5.4.3 FLOOD

This section provides a profile and vulnerability assessment for the flood hazard.

HAZARD PROFILE

This section provides profile information including description, location, extent, previous occurrences and losses and the probability of future occurrences.

Description

Floods are one of the most common natural hazards in the U.S. 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) (Federal Emergency Management Agency [FEMA], 2010). Most communities in the U.S. have experienced some kind of flooding, after spring rains, heavy thunderstorms, coastal storms, or winter snow thaws (George Washington University, 2001). Floods have been and continue to be the most frequent, destructive, and costly natural hazard in the State of New Jersey. The large majority of the State's damage reported for major disasters is associated with flooding (NJOEM, 2011). There are a number of flood categories in the U.S., which include:

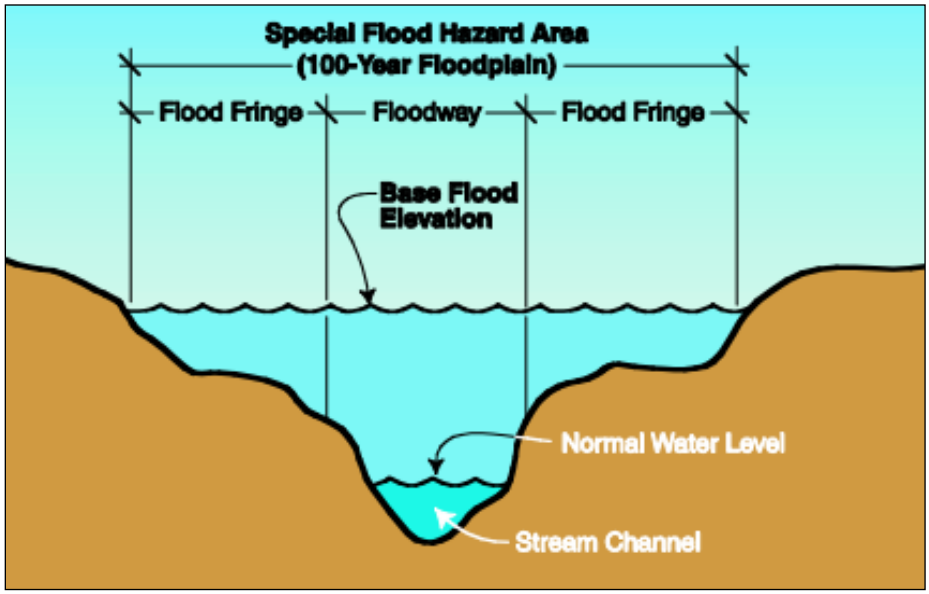
- Riverine flooding, including overflow from a river channel, flash, alluvial fan, ice-jam, and dam breaks
- Local drainage or high groundwater levels
- Fluctuating lake levels
- Coastal flooding, including storm surges
- Debris flow (NJOEM, 2011)

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. A 100-year floodplain is not the flood that will occur once every 100 years, rather it is the flood that has a one-percent chance of being equaled or exceeded each year. Thus, the 100-year flood could occur more than once in a relatively short period of time. With this term being misleading, FEMA has properly defined it as the one-percent annual chance flood. This one percent annual chance flood is now the standard used by most Federal and State agencies and by the National Flood Insurance Program (NFIP) (FEMA, 2003).

One hundred-year floodplains (or 1% annual chance floodplain) can be described as a bag of 100 marbles, with 99 clear marbles and one black marble. Every time a marble is pulled out from the bag, and it is the black marble, it represents a 100-year flood event. The marble is then placed back into the bag and shaken up again before another marble is drawn. It is possible that the black marble can be picked one out of two or three times in a row, demonstrating that a 100-year flood event could occur several times in a row (Interagency Floodplain Management Review Committee, 1994).

Figure 5.4.3-1 depicts the special flood hazard area, the flood fringe, base flood elevation, and the floodway areas of a floodplain.

Figure 5.4.3-1. Floodplain



Source: NJOEM, 2011

Many floods fall into three categories: riverine, coastal and shallow (FEMA, 2005). Other types of floods may include ice-jam floods, alluvial fan floods, dam failure floods, and floods associated with local drainage or high groundwater (as indicated in the previous flood definition). For the purpose of this HMP and as deemed appropriate by the County, riverine/flash, dam failure and ice jam flooding are the main flood types of concern for the Planning Area. These types of flood or further discussed below.

Riverine/Flash Floods – Riverine floods are the most common flood type and 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, 2005; FEMA, 2008).

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" (NWS, 2009).

Ice-Jam Floods – 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 snow melt. 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 (NESEC, Date Unknown; FEMA, 2008).

There are two different types of ice jams: freeze-up and breakup. Freeze-up jams occur when floating ice may slow or stop due to a change in water slope as it reaches an obstruction to movement. Breakup jams occur during periods of thaw, generally in late winter and early spring. The ice cover

breakup is usually associated with a rapid increase in runoff and corresponding river discharge due to a heavy rainfall, snowmelt or warmer temperatures (USACE, 2002).

Dam Failure Floods – A dam is an artificial barrier that has the ability to impound water, wastewater, or any liquid-borne material for the purpose of storage or control of water (FEMA, 2010). Dams are man-made structures built across a stream or river that impound water and reduce the flow downstream (FEMA, 2003). They are built for the purpose of power production, agriculture, water supply, recreation, and flood protection. Dam failure is any malfunction or abnormality outside of the design that adversely affect a dam's primary function of impounding water (FEMA, 2011). Dams can fail for one or a combination of the following reasons:

- Overtopping caused by floods that exceed the capacity of the dam (inadequate spillway capacity);
- Prolonged periods of rainfall and flooding;
- Deliberate acts of sabotage (terrorism);
- Structural failure of materials used in dam construction;
- Movement and/or failure of the foundation supporting the dam;
- Settlement and cracking of concrete or embankment dams;
- Piping and internal erosion of soil in embankment dams;
- Inadequate or negligent operation, maintenance and upkeep;
- Failure of upstream dams on the same waterway; or
- Earthquake (liquefaction / landslides) (FEMA, 2010).

Extent

In the case of riverine or flash flooding, 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. One element is the size of rivers and streams in an area; but an equally important factor is the land's absorbency. When it rains, soil acts as a sponge. When the land is saturated or frozen, infiltration into the ground slows and any more water that accumulates must flow as runoff (Harris, 2001).

Flood severity from a dam failure can be measured with a low, medium or high severity, which are further defined as follows:

- Low severity - No buildings are washed off their foundations; structures are exposed to depths of less than 10 feet.
- Medium severity - Homes are destroyed but trees or mangled homes remain for people to seek refuge in or on; structures are exposed to depths of more than 10 feet.

- High severity - Floodwaters sweep the area clean and nothing remains. Locations are flooded by the near instantaneous failure of a concrete dam, or an earthfill dam that turns into "jello" and washes out in seconds rather than minutes or hours. In addition, the flooding caused by the dam failure sweeps the area clean and little or no evidence of the prior human habitation remains after the floodwater recedes (Graham, 1999).

Two factors which influence the potential severity of a full or partial dam failure include (1) The amount of water impounded; and (2) The density, type, and value of development and infrastructure located downstream (City of Sacramento Development Service Department, 2005).

Location

Floods can occur almost anywhere in the State of New Jersey, although they tend to occur in and around areas near existing bodies of water, such as rivers, streams, and the Atlantic Ocean. According to FEMA Flood Insurance Studies (FISs) and Flood Insurance Rate Maps (FIRMs), the most damaging floods affecting developed areas occur in the northern half of the State. This is due to the number of physiographic and physical features of the landscape. Greater geographic relief in this part of the State results in flowing water moving down steeper gradients, naturally or artificially channelized through valleys and gullies. Development patterns have resulted in denser development in North Jersey, and proximity to New York City boosts property values and thus damage dollar totals. Extensive development also leaves less natural surface available to absorb rainwater, forcing water directly into streams and rivers, swelling them more than when more natural surface existed. Since the Delaware, Raritan and Passaic Rivers drain more than 90% of the northern counties in the State, these rivers and their tributaries are common locations for flooding (NJOEM, 2011).

Based on historic events, NFIP records and analysis engineering data about floodplains (FEMA FIRM, DFIRM and Q3 data), it is evident that New Jersey is one of the most flood prone states in the U.S.

Please refer to Section 4 (County Profile) for detailed information regarding the river basins and the hydrography/hydrology of Somerset County.

Passaic River Basin (PRB)

The PRB, shown in Figure 5.4.3-2 below, has been recognized by hydrologic experts as one of the most flood-prone river systems in the U.S, and at risk of frequent flooding due to its topography and heavy development within the floodplain.

Figure 5.4.3-2. Passaic River Basin

Source: Musser, 2007
Note: The black circle indicates where the PRB lies within Somerset County.

The amount and character of flooding within the PRB varies within the three main regions of the basin: (1) the Highlands, (2) the Central Basin and (3) the Lower Valley (Passaic River Coalition, Date Unknown). Flood damage tends to be the greatest in the Central section of the PRB because of extensive development in the flood plains; the amount of lowlands, swamps and flood-prone meadows; and the flat stream slopes (Philips and Schopp, 1986). The north-northeastern section of Somerset County falls within the Central Basin region, including the Townships of Bernards, Bridgewater and Warren, and the Boroughs of Bernardsville and Far Hills (a total of 37.5 square miles) (NJDWSC, 2010; NJDWSC, 2002).

Raritan River Basin (RRB)

A majority of Somerset County lies within the RRB as identified in Figure 5.4.3-3, which includes 16 major watersheds. The NJDEP has aggregated these watersheds into three Watershed Management Areas (WMAs), identified as the Upper Raritan (North and South Branch Raritan) WMA (WMA 8), the Lower Raritan WMA (WMA 9) and the Millstone WMA (WMA 10) [New Jersey Water Supply Authority (NJWSA), 2010]. The floodplains of the streams and tributaries within the RRB typically inundate portions of nineteen municipalities within Somerset County (ANC, 1972-1975).

Figure 5.4.3-3. Raritan River Basin

Source: Musser, 2007
Note: The black circle within New Jersey indicates the approximate location Somerset County.

Within the RRB, four major rivers conjoin together within Somerset County, including the Raritan River, North and South Branch Raritan (branches of Raritan River) and the Millstone River (New Jersey Water Supply Authority, 2002). As indicated by the Somerset County Road Division, low-lying areas of Somerset County that are adjacent to the Raritan and Millstone Rivers, are found in the Boroughs of Manville and Bound Brook, and the Township of Hillsborough (Somerset County Road Division, Date Unknown).

The RRB has persistent flooding problems when excessive rain from storms affects the river basin. Flooding is exacerbated throughout the communities that lie within the floodplains of the RRB as a result of increased improper development and utilization by man within those floodplains (or designated flood hazard areas) through the years (ANC, 1972-1975). Flooding problems within those municipalities of the County that lies within the RRB primarily originate from the Raritan and Millstone Rivers. According to the 2007 FEMA FIS for Somerset County, the North and South Branches of the Raritan River and Millstone River all have extensive flat floodplains up to 2,000 feet wide. Flood waters cover these floodplains several times a decade (FEMA, 2007).

As indicated through a variety of sources, severe flooding has been known to create damage and losses throughout almost all municipalities within the RRB after prolonged heavy rainfall events, particularly from the floodwaters that originate from the Raritan River. However, other areas of particular flood concern that lie within the RRB include, but are not limited to, the Borough of Bound Brook located partially within the Green Brook Basin (GBB) and the Borough of Manville located within the Millstone River Basin (MRB). These two locations are further discussed throughout this profile. Other towns in the Basin also experience flooding to a lesser degree.

Green Brook Basin (GBB / Watershed)

The GBB is located within the RRB in north-central New Jersey and drains approximately 65 square miles of primarily urban and industrialized area. Communities within Somerset County that fall within or partially within this basin include the Townships of Bridgewater, Green Brook, and Warren and the Boroughs of Bound Brook, South Bound Brook, North Plainfield and Watchung. Flooding has been a longstanding problem in this basin, particularly in Borough of Bound Brook and Townships of Bridgewater and North Plainfield (USACE, Date Unknown). Bound Brook Borough has experienced the most damaging floods of record resulting from the August 2, 1973 storm, Tropical Storm Floyd on September 16, 1999 and April 14-16, 2007 Nor'Easter.

To address the ongoing flooding problems within the communities of this basin, the USACE proposed the Green Brook Flood Control Project. The overall project area will encompasses the 65 square-mile GBB as well as short reaches of the Raritan River itself and its Middle Brook tributary. The entire project area includes thirteen municipalities in three counties, consisting of the Boroughs of Dunellen, Middlesex, and South Plainfield, and the Township of Piscataway in Middlesex County; the Boroughs of Bound Brook, North Plainfield, and Watchung, and the Townships of Green Brook and Bridgewater in Somerset County; and the Borough of Fanwood, the Townships of Scotch Plains and Berkeley Heights, and the City of Plainfield in Union County.

NJDEP has partnered with the New York District of the Army Corps of Engineers (USACE) and Somerset and Middlesex Counties to build the Green Brook Flood Control Project. The project is supported by the 13 impacted communities and the Green Brook Flood Control Commission. The Bound Brook portion of the project is at the lower end of the Green Brook basin and has been the focus of the design and the construction. The structural elements of the Bound Brook Flood Works will be certifiable by FEMA and will provide a 150 year level of protection. The construction of the Bound Brook Flood Works was started in 1999 and was scheduled to be completed in 2012 (NJDEP, 2013; USACE, 2005).

Millstone River Basin (MRB)

From its headwaters near Millstone Township in Monmouth County, the Millstone River flows northward to its confluence with the Raritan River at the Borough of Manville. In Somerset County, the Towns of Hillsborough, Montgomery and Franklin and the Borough of Manville, Millstone and Rocky Hill fall within the MRB. Flooding in the MRB occurs as the result of intense thunderstorms, Nor'Easters, and hurricanes. Coincident and backwater flooding also occurs in association with the Raritan River. The Borough of Manville, located at the confluence of the Millstone and the Raritan Rivers, is flooded by both rivers (USACE, 2013).

As indicated in a 2000 USACE reconnaissance study, the most significant flooding problems in the MRB are in the Borough of Manville. Manville has the distinction of being the location where the slow moving Raritan River (which passes to the north) and the tributary Millstone River (which passes to the east) join together, in the far northeastern corner of the Borough. Severe flooding occurs in Manville when these rivers overflow their banks into the northern section (Raritan) and the Lost Valley section (Millstone). The southern parts of Main Street also suffer from flooding, due to the presence of a stream that backs up with water from the nearby Millstone River in which it empties, known as Royce Brook. Floodplains from each of these rivers can combine and isolate a central portion of the Borough of Manville, if flooding conditions become severe enough (USACE, 2000).

As of April 27, 2006, a summary of flood conditions up to April 2006 and preliminary flood control alternatives/measures within the Manville area was prepared from this *Flood Damage Reduction and Ecosystem Restoration Study*. This summary mapped the floodplains of Manville, and identified the flood water reaches within Manville. In December, 2012, USACE New York District approved a Review Plan

for the MRB Flood Risk Management Feasibility Report, with the purpose of obtaining Congressional Authority for constructing the recommended plan (USACE, 2012).

Also, a December 2004 "*Millstone River Watershed Flood Damage and Mitigation Analysis Report"* was prepared by the USDA NRCS and provides additional information on flood locations within Somerset County. The NRCS report indicated that many flood events occurred within the MRB, and identified all the historical flood damage locations throughout the MRB. Although Manville appears to have experienced the most overall damages, Millstone Borough has reportedly had the greatest historical damages of any municipality on a per structure basis (NRCS, 2004). Those locations throughout Somerset County are identified in Table 5.4.3-1.

