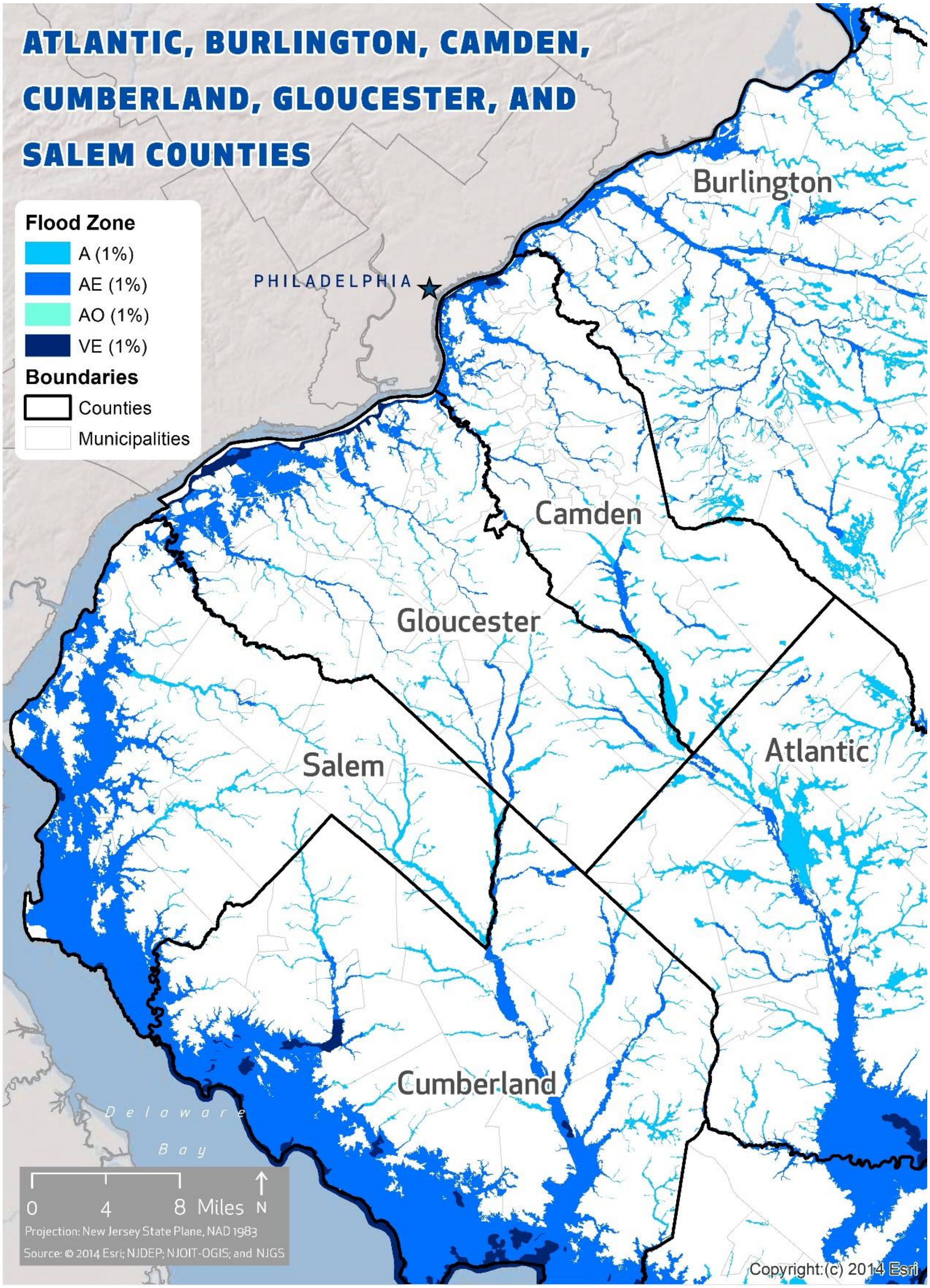
Source: NJGIN, 2023; FEMA, 2023

Figure 4.7-6 FEMA Flood Hazard Areas in Central New Jersey



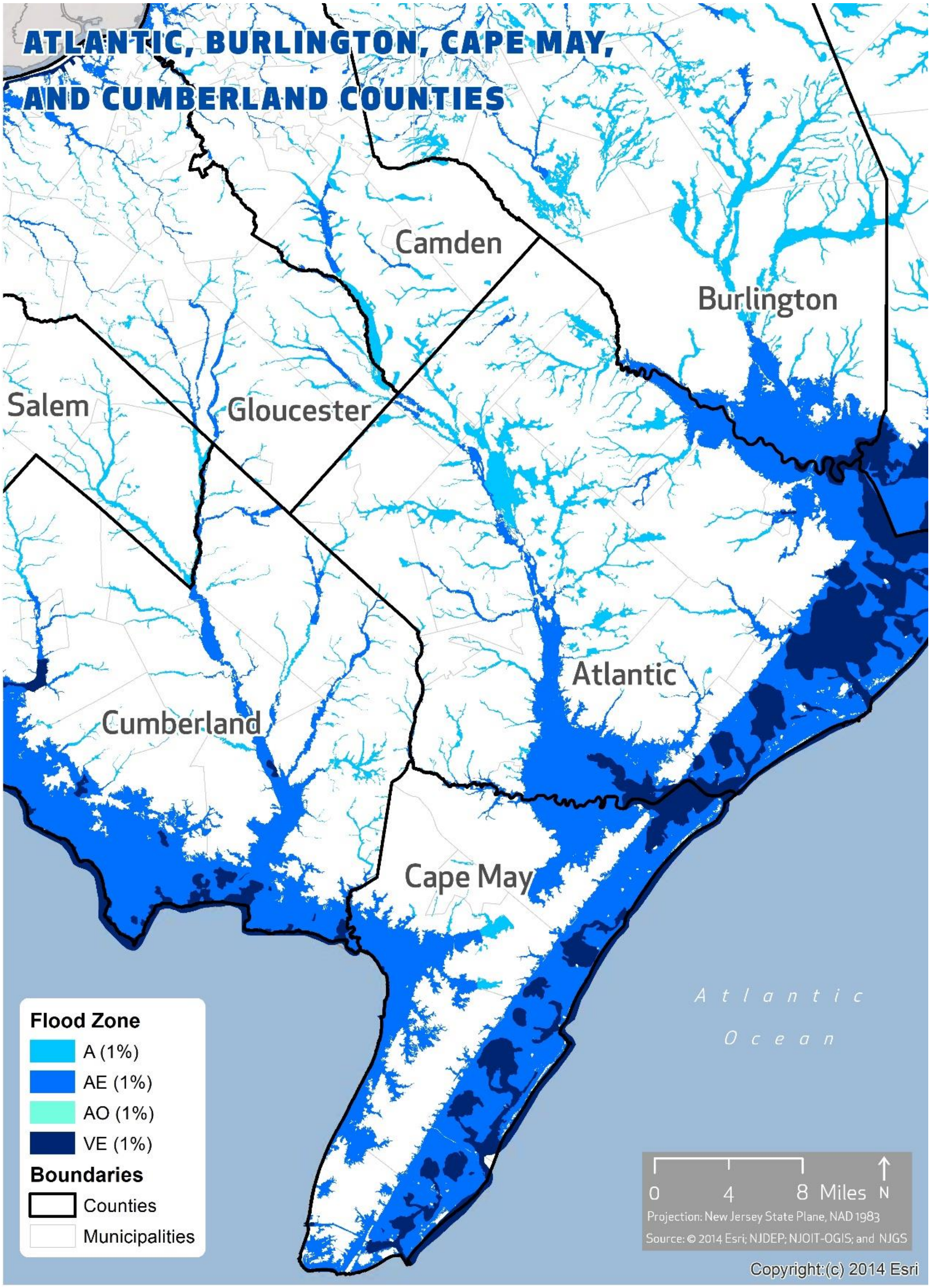
Source: NJGIN, 2023; FEMA, 2023

Figure 4.7-7 FEMA Flood Hazard Areas in Southwestern New Jersey



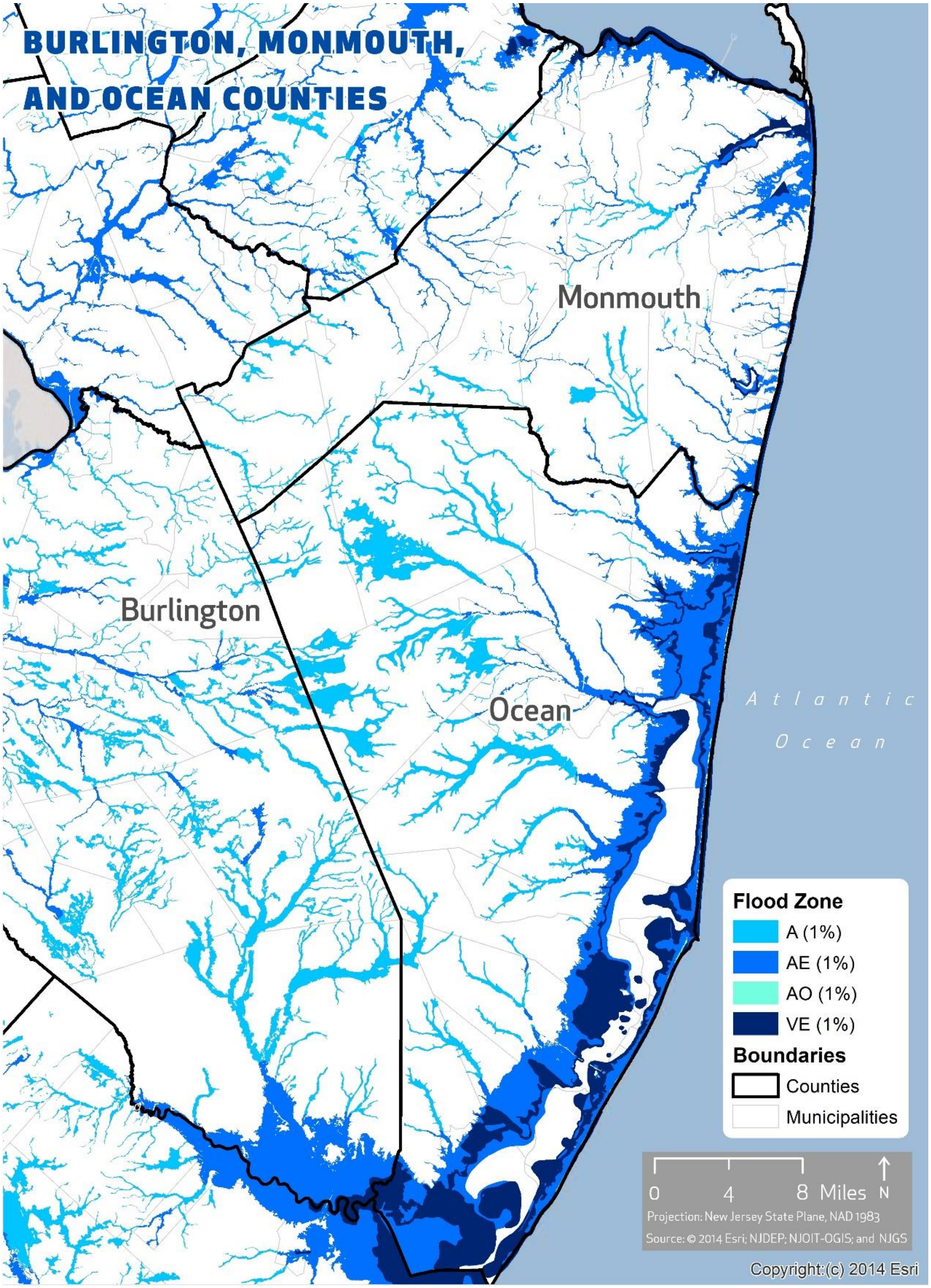
Source: NJGIN, 2023; FEMA, 2023

Figure 4.7-8 FEMA Flood Hazard Areas in Southern New Jersey



Source: NJGIN, 2023; FEMA, 2023

Figure 4.7-9 FEMA Flood Hazard Areas in Southeastern New Jersey



Source: NJGIN, 2023; FEMA, 2023

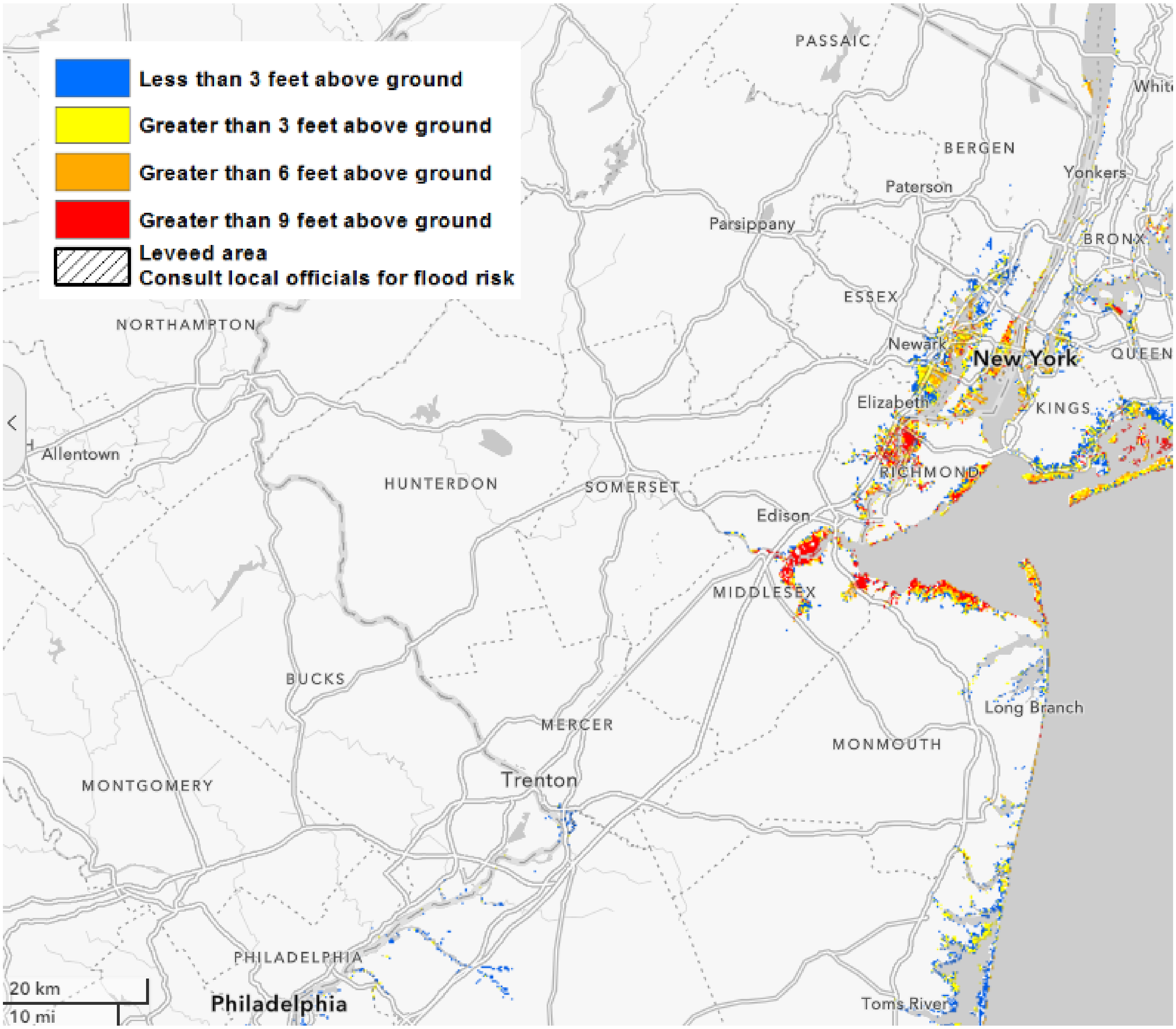
Coastal Flooding

New Jersey and its coastal communities are vulnerable to the damaging impacts of major storms along the Atlantic coastline, Back Bays, the Delaware Bayshore, and tidally influenced areas. New Jersey's coastal zone includes portions of eight counties and 126 municipalities. The coastal area includes coastal waters to the limit of tidal influence including: the Atlantic Ocean (to the limit of New Jersey's seaward jurisdiction); Upper New York Bay, Newark Bay, Raritan Bay and the Arthur Kill; the Hudson, Raritan, Passaic, and Hackensack Rivers, and the tidal portions of the tributaries to these bays and rivers. The Delaware River and Bay and other tidal streams of the Coastal Plain are also in the coastal area, as is a narrow band of adjacent uplands in the Waterfront Development area beyond the CAFRA area. Due to the impacts of Superstorm Sandy, coastal flooding has been the costliest type of flooding events causing significant beach erosion, damage to dunes and shore protection structures as well as tidal flooding impacts.

Storm Surge

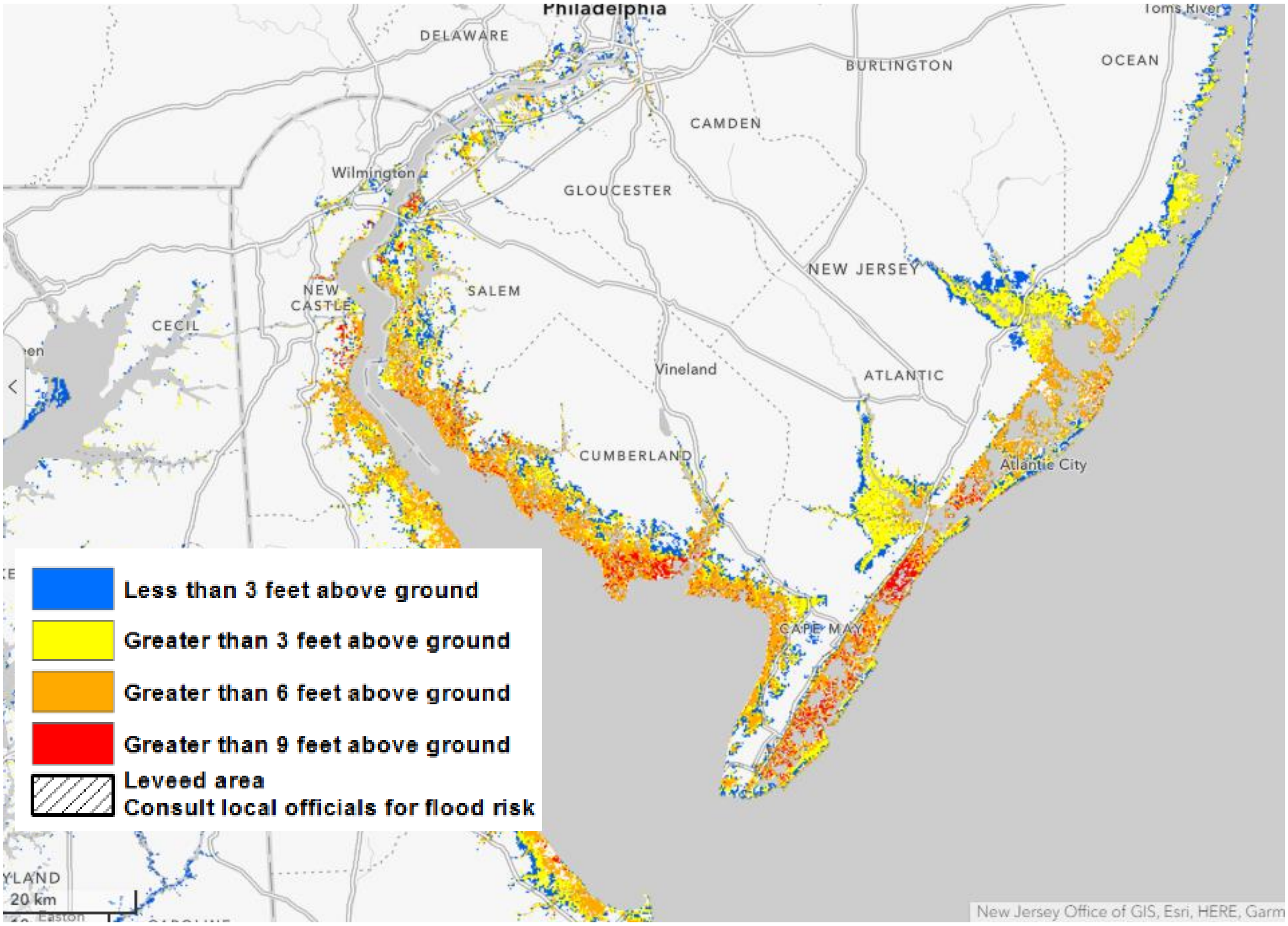
Storm surge also contributes to coastal flooding from the combined effects of strong winds and large waves. Storm surges inundate coastal floodplains by dune overwash, tidal elevation rise in inland bays and harbors, and backwater flooding through coastal river mouths. The extent of the storm surge will depend on the severity of the conditions created by the storm. NOAA's National Hurricane Center has published Storm Surge Risk Map for most of the coastal areas in the United States, with different maps showing impacts from Category 1 through 5 hurricanes. The following eight figures showcase the results of this analysis for coastal New Jersey.

Figure 4.7-10 Storm Surge from Category 1 Hurricane (Northern New Jersey)



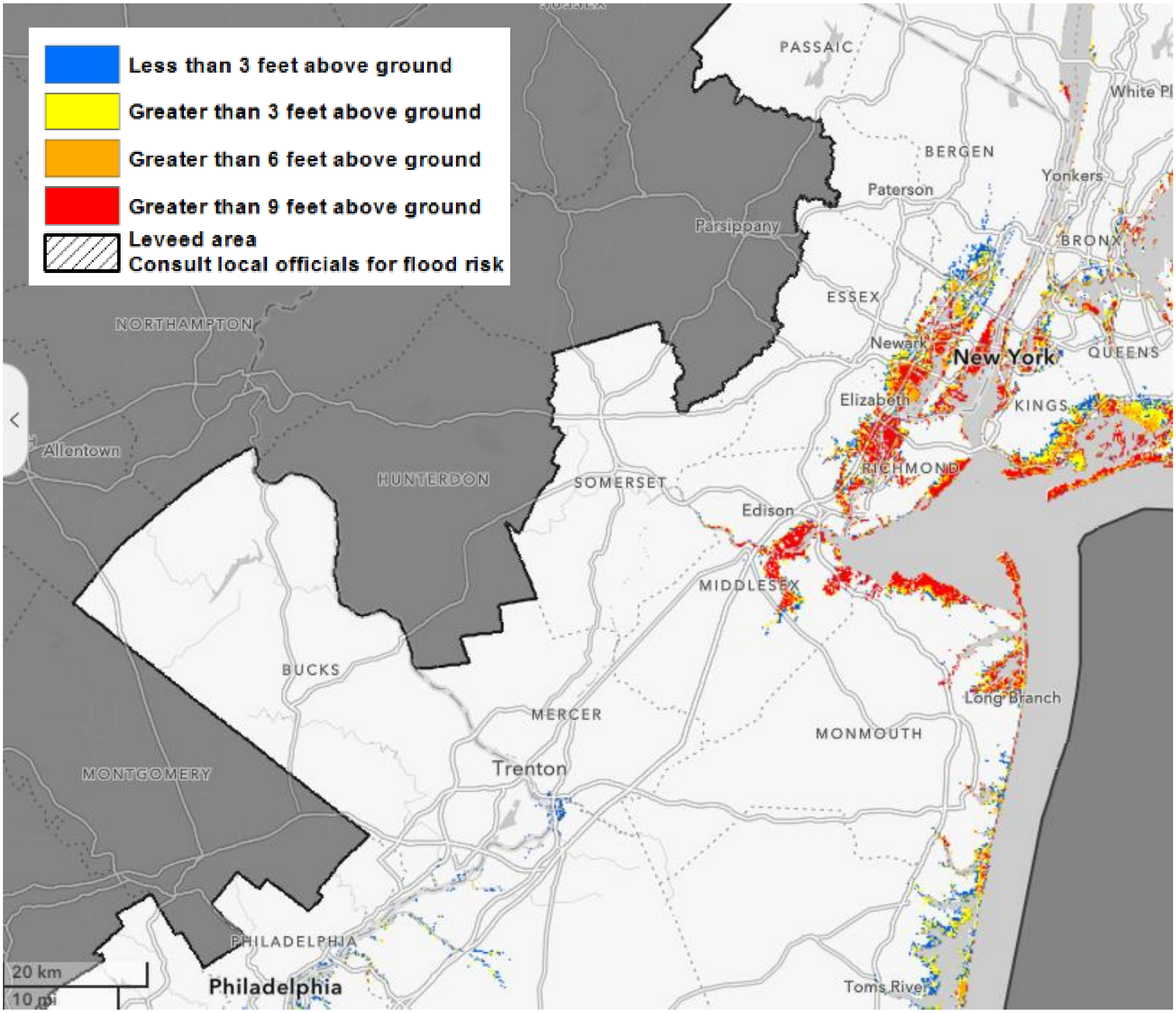
Source: Zachry et al., 2015

Figure 4.7-11 Storm Surge from Category 1 Hurricane (Southern New Jersey)



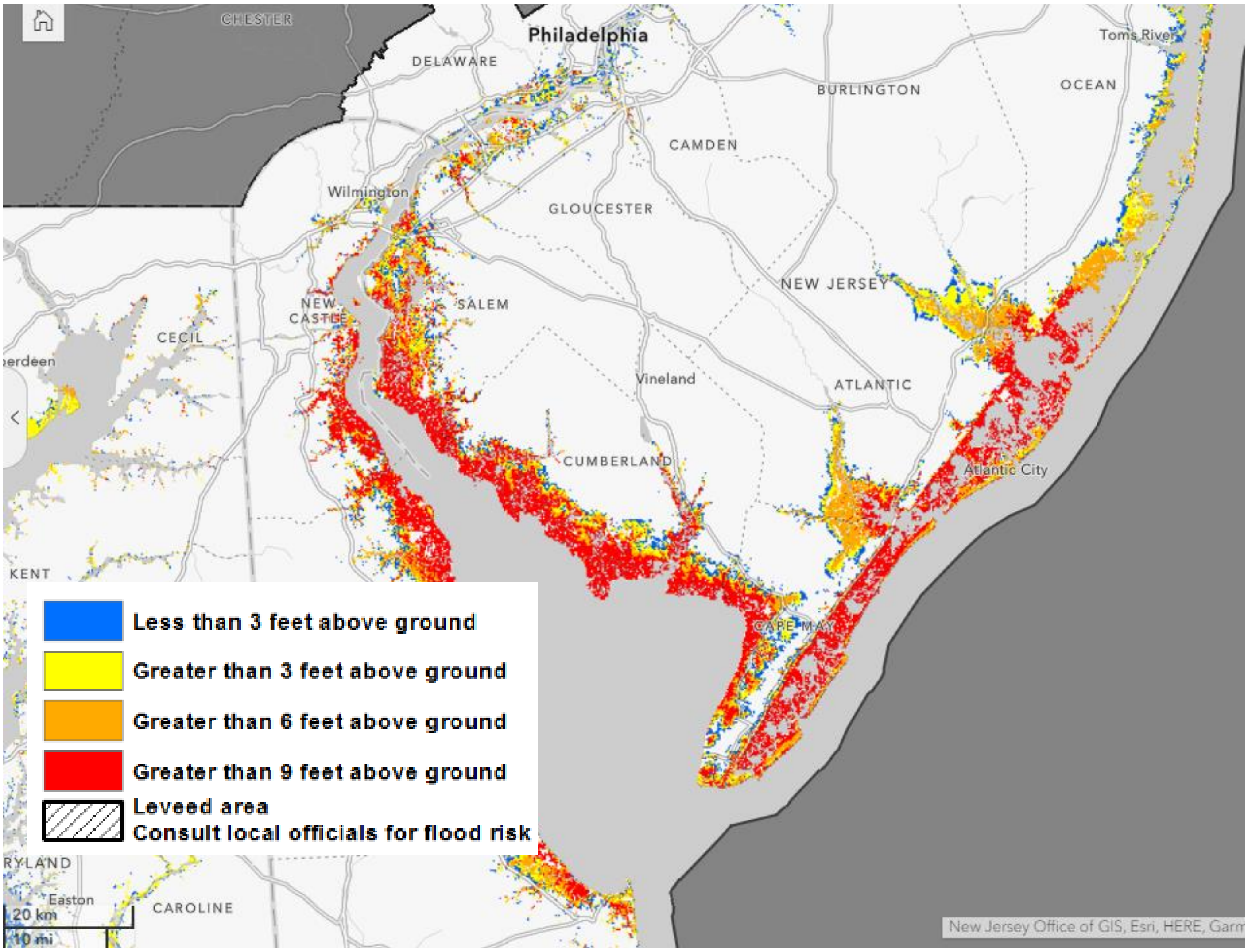
Source: Zachry et al., 2015

Figure 4.7-12 Storm Surge from Category 2 Hurricane (Northern New Jersey)



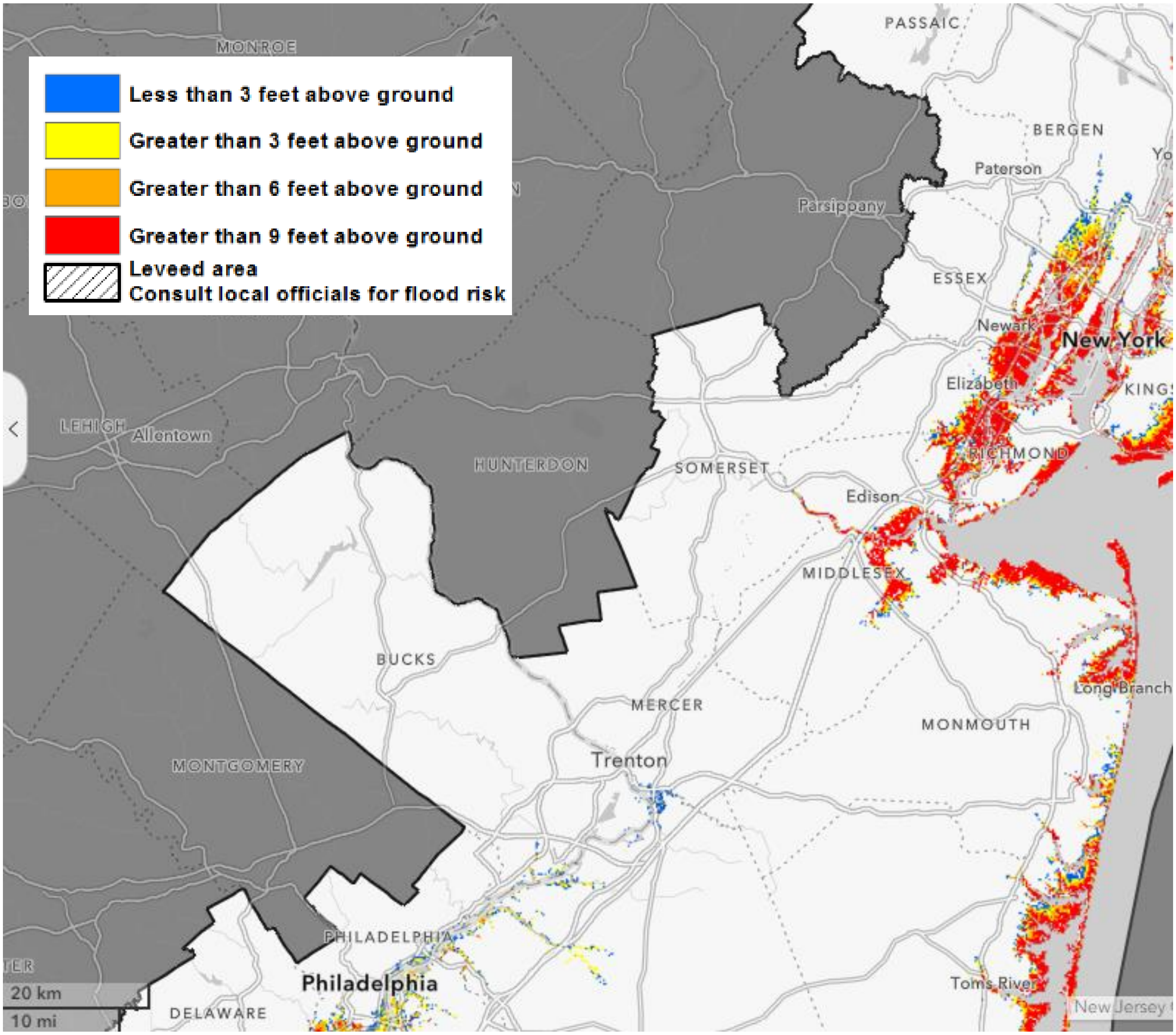
Source: Zachry et al., 2015

Figure 4.7-13 Storm Surge from a Category 2 Hurricane (Southern New Jersey)



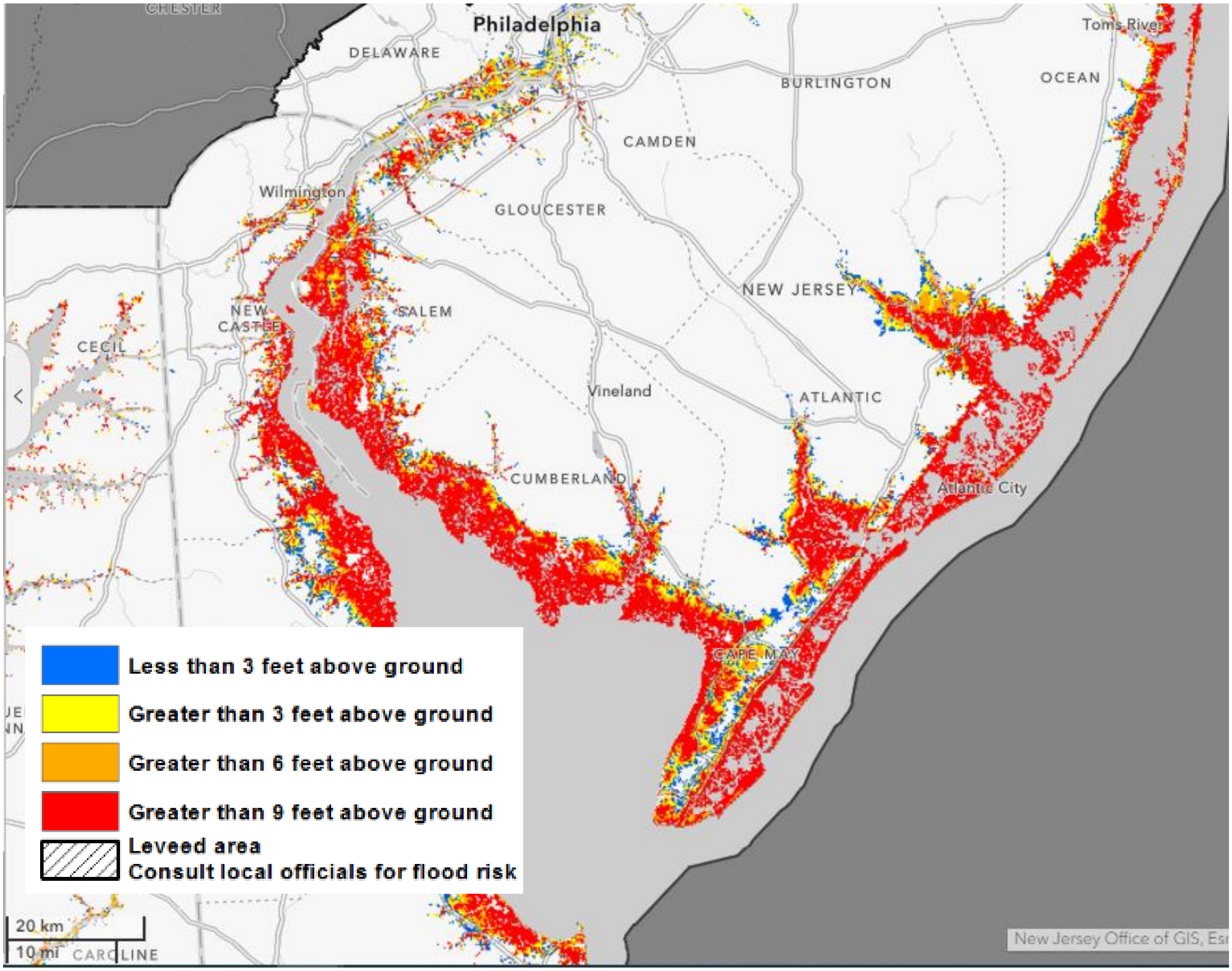
Source: Zachry et al., 2015

Figure 4.7-14 Storm Surge from a Category 3 Hurricane (Northern New Jersey)



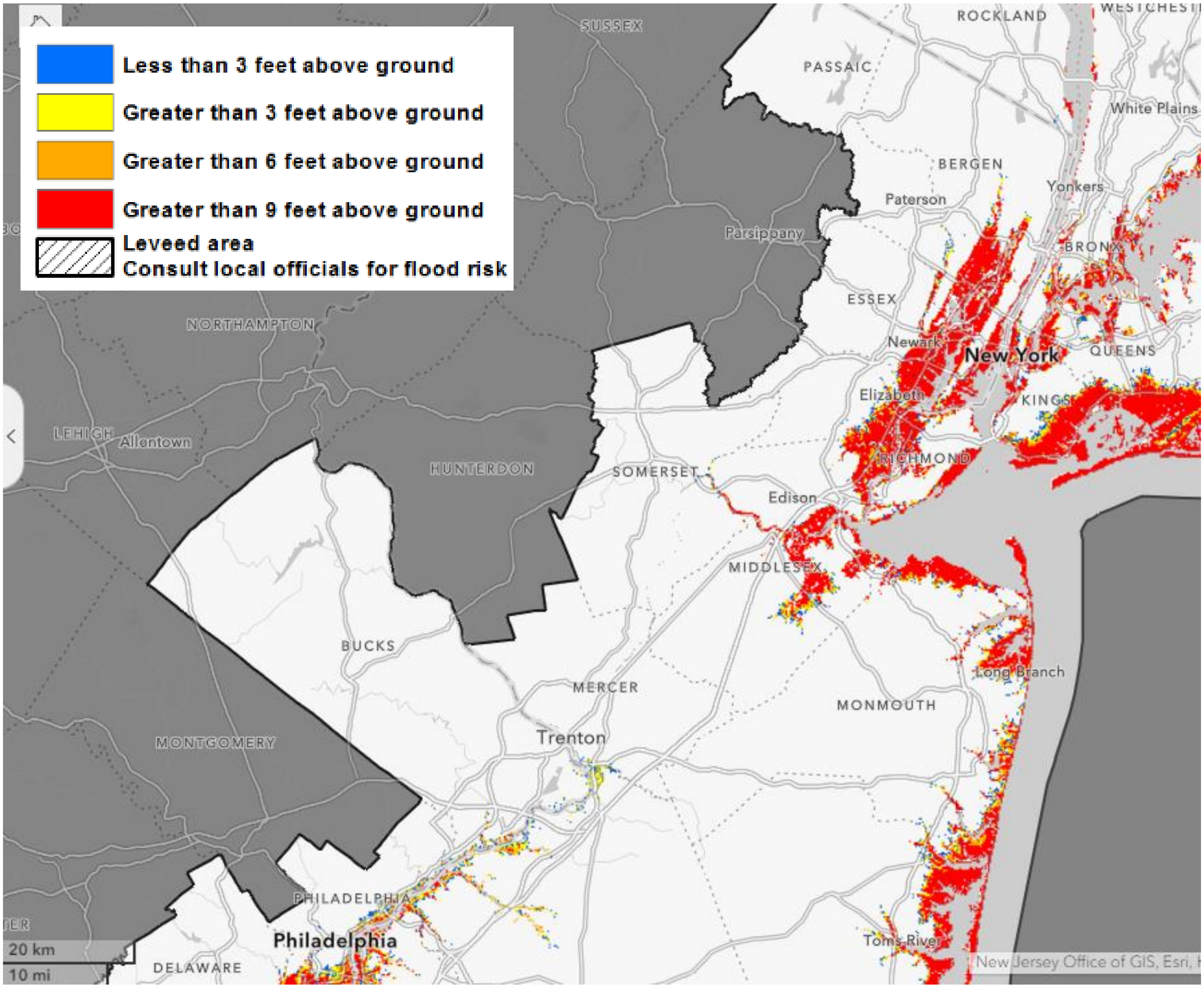
Source: Zachry et al., 2015

Figure 4.7-15 Storm Surge from a Category 3 Hurricane (Southern New Jersey)



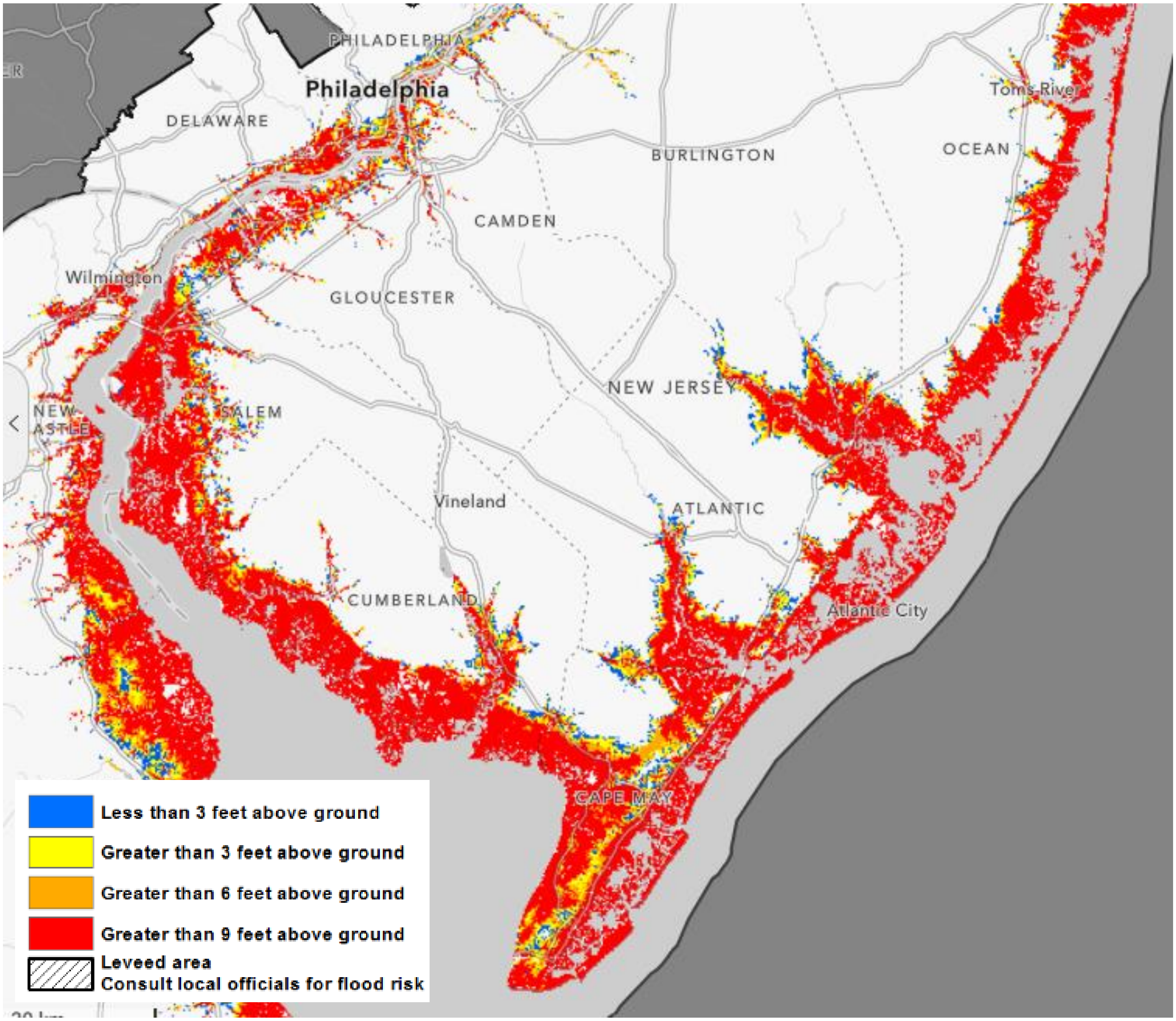
Source: Zachry et al., 2015

Figure 4.7-16 Storm Surge from a Category 4 Hurricane (Northern New Jersey)



Source: Zachry et al., 2015

Figure 4.7-17 Storm Surge from a Category 4 Hurricane (Southern New Jersey)

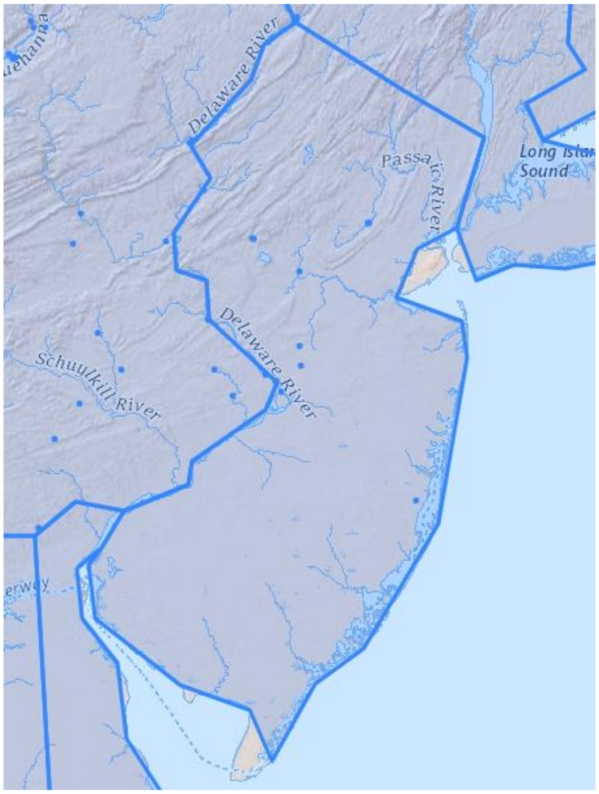


Source: Zachry et al., 2015

Ice Jams

According to the United States Army Corps of Engineers, there have been 109 reported ice jams in New Jersey since 1904 (CRREL, 2023). The rivers that experienced the greatest number of ice jams during this time period included the Delaware River (33 reported ice jams) and the South Branch Raritan River (20 reported ice jams). Figure 4.7-18 presents the number of ice jam incidents in New Jersey during this time period, which has not changed since the last plan as no ice jams were reported since 2018.

Figure 4.7-18 Ice Jams in New Jersey from 1780 to 2023



Source: CRREL, 2023

Tsunami

According to a document titled *U.S. States and Territories National Tsunami Hazard Assessment: Historical Record and Sources for Waves*, the United States Atlantic coast has experienced very few tsunamis in the last 200 years. Georgia, Virginia, North Carolina, Pennsylvania, and Delaware have no known historical tsunami records. Only six tsunamis have been recorded in the Gulf or other East Coast states. Three of these tsunamis were generated in the Caribbean. Two of these tsunamis were related to a magnitude 7+ earthquake along the Atlantic coast. The other reported tsunami occurred in the Mid-Atlantic States that may have been related to an underwater explosion or landslide (Dunbar and Weaver, 2008).

Tsunami and tsunami-like waves that have impacted the East Coast were analyzed by Lockridge et al. NOAA's National Geophysical Data Center (NGDC) compiled a listing of all tsunamis and tsunami-like waves of the eastern United States and Canada. Forty-nine potential tsunami events have been identified as possibly impacting the East Coast of the United States between 1668 and 2008. Of these events, eight were categorized as definite or probable tsunamis (NOAA NGDC, 2013).
The following present the most significant tsunami threats to the East Coast of the United States:

- *Mid-Atlantic Ridge*—The closest tectonic boundary to the East Coast is the spreading Mid-Atlantic Ridge, which contains numerous faults. However, according to the Maine Geological Survey, tsunamis are more likely to occur at convergent margins.
- *Caribbean Islands*—The Caribbean is home to some of the most geologically active areas outside of the Pacific Ocean. This area has a subduction zone that is located just north of Puerto Rico, along with other troughs and areas of plate tectonics that have produced numerous earthquakes, sub-marine landslides, volcanic eruptions, and resulting tsunami activity.
- *North Carolina/Virginia Continental Shelf*—Evidence of a large sub-marine landslide off the coasts of Virginia and North Carolina was found and named the Albemarle-Currituck Slide. This event occurred approximately 18,000 years ago when over 33 cubic miles of material slid seaward from the edge of the continental shelf, most likely

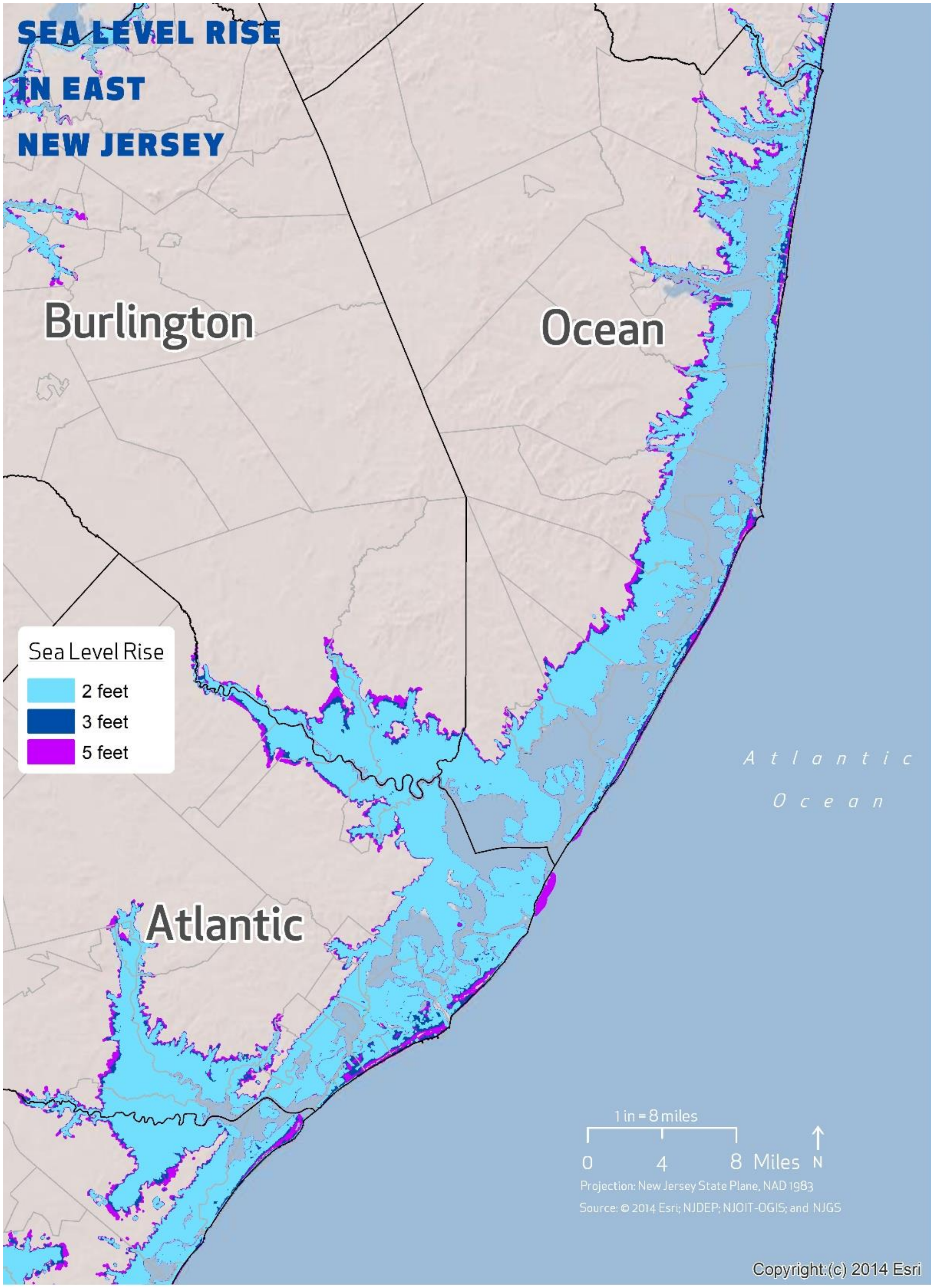
causing a tsunami.

- *Canary Islands*—The Canary Islands are a volcanic island-arc chain located in the eastern Atlantic Ocean, just west of the Moroccan coastline. Based on a study of past landslide deposits and existing geology of the volcano, some scientists suggest that the west flank of a volcano known as Cumbre Vieja may experience failure during a future eruption, resulting in a landslide into the Atlantic Ocean. Although the flank instability of Cumbre Vieja is noted, other scientists disagree with massive failure scenarios for the western flank of the volcano, believing it would happen in smaller, separate events that would not be capable of triggering a mega-tsunami.