Table 5.4.3-1. Somerset County Historical Flood Damage Locations through 2004 in MRB

Township	Location / Flood Frequency
Franklin Township	• Blackwell Mills Road at Millstone River (annual flood frequency) • Griggstown Road at Millstone River (annual flood frequency) • Route 518 at Millstone River (annual flood frequency) • Zarephath (Alma White College) [floods during Hurricane Floyd (and other hurricane events)] • Route 27 at Millstone River (Kingston) (floods during Hurricane Floyd)
Hillsborough Township	• Dukes Parkway East. at Kimberly Dr. at Raritan River (floods during Hurricane Floyd) • Millstone River Road north of Millstone Borough (floods during Hurricane Floyd)
Manville Borough	• Severe and frequent flood damages, primarily within the "Lost Valley" section of the Borough. (Floods during a large storm event)
Millstone Borough	• Residential and commercial areas adjacent to Millstone River experience flooding during a large storm event.
Montgomery Township	• Griggstown Causeway (annual flood frequency) • Montgomery Sewer Plant (floods during Hurricane Floyd) • Cruser Brook at Route 601 • Bedens Brook at Route 518 • Pike Brook at River Road • Cruser Brook at Route 206

Source: NRCS, 2004

This 2004 NRCS report concluded that, with the exception of Manville and, to some extent, Millstone Borough, flooding is not a major problem throughout the Millstone watershed. Frequently flooded areas include low lying roads such as South Middlebush Road (County Route 615), Griggstown Causeway and Blackwells Mills Causeway. The frequent flooding of these roadways causes major traffic problems several times a year (NCDC, 2004).

FEMA Flood Hazard Areas

According to FEMA, flood hazard areas are defined as areas that are shown to be inundated by a flood of a given magnitude on a map. These areas are determined using statistical analyses of records of riverflow, storm tides, and rainfall; information obtained through consultation with the community; floodplain topographic surveys; and hydrologic and hydraulic analyses. Flood hazard areas are delineated on FEMA's Flood Insurance Rate Maps (FIRM), which are official maps of a community on which the Federal Insurance and Mitigation Administration has indicated both the Special Flood Hazard Areas (SFHA) and the risk premium zones applicable to the community. These maps identify the SFHAs; the location of a specific property in relation to the SFHA; the base (100-year) flood elevation (BFE) at a specific site; the magnitude of a flood hazard in a specific area; the undeveloped coastal barriers where flood insurance is not available and locates regulatory floodways and floodplain boundaries (100-year and 500-year floodplain boundaries) (FEMA, 2003; FEMA, 2005; FEMA, 2008).

The land area covered by the floodwaters of the base flood is the SFHA on a FIRM. It is the area where the National Flood Insurance Programs (NFIP) floodplain management regulations must be enforced and the area where the mandatory purchase of flood insurance applies. The SFHA includes Zones A, AO, AH, A1-30, AE, A99, AR, AR/A1-30, AR/AE, AR/AO, AR/AH, AR/A, VO, V1-30, VE, and V. (FEMA, 2007). This regulatory boundary is a convenient tool for assessing vulnerability and risk in flood-prone communities since many communities have maps showing the extent of the base flood and likely depths that will be experienced. The base flood is often referred to as the "100-year" flood designation (or 1% annual chance event). The BFE on a FIRM is the elevation of a base flood event, or a flood which has a 1-percent chance of occurring in any given year as defined by the NFIP. The BFE describes the exact elevation of the water that will result from a given discharge level, which is one of the most important factors used in estimating the potential damage to occur in a given area. A structure located within a 1% (100-year) floodplain has a 26-percent chance of suffering flood damage during the term of a 30-year mortgage. The 100-year flood is a regulatory standard used by Federal agencies and most states, to administer floodplain management programs. The 1% (100-year) annual chance flood is used by the NFIP as the basis for insurance requirements nationwide. FIRMs also depict 500-year flood designations, which is a boundary of the flood that has a 0.2-percent chance of being equaled or exceeded in any given year (FEMA, 2003; FEMA, 2005).

It is important to recognize, however, that flood events and flood risk is not limited to the NFIP delineated flood hazard areas. See Section 4 (County Profile) for information regarding the SFHA updates within Somerset County.

Flood Insurance Study (FIS)

In addition to FIRM and DFIRMs, FEMA also provides FISs for entire counties and individual jurisdictions. These studies aid in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. They are narrative reports of countywide flood hazards, including descriptions of the flood areas studied and the engineered methods used, principal flood problems, flood protection measures and graphic profiles of the flood sources (FEMA, Date Unknown).

A countywide FIS for Somerset County has been completed and is dated September 28, 2007. According to the FIS, the County lies within a storm belt and has a history of flooding that has been experienced during all times of the year. Flooding is less frequent during the winter months. Extensive flooding has occurred in late summer and fall. Rainfall in the County is usually heaviest in late summer and fall. Much of the summer rainfall comes as thunderstorms and rainfall totals are greatly affected by the Watchung Mountain ranges.

The following discussion presents flood information as directly provided in the FEMA FIS document(s).

The 2007 FIS discussed the principal flood problems throughout the County.

- Township of Bernards – Harrison Brook and its tributary system causes the largest amount of flood damage in the Township. The Green Brook, lower Passaic River and the lower Dead River are also causes of flooding which have wide floodplains due to flat topography in the over bank areas.

- Borough of Bernardsville – The North Branch of the Raritan River floods from the Borough of Far Hills. The most severe flooding problems in Bernardsville occur along Mine Brook and Tributary MB, U.S Route 202 and Mill Street along Mine Brook and Thompson Road, and

Claremont Road along Tributary F, with the greatest inundation occurring from its mouth upstream to Douglass Road. Tributary I floods from is confluence with Mine Brook upstream for approximately 0.5 miles. The Passaic River floods from the Township of Bernards to the Morris County boundary. Flooding along Indian Grave Brook occurs from its mouth upstream to approximately 0.3 miles below Jockey Hollow Road.

- Borough of Bound Brook – Flooding from the Bound Brook occurs from four major sources. The Raritan River floods the low-lying areas along its banks. During Hurricane Floyd, the Borough was under 10 feet of water in some locations. During Tropical Storm Doria, floodwaters covered Main Street with over four feet of water. The Middle Brook flows along the Borough's western border; however, it does not have a history of flooding. On the lower portion of the Middle Brook, Tropical Storm Doria caused major flood damage.

- Township of Bridgewater – The Township has experienced most of their flooding along the Raritan River. Low-lying areas beyond the Raritan River Power Canal are subject to damaging floods. Substantial flooding occurred in these areas during the storm of August 1971. When the flow of the River is high, the smaller streams have no outlets, which cause them to overflow and inundate low-lying areas.

- Township of Franklin – The towpath of the Delaware and Raritan Canal along the Millstone River somewhat limits flooding until the towpath is overtopped. The floodplain of the Raritan River, which is narrower than the Millstone River, also borders the Canal and restricts flood flows until the towpath is overtopped.

- Green Brook – In the Townships of Green Brook and Bridgewater and the Borough of Bound Brook, flood damages in the Green Brook drainage basin are more numerous and severe than in other places in the Raritan River Basin. At some locations, flooding conditions have been so bad that buildings have been constructed over the top of the stream and the floodplains have been virtually eliminated. Flooding on Green Brook has been described as producing severe flood conditions due to the high intensity of rainfall for a short duration. Along most of the Brook's length in the Borough of North Plainfield, it is contained within its banks during periods of high flow. However, there is flooding along Parkview Avenue in the vicinity of Green Brook Park, just downstream of the confluence with Stony Brook. Flooding can occur from storm sewers and very small streams that frequently get backed up. When the Raritan River and Green Brook flood, flows on the small streams have no place to outlet and can overflow into low-lying areas.

- Township of Green Brook – The most severe storm recorded for the Township occurred on September 16, 1999 (Tropical Storm Floyd). All streams in the Township overflowed their banks during this storm and caused record high damages to residential and commercial properties. The majority of flooding of the Municipal Brook in the Township occurs upstream of Green Brook Road. Backwater from Green Brook, caused by floods with frequencies greater than 10 years, inundates Municipal Brook Valley.

- Borough of North Plainfield – Most flood damage in the Borough is caused by Stony Brook due to its steep slope through a gorge in the Watchung Mountains; the high velocities on Stony Brook tend to cause flash floods. The floodwaters from Stony Brook come off the mountains and inundate Route 22, overflow the Crab Brook drainage divide and then re-enter Stony Brook near Green Brook Road and Grove Street. In the Township of Green Brook and the Borough, the channel bottom slope of Stony Brook, combined with steep valley walls, severely limits accessibility and the amount of possible building. The width of the floodplain in this area averages 100 feet.

- Borough of Peapack-Gladstone – In the Borough, inundation along the North Branch Raritan River is the most severe from the Borough's corporate limits upstream for approximately 1.3 miles. There is widespread flooding along Peapack Brook and the lower portion of Tributary C. Downstream of Park Avenue, the 100-year flood inundates an area behind the Erie-Lakawanna Railroad, where it forms a pocket. The only location where flood waters can flow back into the stream is the culvert at Tributary D. The North and South Branches of the Raritan River and the Millstone River all have extensive, flat floodplains up to 2,000 feet wide. Floodwaters cover these floodplains several times within a 10-year period.

- Borough of Rocky Hill – The low-lying areas in the Borough along the Millstone River and Van Horn Brook are subject to flooding caused by the overflow of these waterbodies. Little damage has been caused due to the wooded nature of the floodplains areas.

- Borough of Somerville – Major flooding in this Borough is caused by the Raritan River and its backwater affecting Peters Brook. Most of the areas subject to flooding in the Borough are parklands located along the streams, cemeteries or vacant lands.

- Borough of South Bound Brook - The Borough has experienced most of their flooding along the Raritan River. Low-lying areas beyond the Raritan River Power Canal are subject to damaging floods. Substantial flooding occurred in these areas during the storm of August 1971. When the flow of the River is high, the smaller streams have no outlets, which cause them to overflow and inundate low-lying areas.

- Township of Warren – Due to its steep channel and high slope banks, Dock Watch Hollow Branch does not have much of a flooding issue except in the vicinity and upstream of Blazier Road. Here, the slope of the stream is milder and the overbank flatter. Dock Watch Hollow Brook Branch experienced flooding conditions in the vicinity of the most upstream Ferguson Road crossing.

NJDEP Bureau of Dam Safety and Flood Control

A list of State Flood Hazard Area delineations were prepared by the NJDEP on May 15, 2002 for every Township and County in the State. Flood Hazard Areas from this source within Somerset County are listed in Table 5.4.3-2. This was the most current list made available by the Bureau. However, according to Somerset County Officials; inaccuracies do exist and not all current flood hazard areas for the County were identified. Additions were made to the Table in accordance with information provided by the County (Somerset County HMP, 2008).

Table 5.4.3-2. New Jersey State Studied Streams in Somerset County

Jurisdiction	River/Stream	Reach Studied
Bedminster Township	Chambers Brook	Downstream of the Head of Echo Lake
	Clucas Brook	Downstream of County Route 523
	Herzog Brook	Downstream of County Route 512
	Hoopstick Brook	Downstream of County Route 523
	Lamington River	Entire Reach
	Middle Brook	Downstream of a point located 50 ft. upstream of Spook Hollow Road
	N. Branch Raritan River	Entire Reach
	Peapack Brook	Entire Reach
Bernards Township	Dead River	Downstream of a point located 300 ft. downstream of Interstate Highway 287
	Harrison Brook	Downstream of a point located 80 ft. upstream of South Alward

Jurisdiction	River/Stream	Reach Studied
		Avenue
	Harrison Brook Branch 2	Downstream of a point located 250 ft. downstream of Debra Lane
	Passaic River	Entire Reach
Bernardsville Borough	Indian Grave Brook	Entire Reach
	Indian Grave Brook (Trib. K)	Downstream of a point located 100 ft. downstream of Washington Corner Road
	N. Branch Raritan River	Entire Reach
	Passaic River	Entire Reach
Bound Brook Borough	Green Brook	Entire Reach
	Raritan River	Entire Reach
Branchburg Township	Holland Brook	Entire Reach
	Lamington River	Entire Reach
	N. Branch Raritan River	Entire Reach
	S. Branch Raritan River	Entire Reach
Bridgewater Township	Chambers Brook	Downstream of the Head of Echo Lake
	Green Brook	Entire Reach
	N. Branch Raritan River	Entire Reach
	Raritan River	Entire Reach
Far Hills Borough	N. Branch Raritan River	Entire Reach
Franklin Township	Millstone River	Entire Reach
	Raritan River	Entire Reach
Green Brook Township	Green Brook	Entire Reach
	Stony Brook	Entire Reach
Hillsborough Township	Millstone River	Entire Reach
	Raritan River	Entire Reach
	S. Branch Raritan River	Entire Reach
	Neschanic River	Entire Reach
Manville Borough	Millstone River	Entire Reach
	Raritan River	Entire Reach
Millstone Borough	Millstone River	Entire Reach
Montgomery Township	Bedens Brook	Entire Reach
	Cruser Brook	Downstream of Belle Mead-Blawenburg Road
	Millstone River	Entire Reach
	Pike Run	Entire Reach
	Rock Brook	Downstream of Camp Meeting Avenue
	Van Horn Brook	Entire Reach
North Plainfield Borough	Green Brook	Entire Reach
	Stony Brook	Entire Reach
Peapack and Gladstone Borough	N. Branch Raritan River	Entire Reach
Rocky Hill Borough	Millstone River	Entire Reach
	Van Horn Brook	Entire Reach
Somerville Borough	Macs Brook	Entire Reach
	Peters Brook	Entire Reach
	Raritan River	Entire Reach
	Ross Brook	Downstream of U.S. Highway 22
South Bound Brook Borough	Raritan River	Entire Reach
Warren Township	Cory's Brook	Downstream of a point located 1250 ft. upstream of Powder Horn Drive
	Dead River	Entire Reach
	Passaic River	Entire Reach
Watchung Borough	Green Brook	Downstream of a point located 1660 ft. upstream of Apple Tree Road
	Stony Brook	Entire Reach

Jurisdiction	River/Stream	Reach Studied
	Stony Brook (E. Branch)	Downstream of a point located 2240 ft. upstream of Valley Drive
	Stony Brook (W. Branch)	Entire Reach
	Stony Brook (W. Branch Trib.)	Downstream of a point located 360 ft upstream of Carrar Drive

Source: NJDEP, 2002

Note: NJDEP indicated that these sources are for informational purposes only and do not necessarily list all New Jersey State Studied Streams. Not all portions of a stream reach listed in the municipality are studied and not all municipalities are necessarily mentioned for each county.

* Provided by Somerset County

Additional Flood-Prone Areas in Somerset County

Additional flood prone areas in Somerset County include the following:

- *Township of Branchburg* – There are three major sources of flooding in the Township. These sources include the Lamington River, the North Branch Raritan River and the South Branch Raritan River. Most floodplain areas in the Township consist of farm fields, open space or natural vegetation, except for the hamlet of North Branch which receives flood waters from the North Branch Raritan River. Flooding within this location has been severe with a depth of approximately five feet above the first floor in some homes and depths of more than three feet above the first flood in several homes and businesses.

- *Township of Bernards* - The three major flooding sources in Bernard Township are Harrison Brook, Dead River and Passaic River. It was indicated that the primary cause of flood damage in the Town is from the flooding of Harrison Brook, particularly along Newell Drive. This waterway flows through the most developed portions of the Town and thus impacts the greatest number of residents.

- *Township of Franklin* – Areas of flooding in the Township include Blackwell Mills Road at the Millstone River, Griggstown Road at Millstone River, Route 518 at Millstone River, Zarephath (Alma White College), and Route 27 at Millstone River. Other areas that have experienced flood damages include East Millstone and Griggstown Lock/Little Valley vicinity.

- *Township of Hillsborough* – Areas of flooding in the Township include: Dukes Parkway East at Kimberly Drive at Raritan River, and Millstone River Road north of Millstone Borough.

- *Borough of Manville* – The Borough has the most significant flooding problems in the Millstone River Basin. It is located where the Raritan River and the tributary to the Millstone River join together in the northeast corner of the Borough. Severe flooding occurs in the Borough where these rivers overflow their banks into the northern section (Raritan) and the Lost Valley section (Millstone). The southern part of Main Street also suffers from flooding due to the presence of Royce Brook, which backs up with water from the Millstone River. Floodplains from each of these rivers can combine and isolate a central portion of the Borough if flooding conditions become severe enough.

- *Borough of Millstone* – Areas of flooding in the Borough include the residential and commercial areas adjacent to the Millstone River. These areas experience flooding during large storm events.

- *Township of Montgomery* – Areas of flooding in the Township include: Griggstown Causeway, Montgomery Sewer Plant, Cruser Brook at Route 601, Bedens Brook at Route 518, Pike Brook at River Road and Cruser Brook at Route 206 (Somerset County HMP, 2008).

Ice Jam Hazard Areas

The Ice Jam Database, maintained by the Ice Engineering Group at the USACE Cold Regions Research and Engineering Laboratory (CRREL), currently consists of over 18,000 records from across the U.S. According to the USACE-CRREL, Somerset County experienced 12 historic ice jam events between 1780 and 2013 (Ice Engineering Research Group, 2012). Historical events are further mentioned in the "Previous Occurrences" section of this hazard profile.

Dam Break Hazard Area

Dams are classified in terms of potential for downstream damage if the dam were to fail. These hazard classifications are identified and defined below:

- *Low Hazard (Class A)* is a dam located in an area where failure will damage nothing more than isolated buildings, undeveloped lands, or township or county roads and/or will cause no significant economic loss or serious environmental damage. Failure or mis-operation would result in no probable loss of human life. Losses are principally limited to the owner's property
- *Intermediate Hazard (Class B)* is a dam located in an area where failure may damage isolated homes, main highways, minor railroads, interrupt the use of relatively important public utilities, and/or will cause significant economic loss or serious environmental damage. Failure or mis-operation would result in no probable loss of human life, but can cause economic loss, environment damage, disruption of lifeline facilities, or impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.
- *High Hazard (Class C)* is a dam located in an area where failure may cause loss of human life, serious damage to homes, industrial or commercial buildings, important public utilities, main highways or railroads and/or will cause extensive economic loss. This is a downstream hazard classification for dams in which more than 6 lives would be in jeopardy and excessive economic loss (urban area including extensive community, industry, agriculture, or outstanding natural resources) would occur as a direct result of dam failure (NYSDEC, Date Unknown).

Refer to Figure 4-23 in the County Profile (Section 4) for dams located in Somerset County. Below are descriptions of high-hazard potential dams in the County that have experienced historical dam flooding.

Table 5.4.3-3. High Hazard Dams in Somerset County

PDP ID	Dam Name	Dam Type	Location	Dam Height (ft.)	Dam Storage (acre-feet)	Dam Hazard Classification
NJ00372	West Branch Reservoir Dam	Earth Gravity	Bridgewater Township	39	465	High
NJ00373	East Branch Reservoir Dam	Concrete	Bridgewater Township	32	77	High
NJ00767	Watchung Lake Dam	Earth Gravity	Watchung Borough	19	175	High
NJ00362	Ravine Lake Dam	Rockfill Masonry	Peapack Borough	45	320	High

Source: NPDP Multi-Attribute Dams Directory Query Summary, Date Unknown.

Additional concern to Somerset County is the potential for flash flooding in the event that the Spruce Run and Round Valley dams in Hunterdon County were to fail, which would particularly impact the communities located along the North and South Branch Raritan Rivers in Somerset County. The Spruce

Run Dam is a 6,000 foot long earthen dam impounding 11-billion gallon of water in the Spruce Run Reservoir. The Round Valley Dams (2 earthen dams) were constructed to develop the 55-billion gallon water storage Round Valley Reservoir. Both reservoirs are an integral part of a water supply system that consists also of the Delaware & Raritan Canal Transmission Complex, which together has the capability of delivering 225 million gallons of raw water per day to the water utilities that serve central New Jersey [New Jersey Water Supply Authority (NJWSA), Date Unknown].

Somerset County Flood Information System (SCFIS)

In order to provide effective flood warnings to Somerset County officials and citizens, in 1990 the Somerset County Flood Information System (SCFIS) was formed, in cooperation with the U.S. Geological Survey (USGS) and NWS. The SCFIS facilities include a network of stream and precipitation gages, a central office that receives data from the gages, the NWS, and other sources, and a communications network with links to emergency management (EM) offices, public works facilities, and emergency responders. Data generated by the gages is also used by NWS in their forecasts and warning efforts. During storm events, the SCFIS disseminates information about river levels and NWS bulletins and forecasts, to a wide variety of local officials and emergency responders (Somerset County HMP, 2008).

Inundation Mapping in Somerset County

Following Hurricane Floyd, Somerset County developed inundation mapping to aid emergency managers during large storm events by assisting personnel in determining which areas might be flooded. These maps are designed to be used by emergency personnel to indicate which portion of the population should be warned before and during a flood event. These maps show flood extent for certain inundation levels and are available for different inundation levels in 2 foot increments showing buildings, roads, railroads, rivers, and streams (Somerset County HMP, 2008).

Previous Occurrences and Losses

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

According to NOAA's NCDC storm events database, Somerset County experienced 143 flood events between 1950 and December 31, 2012. Total property damages, as a result of these flood events, were estimated at over $863 million. This total may also include damages to other counties. According to the Hazard Research Lab at the University of South Carolina's Spatial Hazard Events and Losses Database for the U.S. (SHELDUS), between 1960 and December 31, 2012, 13 flood events occurred within the County. The database indicated that flood events and losses specifically associated with Somerset County and its municipalities totaled over $609 million in property damage. However, these numbers may vary due to the database identifying the location of the hazard event in various forms or throughout multiple counties or regions.

Between 1954 and 2013, FEMA declared that the State of New Jersey experienced 18 flood-related disasters (DR) or emergencies (EM) classified as one or a combination of the following disaster types: hurricane, severe storm, high tides, heavy rains, high winds, coastal storms, mudslides, tropical storm, and coastal flooding. 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. Of those

events, the New Jersey HMP and other sources indicate that Somerset County has been declared as a disaster area as a result of seven flood events (FEMA, 2013).

Based on all sources researched, known flooding events that have affected Somerset County and its municipalities are identified in Table 5.4.3-4. With flood documentation for the State of New Jersey being so extensive, not all sources have been identified or researched. Therefore, Table 5.4.3-4 may not include all events that have occurred throughout the County and region.

Table 5.4.3-4. Flooding Events between 1810 and 2013.

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
1810	Flood	N/A	N/A	No reference and/or no damage reported.	Somerset County HMP
September 21-24, 1882	Tropical Storm/Flooding	N/A	N/A	Brought heavy rain and flooding to the Passaic Valley. The Borough of Bound Brook was inundated.	Somerset County HMP
February 6-8, 1896	Flood	N/A	N/A	One of the worst floods in the 19th century; flooding caused major fires in the Borough of Bound Brook and destroyed buildings. Water was up to six feet deep in some parts of the Borough. The flooding caused 11 fatalities in the Borough.	Somerset County HMP
July 31 – August 5, 1915	Tropical Depression/Flooding	N/A	N/A	A tropical depression moved from Trenton to Bergen County, bringing 7.68 inches of rain to the Borough of Somerville in a four-day period. Urban flooding occurred in Somerset County.	Somerset County HMP
1923	Flood	N/A	N/A	No reference and/or no damage reported.	Somerset County HMP
1934	Flood	N/A	N/A	No reference and/or no damage reported.	Somerset County HMP
1936	Flood	N/A	N/A	No reference and/or no damage reported.	Somerset County HMP
September 21, 1938	Hurricane/Flooding (New England Hurricane of 1938)	N/A	N/A	Heavy rains and flooding occurred along the major river basins of Somerset County.	Somerset County HMP
September 12-14, 1944	Hurricane/Flooding (1944 Great Atlantic Hurricane)	N/A	N/A	The storm caused nine fatalities, 320 injuries and destroyed 463 homes throughout New Jersey. Damages were estimated at $25 M.	Somerset County HMP
June 3, 1946	Flood	N/A	N/A	No reference and/or no damage reported.	Somerset County HMP
December 1948	Flood	N/A	N/A	No reference and/or no damage reported.	Somerset County HMP
1949	Flood	N/A	N/A	No reference and/or no damage reported.	Somerset County HMP

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
August 1955	Flood	N/A	N/A	The Borough of Manville experienced a major flood crest of 21.8 feet (flood stage is 14 feet).	Somerset County HMP
September 12, 1960	Flooding (Hurricane Donna)	N/A	N/A	Somerset County had a six-foot storm surge from this event, causing $46 K in property and crop damages.	Somerset County HMP
March 5-7, 1962	Coastal Flood (Great Atlantic Coastal Storm)	N/A	N/A	No reference and/or no damage reported.	Somerset County HMP
1966	Flood	N/A	N/A	No reference and/or no damage reported.	Somerset County HMP
June 18, 1968	Heavy Rains/Flooding	DR-245	Yes	No reference and/or no damage reported.	FEMA
August 26-28, 1971	Flooding (Tropical Storm Doria)	DR-310	Yes	Tropical Storm Doria was the third largest event in Somerset County, with the Boroughs of Manville and Bound Brook the hardest hit. Overall, the storm killed three people and caused approximately $138.5 M in damages in New Jersey. Public and private properties were damaged (roads, bridges, water supply systems, sewer systems, homes, industrial buildings). Doria brought more than 10 inches of rain to Somerset County. The Raritan River crested at 37.5 feet in the Borough of Bound Brook. Damage was widespread throughout the County. In Franklin Township, a levee along the Millstone River was overtopped and caused severe damage to the Alma White College. In the Borough of Somerville, Peter's Brook overflowed its banks and flooded two fire houses in the Borough. A water treatment plant in the Township of Bridgewater was flooded with 18 inches of water. In Montgomery Township, 11 homes were flooded and damaged. Overall, Somerset County had approximately $2.4 M in property damages and $2 K in crop damages.	Somerset County HMP

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
June 19-24, 1972	Flooding/Heavy Rain (Tropical Storm Agnes)	N/A	N/A	Rainfall totals from this event ranged between one and 15 inches in New Jersey. Somerset County experienced $262 K in property and crop damages and one fatality.	Somerset County HMP
November 6, 1972	Severe Storm/Flooding	N/A	N/A	The County had approximately $25 K in property damage.	Somerset County HMP
August 2, 1973	Severe Storms/Flooding	DR-402	Yes	This storm brought seven inches of rain in five hours. In Somerset County, the storm caused six fatalities, 34 injuries and evacuations of 1,000 residents. The Green Brook and Blue Brook overflowed their banks and flooded neighboring communities, including the Borough of Bound Brook. Damages to the County were estimated $417 K.	Somerset County HMP
July 13-21, 1975	Heavy Rains, High Winds, Hail, Tornadoes	DR-477	Yes	Severe TSTMs brought flooding to New Jersey, causing $12 M in damages and one fatality. Somerset County had approximately $476 K in property and crop damages.	FEMA, Somerset County HMP
November 6-8, 1977	Flood/Severe Storm	N/A	N/A	The County had approximately $2.4 M in damages from this event.	Somerset County HMP
1978	Flood	N/A	N/A	Moderate flood crests were reported in Blackwells Mills on the Millstone River and in Bound Brook and Manville on the Raritan River.	Somerset County HMP
January 24-25, 1979	Flood	N/A	N/A	The Borough of Bound Brook experienced a major flood crest of 33.2 feet from this event (flood stage is 28 feet).	Somerset County HMP
March 1984	Flood	N/A	N/A	$22 M paid in losses to New Jersey	Somerset County HMP
April 5-7, 1984	Flood	N/A	N/A	Heavy rain, combined with a snow-covered ground and reservoirs at capacity, caused flooding and killed three people. In New Jersey, overall damage was $109 M, with $33 M in paid losses to the state.	Somerset County HMP
July 7, 1984	Flood	N/A	N/A	The Raritan River in Somerset County experienced a major flood crest of 15.3 feet (flood stage is 10 feet).	Somerset County HMP
September 27, 1985	Flooding/Heavy Rains (Hurricane Gloria)	N/A	N/A	This event brought heavy rains inland and downed power lines and trees. There was minimal damage to New Jersey.	Somerset County HMP
April 16, 1986	Flood	N/A	N/A	No reference and/or no damage reported.	Somerset County HMP

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
July 5, 1989	Flood	N/A	N/A	In Somerset County, this even caused $62 K in property damages.	Somerset County HMP
December 11-13, 1992	Coastal Storm, High Tides, Heavy Rain, Flooding	DR-973	Yes	The NJOEM indicated that Somerset County was included in this FEMA disaster declaration; however, no reference and/or no damages were reported for the County.	Somerset County HMP
January 18-19, 1996	Flood ("Deluge of 1996")	N/A	N/A	This event was one of the greatest flash flood events in New York, New Jersey and Pennsylvania. All streams and major rivers overflowed their banks in less than 12 hours and ice jams broke, causing flooding in some areas. Damages to these three states were estimated at $1 B. In New Jersey, multiple counties, including Somerset County, were impacted by this event. In the County, the Raritan and Millstone Rivers flooded. In the Borough of Manville, flooding was the worst since Tropical Storm Doria. Approximately 400 homes were damaged in the Borough. In the Borough of Bound Brook, 100 people were evacuated and about 12 homes were damaged. In the Township of Branchburg, 50 people were evacuated and eight homes were damaged.	Somerset County HMP
January 27, 1996	Flooding	N/A	N/A	Flooding occurred in the Boroughs of Manville and Bound Brook.	Somerset County HMP
July 12-13, 1996	Flooding (Hurricane Bertha)	N/A	N/A	This event brought between two and four inches to the area, causing minor urban and poor drainage flooding. 2.88 inches fell in Somerset County.	Somerset County HMP
October 18-23. 1996	Severe Storms/Flooding	DR-1145	Yes	The Raritan River reached record levels during this event. Rainfall amounts ranged between four and eight inches. Evacuations occurred in the Borough of Manville and in the hamlet of North Branch (Township of Branchburg). Basements were flooded and foundations collapsed. Damages to County bridges were estimated at $1 M. In the Borough of Watchung, the Watchung Lake overflowed its banks. Parts of I-287, U.S. Route 202 and 206, State Route 22, and County Route 610 were closed due to flooding. In the Township of Warren, several roads were closed due to the Passaic River flooding. In the Township of Montgomery, the Pine Brook flooded over the Dead Tree Run Bridge, causing severe damage to the bridge.	Somerset County HMP

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
January 23, 1998	Heavy Rain/Flooding	N/A	N/A	Heavy rain (approximately two inches) fell in Somerset County, flooding low lying areas.	Somerset County HMP
January 3, 1999	Heavy Rain	N/A	N/A	Heavy rain fell across New Jersey, bringing over two inches of rain to many areas of Somerset County. Parts of New Jersey experienced flooding.	Somerset County HMP
May 19, 1999	Heavy Rain	N/A	N/A	Heavy rain fell throughout the areas, with totals ranging from 1.74 inches to 2.1 inches.	Somerset County HMP
September 16-18, 1999	Flooding (Hurricane Floyd)	DR-1295 EM-3148	Yes	Hurricane Floyd produced heavy rain and major flooding in many parts of New Jersey. There were four complete dam failures associated with this storm within the State. This was the largest known flood event in Somerset County to date. The Boroughs of Manville and Bound Brook were the hardest hit and experienced the most economic losses. The County was the hardest hit in New Jersey. Rainfall totals ranged between 10 and 12 inches, causing extensive flooding, with the Raritan and Millstone Rivers experiencing the highest known flood levels. FEMA issued a disaster declaration for this event, which included Somerset County. Overall, FEMA approved $38,703,382.74 in PA. Overall, Floyd caused approximately $358 M in damages, 13,000 evacuations, destroyed thousands of homes, caused two fatalities and over 100 injuries in Somerset County. Somerset County submitted over $5 M in flood damage claims.	FEMA, Dam Safety, Somerset County HMP
August 12, 2000	Flash Flood	N/A	N/A	In the central and northern parts of the County, several streams experienced flash flooding, closing roads.	Somerset County HMP
December 17, 2000	Flood	N/A	N/A	Heavy rain caused flooding along the smaller streams in the Raritan River Basin. In Somerset County, Old York Road and Griggstown Causeway were closed due to flooding.	Somerset County HMP
March 30, 2001	Flood	N/A	N/A	In Somerset County, flooding along the Millstone River caused the closure of the Blackwells Mills and Griggstown Causeways. One road over the North Branch of the Raritan River was also closed between Branchburg and Bridgewater Townships.	Somerset County HMP