Sea-level Rise

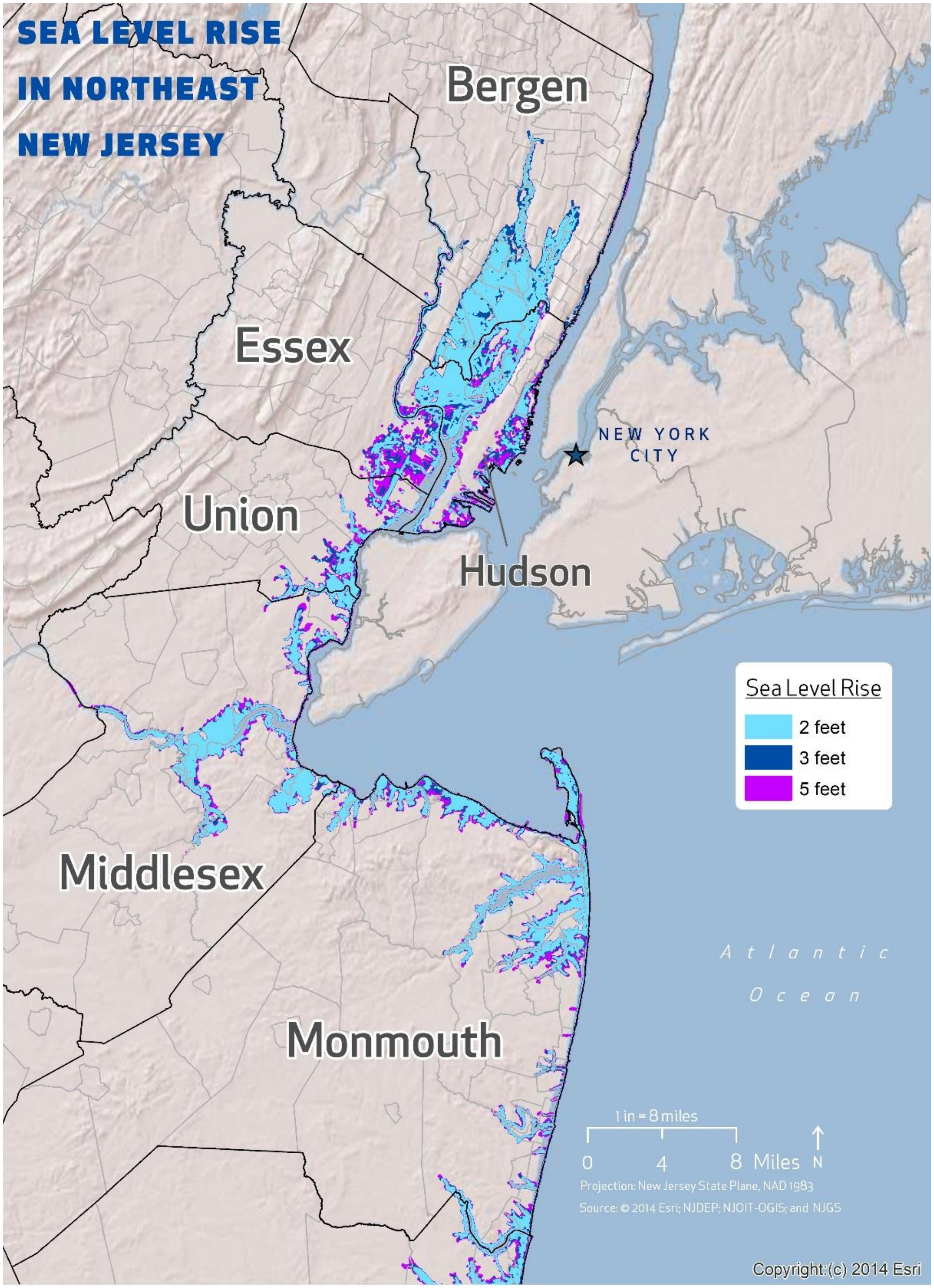
Sea-level continues to impact areas along the Atlantic coast of New Jersey and the Delaware Bay. Effects will reach some inland communities as rivers that empty into either the Atlantic Ocean or Delaware Bay will experience a subsequent rise in their water levels. Even communities along the Delaware River will experience the effects of sea level rise, which can be seen as far north as Mercer County. Figure 4.7-19 through Figure 4.7-22 below visualizes three potential sea-level rise scenarios, at the 2-, 3-, and 5-foot levels. These maps visualize that coastal communities are not the only ones experiencing risk due to sea level rise.

Figure 4.7-19 **Global Mean Sea-level Rise Scenarios for Eastern New Jersey**



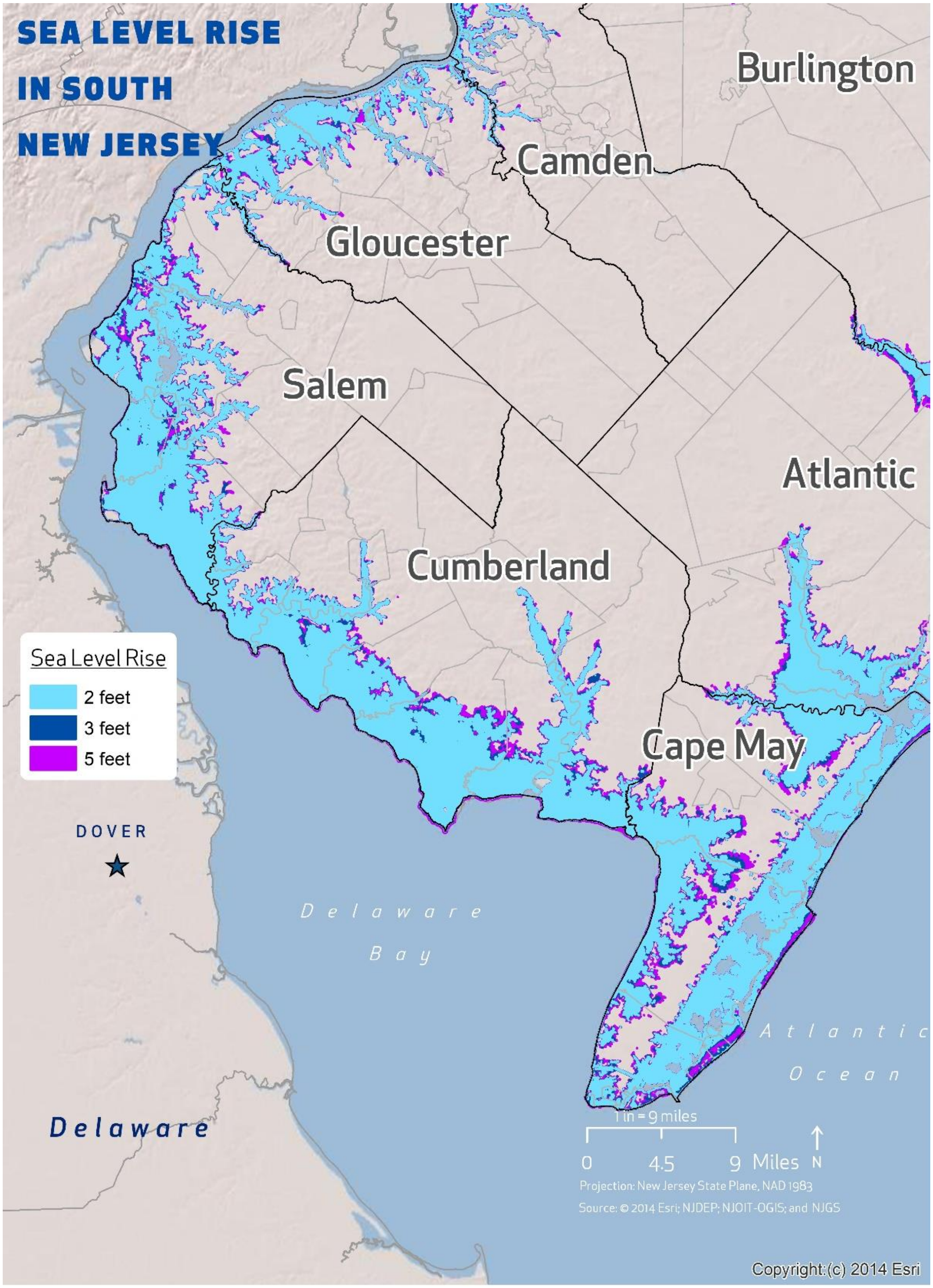
Source: Rutgers University, 2023

Figure 4.7-20 Global Mean Sea-level rise Scenarios for Northeastern New Jersey



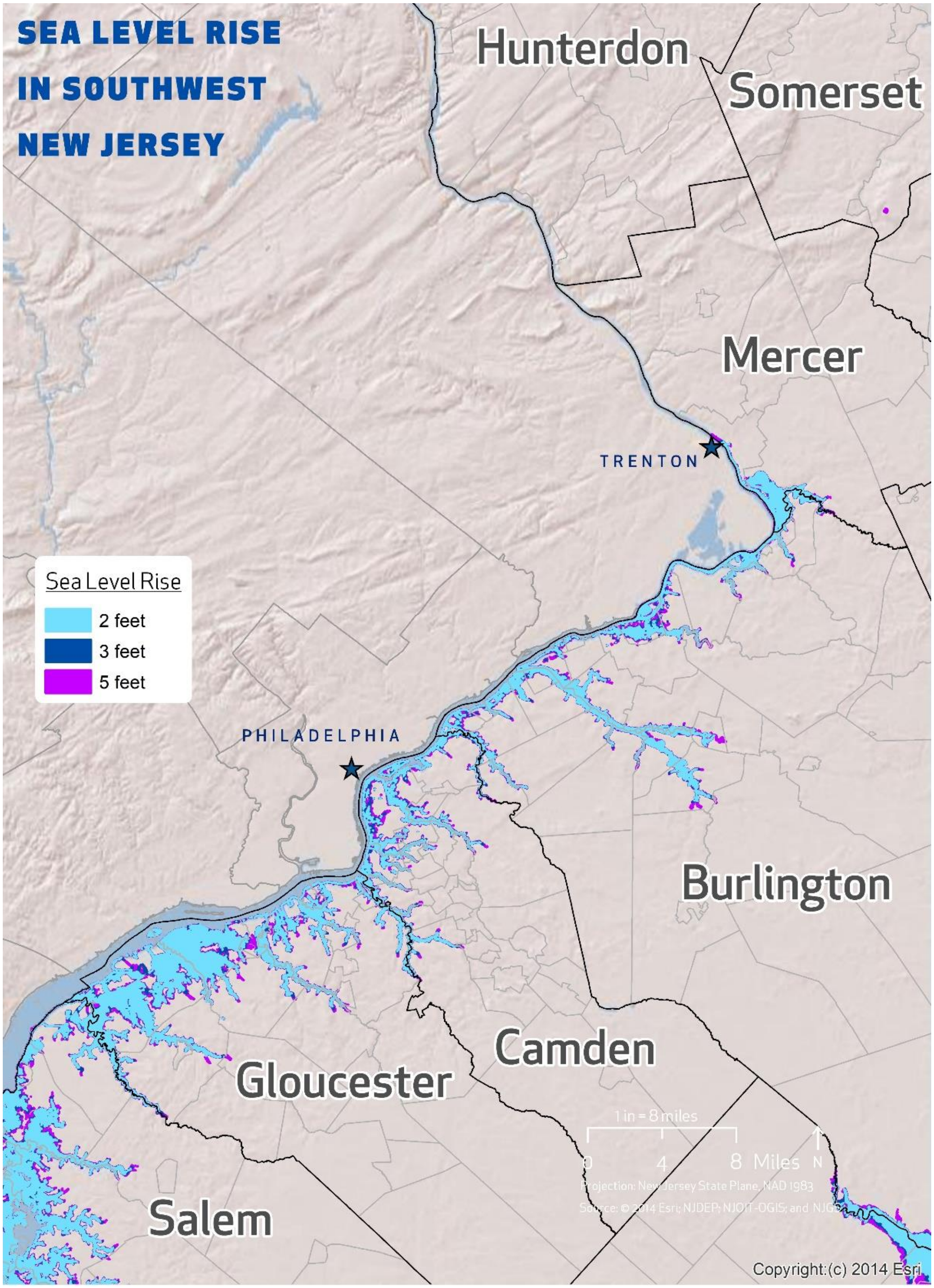
Source: Rutgers University, 2023

Figure 4.7-21 Global Mean Sea-level rise Scenarios for Southern New Jersey



Source: Rutgers University, 2023

Figure 4.7-22 Global Mean Sea-level rise Scenarios for Southwestern New Jersey



Source: Rutgers University, 2023

Extent and Magnitude

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, 2001).

The frequency and severity of 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. The flood frequency equals 100 divided by the discharge probability. For example, the 100-year discharge has a 1% chance of being equaled or exceeded in any given year. The “annual flood” is the greatest flood event expected to occur in a given year. These measurements reflect statistical averages only; it is possible for two or more floods with a 1% annual chance to occur in a short time period. The same flood can have different recurrence intervals at different points on a river.

Tsunami

When a major undersea earthquake occurs near the coast at a shallow depth, a destructive tsunami can be generated. This tsunami could impact near-by coasts within minutes and could travel across entire ocean basins causing damage 1,000 miles away. To notify distant coastal areas, coordinated tsunami warning systems such as the National Tsunami Warning Center have been established to provide warning to countries regarding regional-to-distant tsunamis. The area-of-responsibility of the National Tsunami Warning Center consists of Canadian coastal regions and the ocean coasts of all U.S. States except Hawaii. Information from this system is provided to emergency officials, and as appropriate, directly to the public (NOAA, 2017).

Storm Surge

Typically, storm surge is estimated by subtracting the regular/astrological tide level from the observed storm tide. The height of storm surge can range from a few feet to 9.83 feet, the highest surge recorded in New Jersey during Hurricane Sandy, and even as high as approximately 30 feet during Hurricane Katrina in Mississippi. The exact height of the storm surge and which coastal areas will be flooded depends on many factors: strength, intensity, and speed of the hurricane or storm; the direction it is moving relative to the shoreline; how rapidly the sea floor is sloping along the shore; the shape of the shoreline; and the astronomical tide. The “fetch” or distance across a waterbody over which storm winds blow is also a critical factor.

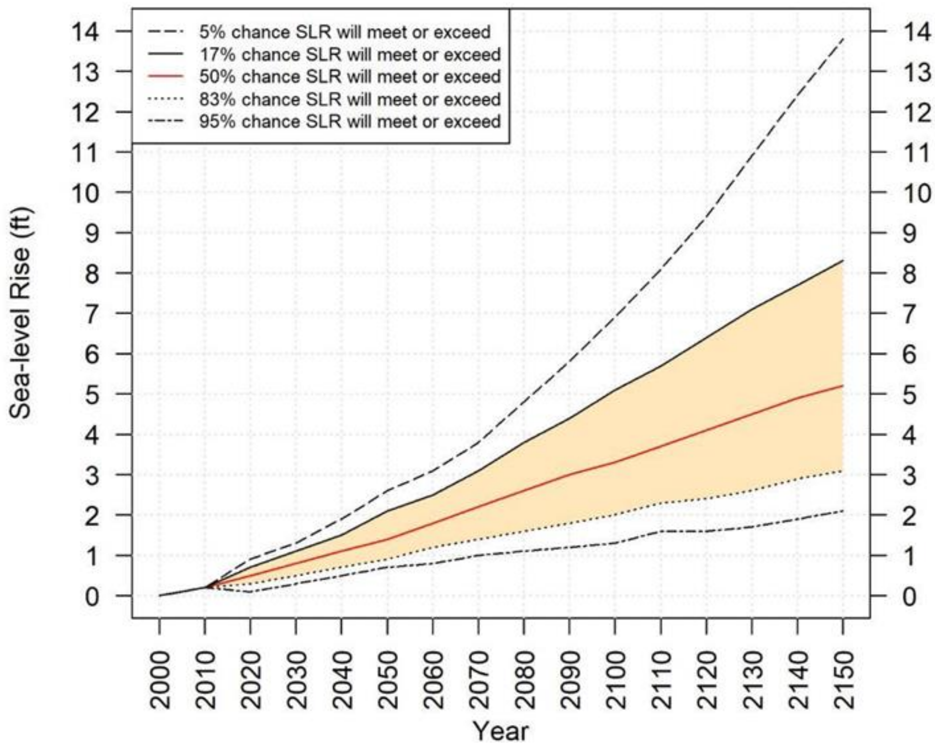
The most common reference to a return period for storm surges has been the elevation of the coastal flood having a one-percent chance of being equaled or exceeded in any given year, also known as the one-percent annual flood. The storm surge inundation limits for the one-percent annual chance coastal flood event are a function of the combined influence of the water surface elevation rise and accompanying wave heights and wave run-up along the coastline.

During Superstorm Sandy, water levels rose along the entire east coast of the United States, with the highest storm surges and greatest inundation on land occurring in New Jersey, New York, and Connecticut. The highest storm surge measured by a tide gauge in New Jersey was 8.57 feet above normal tide levels at the northern end of Sandy Hook. Barrier islands were almost completely inundated in some areas, and breached in some cases, due to storm surge and large waves from the Atlantic Ocean meeting up with water from the back bays (Blake et al., 2013).

Sea-Level Rise

NJ DEP prepared a Sea-Level Rise Guidance document in 2021 that presents projections and strategies to address sea-level rise. Figure 4.7-23 below displays the potential outcomes under various scenarios, which include differing levels of CO_2 emissions. The likely range (colored in orange) represents a 66% probability that sea-level rise is between a "lower end" and "upper end" at a given point in time. For example, the likely range for 2050 represents a 66% probability that SLR will be between 0.9 feet (lower end) and 2.1 feet (upper end). More on the impact of the anticipated sea-level rise is discussed Section 4.62992763-07-4 Probability of Future Occurrence regarding climate change.

Figure 4.7-23 Sea-Level Rise Projections for New Jersey (2000-2150)



Source: NJ DEP, 2021

4.7-3 PREVIOUS OCCURRENCES AND LOSSES

FEMA Disaster Declarations

Between 1954 and 2023, FEMA declared that New Jersey experienced 28 flood-related disasters (DR) or emergencies (EM) classified as one or a combination of the following disaster types: severe storms, winter storms, snowstorms, coastal storms, flash flooding, heavy rains, tropical storms, hurricanes, high winds, ice jams, wave action, high tide, and tornadoes. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. However, not all counties were included in the disaster declarations as determined by FEMA (FEMA, 2013b).

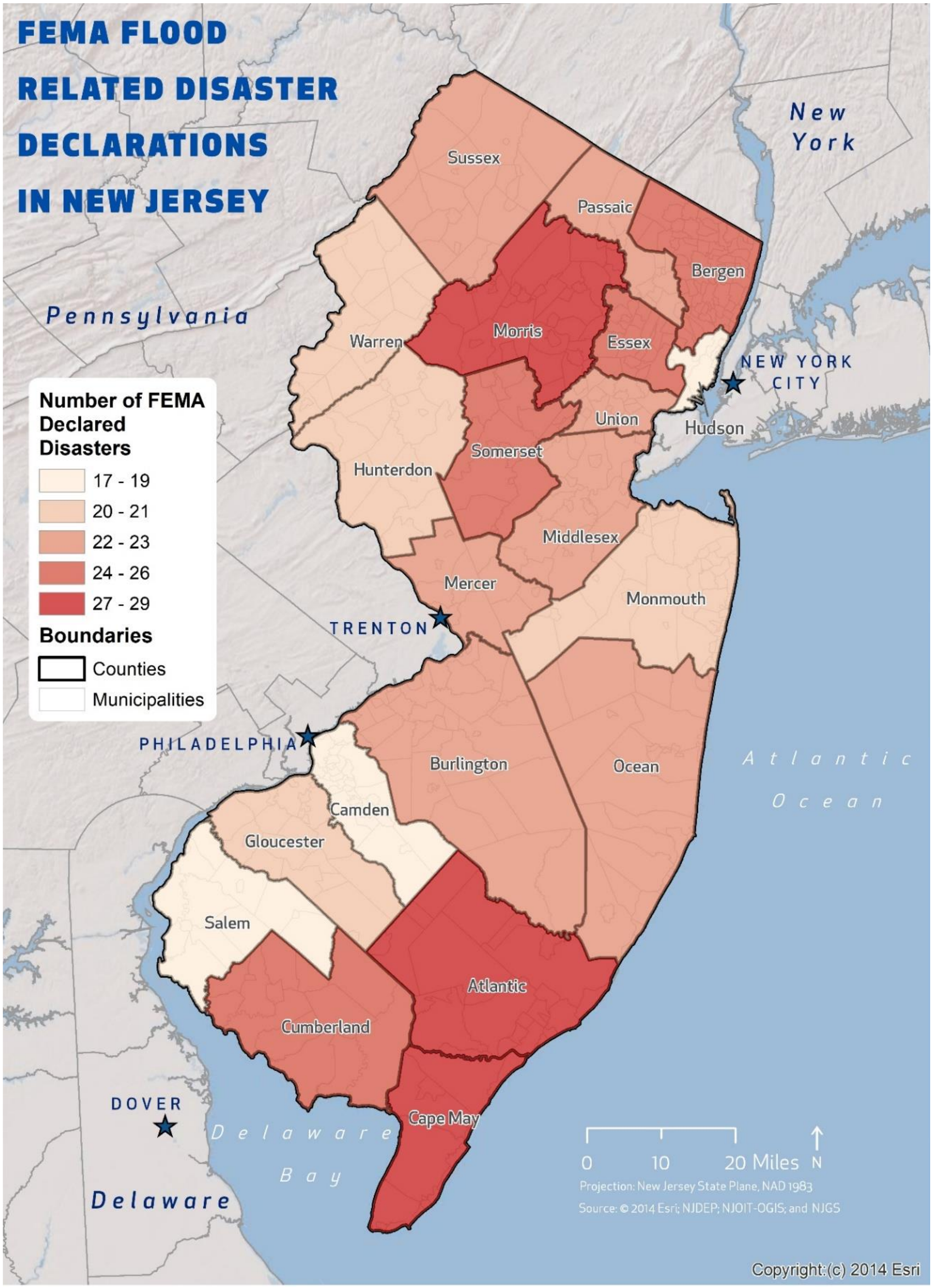
Based on all sources researched, known flooding events that have affected New Jersey and were declared a FEMA disaster, are identified in Table 4.7-2. This table provides information on the FEMA disaster declarations for flooding, including disaster number, disaster type, declaration and incident dates, and counties included in the declaration. Figure 4.7-24 illustrates the number of FEMA-declared disasters by county. Detailed information pertaining to each of the declared disasters since 2014 is provided in Appendix D of this Plan.

Table 4.7-2 FEMA Flood-Related Disaster Declarations (2010 to 2023)

Disaster Number	Disaster Type	Declaration Date	Atlantic	Bergen	Burlington	Camden	Cape May	Cumberland	Essex	Gloucester	Hudson	Hunterdon	Mercer	Middlesex	Monmouth	Morris	Ocean	Passaic	Salem	Somerset	Sussex	Union	Warren	Impacted Counties
1889	Severe Winter Storm and Snowstorm	February 5-6, 2010	X		X	X	X	X		X									X					7
1897	Severe Storms and Flooding	March 12, 2010 – April 12, 2010	X	X	X		X	X	X	X		X	X	X	X	X	X	X		X		X		16
1954	Severe Winter Storm and Snowstorm	December 26, 2010 – December 27, 2010	X	X	X		X	X	X		X		X	X	X	X	X	X		X		X		15
4021	Hurricane Irene	August 27, 2011 – September 5, 2011	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	21
4033	Severe Storms and Flooding	August 13-15, 2011						X		X									X					3
4039	Remnants of Tropical Storm Lee	September 28, 2011 – October 6, 2011										X	X					X			X		X	5
4086	Hurricane Sandy	October 26, 2012 – November 8, 2012	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	21
4231	New Jersey Severe Storm	June 23, 2015	X		X	X				X														4
4264	New Jersey Severe Winter Storm and Snowstorm	January 22-24, 2016	X	X	X	X	X	X	X		X	X	X	X	X	X	X			X		X	X	17
4368	New Jersey Severe Winter Storm and Snowstorm	March 6-7, 2018		X					X							X		X		X				5
4574	Tropical Storm Isaias	August 4, 2020	X	X	X		X	X	X	X					X	X			X		X			11
4614	Remnants of Hurricane Ida	September 1-3, 2021	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	21

Source: FEMA, 2023

Figure 4.7-24 Number of FEMA Flood Declared Disasters by County



Source: FEMA, 2023

Historical Events Summary

There are many sources that provide flooding information for previous impacts, occurrences and losses associated with flooding (riverine, inland, and stormwater) events throughout New Jersey. With so many sources reviewed for the purpose of this Hazard Mitigation Plan (HMP), loss and impact information for many events could vary depending on the source. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP.

NOAA's National Centers for Environmental Information (NCEI) storm events database reported that New Jersey experienced 3,413 flood events between 1996 (the start of flood records on the NCEI database) and 2023. Since January 2018, there have been 864 flood events that have caused around $220 million in damages. These events included flash floods, coastal flooding, and floods. This plan update includes all occurrences from 2010 to 2023. With flood documentation for New Jersey being so extensive, not all sources have been identified or researched. Therefore, Table 4.7-3 and Table 4.7-4 may not include all events that have occurred throughout the State.