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
June 17, 2001	Flood (Remnants of Tropical Storm Allison)	N/A	N/A	Small stream and poor drainage flooding occurred in Somerset County. There were several road closures.	Somerset County HMP
September 13, 2001	Heavy Rain	N/A	N/A	Urban and poor drainage flooding, but no serious injuries or damages were reported.	Somerset County HMP
November 17, 2002	Flood (caused by a Nor'Easter)	N/A	N/A	Flooding occurred along the North Branch of the Raritan River and the Millstone River. Old York Road, Griggstown Causeway and Blackwells Mills Causeways were closed in Somerset County.	Somerset County HMP
June 4, 2003	Flood	N/A	N/A	Urban and poor drainage flooding occurred. Flooding also occurred along sections of the Raritan River Basin. A dozen roads were closed, flood water impacted local businesses, and Old York Road, Griggstown Causeway Blackwells Mills Causeway, Studdiford Drive and S. Middlebush Roads were closed.	Somerset County HMP
June 20-21, 2003	Flood	N/A	N/A	Flooding occurred along the Raritan and Millstone Rivers; Old York Road and Griggstown Causeway were closed.	Somerset County HMP
August 5, 2003	Flash Flood	N/A	N/A	Small stream and poor drainage flooding occurred in the northeast part of Somerset. Most rain fell in the Borough of Watchung; however, the worst reported flooding was in northern parts of Bound Brook Borough. Multiple road closures on main roadways and basements of businesses and homes were flooded.	Somerset County HMP
December 11, 2003	Flood	N/A	N/A	Widespread poor drainage and river flooding occurred in Somerset County. The flooding led to numerous road closures and rescues from floodwaters.	Somerset County HMP
December 24, 2003	Flood	N/A	N/A	Many rivers and streams overflowed their banks. Road closures were reported, including Griggstown and Blackwells Mills Causeways and Old York Rd.	Somerset County HMP
February 6, 2004	Flood	N/A	N/A	Poor drainage and river flooding occurred throughout Somerset County. An ice jam formed on Green Brook, which flooded six homes in the Borough of North Plainfield. Road closures were reported throughout.	Somerset County HMP
April 12-13, 2004	Heavy Rain / Flood	N/A	N/A	Rainfall totals ranged between 2.31 inches and 2.4 inches and caused road closures and stream flooding.	Somerset County HMP

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
July 23-27, 2004	Flash Flood	N/A	N/A	Rainfall totals ranged between 2.6 and 4.24 inches in Somerset County. The Township of Branchburg had the most damage from this event, which included road closures, rescued vehicles, and evacuations. Roads were closed throughout the County.	Somerset County HMP
September 28, 2004	Flood (Remnants of Hurricane Jeanne)	N/A	N/A	The remnants of Hurricane Jeanne brought heavy rains to the area, causing widespread, poor drainage and creek flooding. The Raritan and Millstone Rivers flooded. Many roads flooded and were closed. Water rescues were performed. Rainfall totals in the County ranged from 2.6 inches to 4.24 inches.	Somerset County HMP
January 14, 2005	Flood	N/A	N/A	Urban and poor drainage flooding and led to pockets of river flooding within the County.	Somerset County HMP
April 1-3, 2005	Flood / Wind	N/A	N/A	Somerset County was less affected than counties in the Passaic and Delaware River Basins; however, the Raritan and Millstone Rivers were flooded. Many roads were closed in the County. Raw sewage backed up into several homes in Bernards Township.	Somerset County HMP
October 7-14, 2005	Flood	N/A	N/A	A storm caused flooding throughout Somerset County, closing schools and flooding roadways. An apartment building was evacuated in the Township of Hillsborough. Six people were rescued from Beden Brook in the Township of Montgomery. The worst flooding was along River Road, Griggstown Causeway and Kingston Road. Bridges and roads were closed. Flooding along River Road (Millstone River) in Montgomery and Hillsborough Townships reached into the basements of about 20 to 30 homes. Several vehicles were stranded on flooded roadways throughout the County.	Somerset County HMP
June 23-28, 2006	Flood	N/A	N/A	Minor flooding occurred along the main stem rivers in Somerset County. Road closures were reported in the Townships of Bridgewater, Branchburg and Hillsborough. Actual storm rainfall totals included 5.87 inches in Pottersville, 5.00 inches at the Somerville Airport and 4.20 inches in Bound Brook.	Somerset County HMP
September 2, 2006	Heavy Rain/Flooding (remnants of Tropical Storm Ernesto)	N/A	N/A	Heavy rain and flooding occurred throughout Somerset County, with 2.4 inches in Bound Brook and 1.8 inches in Pottersville.	Somerset County HMP

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
April 14-16, 2007	Severe Storm and Coastal Flooding (also identified as a Nor'Easter)	DR-1694	Yes	This was the second largest flood event in Somerset County, with seven-day rainfall totals ranging from eight to 10 inches. USGS indicated that the North and South Raritan Rivers and the Raritan River had 20-year events; Millstone River had an 80-year event. Acting Governor Codey declared a state of emergency for New Jersey. Damages for the State were estimated at over $180 M in property damages. FEMA issued a disaster declaration for this event, which included Somerset County. Overall, FEMA approved $18,821,508.61 in IA and $17,513,033.42 in PA. Damages in Somerset County included damage to the recently completed Segment T Pumping Station (of the Green Brook Flood Control Project) in Bound Brook. $5.2 M in federal aid is going to Bound Brook (C. Heininger). Many out-of-control fires occurred and numerous roads were closed.	FEMA, Somerset County HMP
February 13, 2008	Heavy Rain & Snowmelt/ Flooding	N/A	N/A	Numerous roadways closed in the County.	Somerset County HMP
March 8, 2008	Flood/Flash Flood	N/A	N/A	Runoff from a heavy rain event lead to flooding along many waterbodies in Somerset County, including the Raritan and Millstone Rivers. The North Branch of the Raritan River at North Branch was above its 12.3 foot flood stage. It crested at 14.66 feet. Further downstream, the North Branch was above its 10 foot flood stage, which crested at 12.93 feet. The main stream of the Raritan River at Manville crested at 16.8 feet (flood stage of 14 feet). The Millstone River at Griggstown crested at 13.10 feet (flood stage of 10 feet). Rainfall totals in the County ranged between 1.94 inches in the Township of Hillsborough to 2.30 inches in the Borough of Bound Brook.	NOAA-NCDC
March 13-17, 2010	Flooding	DR-1897	Yes	Four days of rain led to major flooding in the Passaic and Raritan River Basins. The four day storm total averaged around 2.5 to six inches, with the highest totals in the Raritan and Passaic basins. It was the worst flooding in the Raritan Basin since April 2007 and the worst flooding in the Passaic since April 1984. Over 1,000 people were evacuated in Morris and Somerset Counties. Damages in New Jersey were estimated at $30 M.	FEMA, NOAA-NCDC, SHELDUS

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
				FEMA issued a disaster declaration for this event, which included Somerset County. FEMA approved $16,920,234.13 in IA and $30,742,405.66 in PA. In Somerset County, the Boroughs of Bound Brook Manville and Green Brook were the hardest hit by the heavy rain and flooding. There were 1,300 flood-related emergency calls and 46 water rescues. In the Borough of Bound Brook, about 600 residents were evacuated and shelters were opened. Businesses along Main Street and East 2nd Avenue were flooded. In the Borough of Manville, 200 residents were evacuated in the Lost Valley section and along Duke Parkway. A shelter was opened; the wall of a home collapsed. Approximately 165 homes were flooded. In the Borough of Green Brook, a nursing home was evacuated; roads and bridges were closed near Green Brook. In Hillsborough Township, U.S. Route 206 was flooded at the Raritan River and cut the Township off from the northern half of the County. In Montgomery Township, traffic on U.S. Route 206 was heavy due to it being the only roadway over the Millstone River that was open. In the Borough of Rocky Hill, County Route 518 was closed due to flooding. In other areas of the County, many roads were closed. The North Branch of the Raritan at North Branch crested at 16.44 feet (12.3 foot flood stage); the North Branch at Raritan crested at 13.9 feet (10 foot flood stage). Overall, the County $15 M in property damages, with $2.5 M of that in damages to the Borough of Manville.	
August 27-28, 2011	Flooding (Hurricane Irene)	DR-4021 EM-3332	Yes	Hurricane Irene produced torrential rains that resulted in major flooding and number of record breaking crests on area rivers, tropical storm force winds and record breaking power outages for New Jersey. There was one confirmed tornado and three to five foot storm surges that caused moderate to severe tidal flooding with extensive beach erosion. Approximately one million people were evacuated from New Jersey's coast and low lying areas throughout the state. Power was not fully restored until September 5th in some areas. There were six deaths associated with this storm. FEMA issued a disaster declaration for this event and Somerset County was included. FEMA approved	FEMA, NOAA-NCDC, SHELDUS

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
				$176,934,424.24 in IA and $112,083,577.93 in PA. In Somerset County, approximately 3,400 homes and 250 businesses suffered flood damage. In the Borough of Bound Brook, 700 homes were damaged and 600 damaged in the Borough of Manville. Mandatory evacuations occurred in Manville, Bound Brook, South Bound Brook, and Somerville. In the Borough of Manville, the Lost Valley was one of the hardest hit areas, with 250 people evacuated and numerous water rescues. One in three homes in the Borough was damaged. In the Borough of Bound Brook, most of the evacuations occurred along Main Street. Overall, in Somerset County, 20 of the municipalities suffered major flooding and every municipality had at least one roadway closed. Major flooding was reported along the Raritan River and the North Branch of the Raritan. Overall, the County had over $200 M in damages from Irene.	
September 6-10, 2011	Flooding (Remnants of Tropical Storm Lee)	DR-4039	No	Remnants of Tropical Storm Lee produced heavy rain across New Jersey for several days. Rainfall totals ranged from three to eight inches. The heavy rain caused flooding to the west and northwest of the New Jersey Turnpike, with moderate flooding along the main stem of the Delaware River and moderate to major flooding in the Passaic and Raritan River Basins. Statewide damage was estimated at $11.5 M. In Somerset County, two rounds of heavy rain caused flooding throughout. Most of the gaged waterways were below flood stage except for the Millstone River. Water rescues were performed in the Township of Franklin; vehicles were stuck in flood waters on State Route 28 in the Township of Branchburg; flooding forced the closure of Main Street and Dukes Parkway in Manville and Route 206 in Raritan. The Millstone River at Griggstown had major flooding and crested at 16.89 feet (flood stage of 10 feet). The Millstone River at Blackwells Mills had moderate flooding and crested at 13.77 feet (flood stage of 9 feet). The Millstone River at Weston created at 15.68 feet (flood stage of 12.4 feet). The County had $1 M in damages.	FEMA, NOAA-NCDC, SHELDUS

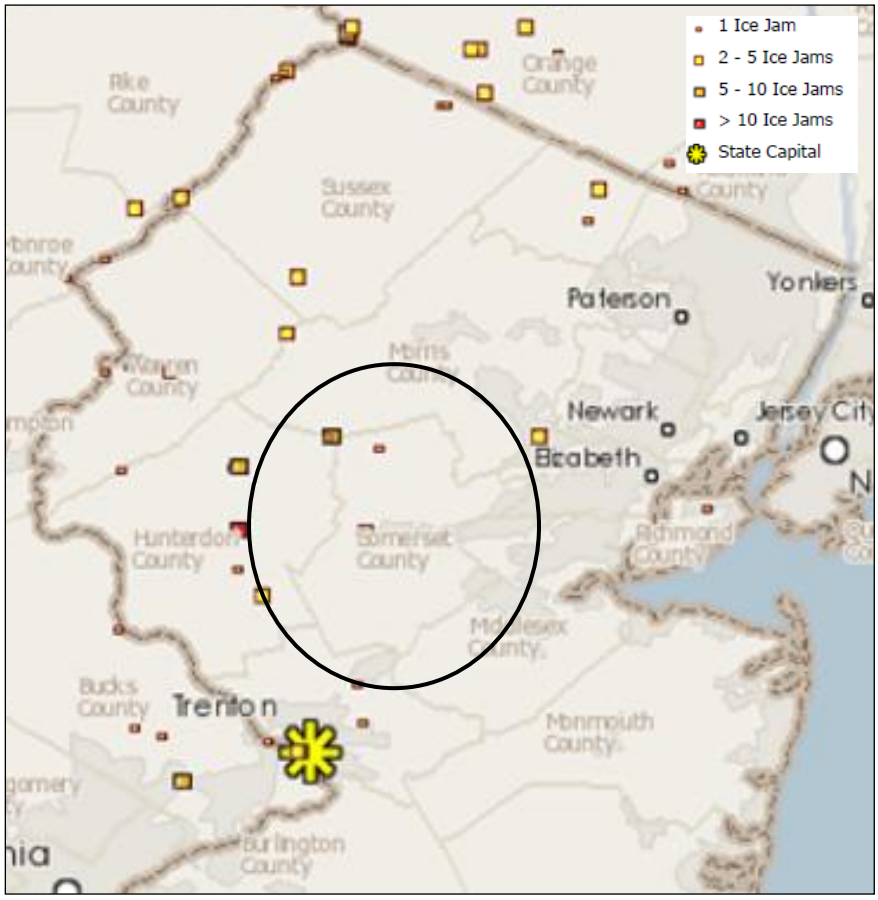
Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
August 1, 2012	Heavy Rain/Flash Flood	N/A	N/A	The combination of a weak cold front and a hot and humid air mass triggered strong to severe TSTMs in New Jersey. These TSTMs produced heavy rain and flooding throughout the state. Storm totals ranged from three to six inches. In Somerset County, in the Borough of Millstone, street flooding was reported along Main Street and Yorktown Road.	NOAA-NCDC
December 21-22, 2012	Heavy Rain/Flood	N/A	N/A	Moderate to heavy rain fell across New Jersey, with storm totals ranging between one and three inches, which led to minor flooding of smaller streams and creeks. In Somerset County, roads were closed. The North Branch of the Raritan River at North Branch crested at 12.53 feet (12.3 foot flood stage); the North Branch of the Raritan River at South Branch crested at 9.01 feet (7 foot flood stage); the Millstone River at Griggstown crested at 11.14 feet (10 foot flood stage). Rainfall totals in the County ranged from 1.46 inches in Warren Township to 1.62 inches at Somerville Airport.	NOAA-NCDC
December 27-29, 2012	Heavy Rain/Flood	N/A	N/A	Heavy rain caused poor drainage flooding and flooding of streams and rivers in central New Jersey. In Somerset County, the Millstone River at Griggstown crested at 11.68 feet (flood stage of 10 feet). The Griggstown Causeway was closed. Rainfall totals in the County ranged from 1.35 inches in the Township of Hillsborough to 1.49 inches in the hamlet of Peapack.	NOAA-NCDC

Note (1): Monetary figures within this table were U.S. Dollar (USD) figures calculated during or within the approximate time of the event. If such an event would occur in the present day, monetary losses would be considerably higher in USDs as a result of increased U.S. Inflation Rates.

B	Billion
DR	Federal Disaster Declaration
EM	Federal Emergency Declaration
FEMA	Federal Emergency Management Agency
IA	Individual Assistance
K	Thousand ($)
M	Million ($)
N/A	Not applicable
NCDC	National Climate Data Center
NOAA	National Oceanic Atmospheric Administration
NWS	National Weather Service
PA	Public Assistance
SHELDUS	Spatial Hazard Events and Losses Database for the U.S.

According to the CRREL database, in Somerset County, ice jams have historically formed at various points along the North Branch Raritan, Lamington, and Raritan Rivers (Ice Engineering Research Group, 2013). Locations of historical ice jam events are indicated in Figure 5.4.3-4 below.

Figure 5.4.3-4. Historic Ice Jams in Somerset County.



Source: CRREL, 2012
Note: The black circle indicates the approximate location of Somerset County.