Table 4.7-3 Flooding Events Since 2010

Date(s) of Event	Event Type	Counties Affected	Description
September 30 to 10/1/2010	Flooding	Bergen, Camden, Gloucester, Hudson, Hunterdon, Morris, Somerset, Sussex, Union	A series of low-pressure systems that moved north along a slowly moving cold front brought heavy rain into the western half of New Jersey on September 30 and October 1. Event precipitation totals ranged between three and seven inches. Totals were lighter along the coastal counties. Several streams and rivers flooded across the area and there was also poor drainage flooding. The first round of heavy rain occurred mainly west of New Jersey during the early morning of September 30. The second and heavier round of precipitation moved in during the evening of September 30 and continued into the morning of October 1. The rain ended by the early afternoon of October 1. The flooding cause approximately $35,000 in property damage.
December 26-27, 2010	Heavy Snow	Statewide	A severe winter storm occurred, and a major disaster declaration was declared. Public assistance for 15 counties was requested and granted.
March 7 to 12, 2011	Flooding	Sussex, Morris, Warren	A slow moving, low pressure, cold front brought between 1.5 and four inches of rain across northern New Jersey from the early morning on March 6 into the early morning of March 7. Melting snow contributed to the runoff. The heaviest rain fell during the late afternoon and evening of March 6. Precipitation turned into snow over the higher terrain of northwest New Jersey during the early morning on March 7 and then ended briefly. In eastern Morris County, sections of the Pompton and Passaic Rivers were still above flood stage when another heavy rain event occurred from the early morning on March 10 into the morning on March 11. An additional two to five inches of rain fell and caused major flooding on both rivers. Governor Chris Christie declared a state of emergency before the start of the second round of heavy rain on March 9. Throughout the state, 683 homes were affected by both flooding events and 207 homes suffered at least major damage. About 1,500 people were evacuated and 2,000 residents were affected by the flood waters. The flooding caused over $11 million in property damage.
April 16 to 17, 2011	Flooding	Burlington, Camden, Cumberland, Gloucester, Morris, Salem	The strong southeast onshore flow on April 16, combined with the high tides associated with the full moon, produced minor to moderate tidal flooding along the New Jersey coast and moderate to severe flooding of the Delaware Bay in Cape May and Cumberland Counties. Tidal flooding departures increased farther up both Delaware and Raritan Bays. In addition, the funneling effect of southeast winds up the Delaware Bay contributed to increasing tidal departures. The high tide at Reedy Point (New Castle County, Delaware) established an all- time record high. One injury was reported from this event. The flooding cause approximately $2.75 million in property damage.

Date(s) of Event	Event Type	Counties Affected	Description
August 13 to 16, 2011	Flash Flood	Cumberland, Gloucester, Salem	A series of thunderstorms preceding a cold front brought three to seven inches of rain across a wide portion of New Jersey (less along most of the coast) from overnight on August 13 into the day on August 14. In southern Gloucester, eastern Salem and western Cumberland Counties, rainfall amounts reached seven to 11 inches. Scattered thunderstorms occurred on August 15 and into the morning of August 16. This slowed the recession of rivers and streams in the state. The combined event caused severe flash flooding with dam breaks in southwestern New Jersey and flash flooding and flooding across central and northern New Jersey. The flooding caused over $50 million in property damage.
August 27-29, 2011	Tropical Storm Irene	Statewide	Hurricane Irene moved made its second landfall as a tropical storm near Little Egg Inlet along the southeast New Jersey coast at around 5:35 a.m. on August 28, 2011 Irene brought tropical- storm force winds, destructive storm surge, and record-breaking freshwater inland flooding across northeast New Jersey that resulted in three deaths, thousands of mandatory, and voluntary evacuations along the coast and rivers from surge and freshwater flooding, and widespread power outages that lasted for up to two weeks. The storm surge of three to five feet caused moderate-to-severe tidal flooding along the ocean side and moderate tidal flooding in Delaware Bay and tidal sections of the Delaware River. Major flooding occurred on the Raritan, Millstone, Rockaway, and Passaic Rivers. Overall, Irene brought an average rainfall total of 7.03 inches with a maximum rainfall total of 9.85 inches in Cranford (Union County). Another source indicated a maximum rainfall total of 11.27 inches in Freehold. A maximum wind gust of 65 mph was reported in Cape May (Cape May County). A maximum storm surge of 4.63 feet was reported in Sandy Hook. Irene caused approximately $1 billion in damages in New Jersey and seven deaths in the State.
September 7-10, 2011	Remnants of Tropical Storm Lee	Burlington, Camden, Cape May, Atlantic, Ocean	Remnants of Tropical Storm Lee brought three to eight inches of rain to many parts of New Jersey. The heavy rain caused flooding, mainly in west and northwest New Jersey. Most of the damage was reported along the Delaware River, where two homes were destroyed, 24 suffered major damage, 249 suffered minor damage, and 28 others were affected. Many roads were closed throughout the State because of flooding. Freshwater surge caused moderate tidal flooding along sections of the Delaware River. The State had approximately $11.5 million in damage.
August 25 to 26, 2012	Flash Flood	Cape May	A series of slow-moving thunderstorms caused flash flooding in Cape May County during the evening and overnight on August 25 and into August 26. Doppler Radar storm total estimates reached around five inches. The flooding caused approximately $150,000 in property damage.
October 26 - November 8, 2012	Superstorm Sandy	Statewide	Superstorm Sandy was the costliest natural disaster by far in the State of New Jersey. Record- breaking high tides and wave action combined with sustained winds as high as 60 to 70 mph with wind gusts as high as 80 to 90 mph to batter the State. Statewide, Sandy caused an estimated $29.4 billion in damage, destroyed or significantly damaged 30,000 homes and businesses, affected 42,000 additional structures, and was responsible directly or indirectly for 38 deaths. A new temporary inlet formed in Mantoloking (Ocean County) where some homes were swept away. About 2.4 million households in the State lost power. It would take two weeks for power to be fully restored to homes and businesses that were inhabitable. Also devastated by the storm was New Jersey's shellfish hatcheries including approximately $1 million of losses to buildings and equipment, and product losses in excess of $10,000 at one location alone. Overall, average rainfall totals were 2.78 inches with a maximum rainfall of 10.29 inches at the Cape May (Cape May County) station. Another source indicated a maximum rainfall total of 12.71 inches in Stone Harbor (Cape May County). A maximum wind gust of 78 mph was reported in Robbins Reef. A maximum storm surge of 8.57 feet was reported in Sandy Hook. Tide gages in Atlantic City and Cape May measured storm surges of 5.82 feet and 5.16 feet, respectively. Other areas experienced inundations along the coast due to the storm tide, ranging from two feet in Atlantic, Burlington, Cape May, Essex and Bergen Counties to nine feet in Monmouth and Middlesex Counties. Superstorm Sandy caused approximately $30 billion in damages in New Jersey and caused 12 deaths in the State.

Date(s) of Event	Event Type	Counties Affected	Description
12/21/2012	Heavy Rain	Hunterdon, Warren, Morris, Somerset, Bergen, Warren	Moderate to heavy rain fell across the state, with storm totals ranging between 1 to 3 inches. This rain resulted in some mainly minor flooding of smaller streams and creeks in southern New Jersey. The strong onshore flow contributed to higher high tides with minor to moderate tidal flooding occurring along the southern New Jersey oceanfront.
12/27/2012	Heavy Rain	Hunterdon, Monmouth, Middlesex, Ocean, Somerset, Burlington	Heavy rain caused poor drainage as well as flooding of streams and rivers in the central third of New Jersey. It had the greatest impact on waterways in Monmouth and Ocean Counties. The runoff from the heavy rain also exacerbated the tidal flooding.
1/31/2013	Heavy Rain	Hunterdon, Morris, Warren	The strong south to southwest winds preceding a cold frontal passage brought an unseasonably mild and moist air mass into New Jersey. This caused heavy rain to fall and caused poor drainage flooding as well as isolated stream and river flooding in northwest New Jersey on the 31st. Most of the waterway flooding was minor and all streams and rivers were back within bank full by the evening of the 31st. Event precipitation totals averaged 1.5 to 2.5 inches in northwest New Jersey.
3/12/2013	Heavy Rain	Hunterdon	A slow-moving cold front with waves of low pressure along it caused rain, heavy at times, to fall across northwest New Jersey on the 12th into the late afternoon. Event precipitation totals averaged 1.5 to around 2.0 inches with lesser amounts elsewhere across the state. This rain caused poor drainage flooding as well as isolated river flooding.
5/8/2013	Heavy Rain	Mercer, Hunterdon	Bands of heavy rain during the first half of the day on the 8th that preceded the passage of an occluded front caused poor drainage flooding. Event precipitation totals average between 2.0 and 3.5 inches.
June 7 - 8, 2013	Flooding Associated with Tropical Storm Andrea	Monmouth, Somerset, Union, Mercer, Bergen, Morris	The initial burst of heavy precipitation arrived during the early morning on the 7th as moisture surged into the Mid-Atlantic Region ahead of Tropical Storm Andrea. Runoff from heavy rain that fell during the 7th into the 8th led to flooding.
June 10-11, 2013	Heavy Rain	Burlington, Monmouth, Somerset	Heavy rain that fell on the 10th caused additional flooding across the central third of New Jersey. Event precipitation totals averaged between 1.0 and 2.5 inches.
6/14/2013	Heavy Rain	Morris	Several heavy rain events in the week leading up to the 14th contributed to rises across the areas creek and streams. Some of the heaviest rain was reported across northern New Jersey.
6/18/2013	Heavy Rain	Camden	The combination of a slowly moving cold front with a wave of low pressure along it and wet antecedent conditions helped develop a large area of light to moderate rain with embedded thunderstorms accompanied by heavy rain in New Jersey primarily during the afternoon of the 18th. This led to urban and poor drainage flooding and also flash flooding.
June 27-28, 2013	Heavy Rain	Somerset, Mercer	A series of thunderstorms accompanying a warm front caused very heavy rain during the late afternoon and early evening on the 27th. This caused flooding in central New Jersey that lasted overnight.
6/30/2013	Heavy Rain	Gloucester, Camden, Salem	A nearly stationary front helped trigger showers and thunderstorms with heavy rain that resulted in flash flooding
July 12- 13, 2013	Poor Drainage	Mercer, Monmouth, Burlington, Cape May, Salem, Cumberland	Bands of showers and thunderstorms with heavy rain associated with a low-pressure system along the frontal boundary caused some poor drainage flooding
7/23/2013	Heavy Rain	Burlington	Storm total rainfall measurements ranged mainly between 2 and 7 inches across central to northern New Jersey. Run-off from waves of heavy precipitation resulted in areas of poor drainage and roadway flooding. In addition, the combination of the heavy rain and higher than normal astronomical tides associated with the full moon, caused minor tidal flooding.
July 28-29, 2013	Heavy Rain	Somerset, Burlington, Camden,	A slow-moving cold front coupled with a deep southerly flow of very moist air caused slow moving and, in some instances, back building thunderstorms to occur during the

Date(s) of Event	Event Type	Counties Affected	Description
		Cumberland	afternoon and evening of the 28th. This caused an all-time record-breaking rainfall in nearby Philadelphia as well as flash flooding in southwestern New Jersey and parts of the Passaic and Raritan Basins in northern New Jersey. The flash flooding in the Philadelphia suburbs (Camden County in particular) led to people being stuck on roadways for hours on the 42 Freeway as well as Interstates 295, 76 and 676.
August 9-10, 2013	Heavy Rain	Sussex, Warren	A surface trough helped trigger showers and thunderstorms with torrential downpours during the morning of the 9th in northwestern New Jersey. Event totals reached 2 to 6 inches in western portions of Warren and particularly Sussex County and caused flash flooding of smaller streams as well as poor drainage flooding.
8/13/2013	Heavy Rain	Gloucester, Camden	A complex of showers and thunderstorms produced both wind damage and flash flooding in central and southwest New Jersey on the 13th. Doppler Radar storm total estimates averaged 2.5 to 5.0 inches.
8/22/2013	Heavy Rain	Burlington, Mercer, Middlesex, Morris, Somerset	Heavy rain caused flash flooding of smaller streams, roadways and rivers and led to flooding
9/2/2013	Heavy Rain	Gloucester, Camden	Clusters of showers and thunderstorms with torrential downpours over sections of central and southern New Jersey during the late morning into the early afternoon on the 2nd. This caused urban, poor drainage and small creek flash flooding
9/22/2013	Heavy Rain	Gloucester, Camden	The runoff from heavy rain from showers and isolated thunderstorms caused minor flooding along the Cooper River.
11/27/2013	Heavy Rain	Bergen, Union	An area of low pressure tracked from the Gulf Coast through New England bringing several inches of rain to the Tri-State Area. This resulted in isolated small stream flooding.
January 6-8, 2014	Snow Melt and Freezing Rain, Ice Jam	Somerset, Mercer	The combination of the melting snow as well as freezing rain on the morning of the 5th and rain during the day on the 6th caused minor flooding along sections of the Millstone River. The unseasonably cold arctic air mass resulted in ice jam flooding north of the jam in Trenton.
February 22-24, 2014	Heavy Rain/Snow Melt	Somerset	Melting snow caused minor flooding along sections of the Millstone River from the 22nd through the 24th.
March 29 - April 1, 2014	Heavy Rain	Hunterdon, Somerset, Bergen, Monmouth, Burlington, Middlesex, Cumberland, Salem	An area of low pressure tracking along a stalled frontal boundary extending across the central Appalachians eastward through the Mid-Atlantic States produced multiple waves of heavy rain. Run-off from waves of heavy precipitation caused some poor drainage and roadway flooding.
April 15-16, 2014	Heavy Rain	Somerset	Some urban and poor drainage flooding occurred, because of the recent dry weather, but only isolated river flooding was reported.
April 30 - May 2, 2014	Heavy Rain	Statewide	A frontal system associated with a large cutoff low-pressure system over the Midwest and Lower Great Lakes region caused periods of heavy rain, which resulted in flooding across New Jersey. At the same time a slow-moving low-pressure system and a deep southerly flow from the Gulf of Mexico and then the Atlantic Ocean dropped heavy rain across New Jersey centered on April 30th. Event precipitation totals averaged from 3 to 6 inches, with the highest amounts in central New Jersey. This caused widespread poor drainage flooding as well as flooding of creeks and rivers throughout most of the state.
6/10/2014	Heavy Rain	Gloucester, Camden	A nearly stationary frontal boundary focused slow moving thunderstorms with heavy rain in southwestern New Jersey during the late afternoon and early evening of the 10th. This caused poor drainage flash flooding as well as flash flooding of some smaller creeks.
July 15-16, 2014	Heavy Rain	Ocean, Burlington, Middlesex, Monmouth, Somerset	Thunderstorms with very heavy downpours produced flash flooding.

Date(s) of Event	Event Type	Counties Affected	Description
12/9/2014	Heavy Rain	Essex, Somerset	A coastal storm passed just south and east of the area causing strong winds and heavy rain with isolated flooding in portions of Northeast New Jersey.
January 18-20, 2015	Heavy Rain	Burlington, Mercer, Hunterdon, Union, Somerset	Precipitation totals averaged close to two inches and caused considerable poor drainage flooding as well as flooding along some smaller creeks and rivers mainly in the central third of New Jersey. The most reported flooding occurred in Somerset County where flooding persisted into the 20th. Most other creek and small river flooding ended by late in the evening on the 18th.
March 11-14, 2015	Heavy Rain/Snow Melt	Somerset, Hunterdon	Rainfall amounts combined with around 2 to 5 inches of snow on the ground, caused poor drainage and low-lying area flooding.
7/15/2017	Heavy Rain	Cumberland, Salem, Atlantic, Ocean, Gloucester	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.
8/19/2015	Heavy Rain	Somerset	A moist airmass coupled with daytime heating allowed widely scattered thunderstorms to develop during the afternoon of the 19th. A few thunderstorms produced torrential downpours, leading to localized flash flooding.
9/10/2015	Heavy Rain	Monmouth, Gloucester	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.
February 24-25, 2016	Heavy Rain	Mercer, Sussex, Bergen	A strong low-pressure system moving north through the Great Lakes region, combined with its associated warm front and cold front, copious amounts of moisture, and low-level jet, produced strong to severe thunderstorms, heavy rain, flash flooding, and stream flooding.
May 29-30, 2016	Flooding Associated with Tropical Storm Bonnie	Burlington	Moisture from the remnants of tropical storm Bonnie moved northward into the region and interacted with a frontal boundary over the region. This resulted in several rounds of heavy rain on the night of the 29th and the early morning of the 30th.
6/21/2016	Heavy Rain	Ocean, Burlington, Middlesex, Monmouth, Somerset	A cold frontal boundary moved south into New Jersey during the morning hours of the 21st before stalling. This front served as a focal point for showers and thunderstorms to develop.
7/8/2016	Heavy Rain	Somerset	Heavy rainfall along with strong to severe thunderstorms occurred. Flooding was reported in low-lying areas.
7/25/2016	Heavy Rain	Ocean, Somerset, Mercer	A trough of low pressure led to the development of afternoon and evening showers and thunderstorms which became severe in spots and produced locally heavy rains. 40,000 were left without power across the state.
7/28/2016	Heavy Rain	Gloucester, Atlantic, Cape May	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.
July 30-31, 2016	Heavy Rain	Middlesex, Ocean, Hunterdon	Several clusters of thunderstorms associated with several shortwaves and a cold front caused flooding.
9/19/2016	Flooding Associated with Tropical Storm Julia	Gloucester, Ocean, Atlantic, Cape May	The remnants of tropical storm Julia and a frontal boundary interacted leading to several rounds of rainfall over the region.
11/15/2016	Heavy Rain	Essex	Low pressure moving north along the east coast of the United States resulted in a widespread 1-3-inch rainfall event across northeast New Jersey. Isolated flooding was observed.

Date(s) of Event	Event Type	Counties Affected	Description
3/31/2017	Heavy Rain	Monmouth, Middlesex, Hunterdon, Somerset, Gloucester	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.
4/6/2017	Heavy Rain	Camden, Hunterdon	Locally heavy showers and thunderstorms occurred. Some of thunderstorms were strong to severe with gusty winds.
5/5/2017	Heavy Rain	Monmouth, Atlantic, Salem, Burlington, Ocean, Middlesex	A large amount of rainfall in a relatively short period of time contributed to flooding.
5/13/2017	Heavy Rain	Monmouth, Atlantic, Cape May	Heavy rain led to some localized flooding.
6/24/2017	Flooding Associated with the Remnants of Tropical Storm Cindy	Somerset, Mercer, Middlesex, Morris	A band of gusty convective showers moved through during the morning hours in association with the remnants of tropical storm Cindy. Several reports of damage were reported from the winds. Thousands lost power.
7/1/2017	Heavy Rain	Passaic	Scattered showers and thunderstorms developed in a moist airmass. The combination of heavy rainfall and runoff resulted in flooding.
7/7/2017	Heavy Rain	Warren, Morris, Bergen	A stationary frontal boundary draped across the Delaware Valley lead to a period of heavy rainfall during the morning of July 7th. Widespread rainfall lead to flooding.
July 13-17, 2017	Heavy Rain	Statewide	A hot and humid airmass was present ahead of a frontal boundary which slowly moved southeast toward and then through the state. Several rounds of thunderstorms moved through the region ahead of this front over the course of a few days.
July 22-24, 2017	Heavy Rain	Somerset, Ocean, Cumberland, Warren	A stalled frontal boundary was the focus for several rounds of thunderstorms that produced damaging winds and flooding in spots.
July 28-29, 2017	Heavy Rain	Cumberland, Atlantic, Cape May,	A rare summertime Nor'easter tracked just offshore producing heavy rain, thunderstorms, and wind. Coastal flooding and beach erosion also occurred.
August 2-3, 2017	Heavy Rain	Middlesex, Warren, Burlington, Morris, Middlesex, Burlington	A hot and humid airmass with weak boundaries led to slow moving strong to severe thunderstorms with damaging winds, hail, and flooding.
8/7/2017	Heavy Rain	Cumberland, Atlantic, Cape May,	Thunderstorms developed along and ahead of a warm front. With a humid airmass in place, these storms produced heavy rain that led to flash flooding.
August 18-23, 2017	Heavy Rain	Ocean, Burlington Somerset, Camden, Gloucester	Severe thunderstorms formed in a hot and humid airmass ahead of a cold front.
9/16/2017	Heavy Rain	Morris	A series of disturbances in the jet stream and a weak surface trough lead to sufficient lift within a tropical air mass to produce slow moving, heavy rain showers across portions of New Jersey. This lead to localized urban and poor drainage flooding.
October 29-30, 2017	Heavy Rain	Statewide	A wave of low pressure formed along a slow-moving cold front before rapidly deepening off the Mid Atlantic coast during the evening. This resulted in reports of flooding.
1/12/2018	Flooding	Bergen	Rain associated with an approaching cold front combined with near record high temperatures and continued snow melt to result in river flooding along the Hohokus Brook in Ho-Ho-Kus, New Jersey. After an average of 5-9 inches of snow the week before, rainfall totals across the region ranged from 1-2.5 inches.
2/11/2018	Flooding	Camden, Gloucester, Middlesex	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 along with some road closures.
March 2-3, 2018	Flooding	Burlington,	Heavy rainfall occurred in New Jersey and Eastern Pennsylvania on March 1st and 2nd,

Date(s) of Event	Event Type	Counties Affected	Description
		Hunterdon, Somerset	with widespread rainfall amounts of 1 to 2 inches. This resulted in flooding along the North Branch of the Rancocas Creek in Burlington County, the Millstone River at Blackwells Mills in Somerset County, and the Neshanic River in Southeastern Hunterdon County. In addition, areal and minor small stream flooding also occurred. Several road closures occurred.
April 16-17, 2018	Flooding, Flash Flooding	Bergen, Essex, Hudson, Middlesex, Morris, Passaic, Somerset, Union	Heavy rainfall developed across the area ahead of a slow-moving warm front. This rain developed in an environment with precipitable water values greater than 1.25 inches, well above normal for mid-April. Rainfall totals generally ranged from 2.5 to 4.5 inches across northeast New Jersey, with the majority of the rain falling in a 3-4 hour period. This resulted in flash flooding and road closures across the region
5/27/2018	Flash Flooding	Mercer, Middlesex, Monmouth, Somerset,	Heavy rain fell in central New Jersey. Rainfall amounts of 2 to 4 inches were common with some locations receiving up to 5 or 6 inches of rain. Several road closures occurred.
6/9/2018	Flash Flooding	Cumberland	Heavy rain fell in Cumberland County on the afternoon of June 9, 2018. Rainfall totals up to 3 to 5 inches occurred in a short period of time.
6/11/2018	Flooding, Flash Flooding	Burlington, Camden, Gloucester, Ocean	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 and several roads were closed.
7/3/2018	Flash Flooding	Bergen, Essex, Gloucester, Morris, Union	Scattered showers and thunderstorms occurred across northeast New Jersey, with very slow storm motions and precipitable water values rising from 1.5 to 2.0 inches and isolated flash flooding across the region. The Caldwell, NJ ASOS reported 1.89 inches of precipitation, and a COOP observer in Harrison, NJ reported 1.00.
7/6/2018	Flash Flooding	Mercer, Ocean	High precipitable water values along with surface convergence allowed storms with high rainfall rates to form. Areas along the I-195 corridor saw the heaviest rainfall near and above 3 inches. Several road closures occurred.
7/17/2018	Flash Flooding	Bergen, Ocean	Showers and thunderstorms developed in a moist and unstable airmass ahead of an approaching cold front, leading to isolated flash flooding. Precipitable water values during the afternoon were around 2 inches. Several road closures occurred.
7/25/2018	Flash Flooding	Passaic	Afternoon showers and thunderstorms with precipitable water values at or above 2 inches. These showers and storms produced isolated flash flooding across parts of Passaic County, NJ.
7/27/2018	Flash Flooding	Cumberland, Essex, Middlesex, Union	Severe thunderstorms with damaging winds, and flash flooding affected parts of New Jersey. Locally heavy rainfall occurred in a short amount of time. Rainfall totals of 3 to 6 inches fell in northeastern Middlesex County and 1-2 inches of rain in a matter of hours in Union and Essex counties. Rainfall totals of 2 to 4 inches fell in western Cumberland County.
8/4/2018	Flooding, Flash Flooding	Bergen, Essex, Hunterdon, Somerset, Union	A developing area of low pressure along a surface trough helped produce heavy rainfall across parts of northeast New Jersey that resulted in flash flooding. Rainfall amounts ranged from 1-3 inches in many places.
8/7/2018	Flash Flooding	Monmouth	Rainfall totals of 2 to 4 inches fell in northeastern Monmouth County in a short amount of time on the evening of August 7, 2018.
August 11-13, 2018	Flash Flooding	Bergen, Burlington, Camden, Hudson, Middlesex, Monmouth, Ocean, Passaic, Somerset, Union	Several areas of flash flooding occurred due to heavy rain. Rainfall totals of 2 to 5 inches were reported in northern New Jersey. Additionally, severe thunderstorms impacted the area. The Caldwell, NJ ASOS recorded 4.92 inches of rain, and multiple other stations across northeast New Jersey received between 2.5 inches and 4 inches of precipitation. The Little Falls area of Passaic County was particularly hard hit when rising water from the Peckman River swept away numerous cars from the Route 46 Chrysler, Jeep, Dodge dealership. $3.2 million in damages were reported in Passaic County. Several road closures and stranded vehicles occurred in every county.
8/17/2018	Flash Flooding	Hudson, Somerset	Showers and thunderstorms developed in a warm and humid environment ahead of an approaching cold front, resulting in isolated flash flooding across portions of urban northeast New Jersey. These storms brought 1-2 inches of rain to the region in a matter of hours, with a cooperative observer in Harrison, NJ recording 1.79 inches of rain during the event.