Based on review of the CRREL Database, Table 5.4.3-5 lists the ice jam events that have occurred in Somerset County between 1780 and 2013. Information regarding losses associated with these reported ice jams was limited.

Table 5.4.3-5. Ice Jam Events in Somerset County between 1780 and 2013

Date	River / Location	Description	Source(s)
February 12, 1925	Raritan at North Branch Raritan River	The USGS reported a maximum annual gage height of 9 feet affected by backwater from ice.	CRREL
January 20, 1927	Pottersville at Lamington (Black) River	The USGS reported a gage height of 2.83 feet, affected by backwater from ice. Bankfull stage at 5 feet.	CRREL
March 3, 1934	Pottersville at Lamington (Black) River	The USGS reported a gage height of 3.33 feet, affected by backwater from ice. Additional ice-affected gage height of 3.51 feet was reported on March 4th. Bankfull stage at 5 feet.	CRREL
January 3, 1936	Pottersville at Lamington (Black) River	The USGS reported a maximum annual gage height of 4.19 feet, affected by backwater from ice. Discharge was 780 cfs and bankfull stage was 5 feet.	CRREL
January 3, 1936	Pottersville at Lamington (Black) River	The USGS reported a maximum annual gage height of 4.19 feet affected by backwater from ice. Discharge was 780 cfs and bankfull stage of 5 feet.	CRREL
January 3, 1936	Far Hills at North Branch Raritan River	The USGS reported a gage height of 4.81 feet, affected by backwater from ice.	CRREL
January 15, 1940	Pottersville at Lamington (Black) River	The USGS reported a gage height of 3.54 feet affected by backwater from ice. Bankfull stage at 5 feet.	CRREL
December 22, 1942	Pottersville at Lamington (Black) River	The USGS reported a gage height of 3 feet affected by backwater from ice. Bankfull stage of 5 feet.	CRREL
December 25, 1945	Pottersville at Lamington (Black) River	The USGS reported a gage height of 3.66 feet affected by backwater from ice. Discharge was 450 cfs and bankfull stage of 5 feet.	CRREL
February 20, 1948	Raritan at North Branch Raritan River	The USGS reported a maximum annual gage height of 9.39 feet affected by backwater from ice.	CRREL
January 21, 1959	Pottersville at Lamington (Black) River	The USGS reported a maximum annual gage height of 3.64 feet affected by backwater from ice. Bankfull state was 5 feet.	CRREL
January 28-29, 1994	Lower Raritan and Millstone Rivers	A warm front after a significant snow fall caused the lower Raritan and Millstone Rivers to flood due to rain, snow melt and ice jams.	NOAA-NCDC
February 7, 2004	Raritan at Raritan River	The USGS reported a maximum peak stage of 11.32 feet as a result of an ice jam at the North Branch Raritan near Raritan, NJ USGS gaging station. The average daily discharge was estimated to be 3,150 cfs.	CRREL
February 7, 2004	Green Brook	The combination of heavy rain and snow melt caused poor drainage and river flooding throughout Somerset County. An ice jam developed on the Green Brook and dynamite was used to break the jam.	NOAA-NCDC

Source: CRREL, 2013
Note: Although many events were reported for Somerset County, information pertaining to every event was not easily ascertainable; therefore this table may not represent all ice jams in the County.

Cfs Cubic Feet Per Second
CRREL U.S. Army Cold Regions Research and Engineering Laboratory
NCDC National Climatic Data Center
NOAA National Oceanic and Atmospheric Administration
USGS U.S. Geological Survey

National Flood Insurance Program

The U.S. Congress established the NFIP with the passage of the National Flood Insurance Act of 1968 (FEMA's 2002 *National Flood Insurance Program (NFIP): Program Description*). The NFIP is a Federal program enabling property owners in participating communities to purchase insurance as a protection against flood losses in exchange for State and community floodplain management regulations that reduce future flood damages. As stated in the NYS HMP, the NFIP collects and stores a vast quantity of information on insured structures, including the number and location of flood insurance policies, number of claims per insured property, dollar value of each claim and aggregate value of claims, repetitive flood loss properties, etc. NFIP data presents a strong indication of the location of flood events among other indicators (NYSDPC, 2008).

There are three components to NFIP: flood insurance, floodplain management and flood hazard mapping. Nearly 20,000 communities across the U.S. and its territories participate in the NFIP by adopting and enforcing floodplain management ordinances to reduce future flood damage. In exchange, the NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in these communities. Community participation in the NFIP is voluntary. Flood insurance is designed to provide an alternative to disaster assistance to reduce the escalating costs of repairing damage to buildings and their contents caused by floods. Flood damage is reduced by nearly $1 billion a year through communities implementing sound floodplain management requirements and property owners purchasing of flood insurance. Additionally, buildings constructed in compliance with NFIP building standards suffer approximately 80 percent less damage annually than those not built in compliance (FEMA, 2008).

NFIP data for Somerset County is presented further in Table 5.4.3-13 in the Vulnerability Assessment section of this profile.

As an additional component of NFIP, the Community Rating System (CRS) is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. As a result, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community actions meeting the three goals of the CRS: (1) reduce flood losses; (2) facilitate accurate insurance rating; and (3) promote the awareness of flood insurance (FEMA, 2012).

Probability of Future Events

Given the history of flood events that have impacted Somerset County, it is apparent that future flooding of varying degrees will occur. The fact that the elements required for flooding exist and that major flooding has occurred throughout the county in the past suggests that many people and properties are at risk from the flood hazard in the future.

It is estimated that Somerset County will continue to experience direct and indirect impacts of floods annually. Table 5.4.3-6 summarizes the occurrences of flood events and their annual occurrence (on average).

Table 5.4.3-6. Occurrences of Flood Events in Somerset County, 1993 - 2012

Event Type	Total Number of Occurrences	Annual Number of Events (average)
Flash Flood	32	1.6
Flood	106	5.6
Flood/Flash Flood	3	0.16
Urban Flooding	1	0.05
Urban/Small Stream Flooding	1	0.05
TOTAL	**143**	**7.5**

Source: NOAA-NCDC, 2013
Note: On average, Somerset County experiences 7.5 flood events each year.

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

VULNERABILITY ASSESSMENT

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. For the flood hazard, areas identified as hazard areas include the 1% and 0.2% (100- and 500-year) floodplains. The following text evaluates and estimates the potential impact of flooding in Somerset County including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on: (1) life, safety and health, (2) general building stock, (3) critical facilities and infrastructure, (4) economy and (5) future growth and development
- Effect of climate change on vulnerability
- Change of vulnerability as compared to that presented in the 2008 Somerset County Multi-Jurisdictional Multi-Hazard Mitigation Plan
- Further data collections that will assist understanding of this hazard over time

Overview of Vulnerability

Flood is a significant concern for Somerset County. To assess vulnerability, potential losses were calculated for the County for 100-year and 500-year Mean Return Period (MRP) flood events. The flood hazard exposure and loss estimate analysis is presented below.

Data and Methodology

The 1- and 0.2-percent annual chance flood events were examined to evaluate Somerset County's risk and vulnerability to the flood hazard. These flood events are generally those considered by planners and evaluated under federal programs such as the NFIP.

The HAZUS-MH version 2.1 riverine flood model was used to estimate Somerset County's estimated potential losses. HAZUS-MH applies engineering and scientific risk calculations that have been developed by hazard and information technology experts to provide defensible damage and loss estimates. These methodologies are accepted by FEMA and provide a consistent framework for assessing risk across a variety of hazards. The GIS framework also supports the evaluation of hazards and assessment of

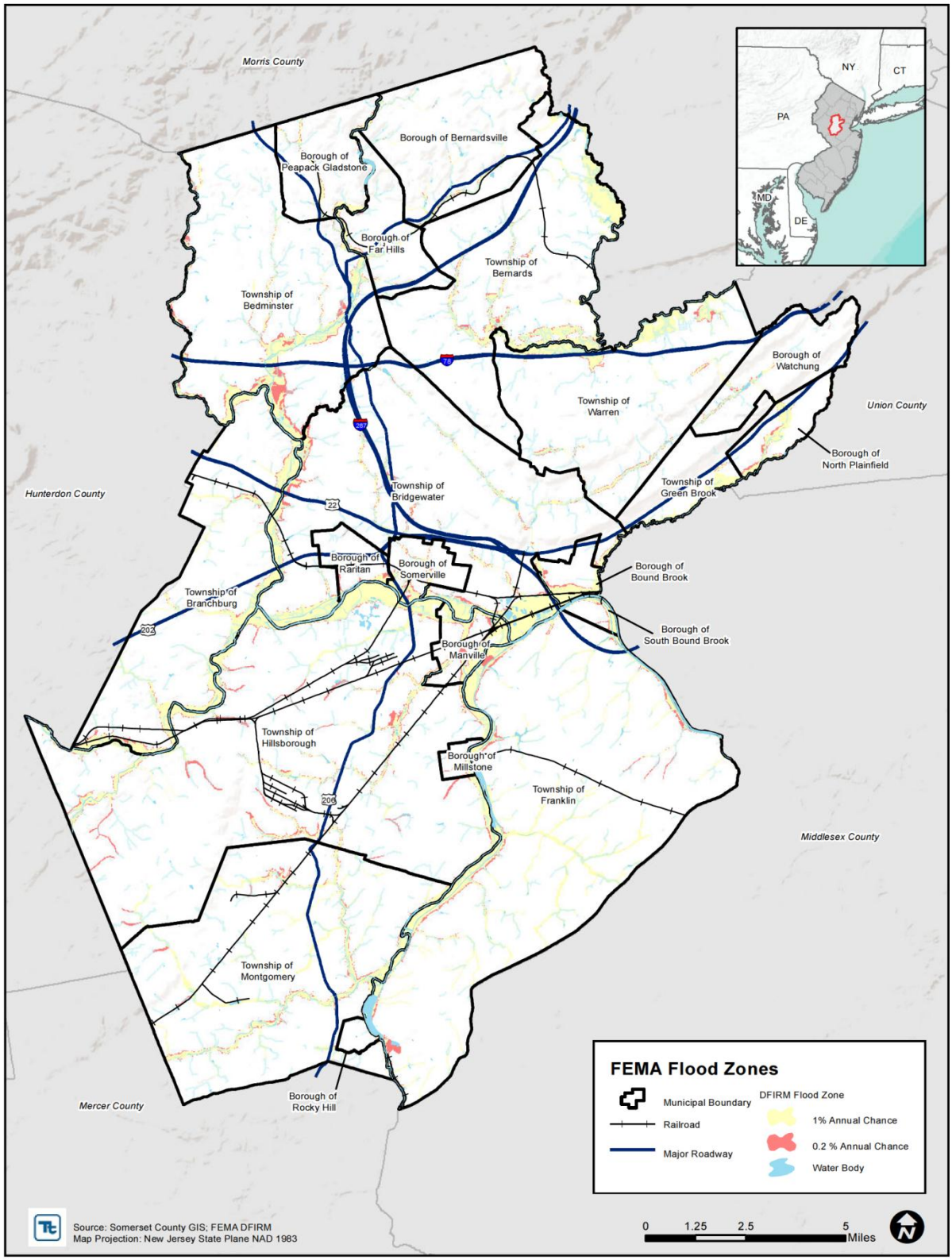
inventory and loss estimates for these hazards. HAZUS-MH can serve as a basis to quantify risk and to allocate limited resources for prioritization of mitigation projects. Refer to the Methodology section of this Plan for further details on HAZUS-MH.

The HAZUS-MH flood model is designed for three levels of analysis. A Level 1 analysis is the simplest type of analysis based on default data provided with the software. A Level 2 analysis provides a more tailored, accurate result using building attributes provided by the County. A Level 2 HAZUS-MH riverine flood analysis was performed for Somerset County. For this update, the default general building stock in HAZUS-MH was updated and replaced with a custom inventory at the structure and aggregate level. An updated critical facility inventory was used in place of the HAZUS-MH defaults for essential facilities and utilities.

The Somerset County FEMA DFIRMs dated September 2007 were used to evaluate exposure and determine potential future losses. The terrain was built using a 10-foot contour provided by the County from USGS. Flood depth grids were developed for the 1- and 0.2-percent flood events for the County. The depth grids were integrated into HAZUS-MH and the model was run to estimate potential losses.

The HAZUS-MH model uses 2000 U.S. Census demographic data. This data was not updated for this analysis due to technical availability; however, the 2010 U.S. Census data was used to estimate population exposure to provide the best available output. In addition, to estimate exposure, the DFIRM flood boundaries were used. HAZUS-MH 2.1 calculated the estimated damages to the general building stock and critical facilities based on the depth grid generated and the default HAZUS damage functions in the flood model. Figure illustrates the FEMA DFIRM flood boundaries used for this vulnerability assessment.

Figure 5.4.3-5. Somerset County DFIRM 1-Percent and 0.2-Percent Flood Zones



Source: Somerset County GIS; FEMA, 2007

Impact on Life, Health and Safety

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

To estimate the population exposed to the 1- and 0.2-percent annual chance flood events, the FEMA DFIRM floodplain boundaries were used. Census blocks do not follow the boundaries of the floodplain and can grossly over or under estimate the population exposed when using the centroid or intersection of the Census block with the flood boundaries. Therefore, the methodology used to generate these estimates counted the number of residential structures within the floodplain, and then estimated the total population by multiplying the number of residential structures by the average Somerset County household size of 2.78 persons per household (based on 2007-2011 Census data). This methodology may underestimate the population at risk to flooding by as much as half; because it does not take into consideration physical access into the area where the property is located such as the ability to travel into the area either on foot or by vehicle. However we feel it is more accurate than the other methods described.

Using this approach, it was estimated that the population within the 1-percent floodplain is 6,608 (2.0-percent of the total County population) with an additional 3,228 in the 0.2-percent flood boundary. Table 5.4.3-7 lists the estimated population located within the 1- and 0.2-percent annual chance flood boundaries by municipality for Somerset County.

Table 5.4.3-7. Estimated Somerset County Population Vulnerable to the 1-Percent and 0.2-Percent Flood Hazards (2010 Census)

Municipality	Total Population	1-Percent Annual Chance Event		0.2-Percent Annual Chance Event	
		Population in SFHA	Percent Population in Boundary	Population in Boundary	Percent Population in Boundary
Bedminster (T)	8,165	81	1.0	125	1.5
Bernards (T)	26,652	131	0.5	197	0.7
Bernardsville (B)	7,707	95	1.2	103	1.3
Bound Brook (B)	10,402	1,724	16.6	2,029	19.5
Branchburg (T)	14,459	128	0.9	178	1.2
Bridgewater (T)	44,464	303	0.7	717	1.6
Far Hills (B)	919	17	1.8	25	2.7
Franklin (T)	62,300	131	0.2	281	0.5
Green Brook (T)	7,203	378	5.2	389	5.4
Hillsborough (T)	38,303	195	0.5	375	1.0
Manville (B)	10,344	1,268	12.3	2,280	22.0
Millstone (B)	418	44	10.6	70	16.6
Montgomery (T)	22,254	133	0.6	236	1.1
North Plainfield (B)	21,963	1,573	7.2	1,963	8.9

Municipality	Total Population	1-Percent Annual Chance Event		0.2-Percent Annual Chance Event	
		Population in SFHA	Percent Population in Boundary	Population in Boundary	Percent Population in Boundary
Peapack Gladstone (B)	2,582	86	3.3	142	5.5
Raritan (B)	6,881	3	0.0	50	0.7
Rocky Hill (B)	682	3	0.4	14	2.0
Somerville (B)	12,098	47	0.4	161	1.3
South Bound Brook (B)	4,563	64	1.4	158	3.5
Warren (T)	15,311	164	1.1	275	1.8
Watchung (B)	5,801	42	0.7	67	1.2
Somerset County (Total)	**323,444**	**6,608**	**2.0**	**9,836**	**3.0**

Source: FEMA, 2007; U.S. Census, 2010
Notes: SFHA = Special Flood Hazard Area
A zero percentage denotes less than 1/100th percentage and not zero damages or vulnerability as may be the case.