Date(s) of Event	Event Type	Counties Affected	Description
8/31/2018	Flash Flooding	Burlington	Locally heavy rain produced flash flooding in parts of Burlington County. Rainfall totals of 2.5 to 5.5 inches fell in a short amount of time.
9/7/2018	Flash Flooding	Camden, Gloucester	Locally heavy rain fell in the northwestern parts of Gloucester County and Camden County during the late afternoon and evening. Rainfall totals ranged from 3 to 5 inches. A supercell developed along a boundary and produced isolated wind damage.
9/13/2018	Flash Flooding	Middlesex	Locally heavy rain fell in northwestern Middlesex County, with totals ranging from 3.5 to 5.5 inches.
9/18/2018	Flash Flooding	Hudson, Middlesex	A tropical airmass associated with the remnants of Hurricane Florence produced waves of showers and thunderstorms that resulted isolated flash flooding in northeast New Jersey. The precipitable water value in Upton, New York was 2.10, which represents a daily maximum value.
9/25/2018	Flash Flooding	Bergen, Burlington, Essex, Hudson	Rain developed across the area ahead of an approaching warm front, consolidating into a slow-moving band of heavy rain across northeast New Jersey. Precipitable water values increased from 1.84 on the morning sounding from Upton, NY to 2.13 by evening, both above the 90th percentile and the 2.13 value was a record for the date. Rainfall amounts generally ranged from 3-5 inches.
10/2/2018	Flash Flooding	Bergen, Morris, Passaic, Sussex	Multiple rounds of showers and thunderstorms resulted in flash flooding across portions of northeast New Jersey. Rainfall totals across the region generally ranged from 1-3 inches.
October 11-12, 2018	Flash Flooding	Gloucester, Monmouth, Salem	Rainfall totals of 3 to 5 inches fell in parts of southern and central New Jersey, with a few reports of rainfall amounts in excess of 5 inches.
11/3/2018	Flooding	Bergen	The combination of moderate to heavy rain associated with an area of low pressure crossing the region and wet antecedent conditions resulted in minor flooding on the Ramapo River. Rainfall amounts in the area were generally 1-2 inches.
12/21/2018	Flooding, Flash Flooding	Bergen	Low pressure moving up the spine of the Appalachians resulted in widespread heavy rainfall and reports of flash flooding across portions of northeast New Jersey. A record high precipitable water value of 1.66 inches was recorded on the 12Z sounding from Upton, NY. Rainfall amounts across the region ranged from 1.5 to 3 inches.
May 29-30, 2019	Flooding, Flash Flooding	Bergen, Burlington, Hudson, Hunterdon, Somerset, Union, Warren	Low pressure moving along a nearly stationary boundary triggered an area of convection that moved across the region, resulting in isolated flash flooding across northeast New Jersey. Precipitable water values were around 1.5 inches, which is in the 90th percentile for the end of May.
June 18-20, 2019	Flash Flooding	Burlington, Camden, Gloucester, Hunterdon, Monmouth, Somerset, Warren	Showers and thunderstorms produced heavy rainfall and flash flooding. Rainfall amounts of 1 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.
6/25/2019	Flash Flooding	Bergen	A line of showers and thunderstorms moved through northeast New Jersey. Between three quarters of an inch and one inch of rain fell within a two-hour time span, resulting in isolated flash flooding.
July 5-6, 2019	Flash Flooding	Burlington , Gloucester, Ocean	Thunderstorms brought locally heavy rain, with rainfall amounts of 1 to around 2 inches in Burlington, 2 to near 3 inches in sections of Warren County and Gloucester County, and 3 to over 5 inches in Ocean County.
7/11/2019	Flash Flooding	Bergen, Essex, Passaic, Warren	Showers and thunderstorms developed across the area during the afternoon in response to an approaching warm front. Widespread rainfall totals of 1-2 inches were reported across northeast New Jersey, with several reports of 2.5-3 inches.
July 17-18, 2019	Flash Flooding	Essex, Hunterdon, Middlesex, Monmouth, Ocean, Somerset, Union	Showers and thunderstorms developed in a sub-tropical environment ahead of the remnants of Post Tropical Cyclone Barry, resulting in flash flooding across portions of urban northeast New Jersey. Precipitable water values across the region were around 2.25 inches. Rainfall amounts across much of northeast New Jersey ranged from 1-3 inches.
July 22-23, 2019	Flash Flooding	Bergen, Essex, Hudson, Middlesex, Monmouth, Somerset, Union	Thunderstorms brought heavy rain to parts of northern New Jersey with rainfall amounts of 2 to near 4 inches reported.

Date(s) of Event	Event Type	Counties Affected	Description
7/31/2019	Flash Flooding	Monmouth, Ocean, Union	Thunderstorms brought locally heavy rain and flash flooding in urban northeast New Jersey. Rainfall totals of 2 to near 3 inches fell in parts of Monmouth County and Ocean County.
8/3/2019	Flash Flooding	Bergen	Showers and thunderstorms produced 1-2 inches of rainfall in a short amount of time, leading to isolated reports of flash flooding across portions of Bergen County. The ASOS at Teterboro Airport reported 1.52 inches of rain during this event.
August 6-7, 2019	Flash Flooding	Bergen, Essex, Hudson, Hunterdon, Middlesex, Monmouth, Passaic	Thunderstorms brought locally heavy rain to parts of northern, central and southwestern New Jersey. Rainfall totals of 2 to around 4 inches fell in parts of the area.
August 18-19, 2019	Flash Flooding	Camden, Hudson	Thunderstorms brought locally heavy rain, with rainfall amounts of 1 to around 2 inches fell in parts of both counties.
10/31/2019	Flash Flooding	Warren	Showers and thunderstorms brought heavy rain to parts of northern New Jersey. Rainfall totals of 1.0 to 2.5 inches were common.
6/5/2020	Flash Flooding	Monmouth, Ocean	Showers and thunderstorms brought heavy rain to much of central New Jersey. Rainfall totals of 1 to 2 inches were common with some locations receiving up to 2 to 3 inches in a relatively short amount of time.
6/11/2020	Flash Flooding	Monmouth	Thunderstorms produced rainfall totals of 1 to around 2 inches in a short amount of time.
6/20/2020	Flash Flooding	Gloucester	Thunderstorms brought heavy rain with localized rainfall amounts of 2.5 to 3.5 inches.
7/1/2020	Flooding, Flash Flooding	Cape May, Essex, Hudson	Several shortwaves rotating through an upper level low off the New England / Mid-Atlantic coast triggered numerous showers and thunderstorms, which produced strong to severe winds, heavy downpours, and in some cases, small hail.
7/3/2020	Flash Flooding	Hudson	Showers and thunderstorms developed across northeast New Jersey during the early evening hours with between 1-2 inches of rain falling. Most of this rain fell in less than an hour, resulting in isolated flash flooding.
7/6/2020	Flash Flooding	Bergen, Burlington, Cape May, Morris, Passaic, Union	Thunderstorms brought heavy rain to New Jersey with rainfall amounts as high as 2 to 4 inches in parts of the state.
July 10-11, 2020	Flash Flooding	Atlantic, Bergen, Cape May, Cumberland, Essex, Gloucester, Hudson, Middlesex, Morris, Passaic, Salem	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.
July 22-24, 2020	Flash Flooding	Hudson, Middlesex, Monmouth, Ocean, Somerset, Union	A line of convection moving into the region from the west resulted in flash flooding across portions of urban northeast New Jersey. Thunderstorms brought heavy rain to parts of central New Jersey. Rainfall amounts as high as 3 to 5 inches occurred in parts of Middlesex County and Monmouth County. Newark Airport reported 2.12 inches.
8/4/2020	Flooding, Flash Flooding	Bergen, Cumberland, Gloucester, Hunterdon, Warren	Tropical Storm Isaias moved northward along the East Coast, passing west of New York City during the afternoon. With a tropical airmass in place, heavy rainfall on the leading edge of the storm resulted in isolated flash flooding in parts of northeast New Jersey. Rainfall amounts ranged from 1-3 inches, with Teterboro Airport reporting 1.45 inches of rain from the storm.
8/7/2020	Flash Flooding	Atlantic, Cape May, Cumberland, Gloucester, Mercer, Salem	Severe thunderstorms and heavy rain occurred across sections of South Jersey from late afternoon through the evening hours. 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.
August 12-13, 2020	Flash Flooding	Burlington, Gloucester, Mercer, Union	Showers and thunderstorms developed with weak flow aloft and a moist environment, resulting in flash flooding across portions of urban northeast and southern New Jersey. Rainfall amounts were as high as 2 to 4 inches.
8/29/2020	Flash Flooding	Gloucester, Salem	Showers and thunderstorms associated with the remnants of Hurricane Laura brought locally heavy rain to southwestern New Jersey. Rainfall totals as high as 3 to 5 inches were reported.

Date(s) of Event	Event Type	Counties Affected	Description
12/25/2020	Flooding	Bergen	A strong area of low pressure impacted the region with moderate to heavy rain developing out ahead of the approaching cold front in an anomalously moist environment, leading to river flooding along the Ramapo River. Precipitable water values on the 12Z 12/25 sounding from Upton, NY were around 1.5 inches, a record for the date based on the Storm Prediction Center's sounding climatology.
June 8-9, 2021	Flash Flooding	Atlantic, Bergen, Burlington, Hudson	Thunderstorms developed in an environment with high precipitable water values, resulting in several reports of flash flooding. Rainfall amounts varied widely across the area. The ASOS at the Teterboro Airport reported 1.66 inches of rain, while the Newark Airport ASOS reported 2.19 inches.
6/14/2021	Flash Flooding	Camden	Thunderstorms brought locally heavy rain with rainfall totals around 2 to 3 inches.
7/2/2021	Flash Flooding	Essex, Hudson	Scattered showers and thunderstorms resulted in flash flooding across portions of urban northeast New Jersey. Rainfall amounts in the heaviest storms ranged from around 1 to 1.5 inches, including 1.47 inches reported by the Newark Airport ASOS.
7/8/2021	Flash Flooding	Bergen, Passaic	A predecessor rainfall event resulted in flash flooding across portions of the area as moisture streaming northward ahead of Tropical Storm Elsa encountered a stationary boundary draped across the area. Rainfall amounts ranged 1.5-4 inches, with the ASOS at Teterboro Airport reporting 2.37 inches of rain from this event
7/12/2021	Flash Flooding	Burlington, Essex, Hudson, Hunterdon, Mercer, Passaic, Somerset	Showers and thunderstorms developed in a moist environment, with precipitable water values greater than 2 inches, and relatively weak low-level flow. In addition, antecedent conditions were quite wet, with 3-5+ inches of rain falling across the area the week before. These conditions combined to result in isolated flash flooding.
7/14/2021	Flash Flooding	Monmouth	Thunderstorms brought locally heavy rain as rainfall amounts of 1.5 to 2.5 inches fell in a short amount of time.
7/17/2021	Flash Flooding	Essex, Hudson,	Showers and thunderstorms developed with precipitable water values approaching 2 inches, resulting in widespread flash flooding across portions of urban northeast New Jersey. Rainfall totals include 2.28 inches recorded by the Newark Airport ASOS and 2.17 inches reported by a COOP observer in Harrison. This rain fell across an area with wet antecedent conditions as a result of several rounds of heavy rainfall during the previous week to week and a half.
7/29/2021	Flash Flooding	Bergen, Burlington, Essex, Mercer, Middlesex, Monmouth, Passaic	Scattered showers and thunderstorms developed across New Jersey, resulting in isolated reports of flash flooding. As much as 2 to 5 inches of rain fell in parts of the area.
8/10/2021	Flash Flooding	Burlington	Thunderstorms produced locally heavy rain with rainfall totals up to 2 to 4 inches.
August 21-23, 2021	Flooding, Flash Flooding	Bergen, Essex, Hudson, Hunterdon, Mercer, Middlesex, Monmouth, Ocean, Passaic, Somerset, Union, Warren	Rainfall from Tropical Storm Henri resulted in widespread flash flooding across portions of northeast New Jersey With a tropical airmass in place (precipitable water values greater than 2 inches), rainfall totals generally ranged from 2-4 inches, with this rain coming in addition to the 1-3 inches that fell during the predecessor rainfall event the night before. This resulted in widespread rainfall amounts of 3-7 inches in many locations over a 24–36-hour period. The ASOS at Newark Airport recorded a total of 4.67 inches across the two days, while the COOP observer in Harrison reported a two-day total of 8.02 inches.
August 27-29, 2021	Flash Flooding	Atlantic, Cape May, Hudson, Middlesex, Passaic	With weak upper-level flow resulting in slow storm motions and wet antecedent conditions as a result of rainfall associated with Tropical Storm Henri less than a week earlier, this resulted in isolated flash flooding in northeast New Jersey. Thunderstorms brought locally heavy rain to southeastern New Jersey and rainfall totals were as high as 2.5 to 4.5 inches.
9/1/2021	Flooding, Flash Flooding	Bergen, Camden, Essex, Hudson, Hunterdon, Middlesex, Passaic, Somerset, Sussex, Warren	Extremely heavy rainfall associated with the remnants of Hurricane Ida overspread northeast New Jersey during the evening of September 1 and continued through the early morning hours of September 2. Rainfall totals ranged from 5-8+ inches across much of the region, with much of that rain falling in just a few hours. The ASOS at Newark Airport recorded 8.44 inches of rain, while the ASOS at Teterboro Airport recorded 7.14 inches. This resulted in widespread flash flooding leading to numerous road closures and water rescues in addition to extensive river flooding. Eight people died as a result of the flash flooding.

Date(s) of Event	Event Type	Counties Affected	Description
10/26/2021	Flooding	Bergen	A low-pressure system developing over the area brought rounds of thunderstorms over the area, which dropped 1-3 of rain over a several hour period. Total rainfall amounts of 2-4 were observed.
4/7/2022	Flooding	Bergen	A cold front moving through the area brought multiple rounds of rain. A total of 2 to 3 inches of rain fell over a several hour period. This resulted in river and poor drainage flooding.
August 5-6, 2022	Heavy Rain, Flash Flooding	Hunterdon, Mercer, Middlesex, Monmouth, Ocean	Training clusters of thunderstorms developed near the intersection of the sea breeze and an outflow boundary approaching from the south. This resulted in an area of heavy rainfall which produced some locally significant flash flooding.
12/23/2022	Flooding	Bergen	A frontal system moving through the area produced several rounds of heavy rainfall, which resulted in a widespread 1.5 to 3 inches of rainfall with localized areas of flash flooding and river flooding.

Source: NOAA-NCEI, 2023

Table 4.7-4 Coastal Flooding Events Since 2010

Date(s) of Event	Event Type	Counties Affected	Description
3/13/2010	Coastal Flooding	Essex, Hudson, Middlesex, Monmouth, Ocean, Union	A prolonged period of strong easterly winds resulted in widespread moderate flooding. Positive tidal departures of 3 to 5 feet were recorded, with many places seeing water levels reaching their highest levels in almost 20 years. There was $4 million in reported damages.
3/28/2010	Coastal Flooding	Burlington, Camden, Gloucester, Hudson, Salem	An up the Delaware Bay southeasterly flow that combined with freshwater runoff and astronomical spring tides associated with the full moon caused moderate tidal flooding along the Delaware River. Minor tidal flooding also occurred along its tributaries as well as in Delaware Bay and along the ocean front. The tidal flooding was assisted by a series of low-pressure systems.
4/16/2011	Coastal Flooding	Burlington, Cape May, Gloucester, Middlesex, Monmouth, Salem	The strong southeast wind up the Delaware Bay and River combined with the already high astronomical tides associated with the full moon and freshwater runoff from heavy rain to produce severe tidal flooding along the Delaware River and tidal sections of its tributaries. There was $3 million in reported damages.
9/29/2011	Coastal Flooding	Burlington, Camden, Gloucester, Salem	The combination of freshwater runoff, unusually high spring astronomical tides and a weak southeasterly flow produced moderate tidal flooding during the afternoon high tide cycle along tidal sections of the Delaware River and its tributaries. There was $300,000 in reported damages.
10/29/2011	Coastal Flooding	Atlantic, Cape May, Monmouth, Ocean	While northwestern sections of New Jersey were being hit hard with heavy snow, the same low-pressure system caused strong winds and minor to moderate coastal flooding along the Atlantic Coast and lower Delaware Bay. Minor tidal flooding also occurred in Upper Delaware Bay and along tidal sections of the Delaware River and its tributaries.
June 1-6, 2012	Coastal Flooding	Atlantic, Burlington, Cape May, Cumberland, Monmouth, Ocean	The combination of spring tides associated with the full moon and then an onshore flow associated with a Cape Cod low pressure system caused minor to moderate tidal flooding during the first six days of June. Moderate tidal flooding occurred along Raritan Bay, coastal New Jersey and Delaware Bay during the evening and overnight high tide cycles. Tidal flooding nearly reached moderate levels on tidal sections of the Delaware River also.
March 6-10, 2013	Coastal Flooding	Atlantic, Cape May, Burlington, Hudson, Monmouth, Ocean	An intense nor'easter brought strong to high winds across most of central and southern New Jersey as well as minor to moderate tidal flooding along Raritan Bay, lower Delaware Bay and on the ocean side. The coastal flooding was exacerbated by wave action as waves off of Barnegat (Ocean County) reached 15 feet and seas offshore 25 feet. The coastal flooding caused new breaches in Mantoloking, flooded roadways and prompted some voluntary evacuations in Monmouth and Ocean Counties. This was the greatest and most persistent tidal flooding to affect the New Jersey coast since Hurricane Sandy last October. There was $745,000 in reported damages.

Date(s) of Event	Event Type	Counties Affected	Description
1/3/2014	Coastal Flooding	Atlantic, Burlington, Middlesex, Monmouth, Ocean	A winter storm dropped 5 to 9 inches of snow across most of New Jersey, except around 10 inches in northern Ocean County and in Monmouth County. The tidal flooding from the storm left many roadways icy because of the extremely low temperatures.
April 30 – May 1, 2014	Coastal Flooding	Burlington, Camden, Gloucester, Salem	The combination of freshwater runoff, onshore flow and high astronomical tides associated with the new moon caused moderate tidal flooding along the tidal Delaware River with the overnight high tide cycle on the 30th.
12/9/2014	Coastal Flooding	Atlantic, Burlington, Cape May, Middlesex, Monmouth, Ocean	A strong nor'easter caused strong winds as well as minor to moderate tidal flooding in Upper Delaware Bay and around Raritan Bay and moderate tidal flooding in Lower Delaware Bay and Atlantic Coastal New Jersey.
October 1-4, 2015	Coastal Flooding	Cape May, Cumberland	A persistent onshore flow caused periods of heavy rain, strong to high winds, beach erosion, and minor to moderate tidal flooding to occur along the Atlantic coast of New Jersey and into Delaware Bay from the 1st through the 4th. There was $2 million in reported damages.
1/10/2016	Coastal Flooding	Atlantic, Monmouth	A low-pressure system produced a persistent southerly flow which in turn created tidal anomalies of 1 to 2 feet, enough to cause moderate tidal flooding on the Ocean front and back bays at the time of high tide.
February 8-9, 2016	Coastal Flooding	Atlantic, Burlington, Middlesex, Monmouth, Ocean	An onshore flow associated with low pressure along the mid-Atlantic coast, in combination with a new moon, produced moderate coastal flooding during high tide. Multiple roadways were flooded on Long Beach Island and Ocean City due to coastal flooding. Roads and bridges were also closed in Atlantic and Cape May Counties due to tidal flooding.
May 5-9, 2016	Coastal Flooding	Atlantic, Cape May, Middlesex, Monmouth, Ocean	A low-pressure system slowly moved onshore on the 6th leading to a persistent period of onshore flow. Coupled with a New Moon cycle this led to abnormally high tidal levels and frequent minor to moderate coastal flooding corresponding to the high tides.
1/24/2017	Coastal Flooding	Atlantic, Monmouth, Ocean	A developing storm brought a strong onshore flow which resulted in minor to moderate tidal flooding for the high tide cycles. Considerable beach erosion occurred during the event as well across all of New Jersey coastal counties, including a 70 percent loss of the dunes near the Mantoloking and Harvey Cedars beaches.
3/14/2017	Coastal Flooding	Cape May, Burlington, Middlesex, Monmouth, Ocean	Low pressure systems across the Ohio Valley and Carolinas phased. This led to a rapidly developing storm which tracked just offshore. Wind, coastal flooding, heavy rain and snow all occurred. Heavy rainfall in Southeast New Jersey ranged from 1-3 inches.
5/25/2017	Coastal Flooding	Atlantic, Cape May, Middlesex, Monmouth	Several clusters of showers and thunderstorms moved through the state in the afternoon and evening hours producing a few strong but sub-severe wind gusts and hail near severe limits. Moderate coastal flooding also occurred with the evening high tide.
9/19/2017	Coastal Flooding	Atlantic, Burlington, Cape May, Ocean	Moderate coastal flooding affected the New Jersey counties of Ocean, southeastern Burlington, Atlantic and Cape May with the evening high tide on Tuesday, September 19. Widespread roadway flooding was reported in the communities along tidal waters and many roads were closed.
March 2-4, 2018	Coastal Flooding	Atlantic, Burlington, Cape May, Middlesex, Monmouth, Ocean	Strong Northwest winds with gusts up to around 60 mph occurred on March 2nd and 3rd.. Minor coastal flooding over multiple tide cycles occurred along the New Jersey coast March 2nd through 4th. Moderate flooding occurred during the morning high tide of Saturday the 3rd in Monmouth County, most of the NJ oceanfront Saturday evening and again Sunday morning the 4th. Conversely, blowout tides occurred in portions of Delaware Bay late on March 2nd into the 3rd. In addition, areal and minor small stream flooding also occurred.
April 15-16, 2018	Coastal Flooding	Burlington, Camden, Mercer, Middlesex, Salem	A strong 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.

Date(s) of Event	Event Type	Counties Affected	Description
August 9-11, 2018	Coastal Flooding	Atlantic, Burlington, Cape May, Gloucester, Mercer, Middlesex, Monmouth, Ocean, Salem,	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.
10/27/2018	Coastal Flooding	Atlantic, Cape May, Middlesex, Monmouth, Ocean	Strong low pressure moved northward along the coasts of Delaware and New Jersey on October 27. The system brought moderate to major coastal flooding and high winds to the coastal counties of New Jersey during the morning and early afternoon hours.
11/16/2018	Coastal Flooding	Middlesex, Monmouth	Moderate tidal flooding occurred in the coastal communities of Middlesex and Monmouth Counties during the hours after midnight on November 16. There was widespread roadway flooding.
November 25-26, 2018	Coastal Flooding	Burlington, Camden, Mercer, Middlesex, Monmouth	Moderate tidal flooding occurred along the tidal Delaware River and its tidal tributaries. Some roads were flooded.
1/20/2019	Coastal Flooding	Middlesex, Monmouth	A winter storm impacted New Jersey on January 19 and 20, bringing moderate coastal flooding to the northern part of the New Jersey coast.
October 9-11, 2019	Coastal Flooding	Atlantic, Cape May, Monmouth, Ocean	Slow moving low pressure centered well off the coasts of New Jersey and Delaware produced coastal flooding during several consecutive high tide cycles from October 9 through October 12. Moderate coastal flooding occurred with the evening high tide on the 10th, and with the morning and evening high tides on the 11th.
10/30/2020	Coastal Flooding	Atlantic, Cape May	Low pressure passing off the Middle Atlantic coast caused a strong and steady northeast wind to develop along the coasts of Delaware and New Jersey. Widespread moderate coastal flooding occurred with the high tide on the morning of October 30.
12/17/2020	Coastal Flooding	Middlesex, Monmouth	Strengthening low pressure moved up the Middle Atlantic coast and along the coasts of Long Island and southeastern New England from the afternoon of December 16 through the afternoon of December 17.
February 1-2, 2021	Coastal Flooding	Atlantic, Cape May, Middlesex, Monmouth, Ocean	Strong low pressure moved slowly northeastward over the waters off Delaware and New Jersey on February 1-2, 2021. The brisk onshore flow resulted in two consecutive high tide cycles with widespread moderate flooding along the New Jersey coast.
5/28/2021	Coastal Flooding	Middlesex, Monmouth	Coastal low pressure resulted in a prolonged period of onshore flow along the coast of New Jersey from May 28th through the 30th. Moderate coastal flooding occurred along the northern part of the New Jersey coast on the night of May 28-29.
October 28-30, 2021	Coastal Flooding	Burlington, Camden, Cumberland, Mercer, Ocean, Salem	Strong high pressure located in eastern Canada and slow-moving low pressure approaching from the southeastern states resulted in a prolonged onshore flow along the Middle Atlantic coast. Moderate flooding occurred along the tidal Delaware River and its tributaries on the evening of October 28, and there was moderate to major flooding in those areas on the evening of October 29.
1/3/2022	Coastal Flooding	Atlantic, Cape May	Deepening low pressure passed off the Middle Atlantic Coast on January 3. The resulting onshore flow caused moderate coastal flooding in the tidal areas of Cape May County and Atlantic County around the time of the morning high tide.
4/18/2022	Coastal Flooding	Atlantic, Cape May, Cumberland	Strengthening low pressure moved slowly up the Middle Atlantic Coast from the 18th into the 19th. The resulting onshore flow caused moderate tidal flooding in parts of New Jersey.
October 2-4, 2022	Coastal Flooding	Atlantic, Cape May, Burlington, Ocean	Low pressure remained off the Middle Atlantic Coast from October 2nd through 5th, before moving out to sea on the 6th. The low maintained an onshore flow along the coasts of New Jersey and Delaware during that period of time.
12/16/2022	Coastal Flooding	Ocean	Deepening low pressure moved slowly northeastward from the Chesapeake Bay Region and produced moderate tidal flooding in Ocean County, New Jersey.
12/23/2022	Coastal Flooding	Atlantic, Burlington, Cape May, Cumberland, Gloucester, Mercer, Monmouth	Low pressure moved northward from the eastern Carolinas on the 22nd to eastern Pennsylvania on the morning of the 23rd. It was then absorbed by a stronger low moving across the eastern Great Lakes. The system produced moderate to major tidal flooding in New Jersey.

Source: NOAA-NCEI, 2023

Ice Jams

There have been 109 reported ice jams in New Jersey since 1904 (CRREL, 2023). Since 2010, there have only been 5. According to the United States Army Cold Regions Research and Engineering Laboratory's (CRREL) database, ice jams have historically formed at various points along the Assunpink Creek, Beaver Brook, Cedar Creek, Delaware River, Flat Brook, Forked River, Great Egg Harbor River, Lamington (Black) River, Maurice River, Musconetcong River, Neshanic River, North and South Branch Raritan River, Passaic River, Pequest River, Raritan River, Stony Brook, Walnut Brook, Wanaque River, and West Brook. All five of these most recent jams occurred on the Delaware River. Table 4.7-5 lists the ice jam events that have occurred in New Jersey between 2010 and 2023. Information regarding losses associated with these reported ice jams was limited.

Table 4.7-5 Ice Jams in New Jersey Since 2010

Event Date	River/Location	County	Description/Losses
1/27/2011	Delaware River at Trenton	Mercer	An ice jam formed downstream from the gaging station at the Trenton Makes Bridge. Water levels increased from nine feet to 13 feet. The ice jam became more restrictive and pushed water up another two feet at the gage.
1/31/2011	Delaware River at Montague	Sussex	Solid ice cover was observed upstream from the Milford-Montague toll bridge. There was significant backwater from ice at the gaging station. There was an ice jam upstream in the area of Mashipacong Island.
1/7/2014	Delaware River	Mercer	According to blog.nj.com on 8 Jan 2014, the Delaware River was flooding at Trenton, NJ due to an ice jam. The river had risen 6 feet in the past 12 hours and was located about one mile south of the route 1 bridge. Flooding was reported at rte. 29 and Market St, and at the lower State House parking lot adjacent to the river. There are inundation concerns once the jam breaks and released a wall of water downstream.
1/14/2018	Delaware River	Mercer	Warmer temperatures and heavy rain contributed to an ice jam that ended up causing several road closures, including rte. 29. The river reached a height of 20.58 feet.
1/24/2018	Delaware River	Warren	Reports indicate the ice jam was approximately four miles long, from the confluence with Brodhead Creek to the Smithfield Beach National Recreation Area. No flooding was reported.

Source: CRREL 2023; NOAA-NCEI 2018; The Trentonian, 2018

Tsunami

While the probability of a large tsunami impacting the coast of New Jersey is very small due to the position of New Jersey on the trailing edge of the North Atlantic Plate, the Mid-Atlantic region has been subjected to minor tsunami action over the past 250 years and perhaps significant tsunami action over the last geologic period. Lockridge, et al. (2002) analyzed tsunami and tsunami-like waves that have impacted the East Coast of the United States NOAA's NCEI compiled a listing of all tsunamis and tsunami-like waves of the eastern United States and Canada. Thirty-nine potential tsunami events have been identified as possibly impacting the East Coast of the United States since 1668. Of these events, four are categorized as definite or probable tsunamis.

The NCEI identified seven potential tsunami events that have possibly impacted the State of New Jersey. Of those seven events, two were categorized as a probable tsunami. Table 4.7-6 describes potential tsunami events that have impacted the State of New Jersey since 2010. The only tsunami event in this period occurred in 2013 and was a rare type of tsunami called a "Meteotsunami" that was caused by a strong weather system that moved from across the eastern U.S. that day.

Table 4.7-6 Potential Tsunami Events Since 2010

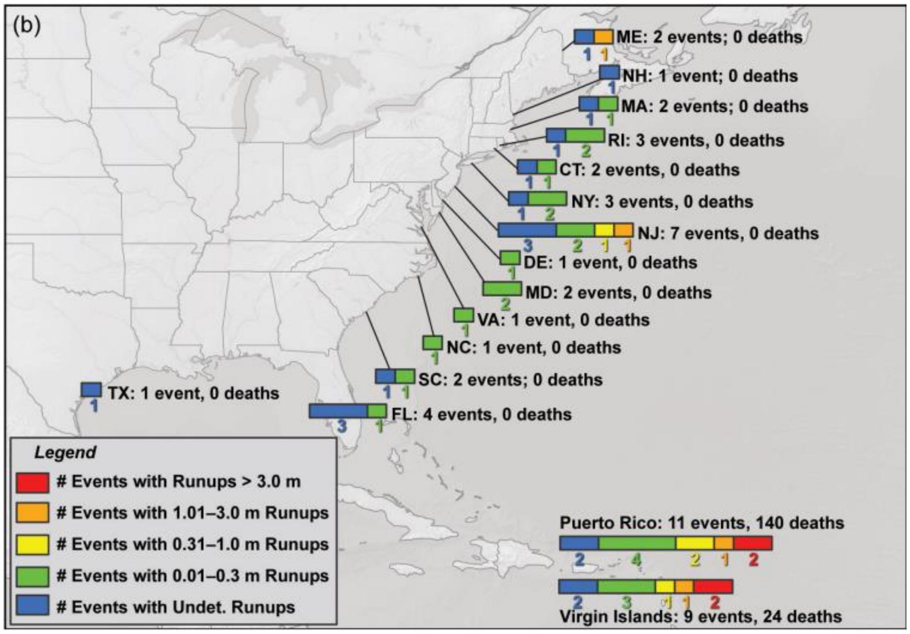
Event Date	Source Location	County	Description/Losses
6/13/2013	East Coast	Ocean	A rare type of tsunami called a "Meteotsunami" hit the New Jersey coast. It was caused by a strong weather system that moved from across the eastern U.S. that day. The weather system caused a jump in air pressure, which created the wave. An approximately 6-foot wave knocked three people off the inlet jetty, injuring at least two of them. No coastline damage was reported.

Source: Lockridge et al. 2002; NOAA, 2017

According to the 2008 NOAA study (*U.S. States and Territories National Tsunami Hazard Assessment: Historical Record and Sources for Waves*), tsunami events and losses were summarized for the Atlantic Region. Figure 4.7-25 shows the number of tsunami events and total number of events causing run-up heights from 0.1 meters to greater than three meters for the United States and its territories in the Atlantic, Gulf Coast, Puerto Rico, and the United States Virgin Islands.

The figure indicates that New Jersey has experienced six tsunami events with any observed run-up. Run-up is a measurement of the height of the water onshore observed above a reference sea level. Tsunami run-up occurs when a peak in the tsunami wave travels from the near-shore region onto shore. There were no reported deaths or injuries associated with these events.

Figure 4.7-25 Total Number of Tsunami Events for the Eastern United States and Territories



Source: USGS, 2015

4.7-4 PROBABILITY OF FUTURE OCCURRENCES

Flooding is a common occurrence in New Jersey and can take place any time of the year. Based on the history of flood events and the potential for a change in climate and sea level rise, flooding events may become more frequent throughout New Jersey. The State is vulnerable to riverine (inland) and coastal flooding, ice jam flooding, stormwater flooding, tsunami events, and sea-level rise. The historical record of FEMA declared disasters (flood-related) for the State indicates that New Jersey has experienced 31 flood-related disasters from 1954 to 2023 (FEMA 2023). Refer to Table 4.7-7 and Appendix D for a summary of these disasters. Based on these statistics, New Jersey may experience serious flooding events that result in a FEMA declaration once every two years. However, some areas of New Jersey are more flood prone than others and the frequency and size of flood events vary based on watershed, riverine reach, and location along each reach.

Floods are typically described in terms of their extent and their recurrence interval. The recurrence interval or return period is measure of how often a flood event is expected to occur based on the probability of exceeding a given threshold. The actual number of years between floods of any given size varies because of the naturally changing climate (USGS 2013). For example, a flood with a recurrence interval of 10 years has a 10% chance of recurring in any given year. This does not mean it will occur once every ten years. Table 4.7-7 describes the recurrence intervals and probabilities of occurrences for flood events.

Table 4.7-7 Recurrence Intervals and Probabilities of Occurrences

Recurrence Interval (in years)	Probability of Occurrence in Any Given Year	Percent Chance of Occurrence in Any Given Year
500	1 in 500	.02
100	1 in 100	1
50	1 in 50	2
25	1 in 25	4
10	1 in 10	10
5	1 in 5	20
2	1 in 2	50

Source: USGS

FEMA flood insurance rate maps (FIRMs), digital FIRMs (DFIRMs), and flood insurance studies (FIS) offer the best available information for states, counties, and municipalities and where floods are likely to occur within specific areas (FEMA, 2014). For the purposes of this plan, the most recent preliminary and effective FIRMs across the state were combined to provide the best available data.

FEMA Region 2 periodically prepares coastal flood studies to update FIRMs for communities in coastal New Jersey and New York. The flood hazards shown on the FIRM are used to determine flood insurance rates and requirements and where floodplain development regulations apply (FEMA Region 2, 2015). For further information regarding flood prone areas, updated FIRMs and coastal flood studies in New Jersey, see https://r2-coastal-fema.hub.arcgis.com/.

Potential Effects of Climate Change

Climate change impacts are expected to make flood events throughout New Jersey, including both coastal and inland areas, more frequent and damaging in the future. Several climate related factors contribute to this increased risk including heavier precipitation, more intense hurricanes and tropical storms, and sea level rise.

New Jersey is becoming warmer and wetter. General trends towards more intense precipitation in the state increase flood risk. In the Northeastern United States, climate-induced increases in the magnitude and frequency of floods have already been observed and these trends are expected to continue as annual precipitation continues to increase in the region at a projected 4% to 11% by 2050 (NJDEP, 2020). Changes in precipitation patterns resulting in longer wet periods and longer dry periods affect the ability of the soil to absorb water. Risk of flooding increases during periods of frequent precipitation as the ground is too saturated to allow for soil additional infiltration and during periods of drought when the soil is too dry to absorb large amounts of rain occurring in a short period of time resulting in more runoff which can overwhelm rivers and streams (NJDEP, 2020).

Hurricanes and tropical storms bring heavy rain and wind to coastal areas. Climate change is anticipated to increase the power of these storms. It is generally accepted that warmer sea surface temperatures increase the potential energy in a storm system thus resulting in stronger tropical storms that produce more extreme precipitation along with stronger winds that generate greater storm surge. Over the last 50 years, in New Jersey, storms that resulted in extreme rain increased by 71% (NJDEP, 2020).

By 2050, there is a 50% chance that sea-level rise in the state will meet or exceed 1.4 feet and a 17% chance it will exceed 2.1 feet. Those levels increase to 3.3 and 5.1 feet by the end of the century (NJDEP, 2020). In addition to amplifying flood risk from storm surge because the water is at a higher level to begin with, sea-level rise increases high-tide flooding. Many coastal parts of the state experience frequent high tide or nuisance flooding due to sea level rise. These higher-than-average rates of sea level rise measured in the Northeast have also led to a 100%–200% increase in high tide or nuisance flooding in some coastal areas of the region, causing more persistent and frequent impacts over the last few decades. In Atlantic City, tidal flooding events have already increased from happening less than once per year in the 1950s to an average of eight times per year between 2007 and 2016. Under a moderate emissions scenario by 2100, it is extremely likely (greater than a 95% chance) that high-tide flooding will occur in Atlantic City at least 95 days a year with a 50% chance it will occur 355 days per year (NJDEP, 2020). Additionally, sea level rise could result in additional stormwater flooding as levels rise to submerge existing sewage outfalls leading to backups in these systems.

Flooding can lead to direct health and mortality impacts such as drowning, injury, and hypothermia. Acute and chronic health effects secondary to a flooding event include respiratory illnesses from mold exposure and infectious disease spread from microorganism contamination of clean water as well as mobilized pollutants from contaminated sites such as superfund site. These health losses caused by floods will likely increase over the century (NJDEP, 2020)

4.7-5 VULNERABILITY ASSESSMENT

Data and Methodology

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. Data for this section came from FEMA, Rutgers University (RU), NJDEP, and NOAA. The following section evaluates and estimates potential impact of flood hazards to and the built environment (including state facilities), population and economy, and ecosystems and natural assets in New Jersey. For flood hazards, a spatial analysis was performed under a variety of flood scenarios detailed below.

- Special Flood Hazard Area (SFHA) – also known as the FEMA 1% annual chance (100-Year) flood scenario. Includes the most current FEMA-defined flood zones. Preliminary and existing FIRMs were combined to provide the best available data. Source: FEMA-downloaded from FEMA
- SFHA plus 3 feet– the extent of flooding if 3 feet were added above the water level of the current FEMA-defined flood zones. Source: provided by Rutgers University.
- Coastal Base Flood Elevation (BFE) plus 5 feet–An approximate delineation resulting from an additional 5-foot flood water height added to the FEMA coastal SFHA- as depicted on the NJDEP's “Tidal Climate Adjusted Flood Elevation" GIS layer which reflects NJDEP's Sea Level Rise Guidance recommendation. Also known as the tidal climate adjusted flood elevation for New Jersey. Source: DEP, downloaded from NJGIN
- Sea-Level Rise (SLR) plus 2, 3, and 5 feet – potential sea level rise inundation above current Mean Higher High Water (MHHW). Three scenarios include 2 feet above MHHW, 3 feet above MHHW, and 5 feet above MHHW. Source: Data was provided by Rutgers University.

Storm Surge (Categories 1-4) - estimated storm surge heights resulting from historical, hypothetical, or predicted Category 1, Category 2, Category 3, and Category 4 hurricanes. Source: NOAA – downloaded as SLOSH MOM from National Hurricane Center.

Vulnerable Jurisdictions

A review of the historic record indicates that all counties have experienced flooding. Further, all counties identified flooding as a hazard of concern in their hazard mitigation plans, as summarized in the table below. In addition to the rankings created by the counties, Table 4.7-8 includes the Hazard Risk Rating data from the National Risk Index. These ratings are relative to other jurisdictions and based on a risk equation consisting of a natural hazard risk component multiplied by a Community Risk Factor (CRF). Expected Annual Loss is the natural hazards risk component, measuring the expected loss of building value, population, and/or agricultural value each year due to natural hazards. The CRF is determined by combining the community’s social vulnerability and community resilience. Social vulnerability measures the susceptibility of social groups to the adverse impacts of natural hazards while community resilience uses demographic characteristics to measure a community’s ability to prepare for, adapt to, withstand, and recover from the effects of natural hazards. Organizationally, the NRI separates flooding by category (coastal or riverine) whereas County HMPs create a ranking based on overall flooding.

Table 4.7-8 Flood Risk Rankings

County	NRI		County
	Coastal Flooding Hazard Risk Rating	Riverine Flooding Hazard Risk Rating	Overall Flood Hazard by County HMP
Atlantic	Very High	Relatively High	High
Bergen	Very High	Relatively High	No Ranking System
Burlington	Relatively Moderate	Relatively High	Medium
Camden	Relatively Moderate	Relatively High	High
Cape May	Very High	Relatively Moderate	High
Cumberland	Relatively High	Relatively Moderate	High
Essex	Relatively Moderate	Relatively Moderate	High
Gloucester	Relatively Moderate	Relatively Moderate	Medium
Hudson	Very High	Relatively Low	High
Hunterdon	Not Applicable	Relatively Moderate	High
Mercer	Relatively Moderate	Relatively High	High
Middlesex	Relatively High	Relatively High	High
Monmouth	Very High	Relatively Moderate	High
Morris	Not Applicable	Relatively High	High
Ocean	Very High	Relatively High	High
Passaic	Relatively Low	Relatively Moderate	High
Salem	Relatively High	Relatively Moderate	High
Somerset	Very Low	Relatively High	High
Sussex	Not Applicable	Relatively Moderate	High
Union	Relatively High	Relatively High	High
Warren	Not Applicable	Relatively Moderate	Medium

Source: FEMA's NRI (accessed 07/2023), County Hazard Mitigation Plans (accessed 07/2023)

Built Environment

Potential Losses from Buildings

Table 4.7-9 shows estimated potential annual losses (EAL) for both coastal and riverine flooding by county in the state of New Jersey. Total building EAL was derived from FEMA's National Risk Index while EAL for state owned assets was calculated using Replacement Cost Value for state owned facilities per county derived from LBAM data multiplied by Expected Annual Loss Rate for Buildings by county provided by the NRI.

Table 4.7-9 Estimated Potential Annual Losses for Flooding (Coastal and Riverine)

County	Coastal Flooding		Riverine Flooding	
	Total Buildings	State-Owned Assets	Total Buildings	State-Owned Assets
Atlantic	$76,979,919.69	$525,661.02	$10,533,433.77	$71,928.05
Bergen	$197,965,130.28	$177,719.11	$5,870,837.75	$5,270.42
Burlington	$5,854,650.16	$37,624.34	$6,063,115.05	$38,964.02
Camden	$1,013,830.79	$4,996.27	$2,119,237.30	$10,443.84
Cape May	$64,160,717.89	$193,116.83	$342,391.75	$1,030.56
Cumberland	$19,711,626.94	$423,287.69	$3,016,521.73	$64,776.82
Essex	$3,082,084.18	$19,664.31	$1,758,983.49	$11,222.67
Gloucester	$1,935,277.40	$3,414.29	$1,616,472.41	$2,851.84
Hudson	$43,815,361.64	$146,969.87	$287,713.20	$965.08

County	Coastal Flooding		Riverine Flooding	
	Total Buildings	State-Owned Assets	Total Buildings	State-Owned Assets
Hunterdon	-	-	$7,338,350.94	$47,903.68
Mercer	$1,961,291.53	$65,026.45	$7,895,021.53	$261,758.76
Middlesex	$22,154,801.12	$72,873.89	$6,435,248.53	$21,167.49
Monmouth	$52,652,433.70	$150,569.43	$2,217,752.83	$6,342.08
Morris	-	-	$15,338,714.53	$47,868.45
Ocean	$99,714,753.21	$285,969.87	$1,041,667.31	$2,987.38
Passaic	$64,511.01	$191.34	$1,264,927.40	$3,751.83
Salem	$7,519,927.81	$37,164.46	$2,116,959.10	$10,462.29
Somerset	$41,612.68	$107.01	$36,774,594.23	$94,571.09
Sussex	-	-	$3,625,113.59	$9,877.17
Union	$6,642,855.70	$11,779.72	$1,064,505.01	$1,887.68
Warren	$76,979,919.69	-	$5,671,410.75	$15,758.42
Total	**$682,250,705.42**	**$2,156,135.90**	**$122,392,972.20**	**$731,789.62**

Source: FEMAs NRI; NJOMB, 2023

To estimate the potential losses by county, the HAZUS-MH flood model was used to estimate the potential losses to the default general building stock provided by the model. This analysis has been refined since the 2019 Plan due to the updated and improved flood hazard areas and depth grids across the State. Table 4.7-10 summarizes the estimated potential losses to the default general building stock by county. As shown in the table below, the potential damage estimated to the general building stock inventory associated with the 1% annual chance flood is approximately $27 billion which represents approximately 2% of the State's overall total general building stock inventory.

Table 4.7-10 Estimated General Building Stock Losses from the 1% Annual Chance Flood Event, by County

County	Total Building RCV	SFHA	
		Estimated Building Related Loss	% of Total
Atlantic	$61,379,829,000	$2,361,270,000	4%
Bergen	$183,666,174,000	$4,076,850,000	2%
Burlington	$92,241,903,000	-	0%
Camden	$90,665,600,000	$434,390,000	0%
Cape May	$36,441,903,000	2,086,310,000	6%
Cumberland	$28,958,285,000	$300,590,000	1%
Essex	$127,984,713,000	$1,590,560,000	1%
Gloucester	$59,994,718,000	$328,040,000	1%
Hudson	$81,427,027,000	$3,960,790,000	5%
Hunterdon	$38,276,801,000	$415,520,000	1%
Mercer	$82,458,438,000	$ 414,090,000	1%
Middlesex	$175,347,158,000	$1,480,560,000	1%
Monmouth	$146,045,608,000	$1,384,550,000	1%
Morris	$118,660,108,000	$1,619,670,000	1%
Ocean	$105,814,735,000	$2,154,140,000	2%
Passaic	$74,265,718,000	$1,529,780,000	2%
Salem	$15,067,001,000	$443,090,000	3%
Somerset	$85,927,171,000	$780,570,000	1%
Sussex	$31,080,729,000	$135,750,000	0%

County	Total Building RCV	SFHA	
		Estimated Building Related Loss	% of Total
Union	$92,656,561,000	$1,272,790,000	1%
Warren	$26,137,453,000	$383,830,000	1%
State Total	**$1,754,497,633,000**	**$27,153,140,000**	**2%**

Source: HAZUS v6.0

Lifeline Impacts

FEMA created the eight Community Lifelines to contextualize information from incidents, communicate impacts in plain language, and promote a more unified effort across a community that focuses on stabilizes these lifelines during response. More information on these lifelines can be found in Section 4.1 Risk Assessment Overview. Table 4.7-11 showcases the most likely lifelines to be impacted by flood, including a short description of anticipated impacts.

Table 4.7-11 Lifelines Most Likely Impacted by Flood

Lifeline Categories	Notable Impacts
Safety and Security	Community safety may be threatened due to potential direct harm from flooding and compounding effects on administration of services. Transportation infrastructure issues may directly impact the abilities of law enforcement, fire service, search and rescue, and other government services to respond to a flooding hazard.
Food, Hydration, Shelter	Flooding can cause damage to structures which provide shelter, and the food that people store in those structures. while the food supply chain may be disrupted due to impacts on agricultural production and transportation infrastructure.
Health and Medical	Medical facilities can be impacted due to damage to structures from flooding, while patient movement and medical supply chains can be impacted by effects on transportation infrastructure.
Energy	Components of electric power generation, transmission and distribution systems are at risk for damage by floods, potentially resulting in service failure. Flooding can also adversely impact oil and gas production and electricity generation impacting energy supply.
Communications	Flooding can damage telecommunications equipment. Communications can also be impacted by power outages caused by flooding. This can impact response coordination.
Transportation	Flooding can strain the Transportation lifeline in both the short- and long-term through transportation delays and infrastructure damage. When flooding occurs on roadways, it can make transportation dangerous or even impossible. Damage to the Transportation lifeline has cascading effects among other lifelines which depend on movement of people or goods.
Hazardous Materials	The Hazardous Materials lifeline could be impacted by flooding. Facilities may be directly impacted, or transport of hazardous materials could be hindered by flooded infrastructure. Flooding of contaminated sites can uproot those hazardous materials which may be present and transport them amongst the floodwaters.
Water Systems	Flooding could pose a threat to the Water System lifeline. Floods can damage drinking water wells and lead to aquifer or well contamination. Sewage systems especially those that are combined may be affected leading to backups in sewer pipes or direct overflow discharge of sewage into water sources.

Critical Facilities

Community Lifelines

Community lifelines are important in ensuring the day-to-day function of society. These facilities include utilities, hospitals, and schools, among others similar in nature. Like State-owned and leased entities, these community lifelines need to ensure continuity of operation during a disaster. In addition to community lifelines, financial institutions and cultural and historic sites are important statewide assets. Table 4.7-12 through Table 4.7-21 outline the number of community lifelines and other valuable statewide assets that are located within flood areas for the following scenarios: Special Flood Hazard Area, Base Flood Elevation Plus 3, Coastal BFE Plus 5, Storm Surge Category 1, Storm Surge Category 2, Storm Surge Category 3, Storm Surge Category 4, Sea Level Rise Plus 2, Sea Level Rise Plus 3, and Sea Level Rise Plus 5.

Table 4.7-12 Number of Critical Facilities Located within a Special Flood Hazard Area

County	Communi-cations	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transport-ation	Financial	Cultural
Atlantic	91	10	19	257	37	56	22	6	1,889
Bergen	70	8	26	530	34	68	17	18	748
Burlington	4	3	6	88	4	14	16	6	1,618
Camden	18	4	5	154	4	9	52	0	676
Cape May	54	8	22	83	27	41	23	14	4,291
Cumberland	2	0	2	15	2	3	10	0	305
Essex	9	7	5	294	11	24	64	8	405
Gloucester	1	5	3	42	1	3	17	2	168
Hudson	98	24	8	882	42	121	168	18	2,934
Hunterdon	0	0	2	19	7	6	1	3	795
Mercer	17	4	1	59	2	14	12	4	362
Middlesex	11	8	2	185	10	14	58	14	343
Monmouth	8	1	11	88	25	45	14	10	353
Morris	9	1	4	112	11	19	4	5	390
Ocean	24	8	23	73	35	46	16	3	3,194
Passaic	10	1	4	95	10	26	9	3	283
Salem	5	3	7	31	6	13	7	1	468
Somerset	1	3	6	51	8	15	4	2	609
Sussex	0	0	2	9	0	0	24	0	57
Union	6	8	6	117	7	21	0	4	591
Warren	1	0	0	17	4	4	1	1	412
Total	439	106	164	3,201	287	562	539	122	20,891

Source: HIFLD, 2006, 2007, 2012, 2014, 2017, 2018, 2019, 2020, 2021, 2022; NJOGIS, 2019, 2020; NJ TRANSIT, 2021; PANYNJ, 2023; USDOT, 2022; NOAA, 2022; University, 2023.; FEMA, 2023 ; NJDEP, 2022.

Table 4.7-13 Number of Critical Facilities Located within Base Flood Elevation Plus 3 Flood Area

County	Communi-cations	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transport-ation	Financial	Cultural
Atlantic	97	11	25	296	52	68	28	12	2,365
Bergen	85	15	49	776	74	136	24	46	1,481
Burlington	25	5	24	151	15	32	20	14	3,255
Camden	25	6	23	243	23	37	56	2	2,141
Cape May	70	9	30	102	37	58	23	17	5,790
Cumberland	7	1	8	44	11	12	11	2	1,114
Essex	57	18	20	652	56	107	133	31	1,300
Gloucester	4	10	8	82	4	18	21	6	256
Hudson	128	24	9	977	51	136	166	16	3,242
Hunterdon	0	3	4	32	11	7	1	4	1,225
Mercer	51	6	2	108	12	44	15	6	711
Middlesex	18	10	8	305	30	46	56	21	529
Monmouth	16	4	25	171	46	82	21	18	635
Morris	13	5	8	191	28	40	7	12	742
Ocean	37	11	46	128	61	77	38	17	3,166
Passaic	12	6	7	247	29	51	10	14	496
Salem	10	10	14	76	13	29	15	6	1,102
Somerset	2	4	11	89	20	38	7	5	843
Sussex	0	1	5	22	5	4	58	4	139

County	Communi-cations	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transport-ation	Financial	Cultural
Union	15	19	23	367	39	105	0	26	1,282
Warren	1	1	1	30	10	11	2	2	674
Total	**673**	**179**	**350**	**5,,089**	**627**	**1,138**	**712**	**281**	**32,488**

Source: HIFLD, 2006, 2007, 2012, 2014, 2017, 2018, 2019, 2020, 2021, 2022; NJOGIS, 2019, 2020; NJ TRANSIT, 2021; PANYNJ, 2023; USDOT, 2022; NOAA, 2022; University, 2023.; FEMA, 2023 ; NJDEP, 2022.

Table 4.7-14 Number of Critical Facilities Located within Coastal BFE Plus 5 Flood Area

County	Communi-cations	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transport-ation	Financial	Cultural
Atlantic	103	12	25	308	54	77	29	13	2,737
Bergen	88	15	53	829	78	152	25	48	1,591
Burlington	34	5	27	169	18	39	21	14	3,437
Camden	27	6	25	282	27	55	59	4	3,451
Cape May	76	9	34	109	46	72	24	19	6,571
Cumberland	8	1	12	56	17	23	14	2	1,737
Essex	63	19	20	794	64	123	140	41	1,373
Gloucester	6	13	9	116	10	26	26	6	309
Hudson	139	25	16	1,155	67	180	176	26	4,863
Hunterdon	0	3	4	32	11	7	1	4	1,230
Mercer	51	6	2	109	12	44	15	6	725
Middlesex	22	13	12	410	39	66	60	31	590
Monmouth	22	4	34	256	79	127	23	32	1,326
Morris	13	5	8	192	28	40	7	12	746
Ocean	46	12	53	147	69	99	41	21	3,974
Passaic	12	6	7	250	30	55	11	14	561
Salem	13	15	22	111	15	40	16	7	1,538
Somerset	2	4	11	89	20	38	7	5	844
Sussex	0	1	5	22	5	4	73	4	140
Union	20	24	26	431	47	128	0	26	1,415
Warren	1	1	1	30	10	11	2	2	675
Total	**746**	**199**	**406**	**5,897**	**746**	**1,406**	**770**	**337**	**39,833**

Source: HIFLD, 2006, 2007, 2012, 2014, 2017, 2018, 2019, 2020, 2021, 2022; NJOGIS, 2019, 2020; NJ TRANSIT, 2021; PANYNJ, 2023; USDOT, 2022; NOAA, 2022; University, 2023.; FEMA, 2023 ; NJDEP, 2022.