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

Using 2000 U.S. Census data, HAZUS-MH 2.1 estimates the potential sheltering needs as a result of a 1-percent chance flood event. For the 1-percent flood event, HAZUS-MH 2.1 estimates 20,436 households will be displaced and 15,289 people will seek short-term sheltering, representing approximately 4.7% of the Somerset County population seeking short-term shelter. For the 0.2-percent flood event, HAZUS-MH 2.1 estimates 25,923 households will be displaced and 20,029 people will seek short-term sheltering, representing approximately 6.2% of the Somerset County population seeking short-term shelter. These statistics, by municipality, are presented in Table 5.4.3-8.

Table 5.4.3-8. Estimated Population Displaced or Seeking Short-Term Shelter from the 1-Percent and 0.2-Percent Annual Chance Flood Events

Municipality	Total Population (2010 U.S. Census)	1-Percent Annual Chance Event		0.2-Percent Annual Chance Event	
		Displaced Households	Persons Seeking Short-Term Sheltering	Displaced Households	Persons Seeking Short-Term Sheltering
Bedminster (T)	8,165	222	106	283	155
Bernards (T)	26,652	2,921	2,594	3,237	2,906
Bernardsville (B)	7,707	281	75	318	99
Bound Brook (B)	10,402	3,393	3,218	4,269	4,064
Branchburg (T)	14,459	642	302	699	344
Bridgewater (T)	44,464	1,606	1,045	2,180	1,522
Far Hills (B)	919	123	64	148	71
Franklin (T)	62,300	1,713	1,147	1,986	1,292
Green Brook (T)	7,203	575	528	591	543

Municipality	Total Population (2010 U.S. Census)	1-Percent Annual Chance Event		0.2-Percent Annual Chance Event	
		Displaced Households	Persons Seeking Short-Term Sheltering	Displaced Households	Persons Seeking Short-Term Sheltering
Hillsborough (T)	38,303	1,372	906	1,981	1,421
Manville (B)	10,344	1,557	1,131	2,570	2,055
Millstone (B)	418	52	18	75	28
Montgomery (T)	22,254	1,103	510	1,247	620
North Plainfield (B)	21,963	2,531	2,162	2,941	2,536
Peapack Gladstone (B)	2,582	220	79	281	132
Raritan (B)	6,881	105	67	223	154
Rocky Hill (B)	682	50	34	57	38
Somerville (B)	12,098	663	487	1,092	894
South Bound Brook (B)	4,563	437	401	682	591
Warren (T)	15,311	630	309	763	386
Watchung (B)	5,801	240	106	300	178
Somerset County (Total)	**323,444**	**20,436**	**15,289**	**25,923**	**20,029**

Source: FEMA, 2007; HAZUS-MH 2.1
Note: The population displaced and seeking shelter was calculated using the 2000 U.S. Census data (HAZUS-MH 2.1 default demographic data).

HAZUS' sheltering estimates are greater than the estimated population exposed. This may be because HAZUS sheltering estimates take into consideration many factors including demographics and the estimated damages to buildings calculated at the Census-block level. As explained in the following section (Impact to General Building Stock), we estimate building potential loss for the County at the residential structure level, not the Census-block level, while using HAZUS' damage functions. We feel this methodology provides a more accurate estimate of potential losses for the residential population. However, we recognize this methodology does not include the population occupying the commercial, industrial, religious, government and education occupancy class buildings.

When comparing the potential building losses for the County, we find that at the total estimated loss at structure level for the 1-percent event is $858 million; and the total estimated loss at the Census-block level for the 1-percent event is $ 1.5 billion. Both methodologies used the same number of buildings and replacement cost values, damage functions and depth grid; however the results at the Census-block level are much higher due to the differences is methodology. This explains why the sheltering estimates calculated by HAZUS (at the Census-block level) are much higher than our exposure level (based on the structure level).

The limitations of these analyses are recognized, and as such the results are only used to provide a general estimate. Please take this into consideration when estimating for flood sheltering needs.

The total number of injuries and casualties resulting from typical riverine flooding is generally limited based on advance weather forecasting, blockades and warnings. Therefore, injuries and deaths generally are not anticipated if proper warning and precautions are in place. Ongoing mitigation efforts should help to avoid the most likely cause of injury, which results from persons trying to cross flooded roadways or channels during a flood. Mitigation action items addressing this issue are included in Section 9 (Mitigation Strategies) of this plan.

All population in a dam failure inundation zone is considered exposed and vulnerable. Similar to riverine flooding, of the population exposed to dam failure and flash flooding, the most vulnerable include the economically disadvantaged and the population over the age of 65.

There is often limited warning time for dam failure and flash flooding. These events are frequently associated with other natural hazard events such as earthquakes, landslides or severe weather, which limits their predictability and compounds the hazard. Populations without adequate warning of the event are highly vulnerable to this hazard.

Impact on General Building Stock

After considering the population exposed and vulnerable to the flood hazard, the built environment was evaluated. Exposure in the flood zone includes those buildings located in the flood zone. Potential damage is the modeled loss that could occur to the exposed inventory, including structural and content value.

The total land area located in the 1- and 0.2-percent annual chance flood zones was calculated for each municipality, as presented in Table 5.4.3-9 below.

Table 5.4.3-9. Total land area located in the 1- and 0.2-percent annual chance flood zones

Municipality	Total Area (sq. mi.)	1% Flood Event Hazard Area		0.2% Flood Event Hazard Area	
		Area Exposed (sq. mi.)	% of Total	Area Exposed (sq. mi.)	% of Total
Bedminster (T)	26.4	2.7	10.2	3.4	12.9
Bernards (T)	24.2	2.8	11.6	3.0	12.4
Bernardsville (B)	13.0	0.5	3.8	0.6	4.6
Bound Brook (B)	1.6	0.5	31.3	0.6	37.5
Branchburg (T)	20.2	2.9	14.4	3.1	15.3
Bridgewater (T)	32.6	4.0	12.3	4.5	13.8
Far Hills (B)	4.9	0.5	10.2	0.5	10.2
Franklin (T)	46.9	4.8	10.2	5.4	11.5
Green Brook (T)	4.4	0.5	11.4	0.5	11.4
Hillsborough (T)	54.9	4.4	8.0	5.5	10.0
Manville (B)	2.5	0.9	36.0	1.1	44.0
Millstone (B)	0.7	0.1	14.3	0.1	14.3
Montgomery (T)	32.5	2.7	8.3	3.1	9.5
North Plainfield (B)	2.8	0.5	17.9	0.6	21.4
Peapack Gladstone (B)	5.9	0.5	8.5	0.6	10.2
Raritan (B)	2.0	0.2	10.0	0.2	10.0
Rocky Hill (B)	0.6	0.04	6.7	0.05	8.3
Somerville (B)	2.4	0.4	16.7	0.5	20.8
South Bound Brook (B)	0.8	0.3	37.5	0.3	37.5
Warren (T)	19.6	1.9	9.7	2.1	10.7
Watchung (B)	6.1	0.3	4.9	0.3	4.9
Somerset County (Total)	**304.9**	**31.4**	**10.3**	**36.1**	**11.8**

Source: FEMA, 2007
Note: sq.mi. = Square miles; % = Percent

These estimates are based on the provided Cayuga GIS municipal boundaries and should be treated as estimates. The area presented includes the area of inclusive waterbodies.

To provide a general estimate of number of structures and structural/content replacement value exposure, the FEMA DFIRM flood boundaries (1- and 0.2-percent flood zones) were overlaid upon Somerset County's updated building stock inventory point shapefiles. The structures within the boundaries were totaled for each municipality. Refer to Table 5.4.3-10.

It is estimated there are 3,046 structures located in the 1-percent annual chance floodplain and 4,538 structures located in the 0.2-percent annual chance floodplain in Somerset County. This represents 3- and 4.5-percent of all structures located in the planning area, respectively. Of the buildings located in and thus exposed to the 1- and 0.2-percent annual chance flood events, it is estimated that greater than 75% are residential structures.

There is approximately $1.8 billion of building/contents exposed to the 1-percent annual chance flood in Somerset County. This represents approximately 2% of the County's total general building stock replacement value inventory ($83.4 billion; see Section 4). For the 0.2-percent annual chance flood event, it is estimated there is nearly $2.7 billion of buildings/contents exposed in Somerset County. This is approximately 3.4% of the County's total general building stock replacement value inventory.

The potential damage estimated to the general building stock inventory associated with the 1-percent annual chance flood is greater than $380 million. For the 0.2-percent annual chance flood event, the potential damage estimate is nearly $732 million (structure and contents).

Table 5.4.3-10. Estimated General Building Stock Exposure to the 1-Percent and 0.2-Percent Annual Chance Flood Events

Municipality	Total Number of Buildings	Total RCV	1% Annual Chance Flood Boundary				0.2% Annual Chance Flood Boundary			
			Number of Buildings	% of Total	RCV	% of Total	Number of Buildings	% of Total	RCV	% of Total
Bedminster (T)	2,531	$2,806,782,802	41	1.6	$18,256,023	0.7	86	3.4	$68,573,282	2.4
Bernards (T)	7,576	$7,022,125,235	71	0.9	$37,024,272	0.5	101	1.3	$63,053,088	0.9
Bernardsville (B)	3,282	$2,478,180,688	64	2.0	$38,592,103	1.6	71	2.2	$43,101,431	1.7
Bound Brook (B)	3,011	$1,594,581,503	754	25.0	$497,870,408	31.2	874	29.0	$576,388,282	36.1
Branchburg (T)	5,369	$5,675,235,512	80	1.5	$77,341,589	1.4	123	2.3	$119,541,528	2.1
Bridgewater (T)	14,316	$11,777,778,734	183	1.3	$243,057,969	2.1	380	2.7	$388,250,606	3.3
Far Hills (B)	536	$516,657,295	24	4.5	$11,169,118	2.2	40	7.5	$27,242,495	5.3
Franklin (T)	15,592	$15,364,220,511	77	0.5	$61,700,077	0.4	184	1.2	$181,432,254	1.2
Green Brook (T)	2,465	$1,799,102,751	158	6.4	$59,968,222	3.3	162	6.6	$61,704,991	3.4
Hillsborough (T)	10,812	$9,911,832,655	89	0.8	$48,523,399	0.5	170	1.6	$95,907,978	1.0
Manville (B)	4,250	$1,541,350,917	496	11.7	$176,523,214	11.5	909	21.4	$347,538,013	22.5
Millstone (B)	221	$97,566,768	21	9.5	$8,856,725	9.1	32	14.5	$15,848,699	16.2
Montgomery (T)	6,899	$7,071,744,718	71	1.0	$57,173,469	0.8	129	1.9	$96,254,428	1.4
North Plainfield (B)	5,781	$2,712,590,195	655	11.3	$260,272,368	9.6	801	13.9	$315,011,332	11.6
Peapack Gladstone (B)	1,118	$901,123,154	46	4.1	$27,183,297	3.0	77	6.9	$46,418,193	5.2
Raritan (B)	2,418	$1,768,165,532	11	0.5	$15,512,846	0.9	36	1.5	$58,865,839	3.3
Rocky Hill (B)	352	$236,740,606	3	0.9	$1,633,151	0.7	9	2.6	$11,275,426	4.8
Somerville (B)	3,799	$2,320,601,721	46	1.2	$62,346,924	2.7	98	2.6	$134,606,605	5.8
South Bound Brook (B)	1,420	$532,228,106	41	2.9	$57,038,534	10.7	85	6.0	$100,612,122	18.9
Warren (T)	5,999	$5,277,875,043	72	1.2	$43,887,611	0.8	113	1.9	$65,933,594	1.2
Watchung (B)	2,206	$2,056,888,261	43	1.9	$35,623,622	1.7	58	2.6	$43,194,486	2.1
Somerset County (Total)	**99,953**	**$83,463,372,709**	**3,046**	**3.0**	**$1,839,554,941**	**2.2**	**4,538**	**4.5**	**$2,860,754,673**	**3.4**

Source: Somerset County, 2012; FEMA DFIRM, 2007; Tetra Tech, 2013
Notes: % = Percent; RCV = Replacement cost value (structure and contents)

Table 5.4.3-11. Estimated General Building Stock Potential Loss to the 1-Percent and 0.2-Percent Annual Chance Flood Events

Municipality	Total Number of Buildings	Total RCV	1% Annual Chance Flood Boundary				0.2% Annual Chance Flood Boundary			
			Number of Buildings	% of Total	RCV	% of Total	Number of Buildings	% of Total	RCV	% of Total
Bedminster (T)	2,531	$2,806,782,802	41	1.6	$1,388,425	0.0	87	3.4	$11,402,395	0.4
Bernards (T)	7,576	$7,022,125,235	71	0.9	$512,928	0.0	99	1.3	$1,956,805	0.0
Bernardsville (B)	3,282	$2,478,180,688	64	2.0	$1,727,011	0.1	72	2.2	$5,238,571	0.2
Bound Brook (B)	3,011	$1,594,581,503	753	25.0	$129,205,678	8.1	871	28.9	$203,860,476	12.8
Branchburg (T)	5,369	$5,675,235,512	78	1.5	$6,683,492	0.1	124	2.3	$30,739,371	0.5
Bridgewater (T)	14,316	$11,777,778,734	187	1.3	$50,838,083	0.4	385	2.7	$120,050,997	1.0
Far Hills (B)	536	$516,657,295	24	4.5	$1,650,771	0.3	40	7.5	$3,173,368	0.6
Franklin (T)	15,592	$15,364,220,511	81	0.5	$1,652,865	0.0	180	1.2	$36,062,891	0.2
Green Brook (T)	2,465	$1,799,102,751	158	6.4	$1,782,812	0.1	161	6.5	$3,599,873	0.2
Hillsborough (T)	10,812	$9,911,832,655	89	0.8	$4,732,786	0.0	171	1.6	$11,731,677	0.1
Manville (B)	4,250	$1,541,350,917	497	11.7	$30,944,722	2.0	908	21.4	$64,125,651	4.2
Millstone (B)	221	$97,566,768	21	9.5	$1,393,615	1.4	32	14.5	$3,641,540	3.7
Montgomery (T)	6,899	$7,071,744,718	70	1.0	$2,072,430	0.0	128	1.9	$5,909,506	0.1
North Plainfield (B)	5,781	$2,712,590,195	653	11.3	$102,751,797	3.8	794	13.7	$141,264,995	5.2
Peapack Gladstone (B)	1,118	$901,123,154	45	4.0	$2,496,063	0.3	77	6.9	$6,433,480	0.7
Raritan (B)	2,418	$1,768,165,532	12	0.5	$4,295,399	0.2	36	1.5	$8,955,445	0.5
Rocky Hill (B)	352	$236,740,606	4	1.1	$255,254	0.1	13	3.7	$767,310	0.3
Somerville (B)	3,799	$2,320,601,721	48	1.3	$12,056,254	0.5	98	2.6	$27,625,056	1.2
South Bound Brook (B)	1,420	$532,228,106	39	2.7	$3,074,807	0.6	85	6.0	$11,983,601	2.3
Warren (T)	5,999	$5,277,875,043	72	1.2	$4,417,815	0.1	116	1.9	$12,643,177	0.2
Watchung (B)	2,206	$2,056,888,261	42	1.9	$16,746,529	0.8	56	2.5	$20,246,138	1.0
Somerset County (Total)	**99,953**	**$83,463,372,709**	**3,049**	**3.1**	**$380,679,536**	**0.5**	**4,533**	**4.5**	**$731,412,324**	**0.9**

Source: FEMA, 2007; Somerset County, 2012; Tetra Tech, 2013
Notes: % = Percent; RCV = Replacement cost value
A zero percentage denotes less than 1/100th percentage and not zero damages or vulnerability as may be the case.

In addition to total building stock modeling, individual data available on flood policies, claims, Repetitive Loss Properties (RLP) and severe RLP (SRLs) were analyzed. FEMA Region 2 provided a list of residential properties with NFIP policies, past claims and multiple claims (RLPs). According to the metadata provided: "The (*sic* National Flood Insurance Program) NFIP Repetitive Loss File contains losses reported from individuals who have flood insurance through the Federal Government. A property is considered a repetitive loss property when there are two or more losses reported which were paid more than $1,000 for each loss. The two losses must be within 10 years of each other & be as least 10 days apart. Only losses from (*sic* since) 1/1/1978 that are closed are considered."