Table 4.7-15 Number of Critical Facilities Located within Storm Surge Category 1 Area

County	Communi-cations	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transport-ation	Financial	Cultural
Atlantic	78	11	17	230	29	51	6	5	1,683
Bergen	9	2	2	40	7	2	4	2	34
Burlington	0	0	0	5	0	0	0	0	5
Camden	2	2	1	68	0	0	20	0	110
Cape May	65	8	23	90	35	51	6	15	5,003
Cumberland	5	0	3	11	3	5	1	0	702
Essex	24	10	5	268	3	8	121	5	161
Gloucester	1	5	2	39	0	3	8	1	69
Hudson	84	21	9	839	43	127	116	17	3,440
Hunterdon	0	0	0	0	0	0	0	0	0
Mercer	0	0	0	0	0	0	0	0	0

County	Communi-cations	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transport-ation	Financial	Cultural
Middlesex	9	9	0	139	7	7	35	10	178
Monmouth	9	1	13	83	21	37	11	8	355
Morris	0	0	0	0	0	0	0	0	0
Ocean	19	5	15	47	15	22	5	1	2,007
Passaic	0	0	0	0	0	0	0	0	0
Salem	7	7	8	68	11	18	11	4	1,042
Somerset	0	0	0	0	0	0	0	0	0
Sussex	0	0	0	0	0	0	57	0	0
Union	8	14	1	116	3	9	0	2	159
Warren	0	0	0	0	0	0	0	0	0
Total	320	95	99	2,043	177	340	401	70	14,948

Source: HIFLD, 2006, 2007, 2012, 2014, 2017, 2018, 2019, 2020, 2021, 2022; NJOGIS, 2019, 2020; NJ TRANSIT, 2021; PANYNJ, 2023; USDOT, 2022; NOAA, 2022; University, 2023.; FEMA, 2023 ; NJDEP, 2022.

Table 4.7-16 Number of Critical Facilities Located withing Storm Surge Category 2 Area

County	Communi-cations	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transport-ation	Financial	Cultural
Atlantic	95	12	18	273	45	62	11	8	2,157
Bergen	38	4	4	182	11	11	6	4	189
Burlington	1	0	0	11	0	0	0	0	22
Camden	13	4	4	144	1	6	37	0	725
Cape May	72	11	33	107	48	73	8	20	6,443
Cumberland	7	0	5	31	12	18	4	0	1,310
Essex	34	13	5	420	8	20	127	12	213
Gloucester	2	7	4	45	2	10	8	4	111
Hudson	128	24	13	1,074	58	173	131	24	4,590
Hunterdon	0	0	0	0	0	0	0	0	0
Mercer	0	0	0	0	0	0	0	0	0
Middlesex	12	12	5	232	13	23	38	16	222
Monmouth	15	2	22	171	52	90	13	19	891
Morris	0	0	0	0	0	0	0	0	0
Ocean	23	5	24	73	36	47	6	5	3,079
Passaic	0	0	0	0	0	0	0	0	0
Salem	14	13	18	98	16	31	12	6	1,546
Somerset	0	0	0	0	0	0	0	0	0
Sussex	0	0	0	0	0	0	67	0	0
Union	22	17	4	258	13	40	0	8	348
Warren	0	0	0	0	0	0	0	0	0
Total	476	124	159	3,119	315	604	468	126	21,846

Source: HIFLD, 2006, 2007, 2012, 2014, 2017, 2018, 2019, 2020, 2021, 2022; NJOGIS, 2019, 2020; NJ TRANSIT, 2021; PANYNJ, 2023; USDOT, 2022; NOAA, 2022; University, 2023.; FEMA, 2023 ; NJDEP, 2022.

Table 4.7-17 Number of Critical Facilities Located within Storm Surge Category 3 Area

County	Communi-cations	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transport-ation	Financial	Cultural
Atlantic	96	12	22	279	51	71	11	9	2,352
Bergen	62	7	11	424	20	44	13	13	361
Burlington	5	0	4	59	2	5	3	0	428

County	Communi-cations	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transport-ation	Financial	Cultural
Camden	16	4	12	208	14	32	39	2	2,368
Cape May	84	13	40	129	58	92	8	26	7,082
Cumberland	7	0	10	35	13	21	4	0	1,588
Essex	44	15	5	550	17	41	128	18	287
Gloucester	3	9	7	93	7	24	17	5	189
Hudson	143	26	18	1,199	66	192	133	28	5,006
Hunterdon	0	0	0	0	0	0	0	0	0
Mercer	0	0	0	0	0	0	0	0	0
Middlesex	22	13	10	294	28	53	38	21	310
Monmouth	21	2	32	247	77	128	15	34	1,329
Morris	0	0	0	0	0	0	0	0	0
Ocean	37	8	50	117	67	93	8	15	3,801
Passaic	0	0	0	0	0	0	0	0	0
Salem	15	16	21	121	23	50	13	8	1,684
Somerset	0	0	0	1	1	1	0	0	11
Sussex	0	0	0	0	0	0	68	0	0
Union	28	19	9	377	23	66	0	13	920
Warren	0	0	0	0	0	0	0	0	0
Total	583	144	251	4,133	467	913	498	192	27,716

Source: HIFLD, 2006, 2007, 2012, 2014, 2017, 2018, 2019, 2020, 2021, 2022; NJOGIS, 2019, 2020; NJ TRANSIT, 2021; PANYNJ, 2023; USDOT, 2022; NOAA, 2022; University, 2023.; FEMA, 2023 ; NJDEP, 2022.

Table 4.7-18 Number of Critical Facilities Located within Storm Surge Category 4 Area

County	Communi-cations	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transport-ation	Financial	Cultural
Atlantic	104	12	36	303	59	105	11	17	3,409
Bergen	76	9	26	633	37	78	17	24	1,002
Burlington	19	4	6	111	10	23	8	4	1,852
Camden	19	6	18	289	26	61	41	6	4,655
Cape May	93	16	48	144	68	111	8	30	7,401
Cumberland	7	0	13	46	17	26	4	0	2,342
Essex	52	17	5	642	22	57	128	26	471
Gloucester	4	13	8	132	11	37	18	9	312
Hudson	151	27	29	1,277	74	214	133	42	5,291
Hunterdon	0	0	0	0	0	0	0	0	0
Mercer	0	1	0	3	0	0	2	0	1
Middlesex	58	22	18	388	38	91	38	26	374
Monmouth	37	2	44	359	102	184	15	40	1,874
Morris	0	0	0	0	0	0	0	0	0
Ocean	61	12	73	156	95	143	8	22	4,244
Passaic	0	0	0	18	2	0	1	0	43
Salem	16	16	25	134	28	60	13	9	1,767
Somerset	0	0	0	2	2	1	0	0	53
Sussex	0	0	0	0	0	0	68	0	0
Union	35	21	12	472	43	103	0	24	1,624
Warren	0	0	0	0	0	0	0	0	0
Total	732	178	361	5,109	634	1294	513	279	36,715

Source: HIFLD, 2006, 2007, 2012, 2014, 2017, 2018, 2019, 2020, 2021, 2022; NJOGIS, 2019, 2020; NJ TRANSIT, 2021; PANYNJ, 2023; USDOT, 2022; NOAA, 2022; University, 2023.; FEMA, 2023 ; NJDEP, 2022.

Table 4.7-19 Number of Critical Facilities Located within Sea Level Rise Plus 2 Area

County	Communi-cations	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transport-ation	Financial	Cultural
Atlantic	9	1	3	16	0	1	15	0	71
Bergen	22	0	2	100	3	1	8	0	92
Burlington	0	0	3	17	1	2	8	0	91
Camden	1	0	0	15	0	0	20	0	61
Cape May	3	0	1	6	0	6	20	2	324
Cumberland	0	0	2	0	0	1	7	0	69
Essex	0	0	1	8	0	0	5	0	14
Gloucester	0	2	0	22	0	2	13	2	46
Hudson	12	2	0	91	3	3	13	1	244
Hunterdon	0	0	0	0	0	0	0	0	0
Mercer	0	1	0	0	0	0	2	0	6
Middlesex	1	0	0	8	0	0	9	0	31
Monmouth	0	0	1	5	0	0	0	0	36
Morris	0	0	0	0	0	0	0	0	0
Ocean	2	0	0	6	0	1	25	1	163
Passaic	0	0	0	0	0	0	0	0	8
Salem	2	2	1	13	2	3	3	0	188
Somerset	0	0	0	0	0	0	0	0	0
Sussex	0	0	0	0	0	0	2	0	0
Union	0	0	0	3	0	0	0	0	13
Warren	0	0	0	0	0	0	0	0	0
Total	**52**	**8**	**14**	**310**	**9**	**20**	**150**	**6**	**1,457**

Source: HIFLD, 2006, 2007, 2012, 2014, 2017, 2018, 2019, 2020, 2021, 2022; NJOGIS, 2019, 2020; NJ TRANSIT, 2021; PANYNJ, 2023; USDOT, 2022; NOAA, 2022; University, 2023.; FEMA, 2023 ; NJDEP, 2022.

Table 4.7-20 Number of Critical Facilities Located within Sea Level Rise Plus 3 Area

County	Communi-cations	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transport-ation	Financial	Cultural
Atlantic	13	1	6	47	14	1	16	0	228
Bergen	50	4	7	344	13	25	14	8	338
Burlington	0	0	3	26	1	3	8	0	208
Camden	1	0	1	35	0	0	25	0	126
Cape May	10	2	8	30	17	8	20	4	852
Cumberland	1	0	2	2	1	2	8	0	106
Essex	0	0	1	31	0	0	7	0	18
Gloucester	0	3	2	27	1	2	15	2	64
Hudson	23	2	0	172	17	15	18	1	536
Hunterdon	0	0	0	0	0	0	0	0	0
Mercer	0	1	0	2	0	0	2	0	6
Middlesex	1	0	0	13	0	0	12	0	52
Monmouth	0	0	2	18	7	0	1	1	86
Morris	0	0	0	0	0	0	0	0	0
Ocean	3	0	4	14	17	3	25	1	774
Passaic	0	0	0	0	0	0	0	0	8
Salem	4	3	5	18	8	4	5	0	293
Somerset	0	0	0	0	0	0	0	0	0

County	Communi-cations	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transport-ation	Financial	Cultural
Sussex	0	0	0	0	0	0	4	0	0
Union	0	0	0	4	0	0	0	0	18
Warren	0	0	0	0	0	0	0	0	0
Total	106	16	41	783	96	63	180	17	3,713

Source: HIFLD, 2006, 2007, 2012, 2014, 2017, 2018, 2019, 2020, 2021, 2022; NJOGIS, 2019, 2020; NJ TRANSIT, 2021; PANYNJ, 2023; USDOT, 2022; NOAA, 2022; University, 2023.; FEMA, 2023 ; NJDEP, 2022.

Table 4.7-21 Number of Critical Facilities Located within Sea Level Rise Plus 5 Area

County	Communi-cations	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transport-ation	Financial	Cultural
Atlantic	36	9	12	195	14	31	21	3	975
Bergen	53	4	7	356	13	25	16	8	352
Burlington	2	0	3	55	1	7	11	1	554
Camden	8	2	2	111	0	2	46	0	451
Cape May	42	6	15	72	17	23	21	13	2,589
Cumberland	3	0	2	10	1	3	8	0	291
Essex	6	5	2	147	0	1	46	3	50
Gloucester	1	5	3	44	1	3	18	2	107
Hudson	53	16	2	416	17	46	85	12	1,429
Hunterdon	0	0	0	0	0	0	0	0	1
Mercer	0	1	0	5	0	0	3	0	8
Middlesex	3	4	0	31	0	0	38	1	102
Monmouth	2	0	4	39	7	8	11	2	254
Morris	0	0	0	0	0	0	0	0	0
Ocean	19	6	16	53	17	21	29	1	2,076
Passaic	0	0	0	0	0	0	0	0	9
Salem	5	6	7	38	8	10	11	3	695
Somerset	0	0	0	0	0	0	0	0	0
Sussex	0	0	0	0	0	0	19	0	0
Union	0	4	0	40	0	0	0	1	49
Warren	0	0	0	0	0	0	0	0	0
Total	233	68	75	1,612	96	180	383	50	9.992

Source: HIFLD, 2006, 2007, 2012, 2014, 2017, 2018, 2019, 2020, 2021, 2022; NJOGIS, 2019, 2020; NJ TRANSIT, 2021; PANYNJ, 2023; USDOT, 2022; NOAA, 2022; University, 2023.; FEMA, 2023 ; NJDEP, 2022.

Roadways, Evacuation Routes, Bridges, and Tunnels

Flooding can have a negative impact on the road transportation network, one of our most valuable infrastructure assets, preventing access and movement and resulting in damage to physical surfaces. Table 4.7-22 documents the number of miles of roadway at risk of flooding by scenario.

Table 4.7-22 Miles of Roadway at Risk from Flooding, by Scenario

Hazard Scenario	Miles of Roadway	Percent of Total Roadway
Statewide	**41, 988**	**100%**
SFHA	4,944	12%
SFHA +3	8,682	21%
Coastal SFHA +5	4,499	11%
Storm Surge Category 1	2,335	6%
Storm Surge Category 2	3,512	8%
Storm Surge Category 3	4,855	12%

Hazard Scenario	Miles of Roadway	Percent of Total Roadway
Storm Surge Category 4	6,417	15%
SLR 2	376	1%
SLR 3	910	2%
SLR 5	1,937	5%

Source: NJDOT, 2022; NOAA, 2022; Rutgers University, 2023; FEMA, 2023; NJDEP, 2022.

In the event of hazards such as approaching tropical storms or hurricanes, evacuation of at-risk areas may be necessary to protect human health and safety. NJOEM has designated various federal, interstate, and state roadways as potential evacuation routes in these instances. Flooding associated with these hazards could impact roadways hampering the ability of communities to evacuate at risk areas. Table 4.7-23 depicts the miles of evacuation routes at risk by flood scenario.

Table 4.7-23 Miles of Evacuation Routes at Risk from Flooding, by Scenario

Asset Type	SFHA	SFHA +3	Storm Surge Category 1	Storm Surge Category 4	SLR 2
Federal Highway	319.5	410	102.5	197.2	40.3
Interstate Highway	74.9	109.3	38.6	81.6	16.7
State Highway	848.9	1003.2	344.4	618.2	102.3
Street	729.3	788.4	339.1	553.0	190.3
Total	**1,967.7**	**2,311**	**824.7**	**1,450**	**349.6**

Source: HIFLD, 2007; NOAA, 2022; Rutgers University, 2023; FEMA, 2023; NJDEP, 2022.

Bridges and Tunnels are critical nodes in our transportation infrastructure. Flooding has the potential to cause damage to bridges and tunnels, possibly even resulting in collapse. Tables 4.7-24 to 4.7-26 below show the number of bridges and tunnels in each county that are vulnerable to flooding for each scenario.

Table 4.7-24 Number of Bridges and Tunnels Impacted by Riverine and Coastal Flooding

County	Riverine and Coastal Flooding Scenario		
	SFHA	BFE+3	Coastal BFE +5
Atlantic	123	142	148
Bergen	238	316	339
Burlington	174	224	228
Camden	84	139	152
Cape May	57	65	67
Cumberland	60	71	71
Essex	155	260	311
Gloucester	96	138	149
Hudson	58	90	111
Hunterdon	226	258	261
Mercer	181	234	237
Middlesex	185	232	250
Monmouth	206	264	273
Morris	242	296	299
Ocean	156	186	193
Passaic	138	201	205
Salem	75	82	84
Somerset	234	278	279

County	Riverine and Coastal Flooding Scenario		
	SFHA	BFE+3	Coastal BFE +5
Sussex	91	112	112
Union	154	236	256
Warren	141	161	162
Total	**3,074**	**3,985**	**4,187**

Source: USDOT, 2022; FEMA, 2023; NJDEP, 2022; Rutgers, 2023

Table 4.7-25 Number of Bridges and Tunnels Impacted by Sea-Level Rise

County	Sea-Level Rise Scenario		
	SLR 2	SLR 3	SLR 5
Atlantic	16	18	32
Bergen	26	42	48
Burlington	29	32	39
Camden	24	29	45
Cape May	14	14	25
Cumberland	20	23	26
Essex	15	18	37
Gloucester	38	40	49
Hudson	10	15	33
Hunterdon	0	0	0
Mercer	18	18	23
Middlesex	23	24	31
Monmouth	37	39	59
Morris	0	0	1
Ocean	16	19	33
Passaic	3	3	5
Salem	13	16	27
Somerset	1	1	2
Sussex	0	0	0
Union	27	28	33
Warren	0	0	0
Total	**330**	**379**	**548**

Source: USDOT, 2022; Rutgers University 2023

Table 4.7-26 Number of Bridges and Tunnels Impacted by Storm Surge

County	Storm Surge Scenario			
	Category 1	Category 2	Category 3	Category 4
Atlantic	35	48	55	67
Bergen	6	23	46	86
Burlington	1	5	10	27
Camden	6	15	35	54
Cape May	31	36	38	40
Cumberland	7	10	14	16
Essex	52	98	116	129

County	Storm Surge Scenario			
	Category 1	Category 2	Category 3	Category 4
Gloucester	13	23	34	41
Hudson	54	73	91	100
Hunterdon	0	0	0	0
Mercer	2	4	4	4
Middlesex	23	45	56	62
Monmouth	36	51	56	66
Morris	1	1	1	1
Ocean	13	26	48	68
Passaic	0	0	0	8
Salem	12	15	21	28
Somerset	1	3	4	7
Sussex	0	0	0	0
Union	27	46	52	67
Warren	0	0	0	0
Total	**320**	**522**	**681**	**871**

Source: USDOT, 2022; NOAA, 2022

State Facilities

To assess the vulnerability of the state-owned and -leased facilities provided by New Jersey's Office of Management and Budget (NJOMB), an analysis was conducted using the 1% annual chance flood hazard areas, Base Flood Elevation Plus 3, Coastal BFE Plus 5, Storm Surge Category 1, Storm Surge Category 2, Storm Surge Category 3, Storm Surge Category 4, Sea Level Rise Plus 2, Sea Level Rise Plus 3, and Sea Level Rise Plus 5. Using geographic information system (GIS) software, these hazard areas were overlaid with the state facility data to determine the number of state facilities vulnerable.

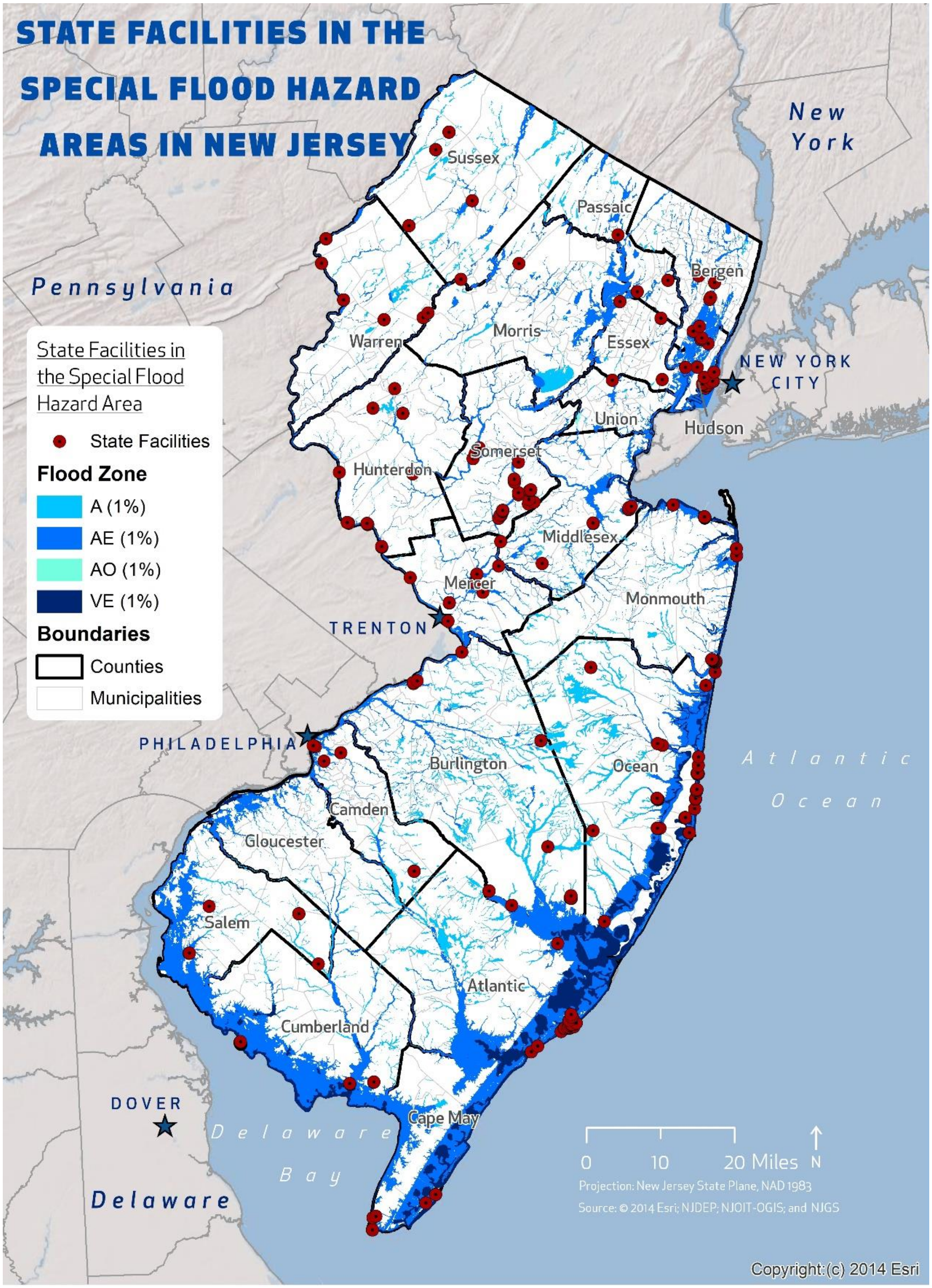
Table 4.7-27 State Facilities Located within Flood Areas, by Scenario

County	SFHA	BFE +3	BFE +5	Storm Surge Category 1	Storm Surge Category 2	Storm Surge Category 3	Storm Surge Category 4	SLR 2	SLR 3	SLR 5
Atlantic	47	53	53	43	49	49	62	3	4	38
Bergen	7	13	13	0	4	6	11	3	6	7
Burlington	140	180	184	1	1	2	18	117	117	119
Camden	14	31	32	1	7	9	12	0	0	2
Cape May	21	34	43	18	40	53	63	2	3	5
Cumberland	23	50	193	32	197	283	286	11	18	22
Essex	4	43	53	41	45	48	51	0	0	1
Gloucester	0	5	7	0	0	2	6	0	0	0
Hudson	34	34	37	35	36	37	37	0	0	12
Hunterdon	25	31	31	0	0	0	0	0	0	0
Mercer	15	30	30	0	0	0	0	0	0	0
Middlesex	10	13	15	4	8	90	100	1	3	5
Monmouth	40	54	72	41	60	77	86	1	8	35
Morris	1	7	8	0	1	1	1	0	0	0
Ocean	100	92	117	28	66	88	97	9	22	35
Passaic	9	10	12	0	0	0	0	0	0	0

County	SFHA	BFE +3	BFE +5	Storm Surge Category 1	Storm Surge Category 2	Storm Surge Category 3	Storm Surge Category 4	SLR 2	SLR 3	SLR 5
Salem	15	33	50	22	42	49	53	4	6	8
Somerset	41	45	45	0	0	0	0	0	0	0
Sussex	25	37	37	0	0	0	0	0	0	0
Union	1	4	13	1	13	18	23	0	0	0
Warren	25	29	29	0	0	0	0	0	0	0
Total	597	828	1074	267	569	812	906	151	187	289

Source: NJOMB 2023; NJOGIS, 2019, 2020;; NOAA, 2022; University, 2023.; FEMA, 2023 ; NJDEP, 2022.

Figure 4.7-26 State Facilities on the Special Flood Hazard Area



Source: NJ OMB 2023

Future changes in growth and development may impact vulnerability. Section 3.0: State Profile indicates an increase in the number of housing units authorized by building permits over the past five years. for many of the coastal counties exposed to coastal erosion and sea-level rise: Bergen, Essex, Hudson, Middlesex, Monmouth, Ocean, and Union. If the proposed new development is located within the hazard areas, there is a potential increase in risk to life, property, and the environment. However, the State has controls through CAFRA which regulates development in defined CAFRA boundaries. In addition, new construction will be required to meet current standards which are designed to provide increased protection compared to existing development in the area.

Similar to new construction, redevelopment, such as occurs after a destructive flood event, will be required to meet current standards which may provide increased protection compared to their pre-event conditions. Dune replenishment projects will continue and their role in mitigating vulnerabilities considered. The U. S. Army Corps of Engineers dune replenishment projects will serve to help mitigate the impacts of coastal erosion. Any identified vulnerabilities will be considered as the State continues to rebuild and redevelop in the aftermath of Superstorm Sandy and beyond.

As the State of New Jersey continues to be developed, state facilities will need to be located to conveniently serve the population base. As the New Jersey population continues to grow, so will the need for state services and facilities. Refer to the discussion earlier in this section regarding existing legislation and mitigation measures at the federal and state-level to reduce the impacts to future flood event.

Population and Economy

Of the exposed population, the most vulnerable include the economically disadvantaged and those over the age of 65. Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make evacuation decisions based on the net economic impact to their family. Those over 65 are also more vulnerable because they are more likely to seek or need medical attention which may not be available during a flood event, and they may have more difficulty evacuating.

As noted earlier, the population exposed to a tsunami cannot be determined at this time due to the lack of tsunami inundation areas or hazard zones. However, in general, the populations most vulnerable to the tsunami hazard are the elderly, disabled, and very young who reside near beaches, low-lying coastal areas, tidal flats, and river deltas that empty into ocean-going waters. In the event of a local tsunami generated in or near the State, there would be little warning time, so more of the population would be vulnerable. The degree of vulnerability of the population exposed to the tsunami hazard event is based on a number of factors:

- Whether there is a warning system in place
- How much lead time a warning provides
- The method for disseminating the warning
- Whether the people warned will evacuate

Tables 4.7-28 through 4.7-30 show the Disadvantaged Communities within the SFHA, BFE +3ft and Coastal FHA. There are three tables for these flood scenarios; the first table using the White House Climate and Economic Justice Screening Tool data, the second using the CDC/ATSDR Social Vulnerability Index data, and the third using NJDEP Overburdened Communities under the Environmental Justice Rule data.