SRLs were then examined for the County. According to section 1361A of the National Flood Insurance Act, as amended (NFIA), 42 U.S.C. 4102a, an SRL property is defined as a residential property that is covered under an NFIP flood insurance policy and:

- Has at least four NFIP claim payments (including building and contents) over $5,000 each, and the cumulative amount of such claims payments exceeds $20,000; or
- For which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building.
- For both of the above, at least two of the referenced claims must have occurred within any 10-year period, and must be greater than 10 days apart.

Table 5.4.3-12 and Table 5.4.3-13 summarize the NFIP policies, claims and repetitive loss statistics for Somerset County. According to FEMA, Table 5.4.3-12 summarizes the occupancy classes of the repetitive loss and severe repetitive loss properties in Somerset County. The majority of the repetitive loss occupancy class is single family residences (57.5%). The majority of severe repetitive loss occupancy class is also single family residences (53.8%) (FEMA Region 2, 2013). This information is current as of February 28, 2013.

Table 5.4.3-12. Occupancy Class of Repetitive Loss Structures in Somerset County

Occupancy Class	Repetitive Loss Properties	Severe Repetitive Loss Properties	Total
2-4 Family	145	44	189
Condominium	13	18	31
Non-Residential	91	33	124
Other Residential	13	2	15
Single Family	354	113	467
Grand Total	616	210	826

Source: FEMA Region 2, 2013

(1) Policies, claims, repetitive loss and severe repetitive loss statistics provided by FEMA Region 2, and are current as of February 28, 2013.

The location of the properties with policies, claims and repetitive and severe repetitive flooding were geocoded by FEMA with the understanding that there are varying tolerances between how closely the longitude and latitude coordinates correspond to the location of the property address, or that the indication of some locations are more accurate than others.

Figure 5.4.3-6 indicates the repetitive loss areas within the County. Information regarding the locations of the NFIP policies and claims is cataloged at the County.

Table 5.4.3-13. NFIP Policies, Claims and Repetitive Loss Statistics

Municipality	# Policies (1)	# Claims (Losses) (1)	Total Loss Payments (2)	# Rep. Loss Prop. (1)	Severe Rep. Loss Prop. (1)	# Policies in the 1% Flood Boundary (3)	# Policies in the 0.2% Flood Boundary (3)	# Policies Outside the Combined 1% and 0.2% Flood Boundaries Hazard Areas (3)
Bedminster (T)	56	22	$363,790	1	0	19	2	35
Bernards (T)	118	42	$781,760	5	0	39	6	73
Bernardsville (B)	55	11	$41,932	0	0	19	2	34
Bound Brook (B)	620	1,770	$62,878,867	301	94	568	25	27
Branchburg (T)	73	147	$5,932,989	6	5	29	6	38
Bridgewater (T)	240	156	$3,453,657	5	2	82	18	140
Far Hills (B)	18	8	$110,326	1	0	7	0	11
Franklin (T)	235	102	$3,391,278	6	1	24	15	196
Green Brook (T)	120	179	$3,410,949	23	6	89	0	31
Hillsborough (T)	173	132	$6,372,147	13	6	48	20	105
Manville (B)	594	1,387	$48,755,251	191	76	338	120	136
Millstone (B)	15	73	$3,211,551	8	4	11	1	3
Montgomery (T)	151	74	$2,025,356	3	1	21	3	127
North Plainfield (B)	430	301	$2,727,336	28	4	343	21	66
Peapack Gladstone (B)	24	6	$166,328	1	0	5	0	19
Raritan (B)	15	12	$3,000,794	0	1	4	1	10
Rocky Hill (B)	15	10	$381,346	2	0	6	3	6
Somerville (B)	80	142	$8,801,761	13	4	22	15	43
South Bound Brook (B)	57	58	$2,084,893	6	6	13	7	37
Warren (T)	91	30	$276,211	2	0	32	3	56
Watchung (B)	49	16	$214,479	1	0	13	0	36
Somerset County (Total)	**3,229**	**4,678**	**$158,383,001**	**616**	**210**	**1,732**	**268**	**1,229**

Source: FEMA Region 2, 2013

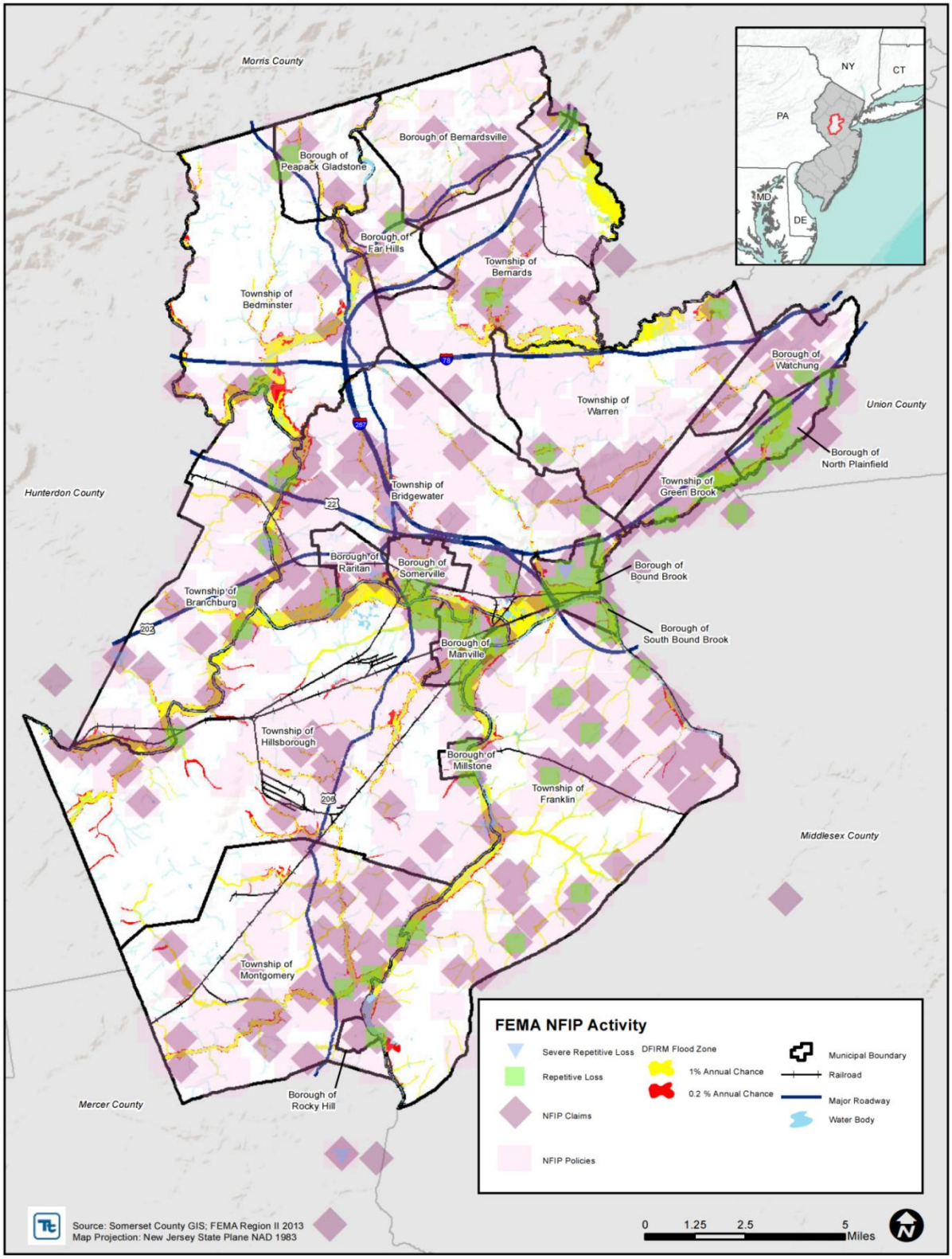
(1) Policies, claims, repetitive loss and severe repetitive loss statistics provided by FEMA Region 2, and are current as of February 28, 2013. Please note the total number of repetitive loss properties excludes the severe repetitive loss properties. The number of claims represents claims closed by 2/28/2013.

(2) Total building and content losses from the claims file provided by FEMA Region 2.

(3) The policies inside and outside of the flood zones is based on the latitude and longitude provided by FEMA Region 2 in the policy file.

Notes: FEMA noted that where there is more than one entry for a property, there may be more than one policy in force or more than one GIS possibility. A zero percentage denotes less than 1/100th percentage and not zero damages or vulnerability as may be the case.

Figure 5.4.3-6. NFIP Repetitive Loss Areas



Source: Somerset County GIS; FEMA Region 2, 2013

Impact on Critical Facilities

In addition to considering general building stock at risk, the risk of flood to critical facilities, utilities and user-defined facilities was evaluated. HAZUS-MH was used to estimate the flood loss potential to critical facilities exposed to the flood risk. Using depth/damage function curves, HAZUS estimates the percent of damage to the building and contents of critical facilities. Table 5.4.3-14 lists the critical facilities and utilities located in the FEMA flood zones and the percent damage HAZUS-MH 2.1 estimates to the facility as a result of the 1- and 0.2-percent annual chance events.

In cases where short-term functionality is impacted by a hazard, other facilities of neighboring municipalities may need to increase support response functions during a disaster event. Mitigation planning should consider means to reduce impact to critical facilities and ensure sufficient emergency and school services remain when a significant event occurs. Actions addressing shared services agreements are included in Section 9 (Mitigation Strategies) of this plan.

Table 5.4.3-14. Critical Facilities Located in the 1-Percent and 0.2-Percent Annual Chance Flood Boundaries and Estimated Potential Damage

Name	Municipality	Type	Exposure		Potential Loss from 1% Flood Event			Potential Loss from 0.2% Flood Event		
			1% Event	0.2% Event	Percent Structure Damage	Percent Content Damage	Days to 100-Percent[2]	Percent Structure Damage	Percent Content Damage	Days to 100-Percent[2]
Bedminster-Far Hills First Aid Squad	Bedminster (T)	Fire	x	x	-	-	-	-	-	-
Bedminster-Far Hills Fire Dept	Bedminster (T)	Fire		x	-	-	-	-	-	-
DPW	Bedminster (T)	DPW		x	-	-	-	-	-	-
Lord Sterling Schools, Inc.	Bernards (T)	School	x	x	9.0	62.4	480.0	10.4	68.7	630
Liberty Corner First Aid Squad	Bernards (T)	Fire	x	x	-	-	-	-	-	-
Madisonville PS	Bernards (T)	WW	x	x	-	-	-	-	-	-
Harrison Brook STP	Bernards (T)	WW	x	x	-	-	-	-	-	-
Fellowship Village	Bernards (T)	Senior	x	x	-	-	-	-	-	-
Well 1	Bernardsville (B)	Potable Water	x	x	-	-	-	0.5	NA	NP
Holy Family Academy	Bound Brook (B)	School		x	-	-	-	7.0	38.1	480
Lamonte School Annex	Bound Brook (B)	School		x	-	-	-	9.4	65.7	630
Lamonte School	Bound Brook (B)	School	x	x	-	-	-	7.5	41.8	480
Green Brook Academy	Bound Brook (B)	School	x	x	9.9	67.4	630.0	17.5	79.6	720
Green Brook Academy	Bound Brook (B)	School	x	x	6.3	34.2	480.0	12.5	71.5	630
Green Brook Academy	Bound Brook (B)	School	x	x	11.4	70.4	630.0	19.7	82.7	720
Bound Brook Hose Co No 1	Bound Brook (B)	Fire	x	x	26.2	99.6	720.0	36.3	100	720
Bound Brook Relief Company No 4	Bound Brook (B)	Fire	x	x	19.3	87.0	630.0	34.1	100	720
Bound Brook Rescue Squad	Bound Brook (B)	Fire	x	x	19.1	86.6	630.0	36.5	100	720
Talmadge Commons Sr. Residence	Bound Brook (B)	Senior	x	x	15.0	87.2	NP	19.7	100	NP
Pump Station	Branchburg (T)	WW	x	x	-	-	-	-	-	-
Neshanic Station WTP	Branchburg (T)	WW	x	x	-	-	-	-	-	-
Milltown School	Bridgewater (T)	School		x	-	-	-	9.0	59.1	480
Somerset Secondary Academy	Bridgewater (T)	School	x	x	-	-	-	7.6	42.7	480
Somerset Alternative Academic High	Bridgewater (T)	School	x	x	-	-	-	7.6	42.7	480
NJ American Water Company	Bridgewater (T)	Potable Water	x	x	13.9	NA	NP	40.0	NA	NP
Well C-1	Bridgewater (T)	Potable Water	x	x	-	-	-	40.0	NA	NP

Name	Municipality	Type	Exposure		Potential Loss from 1% Flood Event			Potential Loss from 0.2% Flood Event		
			1% Event	0.2% Event	Percent Structure Damage	Percent Content Damage	Days to 100-Percent[2]	Percent Structure Damage	Percent Content Damage	Days to 100-Percent[2]
Well C-2	Bridgewater (T)	Potable Water	x	x	-	-	-	40.0	NA	NP
Kirkside at North Branch	Bridgewater (T)	Senior		x	-	-	-	-	-	-
Chelsea at Bridgewater	Bridgewater (T)	Senior		x	-	-	-	20.4	100	NP
Park Commission	Bridgewater (T)	County	x	x	-	-	-	2.8	16.9	NP
Commerce Ball Park	Bridgewater (T)	County		x	-	-	-	15.9	100	NP
Bound Brook Pump House	Bridgewater (T)	County	x	x	13.7	80.1	NP	33.1	100	NP
Far Hills Borough Hall	Far Hills (B)	Town Hall		x	-	-	-	-	-	-
Zarephath Christian School	Franklin (T)	School		x	-	-	-	15.4	75.8	720
Somerset Christian College	Franklin (T)	School		x	-	-	-	14.6	74.4	630
East Millstone First Aid Squad	Franklin (T)	Fire	x	x	7.0	8.2	480.0	12.4	57.0	630
North Brunswick Water Plant	Franklin (T)	Potable Water		x	-	-	-	11.6	NA	NP
Willow Creek Rehab and Care Center	Franklin (T)	Senior	x	x	-	-	-	7.3	40.0	NP
Guild Housing	Franklin (T)	Bus Facility	x	x	-	-	-	24.7	24.5	NP
Greenbrook Middle School	Green Brook (T)	School	x	x	-	-	-	-	-	-
Green Brook Twp PD	Green Brook (T)	Police	x	x	-	-	-	-	-	-
Green Brook Township Vol Fire Co 1	Green Brook (T)	Fire	x	x	-	-	-	-	-	-
Green Brook Well 5	Green Brook (T)	Potable Water	x	x	-	-	-	-	-	-
Green Brook Well 6	Green Brook (T)	Potable Water	x	x	-	-	-	-	-	-
Green Brook Well 7	Green Brook (T)	Potable Water	x	x	-	-	-	-	-	-
Green Brook Well 8	Green Brook (T)	Potable Water	x	x	-	-	-	-	-	-
Green Brook Well 9	Green Brook (T)	Potable Water	x	x	-	-	-	-	-	-
Green Brook Well 11	Green Brook (T)	Potable Water	x	x	-	-	-	-	-	-
Green Brook Well 1	Green Brook (T)	Potable Water	x	x	-	-	-	-	-	-
Green Brook Well 2	Green Brook (T)	Potable Water	x	x	-	-	-	-	-	-
Green Brook Well 3	Green Brook (T)	Potable Water	x	x	-	-	-	-	-	-
Green Brook Well 4	Green Brook (T)	Potable Water	x	x	-	-	-	-	-	-
Green Brook Manor Nursing Home	Green Brook (T)	Senior		x	-	-	-	-	-	-