Table 4.7-28 New Jersey Disadvantaged Communities (per White House Climate and Economic Justice Screening Tool) within the SFHA, BFE +3ft and Coastal FHA

County	Total Countywide Population	SFHA		BFE +3 ft		Coastal FHA	
		Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Population that is Disadvantaged
Atlantic	274,534	47,508	17%	53,952	20%	157,206	57%
Bergen	955,732	17,321	2%	27,510	3%	230,173	24%

County	Total Countywide Population	SFHA		BFE +3 ft		Coastal FHA	
		Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Population that is Disadvantaged
Burlington	461,860	8,667	2%	12,113	3%	116,224	25%
Camden	523,485	26,516	5%	39,370	8%	210,752	40%
Cape May	95,263	8,517	9%	10,842	11%	52,565	55%
Cumberland	154,152	8,560	6%	14,860	10%	126,785	82%
Essex	863,728	17,682	2%	73,960	9%	374,672	43%
Gloucester	302,294	3,033	1%	5,583	2%	87,830	29%
Hudson	724,854	47,535	7%	47,295	7%	336,492	46%
Hunterdon	128,947	344	0%	807	1%	16,894	13%
Mercer	387,340	14,241	4%	26,112	7%	148,607	38%
Middlesex	863,162	29,557	3%	34,396	4%	303,938	35%
Monmouth	643,615	7,671	1%	16,003	2%	184,230	29%
Morris	509,285	3,768	1%	6,018	1%	78,169	15%
Ocean	637,229	12,044	2%	24,440	4%	216,361	34%
Passaic	524,118	18,578	4%	33,374	6%	236,109	45%
Salem	64,837	3,879	6%	6,623	10%	31,308	48%
Somerset	345,361	2,460	1%	5,953	2%	78,754	23%
Sussex	144,221	301	0%	451	0%	2,024	1%
Union	575,345	20,233	4%	55,134	10%	276,399	48%
Warren	109,632	910	1%	1,032	1%	15,423	14%
Total	**9,288,994**	**299,325**	**3%**	**495,828**	**5%**	**3,280,915**	**35%**

Source: United States 2020 Census; White House Climate and Economic Justice Screening Tool; FEMA, 2023; NJDEP, 2022; Rutgers, 2023

Table 4.7-29 New Jersey Disadvantaged Communities (per CDC/ATSDR Social Vulnerability Index) within the SFHA, BFE +3ft and Coastal FHA

County	Total Countywide Population	SFHA		BFE +3 ft		Coastal FHA	
		Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Population that is Disadvantaged
Atlantic	274,534	58,127	21%	70,689	26%	74,252	27%
Bergen	955,732	51,849	5%	77,839	8%	85,330	9%
Burlington	461,860	17,361	4%	24,501	5%	26,487	6%
Camden	523,485	36,146	7%	57,176	11%	64,748	12%
Cape May	95,263	12,343	13%	14,837	16%	17,127	18%
Cumberland	154,152	15,535	10%	23,569	15%	25,201	16%
Essex	863,728	24,049	3%	87,443	10%	111,936	13%
Gloucester	302,294	6,727	2%	12,033	4%	13,131	4%
Hudson	724,854	80,353	11%	82,002	11%	101,770	14%
Hunterdon	128,947	355	0%	821	1%	822	1%
Mercer	387,340	18,041	5%	34,695	9%	35,022	9%
Middlesex	863,162	39,706	5%	52,115	6%	67,237	8%
Monmouth	643,615	17,721	3%	31,564	5%	42,071	7%
Morris	509,285	6,617	1%	10,018	2%	10,063	2%
Ocean	637,229	20,509	3%	29,945	5%	31,425	5%

County	Total Countywide Population	SFHA		BFE +3 ft		Coastal FHA	
		Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Population that is Disadvantaged
Passaic	524,118	26,596	5%	50,486	10%	51,749	10%
Salem	64,837	8,153	13%	13,120	20%	16,272	25%
Somerset	345,361	11,962	3%	17,831	5%	17,891	5%
Sussex	144,221	1,965	1%	2,420	2%	2,435	2%
Union	575,345	28,270	5%	76,941	13%	93,357	16%
Warren	109,632	2,830	3%	4,755	4%	4,794	4%
Total	**9,288,994**	**485,215**	**5%**	**774,800**	**8%**	**893,120**	**10%**

Source: United States 2020 Census; CDC/ATSDR Social Vulnerability Index; FEMA, 2023; NJDEP, 2022; Rutgers, 2023

Table 4.7-30 New Jersey Disadvantaged Communities (Overburdened Communities under the Environmental Justice Rule) within the SFHA, BFE +3ft and Coastal FHA

County	Total Countywide Population	SFHA		BFE +3 ft		Coastal FHA	
		Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Population that is Disadvantaged
Atlantic	274,534	54,313	20%	68,084	25%	70,842	7%
Bergen	955,732	91,911	10%	149,336	16%	158,562	7%
Burlington	461,860	25,104	5%	39,374	9%	41,481	7%
Camden	523,485	36,693	7%	58,526	11%	66,104	7%
Cape May	95,263	8,756	9%	11,109	12%	12,827	7%
Cumberland	154,152	13,562	9%	21,079	14%	22,955	7%
Essex	863,728	32,399	4%	109,988	13%	137,252	7%
Gloucester	302,294	7,771	3%	13,005	4%	14,492	7%
Hudson	724,854	184,675	25%	182,061	25%	211,832	7%
Hunterdon	128,947	183	0%	241	0%	249	7%
Mercer	387,340	26,206	7%	48,023	12%	48,379	7%
Middlesex	863,162	81,758	9%	123,075	14%	143,687	7%
Monmouth	643,615	19,164	3%	33,631	5%	43,464	7%
Morris	509,285	12,916	3%	19,099	4%	19,170	7%
Ocean	637,229	16,634	3%	27,980	4%	29,311	7%
Passaic	524,118	25,713	5%	48,946	9%	50,233	7%
Salem	64,837	8,527	13%	13,707	21%	16,951	7%
Somerset	345,361	24,424	7%	39,282	11%	39,724	7%
Sussex	144,221	2,015	1%	2,490	2%	2,505	7%
Union	575,345	37,135	6%	95,919	17%	112,652	7%
Warren	109,632	1,081	1%	1,793	2%	1,797	7%
Total	**9,288,994**	**710,940**	**8%**	**1,106,748**	**12%**	**1,244,469**	**7%**

Source: United States 2020 Census; NJDEP Overburdened Communities under the Environmental Justice Rule; FEMA, 2023; NJDEP, 2022; Rutgers, 2023

Tables 4.7-31 through 4.7-33 show the Disadvantaged Communities within Sea-level Rise of 2 ft, 3 ft and 5 ft. There are three tables for these flood scenarios; the first table using the White House Climate and Economic Justice Screening Tool data, the second using the CDC/ATSDR Social Vulnerability Index data, and the third using NJDEP Overburdened Communities under the Environmental Justice Rule data.

Table 4.7-31 New Jersey Disadvantaged Communities (per White House Climate and Economic Justice Screening Tool) within the Sea-level Rise of 2 ft, 3 ft and 5 ft

County	Total Countywide Population	SLR +2 ft		SLR +3 ft		SLR +5ft	
		Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Population that is Disadvantaged
Atlantic	274,534	16,957	6%	21,082	8%	37,284	14%
Bergen	955,732	4,411	0%	11,019	1%	11,535	1%
Burlington	461,860	2,824	1%	3,227	1%	4,616	1%
Camden	523,485	13,448	3%	15,754	3%	23,109	4%
Cape May	95,263	3,278	3%	4,581	5%	7,794	8%
Cumberland	154,152	3,336	2%	3,718	2%	4,649	3%
Essex	863,728	4,100	0%	5,621	1%	14,267	2%
Gloucester	302,294	2,067	1%	2,259	1%	2,982	1%
Hudson	724,854	13,949	2%	16,738	2%	26,204	4%
Hunterdon	128,947	0	0%	0	0%	0	0%
Mercer	387,340	5,029	1%	5,328	1%	6,332	2%
Middlesex	863,162	10,753	1%	11,713	1%	16,815	2%
Monmouth	643,615	1,952	0%	2,485	0%	4,904	1%
Morris	509,285	0	0%	0	0%	0	0%
Ocean	637,229	148	0%	190	0%	283	0%
Passaic	524,118	1,895	0%	1,974	0%	2,297	0%
Salem	64,837	2,589	4%	3,260	5%	4,931	8%
Somerset	345,361	3	0%	4	0%	6	0%
Sussex	144,221	0	0%	0	0%	0	0%
Union	575,345	4,607	1%	5,355	1%	9,561	2%
Warren	109,632	0	0%	0	0%	0	0%
Total	**9,288,994**	**91,346**	**1%**	**114,308**	**1%**	**177,569**	**2%**

Source: United States 2020 Census; White House Climate and Economic Justice Screening Tool; Rutgers, 2023

Table 4.7-32 New Jersey Disadvantaged Communities (per CDC/ATSDR Social Vulnerability Index) within the Sea-level Rise of 2 ft, 3 ft and 5 ft

County	Total Countywide Population	SLR +2 ft		SLR +3 ft		SLR +5ft	
		Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Population that is Disadvantaged
Atlantic	274,534	24,523	9%	28,937	11%	44,815	16%
Bergen	955,732	17,547	2%	37,766	4%	39,430	4%
Burlington	461,860	7,880	2%	8,702	2%	11,387	2%
Camden	523,485	15,727	3%	18,571	4%	27,401	5%
Cape May	95,263	4,808	5%	6,473	7%	10,510	11%
Cumberland	154,152	7,593	5%	8,336	5%	9,894	6%
Essex	863,728	4,159	0%	5,484	1%	13,599	2%
Gloucester	302,294	3,452	1%	3,748	1%	4,811	2%
Hudson	724,854	25,856	4%	29,726	4%	44,645	6%
Hunterdon	128,947	0	0%	0	0%	0	0%
Mercer	387,340	5,166	1%	5,466	1%	6,468	2%
Middlesex	863,162	11,695	1%	13,025	2%	18,037	2%

County	Total Countywide Population	SLR +2 ft		SLR +3 ft		SLR +5ft	
		Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Population that is Disadvantaged
Monmouth	643,615	3,926	1%	5,099	1%	9,130	1%
Morris	509,285	0	0%	0	0%	0	0%
Ocean	637,229	7,976	1%	8,296	1%	9,086	1%
Passaic	524,118	1,978	0%	2,056	0%	2,377	0%
Salem	64,837	5,986	9%	7,130	11%	9,698	15%
Somerset	345,361	0	0%	0	0%	0	0%
Sussex	144,221	0	0%	0	0%	0	0%
Union	575,345	4,935	1%	5,816	1%	9,968	2%
Warren	109,632	0	0%	0	0%	0	0%
Total	**9,288,994**	**153,207**	**2%**	**194,631**	**2%**	**271,256**	**3%**

Source: United States 2020 Census; CDC/ATSDR Social Vulnerability Index; Rutgers, 2023

Table 4.7-33 New Jersey Disadvantaged Communities (Overburdened Communities under the Environmental Justice Rule) within the Sea-level Rise of 2 ft, 3 ft and 5 ft

County	Total Countywide Population	SLR +2 ft		SLR +3 ft		SLR +5ft	
		Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Population that is Disadvantaged
Atlantic	274,534	18,671	7%	22,946	8%	40,167	15%
Bergen	955,732	26,163	3%	53,643	6%	58,727	6%
Burlington	461,860	10,234	2%	11,172	2%	14,388	3%
Camden	523,485	15,922	3%	18,627	4%	26,836	5%
Cape May	95,263	3,781	4%	5,149	5%	8,068	8%
Cumberland	154,152	7,015	5%	7,736	5%	9,460	6%
Essex	863,728	4,854	1%	6,450	1%	15,511	2%
Gloucester	302,294	3,487	1%	3,885	1%	4,976	2%
Hudson	724,854	40,531	6%	47,578	7%	90,561	12%
Hunterdon	128,947	0	0%	0	0%	0	0%
Mercer	387,340	5,197	1%	5,497	1%	6,507	2%
Middlesex	863,162	19,057	2%	21,524	2%	31,196	4%
Monmouth	643,615	4,387	1%	5,334	1%	9,908	2%
Morris	509,285	0	0%	0	0%	0	0%
Ocean	637,229	3,507	1%	4,054	1%	5,754	1%
Passaic	524,118	2,220	0%	2,307	0%	2,700	1%
Salem	64,837	5,957	9%	7,168	11%	9,848	15%
Somerset	345,361	24	0%	25	0%	34	0%
Sussex	144,221	0	0%	0	0%	0	0%
Union	575,345	4,975	1%	5,836	1%	10,693	2%
Warren	109,632	0	0%	0	0%	0	0%
Total	**9,288,994**	**175,982**	**2%**	**228,931**	**2%**	**345,334**	**4%**

Source: United States 2020 Census; NJDEP Overburdened Communities under the Environmental Justice Rule; Rutgers, 2023

Tables 4.7-34 through 4.7-36 show the Disadvantaged Communities within Storm Surge of 1 ft, 2 ft, 3 ft and 4 ft. There are three tables for these flood scenarios; the first table using the White House Climate and Economic Justice Screening Tool data, the second using the CDC/ATSDR Social Vulnerability Index data, and the third using NJDEP Overburdened Communities under the Environmental Justice Rule data.

Table 4.7-34 New Jersey Disadvantaged Communities (per White House Climate and Economic Justice Screening Tool) within the Storm Surge of 1 ft, 2 ft, 3 ft and 4 ft

County	Total Countywide Population	Storm Surge Category 1		Storm Surge Category 2		Storm Surge Category 3		Storm Surge Category 4	
		Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Population that is Disadvantaged
Atlantic	274,534	30,762	11%	34,907	13%	80,594	29%	121,689	44%
Bergen	955,732	654	0%	2,975	0%	14,071	1%	36,692	4%
Burlington	461,860	767	0%	961	0%	3,906	1%	8,365	2%
Camden	523,485	6,643	1%	16,295	3%	49,821	10%	92,705	18%
Cape May	95,263	8,093	8%	10,321	11%	31,119	33%	45,632	48%
Cumberland	154,152	3,152	2%	4,830	3%	13,297	9%	21,967	14%
Essex	863,728	19,443	2%	38,786	4%	121,805	14%	195,471	23%
Gloucester	302,294	1,012	0%	1,477	0%	5,574	2%	9,474	3%
Hudson	724,854	27,346	4%	41,050	6%	120,804	17%	186,271	26%
Hunterdon	128,947	0	0%	0	0%	0	0%	0	0%
Mercer	387,340	820	0%	1,465	0%	4,011	1%	6,439	2%
Middlesex	863,162	11,981	1%	18,984	2%	55,530	6%	86,101	10%
Monmouth	643,615	2,729	0%	9,560	1%	26,758	4%	49,894	8%
Morris	509,285	0	0%	0	0%	0	0%	0	0%
Ocean	637,229	144	0%	261	0%	1,562	0%	5,034	1%
Passaic	524,118	24	0%	48	0%	212	0%	3,746	1%
Salem	64,837	4,931	8%	7,534	12%	21,322	33%	30,359	47%
Somerset	345,361	1	0%	1	0%	8	0%	1,058	0%
Sussex	144,221	0	0%	0	0%	0	0%	0	0%
Union	575,345	15,487	3%	29,293	5%	94,873	16%	186,175	32%
Warren	109,632	0	0%	0	0%	0	0%	0	0%
Total	**9,288,994**	**133,989**	**1%**	**218,748**	**2%**	**645,267**	**7%**	**1,087,072**	**12%**

Source: United States 2020 Census; White House Climate and Economic Justice Screening Tool; NOAA, 2022

Table 4.7-35 New Jersey Disadvantaged Communities (per CDC/ATSDR Social Vulnerability Index) within the Storm Surge of 1 ft, 2 ft, 3 ft and 4 ft

County	Total Countywide Population	Storm Surge Category 1		Storm Surge Category 2		Storm Surge Category 3		Storm Surge Category 4	
		Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Countywide Population that is Disadvantaged	Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Population that is Disadvantaged
Atlantic	274,534	36,361	13%	42,813	16%	97,430	35%	153,700	56%
Bergen	955,732	4,216	0%	17,048	2%	57,372	6%	118,411	12%
Burlington	461,860	1,764	0%	2,566	1%	9,624	2%	20,483	4%
Camden	523,485	8,133	2%	18,937	4%	57,778	11%	105,669	20%

County	Total Countywide Population	Storm Surge Category 1		Storm Surge Category 2		Storm Surge Category 3		Storm Surge Category 4	
		Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Countywide Population that is Disadvantaged	Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Population that is Disadvantaged
Cape May	95,263	11,874	12%	15,079	16%	44,115	46%	65,465	69%
Cumberland	154,152	7,234	5%	9,711	6%	24,319	16%	39,760	26%
Essex	863,728	17,263	2%	34,271	4%	110,981	13%	181,472	21%
Gloucester	302,294	1,322	0%	1,974	1%	7,559	3%	13,627	5%
Hudson	724,854	47,484	7%	69,181	10%	202,528	28%	307,263	42%
Hunterdon	128,947	0	0%	0	0%	0	0%	0	0%
Mercer	387,340	820	0%	1,466	0%	4,013	1%	6,442	2%
Middlesex	863,162	20,597	2%	35,004	4%	104,085	12%	167,822	19%
Monmouth	643,615	7,922	1%	21,252	3%	60,555	9%	109,708	17%
Morris	509,285	0	0%	0	0%	0	0%	0	0%
Ocean	637,229	4,535	1%	5,322	1%	19,591	3%	34,417	5%
Passaic	524,118	24	0%	48	0%	212	0%	3,738	1%
Salem	64,837	8,938	14%	13,065	20%	37,493	58%	55,485	86%
Somerset	345,361	0	0%	9	0%	64	0%	2,049	1%
Sussex	144,221	0	0%	0	0%	0	0%	0	0%
Union	575,345	18,516	3%	37,541	7%	123,071	21%	241,342	42%
Warren	109,632	0	0%	0	0%	0	0%	0	0%
Total	**9,288,994**	**197,003**	**2%**	**325,287**	**4%**	**960,790**	**10%**	**1,626,853**	**18%**

Source: United States 2020 Census; CDC/ATSDR Social Vulnerability Index; NOAA, 2022

Table 4.7-36 New Jersey Disadvantaged Communities (Overburdened Communities under the Environmental Justice Rule) within the Storm Surge of 1 ft, 2 ft, 3 ft and 4 ft

County	Total Countywide Population	Storm Surge Category 1		Storm Surge Category 2		Storm Surge Category 3		Storm Surge Category 4	
		Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Countywide Population that is Disadvantaged
Atlantic	274,534	33,138	12%	38,634	14%	87,647	32%	137,298	50%
Bergen	955,732	10,079	1%	26,006	3%	88,912	9%	177,325	19%
Burlington	461,860	1,981	0%	2,606	1%	10,539	2%	22,303	5%
Camden	523,485	8,356	2%	18,301	3%	56,300	11%	102,891	20%
Cape May	95,263	8,795	9%	11,101	12%	33,919	36%	50,509	53%
Cumberland	154,152	7,036	5%	10,190	7%	25,778	17%	41,817	27%
Essex	863,728	19,461	2%	38,844	4%	123,349	14%	200,750	23%
Gloucester	302,294	2,330	1%	3,384	1%	11,280	4%	19,452	6%
Hudson	724,854	102,829	14%	137,330	19%	398,356	55%	578,118	80%
Hunterdon	128,947	0	0%	0	0%	0	0%	0	0%
Mercer	387,340	820	0%	1,467	0%	4,016	1%	6,446	2%
Middlesex	863,162	32,365	4%	51,741	6%	152,977	18%	239,800	28%
Monmouth	643,615	6,359	1%	18,276	3%	51,992	8%	94,680	15%
Morris	509,285	0	0%	0	0%	0	0%	0	0%
Ocean	637,229	2,686	0%	3,958	1%	13,972	2%	27,936	4%
Passaic	524,118	36	0%	68	0%	308	0%	4,513	1%
Salem	64,837	9,370	14%	13,303	21%	38,812	60%	57,980	89%

County	Total Countywide Population	Storm Surge Category 1		Storm Surge Category 2		Storm Surge Category 3		Storm Surge Category 4	
		Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Population that is Disadvantaged	Total Disadvantaged Population	% of Countywide Population that is Disadvantaged
Somerset	345,361	15	0%	128	0%	802	0%	3,909	1%
Sussex	144,221	0	0%	0	0%	0	0%	0	0%
Union	575,345	18,325	3%	37,180	6%	121,262	21%	238,417	41%
Warren	109,632	0	0%	0	0%	0	0%	0	0%
Total	**9,288,994**	**263,981**	**3%**	**412,517**	**4%**	**1,220,221**	**13%**	**2,004,144**	**22%**

Source: United States 2020 Census; NJDEP Overburdened Communities under the Environmental Justice Rule; NOAA, 2022

As noted earlier, the buildings exposed to the tsunami hazard cannot be determined at this time. The impact of the waves and the scouring associated with debris that may be carried in the water could be very damaging to structures located in the tsunami's path. Structures that would be most vulnerable are those located in the front line of tsunami impact and those that are structurally unsound.

The NFIP data is also a useful tool to determine areas vulnerable to flood and severe storm hazards for each jurisdiction. Table 4.7-37 summarizes the NFIP policies, claims, cumulative loss value, RL properties, and SRL properties in each county as of June 2023. Appendix Q summarizes this data at the community level. Cape May County has the highest number of RL properties in the State. Passaic County has the highest number of SRL properties in the State. See Section 7.0: Repetitive Loss Strategy for additional information.

Table 4.7-37 Status of NFIP Policies, Claims, and Repetitive Loss Statistics

County	Number of Policies	Number of Claims	Cumulative Loss Value*	Number RL Properties*	Number of SRL Properties*
Atlantic	23,307	14,350	$93,604,501	1,038	162
Bergen	10,277	2,059	$235,510,282	1,964	432
Burlington	3,015	1,263	$16,139,121	215	42
Camden	1,514	28,051	$3,316,706	112	11
Cape May	39,839	752	$193,966,766	2,804	514
Cumberland	430	5,791	$5,145,437	75	5
Essex	4,169	694	$70,759,066	566	138
Gloucester	867	5,300	$2,671,309	73	1
Hudson	22,314	1,544	$55,833,131	612	55
Hunterdon	810	2,423	$23,631,545	235	57
Mercer	1,662	5,040	$26,161,973	314	35
Middlesex	3,317	19,794	$84,973,827	689	164
Monmouth	19,962	9,278	$236,143,969	1,648	211
Morris	3,018	52,489	$127,088,235	1,071	403
Ocean	42,720	14,200	$228,361,400	1,882	221
Passaic	2,931	809	$246,485,683	1,790	817
Salem	1,448	6,284	$5,400,013	54	10
Somerset	2,059	191	$155,640,202	1,051	293
Sussex	221	7,186	$721,676	16	1
Union	4,472	1,234	$81,494,000	748	174
Warren	429	14,350	$27,894,382	271	74
Total	**188,781**	**199,557**	**$1,920,943,220**	**17,228**	**3,820**

** Number of RL and SRL properties consist of combined NFIP and FMA statistics*

Source: NFIP PIVOT Database 2023

Table 4.7-38 below shows a comparison in number of active NFIP policies in the state before and after Hurricane Isaias which struck New Jersey in August 2020, and Table 4.7-39 is a comparison of active NFIP policies before and after Hurricane Ida which impacted the state in September of 2021.

Table 4.7-38 Comparison of NFIP Policies Before and After Hurricane Isaias

Number of Policies		
On Date of Isaias	One Year After Isaias	Change
205,013	198,896	-6,117

Source: FEMA, 2023

Table 4.7-39 Comparison of NFIP Before and After Hurricane Ida

Number of Policies		
On Date of Ida	One Year After Ida	Change
198,515	198,310	-205

Source: FEMA, 2023

Ecosystems & Natural Assets

Beaches and Dunes

Flooding can result in the destruction of beaches and leveling of dunes by reducing their usable area and limiting their capacity to act as a natural barrier for inland communities and natural resources. Table 4.7-40 shows the impacted acreage of beaches and dunes in the state by flooding scenario.

Table 4.7-40 Total Area of Beaches and Dunes Impacted by Flooding by Scenario

Flood Hazard	Acres Impacted
SFHA	11,593
SFHA +3	5,869
Coastal SFHA +5	7,152
Storm Surge Category 1	7,840
Storm Surge Category 2	8,208
Storm Surge Category 3	3,653
Storm Surge Category 4	5,013
SLR 2	5,690
SLR 3	16,497
SLR 5	8,552

Source: HIFLD, 2006, 2007, 2012, 2014, 2017, 2018, 2019, 2020, 2021, 2022; NJOGIS, 2019, 2020; NJ TRANSIT, 2021; PANYNJ, 2023; USDOT, 2022; NOAA, 2022; University, 2023.; FEMA, 2023; NJDEP, 2022.

Water Resources

Flooding can damage surface waters by increasing sedimentation and bank erosion and by introducing hazardous materials and waterborne illnesses that may make their way into local potable water supplies.

Freshwater and Coastal Wetlands

Increased flooding and salinity in the State's wetland areas are projected to lead to a loss of 92% of brackish marshes, 32% of tidal swamps, and 6% of tidal fresh marshes in the Delaware Estuary by 2100. Additionally, flooding from sea level rise may result in the loss of some New Jersey tidal wetlands because they cannot gain elevation at a rate that equals the rate of sea-level rise. (NJDEP, NJ Scientific report on Climate change).

Forests and Vegetated Lands

Forests and vegetated lands reduce flooding by containing excess rainwater, decreasing the rate of run off, and preventing flash flooding of nearby channels. Where excess water cannot be contained by vegetated lands, riverine flooding can result in bank erosion and damage in low-lying areas. Flooding in areas with high groundwater levels can contribute to inundation of forests resulting in the creation of ghost forests. Inundation of vegetated lands can reduce their ability to contain floods over time and can damage crops which could negatively impact the agricultural industry.

In coastal areas, increasing sea level rise can accelerate beach and dune erosion leaving inland areas more susceptible to overland flooding from coastal storm surges. High groundwater levels can also contribute to stormwater flooding. If local conditions cannot accommodate intense precipitation through a combination of infiltration and surface runoff, water may accumulate and cause flooding problems.