Name	Municipality	Type	Exposure		Potential Loss from 1% Flood Event			Potential Loss from 0.2% Flood Event		
			1% Event	0.2% Event	Percent Structure Damage	Percent Content Damage	Days to 100-Percent[(2)]	Percent Structure Damage	Percent Content Damage	Days to 100-Percent[(2)]
Green Brook Town Hall	Green Brook (T)	Town Hall	x	x	-	-	-	-	-	-
Pump Station	Hillsborough (T)	WW	x	x	-	-	-	-	-	-
Pump Station	Hillsborough (T)	WW	x	x	-	-	-	-	-	-
Riverview/Laidlaw	Hillsborough (T)	Bus Facility		x	-	-	-	30.0	33.4	NP
Manville Rescue Squad	Manville (B)	Fire		x	-	-	-	11.7	49.0	480
Fire Company No. 1	Manville (B)	Fire		x	-	-	-	11.5	46.3	480
Emmanuel Baptist Church	Manville (B)	Shelter		x	-	-	-	11.0	76.9	NP
Manville Senior Center	Manville (B)	Shelter		x	-	-	-	12.0	66.4	NP
Manville American Legion	Manville (B)	Shelter	x	x	6.5	27.1	NP	14.1	44.1	NP
Manville Borough Hall	Manville (B)	Town Hall		x	-	-	-	-	-	-
Manville Pump House	Manville (B)	County	x	x	15.0	100.0	NP	23.1	100	NP
DPW	Manville (B)	DPW	x	x	23.6	22.6	NP	46.0	58.2	NP
Montgomery Well 1	Montgomery (T)	Potable Water	x	x	-	-	-	-	-	-
3M Well Number 4	Montgomery (T)	Potable Water		x	-	-	-	-	-	-
Stage II WWTP	Montgomery (T)	WW	x	x	-	-	-	-	-	-
Seminole Road	Montgomery (T)	WW	x	x	-	-	-	-	-	-
Stage II WWTP	Montgomery (T)	WW	x	x	-	-	-	-	-	-
Stony Brook School/Harrison School	North Plainfield (B)	School	x	x	12.5	71.5	630.0	16.2	77.3	720
DPW	North Plainfield (B)	DPW	x	x	31.0	35.0	NP	41.8	54.2	NP
DPW	North Plainfield (B)	DPW	x	x	31.0	35.0	NP	41.8	54.2	NP
Peapack Gladstone PS	Peapack Gladstone (B)	Potable Water	x	x	-	-	-	-	-	-
Pump Station	Peapack Gladstone (B)	WW	x	x	-	-	-	-	-	-
DPW	Peapack Gladstone (B)	DPW		x	-	-	-	-	-	-
DPW	Peapack Gladstone (B)	DPW	x	x	-	-	-	27.4	29.0	NP
DPW	Raritan (B)	DPW	x	x	23.6	22.6	NP	41.5	53.7	NP
S Bound Brook Disaster Control	S. Bound Brook (B)	EOC	x	x	-	-	-	7.6	10.3	480
S. Bound Brook Boro PD	S. Bound Brook (B)	Police	x	x	-	-	-	-	-	-

Name	Municipality	Type	Exposure		Potential Loss from 1% Flood Event			Potential Loss from 0.2% Flood Event		
			1% Event	0.2% Event	Percent Structure Damage	Percent Content Damage	Days to 100-Percent(2)	Percent Structure Damage	Percent Content Damage	Days to 100-Percent(2)
DPW	S. Bound Brook (B)	DPW	x	x	39.4	50.7	NP	47.7	60.6	NP
South Bound Brook Rescue Squad	S. Bound Brook (B)	Fire	x	x	-	-	-	-	-	-
South Bound Brook Borough Hall	S. Bound Brook (B)	Town Hall	x	x	-	-	-	-	-	-
PSE&G Substation	Somerville (B)	Electric Substation	x	x	-	-	-	-	-	-
ENGINE COMPANY NO. 1	Somerville (B)	Fire	x	x	10.0	20.0	480.0	13.5	62.5	630
Somerville First Aid and Rescue Squad	Somerville (B)	Fire	x	x	10.8	33.5	480.0	15.9	75.0	630
DPW	Somerville (B)	DPW	x	x	37.1	47.1	NP	48.9	63.4	NP
Pump Station	Warren (T)	WW	x	x	-	-	-	-	-	-
Pump Station	Warren (T)	WW	x	x	-	-	-	-	-	-
Warren Stage 1 & 2 WTP	Warren (T)	WW	x	x	-	-	-	-	-	-
Warren Stage 4 WTP	Warren (T)	WW	x	x	-	-	-	-	-	-
Warren Emergency Management	Watchung (B)	EOC	x	x	51.2	100.0	900.0	61.6	100	900

Source: HAZUS-MH 2.1
Note: B = Borough; NA = Not applicable; NP = Not provided by HAZUS; T = Town.
x = Facility located within the DFIRM boundary.
- = No results generated in HAZUS.

Please note it is assumed the wells have electrical equipment and openings are three-feet above grade.

(1) HAZUS-MH 2.1 provides a general indication of the maximum restoration time for 100% operations. Clearly, a great deal of effort is needed to quickly restore essential facilities to full functionality; therefore this will be an indication of the maximum downtime (HAZUS-MH 2.1 User Manual).

(2) In some cases, a facility may be located in the DFIRM flood hazard boundary; however HAZUS did not calculate potential loss. This may be because the depth of flooding does not amount to any damages to the structure according to the depth damage function used in HAZUS for that facility type.

Impact on the Economy

For impact on economy, estimated losses from a flood event are considered. Losses include but are not limited to general building stock damages, agricultural losses, business interruption, impacts to tourism and tax base to Somerset County. Damages to general building stock can be quantified using HAZUS-MH as discussed above. Other economic components such as loss of facility use, functional downtime and social economic factors are less measurable with a high degree of certainty. For the purposes of this analysis, general building stock damages are discussed further.

Flooding can cause extensive damage to public utilities and disruptions to the delivery of services. Loss of power and communications may occur; and drinking water and wastewater treatment facilities may be temporarily out of operation. Flooded streets and road blocks make it difficult for emergency vehicles to respond to calls for service. Floodwaters can wash out sections of roadway and bridges (Foster, Date Unknown).

Direct building losses are the estimated costs to repair or replace the damage caused to the building. The potential damage estimated to the general building stock inventory associated with the 1-percent flood is approximately $380 million which represents less than one-percent of the County's overall total general building stock inventory. The potential damage estimated to the general building stock inventory associated with the 0.2-percent flood is approximately $731 million, or nearly one-percent of the County's total building inventory. These dollar value losses to the County's total building inventory replacement value, in addition to damages to roadways and infrastructure, would greatly impact the local economy.

HAZUS-MH estimates the amount of debris generated from the flood events as a result of 1- and 0.2-percent events. The model breaks down debris into three categories: 1) finishes (dry wall, insulation, etc.); 2) structural (wood, brick, etc.) and 3) foundations (concrete slab and block, rebar, etc.). The distinction is made because of the different types of equipment needed to handle the debris. Table 5.4.3-15 summarizes the debris HAZUS-MH 2.1 estimates for these events.

Table 5.4.3-15. Estimated Debris Generated from the 1-Percent and 0.2-Percent Flood Events

Municipality	1% Flood Event				0.2% Flood Event			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Bedminster (T)	1,116	824	174	118	5,433	1,705	2,270	1,458
Bernards (T)	843	716	76	52	1,649	1,403	145	100
Bernardsville (B)	399	252	84	63	685	399	164	122
Bound Brook (B)	14,465	7,861	3,894	2,710	34,311	12,325	13,175	8,812
Branchburg (T)	2,188	996	729	464	5,997	1,456	2,724	1,817
Bridgewater (T)	8,260	2,810	3,226	2,224	18,709	4,761	8,216	5,732
Far Hills (B)	285	185	57	43	550	340	121	89
Franklin (T)	6,321	2,238	2,337	1,746	11,061	3,888	4,133	3,039
Green Brook (T)	286	181	62	44	482	273	121	88
Hillsborough (T)	7,791	3,122	2,709	1,960	13,461	4,384	5,229	3,848
Manville (B)	15,644	3,542	7,500	4,603	20,193	5,708	8,926	5,559
Millstone (B)	2,009	476	875	658	2,559	598	1,114	846
Montgomery (T)	4,081	1,948	1,298	835	8,676	2,901	3,519	2,256

Municipality	1% Flood Event				0.2% Flood Event			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
North Plainfield (B)	29,765	5,382	14,626	9,756	38,670	8,913	17,756	12,001
Peapack Gladstone (B)	302	296	4	2	1,330	802	311	217
Raritan (B)	509	286	140	83	1,843	618	753	472
Rocky Hill (B)	1,110	300	481	330	1,541	393	645	503
Somerville (B)	4,967	1,624	2,037	1,306	9,966	2,615	4,459	2,893
South Bound Brook (B)	305	292	8	5	666	589	48	30
Warren (T)	1,427	951	275	201	3,002	1,607	832	563
Watchung (B)	4,421	1,051	2,016	1,354	7,171	1,460	3,447	2,263
Somerset County (Total)	**106,497**	**35,333**	**42,606**	**28,558**	**187,955**	**57,140**	**78,108**	**52,707**

Source: HAZUS-MH 2.1

Effect of Climate Change on Vulnerability

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

Change of Vulnerability

Somerset County and its municipalities continue to be vulnerable to the flood hazard. However, there are several differences between the exposure and potential loss estimates between this plan update to the results in the original 2008 HMP. Their differences are due to the new and updated population and building inventories used, and more accurate flood depth grids used to estimate potential losses in HAZUS-MH.

Differences in exposure and potential losses estimated from the 2008 HMP can be attributed to the difference in building stock inventory and methodology used for the risk assessment. For example, the 2008 HMP building inventory used was the default HAZUS-MH general building stock with replacement values based on 2006 RSMeans. The potential loss analysis was conducted at the aggregate level (Census block), whereas for this plan update, the analysis was conducted at the structure level. This building inventory used for this plan was based on the 2007 building footprints and 2012 parcel spatial files provided by the County. Replacement cost values were estimated 2012 RSMeans values.

For this plan update, the two-foot County-wide contours were used to generate a Digital Elevation Model (DEM). This DEM is higher in resolution compared to the DEM generated for the original 2008 HMP using the NJDEP 10-meter digital elevation grids by watershed area and the August 2004 topographic data available for Bernards Township. This higher resolution terrain, in addition to the DFIRM BFEs and 0.2-percent water surface elevations from the FIS, were then used to generate the flood depth grids used in this plans analysis. The depth grids were integrated into the most current version of HAZUS-MH (2.1) and the model was run to estimate potential losses at the structure level utilizing the custom building inventory developed for this plan update. The Flood Wizard tool, used in the original HMP was not used for this analysis.

The countywide 2008 HMP 1-percent flood event building potential loss estimate (all occupancies, structure and contents) was $858 million. As noted, this estimate was generated by a Census block-level analysis. This HMP update estimates potential losses using individual structures and is reported as such in Table 5.4.3-15. However, to compare apples to apples using the same aggregate methodology (noting difference building inventories), when the1-percent potential losses are generated at the Census-block level using the updated building inventory, the loss estimate is $ 1.5 billion.

Overall, this vulnerability assessment using a structure-level approach provides more accurate estimated exposure and potential losses for Somerset County.

Future Growth and Development

As discussed in Section 4, areas targeted for future growth and development have been identified across the County. Any areas of growth could be potentially impacted by the flood hazard if located within the identified hazard areas. Figure 5.4.3-**7** illustrates the identified areas of potential new development in relation to the flood boundaries. It is the intention of the County to discourage development in vulnerable areas or to encourage higher regulatory standards on the local level.

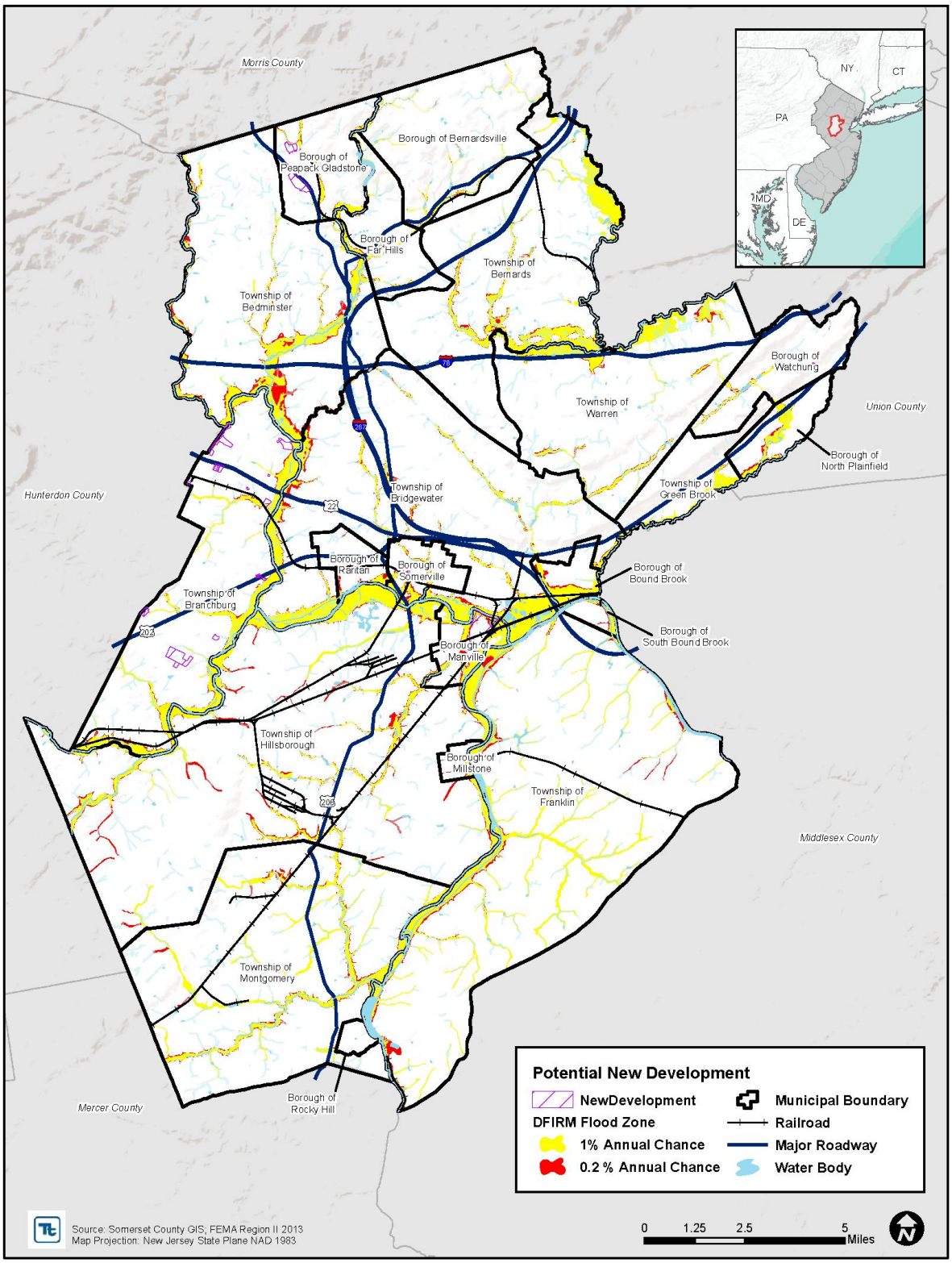
Additional Data and Next Steps

A HAZUS-MH riverine flood analysis was conducted for Somerset County using the most current and best available data including updated building and critical facility inventories, DFIRMs and DEM created using 2-foot contours. For future plan updates, more accurate exposure and loss estimates can be produced by replacing the national default demographic inventory with 2010 U.S. Census data when it becomes available in the HAZUS-MH model. To enhance the custom building inventory, when available, the updated building footprint spatial files based on new imagery and linked to the Assessor data can be used.

FEMA's Risk Mapping, Assessment, and Planning (Risk MAP) program provides the flood depth and analysis grids as part of the publicly available DFIRM deliverable. When these depth grids are available for Somerset County, they can be incorporated into HAZUS and used to recalculate the potential losses to the County's inventory for these recurrence intervals.

Specific mitigation actions addressing improved data collection and further vulnerability analysis is included in Volume II, Section 9 of this plan.

Figure 5.4.3-7. Potential New Development and Flood Boundaries



Source: Somerset GIS; FEMA, 2007